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Corporate Hedging and Risk Management Theory: Evidence from Polish Listed Companies

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This paper was published in The Journal of Risk Finance, 2008, Vol. 9 (1), pp. 20-39.

It is availabe for download at: http://www.emeraldinsight.com/10.1108/15265940810842393

Citation:

Klimczak, K.M, (2008), Corporate Hedging and Risk Management Theory: Evidence from Polish Listed Companies, The Journal of Risk Finance, Vol. 9 (1), pp. 20-39.

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Purpose

This paper aims to provide a comprehensive empirical assessment of major contemporary corporate hedging theories: financial theory, agency theory, stakeholder theory and new institutional economics.

Methodology/Approach

Hypotheses regarding determinants of hedging are tested on a sample of 150 companies listed at the Warsaw Stock Exchange. The panel covers a period of five years (2001-2005). Unlike in previous research the tests are organised around theories rather than individual hypotheses. In addition to classic tests, CART analysis is used to verify hypotheses.

Findings

Results show low empirical verification of all theories considered. However, results support some single hypotheses. Tests identified currency exposure, market-to-book value, IT and service sectors, and size as determinants of hedging.

Research limitations/implications (if applicable)

Results provide evidence for low usefulness of contemporary theories. New models are needed to explain hedging behavior more accurately.

Practical implications (if applicable)

Results identify characteristics shared by firms that use hedging. Companies which consider implementing hedging can check whether they share these characteristics.

Originality/value of paper.

This paper adds to risk management research by providing strong empirical evidence of theory verification status. It can serve as a base for future conceptual research.

Paper type: Research paper

Keywords: corporate risk management, hedging, derivatives

Corporate Hedging and Risk Management Theory: Evidence from Polish Listed Companies

Many empirical studies have attempted to find support for different theories of corporate financial risk management. However, most of them failed to determine which theories are supported by empirical observation of corporate hedging and which are not. After a spate of new research in this field in the late 1990's there have been few studies that added to our understanding of corporate hedging behaviour. Incidentally, most valuable papers in recent years concentrated on methodological issues such as the endogeneity problem (Jin and Jorion, 2006), inclusion of non-derivative hedging (Davies et al., 2006; Judge, 2006), and assumptions about the purpose of derivative use (Faulkender, 2005). This focus on methodological issues indicates that researchers in the field of hedging still need strong empirical evidence.

The paper examines corporate hedging models nested in four different theories of the firm: financial theory, agency theory, stakeholder theory and new institutional economics. The discussion follows a methodological strain which appears in the most recent research in the field (Davies et. al. 2006; Faulkender, 2005; Jin and Jorion, 2006; Judge, 2006). The new approach to testing suggested in this paper is to focus on theories, rather than individual hypotheses. So far, hedging research analysed hypotheses as if they were not part of a specific theory and thus no conclusions were drawn as to the verification status of the theories. However, to develop new theories we need information about empirical evidence in support of whole theories, not just selected hypotheses. Results show that none of the theories tested in this paper are supported by observation. On the other hand, individual hypotheses were verified positively: currency exposure, market-to-book value, IT and service sectors and size were identified as determinants

of hedging. These findings can be used as a base for creating models which will serve as an improved explanatory tool for analysing corporate hedging behaviour.

Statistical tests conducted in this study follow a strict methodology in order to produce robust results. Firstly, a set of hypotheses was designed following guidelines from previous research and the hypotheses are discussed in detail. Secondly, despite using a new approach to empirical verification, the results maintain comparability with previous studies in terms of hypotheses and statistical methods. Thirdly, hypotheses are tested using a wide range of statistical methods, with repeated testing of the same hypotheses, allowing verification of results. Additionally, for the first time in corporate hedging research, CART analysis is used in this study on top of traditional tests.

The dataset for this study comprises annual report data for 150 Polish listed companies in the 2001-2005 period. During this period Polish companies were already accustomed to the rules of a free-market economy, and were continuing to develop their financial management practices. They had ready access to derivatives, and were subject to national regulation based on International Accounting Standards 32 and 39. However, only one third used hedging, far fewer than in developed European or overseas markets. There is no evidence that the frequency of hedging was growing with time, nor that Poland's accession to the European Union in 2004 influenced hedging behaviour. Since hedging is less popular in Poland than in the US, UK or Germany the investigation of Polish listed companies provides a new insight into determinants of corporate hedging.

Theories and previous research

Theory of hedging was originally limited to techniques of derivative contracts use (e.g. Johnson, 1960; Working, 1953). In the 1950s risk became incorporated into theory of finance

(Miller and Modigliani, 1958); at first only as a factor in stock market risk-return calculations. With time theory of finance developed into financial economics, which became an influential theory of the firm. New models described hedging explicitly. However, financial economics approach was always limited by classical ceteris paribus assumptions. These assumptions were relaxed by agency theory, which was introduced to the theory of finance by Jensen and Meckling (1976). Agency theory takes into account asymmetries in information and control. Financial economics and agency theory were the foundation for the majority of risk management research. More recent theories relax classical assumptions even further. New institutional economics accepts limited rationality and focuses on accepted practice, while stakeholder theory looks in detail at relationships between stakeholders.

Financial economics approach

Financial economics approach to corporate risk management has so far been the most prolific in terms of both theoretical model extensions and empirical research. This approach builds upon classic Modigliani-Miller paradigm (Miller and Modigliani, 1958) which states conditions for irrelevance of financial structure for corporate value. The paradigm was later extended to the field of risk management. Rationales for hedging deduced from the irrelevance conditions include: higher debt capacity (Miller and Modigliani, 1963), progressive tax rates, lower expected costs of bankruptcy (Smith and Stulz, 1985), securing internal financing (Froot et al., 1993), information asymmetries (Geczy et al., 1997) and comparative advantage in information (Stulz, 1996). The ultimate result of hedging, if it indeed is beneficial to the firm, should be higher value – a hedging premium.

Evidence in support of the predictions of financial economics theory for corporate hedging is poor. Although risk management does lead to lower variability of corporate value

(e.g. Jin and Jorion, 2006), which is the main prerequisite for all other effects, there seems to be little proof of this being linked with benefits specified by the theory. One of the most widely cited papers by Tufano (1996) finds no evidence to support financial hypotheses, and concentrates on the influence of managerial preferences instead. On the other hand, higher debt capacity hypothesis seems to be verified positively, as shown by Faff and Nguyen (2002), Graham and Rogers (2002) and Guay (1999). Internal financing hypothesis was positively verified by Guay (1999) and Geczy et al. (1997), while it was rejected by Faff and Nguyen (2002) and Mian (1996). Judge (2006) found evidence in support of financial distress hypothesis. Tax hypothesis was verified positively by Nance, Smith and Smithson (1993), while other studies verified it negatively (Mian, 1996, Graham and Rogers, 2002). More recently Jin and Jorion (2006) provide strong evidence of lack of value relevance of hedging, although some previous studies have identified a hedging premium (Allayannis and Weston, 2001, Carter et al., 2006).

