Strategic groups in Polish banking sector and financial stability

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ABSTRACT

The paper provides results of research concerning identification of strategic groups in the Polish banking sector and tests of the usefulness of these groups in the assessment of financial stability. The theory of strategic groups predicts the existence of stable groups of companies, stemming from the strategy adopted by them. The theory also predicts that groups differ in performance. Our empirical research, preceded by a review of relevant literature, has been carried out on the basis of a cluster analysis with the use of Ward's algorithm that optimises allocation of banks into groups. We have identified strategic groups in the Polish banking sector, sustained over time after the year 2000. We have also observed statistically significant differences in performance between banks belonging to different groups, and we have demonstrated further that modelling of profitability within groups with the use of regression yields more precise estimates of parameters than in the case of estimation of a model for the whole sector. Thus, breaking down the whole banking sector into strategic groups creates a possibility to forecast the banking sector earnings in a more precise way, i.e. to provide a more precise *ex ante* assessment of stability of the financial system.

Keywords: Strategic groups, financial stability, clustering, Ward algorithm

JEL classification: C49; G21; L1

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1 Introduction

Financial stability is indicated more and more often, apart from price stability, as one of the main objectives of the central bank. Within this task, a central bank usually conducts *ex post* assessment of the condition of the banking sector, the major element of the financial system. However, in order to fully achieve the stability objective, a central bank should also forecast the condition of the banking sector, i.e. conduct *ex ante* assessment of the stability of financial system. This task may be carried out by predicting the financial result of the banking sector and — on this basis — assessing banks' loss absorption abilities. A formal tool of such an analysis in the National Bank of Poland is the so called analytical scheme of the banking sector, which is presently developed. It is intended to serve for, *inter alia*, forecasting the performance of the banking sector. Ultimately, forecasts and simulations of basic economic values from macro-models, already functioning in the NBP, will also be used in the analytical scheme. The analytical scheme will take into account the fact that particular banks may react to changes of external factors in a different way. Different reactions of banks may stem from various reasons: activity profile, asset size, the market segments being major areas of bank's operations, the level of relations with foreign entities, etc. Within the analytical scheme, equations for groups of banks reacting in a similar way will be estimated. Such an approach, contrary to estimating a single equation for the whole banking sector, will make it possible to avoid biasing of the estimators that stems from excessive aggregation and to make forecasts more precise. Besides, it will be possible to take into account different reactions of banks to external factors.

The paper reports the results of research conducted with the purpose of identifying homogeneous groups of banks in the Polish banking sector, which might be used in the development of the analytical scheme. In relevant literature, a breakdown of entities into groups is usually made in the context of the theory of strategic groups, which has its roots in the theory of management. The theory of strategic groups predicts forming groups of similar

entities, based on convergent activities of some companies operating on a given market. According to the theory, the number of strategies that may be adopted is limited. The choice of a given strategy by a company results in its membership in a certain group. Strategic groups are also relatively stable over time, which stems from mobility barriers.

In the empirical research concerning the banking sector conducted so far, it has been assumed that the bank's strategy is reflected in the structure of its balance sheet. The share of particular balance sheet items in total assets or the share of particular loan categories in the total loan portfolio are called strategic variables or strategic dimensions. In this analysis, most of the strategic variables are related to the balance sheet structure; however, other variables reflecting the adopted strategy in the profit and loss account have been used as well.

As it stems from Hackethal's research (Hackethal, 2001) for the European commercial banks and from Koller's research (Koller, 2001) for the largest Austrian banks, profitability of banks belonging to particular groups shows statistically significant differences between groups. Should banks' profitability show statistically significant differences between groups, a breakdown of the banking sector into groups would be useful due to its further use in the analytical scheme. It would justify the use of the theory of strategic groups in the analysis the Polish banking sector.

The second half of the 1990s witnessed major changes in the ownership in the Polish banking sector, which led to numerous mergers and acquisitions. Ownership changes may disturb the composition of groups, as a change of the owner may entail a shift in the bank's strategy. On the other hand, the share of foreign capital in the Polish banking sector increased substantially at that time. It might have led to an extended scope of services offered by banks, which should be manifested through increased similarity of particular strategic groups[1].

[1]This conclusion requires two assumptions: (1) that the scope of services offered by banks increases more rapidly than the scope of available services in the banking sector

This article contains a review of the theory (chapter 2) and the empirical research (chapter 3) regarding identification of strategic groups. In chapter 4, we describe data used in the research, whereas in chapter 5 we focus on the methods and tools of identification of groups. Chapter 6 includes results of the empirical research and a description of the strategic groups identified in the Polish banking sector in the years 1997-2004. Chapter 7 is a summary of the research, presenting possible use of the results obtained and outlining directions for further research.

2 Strategic groups in theory

The theory of strategic groups was introduced by Hunt (1972) and further developed by Newman (1978). A strategic group is usually defined as a group of companies operating within the same industry that adopt a similar strategy as regards products offered and resources used (Porter, 1979).

Thus, within a strategic group, companies make similar decisions in key areas (Koller, 2001), whereas their similar strategies are characterised by similar values of certain variables, called strategic variables or strategic dimensions. Within a group, strategies of the companies are to a large extent homogeneous, while they differ substantially among particular groups.

The idea of strategic groups has been popularized by Caves and Porter (1977), who, apart from barriers to entry, introduced the term of barriers to mobility. The concept of mobility barriers was supposed to explain the rationale behind the creation of homogeneous groups of companies. Groups are formed as a result of discontinuity in available strategies, which are unevenly distributed over the space spanned by strategic variables. Porter (1980) states that available strategies prevent a company from taking a stuck-in-the-middle position between two strategies.

Mobility barriers may be perceived as a wall separating a given group from its external competition and discouraging a given company from mov-

and (2) that the scope of available services in the banking sector has its limits.

ing to another group. It is believed that mobility barriers may result from undertaking similar investments by companies within a group, which increase their competitiveness and profitability. At the same time, those investments — for financial reasons — prevent or impede access to a given technology or patents to third parties. Such investments may include research on a new technology or invention as well as advertising. In the latter case, the barrier to mobility will comprise a good market position, a recognized brand or reputation of companies in a group (Ferguson, 2000). In such a case mobility barriers occur as a result of similar activities undertaken by enterprises. However, they may also result from offering of similar products. Empirical research confirms the existence of barriers to mobility (Mascarenhas and Aaker, 1989); however, the mechanism of their occurrence has not yet been ultimately identified.

In the case of the banking sector it seems that investments in technology undertaken by banks should not have any significant meaning. Technology, such as the level of IT infrastructure, is a basic condition of existence of an institution in the banking sector. The profitability of a financial institution depends to a greater extent on its ability to maintain the existing and win new customers as well as on the quality of risk management. Therefore, investments that might prove to be significant mobility barriers should to a larger extent involve expenses related to the development of a branch network or of risk management models. Expenses related to advertising which, on the one hand, builds the bank's brand and, on the other hand, supports sales of the products offered that also serve as an indication of the strategy adopted by the bank, may also turn out to be material for the formation of strategic groups.

Adoption of the assumption that mobility barriers exist leads to three conclusions (Leask, 2004), which may be recognized as predictions of the strategic groups theory. Firstly, the theory allows the possibility of existence of a hierarchy of strategic groups. Groups comprising more effective companies are separated by higher mobility barriers than groups of companies

with lower profitability. Secondly, changes in the environment have different influence on particular groups, based on the differences in the impact of external factors, related to various levels of protection regarding the mobility barriers. However, companies within the same group respond in a similar way to changes in external factors. Thirdly, the theory suggests that the lack of mobility between groups results to a larger extent from a company's history and its assets accumulated rather than from the nature of investments currently undertaken.

Porter (1979), on the other hand, argues that the existence of strategic groups reduces the level of competition within an industry. It results from co-ordination and co-operation between group members, which takes the competition within particular groups to a level lower than that of competition between groups. The scope of this dependency is conditioned on three factors: the number of groups and the distribution of their shares in the market, the diversity among the groups (the so-called strategic distance) and the level of diversity in the profiles of buyers of services and products (Heene and Houthoofd, 2002).

Co-ordination of activities rather than co-operation should be of greater importance for the formation of groups in the banking sector. Smaller banks often imitate the behaviour of banks with a stronger market position. It is particularly visible in the case of changes in interest rates on loans and deposits. On the other hand, a lasting co-operation between banks, related to a particular project, is rather difficult to imagine, although exceptions occur. An example of banks' co-operation is the initiative that has led to the creation of a common database of borrowers and their debts. Payment systems are another example of co-operation among banks.

The development of the strategic groups theory has been based on the premises of the explanation of differences in results achieved by different companies operating within the same industry. The existence of mobility barriers does not explain, however, the differences in profits; it only implies a possibility that these differences will be sustained over time. In order

to explain the origin of differences in the profitability of particular groups, authors of the strategic groups theory (Porter, 1980) used the structure-conduct-performance (SCP) paradigm. This hypothesis is based on the assumption that the structure of the market, understood through the prism of the size and number of particular players, determines their position on a given market and specifies their strategy, thus influencing their profitability. Thus, initially, the existence of strategic groups was linked to relative sizes of companies operating on a given market (Caves and Porter, 1978; Caves and Pugel, 1980). Further research, however, expands the analysis to a larger number of strategic dimensions, which generally concern the structure of balance sheets of particular companies (Passmore 1985, Amel and Rhoades, 1988).

Thus, the theory provides for considerable and sustained over time differences in the profitability of companies among groups. Movement of a company to a more effective group is made difficult due to the mobility barriers (Caves and Porter 1977). The theory also predicts similar responses of group members to changes in the environment.

Different reactions of companies to external factors, provided for in the theory, may entail certain differences in the mechanism of interest rate transmission in particular groups (Kashyap and Stein, 1995). The use of monetary policy instruments in ensuring stability must therefore take into account different reactions of banks in different groups, in order for the response of the system to a change in the monetary policy to be as intended. On the other hand, assessment of the financial system stability may be performed with the use of a formalised general equilibrium model (e.g. Goodhart, Sunirand and Tsomocos, 2004) or an econometric model of performance of the banking sector, developed presently in the NBP. Since the theory of strategic groups provides for sustained significant differences in profitability between groups, as well as for different reactions of companies in particular groups to external factors, the breakdown of the banking sector into groups may be used to enhance the quality of modelling the performance of the banking sector.

