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The EUROPEAN JOURNAL *of* MANAGEMENT *and* PUBLIC POLICY

CONTENTS

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Testing the Relation Between Beta and Returns in the Athens Stock Exchange: a Second Attempt

Abstract

The main objective of the current study is the examination of the relationship between beta and returns in the Athens Stock Exchange, taking into account the difference between positive and negative market excess returns' yields. We investigate the period between 1991 and 2002 focusing on the risk-return trade-off by examining separately the up-market and down-market months. We try to verify whether *beta* is an important measure of risk and if there is an inverse relationship between *beta* and *returns* when the return on the market is negative. We also investigate if there is any symmetry between *up* and *down market returns* in the ASE. The estimation of *return* and *beta* without differentiating positive and negative market excess returns produces *a flat unconditional relationship* between *return* and *beta*. Using the *conditional* CAPM and *cross-sectional regression analysis*, the evidence in this paper *tends to support the significant positive relationship in up market and a significant negative relationship in down market*. This is a second attempt in testing the relationship between beta and returns in the ASE, using single stocks instead of forming portfolios (first attempt). Although the new results are similar to those of the previous study they are definitely sounder, improved, and statistically significant. Finally, we get better results, also, when we use portfolios and the MLE method for the estimation of beta coefficients of each stock. (JEL G12).

Key words: CAPM, unconditional – conditional relationship, risk-return trade-off.

1. Introduction

The risk-return relationship is one of the fundamental concepts in finance that is of great importance for investors and portfolio managers, who have as one of their main tasks the estimation of investment risk. The popular Capital Asset Pricing Model, CAPM (Black, 1972; Lintner, 1965; Sharpe, 1964) argues that beta, or the systematic risk is the only relevant risk measure for investment and a positive trade-off between beta and expected returns should exist. Because of its importance and relevance to all investors, it is one of the most extensively tested financial models in the literature. The CAPM postulates that the return on any asset is linearly related to its market beta, with beta being defined as the ratio of the covariance of each asset with the market portfolio to the variance of the market portfolio. In other words, during cross-sectional tests on the returns of assets only the market beta (β) shall be priced.

The empirical evidence to date on the CAPM has been mixed. While the results of many studies, particularly those of the earlier classical work of Black, Jensen and Scholes (1972) and Fama and MacBeth (1973), support the CAPM, some researchers, such as Fama and French (1992), report an inconsistent or a flat relationship between returns and beta. The findings for non-US studies are also inconclusive. For example, studies for France (Hawawini, Michel and Viallet, 1983) and Japan (Hawawini 1991; Chan, Hamao and Lakonishok, 1991) point to a positive relationship between returns and beta, but the empirical findings in Canada (Calvet and Lefoll, 1989), Belgium (Hawawini, Michel and Corhay, 1989), Finland and Sweden (Ostermark, 1991), the United Kingdom (Corhay, Hawawini and Michel, 1987; Chan and Chui, 1996), Singapore (Wong and Tan, 1991), Hong Kong (Cheung and Wong, 1992; Ho, Strange and Piesse, 2000a; 2000b), and Korea and Taiwan (Cheung, Wong and Ho, 1993) suggest either no relationship or an inconsistent relationship between returns and market risk.

Although initial empirical studies supported the CAPM (Fama and MacBeth, 1973; Black, Jensen and Scholes, 1972), new empirical variables were found, e.g., the Market Value of Equity ratio (MVE), the Earnings to Stock Price ratio (E/P) and the Book-to-Market Equity ratio (B/M), that had greater explanatory power than the beta coefficient of the market (Banz, 1981; Basu, 1983; Rosenberg, Reid and Lanstein, 1985).

Ross's (1976) Arbitrage Pricing Theory (APT) commenced a new family of models which have tried to verify that beta is not the only component that could measure the systematic risk of stock returns and other securities. For example, the macroeconomic APT model showed that there are many different variables that have an effect on stock returns (Chen, Roll and Ross, 1986; Chen and Jordan, 1993).

The CAPM studies attempted to test for an unconditional, systematic and positive trade-off between average returns and beta, but failed to take into account the fact that the relationship between realised returns and beta is conditional on the relationship between the realised market returns and the risk-free rate. Pettengill, Sundaram and Mathur (1995) developed a conditional relationship between beta and realised returns by separating periods of positive and negative market excess returns. Using US stock market data in the period 1936 through 1990, they found a significant positive relationship between beta and realised returns when market excess returns are positive and a significant negative relationship between beta and realised returns when market excess returns are negative. This significant relationship is also found when data are divided by months in a year. Furthermore, they found support for a positive risk–return relationship. Isakov (1999) followed the approach of Pettengill, Sundaram and Mathur (1995) and examined the Swiss stock market for the period 1983–1991. He found supporting results that beta is statistically significant related to realised returns and has the expected sign. Hence, Isakov (1999) concluded that beta is a good measure of risk and is still alive.

The aim of the current study is to determine whether beta has a role to play in explaining cross-sectional differences in the returns of the General Greek Index. The main purpose of this paper is to present evidence of the conditional relationship between returns and beta in the Athens Stock Exchange. We try to verify that the coefficient beta is an important measure of systematic risk and also that there is a symmetrical relation between return and beta in up and down markets. We should note here that Pettengill, Sundaram and Mathur (1995) support this notion of symmetry in up and down markets, while Fletcher (1997) had different results in his research in the UK, i.e., the slope equality hypothesis was rejected in comparison to Pettengill, Sundaram and Mathur (1995)

This cross-sectional regression and the subsequent test of the mean of the coefficients estimated in the monthly regressions can be interpreted as a test of two joint hypotheses. The hypothesis that there is a positive relationship between beta and realised return is tested jointly with the hypothesis that the average market risk premium is positive. One important explanation for this result lies in the fact that realisations of the market risk premium are often negative even if the expected, or ex-ante, risk premium is positive. An ex-post formulation of the CAPM predicts that stocks with a higher beta have higher returns only when the market return is higher than the return of the riskless asset. If the market return falls short of the riskless rate, stocks with a higher beta have lower returns. Pettengill, Sundaram and Mathur (1995) call this 'the conditional' (ex-post) relation between beta and return.

They modify the Fama-MacBeth (1973) test procedure in a way that takes the 'conditional' nature of the relation between beta and return into account. Their empirical results support the conclusion that there is a positive and statistically significant relationship between beta and realised returns. The idea underlying the modified test approach of Pettengill, Sundaram and Mathur (1995) rests on the distinction between the ex-ante CAPM and its ex-post representation used for empirical tests. A crucial difference between these formulations is the fact that the expected market risk premium is always positive ex-ante, whereas the realizations of the risk premium may be, and often are, negative.

The purpose of this study is to examine whether the conditional relationship between beta and returns, which has been shown to exist in developed markets like the US (Pettengill, Sundaram and Mathur, 1995), UK (Fletcher, 1997), Belgium (Crombez and Vennet, 1997), Japan (Hodoshima, Garza–Gomez and Kunimura, 2000), Germany (Elsas, El-Shaer and Theissen, 2003), and Switzerland (Isakov, 1999), holds in ASE. The methodology follows an applied research procedure and has a positivist explanatory form as it is focused on causal relationships, i.e., the risk – return relationship between returns and systematic risk.

Next section covers the literature review of the relation between beta and returns. In the subsequent sections the data collection is presented and there

is a detailed analysis on the time series data. In the last section there is a presentation of the conclusions from the data analysis and the corresponding managerial implications on financial institutions are mentioned. Finally, there are proposals for future research on the risk-return trade-off.

2. Literature review

Most of the empirical tests are mainly based on the Fama and MacBeth (1973) methodology using a three-step approach. In the first period, individual stocks' betas are estimated and portfolios are formed according to these estimated betas. In the second period, betas of portfolios that are formed in the first period are estimated. In the final step, using data from a third time period, portfolio returns are regressed on portfolio betas (obtained from the second period) to test the relationship between beta and returns. However, Reinganum (1981) found that the cross-sectional differences in portfolio betas and the differences in average portfolio returns are not reliably related, i.e., the returns on high-beta portfolios are not significantly higher than the returns on low-beta portfolios, casting doubts on the empirical content of CAPM.

Schwert (1983) suggested that Fama and MacBeth (1973) only provided a very weak support for a positive risk–return trade-off since the positive risk–return relationship found is not significant across sub-periods. Furthermore, when considering the seasonal behavior of their results, the *t*-statistic becomes highly suspect and the basic risk–return trade-off virtually disappears. Tinic and West (1984) found that January has a larger risk premium than the other months and further that the significant relationship between risk and expected returns only exists in January. When data for the January months are excluded from the analysis of the risk–return trade-off, the estimates of risk premiums are not significantly different from zero. Thus, they concluded that their results reject the validity of CAPM.

Lakonishok and Shapiro (1986) examined the monthly returns of all stocks traded on the New York Stock Exchange (NYSE) and found that the return on individual security is not specifically related to its degree of systematic risk but to the market capitalisation values. They concluded that the traditional (beta) as well as the alternative risk measure (residual standard error) is not able to explain the cross-sectional variation in return; only size can significantly explain it. Haugen and Baker (1991) examined the risk and return characteristics of 1,000 US stocks that have largest market capitalisation over all US exchanges and markets between 1972 and 1989. They found that the market portfolio is not efficient because low-risk stocks seem to have abnormally high returns, contradicting the relationship between beta and returns as prescribed by CAPM.

Fama and French (1992), using the Sharpe-Lintner-Black CAMP, studied the monthly returns of NYSE stocks and found an insignificant relationship be-

tween beta and average returns. They concluded that the CAPM cannot describe the last 50 years of average stock returns and only market capitalisation and the ratio of book value to market value have significant explanatory power for portfolio returns. This study also produces a controversial finding on the validity of CAPM: first, as the main model in investigating the relationship beta-return; and second, the beta's role in explaining financial asset return. Other studies, related to static CAPM, are reported in Banz (1981), Reinganum (1981), Gibbons (1982), Basu (1983), Chan, Chen and Hsieh (1985), Shanken (1985), Bhandari (1988) and Jagannathan and Wang (1996), who found that the static CAPM is unable to explain the cross-sectional variation of average returns.

Recent studies (e.g., Pettengill, Sundaram and Mathur, 1995, for the US market; and Isakov, 1999, for the Swiss market) suggested an alternative approach to assess the reliability of beta as a measure of risk. Their argument is that since the CAPM deals with the expected returns, while the realised returns are used as proxies, negative realised risk premia could be observed in some periods. Their model is conditional on the realised risk premium, whether it is positive or negative. When the realised risk premium is positive, there should be a positive relationship between the beta and return, and when the premium is negative, the beta and return should be negatively related. The reason is that high beta stocks are more sensitive to the negative realised risk premium and thus will have a lower return than low beta stocks. Their empirical results, based on estimations conditional on the sign of the market excess returns, indicate that betas and returns are positively related in the US capital market. This conditional positive relationship is observed in the UK (Fletcher, 1997), Germany (Elsas, El-Shaer and Theissen, 2003), Belgium (Crombez and Vennet, 1997), and Taiwan (Jagannathan and Wang, 1996) as well.

There are more recent studies asking whether the standard CAPM can be applied to emerging capital markets in order to estimate the cost of equity capital in these markets. Since the individual emerging market has its unique market structure, institutional background, history, level of the market integration, and local risk-free return, the answer may differ across countries. Karacabey (2001) studies the beta-return relationship in the Istanbul Stock Exchange and shows that only the conditional relationship exists. Thus, beta is still a useful risk measure in this emerging market. Estrada (2001) gives evidence that the cross section of returns in emerging markets can be explained by "downside risk" measures as the semideviation of the means. The semi-deviation method uses only negative deviations from a benchmark return such as the mean return of the asset or a specified target mean. Thus, downside risk defines risk as volatility below the benchmark (Nawrocki, 1999; Sortino and van der Meer, 1991). One of the advantages of the downside risk approach is that a desired benchmark return can be chosen, and the investors care about more downside than upside risk. Estrada (2001) points out that for skewed distributions, the semideviation is a more appropriate risk measure.

In summary, previous empirical studies on the unconditional relationship between beta and returns found that the CAPM only provides an inadequate explanatory power for the risk–return relationship observed in both domestic and international stock markets. However, results from empirical studies on the conditional relationship between beta and returns support the model and found a significant conditional relationship in domestic stock markets. A logical question followed is whether the conditional relationship between beta and returns can also be applied to international stock markets. To the best of our knowledge, no study (except one) has investigated this issue.

Fletcher (2000) examined the conditional relationship between beta and returns in international stock markets between January 1970 and July 1998 using the approach of Pettengill, Sundaram and Mathur (1995). Using monthly returns of the MSCI equity indices of 18 countries and the MSCI world index, Fletcher (2000) found that a consistent relation exists. There is a significant positive relationship between beta and returns in periods when the world market excess returns are positive and a significant negative relationship in periods when the world market excess returns are negative. Besides, this relationship is symmetric and there is a positive mean excess return on the index on an average. Fletcher (2000) also found that the significant conditional relationship in January exists only in periods of positive market excess returns and this relationship is insignificant in periods of negative market excess returns. The results differ from those obtained by Pettengill, Sundaram and Mathur (1995) on the US market data. Although Fletcher's (2000) study supported the conditional relationship between beta and returns in international stock markets, the empirical evidence is still limited.

The ASE for a number of years has been characterised as an emerging market and has attracted international interest. During the past 15 years it has entered a period of new structural reforms and development. As a result, the market has become potentially more efficient and competitive. The number of listed companies increased significantly, market liquidity improved, and structural and legislative reforms provided for a modern and adequate regulatory framework. The ASE contains two market segments, the "main" and the "parallel market". The main market primarily includes larger firms with higher equity capital and operating profits. In contrast, stocks traded in the parallel market typically have lower equity capital, a smaller scale of operation, and lower profits.

There has been limited research on the behaviour of stocks traded on the ASE. Papaioannou (1982; 1984) reports price dependencies in stock returns for a period of at least six days. Panas (1990) provides evidence of weak-form efficiency for ten large Greek firms. Koutmos, Negakis and Theodossiou (1993) find that an exponential generalized ARCH model is an adequate representation of volatility in weekly Greek stock returns. Barkoulas and Travlos (1998) test whether Greek stock returns are characterised by deterministic nonlinear structure (chaos). Papaioannou and Philippatos (2000) examined

the impact of non-synchronous trading on the beta estimates of the market model using Greek stock market returns. Niarchos and Georgakopoulos (1986) found that the Greek stock prices respond very slowly to new information and conclude that the Greek market is not efficient.

More recently, Diacogiannis, Glezakos and Segretakis (1998) examined the effect of the Price/Earnings (P/E) ratio and the Dividend Yield (DY) on expected returns of ASE common stocks for the period 1990–1995. They found that P/E is statistically significant variable explaining the cross section variation of expected returns, while the explanatory power of DY was documented rather weak. Karanikas (2000) examined the role of size, book to market ratio and dividend yields on average stock returns in the ASE for the period from January 1991 to March 1997. Following Fama and MacBeth's cross sectional regression methodology enhanced with Shanken's adjustments for the Error in Variables (EIV) problem. He found that a statistically significant positive relationship between book to market ratio, dividend yields and average stock returns is reported. He found also that the market capitalisation variable ("size effect ") does not seem to explain a significant part of the variation in average returns.

Niarchos and Alexakis (2000) investigated whether it is possible to predict stock market returns with the use of macroeconomic variables in the ASE for the period from January 1984 to December 1995 on a monthly base using cointegration analysis and as explanatory variables some macroeconomics factors. With the results of their investigations, they reject statistically the Efficient Market Hypothesis for the case of the Athens Stock Exchange; they noted the statistical significance of the lagged returns which suggest that the monthly returns in the ASE are positively correlated. The above findings can not be explained as a thin trading effect or as non synchronous trading effect because of the monthly time interval used in the investigation.

In summary, emerging markets have proved extremely attractive over the last ten years to international investors hoping to benefit from abnormal returns as well as portfolio risk diversification (Harvey, 1995), and therefore the extent to which cross-sectional return behaviour matches that of more developed markets is of particular interest. However, studies of such markets present a number of problems, ranging from the availability of suitable data on the one hand to methodological problems on the other. The few studies that have been conducted on this market have focused on the dynamic behaviour of Greek stock prices, the market's informational efficiency, or the reaction to announcements (e.g., Koutmos, Theodossiou and Negakis, 1993; Karathanassis and Patsos, 1993; Tsangarakis, 1996; Barkoulas and Travlos, 1998; Phylaktis, Kavussanos and Manalis, 1999; Barkoulas, Baum and Travlos, 2000; Papaioannou, Travlos and Tsangarakis, 2000; and Leledakis, Davidson and Karathanasis, 2003).

3. DATA AND METHODOLOGY

Our data is daily closing prices of the common stocks traded in the Athens Stock Exchange. They are row prices in the sense that they do not include dividends but are adjusted for capital splits. The data was taken from the ASE database. The market return is obtained from the ASE Composite (General) Share Price Index. Time series of excess returns on the market and individual securities are taken over the three-month Government Treasury Bill rate, which is considered to be the short-term interest rate (risk free interest rate).

Daily returns are calculated using the logarithmic approximation:

$$R_{i,t} = \log\left(P_{i,t} \middle/ P_{i,t-1} \right) \tag{1}$$

where $P_{i,t}$ is the closing price of day t for asset i. Then daily returns are aggregated to compose the monthly returns that are the input of our investigation.

The sample period for our study extends from January 1991 to December 2002. The 12 years of our sample period are divided into four 6-year periods such that the test periods do not overlap (table 1).

TABLE 1. – **Separation of the sample period**

Estimation period (beta calculation)	Test period
1/1991 – 12/1994	1/1995 – 12/1996
1/1993 – 12/1996	1/1997 – 12/1998
1/1995 – 12/1998	1/1999 – 12/2000
1/1997 – 12/2000	1/2001 – 12/2002

Each 6-year period is then subdivided into a 4-year beta calculation period, and a 2-year test period. Securities are included in a 6-year period sample if, in the estimation period, have been traded at least for the last 24 months (no missing values and no suspensions) and in the test period have a complete relative price history. We use all listed companies, manufacturing and non-manufacturing, excluding only the financial firms because they have capital structures which differ from all other firms in the sample and thus would show drastically different return behaviour (Fama and French, 1992).

In the **estimation period** we regress the monthly returns of the individual stocks (dependent variable) on the market (independent variable) using the Maximum Likelihood Estimation (MLE). The outputs of the regressions are the beta coefficients of the individual stocks. The formula used for the above estimation is the following:

$$R_{it} = R_{ft} + \beta_i \left(R_{mt} - R_{ft} \right) \tag{2}$$

where R_{it} is the average monthly returns of the security i (dependent variable), R_{ft} is the risk free interest rate and R_{mt} is the average monthly return of

the market (independent variable). Shares with adjusted $R^2 < 0$ or F significant > 0.05 of the first pass regression are excluded from the sample.