The hypotheses tested in this study include all of the above rationales, except for information asymmetries and comparative information advantage. The first two hypotheses test the underlying assumption, that hedging leads to lower volatility of company value, while the third investigates the hedging premium.

Hypothesis 1a: There is a negative relationship between hedging and stock price volatility.
Hypothesis 1b: There is a negative relationship between hedging a particular risk and stock price exposure to that risk factor.
Hypothesis 1c: Firms that begin hedging experience a rise in market value of equity.

According to debt capacity and tax incentive rationales, firms should be interested in raising their gearing ratios (hypotheses 1d and 1e), using the tax shield to full extent (1f and 1g), and lowering their tax charges (1h and 1i). Hedging facilitates such action by lowering risk of default and allowing higher debt capacity. Lower volatility of earnings may also result in lower

average tax charges if the tax curve is concave. However in Poland corporate income tax is flat-rate so this effect is not important. The last hypothesis (1j) tests for internal financing rationale.

Hypothesis 1d: There is a positive relationship between hedging and debt/equity ratio.
Hypothesis 1e: Firms that begin hedging, raise their debt equity ratio subsequently.
Hypothesis 1f: Firms with low times interest earned ratio (EBIT/interest paid), but above one, hedge more often than either firms with high ratio or lower than one.
Hypothesis 1g: Firms that hedge are able to pay their interest charges (times interest earned ratio above one).
Hypothesis 1h: There is a negative relationship between hedging and income tax paid (relative to sales).
Hypothesis 1i: Average tax charge falls after firms start to hedge.
Hypothesis 1j: There is a positive relationship between hedging and growth options, represented by high R&D expenditure or high market-to-book value ratio.

Agency theory

Agency theory extends the analysis of the firm to include separation of ownership and control, as well as managerial motivation. In the field of corporate risk management agency issues have been shown to influence managerial attitudes toward risk taking and hedging (Smith and Stulz, 1985). Agency theory also explains a possible mismatch of goals between shareholders, management and debt-holders caused by asymmetries in earnings distribution, which can result in the firm taking too much risk or not engaging in positive net value projects (Mayers and Smith, 1987). Consequently, agency theory implies that defined hedging policies can have important influence on firm value (Fite and Pfleiderer, 1995).

Managerial motivation factors which influence implementation of hedging have been empirically investigated in a few studies to an overall negative effect (Faff and Nguyen, 2002; MacCrimmon and Wehrung, 1990; Geczy et al., 1997). Notably, positive evidence was found by Tufano (1996) in his analysis of the gold mining industry in the US.

The following hypotheses are designed to test the basic implications of agency theory. The first hypothesis tests if firms hedge in order to decrease block shareholders' risk. The next

three hypotheses address the question of hedging as a tool to safeguard debt-holder interests and thus increase debt capacity. Unfortunately, because of data limitations it was not possible to test managerial option and stock holding determinants of hedging.

Hypothesis 2a: There is a positive relationship between hedging and individual block ownership.
Hypothesis 2b: Hedging is used most often by companies with high debt/equity ratios.
Hypothesis 2c: Firms start hedging more often if they have low equity/assets ratios and wish to issue debt or take out a bank loan.
Hypothesis 2d: Firms start hedging more often if they have high debt/equity ratios and wish to issue debt or take out a bank loan.

New Institutional Economics

New institutional economics theory is empirically investigated in the context of corporate hedging in this study for the first time. New institutional economics shifts the focus to governance processes and socio-economic institutions that guide these processes, as explained by Williamson (1998). Although no empirical studies of new institutional economics approach to risk management have been carried out so far, this theory offers an alternative explanation of corporate behaviour. Namely, it predicts that risk management practices may be determined by institutions or accepted practice within a market or industry (hypotheses 3a and 3d). In emerging markets, as managers and investors become more educated and institutions that support hedging develop, it can be expected that hedging will gain popularity with time (3b). Moreover, the theory links security with specific assets purchase (Williamson, 1987). This implies that risk management can be important in contracts which bind two non-diversified parties, such as large financing contracts or close cooperation within a supply chain (3c).

Hypothesis 3a: There are differences in popularity of hedging between industries.
Hypothesis 3b: The frequency of hedging changes with time.
Hypothesis 3c: Hedging is positively related to individual block ownership.
Hypothesis 3d: Hedging behaviour is influenced by ownership structure: the government, institutional investors, foreign investors.

Stakeholder theory

Stakeholder theory, developed originally by Freeman (1984) as a managerial instrument, has since evolved into a theory of the firm with high explanatory potential. Stakeholder theory focuses explicitly on an equilibrium of stakeholder interests as the main determinant of corporate policy. The most promising contribution to risk management is the extension of implicit contracts theory (a part of stakeholder theory) from employment to other contracts, including sales and financing (Cornell and Shapiro, 1987). In certain industries, particularly high-tech and services, consumers' trust in a company can substantially contribute to the company's value (hypothesis 4a). The value of implicit claims is highly sensitive to expected costs of financial distress and bankruptcy. Since corporate risk management practices lead to a decrease in these expected costs, company value rises (Klimczak, 2005). The more sensitive a company's value is to financial distress, the higher the motivation for hedging (hypotheses 4b and 4c). Nevertheless, stakeholder theory has not been tested directly yet. Investigations of financial distress hypothesis (Smith and Stulz, 1995) provide only indirect evidence (e.g. Judge, 2006).

Hypothesis 4a: Hedging is more popular among firms form IT and service sectors.
Hypothesis 4b: Companies with high market-to-book value hedge more.
Hypothesis 4c: Hedging is more common among smaller firms.

Methodology

The aim of this study is to test alternative theories of corporate hedging and determine which of them accurately identify determinants of hedging. Consequently, the study is focused on theories and not individual hypotheses. The hypotheses are tested as elements of a theory: a theory is verified positively if test results support a majority of its hypotheses. Theories which produce only partly accurate empirical predictions cannot be relied upon as a whole. Of course, empirical tests have their limitations. One cannot lightly discard theories because one hypothesis

is not verified positively. Still, when strong negative evidence accumulates, theories have to be reviewed and reformulated. The preceding section shows that evidence in support of the two main theoretical approaches, financial economics and agency theory is very weak. This study tests both approaches using the same methodology. The two more recent approaches, new institutional economics and stakeholder theory, are introduced in an attempt to check whether they can be useful in explaining corporate hedging behaviour. These two theories have not been tested yet in the field of hedging.