3 Review of empirical research

In spite of the criticism towards both the theory and the methodology of identifying strategic groups (cf. Barney and Hoskisson, 1990; Cool and Dierickx, 1993; Ferguson and Ketchen, 1999; Hatten and Hatten 1987; Ketchen and Shook, 1996), popularity of research on strategic groups resulted in multiple empirical research aimed at identifying strategic groups in particular industries. Research was related both to manufacturing companies: beer industry (Tremblay, 1985; Houthoofd and Heene, 2002) and pharmaceutical industry (Cool and Dierickx, 1993), and to service providers: healthcare (Nath and Grucka, 1997), IT (Duysters and Hagedoorn, 1995), and — in particular — companies providing financial services: the insurance sector (Fiegenbaum and Thomas, 1993) and the banking sector (Amel and Rhoades, 1988; Mehra, 1996).

Initially, the research on strategic groups linked the membership of a company in a group with the relative size of the company (its market share), what resulted directly from adoption of the structure-conduct-performance hypothesis. Such an approach was adopted by Porter (1979) and Caves and Pugel (1980). Newman (1978) noticed that the existence of strategic groups may stem from the adoption of various target functions by different companies; however, he still uses the measure of the relative size of the company — the Herfindahl-Hirschman index — as a measure of homogeneity of companies in a given industry.

Oster (1982) on the other hand uses the ratio of advertising expenditure to sales revenues as a strategic variable in her research. She also proposes to base the separation of groups on certain leading variables, i.e. predetermined variables, which would be used in all the research related to the identification of strategic groups. It would be difficult, however, to identify such variables for various industries, considering the fact that, in particular industries, various balance sheet items may reflect the strategy adopted by the company. This is especially true in the case of the banking sector, where banks' assets and liabilities items differ substantially from balance sheets of companies in

other industries. Oster's (1982) recommendation may be taken into consideration only when conducting research related to a certain industry.

All the research mentioned above assumes that strategic groups exist and are defined by a certain variable selected a priori by the researcher (Amel and Rhoades, 1988). Hayes, Spence and Marks (1983) conducted research aimed at determining whether strategic groups may be isolated within US investment banks. The shortcoming of their approach is the use of a simple analysis of correlation of the vectors of earnings, which — as Amel and Rhoades (1988) demonstrate — does not necessarily determine the existence of a group. Passmore's (1985) research is free from this shortcoming. He does not adopt a strategic variable *a priori* either but analyses the shares of particular balance sheet items in the total portfolios of the 50 largest commercial banks in the US. Passmore divides banks into two groups on the basis of correlation between particular variables. The identified division overlaps with the classification of banks as wholesale and retail commercial banks.

Amel and Rhoades (1988) agree with Passmore's concept to isolate groups with the use of shares of particular asset items and not with the use of variables based on financial results.

Their justification is based on the fact that the strategy adopted by a manager should be better reflected in the balance sheet rather than in the profit and loss account. Moreover, it is coherent with the theory that membership of a company in a given group stems from its history, which is reflected in accumulated assets (cf. Chapter 2). Amel and Rhoades (1988) also first used a more refined method of group isolation — the cluster analysis, which allows to define groups on the basis of more than one variable. Apart from that, the authors check the stability of the breakdown into groups, by testing whether the membership in particular groups does not change significantly in three different years[2]. The necessity of existence of breakdowns sustainable over

[2]Research by Amel and Rhoades (1988) concerns also the banking sector and covers the years 1978, 1981 and 1984.

time is a remark of particular significance, as the definition of a strategic group is related to a time horizon that is longer than one year. A breakdown identified in a given year may stem from adopting short-term strategies or be accidental (cf. Amel and Rhoades, 1988). The authors identified 6 groups stable over time. Membership of a bank in a given group does not depend on the size of the bank or on its location (small-large cities, particular states). The identified groups do not overlap with a common classification of banks as wholesale and retail commercial banks.

The concept of strategic groups was created in order to explain the sustained differences in financial results of particular companies in an industry. This is why most of empirical research is also focused on the significance of differences in profitability between particular groups. The majority of researchers have identified significant differences in financial results between isolated groups (cf. Dess and Davis, 1984; Reger and Huff, 1993; Heene and Houthoofd, 2002). Some of them, however, did not detect significant differences in profitability that could be explained by the membership in a group (cf. Frazier and Howell, 1983; Cool and Schendel, 1987; Martens, 1988). In the research of the banking sector the measures of profitability generally exhibited significant differences between groups (Mehra, 1996; Koller, 2001). Additionally, the research by Hackethal (2001) showed that only membership in groups isolated on the basis of market variables explained differences in profitability. On the other hand, there were no significant differences in ROA and ROE detected between groups isolated on the basis of resource based variables[3].

None of the research conducted in order to identify strategic groups in the banking sector was aimed to explain the earnings taking the profit-risk interdependence into consideration. The earnings of a company operating in

[3]Hackethal (2001) introduced two kinds of breakdowns of 624 European commercial banks: one was based on resource-based-view variables, e.g. share of deposits in total assets or the ratio of deposits placed to deposits accepted on the interbank market, whereas the other was based on market-based-view variables, e.g. average growth in assets or share of loans in total assets. Each bank was thus classified into two groups.

the financial sector is significantly influenced by — apart from the quality of management — the adopted risk profile. Assuming that the risk profile is reflected in the balance sheet structure of the bank, the breakdown into strategic groups, performed on the basis of variables that represent ratios of particular asset items to total assets, should take the bank's risk profile into account. Major differences not only in the earnings but also in the adopted risk profile should occur between the thus isolated groups.

Amel and Rhoades (1988) set a kind of standard of research on strategic groups in the banking sector. Most of research concerning this sector takes into account their remark that balance sheet-based variables should be used in identification of groups (cf. Koller, 2001; Hackethal, 2001). Similarly to Amel and Rhoades (1988), Koller (2001), in relation to Austrian banks, and Hackethal (2001), in relation to European banks, use non-hierarchical clusters as a tool of banks' breakdown into groups. The concept lying behind breaking down banks into clusters is merging into groups on the basis of a criterion that usually minimises differences between standardised values of strategic variables.

Although most researchers have identified strategic groups in the researched sectors, some of them question the existence of any breakdowns within industries and claim that strategic groups stem from the use of false detection methods or from the *ad hoc* choice of a strategic variable (cf. Thomas and Venkatraman, 1988; Barney and Hoskisson, 1990).

Leask (2004) criticises research within the scope of strategic groups. He claims that particular researchers select industry-specific variables, for which the differences may be significant in one industry but not necessarily in another. Similarly to Oster (1982), he criticises the fact that there is no standard of selection of variables that constitute strategy dimensions, which is why they are somewhat subjective. He proposes to focus research on several predefined strategic variables, so that it becomes comparable. Another criticism concerns the lack of a unified method of breakdown into groups and errors in the use of techniques based on cluster analysis. Leask notes that the

majority of researchers do not use any test of cohesion of results obtained, that would be alternative to the cluster analysis *per se*. Another common error is including significantly correlated variables in analyses, which results in multiple use of the same information.

Leask's requirement of the same strategic variables for all the research concerning strategic groups cannot be met in the case of the banking sector, due to different characteristics of balance sheets of financial institutions in comparison with those of manufacturing companies. However, in the selection of strategic variables we took into account most of the balance sheet structure variables analysed by Amel and Rhoades (1988), Koller (2001) and Hackethal (2001). Thus we made an effort to make our research comparable with other research on strategic groups in the banking sector.

In spite of the criticism and the high and low tides of interest that accompany research on strategic groups, it seems to have achieved a certain level of analytical standard which allows for a statement that it has become a recognised field of research (cf. Heene and Houthoofd, 2002).

4 Data — strategy dimensions

The data analysed in this paper come from all the operating Polish commercial banks, including 3 associating cooperative banks, from the period between the first quarter of 1997 and the third quarter of 2004. The banks that went bankrupt in this period or were under commissary administration have also been included. The data come from banks' reports and include the balances sheet items as at the end of March, June, September and December[4] or quarterly data for the profit and loss account items. The ratios that constitute the dimensions of the strategy have been derived from yearly data. In the case of balance sheet data, the arithmetic mean has been calculated for particular items as at the end of each quarter. In the case of the profit

[4]Data on Treasury bills are an exception — their balances as at the end of every of the 12 months have been taken into account, due to the high volatility of this asset category.

and loss account items, the ratios have been calculated based on the values of particular items as at year-end. In the case of a bank that terminated its operation or was taken over by another bank during the year, it has been included in the analysis within the scope of the data from the year preceding its liquidation or acquisition.

The measure of homogeneity (similarity) in the cluster analysis is the degree of diversity between particular strategic variables in consecutive periods. We have divided these variables into three categories:

Category I: variables defining the strategy of use of acquired resources. They are taken into account with the purpose of defining the market segment or the product group on which a given bank focuses its activity. Some of the ratios characterise also major customer groups — on the asset side:

- Total loans / total assets
- Loans to individuals / total loans
- Housing loans / loans to households
- Corporate loans / total loans
- Securities / total assets
- Foreign currency loans / foreign currency liabilities[5].

Category II: variables defining the strategy of acquiring resources. The ratios below define the way a bank acquires resources for financing assets and its competitiveness in this area. Some of the variables characterise also customer groups — on the liabilities side.

[5]In Category I three other ratios have also been taken into account: (*Securities + net debt on the interbank market*) / *total assets*, *housing loans* / *total loans* and *foreign currency loans* / *total loans*. However, they have been removed from the set of variables constituting strategy dimensions due to their high coefficients of correlation (over 0.6) with other variables.

- Net debt on the interbank market / total assets
- Debt in foreign financial institutions / total assets
- Deposits from individuals / total assets
- Corporate deposits / total assets
- Foreign currency deposits from non-financial sector / total assets.

Category III: variables defining the strategy in the bank's structure of costs and revenues. They are taken into account in order to differentiate between retail and wholesale banks.

- Total assets per employed (the lower the ratio, the more retail the bank is — more numerous customer service staff)
- Salaries / total assets
- Fee income / income from banking activity (indicates whether the bank focuses on the traditional income on margin or is rather focused on services)
- Personnel costs per employed[6].

All the variables mentioned above have been taken into account in the calculations jointly, as well as separate clusters have been isolated for different categories of variables. Thus, we have obtained results on the basis of a multidimensional analysis, i.e. analysis of clusters in three different dimensions defined by variables from particular categories[7], and on the basis of a one-dimensional analysis of clusters taking into account all the variables

[6]In Category III three other ratios have been initially taken into account: *interest expenses from the non-financial sector / total interest expenses*, (*interest expenses + fee expenses*) *from the non-financial sector / financial income from banking activity, operating costs / total assets*. These variables have been excluded from further analysis due to their high correlation coefficients (over 0.6) with other variables from the set.