In our previous study (Theriou, Aggelidis and Maditinos, 2004) we have used returns on portfolios as regressors in the first and second pass regressions. However, the current analysis has been conducted using data on individual stocks in the asset pricing tests. This has been commanded for the reason that the small sample size (maximum 157 stocks) is quite restrictive in forming adequate portfolios to counter the error in variable (EIV) problem in estimating betas at the first pass regressions. Moreover, in order to correct the error in variable problem of the estimated betas we use the method of Maximum Likelihood Estimation (MLE) adopted first by Litzenberger and Ramaswamy (1979) and later by many other scholars. Their correction method is N-consistent, i.e., consistent when the size of time series sample, T, is fixed and the number of assets N is allowed to increase without bound. Given the relative scarcity of empirical studies on Greek data, our study would be subject to less data-snooping bias in the sense of Lo and McKinlay (1990), and also is subject to less survivorship bias because very few firms from the ASE were either delisted or merged during the examined period (1991-2002). However, several firms were newly listed and added to our sample, and this might have induced some forward-looking bias (Kubota and Takehara, 1996).

After the first pass regression summary statistics are produced to check out the null hypothesis of the normal distribution[1] of our sample data. These include mean, standard deviation, skewness[2], kurtosis[3], and the normality test of Kolmogorov & Smirnov[4], for each share included in the sub period under examination (table 2).

In the *testing period*, using the last two years of the period under investigation, we estimate the excess returns ($R_{it} - R_{ft}$) of each security from a time series of returns of ASE listed stocks and the market premium ($R_{mt} - R_{ft}$). Then, monthly excess returns are regressed on betas. The number of observations in the cross-sectional regressions is equal to the number of stocks in the period under investigation (table 2, column G). We estimated the regressions both using the traditional test procedure and the conditional approach.

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[1] *The Normal Distribution* has skewness and kurtosis values equal to zero. It is fully described by the first two central moments, the mean and standard deviation.

[2] *Skewness* measures the direction and degree of asymmetry of a distribution. A value of zero indicates a symmetrical distribution.

[3] *Kurtosis* measures the degree of peakedness and heaviness of the tails of a distribution. A normal distribution has a kurtosis value equal to 0.

[4] *Kolmogorov-Smirnov (Lilliefors)* is a modification of the Kolmogorov-Smirnov test that tests for normality when means and variances are not known, but must be estimated from the data. The Kolmogorov-Smirnov test is based on the largest absolute difference between the observed and the expected cumulative distributions.

3.1. Traditional test

$$R_{pt} = \widehat{\gamma}_{0t} + \widehat{\gamma}_{1t} * \beta_{pt} + \varepsilon_{pt} \quad \text{p=1... N, t=1... T} \tag{3}$$

where R_{pt} is the excess return estimated in the second step, β_{pt} is the beta of the individual stocks estimated in the first step, ε_{pt} denotes an error term with $E\varepsilon_{pt} = 0$ and N and T are the number of stocks and observations, respectively.

3.2. Conditional approach

$$R_{pt} = \widehat{\gamma}_{0t} + D_t * \widehat{\gamma}_{2t} * \beta_{pt} + (1 - D_t) * \widehat{\gamma}_{3t} * \beta_{pt} + \varepsilon_{pt} \quad \text{p=1... N, t=1... T} \tag{4}$$

where D_t a dummy variable which takes on the value 1 [0] if the market risk premium in the month under consideration is positive [negative].

Discarding the earliest two years of data and adding two new years we repeat this two-step procedure of six years. This procedure was used by Lakonishok and Shapiro (1984) and is very similar to the 5-5-5 procedure used by Pettengill, Sundaram and Mathur (1995). Finally the coefficients estimated in the cross-sectional regressions were averaged and hypothesis tests are based on these averages.

The main objective of this study is to examine the conditional relationship between beta and return. Pettengill, Sundaram and Mathur (1995) argued that studies focusing on the relationship between return and beta need to take into consideration the fact that ex post returns have been used in the tests and not ex ante returns. When realised returns are used, a conditional relationship between beta and return should exist, where investors expect that their realised return on a low beta portfolio should be greater than the return on a high beta portfolio, otherwise no investor would hold the low beta portfolio. Pettengill, Sundaram and Mathur (1995) assumed that this occurs only when the market return is lower than the risk-free return, something that comes out of the excess returns market model. The implication of this line of thinking is that there should be a positive relationship between beta and return when the excess market return (premium) is positive, and a negative relationship when the excess market return is negative.

To test the conditional relationship, the sample period was divided into up market months and down market months for all the months. The hypotheses proposed by Pettengill, Sundaram and Mathur (1995) are:

$$H_0 : \bar{\gamma}_2 = 0$$
$$H_a : \bar{\gamma}_2 > 0$$

$$H_0 : \bar{\gamma}_3 = 0$$
$$H_a : \bar{\gamma}_3 < 0$$

where $\bar{\gamma}_2$ and $\bar{\gamma}_3$ are the average values of the coefficients $\bar{\gamma}_{2t}$ and $\bar{\gamma}_{2t}$ of the equation (4). Since $\bar{\gamma}_2$ is estimated in periods with positive market excess re-

turns, the expected sign of this coefficient is positive. On the other hand, since $\bar{\gamma}_3$ is estimated in periods with negative market excess returns, the expected sign of this coefficient is negative. A systematic conditional relationship between beta and realised returns is supported if, in both cases, the null hypothesis is rejected in favour of the alternate. These can be tested by the standard t-tests of Fama and MacBeth (1973). Hence, given the time series of γ_i we could test the implications using a standard t-test. Defining ω as the t-statistic, we have:

$$\omega(\widehat{\gamma}_i) = \frac{\widehat{\gamma}_i}{\sqrt{T} * s(\gamma_i)}$$

where T is the number of months in the period, which is also the number of the estimates γ_i used to compute the mean $\bar{\gamma}_i$ and the standard deviation $s\gamma_i$ of γ_i.

Pettengill, Sundaram and Mathur (1995), pointed out that the above conditional relationship does not guarantee a positive risk and return trade-off. They stated that two conditions are necessary to hold, simultaneously, for a positive trade-off between risks and return: (a) the excess market return should be positive on average and (b) the risk premium in up markets and down markets should be symmetrical. The symmetrical relationship can be tested by the following hypothesis:

$$H_0 : \bar{\gamma}_2 - \bar{\gamma}_3 = 0$$

This can be tested by a two-population t tests, but the sign of the $\bar{\gamma}_{3t}$ coefficient needs to be reversed and its mean value is recalculated.

4. RESULTS

The statistics in table 2 (column F) show that the null hypothesis of normality cannot be rejected at the 5 per cent level of confidence in 51 per cent of the shares in the period 1991–1994, 57 per cent in the period 1993–1996, 57 per cent in the period 1995–1998 and 70 per cent in the period 1997–2000. These results are in accord with the findings of Mandelbrot (1963) and Fama (1965) for the US market.

TABLE 2. – **Summary statistics**

Period	A	B	C	D	E	F	G
1/1991 – 12/1994	77	0%	11.6%	76.6%	2.5%	51%	68
1/1993 – 12/1996	110	0%	27.2%	80%	3.5%	57%	82
1/1995 – 12/1998	150	0%	29%	85%	3%	57%	106
1/1997 – 12/2000	176	0%	10.8%	90.5%	0%	70%	157

A: Sample size, **B: %** of Negative Adjusted R², **C: %** of F significant > 0.05, **D: %** of Durbin Watson (1.8-2.2), **E: %** of Durbin Watson < 1.5, **F: %** of Gaussian distribution, **G:** sample size after filtering

The filtering procedure (i.e., (a) the shares included in each of the estimation periods must have been traded at least in the last 24 month with no missing values and no suspensions, (b) in the testing periods all shares must have a complete price relative history, and (c) the coefficient of the F statistics in the first pass regression must be less than 0.05) produces sample sizes of 68, 82, 106 and 157 for the four sub-periods, respectively (table 2, column G).

The statistics in table 3 give some insights into the characteristics of the 'up' and 'down' market periods during the 96-month test period from January 1995 to December 2002. It is observed that there are significant positive (8.22 per cent per month) and negative (-5.95 per cent per month) rewards for bearing market risk during the 'up' and 'down' market periods respectively, which might imply that the relationship between realised returns and beta is conditional on market situations.

TABLE 3. – **Average Monthly Excess Market Returns**

		All Months		Up Markets		Down Markets	
Full sample 1995–2002	Number of Months	96		40		56	
	Excess Market Return	−0.047%		8.22%		−5.95%	
		t–statistics	p–value	t–statistics	p–value	t–statistics	p–value
		−0.049	0.96	7.30	0.000	−7.764	0.000
Period 1 1995–1998	Number of Months	48		21		27	
	Excess Market Return	1.35%		9.4%		−4.9%	
		t–statistics	p–value	t–statistics	p–value	t–statistics	p–value
		0.915	0.36	4.89	0.000	−4.32	0.000
Period 2 1999–2002	Number of Months	48		19		29	
	Excess Market Return	−1.44%		6.92%		−6.92%	
		t–statistics	p–value	t–statistics	p–value	t–statistics	p–value
		−1.17	0.24	6.68	0.000	−6.77	0.000

Whilst the evidence also indicates a marginally negative compensation (-0.047 per cent per month) for holding the market portfolio during the entire test period, this does not necessarily mean that a negative relationship exists between beta and returns.

Furthermore, the existence of a large number of negative excess market return periods suggests that the previous studies that tested for an unconditional positive correlation between beta and realised returns were biased against finding a systematic relationship. In contrast, the test procedures employed in the present study have taken into consideration the segmented relationship (in "up" and "down" market periods).

Table 4 presents the results both for the full sample and two sub periods of equal length (48 months). The coefficients estimated in the monthly cross –

sectional regressions are averaged. Then, a t-test is used to determine whether the mean of the coefficient is significantly different from zero. The results for the unconditional (traditional) relationship between beta and realised returns are, as expected, not significant and are consistent with Fama and French (1992) and many other studies documenting no significant relation between beta and return. According to the traditional CAPM, $\bar{\gamma}_1$ (equation 3) should equal the expected excess return on the market portfolio and since the investors are risk averse it should be positive. As we can notice in all three periods (the overall period and the two sub periods) average $\bar{\gamma}_1$ are negative and not statistically significant. Consequently, the null hypothesis of no relation between beta and returns cannot be rejected for the full sample and the sub periods.

TABLE 4. – **The Results (traditional CAPM)**

Period	$\bar{\gamma}_1$	t – statistics	p–value
Full sample			
1995 – 2002	–0.325%	–0.402	0.685
Period 1			
1995 – 1998	–0.226%	–0.332	0.742
Period 2			
1999 – 2002	–0.425%	0.292	0.771

(The slope coefficient estimates from the unconditional cross-sectional regression $R_{pt} = \gamma_{0t} + \gamma_{1t}\beta_p + \varepsilon_{pt}$ were averaged over the indicated periods. The third column reports the t-statistics and the forth column reports the corresponding p-value for a t-test of the null hypothesis that the mean is zero.)

However, the main purpose of this paper is to examine the conditional relation between beta and returns. Thus, the second step is to run the regression equation that takes under consideration the conditional nature between beta and returns. Table 5 presents the results after taking into consideration the segregation effect, for the overall sample period and the two sub periods. The mean value of $\bar{\gamma}_2$ during up markets (positive market excess returns) is 4.14 per cent for the full sample, 2.21 per cent for the first sub period and 6.28 per cent for the second sub period. The values for the overall period and the sub periods are significant at the 0.05 level.

(The slope coefficient estimates from the conditional cross-sectional regression $R_{pt} = \gamma_{0t} + \gamma_{2t}D_t\beta_p + \gamma_{3t}(1-D_t)\beta_p\varepsilon_{pt}$ were averaged over the indicated periods. t-statistics and p– values are reported for a t-test of the null hypothesis that the mean is zero).

The mean value of $\bar{\gamma}_3$ during down markets (negative market excess returns) is –3.43 per cent for the full sample, –1.93 per cent for the first sub period and –4.82 per cent for the second sub period. The values for the overall period and the sub periods are also significant at the 0.05 level. The results show

TABLE 5. – **The Results (conditional CAPM)**

Period	Positive market risk premium $\bar{\gamma}_2$		Negative market risk premium $\bar{\gamma}_3$		Symmetry $\bar{\gamma}_2 - \bar{\gamma}_3 = 0$	
Full sample 1995 – 2002	4.14%		−3.43%		t–statistics	p-value
	t–statistics	p-value	t–statistics	p-value		
	3.42	0.001	−4.06	0.000	7.691	0.000
Period 1 1995 – 1998	2.21%		−1.93%		t–statistics	p-value
	t–statistics	p-value	t–statistics	p-value		
	2.176	0.041	−2.652	0.013	2.059	0.001
Period 2 1999 – 2002	6.28%		−4.82%		t–statistics	p-value
	t–statistics	p-value	t–statistics	p-value		
	2.83	0.011	−3.32	0.002	4.385	0.000

that in all three periods under investigation (a) there is a statistically significant relation between beta and return, and (b) all the coefficients' means have the expected sign. In other words, stocks with higher betas have higher returns when the market risk premium is positive and lower returns when the market risk premium is negative. Thus, the results of the conditional test tend to support the prediction of CAPM that betas are related to the realised returns.

Pettengill, Sundaram and Mathur (1995), however, argue that the results indicating of a systematic conditional relation between beta and returns do not guarantee a positive risk return trade-off. In order to examine the positive risk return trade-off we should test whether the risk premium, in up and down markets, is symmetrical ($\bar{\gamma}_2 - \bar{\gamma}_3 = 0$). Table 5 (last column) reports the results of this test. The hypothesis that the relation between beta and return in up and down market is symmetrical is accepted for all periods, the overall period and the two sub periods, at the 0.001 level. This is consistent with Pettengill, Sundaram and Mathur (1995) findings. We notice that above results are very similar with those of our first study (Theriou, Aggelidis and Maditinos, 2004), where we used the same methodology based on the formation of portfolios (table 6) instead of single stocks:

However, the new results are definitely sounder, improved, and statistically significant for all three covered periods: (a) the mean values of coefficients $\bar{\gamma}_2$ and $\bar{\gamma}_3$, for all periods and for positive and negative market risk premium months, have the right sign, higher explanatory power, and all are statistically significant at least at the 0.05 level, and (b) the test for the symmetrical relationship hypothesis, H_o: $\bar{\gamma}_2 - \bar{\gamma}_3 = 0$, gives us significant statistical results at the 0.001 level. Furthermore, we proceeded to a third and final analysis, trying to cover, more or less the whole research spectrum of testing the conditional CAPM.

TABLE 6. – **The Results (conditional CAPM with the use of portfolios)**

Period	Positive market risk premium $\bar{\gamma}_2$		Negative market risk premium $\bar{\gamma}_3$		Symmetry $H_o: \bar{\gamma}_2 - \bar{\gamma}_3 = 0$	
Full sample 1995 – 2002	0.0376		−0.03082		t–statistics	p-value
	t–statistics	p-value	t–statistics	p-value		
	2.479	0.017	−2.1420	0.036	3.23	0.001
Period 1 1995 – 1998	0.053		−0.05891		t–statistics	p-value
	t–statistics	p-value	t–statistics	p-value		
	3.533	0.002	−3.69699	0.001	5.14	0.000
Period 2 1999 – 2002	0.018		−0.0056		t–statistics	p-value
	t–statistics	p-value	t–statistics	p-value		
	0.689	0.500	−0.251	0.804	0.632	0.530

In the *estimation period* we formed nine (9) portfolios as follows: We formed three (3) equally weighted portfolios based on size (capitalisation) and then each of these portfolios was subdivided into three more, based on beta coefficients of single stocks calculated with the use of the Maximum Likelihood Estimation-MLE method. Then, we estimated the portfolios' beta coefficients by taking the average of the betas of the stocks assigned to that portfolio (Fama and MacBeth, 1973). This way of beta's calculation corrects the phenomenon known as reversion to the mean).

In the *testing period*, we estimate the monthly excess returns of each portfolio by averaging the excess returns of the stocks of each portfolio. Then monthly portfolio excess returns are regressed on the portfolio betas. The number of observations in the cross-sectional regressions is equal to the number of portfolios. We estimate the regressions using both the traditional (unconditional) test procedure and the conditional approach. The results are as follows:

TABLE 7. – **The Results (traditional-unconditional CAPM : 9 portfolios according to size and beta)**

Period	$\bar{\gamma}_1$	t – statistics	p–value
Full sample 1995 – 2002	−0.74%	−0.520	0.605
Period 1 1995 – 1998	−0.11%	−0.056	0.955
Period 2 1999 – 2002	−1.36%	−0.658	0.514

As far as the traditional (unconditional) results are concerned we notice no real improvement (in comparison with those in table 4) after the adoption of portfolios in our

TABLE 8. – **The Results (conditional CAPM : 9 portfolios according to size and beta)**

Period	Positive market risk premium $\bar{\gamma}_2$		Negative market risk premium $\bar{\gamma}_3$		Symmetry $\bar{\gamma}_2 - \bar{\gamma}_3 = 0$	
Full sample 1995– 2002	7.88%		−9.73%		t–statistics	p-value
	t–statistics	p-value	t–statistics	p-value		
	4.789	0.000	−6.629	0.000	7.961	0.000
Period 1 1995 – 1998	6.17%		−8.90		t–statistics	p-value
	t–statistics	p-value	t–statistics	p-value		
	2.960	0.006	−3.314	0.003	4.439	0.000
Period 2 1999 – 2002	10.18%		−10.34%		t–statistics	p-value
	t–statistics	p-value	t–statistics	p-value		
	3.874	0.001	−6.297	0.000	7.046	0.000

analysis, even when we used the MLE method for the estimation of beta co-efficients of each stock. According to the traditional CAPM, $\bar{\gamma}_1$ (equation 3) should equal the expected excess return on the market portfolio and since the investors are risk averse it should be positive. As we can notice, in all three periods, average $\bar{\gamma}_1$ are negative and not statistically significant. Consequently, the null hypothesis of no relation between beta and returns cannot be rejected for the full sample and the sub periods.

However, results are getting better in the conditional testing when we use portfolios and the MLE method for the estimation of beta coefficients of each stock. The mean value of $\bar{\gamma}_2$ during up markets (positive market excess returns) is 7.88 per cent for the full sample, 6.17 per cent for the first sub period and 10.18 per cent for the second sub period. The values for the overall period and the sub periods are significant at the 0.01 level. The mean value of $\bar{\gamma}_3$ during down markets (negative market excess returns) is -6.73 per cent for the full sample, -8.90 per cent for the first sub period and -10.34 per cent for the second sub period. The values for the overall period and the sub periods are also significant at the 0.05 level. The new results (table 8) show that in all three periods under investigation (a) there is a statistically significant relation between beta and return, and (b) all the coefficients' means have the expected sign. In other words, portfolios with higher betas have higher returns when the market risk premium is positive and lower returns when the market risk premium is negative. Consequently, the new results of the conditional test tend to support, again, the prediction of CAPM that betas are related to the realised returns.