Data

The sample consists of 537 year-firm observations of Polish companies listed at the Warsaw Stock Exchange, both hedgers and non-hedgers. Observations were collected using consolidated annual reports from 2001 to 2005. The first three periods were used for testing. Results were verified by checking all predictions on a random sample of 30 companies for 2004 and 2005. The full sample includes only non-financial corporations. The presented approach, adopted by Nance et al. (1993), Faff and Nguyen (2002) and Berkman and Bradbury (1996) is based on the premise that banks, insurance companies and other financial sector enterprises purchase and issue derivative instruments not only for hedging but also for trading purposes. Since both in these and in this study derivative instruments use is a proxy for hedging such companies had to be excluded from the sample. After reviewing variable distribution two largest companies were removed as outliers (TP S.A. and PKN Orlen S.A.). Both of these companies use hedging extensively, but they are incomparably larger than other listed companies.

The choice of Polish listed companies for theory verification requires a comment, since there may be concerns about possible idiosyncratic factors which influence risk management in Poland. The position adopted for the purpose of this study is that verifying risk management

theory on a sample from a country which is still developing can yield results as reliable as studies based on data from richer countries. At the same time, results can add to our understanding of hedging. For the past 17 years Polish companies have been rapidly learning new business models and techniques, including financial management. There is no reason to doubt their rationality. Secondly, as a result of ongoing economic transition, there are fewer historical and institutional determinants of the current state of risk management in Poland than there might be in the US, UK, or Germany. Thirdly, since sufficient financial market infrastructure exists in Poland companies can engage in hedging. Consequently, Polish companies can implement financial risk management processes provided they find them useful. Finally, since 2001 domestic law requires companies to follow a regulation based on IAS 39. Under this regulation, disclosure of derivative instruments is mandatory, which allows reliable data collection.

Variables

The choice of the dependent variable for corporate hedging studies poses an important methodological problem. This study uses a binary proxy, which is set to value 'one' if a company uses derivative instruments and to zero otherwise. If a company uses derivatives, it is assumed to be a hedger. This construction of the hedging variable is of course subject to justified criticism. For example Faulkender (2005) stresses the importance of determining if derivatives are actually used for hedging purposes. Other authors point to the significance of non-derivative hedging (e.g. Judge 2006). Nevertheless, it is the binary proxy method that has appeared most often in risk management research; Fehle (1999), Geczy at al. (1997), Graham and Rogers (2002), Guay (1999), Mian (1996), Nance et al. (1993) all use binary variables. The main drawback of a binary proxy is that it does not measure the intensity of hedging activity. For this reason Tufano (1996),

as well as Jin and Jorion (2006) use derivative portfolio delta instead, while Faff and Nguyen (2002) use face value of contracts. The binary proxy was selected for this study for two reasons. Firstly, it allows comparison of results with the larger part of previous research. Secondly, detailed portfolio listings were not available for most companies, so it was impossible to calculate deltas. Moreover, Polish companies refrain from using hedge accounting because of cumbersome regulatory requirements and many of them do not state clearly the purpose of derivative use. Consequently, it had to be assumed that most companies use derivatives for hedging, rather than speculation. Therefore, the binary dependent variable measures derivative use, which is used as a proxy for hedging.

Variables are described in Table 1. Exposure indicators were calculated for EUR/PLN, USD/PLN exchange rates and for WIBOR, EUR LIBOR, and USD LIBOR as betas in a CAPM style rates-of-return regression, following common practice (e.g. Choi and Prasad, 1995; Bradley and Moles, 2001; Chen and So, 2002; Crabb, 2002). The indicators were later changed to absolute values, so that they measure the extent of exposure and not its direction. Since all previous studies show size to be a strong determinant of risk management practices, sales revenue was used as a scaling variable. Industry coding was done in accordance with the general nomenclature of the Warsaw Stock Exchange. Table 2 presents sample characteristics for the first three periods of analysis (2001-2003). For years 2004 and 2005 the sample was limited to 30 companies selected randomly. The smaller sample was used only to verify results of tests carried out on the main sample.

[Tables 1 and 2 here]

Results

A number of statistical methods were used to test hypotheses. Tests of means and medians were carried out first, as is usually done in studies of this field. Analysis then proceeded

to ANOVA, logit regression, and CART analysis (all of the analysis was performed in R statistics package). In some cases tests were performed using different measures (GEAR and GEAR_INT, RD and MTBV), and the one that provided better fit was chosen. The last method, CART analysis, is in essence a decision tree method for breaking a sample into two categories. It has not yet become popular in financial research but it has a number of advantages which are explained below.

All tests were carried out first for hedgers vs. non-hedgers, and then for new-hedgers vs. non-hedgers. In general tests in the second, dynamic approach provided widely varying results, both in terms of magnitude and sign, no matter what statistical method was used. Therefore results of dynamic tests are described only briefly.

Univariate tests for the difference of means (Table 3) indicate significant differences between hedgers and non-hedgers in size: hedgers tend to be larger both in terms of sales and market value of equity. This has been shown to be true in other markets by all previous studies. It is a clear proof of either barriers or strong economies of scale in derivative hedging. On the other hand, this result contradicts hypotheses 2a, 3c and 4c, all of which imply that smaller, more risky firms should benefit more from implementing hedging. Two other significant differences appear in tax charges and individual block ownership but the sign in both cases is opposite to the predictions (hypotheses 1h, 2a and 3c). Comparisons of means between new hedgers and non-hedgers show only two significant differences in the year 2002 for exposure to EUR/PLN exchange rate and WIBOR interest rate.

[Table 3 here]

Tests for the difference of medians (Table 4) confirm the results of the means test: size, tax charges and individual block holding are all significant again. However, there are also other

significant differences, because tests of medians are not as sensitive to skewed distribution as tests of means. Hedgers tend to have a higher median of foreign currency assets and liabilities. This is in fact a measure of accounting exposure, which provides a clear reason for hedging. In accordance with predictions, hedgers exhibit also lower volatility of stock prices (hypothesis 1a) and higher market-to-book value (1j and 4b). Test of new hedgers vs. non-hedgers show no significant differences.

