# DISCRIMINANT ANALYSIS OF BANK PROFITABILITY LEVELS

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## Abstract

Discriminant analysis has been employed in this paper in order to identify and explain key features of bank profitability levels. Bank profitability is set up in the form of two categorical variables: profit or loss recorded and above or below average return on equity. Predictor variables are selected from various groups of financial indicators usually included in the empirical work on microeconomic determinants of bank profitability. The data from the Croatian banking sector is analyzed using the Enter method. General recommendations for a more profitable business of banking found in the bank management literature and existing empirical framework such as rationalization of overhead costs, asset growth, increase of non-interest income by expanding scale and scope of financial products proved to be important for classification of banks in different profitability levels. A higher market share may bring additional advantages. Classification results, canonical correlation and Wilks' Lambda test confirm statistical significance of research results. Altogether, discriminant analysis turns out to be a suitable statistical method for solving presented research problem and moving forward from the bankruptcy, credit rating or default issues in finance.

**Key words:** *Discriminant analysis, Bank profitability, Croatia*

## 1. PAPER MOTIVATION

Discriminant analysis has been widely applied to numerous issues in the financial theory and practice. Bankruptcy or financial distress models for enterprises (financial institutions and/or non-financial enterprises) as well as credit rating and scoring models usually employ discriminant analysis technique or logistic regression. The most famous example of such a practice is the work of Edward Altman who

developed one of the first bankruptcy prediction models for non-financial enterprises using financial ratios in a dicriminant analysis yet in 1968 and named it Z-score model. Since then various bankruptcy prediction and credit capacity models have flooded financial literature and business practice. However, bankruptcy prediction models were mainly used in (e.g. Rozga, Klinac and Ercegovac, 2009), rather than, for financial institutions assessments until Sinkey (1975, 1978) developed discriminant model for predicting financial distress of banks in the USA. Taking into consideration a wave of bank bankruptcies in the 1990s in the Republic of Croatia several microeconomic models for predicting bank crises were developed on the basis of discriminant analysis (Festini, 2003: Novak, 2003: Sajter, 2005).

Determinants of bank profitability have been widely theoretically and empirically explored. Even researches for developing countries in post-transitional era like the South Eastern European region are not rare anymore (e.g. Athanasoglou, Delis and Staikouras, 2006: Košak and Čok, 2008: Pejić-Bach, Posedel and Stojanović, 2009: Kundid, Škrabić and Ercegovac, 2011; Kundid, 2012). The panel data models are the most common methodological choice in this field.

Taking into consideration methodological features of the aforementioned bodies of literature it has been found, to the best of our knowledge, that the discriminant analysis has not yet been applied in descriptions of bank profitability. Thus, the paper attempts to answer on two main research questions: What is the scope of discriminant analysis when applied to the chosen research problem? Are results obtained through discriminant analysis (i.e. explicators of differences in bank profitability levels) in line to the ones obtained through the panel data analysis? Altogether, a research hypothesis $H_1$ is set up:

$H_1$: Discriminant analysis is a suitable statistical method for distinguishing and classifying banks in different profitability levels, according to some generally accepted predictors (determinants) of bank profitability.

## 2. EXPLANATIONS OF DIFFERENCES IN PROFITABILITY AMONG COMMERCIAL BANKS

Differences in bank profitability levels can be attributed to bank features, industry characteristics and contextual properties. Thus, empirical researches on determinants of bank profitability usually contain various bank and banking sector specific variables and some macroeconomic indicators (e.g. inflation, interest rates, and GDP growth). This paper aims to identify microeconomic factors that distinguish profitable from non-profitable banks as well as above and below average bank profitability. In the

empirical evidence that follows macroeconomic variables are omitted due to sample attributes i.e. macroeconomic conditions are criterion for sample selection. This is why empirical findings on macroeconomic impact on bank profitability are not discussed herein. The basic rationale that lies behind this methodological approach is not only related to discriminant analysis conditions, rather summarized in the fact that sound bank managers can achieve profit persistence in disrupted economy as well as incompetent bank managers may destroy the best bank in a time of prosperity (Prga, 2002, p. 497). In short, internal features are of the first class importance for bank profitability. However, it is beyond the scope of this paper to discuss each area relevant for bank profitability due to numerous hypotheses which could be tackled and a rich body of literature already being synthesized by e.g. Athanasoglou, Delis and Staikouras (2006), Košak and Čok (2008) and Kundid, Škrabić and Ercegovac (2011). Reasonable loan growth, stable deposit financing, cost management efficiency, credit rationing in practice, business diversification, lower bankruptcy and refinancing costs as a consequence of higher equity to assets ratio are strongholds of bank profitability.