5. CONCLUSIONS

Previous studies testing for a systematic relationship between risk (as measured by beta) and returns find weak and intertemporally inconsistent results. These test results are biased due to the conditional relation between beta and realised returns. A positive relation is always predicted between beta and expected returns, but this relation is conditional on the market excess returns when realised returns are used for tests. In this study, Pettengill, Sundaram and Mathur (1995) methodology is employed, which considers the positive relation between beta and returns during up markets and the negative relation during down markets. This methodology yields the following findings:

Our results for an unconditional relationship between beta and realised returns are, as expected, not significant and consistent with the findings of Fama and French (1992) that document, among others, no significant positive relationship between risk and return.

However, when we take into consideration the conditional nature between beta and returns, the results prove the existence of a statistically significant systematic relation between beta and return for the total sample period and is consistent across subperiods and across months in a year.

Stocks (or portfolios) with higher betas have higher returns, when the market risk premium is positive, and lower returns when the market risk premium is negative. Thus, the results of the conditional test support the prediction of CAPM that betas are related to the realised returns. Although these results indicate a systematic conditional relation between risk and returns they do not guarantee a positive risk-return trade-off. For such a positive relation to hold, two conditions are necessary: (a) the excess market return should be positive on average, and (b) the risk premium in up and down markets should be symmetrical. From our findings both conditions hold.

Consequently, since the concerns regarding the weak correlation between beta and the cross-section of returns appear to be unfounded, the results support the continued use of beta as a measure of market risk.

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Corporate Governance and the Timeliness of Financial Reporting: A Case Study of the Russian Energy Sector

Abstract

Timeliness of financial reporting is an attribute of good corporate governance. Shareholders and other stakeholders need information while it is still fresh and the more time that passes between year-end and disclosure, the more stale the information becomes and the less value it has. This article examines the timeliness of financial reporting in the Russian energy sector. One reason why this segment of the economy was chosen is because it is one of the most important economic sectors. Another reason is because the energy sector has been the recipient of large sums of foreign investment, which presumably means the standards of financial reporting in the energy sector is better than average. The timeliness of financial reporting in the Russian energy sector was measured by counting the number of days that elapsed between year-end and the date of the independent auditor's report. Those results were then compared to the timeliness of financial reporting by non-Russian energy companies to determine whether there was a significant difference in the timeliness of financial reporting. The study found that Russian companies took significantly more time to report financial results than did the non-Russian companies.

Key words: Corporate governance; Financial reporting, Russia

1. Introduction

Transparency is one of those terms that has many facets. It is used in different ways. It can refer to the openness of governmental functions. It can refer to a country's economy. Or it can refer to various aspects of corporate governance and financial reporting. The OECD (1998) lists transparency as one element of good corporate governance. Kulzick (2004) and others (Blanchet, 2002; Prickett, 2002) view transparency from a user perspective. According to their view, transparency includes the following eight concepts:

- Accuracy
- Consistency
- Appropriateness
- Completeness
- Clarity
- Timeliness

- Convenience

- Governance and enforcement

This article focuses on just one aspect of transparency – timeliness.

The International Accounting Standards Board considers timeliness to be an essential aspect of financial reporting. In APB Statement No. 4, the Accounting Principles Board (1970) in the USA listed timeliness as one of the qualitative objectives of financial reporting disclosure. APB Statement No. 4 was later superseded but the Financial Accounting Standards Board continued to recognize the importance of timeliness in its Concepts Statement No. 2 (1980). The U.S. Securities and Exchange Commission also recognizes the importance of timeliness and requires that listed companies file their annual 10-K reports by a certain deadline.

The issue of timeliness has several facets. There is an inverse relationship between the quality of financial information and the timeliness with which it is reported (Kenley & Staubus, 1974). Accounting information becomes less relevant with the passage of time (Atiase, Bamber & Tse, 1989; Hendriksen & van Breeda, 1992; Lawrence & Glover, 1998).

Studies show mixed conclusions regarding the relationship of quickness of reporting and the nature of the information being reported. Some studies show that good news is reported before bad news whereas other studies show that bad news is reported before good news.

There is some evidence to suggest that it takes more time to report bad news than good news (Bates, 1968; Beaver, 1968), both because companies hesitate to report bad news and because companies take more time to massage the numbers or resort to creative accounting techniques when they have to report bad news (Givoli & Palmon, 1982; Chai & Tung, 2002; Trueman, 1990). Stated differently, there seems to be a tendency to rush good news to press, such as better than expected earnings, and delay the reporting of bad news or less than expected earnings (Chambers & Penman, 1984; Kross & Schroeder, 1984). Dwyer & Wilson (1989) found this relationship to hold true for municipalities. Haw, Qi and Wu (2000) found it to be the case with Chinese companies. Leventis and Weetman (2004) found it to be the case for Greek firms.

However, Annaert, DeCeuster, Polfliet & Campenhout (2002) found that this was not the case for Belgian companies and Han & Wang (1998) found that this was not the case for petroleum refining companies, which delayed reporting extraordinarily high profits during the Gulf crisis of the 1990s, perhaps because political repercussions outweighed what would otherwise have been a good market reaction. Rees & Giner (2001) found that companies in France, Germany and the UK tended to report bad news sooner than good news.

A study by Basu (1997) found that companies tend to report bad news quicker than good news, presumably because of conservatism. Gigler & Hemmer (2001) discuss this point in their study, which finds that firms with more conservative accounting systems are less likely to make timely voluntary disclosures than are firms with less conservative accounting systems.

Building upon the Basu study (1997), Pope and Walker (1997) found that there were cross-jurisdictional effects when extraordinary items were either included or excluded, using US and UK firms for comparison. Han & Wild (1997) examined the potential relationship between earnings timeliness and the share price reactions of competing firms. But Jindrichovska and Mcleay (2005) found that there was no evidence of conservatism in the Czech accounting system when it came to reporting bad news earlier than good news, presumably because the Czech tax system offers little incentive to do so. Ball, Kathari and Robin (2000) found that companies in jurisdictions that have a strong shareholder orientation tend to disclose earnings information sooner than companies in countries operating under a legal code system.

There is also a relationship between the speed with which financial results are announced and the effect the announcement has on stock prices. If information is released sooner, the effect on stock prices is more pronounced. The longer the time lapse between year-end and the release of the financial information, the less effect there is on stock price, all other things being equal (Ball & Brown, 1968; Brown & Kennelly, 1972). This phenomenon can be explained by the fact that financial information seems to seep into the stock price over time, so the more time that elapses between year-end and the release of the financial reports, the more such information is already included in the stock price.

Some countries report financial results faster than other countries. DeCeuster & Trappers (1993) found that Belgian companies take longer to report their financial results than do Anglo-Saxon countries. Annaert, DeCeuster, Polfliet & Campenhout (2002) found this to be the case for interim information as well. Companies can report financial results faster on the internet and the information can be more widely disbursed but posting two-year-old annual reports does nothing to improve timeliness (Ashbaugh, Johnstone & Warfield, 1999).

Atiase, Bamber & Tse (1989) found that large companies report earnings faster than small companies and that the reporting of earnings has a more significant market reaction for small firms than for large firms. In a study of Australian firms, Davies & Whittred (1980) found that small firms and large firms made significantly more timely reports than medium-size firms and that profitability was not a significant variable.

Whittred (1980) found that the release of financial information for Australian companies is delayed the first time an audit firm issues a qualified report and that the extent of the delay is longer in cases where the qualification

is more serious. Keller (1986) replicated that study for US companies and found the same thing to be true. Whittred and Zimmer (1984) found that it took Australian firms in financial distress a significantly longer time to publish their financial information. A study of more than 5,000 annual reports of French companies found that it took longer to release audit reports where there had been a qualified opinion, and that the more serious the qualification, the greater the delay in releasing the report (Soltani, 2002).

Krishnan (2005) found that the audit firm's degree of expertise has an effect on the timeliness of the publication of bad earnings news. Audit firms that specialize in the industry in which the company operates are more timely in reporting bad financial news than are audit firms that have less industry expertise.

2. Timeliness

One measure of transparency and quality of financial reporting is timeliness. The lapse of time between a company's year-end and the date when financial information is released to the public is related to the quality of the information reported. Issuing excellent, accurate and comprehensive financial information two or three years after year-end is not as desirable as issuing less comprehensive and complete financial information a few months after year-end. Financial information becomes stale after a few months, and certainly after two or three years. The more stale it is, the less relevant it is to potential investors and creditors.

There are a number of reasons for the time lag between year-end and the issuance of the audit report and the publication of financial information. Ashton, Graul and Newton (1989) identified auditor size, industry classification, the presence or absence of extraordinary items and the sign of net income as some factors that influence timeliness. To that one might add the culture, political and economic system of the country in which the particular firm is located. One purpose of the present study is to determine whether Russian energy companies are any less timely in the speed of financial reporting than companies in Western Europe and the United States.

In the not too distant past, some Russian enterprises were criticized for waiting too long to issue their financial reports. Some Russian companies did not issue their annual reports until a year or more after the end of the year. In some cases, Russian firms did not even have annual audits.

Measuring timeliness is relatively easy. The present study measures timeliness by computing the number of days that elapse between the company's year-end and the date of the auditor's report. Data for some large Russian companies in the energy sector are calculated and compared to those of selected non-Russian companies in the petroleum refining industry.

3. Comparing Russian and Non-Russian Company Data

Data were collected from company websites. The dates used were the dates of the auditor's report, which is not necessarily the same as the date the financial information was released to the public. However, it was not possible to determine when the annual financial reports were published, so the date of the audit opinion was selected as a surrogate. Using this date also made it possible to compare Russian and non-Russian company data.

Table 1 shows the number of days it took Russian energy companies to issue their audit report. The information found was incomplete. Not all Russian companies reported their results on their websites for all years under study. However, a sufficient amount of data was available to reach some tentative conclusions.

The sample size was 68. The range was 50 to 351 days, with an average of 145.5 days. In other words, assuming the company's year-end was December 31, some companies published their audit opinion as early as February 19 while others took until December 17. The average company from this group published its audit report on May 26.

TABLE 1. – **Russian Oil, Gas & Energy Companies**
1 US Dollar = 28.74 Russian Ruble as at December 31, 2005

Company	Revenues $ mil.	Year	Days Delay in Issuing Audit Report	Auditor	Standards Used
Gazprom (R1) (G102) www.gazprom.ru	50,824.4	2005	89	PWC	RAS
	35,090	2004	139	PWC	RAS
		2003	89	PWC	RAS
		2002	87	PWC	RAS
Lukoil (R2) (G115) www.lukoil.ru	46,284.0	2005	135	KPMG	US GAAP
	28,810	2004	144	KPMG	US GAAP
		2003	173	KPMG	US GAAP
		2002	150	KPMG	US GAAP
		2001	176	KPMG	US GAAP
		2000	220	KPMG	US GAAP
		1999	81	KPMG	US GAAP
RAO Unified Energy System of Russia (R3) (G213) www.rao-ees.ru/	27,768.1	2005	243	PWC	IFRS
	22,603	2004	179	KPMG	IFRS
		2003	187	KPMG	IFRS
		2002	157	PWC	IFRS
		2001	177	PWC	IFRS
		2000	232	PWC	IFRS
		1999	283	PWC	IFRS
		1998	347	PWC	IFRS

Company	Revenues $ mil.	Year	Days Delay in Issuing Audit Report	Auditor	Standards Used
Sibneft (R4)	14,585.3	2005	181	PWC	US GAAP
www.gazprom-neft.ru	8,886.4	2004	181	Unk	US GAAP
		2003	182	Unk	US GAAP
		2002	144	Unk	US GAAP
		2001	172	Unk	US GAAP
		2000	120	AA	US GAAP
		1999	121	AA	US GAAP
		1998	120	AA	US GAAP
		1997	118	AA	US GAAP
		1996	258	AA	US GAAP
Tatneft (R12)	5,913	2005			
www.tatneft.ru	887	2004	178	E&Y	RAS
		2003			
		2002	160	PWC	US GAAP
		2001	161	PWC	US GAAP
		2000	151	PWC	US GAAP
		1999	139		
Mosenergo (R16)	2,471	2005	83	PWC	IFRS
www.mosenergo.ru/	3,202	2004	109	Top-Audit	IFRS
		2003	90	PWC	IFRS
		2002	84	PWC	IFRS
Lenenergo (R25)		2005			
www.lenenergo.ru/	1,134	2004	126	Moore Stephens	RAS
		2003	119	Moore Stephens	IFRS
		2002	133	Unk	IFRS
		2001	87	PWC	RAS
		2000	61	Inaudit	RAS
Novatek (R30)	1,520.2	2005	104	PWC	IFRS
www.novatek.ru	887	2004	147	PWC	IFRS
		2003	175	PWC	IFRS
		2002	351	PWC	IFRS
Samaraenergo (R32)		2005	-	-	-
www.samaraenergo.ru/	829	2004	159	Moore Stephens	IFRS
		2003	172	Moore Stephens	Unk
		2002	-	Inaudit	-
		2001	70	Inaudit	-

Company	Revenues $ mil.	Year	Days Delay in Issuing Audit Report	Auditor	Standards Used
Irkutskenergo (R37) www.irkutskenergo.ru		2005			RAS
	529	2004	81	ZAO AKF Sovremennie Business-Teknologii	RAS
Novosibirskenergo (R48) www.nske.ru	594	2005	111	PWC	RAS
	494	2004	70	PWC	RAS
		2003	69	PWC	RAS
TNK-BP www.tnk-bp.ru	14,298	2004	180	PWC	US GAAP
		2003	152	PWC	US GAAP
		2002	135	PWC	US GAAP
Rosneft (G367) www.rosneft.ru	17,670.0	2005	135	E&Y	US GAAP
	5275	2004	175	E&Y	US GAAP
		2003	167	E&Y	US GAAP
		2002	166	Unk	US GAAP
Transneft www.tansneft.ru		2005	150	KPMG	IFRS
		2004	145	KPMG	IFRS
		2003			
		2002			
		2001	143	PWC	IAS
Surgutneftegas (G443) www.surgutneftgas.ru	15,153.6	2005	89	Rosekspertiza	IFRS
		2004			
		2003			
		2002	50	Aval	US GAAP
		2001	52	Rosekspertiza	FRS
		2000	No date	Rosekspertiza	FRS
		1999	No date	Rosekspertiza	FRS
Sverdlovenergo www.irkutskenergo.ru	665	2005	No date	RF Ministry	IAS
	529	2004	81	-	IAS

Chart 1 shows the range of reporting dates for the Russian companies included in this study.

CHART 1. – **Russian Companies**
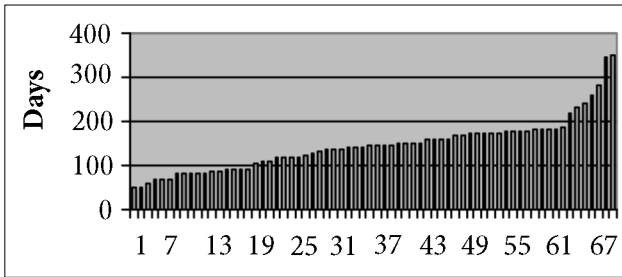
In some cases there were several release dates. For example, in 2004 Gazprom's audit report was issued after 89 days for its separate financial statements and after 139 days for its consolidated statements. In cases where there was more than one audit report date, the date for the consolidated statements was the one used.

Some companies in this study were among the 50 largest public companies in Russia as of 2005 (Demos, 2006). Companies made that Top 50 list if they publish audited financial reports according to internationally accepted accounting standards. Their ranking is indicated by (R). A few companies also made the Fortune Global 500 list for 2005 (Fortune, July 25, 2005). Those companies are indicated by (G).

It was thought that compiling statistics on the firms that audit Russian firms would also be useful. There is a perception that the Big-4 international accounting firms have a monopoly on large Russian company audits. This perception was tested by looking at the most recent year where the information was available. The results are given in Table 2.

TABLE 2. – **Audit Firms of Russian Companies**

	# of Audits	%
PricewaterhouseCoopers	7	43.8
KPMG	2	12.5
Ernst & Young	2	12.5
Deloitte & Touche	0	0.0
Moore Stephens	2	12.5
Rosekspertiza	1	6.3
ZAO AKF	1	6.3
RF Ministry	1	6.3
Total	16	

As can be seen, only three of the Big-4 firms have Russian clients. However, they have captured more than 60 percent of the market. A few Russian firms and other, smaller non-Russian firms have a few audit clients. Chart 2 shows the relative market share for each firm.

CHART 2. – **Audit Firm Market Shar**
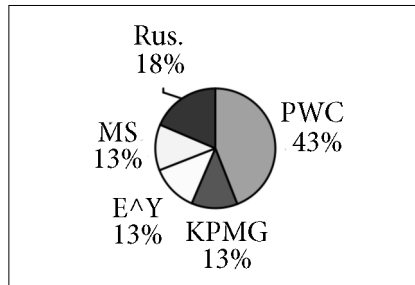
It was thought that compiling statistics on the kind of accounting standards used in the companies' annual reports would also be interesting. Table 3 shows the relative frequency of use of International Financial Reporting Standards (IFRS), U.S. GAAP and Russian Accounting Standards (RAS) for the most recent year for which information was available.

TABLE 3. – **Frequency of Use of Accounting Standards**
By Russian Companies

	#	%
IFRS	7	43.8
RAS	5	31.2
U.S. GAAP	4	25.0
Total	16	

As can be seen Russian companies have a tendency to use International Financial Reporting Standards in addition to Russian Accounting Standards. Russian Accounting Standards came in second in terms of popularity.

Non-Russian companies were taken from the *Fortune Global 500* list. The *Fortune* article classified the selected companies as being in the petroleum refining industry. Data for the most recently reported year was chosen. The year in parentheses indicates the year of the annual report.

Table 4 lists some major non-Russian energy companies. This list was compiled from the Fortune Global 500 list (July 24, 2006 issue of Fortune). The other information was taken from company websites or the cnn.com website. Revenues are listed in millions of USD, after deducting excise taxes in the case of the Fortune Global 500 companies. Ranking is listed in parentheses.