[7]Hackethal (2001) has broken down banks in two dimensions (cf. footnote 3).

jointly. Such an approach aims, among other things, at defining which of the categories of variables (which of the dimensions) best explains the banks' earnings. In the analytical scheme, it will be possible to use clusters defined in different breakdowns, depending on what the equation from the analytical scheme is related to.

As it stems from theoretical deliberations, potential variables that are strategy dimensions should include such values as the risk management quality, the ability to maintain the existing and win new customers, expenses for the development of a branch network and risk management models, or advertising expenditure. However, these values are difficult to measure or they are unavailable in the banking statistics, which is why taking into account the measures of e.g. management quality would give rise to doubts as regards their definitions. Apart from that, we assume that expenses for the development of a branch network or advertising expenditure should be reflected in the variables that have been taken into account, such as *total assets per employed* or *deposits from individuals / total assets*.

5 Adopted research method

There are many methods of building the groups. According to (Halkidi *et al.*, 2001) the following clustering procedures can be differentiated:

- partitional clustering — consists in partitioning the population into a predetermined number of clusters. The number of clusters is determined on the basis of a predetermined optimisation criterion (e.g. minimisation of the loss of information),
- hierarchical clustering — by this method, groups are obtained recursively as a result of agglomerating smaller clusters into larger ones, and an adequate indicator of the cutting level (e.g. the inconsistency ratio) is used as a criterion of stopping the procedure before obtaining only one group,

- density-based clustering — clusters are formed through increasing the appropriately measured density of elements in clusters,
- grid-based clustering — groups are created as a result of dividing the element feature space into cubes. By this very simple method, clusters are created from single cubes that elements of the population fall into.

Cluster research does not finish with the mere constructing of the groups. In order to justify the correctness of results it is necessary to carry out significance tests for the groups in terms of the selected analysis criteria or the purpose of cluster building. These can be statistical or econometric tests, or adequate validity indices in the case of models that lack a defined probabilistic structure (e.g. when clusters are fuzzy sets).

For the purpose of clustering banks Ward's algorithm has been used, that minimises distances between variables within a group (i.e. maximises the group's homogeneity). The advantage of this hierarchical method is that it allows illustrating interdependencies between groups. The so-called dendrograms that are created during the visualisation of the algorithm allow to define distances between clusters and to isolate elements that are most alike within a given group, as well as elements that fit less to the cluster, in terms of the clustering criterion used. As Ward (1953) pointed out, the purpose of his research was to find a breakdown of population that would minimise the loss of information about the population, resulting from the clustering process. In his search for optimal clustering, Ward limited himself to procedures that, in their each step, decrease the number of groups by 1 and minimise the loss of information. Ward's approach (1963) was a compromise between the simplicity of the scheme and its optimality in the broadest meaning. Ward's procedure comprises n subsequent steps, where n is a number of elements (in this paper, the elements are banks) of the starting set. Ward assumed that a structure every element of which constitutes a separate group contains the most information about the elements of the examined set. In step zero, one-element groups are created from all the elements of the examined population. In every following step of the algorithm, two groups remaining from

the previous step of the procedure are merged in a way that will minimise the increase in the cost of information loss, i.e. — as Ward assumed — the $d_i^2(G,H)$ value, where:

$$d_i^2(G,H) = n_G n_H \frac{\|\bar{x}_G - \bar{x}_H\|^2}{n_G + n_H} \tag{1}$$

whereas $\bar{x}_G$, $\bar{x}_H$, n_G and n_H are mean values of elements from sets G and H and their sizes, respectively, minimised after all breakdowns of GH obtained in step $i-1$ into sets G and H ($G \cup H = GH$ and $G \cap H = \emptyset$). In other words, two groups are merged in a given step, where no other pair of groups with a smaller distance between them can be found. When two groups are merged, the procedure goes to the next step. d_i^2 is a measure of distance; during its calculation, the groups are identified with their "mean" element (the average representative) and Euclidean distance between them is measured. Only two groups are merged in a given step, all the other ones remain unchanged.

As a result of applying the procedure mentioned above, all the elements are clustered, i.e. the procedure does not leave any elements unclassified. However, when analysing the hierarchy of the groups created in subsequent steps, we can use additional criteria of stopping the algorithm. The algorithm itself does not have any principle that would allow it to stop before creating one group of all the elements (banks), when m groups ($1 < m < n$), are created. Such a principle could consist in defining what part of the variance should be explained, where the larger the number of groups (clusters) is, the more variance is explained. On the one hand, the number of clusters should not be excessively large as it makes identification of groups that remain steady over time more difficult. A smaller number of clusters though may cause a situation where a single cluster comprises banks of different activity profiles and different risk profiles that affect profitability in different ways. The problem of selecting the cutting level may be avoided with the use of an adequate variant of the method based on a group cohesion index (e.g. Celinski-Harabasz index, Dunn index etc., see Halkidi *et al.*, 2001). For a predetermined number of clusters, which are supposed to result from the use

of a selected method of clustering, an index is calculated and the breakdown that gives the highest value of the index, is selected. The choice of an index usually becomes an issue of controversy.

In the initial phase of research, a cutting rule was adopted, which was used to isolate more than 1 group. It is based on the so-called inconsistency ratios, which measure the weight of linkages created between elements comprising particular groups — the "closer" to each other two elements are in terms of their isolated features (the more they are alike), the lower the inconsistency ratios bare. The number of groups proved to be sensitive to the level of criterion adopted. Slight changes in the cutting level caused a two-fold increase in the number of groups. Defining the distance level above which building of subsequent groups was stopped turned out to be a better criterion stopping the procedure. With regard to the comparability of results for different clustering criteria, the stop level was defined as a percentage of the maximum distance between groups, whose merging in the next step would result in the whole studied population becoming one single group. In other words, it is a percentage of the distance between groups in the case where there is no stopping criterion and, as a result of using the algorithm, there are only 2 groups left. The percentage of the distance was determined at 70%. The stop level therefore defines the depth, down to which the merging of the population elements into groups takes place.

Alternatively, the balance between the number of clusters and the explained variance may be defined with the use of the so-called jack-knifing, i.e. through defining a boundary (acceptable) percentage of unclassified banks, e.g. at 10%, or with the use of discriminative analysis, i.e. finding a boundary (optimal) percentage of explained variance on the basis of adopted optimisation criterion (target function).

Within particular groups (clusters), the variables that differ in a statistically significant way between groups, can be determined with the use of e.g. logit models. It allows for determining the mobility barriers, i.e. the strategic variables — variables that make separating the groups (clusters) reasonable

(significant). Significant differences in the values of these variables and the lack of convergence over time may lead to formulating of a thesis defining the factors of clustering of the banks within particular strategies (clusters).

As the research aims at a breakdown of banks into groups, which would be further used in constructing the analytical scheme for the purposes of, *inter alia*, modelling the financial result of the banking sector for the needs of the financial stability assessment, two hypotheses have been verified:

H1 The groups created differ significantly in terms of their ROA.

H2 In the regression equations of profitability, based on selected micro- and macroeconomic variables, the estimated model parameters are more significant for the estimation of equations for groups of banks than for the total sector.

As the breakdown into groups should be helpful in defining different profitability levels, the return on assets — as one of the profitability measures — has been used to test the diversity of groups[8]. If there were two groups with identical distributions, the differentiation between them would be of no use. The Kolmogorov-Smirnov statistics has been used (cf. Gajek and Kałuszka, 2000), which enables verification of the consistency of distributions of the ratios of the *net income from banking activity / total assets* and the *pre-tax earnings / total assets* between groups. This test is very sensitive to the location of distribution, i.e. the location of the distribution around the mean (due to the way of defining the distance of distributions as the maximum distance between the points of the cumulative distribution function). It also generates relatively high Type II errors, although it has a relatively high power for smaller samples (cf. Capon, 1965; Smirnov, 1948). The null hypothesis for each pair of groups is the equality of profitability distributions in the groups. The hypothesis was tested on three significance levels — 0.01, 0.05 and 0.10.

[8]In research relating to testing the significance of separation into groups, in order to explain differences in profitability return on equity ratio is also used.

Another test was carried out on the basis of linear regression models of the average pre-tax earnings over total assets (ROA) and pre-tax earnings over own funds (ROE) of banks, depending on the average values for a given strategic group of the following variables, which may influence the banks' financial results (similar variables and a series of other variables used in panel estimation of banks' results can be found in e.g. DeYoung and Rice, 2004):

- (dPKB) rate of change in GDP,
- (sprGOSP) spread between the interest rate on household deposits and loans,
- (sprKWIB) spread between the interest rate on corporate loans and the three-month WIBOR rate,
- (sprPRZ) spread between the interest rate on corporate deposits and loans,
- (IrLOAN) percentage of irregular loans,
- (PPI) inflation index,
- (WIG) Warsaw Stock Exchange Index,
- (D-N/AKT) the ratio of the difference between banks' receivables and deposits in banks to assets.

Data from the period between the first quarter of 1998 and the fourth quarter of 2004 have been used. The research is limited to comparing the model estimates with two regressors selected among the above-mentioned variables. For each pair of variables, three models of ROA dependence on the average values of variables in the whole population of analysed banks and on means in the group of banks which in 2004 were classified into 2 selected groups have been estimated. For simplicity purposes it is assumed that the breakdown of banks into groups has not changed over time and remains the

same as in 2004. This is a strong assumption, although a sufficient one for comparison purposes. Better estimates of models for series of mean values of variables in the obtained groups than for the mean calculated for all the banks would suggest that the financial results of the banking sector should be modelled with the use of a breakdown into groups of similar banks.

In the case of researching strategic groups for multiple periods, a question arises about the sustainability of results over time. In the verification of the sustainability, the percentage of banks migrating between groups has been used.

6 Results

In order to identify the strategic groups, we have made calculations for all the variables jointly (a one-dimensional analysis) and taking into account only variables from particular categories described in chapter 4 (a multidimensional analysis). In the one-dimensional analysis, each bank is assigned to one cluster, whereas in the multidimensional analysis — to three clusters. In the multidimensional analysis banks are clustered in three dimensions, considering the strategy relating to assets, liabilities and the income and expense structure.

Figures 1-4 include an exemplary dendrograms for the one-dimensional analysis, whereas figures 5-6 include exemplary results of the multidimensional analysis.