## 3. DISCRIMINANT ANALYSIS APPROACH TO BANK PROFITABILITY IN CROATIA

### 3.1. Data, methodology and model development

The data sample included balance sheet and income statement items of all banks in the Republic of Croatia which were active in two observed years: 2003 (sample of 41 banks) and 2008 (sample of 33 banks). These years were considered to be relevant for the unbiased analysis as they present the first and the last year of the banking sector and/or the economic stability of the country. The year 2003 represents the first year of the banking sector stability after systemic crises which occurred in 1990s and failure of one middle-sized bank in 2002. After the year 2008 national economic instability grounded in the structural problems of the country became more visible and thus, no later items from the financial statements of commercial banks were calculated.

The most of the predictor variables were taken from Kundid, Škrabić and Ercegovac (2011) and present variables which are usually employed in the empirical work on determinants of bank profitability. Financial ratios were calculated or extracted from the publicly available data disclosed by the Croatian National Bank (CNB) and commercial banks in their annual reports.

The dependent variable is set out as a categorical variable, and independent variables are numerical (Table 1). With reference to this, discriminant analysis is used[1]. Profitability indicators are defined as dummy variables in the following way:

- Recorded profit or loss (PROFIT YES/NO), where profit occurrence is 1 and absence 0,
- Return on average equity (ROAE $<;\geq 10$) where 1 is for above average profitability and 0 is for below average profitability. The bank management literature teaches that 15% is the cut-off point between satisfactory and unsatisfactory ROAE. However, financial liberalization and sharpening competition in the banking sector and competition between banks and other financial intermediaries lowered this cut-off point. Thus, we set it on the level of 10%. In that way, banks that have ROAE below 10% are treated as ones with below average profitability and banks with or above 10% ROAE are groped as ones with above average profitability.

*Table 1: Definitions of dependent and predictor variables.*

| **Variable** | **Explanation** | **Group of indicators** |
|---|---|---|
| GROWL | Growth of loans | Credit risk indicator and Growth indicator |
| GROWA | Growth of assets | Growth indicator |
| PRO | Loan loss provisions / Total loans, placements and other potential obligations | Credit risk indicator |
| E/A | Equity / Total assets | Capital structure indicator |
| FEE/A | Net income from fees and commissions / Average assets | Business mix indicator |
| LOAN/DEP | Granted loans / Received deposits | Loan funding structure (business self-financing) |
| RECDEP/A | Received deposits / Total assets | Financial leverage indicator and Liquidity indicator |
| LOAN/A | Granted loans / Total assets | Credit risk indicator and Liquidity indicator |
| OVERH/A | Overhead costs / Average assets | Indicator of cost management efficiency |
| SHARE | Bank total assets / Banking sector total assets | Market share indicator |
| INCEX/A | Income from net exchange rate differences / Average assets | Fx risk management efficiency |
| PROFIT (YES / NO) | Profit = 1; Loss = 0 | Profitability indicator |
| ROAE ($<10;\geq 10$) | ROAE < 10 (below average profitability or loss= 0); ROAE $\geq 10$ (above average profitability =1) | Profitability indicator |

[1] Preliminary analysis encompassed binary logistic regression. It turned out that it was not suitable for the analysis of the research problem or/and the way in which it was set up.

Discriminant analysis aims to identify characteristics which are important for differentiating units between groups and their classification accuracy. Each unit can be classified in only one category or group according to some predictor variables. The main theoretical assumptions for discriminant analysis are linearity and homoscedasticity (Rozga, 2010). Statistical model is given by the following equation:

$$D = \beta_0 + \beta_1 \cdot X_1 + \beta_2 \cdot X_2 + ..... + \beta_i \cdot X_i \quad (1)$$

where $\beta_i$ denotes discriminant coefficients and $X_i$ are predictor variables.