[Table 4 here]

Analysis of variance is a suitable method for testing hypotheses which require breaking the sample into more than two groups, as is the case in hypotheses 1f, 1g, 2c, 2d, 3a-3d, and 4a. The first of these, hypothesis 1f, suggests that hedging is more popular among firms with low, but higher than one, times interest earned ratios. To test this, the sample was divided into three groups: ratio below one, ratio above one but below the median, and ratio above the median. There is no significant difference between the groups, however(F=1.5067 in 2001, 0.1588 in 2002 and 1.4844 in 2002). The second hypothesis, 1g, stated that hedgers are able to cover their interest expenses. A dummy variable was assigned value 1 if this was true, and 0 if times interest earned ratio was below one. Results show no significance, except for 2002 at 8% level (F statistic for 2001-2003 is: 0.0482, 3.1008, 0.8608).

Agency theory hypothesis 2c stated that companies motivated to hedging might be ones with low equity/total assets ratios which raise their gearing level subsequently. To test this two new variables were created: low equity/total asset ratio (split at the median) and rise in gearing (with two levels, 'increase' and 'decrease'). Results show no significant differences for any of the factors or their interaction. The F statistic for 2002 ranges from 0.0341 to 0.4130. For 2003 Kruskal-Wallis test had to be used because heterogeneity of variances was detected – the result is

insignificant (0.9917). Another agency theory hypothesis, 2d, focuses on companies with high gearing which want to increase their debt capacity. There is, however, no significant difference for either 2002 or 2003, both for debt/equity ratio calculated using total debt and interest bearing debt.

New institutional economics hypotheses concentrate on the role of trend, industry and ownership factors. Industry (3a) proves not to influence hedging, with F values of 0.8049, 0.3308 and 0.5968 for 2001-2003 respectively. Pooling companies into larger, more general industry groups did not help. There is also no significant difference between the time periods, as hypothesis 3b suggested (F=1.8981). However, testing for influence of ownership structure on hedging and starting hedging does yield some significant results (hypotheses 3c and 3d, Table 5). For this analysis ownership information was converted into dummy variables taking value 1 if a particular group of owners was present. Heterogeneity of variances was detected in 2001 data, hence Kruskal-Wallis statistic was calculated for this and the following years. Results are presented in Table 5. Results for new-hedgers vs. non-hedgers are poorer, with individual block ownership significant at 8% level in 2003 only, and the interaction with government ownership at 7% confidence level. Government ownership is also significant at 9% level for 2002. The final ANOVA test was for hypothesis 4a of stakeholder theory, which points to IT and service sectors as potentially more interested in risk management. However no significant difference was detected (F statistic: 1.9153, 0.5122, 0.3625).

[Table 5 here]

Logit regression has often been used in similar studies (e.g. Faff and Nguyen, 2002, Mian 1996). In this study variables are not pooled together in one regression model, but rather grouped in separate models for different theories. One equation for hedgers vs. non-hedgers hypotheses and another for new-hedgers vs. non-hedgers hypotheses were created for each of the theories.

To test stability of results and avoid heteroskedasticity models were estimated separately for each of the three years. Models were then verified by comparing coefficients and prediction accuracy. All significant variables maintained their sign and coefficient values changed only slightly, while insignificant variable coefficients varied widely in value. Table 6 shows results for equations estimated on 2002 data, which were consistently best in terms of significance, fit and prediction accuracy. All attempts to model new-hedgers vs. non-hedgers produced insignificant results.

Two models failed to produce any significant results: agency theory model, where hedging was expected to be correlated with individual block ownership and gearing, and new institutional economics equation, which focused on shareholder structure. It should be noted that previous tests of agency theory also produced negative results. Surprisingly, stakeholder theory model has two significant variables – MTBV and SALES – although the overall fit is low, and prediction accuracy poor. The financial economics model obtained a much better result; three variables are significant: expEUR, expUSD and MTBV. However, two variables have signs opposite to expected: exposure to USD/PLN has a negative sign (exposure variables were in absolute values), and income tax has a positive coefficient.

To compare results with previous studies all variables were then pooled together for the final Logit estimation. Table 6 shows that the model has good fit and high prediction accuracy. The significant variables are: exposure to USD and EUR exchange rates, volatility, MTBV, IT and Services sector and size (sales). Predictions were quite accurate: 67% and 70% of correct hits, with 36% and 41% of false positives. The number of false positives could be decreased, although at the expense of positive hits, by estimating an equation with only the significant variables (Table 6).

[Table 6 here]

The final method used to test the hypotheses was classification and regression trees (CART) algorithm. This method, described originally by Breiman et al. (1984), produces a decision tree consisting of a hierarchy of criteria for splitting a sample into two groups: in this case hedgers and non-hedgers. CART is non-linear and can identify differences in hedging determinants between small and large companies, rather than look at averages like other methods do. Moreover, the algorithm automatically selects best variables for classification criteria out of a larger set. Consequently, unlike in logit models, variables from all theories were put into the estimations. CART trees were estimated separately for each of the three periods and then cross-verified. Computations were done in *rpart* library for R, using equal costs of misclassification.

Similarly to logit regression the CART method failed to distinguish new-hedgers from non-hedgers, hence below only the static trees are described. The 2001 tree was dropped, because it had the lowest forecast accuracy (30%). The 2002 tree uses the industry variable twice: it is the criterion for selecting large companies that hedge, and smaller companies that do not hedge (Fig. 1). The other smaller companies are classified as hedgers if they have high exposure to EUR/PLN rate or a very high level of times interest earned ratio (above 5.43). Although high exposure to exchange rate risk could be a determining factor, provided hedging does not remove it, the interest coverage was unexpected. It seems that in 2002 hedgers were highly liquid and had no problems servicing their debt, which is contrary to hypotheses 1f and 1g.

[Figures 1-3 about here]

The 2003 tree starts by classifying all companies with sales lower than 150.881 million PLN as non-hedgers, while all companies larger than 1.2 billion PLN are classified as hedgers

(Fig. 2). Of the ones in between, the industry determines classification of hedgers in the first step, while other companies are classified as hedgers only if they have low volatility of stock price (below 0.0354) and sales higher than 268 million PLN.

The decision trees were then refined by computing them again without the industry variable. Although this variable is indicated by new institutional economics as a possibly determining factor (3a), there is a risk, that results are influenced by low number of companies in some sectors (see Table 2). The new trees are quite different from the previous ones, but maintain the same level of accuracy. The 2003 tree was discarded, as it was too branched, which made interpretation difficult. It also achieves lower accuracy (39% and 41% positive hits, 21% and 11% false positives) than the 2002 tree (Fig. 3). The 2002 tree takes two new variables: total foreign currency assets and liabilities, and market-to-book value. Among smaller companies hedgers are identified as having MTBV ratio above 1.689 – result in line with hypotheses 1j and 4b.