The number of clusters (colours) in a given dendrogram is determined by the adopted cutting level. At a lower cutting level, the number of groups increases and its homogeneity rises. When the cutting level is moved to its lowest value, each bank will constitute a separate cluster.

The Celinski-Harabasz index, calculated for the 2004 data, proves that the adopted cutting level adequately characterised the number of groups and the composition of strategic groups, cf. Figure 7. Although lowering the cutting level to a level that would isolate 9 groups gives a higher value of

the index, the number of groups is then very sensitive to moving the cutting level.

The Celinski-Harabasz index for groups in 2003 expressly indicates 5 clusters, cf. Figure 8. However, the breakdown is again very sensitive to the cutting level. For example, lowering the cutting that gives 5 groups by 10% would result in obtaining 7 groups, and lowering it by 20% would give 8 groups.

Tables on figures 5-6 include an analysis of stability over time of clusters identified in the one-dimensional analysis, i.e. an attempt to identify strategic groups in the Polish banking sector. Banks are sorted on the basis of their assignment to clusters in 2004. Particular numbers of clusters have been replaced with names originating from the profiles of the banks that are the most numerous in a given cluster. No names have been given to the clusters for which defining a dominant profile is impossible. In this case, symbol ,,∗" in cells of tables 5 and 6 denotes banks that are not classified to any of the considered groups. An empty space in the table means the bank was not active in the relevant period. In general, it refers to clusters of no more than 4 banks classified.

On tables on figure 9 we present, for three significance levels, percentages of rejected null hypotheses of the Kolmogorov-Smirnov test on the lack of a significant difference between the distributions of *the pre-tax earnings / total assets* or *net income from banking activity / total assets* ratios among the banks assigned to particular clusters. The percentages are presented for clusters identified for particular categories (the multidimensional analysis) as well as for all the categories jointly (the one-dimensional analysis) in particular years. The aim of this breakdown is to help identify the categories and years which show significant differences in distributions of pre-tax earnings or net income from banking activity, recorded in particular clusters.

Tables 1-6 present estimates of regression equations that serve to assess the significance of the breakdown into groups by the method of modelling the profitability of banks, which are gathered in tables 1-6. Tables 1-3 include

estimates of regression of ROA for arithmetic means of regressor levels in the two most numerous groups of banks and for means in the whole population.

Tables 4-6 present the results of estimations of models explaining the average ROE of banks in groups corresponding to those in the case of ROA. The calculated significance levels of the t-Student statistics that correspond to the statistically significant variables at the level of 5% have been indicated with a bold red font. The penultimate column comprises the F statistic used to test the hypothesis that all parameters of the model, except for the constant term, are equal to 0. The last column comprises results of the Jarque-Bera test. The red font indicates the significance levels at which the null hypothesis of normality of the distribution of residuals cannot be rejected.

7 Conclusions

The analysis of dendrograms and the analysis of sustainability of clusters over time allows for a statement that groups that are sustainable over time started isolating in 2000, which may be related to significant changes in ownership in the years 1998-1999.

The one-dimensional analysis allowed for isolating of the following groups of banks, the names of which have been determined on the basis of the dominant profiles in particular clusters[9]: *universal banks, corporate banks, car finance and mortgage banks, retail banks, regional banks.* The group of *car finance and mortgage banks* remains stable throughout the period, whereas in 2003 it was divided into two groups: (1) *mortgage banks* and (2) *car finance banks.* In the years 1997-2001 there was a stable group of regional banks. There were migrations of some banks between groups, particularly before 2000, but there are also banks that have not changed their group

[9]As the breakdown of banks was considerably different in 1997 and it was impossible to determine dominant profiles of clusters, the largest cluster in this period was called retail-universal-car finance.

membership over the whole period. In the years 2000-2004 the percentage of banks that did not migrate amounted in particular groups to: 63.6% in the group of *car finance and mortgage banks*[10], 58.3% in the group of *retail banks*, 57.9% in the group of *universal banks* and 33.3% in the group of *corporate banks*. Corporate banks form the least stable group over time. Banks that migrated in those years between groups were most often members of two various groups. Only two banks belonged to three various groups within that period.

Weights of groups in terms of the share of assets of banks of particular clusters in the total value of assets of commercial banks vary a lot. In 2004 universal banks dominated with a 61.4% share in assets. Retail banks and corporate banks also had major shares (20.1% and 13.3%, respectively). Clusters of car finance and mortgage banks (3.6%) and housing banks (1.0%) were small in terms of the size of assets.

Membership of banks in groups identified in 2000-2004 overlaps to a large extent with the classification of the General Inspectorate of Banking Supervision (GINB)[11]. Of 10 banks classified as mortgage banks or car finance banks, 8 have been included in the group of car finance-mortgage banks. Of 11 banks classified by GINB as retail banks, 8 have been included in the group of retail banks. The worst convergence was obtained for corporate banks — 10 out of 16 banks. Of 10 banks classified by GINB as universal banks, 9 were assigned to the group of universal banks.

It stems from Figure 9 that significantly higher percentages of rejected null hypotheses of the Kolmogorov-Smirnov test exist only for variables of Category I (from the multidimensional analysis) and for all the variables jointly (one-dimensional analysis). These results are consistent with Hackethal's research (Hackethal, 2001), who identified differences in profitability between groups of European banks, but only on the basis of the breakdown into groups with the use of market based values (cf. Chapter 3). Percentages

[10]The breakdown of this group into two subgroups in 2003 was ignored in the calculation of this percentage.

[11]"Composition of groups of commercial banks for 2005", GINB, April 2005, mimeo

are higher only for the years 2000-2004, in particular for the income from banking activity. No major differences have been observed in the distributions of profitability ratios: *pre-tax earnings / total assets and net income from banking activity / total assets* for other dimensions (for variables of Categories II and III). It means that membership of a bank in a given group may be meaningful for the explanation of differences in profitability after the year 2000, but only for groups identified on the basis of all variables jointly or on the basis of variables of Category I. In terms of the net income from banking activity, the percentage of rejected test hypotheses is higher also for the years 1997-1999; however, the existence of strategic groups that would be meaningful for the explanation of differences in profitability in those years, has no confirmation in the case of *pre-tax earnings / total assets* distribution. Therefore, we have obtained a confirmation of the hypothesis that the strategy adopted by a bank leads to differences in results, but only for the second half of the analysed period. The results of this analysis show that strategic groups in the Polish banking sector can be identified after the year 2000.

Estimation of regression equations of profitability has been carried out for mean values of ratios in 2 groups, called the universal group and the retail group (cf. Chapter 6). These are the most numerous groups identified on the basis of the 2004 data. The groups include 23 universal banks and 12 retail banks. Among the 28 models with ROA as the explanatory variable that have been estimated for the two groups, there are models with good basic statistical properties. In the case of the universal group, statistically significant coefficients different from 0 for at least one variable of the model have been obtained for 7 equations, and in the case of the retail group — for 4 equations. However, for means from the whole examined population of banks (cf. Table 3) no equation proved to be significant at the level of 5%. Estimation statistics support the concept that description and forecasting of profitability should be analysed with banks broken down into groups of similar banks that make e.g. the strategic groups proposed by the authors

of this paper. A ROE analysis does not confirm as clearly as ROA regression estimators that examination of profitability within strategic groups leads to smaller estimation errors. Out of 28 equations (cf. Tables 4 and 5) for the group of universal banks, 9 equations have significant coefficients, but none of the models estimated on the basis of corporate banks data proved to be statistically correct. Some equations describing ROE with parameters calculated on the basis of data for all the banks jointly have better properties, although an equation with all its coefficients significant has not been obtained.

It stems from the analysis carried out with the use of the Kolmogorov-Smirnov test and the regression equations that a breakdown of banks into strategic groups allows for a more precise modelling of profitability of the banking sector. It creates a possibility of better forecasting of the banking sector earnings, which is of vital importance for analyses of the financial system stability. Therefore, results of analysis of the breakdown of banks into strategic groups may be used in further works on the analytical scheme. Making use of the theory of strategic groups in identification of the structure of the banking sector facilitates a more precise *ex ante* assessment of stability of the financial system.

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Annex

The cutting level for dendrograms presented in Annex 1 is at 70% of the maximum distance between groups.

The following symbols denoting groups of banks have been applied:

- (S\H) — car finance and mortgage banks,
- (K) — corporate banks,
- (D) — retail banks,

- (U) — universal banks.

The symbols relate to the classification made on the basis of all the ratios (the one-dimensional analysis) in 2004. Such a breakdown is also applied in this Annex, i.e. in relation to clusters identified on the basis of variables from 1^{st}, 2^{nd} and 3^{rd} category (multidimensional analysis).