Probability that a particular case with disciminant score *D* belongs to the group *i* is calculated using Bayes theorem:

$$P(G_i / D) = \frac{P(D / G_i) \cdot P(G_i)}{\sum_{i=1}^{k} P(D / G_i) \cdot P(G_i)} \quad (2)$$

where $P(D / G_i)$ denotes conditional probability for $D$ for a given group.

Presumptions of variables signs are omitted due to complexity of bank financial management and descriptive rather that predictive nature of discriminant analysis (Sinkey, 1978, p. 184).

### 3.2. Research results and model quality

The data was analyzed using the Enter method in the statistical package SPSS Statistics 17.0. The analysis was performed for two observed years (2003 and 2008) and for differently defined profitability indicators. Results for reduced discriminant models, i.e. models that contain only previously identified statistically significant variables are presented in the following table (Table 2)[2].

All reported predictors (significant ones) have Wilks' Lambda below 1. This confirms discriminant power of variables. Canonical correlation which is the measure of the linkage between discriminant scores and groups is higher than 0,5 in all cases (Model 1 – 0,536; Model 2 – 0,733; Model 3 – 0,546; Model 4 – 0,615). This confirms that statistically significant predictors are good explicators of differences between profitable and non/low profitable banks. In addition, all models possess statistical significance of the Wilks' Lambda and thus conclusion that predictor variables have a certain discriminant power is reached (Model 1 – Wilks' Lambda = 0,713 , sig.=0,030 ; Model 2 – Wilks' Lambda = 0,462 , sig.=0,000 ; Model 3 – Wilks' Lambda = 0,702 , sig.=0,024 ; Model 4 – Wilks' Lambda = 0,622 , sig.=0,001).

[2] Empirical evidence for the first step analysis (the full model) is available upon request.

*Table 2: Test of equality of group means for all models.*

| | Wilks' Lambda | F | df1 | df2 | Sig. |
|---|---|---|---|---|---|
| MODEL 1 (PROFIT YES / NO, N=41, 2003) | | | | | |
| GROWL | 0,891 | 4,761 | 1 | 39 | 0,035 |
| PRO | 0,929 | 2,978 | 1 | 39 | 0,092 |
| E/A | 0,885 | 5,052 | 1 | 39 | 0,030 |
| FEE/A | 0,928 | 3,016 | 1 | 39 | 0,090 |
| OVERH/A | 0,859 | 6,414 | 1 | 39 | 0,015 |
| MODEL 2 (PROFIT YES / NO, N=33, 2008) | | | | | |
| OVERH/A | 0,774 | 9,071 | 1 | 31 | 0,005 |
| FEE/A | 0,774 | 9,059 | 1 | 31 | 0,005 |
| GROWA | 0,851 | 5,421 | 1 | 31 | 0,027 |
| MODEL 3 (ROAE < 10; ≥ 10, N=41, 2003) | | | | | |
| PRO | 0,884 | 5,116 | 1 | 39 | 0,029 |
| E/A | 0,922 | 3,305 | 1 | 39 | 0,077 |
| LOAN/DEP | 0,928 | 3,017 | 1 | 39 | 0,090 |
| SHARE | 0,831 | 7,935 | 1 | 39 | 0,008 |
| OVERH/A | 0,865 | 6,082 | 1 | 39 | 0,018 |
| MODEL 4 (ROAE < 10; ≥ 10, N=33, 2008) | | | | | |
| OVERH/A | 0,717 | 12,222 | 1 | 31 | 0,001 |
| SHARE | 0,722 | 11,919 | 1 | 31 | 0,002 |

Source: Authors' calculation.

Correlations between predictor variables and standardized canonical discriminant function are given in the following table (Table 3).