Results of all tests were verified by computing the tests and estimating models again on a random sample of 30 companies for the years 2004 and 2005. Tests of means and medians produce similar results in terms of the signs, though fewer variables show statistically significant differences. This was to be expected in a smaller sample, and thus consistent signs can be accepted as supporting evidence. Tests of medians produce no significant differences at all. Analysis of variance tests confirm previous results, although industry and ownership hypotheses could not be verified because the number of observations in groups was too low.

Predictions for 2004 and 2005 of significant logit models are accurate at 46%-62% level with false positives ratio ranging between 14% and 31%. As in previous tests, the pooled-variables model attains best results. CART decision trees maintain their level of accuracy in

predictions. The 2002 and 2003 trees with industry variables correctly identify between one third and 44% of hedgers with 0%-23% of false positives. The refined 2002 tree achieves accuracy of 55% and 57%, though the number of false positives is high: 44% and 22% respectively.

Discussion

Results described above show that only few of the determinants indicated by the theories were supported by the data. Out of all financial economics hypotheses the data support only 1a (lower volatility) and 1j (growth options) hypotheses. None of agency theory hypotheses prove helpful in identifying determinants of hedging. On the other hand, the two new approaches tested here, stakeholder theory and new institutional economics, do provide some potentially useful insights: hypotheses 3a (industry factors), 4a (IT and services sector), and 4b (intangible assets) were positively verified. In addition three other variables are significant: size of a company (+), exposure to EUR/PLN rate (+), and foreign currency assets and liabilities as percentage of sales (+). Finally, attempts to verify determinants of starting hedging (dynamic approach) failed, and therefore provide no basis for discussion.

The conclusion of low empirical verification of the theories may be questioned on methodological grounds. Firstly, it may be argued that the sample does not allow generalisations. However, this argument does not stand to closer inspection. Economics assumes that all people and organisations are, at least limitedly, rational, no matter in which market they act. With the exception of new institutional economics none of the theories under investigation make any reference as to cultural or country differences. Moreover, the results match those from previous studies surveyed at the beginning of this paper.

Secondly, cross-industry sample studies suffer from endogeneity issues (Jin, Jorion, 2006). We can never be sure that a significant correlation is not in fact spurious, related to a third

factor. For this reason tests for determinants of starting hedging were included in the study, following Guay (1999), although without significant results. In addition, industry variables were used and proved to be significant. Hence, industry effects were controlled.

Thirdly, it might be questioned why a panel regression was not used in logit estimation instead of separate models for each year. This has been done for two reasons. Firstly, ANOVA tests show no significant difference in hedging activity between the periods. Secondly, this design allowed cross-verification of results by running predictions from the estimated equations on the rest of sample, as shown in Table 6.

Finally, the concept of negative or low verification may be called into question. After all most studies focus on finding empirical support for theories, and either succeed or not, without drawing conclusions as to the usefulness of theories tested. This problem has been extensively discussed in the past, with arguments ranging from popperian falsification (Popper, 1959), to neo-classical non-falsification (e.g. Machlup, 1967). My position on this issue is that although we need to be careful before we discard a theory, critical testing of theories and their assumptions is essential for research progress. This study does not stand alone in showing the shortcomings of present theories, but it has been preceded by over a decade of empirical research which points clearly to low verification of theories in question. Moreover, the aim of this study is not to suggest discarding the theories but to bring the theories together, test them in a systematic fashion and provide a basis for further conceptual research in this area.

Conclusion

The results imply that Polish companies should not base their decision to start hedging on rationale suggested by theory, but rather focus on practical considerations. Polish listed companies hedge in response to direct, accounting exposure, rather than indirect or global

exposure as theory suggests. Hedging is more popular among larger companies, which indicates that costs of starting hedging are high, or that there are economies of scale. These findings should be taken into account when making a decision to engage in hedging. Moreover, since previous research in other markets has led to similar results, such an approach may be advisable in other countries as well. New cross-country studies are needed to confirm that.

The findings of this study need to be further developed in future research. On the one hand, research could focus on identifying other practical determinants of corporate hedging. This can be done only by field research, but so far field research was conducted with the use of structured questionnaires, which did not allow finding new determinants of hedging. A more open approach is needed. On the other hand, new determinants may be identified by conceptual investigations. Contemporary models of risk management can be modified to fit empirical observations better. Results of this study indicate that new institutional economics and stakeholder theory, together with selected elements of financial economics, form a useful basis for new models.

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Tables

Table 1. Description of variables

Symbol	Description	Symbol	Description
CURR	Total foreign currency denominated assets and liabilities/Sales	**investF**	Share of large foreign shareholders in equity (5% and above)
EQASS	Equity/Total assets ratio	**investGov**	Government's share in equity if above 5%.
expEIR	Exposure to euro Libor 3M interest rate	**investInd**	Share of block individual shareholders in equity (5% and above)
expEUR	Exposure to EUR/PLN exchange rate	**investInst**	Share of large institutional investors in equity (5% and above)
expUIR	Exposure to USD Libor 3M interest rate	**isssueE**	Cash inflow from issued equity/Sales
expUSD	Exposure to USD/PLN exchange rate	**issueD**	Cash inflow from issued debt/Sales
expWIR	Exposure to PLN Wibor 3M interest rate	**issueL**	Cash inflow from new loans/Sales
GEAR	Gearing - Debt/Equity ratio	**MTBV**	Market-to-book value of equity
GEAR_INT	Interest bearing gearing = Interest bearing debt/equity ratio	**MV**	Market Value of Equity
goalH	Binary variable set to TRUE if firm stated hedging as the goal of derivative trading	**RD**	R&D Expenditure - Cost of finished R&D projects/Sales
H	Binary hedging variable, set to TRUE if company disclosed derivative instruments	**riskComm**	Binary variable set to TRUE if company used commodity derivatives
INDUSTRY	Coded as: construction, chemical, timber products, machinery, energy, trade, IT, media, metal, construction materials, manufacturing, food, telecom, services	**riskFX**	Binary variable set to TRUE if company used currency derivatives
INTDEBT	Total interest bearing debt as percentage of sales	**riskIR**	Binary variable set to TRUE if company used interest rate derivatives
TIE	Times Interest Earned ratio	**TAX**	Corporate income tax as percentage of sales
SALES	Revenue from sales – proxy for firm size.	**VOL**	Stock price volatility – standard deviation of weekly rates of return