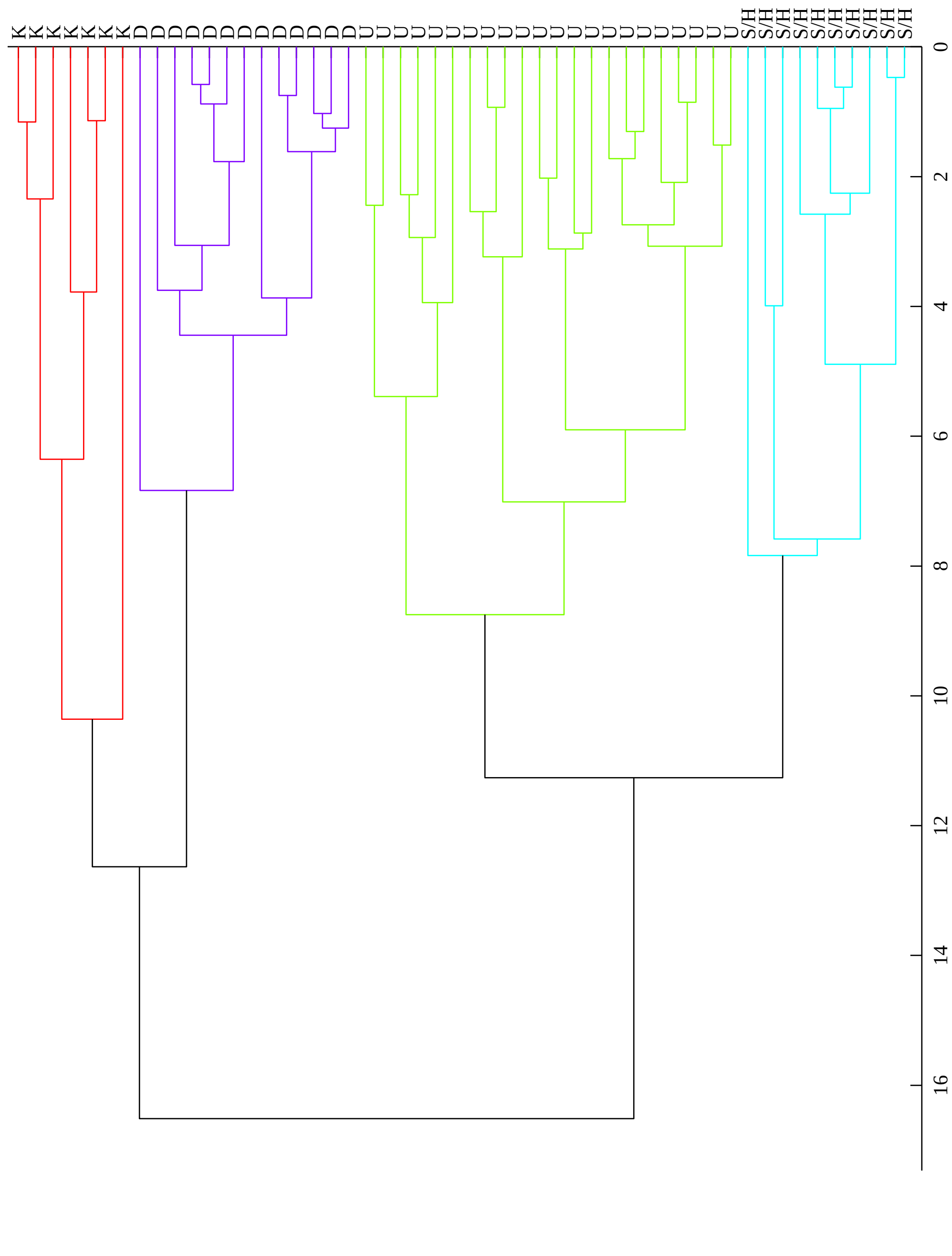

Figure 1: Clusters of banks as at the end of 2004

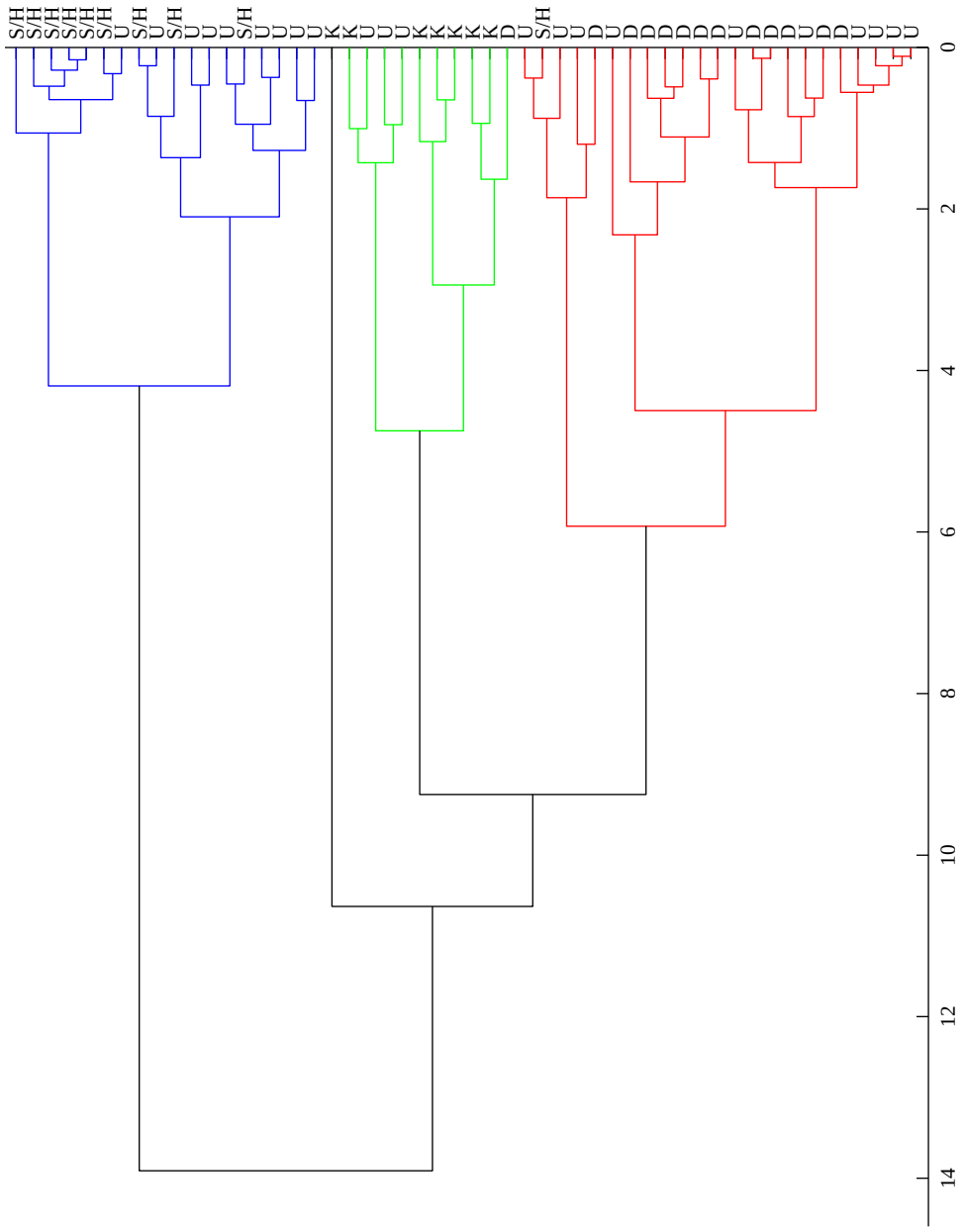

Figure 2: Clusters of banks as at the end of 2004, built on the basis of asset-related ratios

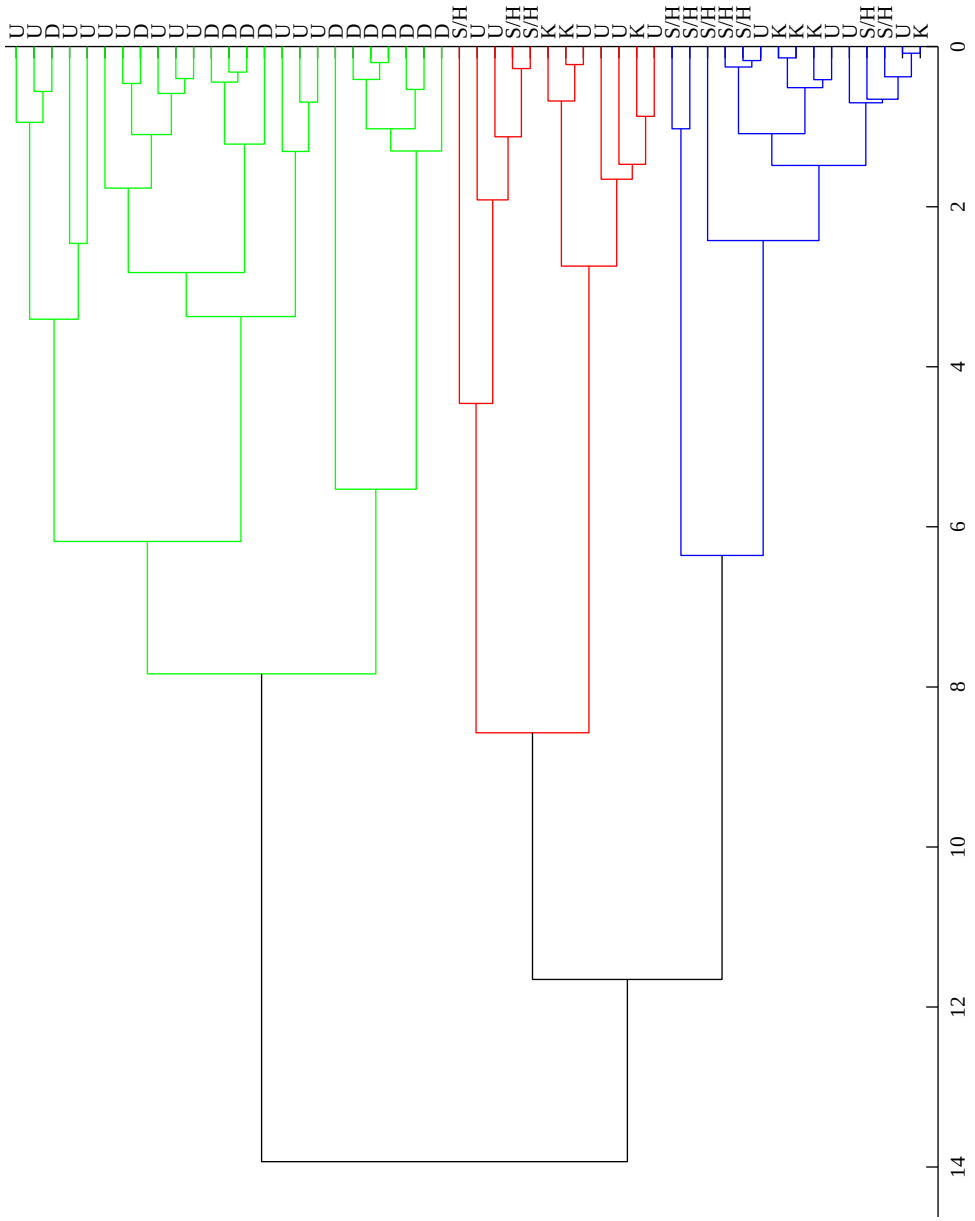

Figure 3: Clusters of banks as at the end of 2004, built on the basis of liabilities-related ratios