TABLE 4. – **Non-Russian Energy Companies**

Days Delay in Releasing Financial Information

	Revenues $ mil. (2005)	Revenues $ mil. (2004)	2005	2004	2003	2002	2001
Fortune Global 500 – Petroleum Refining							
BP [UK] (4) www.bp.com	267,600	285,059	37	38	40	42	43
Exxon Mobil [USA] (1) www.exxonmobil.com	339,938	270,772	59	59	75	85	86
Royal Dutch/Shell Group [Netherlands] (3) www.shell.com	306,731	268,690	67	117	143	64	72
Total [France] (12) www.total.com	152,360.7	152,610	74	–	–	–	–
Chevron Texaco [USA] (6) www.chevrontexaco.com	189,481	147,967	60	62	69	76	86
ConocoPhillips [USA] (10) www.conocophillips.com	166,683	121,663	58	56	62	85	–
Sinopec [China] (23) www.sinopec.com.cn	98,784.9	75,077	90	–	–	87	–
ENI [Italy] (27) www.eni.it	92,603.3	74,228	118	111	111	114	109
Valero Energy [USA] (44) www.valero.com	81,362	53,919	60	62	71	78	64
Marathon Oil [USA] (77) www.marathon.com	58,958	45,444	62	69	56	–	–
Statoil [Norway] (70) www.statoil.no	61,032.7	45,440	68	68	63	73	67
Repsol YPF [Spain] (84) www.respol–ypf.com	56,423.6	44,858	89	91	63	66	58
SK [South Korea] (111) www.sk.com	47,142.6	37,692	51	56	57	64	53
Petrobras [Brazil] (86) www.petrobras.com.br	56,324	36,988	48	133	44	44	–
Nippon Oil (118) www.eneos.co.jp	45,071.2	34,151	90	90	88	88	90
Indian Oil (153) www.iocl.com	36,537	29,643	60	–	–	–	–
Sunoco (187) www.sunocoinc.com	31,176	23,226	54	62	44	45	–
Nippon Mining Holdings (257) www.shinnikko–hd.co.jp	23,615.3	18,817	89	86	86	–	–
PTT (265) www.pttplc.com	23,109	16,023	–	47	–	–	–
Cepsa (322) www.cepsa.com	20,114.4	15,650	90	89	86	80	–

	Revenues $ mil. (2005)	Revenues $ mil. (2004)	2005	2004	2003	2002	2001
Fortune Global 500 – Petroleum Refining							
Cosmo Oil (337) www.cosmo–oil.co.jp	19,100	15,297	90	90	88	88	–
Reliance Industries (342) www.ril.com	18,773.3	14,841	27	29	23	102	30
Fortum		14,509	33	33	35	43	
Bharat Petroleum (368) www.bharatpetroleum.com	17,613.8	14,437	49	119	59	–	–
Premex (40) www.pemex.com	83,381.7	63,698.8	115	112	11	–	–
Tesoro (406) www.tsocorp.com	16,473.	12,139	65	62	70	45	–
Averages			68.1	75.7	65.6	72.1	68.9

The range of scores for non-Russian companies was 11 to 143 days with an average of 70.2 days.

Chart 3 shows the range of dates for Non-Russian companies.

CHART 3. – **Range of Scores – Non-Russian Companies**
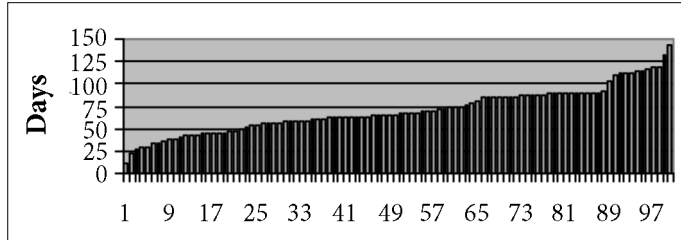
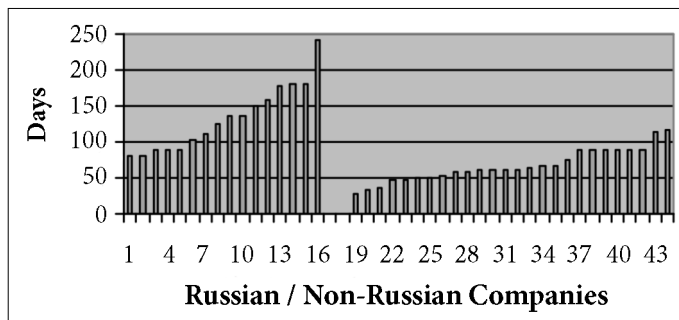The average number of days for all years in the study was 145.5 days for the Russian companies and 70.2 days for the non-Russian companies. The difference was significantly different (p<= 3.912e-18).

CHART 4. – **Range of Days**

Russian and non-Russian scores were also compiled for the most recent date, which was usually 2005. The average scores were 133.1 days and 67.3 days, respectively. The difference in the average number of days was statistically significant (p<= 0.00028).

4. Concluding Comments

Russian companies take more than two months longer to issue their financial statements than do non-Russian companies, which makes their shares less desirable in the international marketplace. The information is not as fresh if its release is delayed by 133.1 days, which is the average delay. That is nearly 98 percent longer than it takes non-Russian companies to issue their financial statements, 67.3 days compared to 133.1 days.

However, this lag in issuing financial statements may not be as bleak as first appears. Early release of financial information is extremely important in a country like the United States, where a large percentage of capital is equity capital. But many Russian companies rely more on debt capital for financing, which makes the timely release of audited financial statements somewhat less important.

Russian companies must satisfy a different audience – bankers rather than shareholders. Although the views, wants and needs of shareholders are important in Russia, there is a tendency to pay more attention to bankers if that is where the capital is coming from. Bankers have access to financial information that shareholders do not. If bankers want financial information that is not reported in the annual financial statements, all they need do is demand it as a condition of giving the loan.

Another factor that reduces the importance of this difference in the timeliness of financial reporting is the attractiveness of investment in the industry. Energy has become an increasingly important industry in recent years. Profitability has increased and is expected to remain good for years to come. It is not likely that energy prices will drop significantly. That being the case, potential investors might not place as much emphasis on timely financial reporting as would be the case in a less profitable industry. Thus, although Russian energy companies need to make an effort to be more timely in their financial reporting, the fact that they are not as quick to report financial results as their non-Russian competitors is not necessarily fatal.

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PETR JAKUBÍK

Credit Risk and the Macroeconomy

Abstract

The importance of credit risk models has increased with the introduction of the New Basel Capital Accord known as Basel II. This paper follows structural Merton's approach. The aim of this study is default rate modeling. A latent factor model is introduced within this framework. Estimation of this model can help to understand relation between credit risk and macroeconomic indicators. The credit risk model of the Czech aggregate economy was estimated in this manner for purpose of stress testing. The results of this study can be used for stress testing of banking sector.

Key words: banking, credit risk, latent factor model, default rate, stress test

1. Introduction

Our recent experience with effects of economic downturn on banks' loan portfolios in the Czech economy in the late 1990s provides an opportunity to investigate the link between macroeconomic development and credit portfolio quality.

Credit risk is one of the most important areas of risk management. It plays an important role mainly for bank institutions. They try to develop their own credit risk models in order to increase bank portfolio quality. A new wave of interest originated with the introduction of the new Basel accord known as Basel II.

Three approaches can be distinguished. The first – traditional models -– are based on comparing client specific information. The objective of these models is a good prediction of future client quality. The default probability is obtained from empirical information. These models are widely used in assessment of banking clients and this approach is also very popular for transitional economies with insufficient capital markets. Models based on option pricing ("Structural models") represent the second possible approach. They are based on financial pricing theory. Here, the value of a firm is mod-

eled as an option price. The firm default is specified in relation to firm value and leverage. The third approach is summarized in so called reduced form models. These models use market bond price as input, and from this information they try to derive default probability and recovery rate. The aim of all approaches is an estimation of firm default probability and loss given default. Together with estimation of exposure at default and effective maturity these credit risk components can be used for determining the capital requirement – Internal Ratings-Based Approach (IRB) (Basel Committee on Banking Supervision, 2004).

One question which has become important is the relationship between credit risk models and business cycle. Research on this relationship has found importance mainly during last few years. Targets of these studies are credit risk models taking into account the macroeconomic environment. Some researches are focused on developing a macro model for credit risk estimation. In general these types of models try to estimate the default rate from macro data. These models are used for stress testing which is emphasized by the new Basel accord. Bank with IRB models should use stress testing in the assessment of capital adequacy. Stress testing should involve identifying possible events or future changes in economic conditions that could have negative effect on the bank capital requirements (Basel Committee on Banking Supervision, 2004). Macro models are also a very useful tool for central banks for research and management of banking system financial stability. Through the application of these models central bank can estimate impact changes in monetary policy or expected or unexpected macroeconomic shocks.

Two basic approaches in default probability modeling can be distinguished. Banks can base borrower's assessments on the current economic condition. Default probability is then conditioned on the point in the cycle. When risk assessments take into account possible change in macroeconomic climate, then forward looking ratings can be derived. The second approach becomes important due to the possibility of implementing different type of countercyclical policy. Macroeconomic models can help with understanding influence of macroeconomic change on the default events.

This paper contributes to contemporary research by applying approach of Merton structural models on the Czech economy.[1] Our study extends empirical analyses (e.g. Virolainen, 2004) of default data by introducing latent systematic factors. In contrast to traditional empirical models, factors models can be a better way of default rate modeling, because they provide microeconomic foundation. This research follows the study of Jakubík (2006) developing structural model approach for the Finnish economy.

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[1] Merton's models are based on the option price model, which estimates value of the firm as a price of put option. For the first time this idea was introduced by Merton (1974).

We focus on developing macro models for default rate prediction in this paper for the financial stability purpose. The target of this study was investigation of the possible approach of default rate macro modeling in literature and the selection of a model for the Czech economy. There are several reasons for being interested in the relationship between business cycle fluctuations and credit default. First, financial regulators need to have a good understanding of the potential downside credit risk in loan and corporate bond portfolios. They therefore need to be able to estimate the potential cyclical variability of default rates. Second, management and regulators want to have some idea of the likely rate of default in the near future. Macroeconomic indices are informative indicators of future default rates, requiring the direct modeling of this relationship. Third, as encouraged by the Basel committee, banks need to be able to develop stress tests of their portfolio performance in business cycle downturn and these tests should be interpretable in terms of the magnitude of some underlying macroeconomic shock. This study can help in all these tasks. A latent factor model is a natural and popular way of to estimate potential downside credit risks. This is why this model is the basis of Pillar 1 of the new Basel accord (Gordy, 2003). But relatively little work has been done on estimating the crucial parameter, representing correlation with systematic factor. Combining this model with macroeconomic indicators provides a natural test of the specification of the macro-relationship. If the macro indicators are indeed informative predictors then the share of fluctuations explained by the latent factor will be relatively small. This unobservable factor represents the unexplained component of the macro-model. We found that latent factor remains important even with the inclusion of macro indicators. Therefore both simulation and forecasting should include allowance for this factor as well as observed macroeconomic indicators considered.

This paper is structured as follows. Section 2 introduces related studies. Section 3 presents selected approach to credit risk modeling. A nonlinear one-factor model, which is derived from idea of return assets modeling by systematic factor and idiosyncratic shocks, is described in details. Section 4 presents estimated one-factor macro credit risk model for the Czech economy. This model is used for the financial stability purpose in the Czech National Bank. Last section concludes and discusses possible further research issues.

2. Related Studies

Some studies focus on business cycle effects on portfolio credit risk; other research procyclicality of credit risk measurement or relationships between financial crises and credit risk models. Four basic components are defined in the new Basel accord according Internal Ratings – Based Approach (Basel Committee on Banking Supervision, 2004).There are default probability, loss given default, exposure at default and effective maturity. In discussions about relationship between business cycle and credit risk models the most impor-

tant is default probability and loss given default. Some papers solve problem of correlation between default probability and loss given default. In general default probability changes over time depending on the macroeconomic environment. Some models use constant value of loss given default, but this also changes over time in practice. Many studies demonstrate this fact. The basic issue of relationship between credit risk models and the economic cycle is estimation of default probability as a function depending on time. Default probability is usually modeled by default rate. This indicator is defined as a ratio between credits in default and total granted credits. This type of data on aggregate level of economy is sometimes very difficult to get. In this case some approximation must be used. These models use aggregate variables to explain default rate. Such models are able to model impact of macroeconomic shock on credit industry.

This paper is related to literature on the influence of the macroeconomic environment on credit risk models. Few papers focus on the issue of the mutual relationship between economic cycle and credit risk. Those studies can be divided into two groups. The first group use company specific information and try to research the influence of the macroeconomic environment to individual risk. Other studies use only aggregate data and investigate the default rate in relation to macroeconomic indicators. In this paper only aggregate information is used and therefore it is in the second group of papers.

In the context of the New Basel Accord, there are studies investigating cyclical effects in credit risk models. They try to model influence of cyclical policy on the bank capital requirement (e.g. Catarineu-Rabell, Jackson and Tsomocos, 2003). They discuss the influence of different implementation of rating system to the bank capital requirement. Lowe (2002) examined whether credit risk is low or high in economic booms. He described how macroeconomic consideration is incorporated into credit risk models and the risk measurement approach that underlies the New Basel Capital Accord. A survey of the literature on cyclical effects on default probability, loss given default and exposure at default can be found in (Allen and Saunders, 2003). They noticed that although systematic risk factors have been incorporated into both academic and proprietary models for default probability, the same is not true for loss given default and exposure at default.

There are studies used latent factor model for investigation business cycle effects on portfolio credit risk.[2]

These models are based on Merton model. Cipollini and Missaglia (2005) attempt to integrate market risk with credit risk by a dynamic factor model. Rösch (2003) estimated one-factor model for the German economy. He used

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[2] Latent factor model is class of the models where unobservable variables are considered as depend variable. In order to estimate such models we need to take into account some assumptions about the distribution of the unobservable factors.

data of bankruptcies for estimation of default probability and correlation between firm normalized return assets. This model is estimated for the whole German economy and also for 16 industry specific sectors. The one-factor model is also employed in (Rösch, 2005). Hamerle, Liebig and Scheule(2004) used also static factor model, but they consider the effect of different assumptions about the error distribution function. They used logistic distribution function in contrast to Rösch, (2003) or Rösch (2005), where normal distributions function was used. They found that the inclusion of variables which are correlated with the business cycle improves the forecasts of default probabilities. Céspedes and Martín (2002) studies two-factor model for credit risk. They compared this model with one-factor model employed in Basel II. Tasche (2005) investigated multi-factor extension of the asymptotic single risk factor model and derive exact formula for the risk contributions to value-at-risk and expected shortfall. He introduced a new concept for diversification index as an application of the risk contribution formula. A three-factor structural model is developed for example by Hui, Lo and Huang(2003).

Pesaran and Schuermann (2003) used the idea of a simple Merton-type credit model for modeling credit risk as a function of correlated equity returns of the borrower companies. These equities are linked to correlated macroeconomic variable using an approach similar to the Arbitrage Pricing Theory. They estimated global macroeconomic model for generating a conditional loss distribution using stochastic simulation. They analyze the impact of a shock set of specific macroeconomic variables on that loss distribution. Koopman and Lucas (2004) used multivariate unobserved components framework to separate credit and business cycle. They used this model for describing the dynamic behavioral of credit risk factors in their relation to real economy. They used data of real GDP, credit spreads and business failure for US economy. They empirically showed positive relationship of spreads and business failure rates and negative of GDP.

Some papers try to develop simple macroeconomic model of default rates predictions. These empirical models are mostly derived from traditional models used for prediction of individual risk. Few papers focus on the developing macroeconomic model of default rates. Virolainen (2004) estimated this kind of model for the Finnish economy based on logistic regression.[3]He used this model for stress testing and tried to investigate the influence of these shocks to the excepted and unexpected loss. Jakubík (2006) also employed data of the Finnish economy. Nevertheless, latent factor model based on the Merton structural approach was used. Our study follows results and methodology of this study.

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[3] The logistic regression model corresponds to linear regression applied after logit transformation of the explained variable. The logit transformation of the explained variable y is defined as $\ln \frac{y}{1-y}$. In the case of credit risk models this expression transforms original values from the interval $[0,1]$ to $(-\infty;+\infty)$.

3. CREDIT RISK MODELS

Two basic groups of models are usually used for credit risk modeling. The first group of models tries to estimate individual risk of debtors. They are involved in credit risk assessment of the commercial banks and are called individual credit risk models. Nevertheless, banks can also incorporate some macroeconomic indicators into a model in an effort to avoid problem of credit risk assessment procyclicality.[4] Outputs of the individual credit risk models can provide inputs for capital adequacy ratio calculation as well – Internal Ratings-Based Approach (IRB) – New Basel Capital Accord (Gordy 2003; Finger, 2001).[5] The estimated model in this paper belongs to group of macro credit risk models. This group of models tries to estimate aggregate credit risk, therefore fit to financial stability purposes. Macroeconomic credit risk models are usually related to individual risk models, which are possible to express by the following general equation.

$$p_t = f(X_t), \tag{1}$$

where p_t is individual default probability at time t and X_t are some indicators of client quality related to financial statement in the case of traditional model, firm value and leverage in the case of structural models or bond price in the case of reduced model. Macroeconomic indicators can be part of these inputs for all types of these models. Originally macroeconomic factors were not considered, but in recent years a lot of papers research the influence of macroeconomic environment on the credit risk model.

Some empirical macroeconomic model may be found in the literature. These models are based on the same idea as the traditional model. They try to find the empirical observed relationship between default rate and some macroeconomic indicators. This relationship is usually modeled very simple by linear, probit or logit models. Static or dynamic approaches are applied for modeling. Vector autoregressive models (VAR) are often used in the case of dynamic model. These models are able to model mutual relationship of time series even in the case of time series nonstationarity. Vector autoregressive model can be applied for nonstationarity time series if cointegration exists. Vector error correction model (VEC) as a reformulation of VAR model is able to distinguish long-run and short-run dependence.

The other different approach is derived from Merton structural model, which is employed in the Basel II framework for risk weight calibration. The model is based on modeling of assets return. Default event is defined as fall of bor-

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[4] That is, the problem where the credit risk of a single entity is assessed in positive terms during a period of economic growth and in negative terms during a period of economic slowdown. Credit risk models which fail to address the issue of pro-cyclicality might result in a further strengthening of the economic downturn.

[5] A One-factor model was used to calibrate risk weights for the purposes of Basel II framework (default probability, assets correlation of borrowers within risk classes).

rowers return assets under some threshold. This model is originally used for estimation of individual risk, but this idea was extended to default rate estimation. The structural model was chosen for the Czech economy stress test purpose. The aim of the model is prediction of the possible future development of non-performing loans as a function of the negative changes in macroeconomic environment. Selected approach follows one-factor model which will be introduced further.

3.1. Credit Risk Models in Central Banks

Most central banks employ some form of sensitivity analysis or stress testing, but only a few of them use a macroeconomic credit model. Where central banks do use such macroeconomic credit models, they are mostly empirical-type models, as, for example, in the case of the United Kingdom, Germany, Belgium and Finland. The Bank of England uses an empirical model which estimates the bankruptcy rate of non-financial corporations and the default rate in the mortgage and credit card portfolios (Bunn, Cunningham, and Drehmann, 2004). The data collected in this manner are then entered into credit loss estimation models as explanatory variables. The default rates are estimated from real GDP, the real interest rate, unemployment, the corporate debt ratio and other aggregate indicators. Finland uses a macroeconomic model based on logistic regression which explains the default rate relationship for individual sectors of the economy using macroeconomic indicators Virolainen (2004). This model regards real GDP, nominal interest rates and the debt ratios of the individual sectors investigated as the explanatory variables. The default rate is modeled using the bankruptcy rate of companies in the total number of companies for the given sector of the economy. The Hungarian central bank is also preparing a credit model which uses the number of bankruptcies of companies for individual sectors of the economy, based on the approach employed by the Finnish central bank. Germany used a regression model estimated on a panel of German banks (Deutsche Bundesbank, 2005). The explanatory variable here is a logistic transformation of the proportion of provisions in the credit portfolio. This model works with the change in the risk-free interest rate, GDP growth and loan portfolio growth as the macroeconomic indicators in the role of explanatory variables. The Belgian central bank uses a model based on logistic regression estimating the aggregate default rate of the corporate sector (National Bank of Belgium, 2005). The output gap, nominal long-term interest rates and the lagged rate of aggregate corporate default are used as the explanatory variables. Generally speaking, the development of macroeconomic credit risk models has become an important area of interest of central banks as institutions pursuing financial stability. However, the topic associated with these models is undergoing very rapid development and there is no overall consensus on which model is the best.