*Table 3: Structure matrix for all models.*

| MODEL 1 (PROFIT YES / NO, N=41, 2003) | | MODEL 3 (ROAE < 10; ≥ 10, N=41, 2003) | |
|---|---|---|---|
| OVERH/A | -0,639 | SHARE | -0,692 |
| E/A | -0,567 | OVERH/A | 0,606 |
| GROWL | 0,550 | PRO | 0,555 |
| FEE/A | 0,438 | E/A | 0,446 |
| PRO | -0,435 | LOAN/DEP | 0,427 |
| MODEL 2 (PROFIT YES / NO, N=33, 2008) | | MODEL 4 (ROAE < 10; ≥ 10, N=33, 2008) | |
| OVERH/A | -0,501 | OVERH/A | 0,805 |
| FEE/A | 0,501 | SHARE | -0,795 |
| GROWA | 0,388 | | |

Source: Authors' calculation.

Using unstandardized discriminant coefficients discriminant score could be calculated for each case. Statistical models are:

$$D(MODEL1) = 0{,}730 + 0{,}018 \cdot GROWL_{1,i} - 0{,}046 \cdot PRO_{2,i} - 0{,}034 \cdot E / A_{3,i} + 0{,}889 \cdot FEE / A_{4,i} - \\ - 0{,}249 \cdot OVERH / A_{5,i} \quad (3)$$

$$D(MODEL2) = 0{,}718 - 0{,}784 \cdot OVERH / A_{1,i} + 0{,}089 \cdot GROWA_{2,i} + 1{,}733 \cdot FEE / A_{3,i} \quad (4)$$

$$D(MODEL3) = -2{,}044 - 0{,}134 \cdot SHARE_{1,i} + 0{,}161 \cdot OVERH / A_{2,i} + 0{,}147 \cdot PRO_{3,i} - \\ - 0{,}014 \cdot E / A_{4,i} + 0{,}015 \cdot LOAN / DEP_{5,i} \quad (5)$$

$$D(MODEL4) = -1{,}529 + 0{,}609 \cdot OVERH / A_{1,i} - 0{,}128 \cdot SHARE_{2,i} \quad (6)$$

"Hit-rates" for all models are between 72,7% and 84,8% (see Appendix, Table 4). Model 3 and Model 4 have lower classification results. In addition, there is higher probability for banks from the non-profitable group to end up in the group of profitable than the opposite (Model 1 and Model 2). When comparing results for 2003 and 2008 it is noticeable that probabilities for banks to end up in the group of profitable banks and vice versa are decreased what confirms profit persistency hypothesis. With reference to ROAE models there is higher probability that banks from the group of above average profitability end up in the group of below average profitability than the opposite (Model 3 and Model 4).

## 4. DISCUSSION OF RESEARCH RESULTS

Growth of loans (GROWL) and growth of assets (GROWA) are positively related to bank profitability. Bearing in mind one-year data analysis, aforementioned results should not be unconditionally accepted as a sign of prudent credit risk management in a banking practice, but more realistically to be considered as an evidence of capital employment and consequence of generating fee income from credit allowance and interest revenues from loans at least in the first year. Indicator of loan loss provisions (PRO) has a negative impact on bank profitability set out in form existence or absence of profitability, which is not surprising if an income statement structure is on mind. On the other hand, a positive impact of the latter indicator on ROAE might be a proof of a gradual provisioning for non performing loans by the above average profitable banks.

A higher equity financing (E/A) is negatively related to profitability existence, but positively to above average ROAE. The former could be explained by the fact that small banks usually have higher equity financing as they do not enjoy implicit protection from the lender of last resort if financial distress occurs. At the same time, small banks have lower profitability in comparison to the large ones or they record losses. A positive sign of E/A in relation to ROAE could be a consequence of: 1) accounting treatment of equity costs i.e. equity is almost cost-free funding source and/or 2) lower refinancing costs due to better credit capacity of bank (Kundid, 2012).

Higher fee income (FEE/A) has a positive influence on profitability achievement. In a sufficiently competitive banking sector, net interest margin is continuously decreasing. Thus, banks which offer various fee based services have comparative advantage in comparison to those that rely mainly on deposit – loan services. In addition, banks with higher product diversification have higher cross-selling opportunities.