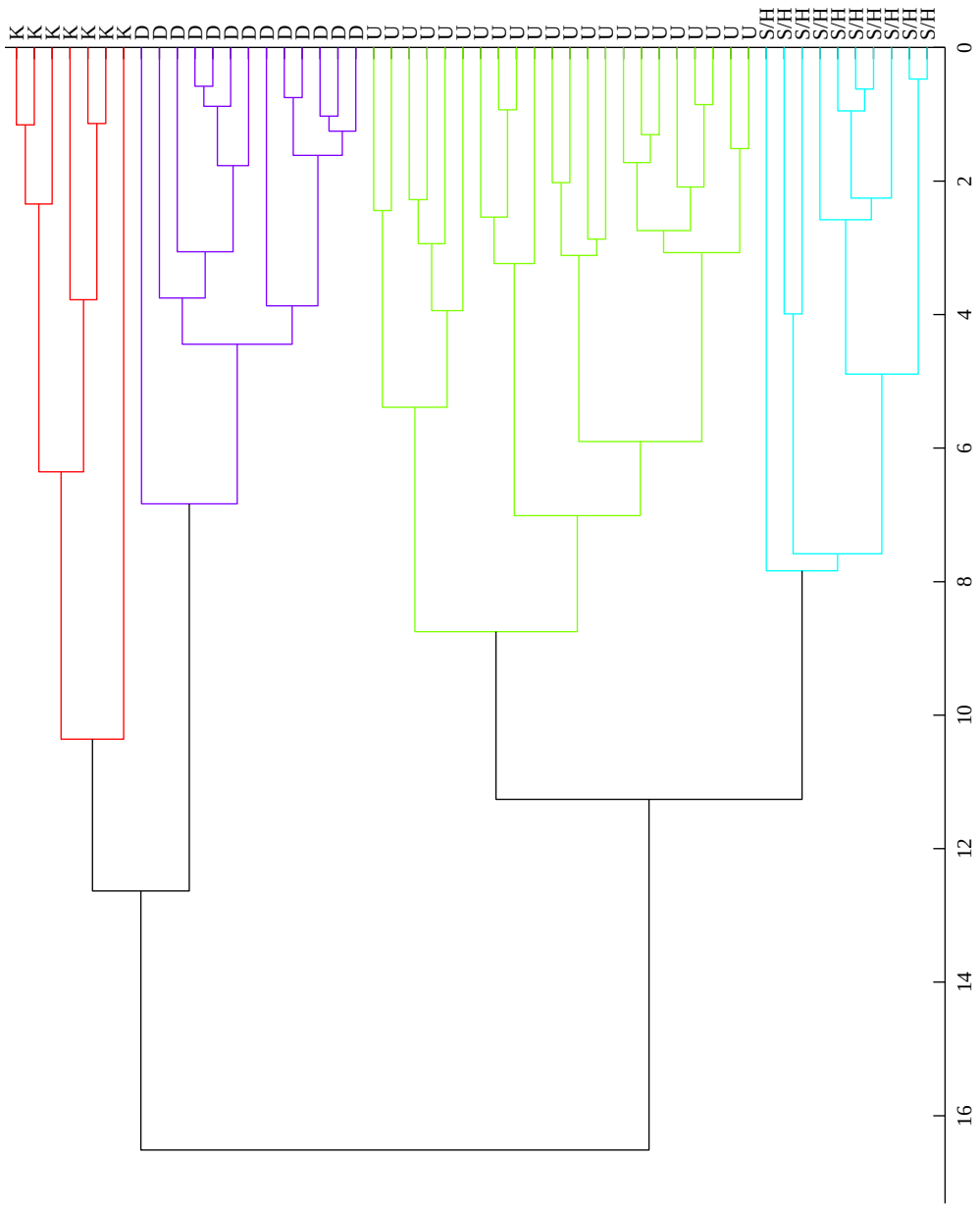

Figure 4: Clusters of banks as at the end of 2004, built on the basis of ratios from profit and loss account

Bank no.	1997	1998	1999	2000	2001	2002	2003	2004, Qs 1-3
1	retail-universal-car finance /mortgage	universal	*	retail	retail	retail	retail	*
2					*	*	*	*
3	retail-universal-car finance /mortgage	universal	retail	retail	retail	universal	*	*
4							*	*
5	retail-universal-car finance /mortgage	universal	regional	universal	retail	*	retail	retail
6	retail-universal-car finance /mortgage	universal	retail	retail	retail	retail	retail	retail
7	retail-universal-car finance /mortgage	universal	retail	retail	retail	retail	retail	retail
8	retail-universal-car finance /mortgage	universal	retail	retail	retail	retail	retail	retail
9	retail-universal-car finance /mortgage	universal	car finance /mortgage	retail	retail	retail	retail	retail
10	retail-universal-car finance /mortgage	universal	car finance /mortgage	retail	retail	retail	retail	retail
11		universal	universal	retail	retail	retail	retail	retail
12		universal	regional	universal	retail	retail	retail	retail
13		universal	universal	universal	retail	retail	retail	retail
14		universal	universal	universal	universal	car finance /mortgage	retail	retail
15	retail-universal-car finance /mortgage	universal	universal	universal	retail	universal	retail	retail
16					*	corporate	corporate	corporate
17	corporate	corporate	corporate	corporate	corporate	corporate	corporate	corporate
18	corporate	corporate	universal	corporate	corporate	corporate	corporate	corporate
19	corporate	*	corporate	corporate	universal	corporate	corporate	corporate
20	universal	corporate	universal	universal	universal	corporate	corporate	corporate
21	universal	corporate	universal	universal	universal	corporate	corporate	corporate
22	universal	corporate	universal	universal	universal	corporate	corporate	corporate
23	universal	corporate	universal	universal	universal	corporate	corporate	corporate
24						corporate	corporate	corporate
25						*	universal	corporate
26	corporate	corporate	corporate	*	corporate	*	universal	corporate
27	corporate	corporate	corporate	corporate	universal	corporate	universal	corporate
28	universal	corporate	universal	universal	universal	corporate	universal	corporate
29					*	*	mortgage	car finance /mortgage
30	retail-universal-car finance /mortgage	universal	retail	*	regional	car finance /mortgage	mortgage	car finance /mortgage
31	*	*	car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance /mortgage	mortgage	car finance /mortgage
32	universal	retail	retail	*	universal	car finance /mortgage	mortgage	car finance /mortgage
33		regional	regional	regional	regional	*	car finance	car finance /mortgage
34	*	car finance /mortgage	car finance /mortgage	car finance /mortgage	regional	car finance /mortgage	car finance	car finance /mortgage
35	retail-universal-car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance /mortgage	regional	car finance /mortgage	car finance	car finance /mortgage
36				*	car finance /mortgage	car finance /mortgage	car finance	car finance /mortgage
37	retail-universal-car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance	car finance /mortgage
38	retail-universal-car finance /mortgage	universal	car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance	car finance /mortgage
39		car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance	car finance /mortgage
40		car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance /mortgage	car finance	car finance /mortgage
41			*	*	corporate	*	mortgage	universal
42	universal	corporate	universal	universal	universal	*	universal	universal
43	*	retail	retail	universal	universal	corporate	universal	universal
44	retail-universal-car finance /mortgage	universal	regional	universal	retail	universal	universal	universal
45	retail-universal-car finance /mortgage	universal	regional	universal	retail	universal	universal	universal

Figure 5: Clusters of banks — cumulative table

	1997	1998	1999	2000	2001	2002	2003	2004, Qs 1-3
46	regional	regional	regional	regional	regional	universal	universal	universal
47	regional	regional	regional	regional	regional	universal	universal	universal
48	regional	regional	universal	regional	regional	universal	universal	universal
49	universal	regional	universal	regional	universal	universal	universal	universal
50	*	retail	retail	universal	universal	universal	universal	universal
51	universal	universal	regional	universal	universal	universal	universal	universal
52	*	*	universal	universal	universal	universal	universal	universal
53	*	*	universal	universal	universal	universal	universal	universal
54	universal	*	universal	universal	universal	universal	universal	universal
55	universal	corporate	universal	universal	universal	universal	universal	universal
56	universal	corporate	universal	universal	universal	universal	universal	universal
57	universal	universal	universal	universal	universal	universal	universal	universal
58	universal	universal	universal	universal	universal	universal	universal	universal
59	universal	universal	universal	universal	universal	universal	universal	universal
60	*	*	universal	universal	universal	universal	universal	
61	retail-universal-car finance /mortgage	universal	regional	universal	retail	*		
62	retail-universal-car finance /mortgage	universal	regional	universal	retail	universal		
63	retail-universal-car finance /mortgage	universal	universal	universal	universal	universal		
64	retail-universal-car finance /mortgage	universal	retail	retail	*			
65	retail-universal-car finance /mortgage	universal	regional	universal	retail			
66	regional	regional	regional	regional	regional			
67	regional	regional	regional	regional	regional			
68	regional	regional	regional	regional	regional			
69	regional	regional	regional	regional	regional			
70	regional	regional	regional	regional	regional			
71	regional	regional	regional	regional	regional			
72		regional	regional	regional	regional			
73	retail-universal-car finance /mortgage	universal	retail	retail				
74	corporate	*	corporate	corporate				
75	regional	regional	regional	regional				
76	retail-universal-car finance /mortgage	universal	regional	universal				
77	retail-universal-car finance /mortgage	universal	regional	universal				
78	universal	corporate	universal	universal				
79	universal	universal	universal	universal				
80	universal	universal	universal	universal				
81	*	*	*					
82	*	retail	*					
83	retail-universal-car finance /mortgage	universal	retail					
84	corporate	corporate	corporate					
85	retail-universal-car finance /mortgage	universal						
86	retail-universal-car finance /mortgage							
87	regional	corporate						
88	universal	universal						
89	universal	universal						
90	universal	universal						
91	universal	universal						
92	universal	universal						

Figure 6: Clusters of banks — cumulative table

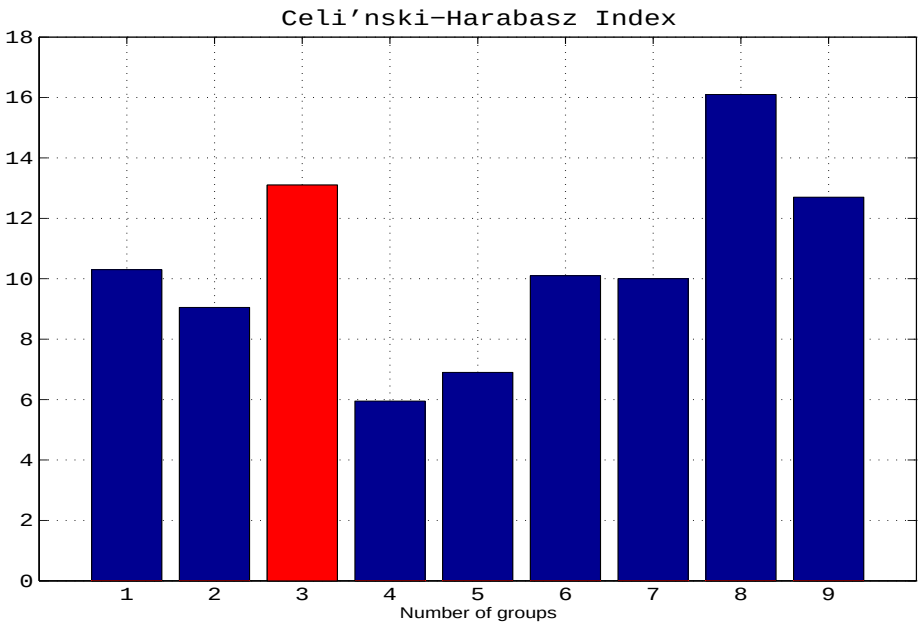

Figure 7: Level of the Celinski-Harabasz index for groups on the basis of the 2004 data

Banks that, at the cutting level of 70% of the maximum distance between groups, created clusters of one or two elements, have been removed from the set of analysed banks. There are 4 banks removed in this way. As a result, an index for clusters potentially significant for the examination of profitability has been obtained.