3.2. One-factor Model

One-factor model is one of the variants of latent factor model which belongs to class of Merton structural model. Following model appears in many papers, for example in Rösch (2005), Céspedes and Martín (2002), Cipollini, Missaglia (2005), or Lucas, Klaassen (2003). Application of the model to the German aggregate economy may be found in Rösch (2003) or Hamerle, Liebig and Scheule 2004).

The model assumes homogenous portfolio of firms in the economy. A random process with a standard normal distribution is assumed for the standardised logarithmic return on assets of a firm. The discrete normal logarithmic return satisfies the following equation for each firm in the economy.

$$R_{it} = \sqrt{\rho}F_t + \sqrt{1-\rho}U_{it} \tag{2}$$

R denotes normal logarithmic return on assets for each firm i at time t. F corresponds to the logarithmic return in the economy independent of firm i at time t, which is assumed to be a random variable with a standard normal distribution. This variable represents the part of the return which is not specific to the firm and can thus satisfy the general conditions for profitability of firms in the economy. U denotes the return specific to the firm i at time t, which is again assumed to be random with a standard normal distribution. The two random variables F and U are also assumed to be serially independent.

$$F_t \approx N(0,1)$$

$$U_{it} \approx N(0,1)$$

The coefficient ρ expresses the correlation between the returns on assets of any two debtors.

$$E(R_{it}) = 0 \tag{3}$$

$$Var(R_{it}) = E(R_{it}{}^2) - E(R_{it})^2 = E(\rho F_t{}^2 + (1-\rho)U_{it}{}^2 + 2\sqrt{\rho}\sqrt{1-\rho}F_t U_{it} = 1 \tag{4}$$

Given these assumptions, the logarithmic return on assets of each firm i at time t also has a standard normal distribution – see equations (3), (4). The model is based on the Merton's approach, according to which a default event occurs if the return on a firm's assets falls below a certain threshold. Formally,

$$P(Y_{it} = 1) = P(R_{it} < T) \tag{5}$$

where Y denotes random variable with the two potential state.

$$Y_{it} = \begin{cases} 1 & \text{borrower i defaults at time t} \\ 0 & \text{else} \end{cases} \tag{6}$$

T can be assumed as a constant or random variable depends on time. Different macroeconomic indicators can be considered if the applied variant of the model assumes that the value of this threshold changes depending on changes in the macroeconomic environment. This value can be modelled as a linear combination of macroeconomic variables. Formally

$$T = \beta_0 + \sum_{j=1}^{N} \beta_j x_{jt}, \tag{7}$$

where x_j represents j-th macroeconomic indicator and β are constant coefficients. The change of macroeconomic environment affects the value of default threshold at time, which is probably higher in good time and lower in bad time. In general, a recession decreases the value of threshold for default events. Based on all these assumptions, the probability of default of the firm can be derived, with Ψ denoting the standard normal distribution function and x_{jt} denoting the macroeconomic indicators included in the model (e.g. gross domestic product, nominal interest rate, inflation, etc.). The default probability of firm i at time t is given by equation (8) in the case of the constant default threshold at time.

$$p_{it} = P(R_{it} < T) = P(\sqrt{\rho} F_t + \sqrt{1-\rho} U_{it} < \beta_0) = \Psi(\beta_0) \tag{8}$$

This enables us to derive the relationship for the conditional probability of default in response to the realization of an unobservable factor (f_t denotes realization of the unobservable factor F_t).[6]

$$p_i(f_t) = P(U_{it} < \frac{\beta_0 - \sqrt{\rho} f_t}{\sqrt{1-\rho}}) = \Psi(\frac{\beta_0 - \sqrt{\rho} f_t}{\sqrt{1-\rho}}) \tag{9}$$

Default probability of firm i at time t is given by equation (10) in the case when change of the threshold at time is considered according equation (7).

$$p_{it} = P(Y_{it} = 1) = P(\sqrt{\rho} F_t + \sqrt{1-\rho} U_{it} < \beta_0 + \sum_{j=1}^{N} \beta_j x_{jt}) = \Psi(\beta_0 + \sum_{j=1}^{N} \beta_j x_{jt}) \tag{10}$$

The conditional probability of default on realization f_t of random factor at time t corresponding to the default probability (10) is given by formula (11).

$$p_i(f_t) = P(U_{it} < \frac{\beta_0 + \sum_{j=1}^{N} \beta_j x_{jt} - \sqrt{\rho} f_t}{\sqrt{1-\rho}}) = \Psi(\frac{\beta_0 + \sum_{j=1}^{N} \beta_j x_{jt} - \sqrt{\rho} f_t}{\sqrt{1-\rho}}) \tag{11}$$

The same result is obtained under the assumption that macroeconomic indicators are considered as a part of the factor of assets return independent on firm i at time t. This concept is used for example in (Hamerle, Liebig, Scheule (2004). Formally,

$$R_{it} = \alpha F_t + \beta_0 + \sum_{j=1}^{N} \beta_j x_{jt} + \omega U_{it} \tag{12}$$

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[6] The unobservable factor, or latent factor, is a random variable representing the return on assets of firms which is common to firms in the whole economic sector studied. The realization of this random variable cannot be observed, but one can make an assumption regarding its distribution. A normal distribution of this variable is considered here, although other forms of distribution, such as a logistic distribution, could also be used.

If very high number of borrowers in portfolio is assumed, all counterparties have the same individual probability p_i and all default events are independent, then according the "law of large numbers" default rate on the portfolio can be estimated as individual default probability.

$$P(p(f_t) = p_i(f_t) \mid F_t = f_t) = 1 \tag{13}$$

Unconditional default probability can be obtained by

$$p_t = P(Y_t = 1) = \int_{-\infty}^{+\infty} P(Y_t = 1 \mid F_t = f_t)\phi(f_t)df_t = \int_{-\infty}^{+\infty} p(f_t)\phi(f_t)df_t, \tag{14}$$

where ϕ is density function of the standard normal distribution.

Random factor is assumed independent between borrowers. Number of defaults $D_t(f_t)$ at time t has binomial distribution with conditional default probability $p(f_t)$ and given number of companies N_t.

$$D(f_t) \approx Bi(N_t, p(f_t)) \tag{15}$$

Conditional probability of having exactly d_t default at time t can be expressed as

$$P(D_t = d_t \mid F_t = f_t) = \binom{n_t}{d_t} p(f_t)^{d_t} (1-p(f_t))^{n_t-d_t}. \tag{16}$$

Unconditional probability can obtained as an integral over the random factor.

$$P(D_t = d_t) = \int_{-\infty}^{+\infty} \binom{n_t}{d_t} p(f_t)^{d_t} (1-p(f_t))^{n_t-d_t} \phi(f_t)df_t \tag{17}$$

Parameters of model (9) or (11) can be estimated whereby log-likelihood function. Number of defaults D_t is conditional binomial distributed random variable with number of borrowers N_t and conditional probability $p(f_t)$ according equation (15). Realization d_t and n_t of random variables D_t and N_t are known. Unconditional number of defaults can be computed by integral over the random effect (14). Log-likelihood function depends only on parameters β and ρ. Formally for model (9)

$$l(\beta,\rho) = \sum_{t=1}^{T} \ln\left\{ \int_{-\infty}^{+\infty} \binom{n_t}{d_t} \Psi\left(\frac{\beta_0 - \sqrt{\rho}f_t}{\sqrt{1-\rho}}\right)^{d_t} \left[1 - \Psi\left(\frac{\beta_0 - \sqrt{\rho}f_t}{\sqrt{1-\rho}}\right)\right]^{n_t-d_t} \phi(f_t)df_t\right\} \tag{18}$$

Log-likelihood function for model (11) can be expressed similarly by equation (19).

$$l(\beta_0,...,\beta_N,\rho) = \sum_{t=1}^{T} \ln\left\{ \int_{-\infty}^{+\infty} \binom{n_t}{d_t} \Psi\left(\frac{\beta_0 + \sum_{j=1}^{N}\beta_j x_{jt} - \sqrt{\rho}f_t}{\sqrt{1-\rho}}\right)^{d_t} \dots \right.$$

$$\dots \left[1 - \Psi \left(\frac{\beta_0 + \sum_{j=1}^{N} \beta_j x_{jt} - \sqrt{\rho} f_t}{\sqrt{1-\rho}} \right) \right]^{n_t - d_t} \phi(f_t) df_t \right\} \tag{19}$$

The generalized version of the one-factor model is multi-factor model which assumes *M* correlated factors in the economy. This framework can be interpreted as a world of the *M* economies or countries where factor is common for all firms of the appropriate economy or country. These *M* economies are related, because there is correlation between factors. A two-factor model is discussed for example in Céspedes and Martín (2002). A continuous version of three-factor model can be found in Hui, Lo and Huang (2003). However due to lack of data, only one-factor model was estimated in this paper for the aggregate Czech economy.

4. Macroeconomic Credit Risk Model of the Czech Economy

This paper focuses on the macroeconomic default rate model in the Czech economy (Jakubík 2006). The aim is to produce a model allowing us to estimate the expected proportion of bad loans in the total loan portfolio of banks in response to the evolution of key macroeconomic indicators. The proportion of bad loans is one of the inputs to the stress testing model developed by the Czech National Bank (CNB).[7] It has had so far been regarded as a constant parameter estimated from extreme historical events. The new approach enables modelling of the impacts of various macroeconomic shocks on loan portfolio quality and subsequently, in combination with the stress-testing system, on the capital of the entire banking system. Such shocks may be set either expertly on the basis of historical experience or constructed in the form of alternative scenarios linked to the CNB's main macroeconomic forecasting model.

4.1. Used Data

Quarterly data for the Czech economy have been used for all calculations. The model is based on time series of total aggregate bad loans in the economy and selected macroeconomic indicators.

4.2. Bad loans

The (dependent) credit risk variable or default variable estimated in the model can be defined in several ways. A default event is commonly defined as a

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[7] The stress testing methodology is described in detail by Čihák, and Heřmánek (2005).

breach of payment discipline. A 12-month default probability is usually employed in credit risk assessments. This is defined for a given moment as the probability of a default event occurring in a 12-month period following that given moment, provided that the given person did not default in the period immediately preceding the given moment. This definition thus corresponds to new default events in the economy.

In our model, the default rate was modeled by the proportion of new bad loans in the total volume of loans in the economy.[8] Quarterly time series of new bad loans were available from 1997 Q1 to 2005 Q3. They were, however, affected by one-off measures entailing reclassification of outstanding mortgage-backed loans in 1999-2001.[9] This period saw significant deviations in the calculated proportion of newly classified loans in the banking portfolio. However, this reclassification did not in fact change the true quality of these portfolios and can be seen as a way of making the indicator of the stock of classified loans more realistic.

FIGURE. – **Corporate default rates in the Czech economy (quarterly data)**
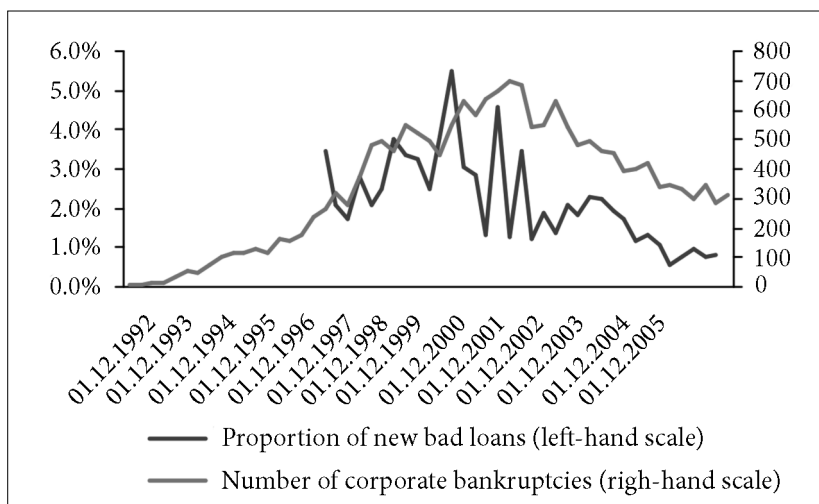
The special (dummy) variable used took a value of 1 for quarters when the monitored indicator saw significant deviations from the observed trend. The

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[8] That is, loans which became "bad" in the given quarter. The moment of default means the time when the loan was classified as substandard or worse for the first time. Shifts within the "bad" loans category (for example, a further downgrading of the loan from doubtful to loss) will not affect the default rate according to this definition. This variable does not correspond to the proportion of total non-performing loans, which are not an optimum measure of credit risk as they may include loans which were first classified a very long time ago and which remain in the loan portfolio, for example, for accounting purposes and are not related to the current economic situation.

[9] CNB Provision of 17 September 1997 stipulating the principles for classifying loan receivables and for provisioning for these receivables, as amended.

quarters include 1999 Q3, 1999 Q4, 2000 Q4 and 2002 Q2. In other cases, this variable takes the value of 0. The dummy variable so defined corresponds to the effect of changes in the approach to loan classification.

An alternative approach to approximating the default rate in the economy is to use time series of the number of adjudicated bankruptcies or compositions. This approach has been used, for example, to estimate the macroeconomic credit risk model of the Finnish economy.[10] For the Czech Republic, such data have been available since the start of the transformation. However, they have probably had higher information content only since the late 1990s.[11]

The quarterly development of the number of adjudicated bankruptcies in the Czech Republic is demonstrated in Figure 1. In practice there seems to be a lag between the filing of petition for bankruptcy and the actual adjudication, and the default event in the loan portfolio usually precedes the adjudication of bankruptcy. The application of such time series for the Czech economy may also be limited by the frequent amendments made to the relevant legislation. Given these facts, the time series of bankruptcies in the end was not used to estimate the macroeconomic credit model for the Czech economy. Nevertheless, chart 1 confirms the similar development of this time series and the share of growth in classified loans in the loan portfolio.

4.3. Considered Macroeconomic Indicators

Various macroeconomic indicators are used as explanatory variables relating to the indicator of the default rate in the economy. Interest rates and gross domestic product are most commonly considered in this context in literature.[12] Gross domestic product (GDP) is a basic indicator of the cyclical position of the economy. A decline or low growth in GDP affects credit risk, for example via a negative effect on corporate earnings, wage growth, unemployment or prices of assets (such as real estate), which, in turn, leads to a deterioration in loan portfolio quality. A rise in interest rates affects the loan portfolio in a similar way, increasing the costs of corporate and household financing, decreasing the market value of assets, etc.

In the case of GDP, annual real GDP growth was applied. One-month and one-year PRIBOR[13] interbank rates were considered as nominal interest rates. Real interest rates were deflated ex post by the consumer price index.

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[10] Macroeconomic models of the credit risk of the Finnish economy using the number of corporate bankruptcies can be found in Virolainen (2004), and Jakubík (2006).

[11] The time series of bankruptcies shows that the number of bankruptcies at the start of the 1990s was very low, probably as a result of inadequate legislation.

[12] For a discussion of the issue of explanatory macroeconomic indicators, see, for example, Virolainen (2004), Deutsche Bundesbank (2005), Rösch (2003) and Jakubík (2006).

[13] Prague Interbank Offered Interest Rate

The real effective exchange rate and the nominal koruna-euro and koruna-dollar rates[14] were also considered among the explanatory variables. They are important for credit risk given the nature of the Czech economy as a small open economy where the financial condition of the corporate sector in particular strongly depends on the exchange rate. The last indicator used was the level of indebtedness of the economy, measured by the ratio of client loans to GDP, which approximates the exposure of the financial sector to the rest of the private sector.

In selecting the set of macroeconomic indicators, the issue of the interpretability of the results obtained was also taken into account. Emphasis was put on obtaining the relationship between credit risk, represented by growth in bad loans in the banking portfolio, and the macroeconomic indicators which already enter the stress testing scenarios.[15] Another partial limitation on the selection of the variables was the effort to link this credit risk model to the results of the CNB's macroeconomic forecast. Although many macroeconomic indicators were considered, finally only GDP, interest rate and inflation were included into the model.[16]

4.3. Model Estimation

We employed the concept of the one-factor model. However, the total number of firms and the number of firms in default in the economy were not available for individual periods for the model estimation (formula 15).Aggregate data on growth in banks' bad loans were employed in the estimation of the model for individual quarters in place of bankruptcies data. To this end, we made following additional assumptions. Each koruna of a loan was considered an individual loan of a single client. In such case, therefore, the random variable D corresponds to the number of new bad koruna loans, or the growth in the volume of bad loans, while N stands for the total volume of loans granted. A default event is represented here by non-repayment of a loan of CZK 1. Under these assumptions, the volume of bad loans can be modelled by means of the relation (15).[17] The model was estimated by maxi-

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[14] An internal CNB calculation based on CPIs and continuous weights corresponding to the average previous annual trade turnover was used to calculate the real exchange rate.

[15] These indicators thus affect the resulting capital adequacy in the stress testing through two channels. The first acts directly via their effect on banks' balance sheets, while the other operates indirectly via the estimate of credit risk.

[16] Other macroeconomic indicators as a indebtedness of the non-financial sector (corporate and households), unemployment rate, nominal and real exchange rate, money aggregate, etc. were considered. However no one of them increased performance of the model and relevant estimated coefficients were not significant.

[17] The assumption regarding koruna loans is somewhat simplified, as koruna loans are not in fact independent. The ideal solution would be to use real default rates of clients in default divided by total number of clients. However this data are not available. Nevertheless all tests of the model shows that model is robust enough and used assumption mentioned above does not destroy the result of a regression.

mization a likelihood function containing a random latent factor, which was assumed to have a standard normal distribution.

Taking into account the criteria for the selection of variables relating to the stress testing scenarios and the outputs of the CNB's macroeconomic forecast, we selected the statistically best model containing GDP, the nominal interest rate, inflation and the dummy variable for the purposes of a change in methodology with a subsequent one-off impact on reclassification of the loan portfolio.[18] The selected model is in line with macroeconomic stress test scenarios and outputs of the macroeconomic prediction model of the Czech National Bank.