Table 2. Sample characteristics by year

		YEAR		
Variable	**Level**	**2001**	**2002**	**2003**
H	FALSE	92 (80%)	96 (70%)	110 (71%)
	TRUE	23 (20%)	41 (30%)	45 (29%)
goalH	FALSE	101 (88%)	112 (82%)	122 (79%)
	TRUE	14 (12%)	25 (18%)	33 (21%)
riskFX	FALSE	102 (89%)	111 (81%)	121 (78%)
	TRUE	13 (11%)	26 (19%)	34 (22%)
riskIR	FALSE	110 (96%)	127 (93%)	146 (94%)
	TRUE	5 (4%)	10 (7%)	9 (6%)
riskComm	FALSE	113 (98%)	134 (98%)	152 (98%)
	TRUE	2 (2%)	3 (2%)	3 (2%)
INDUSTRY	chemical	6	8	8
	clothing	5	5	5
	construction	20	21	21
	construction materials	5	5	5
	energy	2	2	3
	food	13	15	15
	IT	9	12	13
	machinery	13	13	13
	manufacturing	10	10	12
	media	4	4	6
	metal	10	12	13
	other	1	1	1
	pharmaceutical	1	1	1
	services	2	3	4
	telecom	7	7	8
	timber products	6	6	6
	trade	14	15	18
N		128	140	152

Table 3. Tests for the difference of means

	Difference of means hedgers vs. non-hedgers						Difference of means new-hedgers vs. non-hedgers			
	2001	2002	2003	2001	2002	2003	2002	2003	2002	2003
Variable	t	t	t	p	p	p	t	t	p	p
expEUR	0.0180	2.5834	-0.1537	0.9856	**0.0113**	0.8782	-2.2744	-0.9554	**0.0259**	0.3428
expUSD	-0.5256	-0.6075	-1.3748	0.6004	0.5449	0.1721	-0.3277	-0.7700	0.7441	0.4440
expWIR	-0.9926	1.0382	-1.1546	0.3233	0.3018	0.2508	-2.0848	0.6151	**0.0406**	0.5405
expEIR	-0.8514	-0.7575	-0.1073	0.3966	0.4506	0.9148	-0.1885	0.3703	0.8510	0.7123
expUIR	-0.9097	-0.8203	-0.6470	0.3652	0.4141	0.5190	0.1828	0.4755	0.8555	0.6359
VOL	0.6178	-1.0434	-3.4514	0.5382	0.2992	**0.0008**	0.6517	1.3707	0.5165	0.1746
MV	3.6763	4.5954	3.6292	**0.0004**	**0.0000**	**0.0004**	-1.5783	0.6075	0.1191	0.5453
GEAR	0.9471	0.2956	0.1180	0.3457	0.7680	0.9063	-0.6371	0.9379	0.5257	0.3506
GEAR_INT	-0.7300	1.1208	-0.8124	0.4678	0.2647	0.4180	-1.4435	0.3070	0.1543	0.7596
TIE	2.2236	0.8427	0.7208	**0.0283**	0.4009	0.4722	0.5877	-1.5730	0.5582	0.1190
TAX	2.0644	2.5592	1.4474	**0.0413**	**0.0116**	0.1500	-0.4571	-0.1017	0.6487	0.9192
SALES	3.1888	5.3829	4.8907	**0.0019**	**0.0000**	**0.0000**	-0.2053	-1.7967	0.8378	**0.0755**
RD	-0.4606	0.8245	-1.2929	0.6460	0.4111	0.1982	0.4636	0.3160	0.6441	0.7527
MTBV	1.1401	2.9285	1.5973	0.2573	**0.0042**	0.1127	0.0652	0.6282	0.9482	0.5318
investInd	-1.5693	-2.1544	-2.2676	0.1205	**0.0335**	**0.0251**	1.4484	1.3164	0.1529	0.1927
investGov	0.2401	-0.6103	0.2115	0.8108	0.5430	0.8328	0.7881	-0.2448	0.4337	0.8073
investInst	0.0327	0.4377	0.7159	0.9740	0.6625	0.4755	-1.0437	-1.3402	0.3009	0.1848
investF	-0.3465	1.6129	2.6686	0.7299	0.1097	**0.0086**	-1.6960	0.2546	0.0951	0.7998
EQASS	-0.0198	0.7804	0.6153	0.9842	0.4365	0.5393	-0.7609	1.3627	0.4487	0.1761
INTDEBT	-0.3724	1.1131	-0.6470	0.7107	0.2679	0.5187	-1.0659	0.3273	0.2909	0.7443
CURR	2.9863	0.8765	1.4949	**0.0035**	0.3823	0.1372	0.3259	0.2116	0.7453	0.8329
issueL	1.0551	-0.7811	0.7300	0.2937	0.4361	0.4666	0.7525	0.5594	0.4534	0.5772
issueD	-0.5606	-0.4794	-0.6001	0.5762	0.6324	0.5494	0.4256	0.3648	0.6713	0.7160
issueA	2.0399	-0.4955	-1.3467	**0.0438**	0.6210	0.1802	0.8009	0.9947	0.4250	0.3223

In bold: p-values below 0.1 and variable names with significant p-values in two subsequent years.

Table 4. Tests for the difference of medians.

	Difference of Medians hedgers vs. non-hedgers						**Difference of Medians new-hedgers vs. non-hedgers**			
	2001	2002	2003	2001	2002	2003	2002	2003	2002	2003
Variable	W*	W	W	p	p	p	W	W	p	p
expEUR	728	525.5	1150.5	0.3625	0.0000	0.4555	608.5	321	**0.0025**	0.4144
expUSD	837.5	901	1342	0.7679	0.3201	0.2665	465	321	0.2946	0.3249
expWIR	908	904.5	1370.5	0.2165	0.2632	0.1567	526	244	**0.0235**	0.5431
expEIR	884	1028	1305	0.3646	0.6198	0.6920	431.5	236	0.6645	0.4502
expUIR	840.5	980	1270	0.7116	1.0000	0.8148	394	250	0.9264	0.4882
VOL	812	1390	1996	0.9066	**0.0885**	**0.0002**	432	210	0.6519	0.1456
MV	435	519	988	**0.0064**	**0.0000**	**0.0000**	426	267	0.6265	0.5075
GEAR	1046	1915	2450	0.6864	0.8059	0.9233	701	270	0.6673	0.1023
GEAR_INT	437.5	1318	1929	0.4992	0.2467	0.4138	412	382.5	0.1171	0.1554
TIE	935	1617	1846	1.0000	0.0996	0.1476	625	392	0.8220	0.8811
TAX	675.5	1426	1993.5	**0.0175**	**0.0105**	0.3724	645	333	0.8396	0.3903
SALES	693	789	1243	**0.0250**	**0.0000**	**0.0000**	765	444	0.3353	0.6447
RD	1165	2299	3048	0.2376	0.1206	0.0177	786	316	0.2418	0.2866
MTBV	454	773	1503	**0.0135**	**0.0065**	0.1980	419	251	0.6209	0.4278
investInd	696	1613	2106	**0.0802**	**0.0280**	**0.0083**	197	138	0.0757	0.1310
investGov	571	1398	1658	0.9875	0.4342	0.7300	286	220.5	0.2954	1.0000
investInst	522	997	1421	0.7252	0.0557	0.2140	372.5	258	0.1323	0.3492
investF	550	1041	1461	0.9060	**0.0626**	**0.0399**	350	244.5	0.1513	0.8151
EQASS	1037	1917	2492	0.7352	0.8131	0.9483	699	247	0.6818	**0.0543**
INTDEBT	405.5	1465	2118	0.8276	0.7545	0.9804	362	367.5	0.4910	0.2381
CURR	712	1556	1915	**0.0558**	**0.0760**	0.2519	808	382	0.0852	0.8689
issueL	880	1881	1852	0.4681	0.6846	0.1494	959	483	0.5931	0.4478
issueD	1018	1713	1717	0.6752	**0.0349**	**0.0007**	970	391.5	0.3065	0.6526
issueA	1011.5	1693.5	2351	0.7366	0.0521	0.3046	962	319.5	0.4088	0.1741