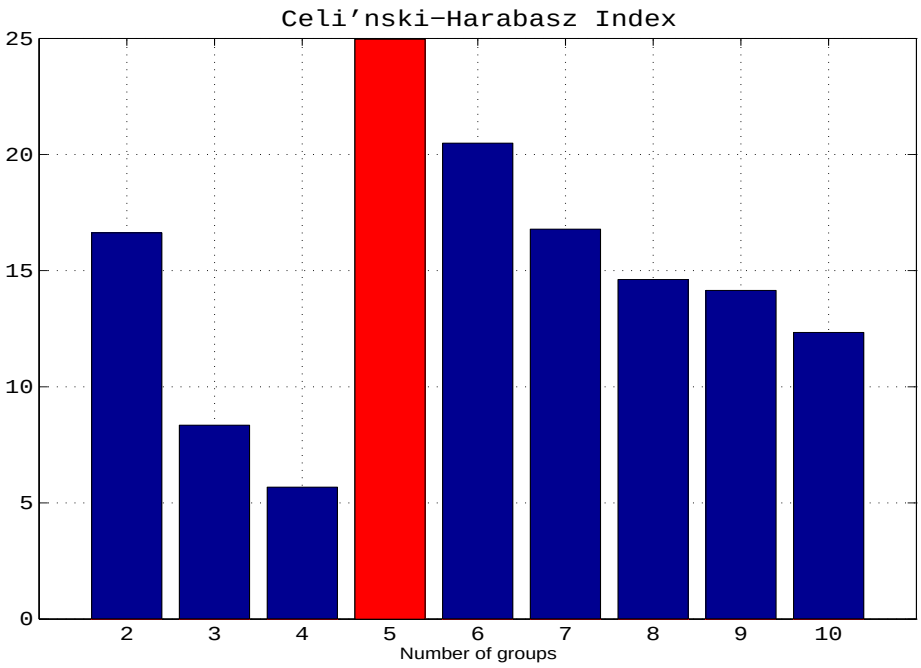

Figure 8: Level of the Celinski-Harabasz index for groups on the basis of the 2003 data

Banks that, at the cutting level of 70% of the maximum distance between groups, created clusters of one or two elements have been removed from the set of analysed banks. There are 3 banks removed in this way. As a result an index for clusters potentially significant for the examination of profitability has been obtained.

Cutting level 0.6
Comparison of distributions of pre-tax earnings

Percentage of rejected null hypotheses

Clusters by variables	Significance level	1997	1998	1999	2000	2001	2002	2003	2004	Total
All categories jointly	0,01	0,0	0,0	0,0	0,1	0,1	0,1	0,3	0,3	0,8
	0,05	0,2	0,2	0,1	0,2	0,3	0,1	0,6	0,8	2,6
	0,1	0,3	0,4	0,2	0,2	0,3	0,4	0,6	0,8	3,3
All categories jointly Suma		*0,6*	*0,6*	*0,3*	*0,5*	*0,7*	*0,6*	*1,5*	*2,0*	*6,7*
Category I (assets)	0,01	0,0	0,2	0,0	0,0	0,0	0,0	0,3	0,0	0,5
	0,05	0,3	0,3	0,0	0,0	0,0	0,3	0,5	0,0	1,5
	0,1	0,3	0,3	0,0	0,3	0,0	0,7	0,5	0,0	2,2
Category I (assets) Suma		*0,7*	*0,8*	*0,0*	*0,3*	*0,0*	*1,0*	*1,3*	*0,0*	*4,2*
Category II (liabilities)	0,01	0,0	0,0	0,2	0,0	0,1	0,0	0,0	0,0	0,3
	0,05	0,4	0,0	0,3	0,3	0,6	0,0	0,3	0,2	2,1
	0,1	0,5	0,5	0,5	0,6	0,7	0,0	0,3	0,3	3,5
Category II (liabilities) Suma		*0,9*	*0,5*	*1,0*	*0,9*	*1,4*	*0,0*	*0,7*	*0,5*	*5,9*
Category III (financial result)	0,01	1,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0	1,3
	0,05	1,0	0,7	0,0	0,3	1,0	0,0	0,7	0,0	3,7
	0,1	1,0	0,7	0,0	0,3	1,0	0,7	0,7	1,0	5,3
Category III (financial result) Suma		*3,0*	*1,7*	*0,0*	*0,7*	*2,0*	*0,7*	*1,3*	*1,0*	*10,3*
Total		5,1	3,6	1,3	2,4	4,1	2,3	4,8	3,5	27,1

Cutting level 0.6
Comparison of distributions of net income from banking activity

Percentage of rejected null hypotheses

Clusters by variables	Significance level	1997	1998	1999	2000	2001	2002	2003	2004	Total
All categories jointly	0,01	0,0	0,1	0,0	0,5	0,3	0,2	0,2	0,0	1,2
	0,05	0,2	0,1	0,3	0,5	0,4	0,3	0,3	0,3	2,5
	0,1	0,3	0,2	0,3	0,5	0,5	0,5	0,3	0,5	3,3
All categories jointly Suma		*0,5*	*0,4*	*0,7*	*1,5*	*1,2*	*1,1*	*0,8*	*0,8*	*7,0*
Category I (assets)	0,01	0,0	0,2	0,0	0,0	0,3	0,7	0,5	0,3	2,0
	0,05	0,3	0,5	0,0	0,0	0,7	0,7	0,7	0,5	3,3
	0,1	0,6	0,5	0,0	0,3	0,7	0,7	0,7	0,5	3,9
Category I (assets) Suma		*0,9*	*1,2*	*0,0*	*0,3*	*1,7*	*2,0*	*1,8*	*1,3*	*9,2*
Category II (liabilities)	0,01	0,0	0,0	0,3	0,0	0,3	0,0	0,0	0,2	0,8
	0,05	0,3	0,5	0,7	0,2	0,4	0,2	0,0	0,3	2,6
	0,1	0,6	0,7	0,8	0,4	0,4	0,2	0,0	0,7	3,7
Category II (liabilities) Suma		*0,9*	*1,2*	*1,8*	*0,6*	*1,1*	*0,3*	*0,0*	*1,2*	*7,1*
Category III (financial result)	0,01	0,0	0,0	0,0	0,7	0,0	0,0	0,0	0,0	0,7
	0,05	0,0	0,0	1,0	0,7	0,0	0,3	0,0	0,0	2,0
	0,1	0,0	0,3	1,0	0,7	0,0	0,3	0,3	0,0	2,7
Category III (financial result) Suma		*0,0*	*0,3*	*2,0*	*2,0*	*0,0*	*0,7*	*0,3*	*0,0*	*5,3*
Total		2,3	3,1	4,5	4,4	4,0	4,1	3,0	3,3	28,7

Cutting level 0.7
Comparison of distributions of pre-tax earnings

Percentage of rejected null hypotheses

Clusters by variables	Significance level	1997	1998	1999	2000	2001	2002	2003	2004	Total
All categories jointly	0,01	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,3	0,5
	0,05	0,2	0,3	0,0	0,0	0,2	0,2	0,7	0,8	2,3
	0,1	0,2	0,3	0,0	0,5	0,5	0,5	0,7	0,8	3,5
All categories jointly Suma		*0,3*	*0,6*	*0,0*	*0,5*	*0,7*	*0,7*	*1,5*	*2,0*	*6,3*
Category I (assets)	0,01	0,0	0,0	0,0	0,0	0,0	0,0	0,7	0,0	0,7
	0,05	0,3	0,3	0,0	0,0	0,0	1,0	0,7	0,0	2,3
	0,1	0,3	0,3	0,0	0,3	0,0	1,0	0,7	0,0	2,7
Category I (assets) Suma		*0,7*	*0,7*	*0,0*	*0,3*	*0,0*	*2,0*	*2,0*	*0,0*	*5,7*
Category II (liabilities)	0,01	0,0	0,0	0,2	0,3	0,1	0,0	0,0	0,0	0,6
	0,05	0,0	0,0	0,3	0,7	0,6	0,0	0,3	0,0	1,9
	0,1	0,0	0,0	0,5	0,7	0,7	0,0	0,3	0,7	2,9
Category II (liabilities) Suma		*0,0*	*0,0*	*1,0*	*1,7*	*1,4*	*0,0*	*0,7*	*0,7*	*5,4*
Category III (financial result)	0,01	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0
	0,05	1,0	0,0	0,0	0,3	1,0	0,0	0,7	0,0	3,0
	0,1	1,0	0,0	0,0	0,3	1,0	0,7	0,7	0,0	3,7
Category III (financial result) Suma		*3,0*	*0,0*	*0,0*	*0,7*	*2,0*	*0,7*	*1,3*	*0,0*	*7,7*
Total		4,0	1,3	1,0	3,2	4,1	3,3	5,5	2,7	25,0

Cutting level 0.7
Comparison of distributions of net income from banking activity