In the case of GDP, non-lagged annual real GDP growth was used. The statistically most significant interest rate was the nominal 1Y PRIBOR lagged by four quarters. In the case of inflation, the annual rate of growth of the average quarterly CPI lagged by two quarters was the most significant. The model was also tested without the dummy variable. This gave very similar results, although it slightly overestimated the default rate at the end of the period under review, showing that the chosen model has some degree of robustness. Table 1 demonstrates results of the estimated model of aggregate default rate in the Czech economy. All the coefficients were significant at the 5 per cent confidence level. The default rate in the economy is negatively related to gross domestic product, hence higher GDP growth leads to lower credit risk. By contrast, the level of credit risk is positively related to interest rates, which is also consistent with economic intuition. Including inflation in the model reduces the effect of nominal interest rates lagged by four quarters by real inflation lagged by two quarters. For this reason, the estimate of the coefficient representing inflation in the model is negative. The combination of nominal interest rates and inflation demonstrates that the credit default rate in the Czech economy depends on real interest rates rather than nominal rates, although the estimated coefficients are not exactly the same and have different lags. The statistical significance of the effect of the unobservable component shows that this factor is still necessary for explaining the dependent variable, despite the inclusion of macroeconomic indicators.[19] This result implies that the default rate in the economy is also affected by other factors than macroeconomic indicators considered.

The following equation (20) of one-factor model (10) express estimated relation for the aggregate default rate in the Czech economy.[20]

$$df_t = \Psi(\text{-}2.0731\text{-}4.9947 gdp_t + 2.7839 R_{t\text{-}4}\text{-}2.4364 \pi_{t\text{-}2} + 0.3296 dum_t) \quad (20)$$

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[18] We tried to use real interest rate instead of lagged nominal interest rate and inflation. However the performance of such estimated model decreased.

[19] The latent factor expressed the unobservable part of the macroeconomic risk in the model, which cannot be explained by macroeconomic indicators.

[20] Ψ denotes standard normal distribution function, *df* denotes quarter default rate, index *t* denotes appropriate time.

TABLE 1. – **Macro credit risk model (10) of the Czech Economy**

Description of variable corresponding to estimated coefficient	Denoted by	Estimate	Standard error	Pr>|t|
Constant	c	−2.0731	0.1019	<0.0001
Gross domestic product	hdp	−4.9947	1.9613	0.0162
Nominal interest rate	R_{t-4}	2.7839	0.9076	0.0045
Inflation	π_{t-2}	−2.4364	1.0994	0.0344
Dummy	dum	0.3296	0.06629	<0.0001
Effect of latent factor	ρ	0.01211	0.003243	0.0008

The dummy variable will continue to take the value of zero for the credit risk prediction. This implies that relationship (20) can be simply rewritten in the form of (21) for the purposes of the quarterly default rate prediction.

$$df_t = \Psi(-2.0731 - 4.9947\,gdp_t + 2.7839\,R_{t-4} - 2.4364\,\pi_{t-2}) \quad (21)$$

The coefficients from equations (20) and (21) cannot be simply interpreted as the commonly used elasticities of impacts of the relevant macroeconomic factors on credit risk, as they are further recalculated using the cumulative distribution function of a normal distribution; hence their impact is not linear. A simple sensitivity analysis of the impacts of changes in macroeconomic variables is given in next subsection 4.3.

FIGURE 2. – **Performance of the one-factor model for the Czech economy**
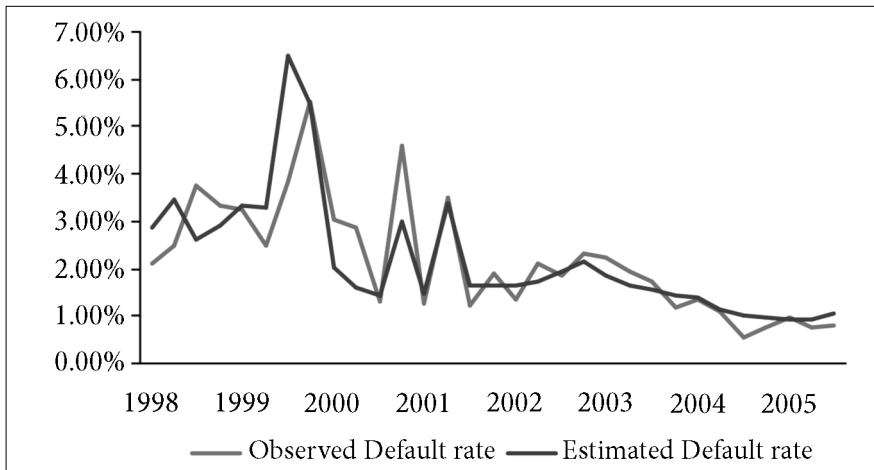
The ability to explain the quarterly default rate by means of the estimated model (20) is shown in figure 2. The estimated model is version of the binary choice model,[21] to which the standard approaches to measuring the statisti-

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[21] Binary models generally consider situations with two possible realizations of a dependent variable (0,1).

cal significance of an estimate cannot be applied. However, there are numerous less common indicators which can be applied and which suggest that the model has a good performance.

One of the tests of model quality is a test of the hypothesis that all the coefficients βj except the constant member are zero ($H_0 : \beta_1 = \beta_2 = \ldots = \beta_N = 0$). This hypothesis can by tested by likelihood ratio $\lambda = L_C/L_U$, where L_C denotes likelihood function of constrained model and L_U likelihood function of unconstrained model. The known result says that $-2\ln\lambda$ is an asymptotic chi-squared distributed variable with N degrees of freedom.[22] The result of the test rejected the hypothesis at a significance level of less than 1%.

The observed criteria of pseudo coefficients of determination based on the likelihood function also bear out the good quality of the model. These coefficients should be in the interval [0,1], with results close to 1 attesting to very good model quality.

$$R_E{}^2 = 1 - \left(\frac{\ln L_U}{\ln L_C)}\right)^{-\frac{2}{n}\ln L_C} = 0.97 \ \ \text{Estrella (1998)} \tag{22}$$

$$R_{CU1}{}^2 = 1 - \left(\frac{L_C}{L_U}\right)^{\frac{2}{n}} = 0.95 \ \ \text{Cragg-Uhler (1970)} \tag{23}$$

$$R_{CU2}{}^2 = \frac{1 - \left(\frac{L_C}{L_U}\right)^{\frac{2}{n}}}{1 - L_C{}^{\frac{2}{n}}} = 0.95 \ \ \text{Cragg-Uhler (1970)} \tag{24}$$

$$= 0.80 \ \ R_{VZ} = \frac{2(\ln L_U - \ln L_C)}{2(\ln L_U - \ln L_C) + n} \frac{2\ln L_C - n}{2\ln L_C} = 0.80$$

$$\text{Veall-Zimmermann (1992)} \tag{25}$$

The residuals of the model (20) were tested for autocorrelation. The model revealed the absence of autocorrelation in the residuals at the 5% significance level.

Furthermore the heteroskedasticity was investigated by Breusch-Pagan test. We ran the following regression.

$$\varepsilon_t^2 = c + \beta_1 gdp_t + \beta_2 R_{t-4} + \beta_3 \pi_{t-2} + \beta_4 dum_t + \upsilon_t \tag{26}$$

We tested the following null hypothesis H_0 against alternative hypothesis H_1. H_0 means that square residuals do not vary with any of the original repressors.

$$H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$$
$$H_1 : \beta_j \neq 0, \ j \in \{1, 2, 3, 4\}$$

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[22] The known result of the distribution is mentioned, for example, by Rao (1973).

We were not able to reject the null hypotheses. The present of the heteroskedascticity was not proved. It seems that estimation of the model (20) is not biased due to the properties of the residuals.

4.5. Use of the model in stress testing

Using the estimated model, the impacts of macroeconomic shocks on the default rate of the banking portfolio can be tested at the level of the aggregate economy. The estimated model is based on quarterly time series, so the estimated default rate is also a quarterly figure, which needs to be annualized for the purposes of stress testing. Two approaches are possible for solving this problem. First, quarterly default rate multiplies by four, which is the upper estimate of the annual default rate. Second, calculation of the four quarter default rates and their sum under the assumption that observed portfolio does not change. In order to forecast the default rate, we have to set the inputs to the macroeconomic credit risk model, which will also be used as the stress testing parameters. They include non-lagged annual real GDP growth rate, nominal annual interest rates lagged by four quarters and annual inflation lagged by two quarters relative to the forecast horizon. These values can be set either expertly or as a percentage deviation from the macroeconomic forecasts drawn up by the CNB or as outputs from the CNB's macroeconomic model under an assumption of significant, improbable, but not entirely impossible, negative macroeconomic shocks. The following table 2 gives the results of the macroeconomic credit risk model for different combinations of values for GDP growth rate, nominal interest rate and inflation rate. These are merely illustrative examples of the sensitivity of the credit risk indicator for different combinations of the explanatory variables, and are not the actual values entering the stress testing.

Table 2 shows that the sensitivity of credit risk for example to a change in GDP growth of 1 percentage point differs ceteris paribus depending on the rate of such growth. For higher GDP growth rates, the impacts of a decline in growth of 1 percentage point are lower than for lower growth rates. The underlying reason is that the chosen variant of the model or estimation of the model (21) uses a calculation based on the standard normal distribution function. A similar conclusion applies to the other variables in the model.

The results of the macroeconomic credit model are used in the current version of stress testing for estimating the proportion of bad loans in the portfolio, which is then entered in the stress testing as an input parameter. The credit risk model allows us to generate bad loans in the banking portfolio as a result of a shock in the form of a change in real GDP growth, nominal interest rates or inflation.

TABLE 2 – **Sensitivity analysis of the model (quarterly change in bad loans in response to the value of exogenous variables).**[23]

CPI	R	GDP Growth Rate							
		−1%	0%	1%	2%	3%	4%	5%	6%
1%	2%	2.3%	2.1%	1.8%	1.6%	1.4%	1.2%	1.1%	1.0%
	3%	2.5%	2.2%	2.0%	1.7%	1.5%	1.3%	1.2%	1.0%
	4%	2.6%	2.4%	2.1%	1.8%	1.6%	1.4%	1.3%	1.1%
	5%	2.8%	2.5%	2.2%	2.0%	1.8%	1.5%	1.4%	1.2%
	8%	3.4%	3.0%	2.7%	2.4%	2.1%	1.9%	1.7%	1.5%
2%	3%	2.3%	2.1%	1.8%	1.6%	1.4%	1.3%	1.1%	1.0%
	4%	2.5%	2.2%	2.0%	1.7%	1.5%	1.4%	1.2%	1.0%
	5%	2.7%	2.4%	2.1%	1.9%	1.6%	1.5%	1.3%	1.1%
	8%	3.2%	2.9%	2.6%	2.3%	2.0%	1.8%	1.6%	1.4%
3%	4%	2.4%	2.1%	1.9%	1.6%	1.4%	1.3%	1.1%	1.0%
	5%	2.5%	2.2%	2.0%	1.8%	1.6%	1.4%	1.2%	1.1%
	8%	3.0%	2.7%	2.4%	2.2%	1.9%	1.7%	1.5%	1.3%
4%	5%	2.4%	2.1%	1.9%	1.7%	1.5%	1.3%	1.1%	1.0%
	6%	2.5%	2.3%	2.0%	1.8%	1.6%	1.4%	1.2%	1.1%
	8%	2.9%	2.6%	2.3%	2.0%	1.8%	1.6%	1.4%	1.2%

5. Conclusion

We have investigated macroeconomic models of default rate estimation. Concept of a latent factor model which is based on the Merton idea was followed. These models were originally employed in individual credit risk modeling. Unobservable factors are integral part of the models. The standard normal distribution of the unobservable factor is usually assumed. A static version of this model was considered for the all estimations in this paper. Coefficients can be estimated by likelihood function. Solution of a maximisation problem leads to the integral over the random effects.

In order to develop a macroeconomic credit model for the Czech economy, we used a one-factor Merton-type model estimated for the aggregate economy. The model confirmed a very strong link between bank portfolio quality and the macroeconomic environment. The estimated macroeconomic credit risk model was incorporated into the existing version of stress testing.

Despite of good performance of the aggregate model, sectoral models would be desirable. Impact of the macroeconomic indicators on the household and corporate sector credit risk should be different. Sectoral analysis could help to distinguish these effects. The others difficulties of the model are related to the incorporation into stress testing. The current framework assumes the

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[23] The sensitivity analysis uses non-lagged GDP growth, CPI inflation lagged by 2 quarters and nominal interest rates lagged by 4 quarters.

worst possible scenario for a variable referred to as "loss given default", i.e. a 100 per cent loss. The modeling of the impact of macroeconomic shocks on the volume of bad loans in the portfolio could be made more precise by estimating a model of loss given default as a function of the probability of default based on aggregate data. Further possible improvements to the default rate modeling of the Czech economy would be to make the model dynamic. This approach is able to capture non constant assets volatility. Nevertheless numerical solution of such models is fairly complicated.

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THE IMPACT OF THE BUSINESS ENVIRONMENT ON MANAGEMENT ACCOUNTING PRACTICES: LIBYAN EVIDENCE

The paper focuses on the management accounting change processes and practices in Libyan companies. Research concentrates on the concept of management accounting change in a developing country and in particular on the Libyan companies and how the companies have responded to the changes in business and regulatory environment in the process of transition from a centrally planned economy to an economic model where markets play a prevalent role. In order to eliminate usual reservations on the country studies of this kind, the paper discusses a number of environmental factors in relation to a large number of management accounting practices present in the Libyan companies and presents the change in the usage patterns over the period of time. The paper is well-grounded in dominant management accounting change and surveys well literature from the early 1980s to the 2000s, with the particular, but by no means exclusive, focus on the contribution of new institutional economics to the better understanding of the process of management accounting change. The paper initially endorses the contingency theory, but again, not in a highly exclusive manner. The study finds that there has been a significant increase in management accounting models and practices in Libyan companies since 1997 when the reform has been institutionalised, and it is true across the sectors: public, private, small and large companies equally endorse new or innovative practices. The changes have contributed to the better performance of the Libyan companies, but again not to the extent a watchful scholar would expect. Interestingly, the introduced changes have also had a positive impact on the environment and long-term changes in the business environment.

1. INTRODUCTION

It is widely agreed that the business environment within which organisations operate, affects the management accounting systems used in these organisations (Amat, Carmona and Roberts, 1994; Hoque and Hopper, 1997; Bhimani, 1992; Anderson and Lanen, 1999; Haldma and Laats, 2002). This association is described as a cause-effect relationship, where any change in the business environment will cause a change in management accounting systems (Kaplan, 1985; Wijewardena and De Zoysa, 1999). It is also argued that change in the broad business environment, such as the growth of privatisation, deregulation of the economy, liberalisation of markets and increased competition, generally results in a change in the management accounting practices adopted by organisations operating in this environment (Anderson and Lanen, 1999; Jaruga and Ho, 2002; Baines and Langfield-Smith, 2003).

Using a contingency theory framework, this study examines the impact of the change in the Libyan economy, as well as other organisation-specific factors, on the management accounting practices of 79 Libyan companies. A

wide set of management accounting practices are examined, related to different managerial functions including: costing, planning and control, short-term decision-making, investment appraisal, financial performance evaluation, competitive analysis and operational control. We provide evidence on changes in management accounting practices, as well as changes in the ways of using these practices in companies from different sectors.

This paper contributes to the existing management accounting literature in different ways. First, the study investigates the issue of management accounting change in the context of the developing economy of Libya, which relies heavily on the oil industry as the main source of national revenue, and has experienced a process of reform from a centrally planned system to a market-oriented mechanism. It adds to the limited existing literature in this area, especially with respect to developing economies (Haldma and Laats, 2002). Second, as an attempt to respond to the criticism that change might be caused by other hidden factors and not those under investigation (Waterhouse and Tiessen, 1978; Otley, 1980; Innes and Mitchell, 1990; Fisher, 1995), this study investigates a wide range of environmental factors in relation to a large number of management accounting practices used for different managerial purposes and compares the usage of these practices over time.

The remainder of this paper is organised as follows. Section 2 presents a brief summary of the existing literature; section 3 presents the research hypotheses followed by the research methodology in section 4. Section 5 reports the study results, while a discussion of the results is provided in section 6. Finally, section 7 provides a summary and conclusion.

2. LITERATURE REVIEW

Management accounting change is defined as the ability of management accounting systems to adapt to changes in an organisation's business environment (Macy and Arunachalam, 1995). The business environment comprises a large number of factors that can generally be classified into external and internal factors[1] (Macy and Arunachalam, 1995; Drury, 2000). A number of external factors have been examined in the literature, including: uncertain and changing market (Bruns and Stalker, 1961; Lawrence and Lorsch, 1967; Lawrence, Gordon and Miller, 1976; Waterhouse and Tiessen, 1978; Chong and Chong, 1997; Wijewardena and De Zoysa, 1999; Reid and Smith, 2000; Baines and Langfield-Smith, 2003); market competition (Khandwalla, 1972; Jones, 1985; Libby and Waterhouse, 1996; Mia and Clarke, 1999); and change in manufacturing technology (Waterhouse and Tiessen, 1978; Rockness and Shields, 1984; Jones, 1985; Bruggeman and Slagmulder, 1995; Abernethy, Lillis, Brownell and Carter, 2001; Baines and Langfield-Smith, 2003).

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[1] Innes and Mitchell (1990) classify change factors, according to their relationship with the process of change, into three groups; motivators, catalysts and facilitators. In addition, other classifications of these factors can be found in Fisher (1990), and Scapens, Ezzamel, Burns and Baldvinsdottir (2003).

Apart from the external factors, the literature provides evidence of the impact of firm-specific and internal factors on management accounting practices. Examples of these factors are: organisational size (Merchant, 1981; Jones, 1985; Szendi, Elmore and Rezaee, 1996; Libby and Waterhouse, 1996; Hoque and James, 2000; Szychta, 2002); organisational strategy (Jones, 1985; Chong and Chong, 1997; Abernethy, Lillis, Brownell and Carter, 2001; Baines and Langfield-Smith, 2003); organisational structure (Lawrence, Gordon and Miller, 1976; Merchant, 1981; Jones, 1985; Libby and Waterhouse, 1996; Reid and Smith, 2000; Baines and Langfield-Smith, 2000); task complexity and uncertainty (Rockness and Shields, 1984; Kaplan and Mackey, 1992); degree of decentralisation of authority (Waterhouse and Tiessen, 1978; Libby and Waterhouse, 1996); and production methods (Reid and Smith, 2000; Hoque and James, 2000). Furthermore, some researchers consider micro-organisational factors to be the key players causing management accounting change, with little attention paid to the macro-context factors[2].

In relation to the above-mentioned management accounting change factors, empirical research has investigated changes in different organisational and management accounting systems. While the early studies concentrated on the wider organisational systems, including accounting systems (Bruns and Stalker, 1961; Lawrence and Lorsch, 1967; Khandwalla, 1972), research has recently tended to focus more on accounting information systems (Lawrence, Gordon and Miller, 1976), management accounting practices in general (Jones, 1985; Szendi, Elmore and Rezaee, 1996; Chong and Chong, 1997; Baines and Langfield-Smith, 2003), the use of accounting information (Kaplan and Mackey, 1992; Szendi, Elmore and Rezaee, 1996; Mia and Clarke, 1999; Wijewardena and De Zoysa, 1999; Reid and Smith, 2000), cost systems (Bruggeman and Slagmulder, 1995; Abernethy, Lillis, Brownell and Carter, 2001), planning and control methods (Waterhouse and Tiessen, 1978; Merchant, 1981; Libby and Waterhouse, 1996; Hoque and James, 2000) and operational control systems (Rockness and Shields, 1984).