*W stands for Mann-Whitney statistic. In bold: p-values below 0.1 and variables with significant p-values in two subsequent years.

Table 5. ANOVA results for ownership structure determinants of hedging.

	year					
	2001		2002		2003	
	st.*	p	st.	p	st.	p
Bartlett test	4,2168	**0,0400**	1,1952	0,2743	2,0040	0,1569
Kruskal-Wallis test	3,5919	**0,0580**	3,6511	**0,0560**	8,5951	**0,0034**
F-statistics:						
Individual	3,4719	**0,0668**	4,0195	**0,0478**	8,9237	**0,0035**
Government	0,2493	0,6192	2,2245	0,1392	0,3859	0,5358
Institutional	0,0201	0,8876	9,4659	**0,0027**	1,0529	0,3072
Foreign	0,0916	0,7631	0,5606	0,4559	0,0128	0,9103
Individual:Government**	0,1317	0,7178	0,1563	0,6935	0,2445	0,6220
Individual:Institutional**	1,0797	0,3025	0,4764	0,4917	3,1740	**0,0777**
Government:Institutional**	0,8827	0,3508	1,4556	0,2307	0,0068	0,9346
Individual:Foreign**	0,3454	0,5587	0,5181	0,4734	0,3488	0,5561
Government:Foreign**	0,8037	0,3732	0,0119	0,9134	0,0053	0,9420
Institutional:Foreign**	0,6033	0,4400	2,9234	**0,0906**	0,3704	0,5440

** st. stands for 'statistic', **interactions*

Table 6. Logit regression results for hedgers vs. non-hedgers (ITS stands for IT and Services industries).

Financial economics hypotheses

Variable	Estimate	z-value	Pr(>|z|)	
(Intercept)	-1,7681	-2,0470	0,0407	*
VOL	-12,1485	-0,9120	0,3615	
expEUR	1,7732	2,7760	0,0055	**
expUSD	-3,4439	-2,4670	0,0136	*
expWIR	6,5984	0,6040	0,5460	
GEAR_INT	0,8931	0,6620	0,5081	
TAX	23,2262	1,1140	0,2654	
MTBV	0,5539	2,0480	0,0406	*
Log-Likelihood	*-41,9079*			
	2001	*2002*	*2003*	
True Positives	*75,00%*	*81,48%*	*67,65%*	
False Positives	*36,73%*	*16,95%*	*47,83%*	

Stakeholder theory hypotheses

Variable	Estimate	z-value	Pr(>|z|)	
(Intercept)	-2,3930	-5,5020	0,0000	***
ITS	0,6685	1,0210	0,3074	
MTBV	0,5463	2,5510	0,0108	*
przychN	0,0000	3,3280	0,0009	***
Log-Likelihood	*-48,2389*			
	2001	*2002*	*2003*	
True Positives	*58,82%*	*64,71%*	*56,41%*	
False Positives	*52,31%*	*45,95%*	*48,15%*	

Best fit with mixed variables

Variable	Estimate	z-value	Pr(>|z|)	
(Intercept)	-1,1870	-1,4830	0,1381	
przychN	0,0000	3,5720	0,0004	***
ITS	3,2000	2,6170	0,0089	**
MTBV	0,3553	1,2400	0,2149	
VOL	-47,1800	-2,3870	0,0170	*
expEUR	1,3670	2,8860	0,0039	**
expUSD	-3,2940	-2,4170	0,0157	*
Log-Likelihood	*-34,1579*			
	2001	*2002*	*2003*	
True Positives	*40,00%*	*71,43%*	*52,94%*	
False Positives	*21,43%*	*19,12%*	*29,17%*	

Agency theory hypotheses

Variable	Estimate	z-value	Pr(>|z|)	
(Intercept)	-0,6648	-1,7110	0,0870	'
investInd	-1,5927	-1,9690	0,0489	*
GEAR_INT	0,8922	0,9140	0,3607	
Log-Likelihood	*-64,7657*			
	2001	*2002*	*2003*	
True Positives	*69,23%*	*71,43%*	*71,79%*	
False Positives	*56,25%*	*56,34%*	*50,00%*	

New Institutional Economics hypotheses

Variable	Estimate	z-value	Pr(>|z|)	
(Intercept)	-0,4128	-1,0500	0,2938	
investInd	-1,6343	-1,8270	0,0677	'
investGov	-2,0121	-1,1530	0,2490	
investInst	-0,2395	-0,2140	0,8304	
investF	0,7730	0,8810	0,3782	
Log-Likelihood	*-63,9055*			
	2001	*2002*	*2003*	
True Positives	*58,82%*	*64,71%*	*56,41%*	
False Positives	*52,31%*	*45,95%*	*48,15%*	

All variables

Variable	Estimate	z-value	Pr(>|z|)	
(Intercept)	-2,9200	-1,1650	0,2440	
CURR	1,2700	0,9230	0,3562	
expEUR	3,1410	2,3920	0,0168	*
expUSD	-5,6090	-2,2800	0,0226	*
expWIR	-3,9480	-0,1420	0,8871	
VOL	-59,9000	-1,9050	0,0568	'
GEAR_INT	0,2651	0,0770	0,9387	
TAX	33,7300	0,8570	0,3917	
MTBV	1,7050	1,8650	0,0622	'
investInd	-3,4780	-1,2970	0,1948	
investGov	-2,3950	-0,6300	0,5285	
EQASS	0,2696	0,0810	0,9352	
ITS	4,3300	1,8250	0,0679	'
SALES	0,0000	2,9810	0,0029	**
Log-Likelihood	*-17,5962*			
	2001	*2002*	*2003*	
True Positives	*66,67%*	*84,62%*	*70,00%*	
False Positives	*35,90%*	*12,00%*	*40,74%*	