Indicator of cost management efficiency (OVERH/A) is negatively related to bank profitability presence which is in line with income statement structure. However, this indicator is positively related to above average ROAE what might be a result of large banks usually having higher non-interest costs in comparison to small banks. Profit efficiency and cost efficiency might not be positively correlated (Maudos, Pastor, Pérez and Quesada, 1999, p. 4). In large banks economies of scale effects might be reduced with cost management inefficiency (so called x-inefficiency). Altogether, this is usually compensated with higher profit efficiency due to higher credit portfolio diversification possibilities and more available non-deposit funding sources of large banks in comparison to the small ones (Scholtens, 2000). Further, decrease in ROAE (or unchanged ROAE) was followed by the increase in market share of the largest banks what could explain two variables being negatively related. Indicator

of business self-financing (LOAN/DEP) is positively related to ROAE as expected. Finally, a majority of obtained results are comparable and consistent to those presented in Kundid, Škrabić and Ercegovac (2011).

## 5. CONCLUDING REMARKS

As sustainability in bank profitability is the building block of its auto-financing process and stability, researching bank profitability is and remains an important issue. In the paper discriminant analysis was performed with a goal of identifying determinants of bank profitability. By using this multivariate statistical method it has been confirmed that according to their financial ratios banks can be classified in groups of profitable or non-profitable and groups of above or below average profitability with very high precision.

Results of discriminant analysis indicate higher classification precision when bank profitability is set out through its existence and absence. Usual conclusions on determinants of bank profitability found in empirical literature have been reached. A reduction in the number of significant predictor variables is noted for a more developed banking sector – year 2008 in comparison to 2003. General recommendations for more profitable business of banking are: rationalization of non-interest costs, expansion of bank assets and increase of non-interest revenues by exploiting financial products economies of scale and scope. Banks with higher market share can have additional comparative advantages, but this could be proved only indirectly through other aspects of doing business.

Even though bank profitability was defined as a categorical variable and discriminant analysis was employed, which is unusual for this research problem, obtained results are consistent with theoretical explanations and empirical framework and possess statistical and economical significance.

## APPENDIX

*Table 4: Classification results for all models.*

| MODEL 1 (PROFIT YES/NO, N=41, 2003)[a] | | | Predicted Group Membership | | Total |
|---|---|---|---|---|---|
| | | | 0 | 1 | |
| Original | Count | 0 | 3 | 1 | 4 |
| | | 1 | 7 | 30 | 37 |
| | % | 0 | 75,0 | 25,0 | 100,0 |
| | | 1 | 18,9 | 81,1 | 100,0 |
| a. 80,5% of original grouped cases correctly classified. | | | | | |
| MODEL 2 (PROFIT YES/NO, N=33, 2008)[a] | | | Predicted Group Membership | | Total |
| | | | 0 | 1 | |
| Original | Count | 0 | 5 | 1 | 6 |
| | | 1 | 4 | 23 | 27 |
| | % | 0 | 83,3 | 16,7 | 100,0 |
| | | 1 | 14,8 | 85,2 | 100,0 |
| a. 84,8% of original grouped cases correctly classified. | | | | | |
| MODEL 3 (ROAE < 10; ≥ 10, N=41, 2003)[a] | | | Predicted Group Membership | | Total |
| | | | 0 | 1 | |
| Original | Count | 0 | 19 | 5 | 24 |
| | | 1 | 5 | 12 | 17 |
| | % | 0 | 79,2 | 20,8 | 100,0 |
| | | 1 | 29,4 | 70,6 | 100,0 |
| a. 75,6% of original grouped cases correctly classified. | | | | | |
| MODEL 4 (ROAE < 10; ≥ 10, N=33, 2008)[a] | | | Predicted Group Membership | | Total |
| | | | 0 | 1 | |
| Original | Count | 0 | 17 | 5 | 22 |
| | | 1 | 4 | 7 | 11 |
| | % | 0 | 77,3 | 22,7 | 100,0 |
| | | 1 | 36,4 | 63,6 | 100,0 |
| a. 72,7% of original grouped cases correctly classified. | | | | | |

Source: Authors' calculation.

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