In addition to the above, the effect of change in management accounting practices on organisational performance has also been under investigation. The vast majority of the previous research supports the proposition that a fit between management accounting system and business environment will result in a better organisational performance (Chong and Chong, 1997; Mia and Clarke, 1999; Hoque and James, 2000; Baines and Langfield-Smith, 2003). However, some studies report a weak association between these variables (Merchant, 1981), whereas in other cases, this relationship has shown to be indirect through mediating variables, such as the managerial relevance information (Williams and Seaman, 2002).

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[2] This notion is strongly supported by researchers using the Institutional Theory perspective to management accounting change. See for instance Scapens and Roberts (1993), Amat, Carmona and Roberts (1994), Burns and Scapens (2000), Burns (2000), Collier (2001), Granlund (2001), and Soin, Seal and Cullen (2002).

In recent years, there has been a growth in research on the emerging and transitional economies, such as that of Haldma and Laats (2002) on 62 Estonian manufacturing firms, Szychta (2002) on 60 Polish firms, Zhou (1988), Skousen and Yang (1988), Firth (1996) and O'Connor, Chow and Wu (2004) in China, Hoque and Hopper (1994) and (1997) on Bangladeshi firms, Anderson and Lanen (1999) on 14 Indian manufacturing firms and Waweru, Hoque and Uliana (2004) on four South African retail companies. The common characteristic of these studies that distinguishes them from those conducted in the developed economies is their focus on change in the broad political and economical systems, considering these as the main factors causing change in management accounting practices. For example, Hoque and Hopper (1997) conclude that macro-context factors, such as political climate, government regulations, competition, industrial relations and aid agencies, have influenced factors related to budgetary procedures (e.g. budget evaluation, participation, flexibility) in a Bangladeshi company.

Keeping in view all of the above-mentioned literature, the process of the transformation of the Libyan economy from a centrally planned to a market-based system, which was launched in 1988, involved fundamental change in the regulatory context, ending the domination of the state-owned sector, which was proved to be responsible for many deficiencies obstructing the growth of the economy (Sharif, 2000; Alqadhafi, 2002). Several procedures were adopted in order to secure a successful movement towards the new market, such as encouraging individuals to establish large economic activities[3], reducing the role of the state to be limited to some public activities such as health, education and security, privatising state-owned interests and liquidating unprofitable business units (Sharif, 2000). This has led to the creation of a new business environment in which Libyan companies, especially the state-owned companies, encounter increasing market competition, which has caused deteriorations in their financial performances[4]. Based on these points, it can therefore be argued that research on the Libyan economy is worth doing. In this regard, since this study was conducted on the developing economy of Libya, which has the unique characteristic of being heavily reliant on the oil industry and has witnessed a fundamental change from a centrally planned to a market-based system, caution is therefore needed in generalising the results to other countries.

This study compares management accounting practices used before 1997 with those used at the time of carrying out the questionnaire survey, 2003.

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[3] The private sector had, from 1978 to 1988, been banned by law from owning even small economic activities.

[4] Using the annual financial reports of 21 Libyan state-owned firms for five years (1995-1999), it was found that most of these firms suffered fluctuation in their profits. In addition, through direct contact with three of these firms, the authors found that these three firms had started suffering loses in 2000 as a direct outcome of the increase in the foreign currencies exchange rates assigned for state-owned firms.

The year 1997 was chosen for a number of different reasons. First, the deregulation of the Libyan economy launched in the late 1980s and the implementation of privatisation policies in the early 1990s has made noticeable change in the structure of the economy. Allowing some time for the effect of the implementation of the new system to appear was essential in order to fulfil the objectives of this study. In accordance, it was assumed that choosing a year after the mid-1990s would be suitable. Second, in 1997, Act number 5 was issued allowing foreign investment in the Libyan market, followed by other important regulations in 1998 and 1999. Therefore, 1997 has been chosen to include the affect of these business environment changes. In addition, the distribution of the questionnaire was carried out in 2003, and the time taken to respond to the change in the market conditions may vary from one company to another; hence, allowing five to six years for companies to respond to the new business environment may improve the reliability of the study.

3. Research Hypotheses

The research hypotheses are linked to the main aim of this study to investigate the influence of change in business environment on management accounting practices used in Libyan companies. Management accounting practices considered in this study include the formal and informal information and decision-making methods that govern the allocation of organisational assets (Anderson and Lanen, 1999). The study also investigates the relationship between the change drivers and the change in management accounting practices. To fulfil these objectives, four main hypotheses are formulated as follows:

H_1: there has been a significant increase in the range of management accounting practices used in Libyan firms since 1997.

H_2: there has been a significant increase in the range of management accounting practices used in Libyan state-owned, private, manufacturing, non-manufacturing, small and large firms, since 1997.

H_3: there is a significant relationship between the effect of the change drivers and the change in management accounting practices used in Libyan firms.

H_4: there is a significant relationship between the change in management accounting practices, caused by the effect of change drivers, and the positive changes in organisational performance.

4. Methodology

4.1. The Sample

A questionnaire survey was used as the main tool for conducting this research. A total of 164 questionnaires were distributed personally to the accounting departments in different companies. The list of firms was selected from the Lib-

yan Commercial Directory[5]; however, the snowball method was used to draw the research sample, which may have caused a sample bias. Selected firms were business units of large firms, or firms in their own right. Questionnaires were distributed personally due to the poor postal service system in Libya, which could have resulted in a low response rate with the limited time in hand. A total of 86 questionnaires were returned, making a response rate of 52.4 per cent. Seven questionnaires were excluded (three for incomplete responses and four because the establishment year of the firm was after 1997, as the study compares the practices used before and after 1997). This leaves the study with 79 usable responses for analysis and a final response rate of 48.2 per cent.

4.2. QUESTIONNAIRE DESIGN

The questionnaire contained 40 questions and was organised into three main sections. Section 1 is devoted to collecting general information on the respondents (job, academic qualification and experience) and firms (ownership, industry type, year of establishing the business and number of employees). Section 2 is based on management accounting change drivers. Sixteen potential change drivers are included and the 5-point scale measure of Haldma and Laats (2002) is employed[6]. Section 3 is based on the change in management accounting practices. This section of the questionnaire is devoted to collecting data on management accounting practices used in 2003 (the time of carrying out the field research) and those used before 1997. The aim of this section is to investigate any change in the range of practices used and the way of using these practices and to examine whether the change is associated with the influence of the environmental factors mentioned above.

As the official language in Libya is Arabic, therefore, for distribution purposes, the questionnaire was translated into Arabic. All completed questionnaires were then retranslated into English.

5. RESULTS

Demographic data related to the respondents' organisational positions, academic qualifications and experience are presented in Table 1. The Table shows that all participants are from the accounting divisions, 24 are finance directors, 21 financial accountants, 20 cost accountants, 8 internal auditors, and 6 management accountants. The vast majority of participants are university graduates.

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[5] The Commercial Directory (1999), Chamber of Commerce, Industry & Agriculture, First Issue, Misurata, Libya.

[6] The 5-point scale ranges from 1 = has significantly slowed down change, to 5 = has significantly sped up change. We also added some more environmental and organisational factors to those used in Haldma and Laats (2002) as an attempt to include all the conditions which might have an impact on management accounting practices used in Libyan firms.

TABLE 1. – **Demographics of respondents**

Job Title	Management Accountant	Cost Accountant	Financial Accountant	Finance Director	Internal Auditor
	6 (7.6%)	20 (25.3%)	21 (26.6%)	24 (30.4%)	8 (10.1%)
Academic qualification	High School	Bachelor	Master	PhD	
	12 (15.2%)	51 (64.6%)	15 (19%)	1 (1.2%)	
Experience (years)	Up to 2	3–5	6–10	Above 10	
Post–qualification	–	2 (2.5%)	22 (27.8%)	55 (69.7%)	
With the current employer	–	7 (8.9%)	34 (43%)	38 (48.1%)	
In the current position	11 (13.9%)	26 (32.9%)	25 (31.6%)	17 (21.6%)	

TABLE 2. – **Classification of firms by sector, industry, year of establishment and number of employees**

Sector (ownership)	State-owned	Private			
	58 (73.4%)	21 (26.6%)			
Type of industry	Manufacturing	Retail trade	Finance	Oil and Gas	Agriculture
	29 (36.7%)	10 (12.7%)	7 (8.9%)	5 (6.3%)	3 (3.8%)
	Transportation	Service	Tourism	Construction	Hotel industry
	3 (3.8%)	8 (10.1%)	3 (3.8%)	8 (10.1%)	3 (3.8%)
Year of establishment	Before 1978	1978-88		1989-97	
	26 (32.9%)	27 (34.2%)		26 (32.9%)	
Number of Employees	Less than 50	50 to 100	101 to 200	201 to 500	Above 500
	15 (19.0%)	9 (11.4%)	13 (16.5%)	19 (24.1%)	23 (29%)

Most of the participants (97.5 per cent) have post-qualification experience of more than 6 years. More than forty-eight per cent of participants have been working in their current firms for more than 10 years, 43 per cent from six to ten years and only about 9 per cent have been working between three to five years with their current employer. More than half of the respondents have occupied their current position for more than five years, about 33 per cent for three to five years, while only 14 per cent have been in their current job for less than two years.

Table 2 presents a classification of the surveyed firms according to sector (ownership), industry type, year of establishment and number of employees. It highlights that more than 73 per cent of firms are state-owned[7], while the

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[7] More than 50 per cent of their shares are owned by the state.

remaining 27 per cent are owned by the private sector. A large proportion of the surveyed companies, 36.7 per cent, are manufacturing firms[8], followed by trade firms with 12.7 per cent, service and construction 10 per cent each, finance 9 per cent, oil and gas 6.3 per cent, and agriculture, transportation, tourism and the hotel industry with 3.8 per cent each.

About 33 per cent of the analysed firms were established before 1978, 34 per cent were established during the period from 1978 to 1988 and 33 per cent of them were established between 1989 and 1997. In terms of employee number, 29 per cent of the surveyed firms employ more than 500 employees, more than 24 per cent employ between 200 and 500 employees, while only 19 per cent employ less than 50 employees.

5.1. The Accounting Information System

Respondents to the survey were asked to indicate the change in importance of a number of accounting system objectives. As shown in table 3, all objectives have become more important, but the biggest increase can be seen in the importance of generating information for top management decision-making, with an average of 3.35, followed by control and performance evaluation (3.26), while the smallest increase can be seen with the tax purpose objective. The same order can be observed among the state-owned, manufacturing, non-manufacturing and large firms. However, among the private firms, the greatest increase is in the importance of preparing financial statements and among the small firms it is in control and performance evaluation.

TABLE 3. – **The importance of accounting information system objectives**

Objective	Mean	Sector		Industry		Size	
		S-O	P	M	N-M	S	L
Providing information for top management decision-making	3.35	3.43	3.14	3.41	3.32	3.07	3.42
Controlling and evaluating performance	3.26	3.27	3.24	3.41	3.18	3.33	3.25
Preparing financial statements	3.10	3.03	3.28	3.14	3.08	3.13	3.09
Help allocating resources to be used more effectively	2.90	2.96	2.70	3.27	2.67	2.64	2.95
Help coordinating activities	2.82	2.88	2.65	3.10	2.65	2.86	2.81
Providing information for decision-making at lower management levels	2.81	3.00	2.28	2.90	2.76	2.20	2.95
Providing a tool of communication	2.64	2.74	2.35	2.96	2.45	2.36	2.70
Tax purposes	2.63	2.57	2.81	2.59	2.66	2.60	2.64

S-O = state-owned, P = private, M = manufacturing, N-M = non-manufacturing, S = small, L = large. Respondents were asked to indicate whether there have been any changes in the importance of objectives of the accounting information system on a 4-point scale (1 = decreased, 2 = no change, 3 = slightly increased, 4 = significantly increased). The overall means are reported as well as the means of sub-group firms.

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[8] Manufacturing companies are defined as those companies which produce goods in various different ways and non-manufacturing companies as otherwise.

5.2. Change in the Range of Management Accounting Practices

To test whether there has been a significant change in the management accounting practices used in Libyan firms since 1997, for hypothesis H_1 and, specifically, among different types of firms, hypothesis H_2, t-tests for comparing means were performed. The results presented in Table 4 show that there has been an increase in the range of management accounting practices used in the analysed firms since 1997 and this increase is significant. Therefore, hypothesis H_1 is accepted, which means that there was a significant increase in the range of management accounting practices used in the surveyed firms between 1997 and 2003.

More specifically, hypothesis H_2 concentrates on the range of management accounting practices used in each of the six groups of firms prior to 1997 and in 2003. The differences in means shown in Table 4 between the state-owned and private firms as well as between the large and small firms indicate that the range of management accounting practices implemented in the state-owned firms is wider than those used in the private firms; and the difference is much wider between large and small firms. However, all *P*-values are statistically significant, suggesting that in each type of firm, the range of management accounting practices has significantly increased since 1997. Therefore, hypothesis H_2 is accepted. However, the differences in t-values would suggest that the change in the practices used in manufacturing firms is greater than in any other group of firms (t-value= 6.62), followed by the large firms (t-value= 6.34) and the state-owned firms (t-value= 5.84). On the other hand, the smallest increase in the range of management accounting practices can be observed among the small firms (t-value= 2.26).

TABLE 4. – **The change in the range of management accounting practices since 1979**

Firms	No. of cases	Mean		Std. dev.		*t*-value	*P*
		In 2003	B1997	In 2003	B 1997		
Whole sample	79	42.39	33.17	20.44	23.20	6.36	0.00
State-owned	58	32.43	24.96	15.92	18.35	5.84	0.00
Private	21	9.96	8.22	5.54	6.13	4.47	0.00
Manufacturing	29	18.43	12.65	7.38	9.02	6.62	0.00
Non-manufacturing	50	23.96	20.52	13.49	14.65	5.17	0.00
Small	15	5.87	5.30	4.33	4.587	2.26	0.03
Large	64	36.52	27.87	17.17	19.77	6.34	0.00

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[9] We list all management accounting practices and the number of firms using them before 1997 and in 2003. Using MINITAB software and $\alpha = 0.05$, we perform paired t-tests to compare the means in the two mentioned periods for the whole sample of 79 firms and for each type of firm.

5.3. MANAGEMENT ACCOUNTING CHANGE DRIVERS

This study uses the 5-point scale question format[10] developed by Haldma and Laats (2002) to ask participants about the effect of a number of change drivers on management accounting practices. The same structure of question is used in this study, adding some factors that might have a potential impact on Libyan firms. As shown in Table 5, the average score is at least 3.01 (impact of retraining programmes), which indicates that none of the factors have slowed down change. It is also apparent that the most influential factor is the change in the state regulations (mean =4.90) and this factor affected most the manufacturing, state-owned and then the large firms. The need for more detailed divisional performance information is ranked second with an overall average of 3.90, and 4.19 among the state-owned firms, followed by the manufacturing and large firms. The impact of management accounting practices existing in the market is ranked third, followed by increasing competition, dissatisfaction with the performance measurement systems, change in organisational strategic goals and change in financial performance.

These findings may indicate that most of the surveyed firms have been affected mainly by factors related to the external business environment and some other internal factors which might also be associated with these external conditions. For instance, the need for more detailed divisional performance information might be a result of poor financial performance and both could be due to the change in the state regulations and/or the increase in market competition. A similar explanation might be applicable to some other factors, such as dissatisfaction with existing performance measures or change in the strategic goals[11]. On the other hand, some other factors which may not be directly affected by the change in the external environment, such as retraining programmes, change of top management and authority of accountants, have a lesser affect on the management accounting practices in the firms that participated.

As a result of the examination of hypotheses H_1 and H_2, the increase in the range of management accounting practices used was significant among the surveyed firms as a whole and also each type of firm separately. Hence, it would seem reasonable to suggest that there is a potential relationship between the effect of change drivers and the change in management accounting practice, hypothesis H_3. In order to examine hypothesis H_3, factor analysis was performed to decide into how many components the change drivers

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[10] 1 = the factor has significantly slowed down change in management accounting, 2 = it has slowed down to some extent, 3 = no effect, 4 = it has sped up to some extent, and 5 = it has significantly sped up change.

[11] Most Libyan state-owned firms were established to fulfil some social and national objectives rather than to seek profitability. Due to the new economic direction, these firms have become more profit-oriented, which may affect their organisational systems including management accounting practices.

could be regrouped, then cluster analysis was used to regroup firms according to the impact of change drivers. Following that, chi-square statistics were performed to examine the association between the effect of change origins and management accounting change.

TABLE 5. – **Drivers that have slowed down or sped up change in management accounting systems**

Change driver and its contingency characteristic	Mean	Sector		Industry		Size	
		S-O	P	M	N-M	S	L
Change in state regulations (E)	4.90	4.48	3.00	4.52	3.84	3.00	4.34
Need for more detailed divisional performance information (OA)	3.90	4.19	3.10	4.14	3.76	3.27	4.05
Impact of management accounting practices existent in the market (E)	3.89	3.93	3.76	3.83	3.92	3.53	3.97
Increasing competition (E)	3.87	4.14	3.09	4.45	3.52	3.07	4.05
Dissatisfaction with performance measurement systems (OA)	3.70	3.88	3.19	3.83	3.62	3.13	3.83
Change in strategic goals (OA)	3.60	3.81	3.00	3.96	3.38	3.00	3.73
Change of financial performance (OA)	3.45	3.84	2.38	3.76	3.28	2.40	3.70
Change in managerial practices (OA)	3.43	3.46	3.33	3.38	3.46	3.27	3.47
Encouraging top management (OA)	3.35	3.36	3.33	3.21	3.44	3.13	3.41
Availability of competent accounting staff (OA)	3.33	3.29	3.43	3.38	3.30	3.20	3.36
Change in organisational structure (OA)	3.28	3.38	3.00	3.41	3.20	3.00	3.34
Authority of accountants (OA)	3.23	3.19	3.33	3.34	3.16	3.13	3.25
Change of top management (OA)	3.16	3.14	3.24	3.07	3.22	3.00	3.20
Change of production technology (OA)	3.10	3.12	3.05	3.27	3.00	3.06	3.11
Change of ownership (OA)	3.03	3.00	3.09	3.03	3.02	3.00	3.03
Impact of retraining programmes (E)	3.01	2.91	3.28	2.69	3.20	3.13	2.98

E = environmental aspect, OA = organisational aspect. S-O = state-owned, P = private, M = manufacturing, N-M = non-manufacturing, S = small, L = large. We report the overall means as well as the means of the sub-groups.

5.4. Factor Analysis of Management Accounting Change Drivers

It is argued that change in management accounting cannot be attributed to one particular factor. Innes and Mitchell (1990) claim that the interaction of different factors related to the internal and external business environment generate and cause management accounting change. Reid and Smith (2000) demonstrated that contingent events are not randomly distributed, but they cluster together to form particular configurations. The aim behind using the factor analysis technique in this study is to determine the appropriate number

of components into which firms can be put according to the influence of the change drivers. Therefore, the principal components analysis (PCA) technique was performed to analyse the sixteen management accounting change drivers presented in Table 6. This technique is recommended for producing new combinations of the original data, reducing the number of variables under investigation and detecting and identifying groups of interrelated variables (Westhead, 1990).