Figures

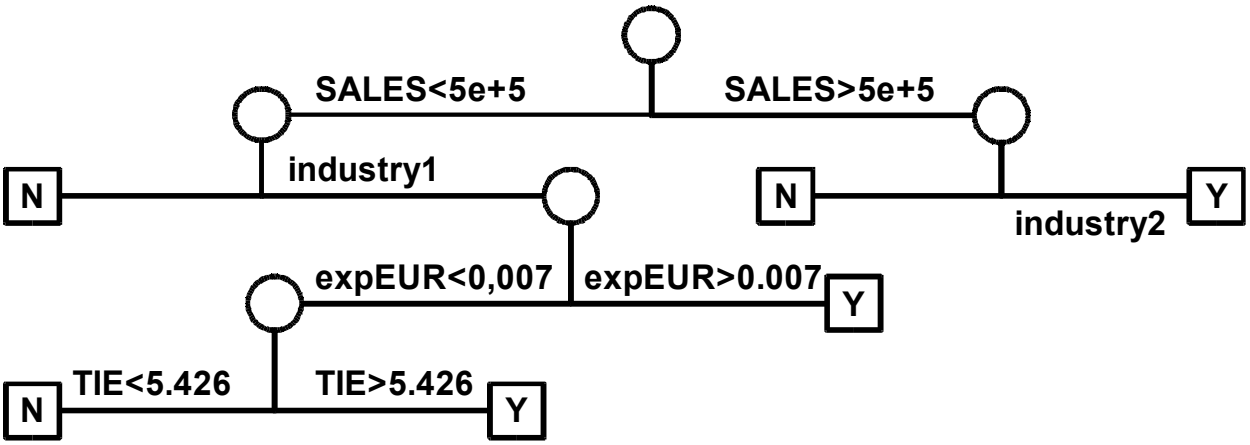

Fig. 1. Classification tree for hedgers (Y) vs. non-hedgers (N) based on 2002 data (industry1 stands for construction, timber products, machinery, energy, trade, IT, media, metal, clothing and services; industry2 stands for chemical, machinery, trade and food). True positives: 39% for 2001 data and 51% for 2003; false positives: 23% and 22% of non-hedgers.

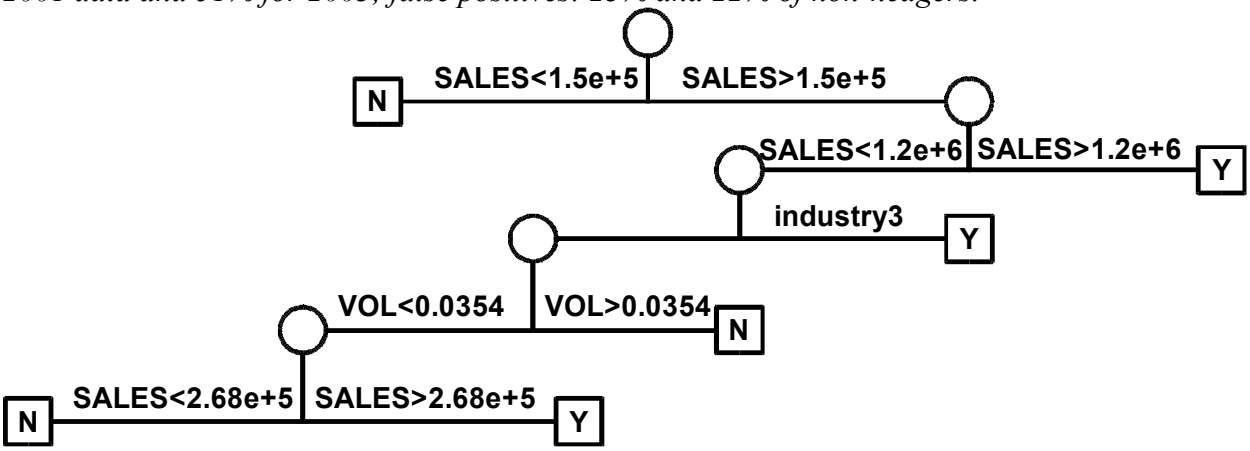

Fig. 2. Classification tree for hedgers (Y) vs. non-hedgers (N) based on 2003 data (industry3 stands for construction, machinery, trade, IT, construction materials, clothing, food, telecom, services and 'other'). True positives: 43% for 2001 data and 44% for 2002; false positives: 20% and 17% of non-hedgers.

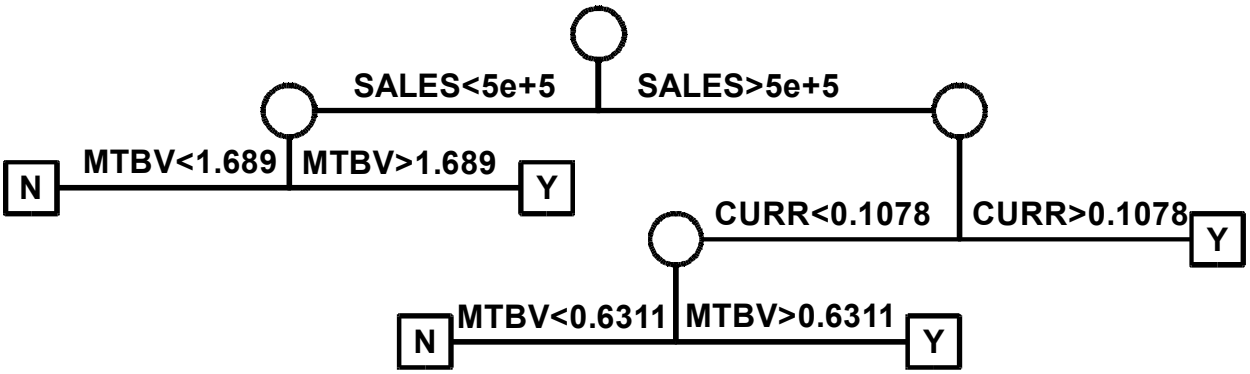

Fig. 3. Classification tree for hedgers (Y) vs. non-hedgers (N) based on 2002 data, without

INDUSTRY variable. True positives: 48% for 2001 data and 53% for 2003; false positives: 19% and 29% of non-hedgers.