Pallant (2003) presents two requirements for the data to be suitable for factor analysis; the Kaiser-Meyer-Oklin (KMO) value must exceed 0.6 and Bartlett's Test of Sphericity (BTS) should be significant (0.05 or smaller)[12]. The PCA technique conducted in this study revealed the presence of four components with eigenvalues exceeding 1, explaining a total of 63.1 per cent (28.6, 18.4, 8.8 and 7.2 per cent) of the variance (see Table 6). Furthermore, it can be seen in the Table that components 1 and 2 explain much more of the variance than the remaining components (about 47 per cent), with component 1 contributing 28.6 per cent and component 2 contributing 18.4 per cent. Therefore, to facilitate the interpretation, it is recommended that the two components be extracted (Pallant, 2003).

TABLE 6. – **Total Variance Explained**

Compo-nent	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% Of Variance**	**Cumulative %**	**Total**	**% Of Variance**	**Cumulative %**
1	4.586	28.660	28.660	4.586	28.660	28.660
2	2.943	18.394	47.055	2.943	18.394	47.055
3	1.414	8.835	55.890	1.414	8.835	55.890
4	1.152	7.199	63.088	1.152	7.199	63.088
5	.995	6.218	69.306			
6	.917	5.731	75.037			
7	.774	4.839	79.876			
8	.586	3.665	83.541			
9	.503	3.142	86.683			
10	.499	3.118	89.801			
11	.437	2.731	92.532			
12	.342	2.141	94.672			
13	.272	1.698	96.370			
14	.247	1.547	97.917			
15	.196	1.226	99.143			
16	.137	.857	100.000			

Extraction Method: Principal Component Analysis (PCA).

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[12] The KMO value is 0.765, exceeding the recommended value of 0.6 and BTS is 0.00, which is less than 0.05, the value indicating statistical significance, supporting the factorability of the correlation matrix.

TABLE 7. – **Rotated Component Matrix**

Change driver	Direct Oblimin components Loading		Extraction Communality
	Factor 1	**Factor 2**	
Change of state regulations	.868		.792
Information needed about sub-units	.862		.770
Change in financial performance	.829		.766
Impact of competition	.763		.778
Change in strategic goals	.734		.594
Dissatisfaction with existing performance measure methods	.719		.588
Change in organisational structure	.407		.284
Change of production technology			.493
Authority of accountants		.768	.613
Encouraging top management		.743	.627
Impact of MAS existent in the market		.737	.682
Availability of competent accounting staff		.693	.693
Impact of retraining programmes	−.436	.624	.628
Change of managerial practices		.602	.524
Change of top management		.401	.693
Change of ownership			.572

Carrying out oblique rotation, two extracted components were yielded, which are presented in Table 7. The first component is dominated by four variables; change of state regulations, information needed about sub-units, change in financial performance and impact of competition, while the second component is dominated by three variables; authority of accountants, encouraging top management and the impact of management accounting systems existent in the market.

5.5. CLUSTER ANALYSIS

The factor analysis indicated that the effect of management accounting change drivers could be used to determine the number of groups into which the sample can be put. Two components of management accounting change drivers were identified across the 79 surveyed firms, and the next step was to cluster the firms according to the extent to which they were affected by those factors. The resulting clusters would each represent groups of firms that are influenced by similar change drivers. The characteristics of each cluster in terms of the mean change in the 16 change drivers are presented in Table 8. Cluster 1 contains 44 firms and has six variables that deviate by more than half a standard deviation from the respective global means.

TABLE 8. – **Cluster analysis of management accounting change drivers13**

Change driver	Cluster[15]		Global Mean	Std. Deviation
	1	2		
Change of state regulations	(+) 4.91	(−) 3.06	4.09	1.05
Information that firms affected by personal drivers needed about sub–units	(+) 4.43	(−) 3.23	3.90	.84
Change in financial performance	(+) 4.20	(−) 2.51	3.45	1.14
Impact of competition	(+) 4.39	(−) 3.2	3.86	.89
Change in strategic goals	(+) 4.02	(−) 3.06	3.59	.81
Dissatisfaction with existent performance measure methods	(+) 4.18	(−) 3.09	3.69	.85
Change in organisational structure	3.48	3.03	3.28	.68
Change of production technology	3.16	3.03	3.10	.38
Authority of accountants	3.07	3.43	3.23	.82
Encouraging top management	3.2	3.54	3.35	.92
Impact of MAS existent in the market	3.77	4.03	3.88	.96
Availability of competent accounting staff	3.07	3.66	3.33	.75
Impact of retraining programmes	2.55	(+) 3.6	3.01	1.08
Change of managerial practices	3.41	3.46	3.43	.65
Change of top management	3.11	3.23	3.16	.61
Change of ownership	3	3.06	3.02	.28

Cluster means that deviate by more than half a standard deviation from the respective global mean are typed in bold. Where: (+) indicates that the cluster mean is above the global mean, and (–) indicates that the cluster mean is below the global mean.

Cluster 1: firms have been affected positively by the change in the business environment.

Cluster 2: firms have been affected negatively by the change in the business environment.

Based on the above, the change in management accounting practices in these firms has been sped up by those variables. This cluster can be named[14] as *"firms have been affected by the change in the business environment"*. In contrast, cluster 2 contains 35 firms and its variable characteristics deviate from the global means for seven variables; six of these variables (change drivers) appeared to have no positive influence on management accounting practices. As such, this cluster can be named as *"firms have not been affected by the change in the business environment"*.

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[13] The cluster mean for each variable provides a reference point for interpreting each cluster. Cases where the cluster mean for a variable deviates by more than half a standard deviation from the respective global mean are typed in bold and are used in the description below to highlight the distin-guishing characteristics of each cluster (Westhead, 1990).

[14] The naming of the clusters for intelligibility purposes is inevitably a highly subjective process (Westhead, 1990).

5.6. THE IMPACT OF BUSINESS ENVIRONMENT ON MANAGEMENT ACCOUNTING

In this section, the relationship between the effect of change drivers, clustered above (the independent variable), and the change in management accounting practices used in the surveyed firms since 1997 (dependent variables) is tested (hypothesis H_3). As described earlier, firms have been clustered into two groups according to how they were affected by the change drivers. In addition, for this analysis and in order to carry out the chi-square test, the answers on management accounting practices were reformulated to reflect the change and recoded as "change" and "no change"[15].

Performing the chi-square test[16], we found a significant relationship between the effect of change drivers and particular management accounting practices related to costing function, planning and control, short-term decision-making, investment appraisal and operational control[17]. Table 9 shows that: first, there is a significant relationship between the introduction of a cost accounting department in the surveyed firms and the effect of change drivers, while no significant association of these change drivers and the introduction of a cost accounting post, and a management accounting post and department. The management accounting function is sometimes performed within the cost accounting department and in other cases, even by the cost accounting post within the accounting department. For instance, management accountants in Japanese organisations, particularly in large firms, are usually known as cost accountants (Wijewardena and De Zoysa, 1999).

Second, we found no significant relationship between the effect of change drivers and the change in a number of costing practices, such as the change in the cost classification methods, the change in the usage of the overhead allocation bases and the method of reallocating service departments' costs to operational departments. In this regard, the only significant relationship was found between the change in the business environment and the change in the method used to allocate overhead costs.

Third, the association between the effect of change drivers and a number of practices related to the planning and control practices was also tested. A short-term budget was indicated by the surveyed firms to be the most widely used method before 1997 and in 2003. Although there has been some in-

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[15] We asked respondents to indicate whether they used each management accounting practice before 1997 (yes or no) and in 2003 (yes or no). To perform the chi-square test, the answers were recoded as follows: if there is no change in the answers in the two periods (yes and yes, or no and no), this was recoded as "no change". On the other hand, if there is a change in the answers (yes and no, or no and yes) this was transformed to "change" in using the practice.

[16] The test was performed on a large number of management accounting practices but we listed only the significant values.

[17] Chi-square value is significant if it is equal or less than the alpha value of 0.05

crease in the number of firms preparing budgets, utilising flexible budgets, etc., these changes are not significantly related to the change in the business environment, except for the change in the starting point of preparing budgets (*P*=0.02), which has shifted from estimated production to estimated sales. This can be attributed to the increase of market competition and uncertainty, which might have forced firms to estimate the amount of sales as a starting point of the budgeting procedure, while in the past, the centrally-planned system and the domination of the state-owned sector allowed them to sell as much as they could produce or supply. Hence, as the sale of their goods was guaranteed, the main concern of these firms in the past was the number of units that they could produce.

TABLE 9. – **The association between environment (change drivers) and management accounting change**

Management accounting practice	Clusters				Chi. Sq. *P*–value
	Cluster 1		Cluster 2		
	Change	No change	Change	No change	
Existence of cost accounting department	14 (31.8%)	30 (68.2%)	2 (5.7%)	33 (94.3%)	0.01
Method used to allocate overhead costs	7				
(15.9%)	36 (81.8%)	–	31 (88.6%)	0.04	
Starting point of preparing budget	20 (45.5%)	21 (47.7%)	6 (17.1%)	19 (54.3%)	0.02
Standard costing process (constant/changeable)	15 (34.1%)	18 (40.9%)	3 (8.6%)	19 (54.3%)	0.02
Calculation of revenue variance	12 (27.3%)	32 (72.7%)	2 (5.7%)	33 (94.3%)	0.03
Analysis of revenue variance	19 (43.2%)	25 (56.8%)	5 (14.3%)	30 (85.7%)	0.01
Pricing method	27 (61.4%)	16 (36.4%)	7		
(20%)	28				
(80%)	0.00				
Pay–back period	16 (36.4%)	28 (63.6%)	2 (5.7%)	33 (94.3%)	0.003
Behavioural control	13 (29.5%)	31 (70.5%)	2 (5.7%)	33 (94.3%)	0.02

Cluster 1: firms have been affected positively by the change drivers (speed up change).

Cluster 2: firms have not been affected by the change drivers or affected negatively (slow down).

No significant association was found between the effect of business environment and the change in the use of standard costs as well as change in the type of standard costs (ideal or practical). However, there is a significant as-

sociation between the change in the environment and the increased use of changeable instead of constant standards ($P=0.02$). In addition, a significant increase is shown in calculating revenue variances ($P=0.028$) and analysing these variances ($P=0.011$), while no significant association was found with the change in the number of firms calculating and analysing cost variances, which might be due to the fact that these practices have been widely used among the surveyed firms since before 1997.

Fourth, the descriptive statistics indicated that there is an increase in the usage of accounting information for making decisions, the frequency of reporting and the participation in making decisions. Nevertheless, none of these changes was significantly related to the effect of change drivers. Moreover, regarding the short-term decision-making methods, such as break-even point analysis and product-pricing procedure, the chi-square test shows that the change in the pricing method from cost-plus and centrally controlled to market-based prices is significantly related to the effect of the business environment change. However, the increase in carrying out competitive analysis, such as competitive product in terms of price and quality, was not significantly related to the change in the environment.

In addition to the above, no significant relationship was found between the environmental factors and any of the financial performance evaluation practices, such as financial statement analysis and the preparation of contribution-based income statements for internal purposes. Regarding the operational control methods, the only significant association found is between the change drivers and the increasing use of behavioural control ($P=0.02$), whereas the relationship is not significant with the output control and self-control methods.

Table 9 also shows that there is a significant association between the effect of business environment and the increased use of payback period as an investment appraisal method, although it was shown from the descriptive statistics that there has been some increase in using other methods, such as return on investment (ROI) and net present value (NPV). In addition, the survey analysis shows no use of so-called advanced management accounting practices, such as activity-based costs (ABC) and balanced scorecard (BSC).

Based on the above analysis, it can be argued that there is a significant relationship between the effect of business environment factors (change drivers) and the change in some management accounting practices, according to which hypothesis H_3 is accepted.

5.7. The Impact of Management Accounting Change on Organisational Performance

Respondents were also asked to indicate whether the change in management accounting practices have had any impact on the performance of firms in

terms of improving financial performance, reducing costs, recovering lost market shares and/or improving the role of accountants (hypothesis H_4). In this regard, the relationship between a number of management accounting practices, influenced significantly by change drivers, and the improvement in the organisational performance, is examined.

Table 10 summarises the association between management accounting change and performance. The Table shows that all changes in management accounting practices have resulted in an improvement in the financial performance. More specifically, most of these changes, except the calculation of revenue variances, have helped in recovering lost markets. Furthermore, the change in pricing method, the way of budgeting, the way of preparing standard costs and analysing revenues variances appeared to have an impact on the four aspects of organisational performance.

TABLE 10. – **The impact of management accounting change on organisational performance**

Management accounting change	Chi-square *P*-value			
	IF	RC	RM	RA
Introduction of cost accounting department	0.005	0.073	0.041	0.198
Change in the overhead costs allocation method	0.042	0.057	0.005	0.101
Change in the pricing methods	0.001	0.000	0.001	0.026
Change in the starting point of preparing budgets	0.000	0.001	0.018	0.004
Change in standard costing process (constant/changeable)	0.035	0.007	0.000	0.001
Calculation of revenue variances	0.014	0.038	0.080	0.171
Analysis of revenue variances	0.002	0.003	0.000	0.002
Behavioural control	0.001	0.104	0.000	0.029
Introduction of pay-back method	0.045	0.123	0.003	0.079

IF = improve financial performance, RC = reduce production costs, RM = recover lost markets, RA = improve the role of accountants in the firm

On the other hand, the Table provides some surprising results, such as the relationship between the introduction of a cost accounting department and the improvement of the role of accountants in the firms, as well as the relationship between the change in the overhead-cost allocation method and cost reduction, which appears not to be significant. In addition, no significant association was found between the increase in implementing behaviour control and cost reduction. However, it is noticeable that the change in each of the listed management accounting practices is significantly associated with at least two organisational performance aspects, according to which hypothesis H_4 is accepted. The results support the conclusion of some of the previous research that the adaptation of management accounting to the change in the business environment may result in an improvement in organisational performance.

6. Discussion

The main concern of this study is to examine whether management accounting practices used in Libyan firms have experienced any change in response to the change that has taken place in the country's business environment. It is apparent that the state-owned firms use a wider range of management accounting practices than the private firms. In addition, the difference is much wider between the large and small firms. These differences did not considerably affect the change in each type of firm; that is, the examination of hypotheses H_1 and H_2 indicates that there has been an increase in the range of management accounting practices used in the surveyed firms in general, and in the different groups of firms in particular. This result supports the widely agreed notion that firms tend to use more management accounting practices when they encounter changeable and competitive market conditions. Moreover, the findings are consistent with the conclusions of a number of previous studies carried out in the transitional economies, which argues that changing the economy towards a market-based system increases the focus on and use of management accounting practices (Zhou, 1988; Skousen and Yang, 1988; Hoque and Hopper, 1994 and 1997; Firth, 1996; Anderson and Lanen, 1999; Jaruga and Ho, 2002; Haldma and Laats, 2002; Szychta, 2002; O'Connor, Chow and Wu, 2004; Waweru, Hoque and Uliana, 2004).

Furthermore, the difference in t-test values among the different types of firms may provide an indicator suggesting that the change in management accounting practices used in the manufacturing firms is the greatest among the surveyed firms, followed by the large firms and the state-owned firms. These results support the findings of a number of studies that large firms use a greater range of management accounting practices compared with small firms (Merchant, 1981; Jones, 1985; Szendi, Elmore and Rezaee, 1996; Libby and Waterhouse, 1996; Hoque and James, 2000; Szychta, 2002) and that these firms have a greater capacity for change (the more practices the firm has, the greater the change that is likely to take place) (Libby and Waterhouse, 1996).

An investigation of the management accounting change factors showed that the most effective factor was the change in the state regulations, followed by the need for more detailed divisional performance information, the effect of the practices used in firms operating in the market, then increase in market competition. These findings are to some extent different in comparison to the findings reported by Haldma and Laats (2002), where the need for more detailed divisional performance information came first, followed by the availability of competent financial staff, changes in managerial practices, advances in information technology, then tightening competition and changes in organisational structure. This could suggest that the Libyan firms have been affected by either external factors or internal factors associated with the external environment, while the Estonian firms on which Haldma and Laats (2002) conducted their study have been affected mostly by factors related to

the internal environment, more precisely organisation-specific factors. For example, the need for more detailed divisional performance information and the poor financial performance might be caused by the increase of market competition. In addition, the change of firms' strategic goals might be an outcome of the deregulation of the economy. This also raises the question of whether the external environment is directly responsible for the change in management accounting or whether it acts by affecting the internal environment, which is a key player in causing this change. This might be a venue for further research in this area.

Using factor analysis, the surveyed firms were categorised into those that have been positively affected by the business environment and others that have not been positively affected in order to test the association between the business environment and the change in management accounting practices, hypothesis H_3. Through performing chi-square statistics on a large number of practices and the ways of using these practices, the results revealed that in relation to the effect of the business environment, there has been a change in management accounting represented by the introduction of a cost accounting department and a change in a number of practices related to costing, planning and control, short-term decision-making, investment appraisal and operational control methods (refer to Table 9 for more details). This finding is consistent with the mainstream of the literature and also the contingency theory perspective that management accounting is subject to the surrounding environment, where any pressure from this environment will result in an introduction of new practices or a reformulation of the currently used ones.

In addition, the relationship between the significantly changed practices in association with the business environment and the organisational performance reflected in improving financial performance, reducing costs, recovering lost markets and improving the role of accountants, hypothesis H_4, was tested using chi-square statistics. Despite this, the results in general suggest that there is an association between the change in management accounting practices and the improvement in organisational performance of the surveyed firms, as proposed in the previous literature (Chong and Chong, 1997; Mia and Clarke, 1999; Hoque and James, 2000; Baines and Langfield-Smith, 2003). However, there were some surprising results, such as the absence of a significant relationship between the introduction of a cost accounting department and the improvement in the role of accountants in the surveyed firms.

7. Conclusion

This study examined the change in management accounting practices used in Libyan firms as a response to the change in business environment. The overall findings can be summarised as follows. First, there has been a significant increase in the range of the management accounting practices in all types of

firms since 1997. Second, the surveyed firms were affected by either external factors, such as the deregulation of the economy, or by internal factors related to the effect of the external environment, such as the need for more detailed information and poor financial performance. Third, there is an association between the change in a number of management accounting practices and the effect of the business environment. Fourth, the change in these practices affected by the environment has resulted in an improvement in the organisational performance. The results are to a very large extent consistent with the mainstream of the literature, suggesting that management accounting is dependent on the business environment within which organisations operate.

This study uses the contingency theory perspective and the questionnaire survey method; hence, future research should explore in-depth the change in management accounting practices using a contingency theory framework and a single or multiple case-study method. In addition, other research may use institutional theory framework to investigate management accounting change in association with the micro-organisational environment. Furthermore, the change in specific management accounting practices used for particular objectives provides an avenue for future studies.

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Revenue, R is calculated as

$$R = P*V \tag{1}$$

where

– P is the selling price, and
– V is the volume of sales in units.

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