Percentage of rejected null hypotheses

Clusters by variables	Significance level	1997	1998	1999	2000	2001	2002	2003	2004	Total
All categories jointly	0,01	0,3	0,2	0,3	0,0	0,2	0,3	0,2	0,0	1,5
	0,05	0,5	0,5	0,5	0,0	0,5	0,5	0,3	0,3	3,2
	0,1	0,7	0,5	0,5	0,2	0,5	0,7	0,3	0,5	3,8
All categories jointly Suma		*1,5*	*1,2*	*1,3*	*0,2*	*1,2*	*1,5*	*0,8*	*0,8*	*8,5*
Category I (assets)	0,01	0,0	0,0	0,0	1,0	1,0	1,0	0,7	0,3	3,0
	0,05	0,0	0,0	0,0	1,0	1,0	1,0	0,7	0,7	3,3
	0,1	0,0	0,0	0,0	0,3	1,0	1,0	0,7	0,7	3,7
Category I (assets) Suma		*0,0*	*0,0*	*0,0*	*0,3*	*3,0*	*3,0*	*2,0*	*1,7*	*10,0*
Category II (liabilities)	0,01	0,0	0,0	0,3	0,0	0,3	0,0	0,0	0,0	0,6
	0,05	0,0	0,0	0,7	0,0	0,4	0,2	0,0	0,7	1,9
	0,1	0,0	0,3	0,8	0,0	0,4	0,2	0,0	0,7	2,4
Category II (liabilities) Suma		*0,0*	*0,3*	*1,8*	*0,0*	*1,1*	*0,3*	*0,0*	*1,3*	*4,9*
Category III (financial result)	0,01	0,0	0,0	0,0	0,7	0,0	0,0	0,0	0,0	0,7
	0,05	0,0	0,0	1,0	0,7	0,0	0,3	0,0	0,0	2,0
	0,1	0,0	0,0	1,0	0,7	0,0	0,3	0,3	0,0	2,3
Category III (financial result) Suma		*0,0*	*0,0*	*2,0*	*2,0*	*0,0*	*0,7*	*0,3*	*0,0*	*5,0*
Total		1,5	1,5	5,2	2,5	5,3	5,5	3,2	3,8	28,5

Figure 9: Kolmogorov-Smirnov test for distributions of ROA measures in the groups of banks

NR	a0	dPKB	sprGOSP	sprKWIB	sprPRZ	IrLOAN	PPI	WIG	D-N/AKT	R^2	F	p (JB)
1)	0 (*0.73*)	0.16 (*0.11*)	0 (*0.97*)	–	–	–	–	–	–	0.17	2.55	**(0.37)**
2)	-0.01 (*0.7*)	0.24 **(0)**	–	0 **(0.03)**	–	–	–	–	–	0.31	5.41	**(0.34)**
3)	-0.03 **(0)**	0.24 **(0)**	–	–	0 **(0)**	–	–	–	–	0.63	20.5	**(0.79)**
4)	0.03 **(0)**	0.03 (*0.41*)	–	–	–	-0.11 **(0)**	–	–	–	0.75	37.31	**(0.54)**
5)	-0.21 **(0)**	-0.08 (*0.46*)	–	–	–	–	0 **(0)**	–	–	0.39	7.78	**(0.5)**
6)	0.02 **(0)**	0.34 **(0)**	–	–	–	–	–	-0.01 **(0)**	–	0.46	10.23	**(0.41)**
7)	-0.03 **(0.04)**	0.26 **(0)**	–	–	–	–	–	–	0.1 **(0)**	0.39	7.72	**(0.63)**
8)	0.04 **(0)**	–	-0.01 **(0.01)**	0 **(0.04)**	–	–	–	–	–	0.22	3.43	**(0.36)**
9)	0.01 (*0.05*)	–	-0.01 **(0)**	–	0 **(0)**	–	–	–	–	0.52	13.33	**(0.3)**
10)	0.02 **(0)**	–	0 (*0.6*)	–	–	-0.11 **(0)**	–	–	–	0.75	36.48	**(0.32)**
11)	-0.29 **(0)**	–	0 (*0.07*)	–	–	–	0 **(0)**	–	–	0.46	10.23	**(0.08)**
12)	0.07 **(0)**	–	-0.01 **(0.01)**	–	–	–	–	-0.01 **(0.02)**	–	0.25	4.13	**(0.65)**
13)	0.02 (*0.05*)	–	-0.01 **(0.03)**	–	–	–	–	–	0.07 (*0.06*)	0.2	3.16	**(0.3)**
14)	-0.01 (*0.24*)	–	–	-0.01 (*0.54*)	0 **(0)**	–	–	–	–	0.28	4.8	**(0.56)**
15)	0.03 **(0)**	–	–	0 (*0.21*)	–	-0.11 **(0)**	–	–	–	0.76	39.22	**(0.15)**
16)	-0.22 **(0)**	–	–	0 **(0)**	–	–	0 **(0)**	–	–	0.54	14.27	**(0.26)**
17)	0.01 (*0.26*)	–	–	0 (*0.76*)	–	–	–	-0.01 (*0.77*)	–	0.02	0.24	**(0.32)**
18)	0 (*0.65*)	–	–	0 (*0.93*)	–	–	–	–	0.03 (*0.45*)	0.03	0.49	**(0.22)**
19)	0.02 **(0)**	–	–	–	0 (*0.11*)	-0.1 **(0)**	–	–	–	0.77	41.34	**(0.69)**
20)	-0.19 **(0)**	–	–	–	0 **(0)**	–	0 **(0)**	–	–	0.65	22.62	**(0.53)**
21)	-0.02 (*0.22*)	–	–	–	0 **(0)**	–	–	0 (*0.46*)	–	0.29	4.92	**(0.56)**
22)	-0.01 (*0.83*)	–	–	–	0 **(0)**	–	–	–	-0.1 (*0.07*)	0.36	7	**(0.95)**
23)	0.01 (*0.65*)	–	–	–	–	-0.11 **(0)**	0 (*0.74*)	–	–	0.75	36.14	**(0.46)**
24)	0.03 **(0)**	–	–	–	–	-0.11 **(0)**	–	-0.01 (*0.07*)	–	0.78	42.68	(*0.03*)
25)	0.02 **(0)**	–	–	–	–	-0.11 **(0)**	–	–	0.02 (*0.22*)	0.76	38.98	**(0.68)**
26)	-0.23 **(0)**	–	–	–	–	–	0 **(0)**	-0.01 **(0)**	–	0.64	21.53	**(0.32)**
27)	-0.22 **(0)**	–	–	–	–	–	0 **(0)**	–	0.08 **(0)**	0.54	14.16	**(0.39)**
28)	0 (*0.75*)	–	–	–	–	–	–	-0.01 (*0.92*)	0.03 (*0.45*)	0.03	0.49	**(0.23)**

Table 1: Estimation for the group of universal banks (2004)

NR	a0	dPKB	sprGOSP	sprKWIB	sprPRZ	IrLOAN	PPI	WIG	D-N/AKT	R^2	F	p (JB)
1)	-0.01 (*0.95*)	0.22 (*0.52*)	-0.01 (*0.86*)	–	–	–	–	–	–	0.04	0.57	(*0*)
2)	-0.05 (**0.02**)	0.48 (*0.08*)	–	0 (*0.09*)	–	–	–	–	–	0.15	2.18	(*0.01*)
3)	-0.13 (**0**)	0.54 (**0**)	–	–	0.01 (**0**)	–	–	–	–	0.55	14.77	(**0.26**)
4)	0.04 (**0**)	-0.06 (*0.76*)	–	–	–	-0.24 (**0**)	–	–	–	0.61	19.29	(**0.31**)
5)	-0.66 (**0.01**)	-0.48 (*0.2*)	–	–	–	–	0 (**0.01**)	–	–	0.24	3.88	(*0.01*)
6)	-0.01 (*0.89*)	0.37 (*0.26*)	–	–	–	–	–	-0.01 (*0.61*)	–	0.05	0.69	(*0*)
7)	-0.15 (*0.25*)	0.61 (*0.15*)	–	–	–	–	–	–	0.15 (*0.31*)	0.08	1.11	(**0.05**)
8)	0.06 (*0.14*)	–	-0.01 (*0.06*)	0.01 (*0.05*)	–	–	–	–	–	0.16	2.4	(*0.04*)
9)	-0.02 (*0.64*)	–	-0.01 (**0**)	–	0.01 (**0**)	–	–	–	–	0.55	15.16	(**0.58**)
10)	0.03 (*0.15*)	–	-0.01 (*0.97*)	–	–	-0.24 (**0**)	–	–	–	0.61	19.17	(**0.31**)
11)	-0.75 (**0.01**)	–	0 (*0.16*)	–	–	–	0 (**0.01**)	–	–	0.25	4.11	(*0.01*)
12)	0.05 (*0.52*)	–	-0.01 (*0.39*)	–	–	–	–	-0.01 (*0.74*)	–	0.03	0.41	(*0*)
13)	0.01 (*0.81*)	–	-0.01 (*0.4*)	–	–	–	–	–	0.02 (*0.8*)	0.03	0.38	(*0.01*)
14)	-0.09 (**0**)	–	–	-0.01 (*0.61*)	0.01 (**0**)	–	–	–	–	0.39	7.72	(**0.3**)
15)	0.03 (**0**)	–	–	0 (*0.78*)	–	-0.24 (**0**)	–	–	–	0.61	19.28	(**0.3**)
16)	-0.58 (**0**)	–	–	0 (**0.02**)	–	–	0 (**0**)	–	–	0.35	6.5	(**0.06**)
17)	-0.07 (*0.12*)	–	–	0 (*0.13*)	–	–	–	0 (*0.22*)	–	0.09	1.26	(*0.03*)
18)	0.01 (*0.86*)	–	–	0 (*0.31*)	–	–	–	–	-0.04 (*0.68*)	0.04	0.55	(*0*)
19)	-0.01 (*0.89*)	–	–	–	0 (*0.08*)	-0.19 (**0**)	–	–	–	0.66	23.41	(**0.78**)
20)	-0.48 (**0**)	–	–	–	0.01 (**0**)	–	0 (**0**)	–	–	0.57	16.34	(**0.51**)
21)	-0.17 (**0**)	–	–	–	0.01 (**0**)	–	–	0 (**0**)	–	0.53	14.04	(**0.46**)
22)	-0.01 (*0.86*)	–	–	–	0.01 (**0**)	–	–	–	-0.13 (*0.11*)	0.44	9.7	(**0.35**)
23)	0.09 (*0.54*)	–	–	–	–	-0.25 (**0**)	-0.01 (*0.72*)	–	–	0.61	19.34	(**0.3**)
24)	0.01 (*0.23*)	–	–	–	–	-0.25 (**0**)	–	0 (*0.16*)	–	0.64	21.86	(**0.49**)
25)	-0.05 (*0.3*)	–	–	–	–	-0.26 (**0**)	–	–	0.11 (*0.05*)	0.67	24.63	(**0.68**)
26)	-0.48 (**0.01**)	–	–	–	–	–	0 (**0.01**)	-0.01 (*0.3*)	–	0.22	3.52	(*0*)
27)	-0.91 (**0**)	–	–	–	–	–	0 (**0**)	–	0.24 (**0.03**)	0.32	5.84	(**0.28**)
28)	-0.01 (*0.98*)	–	–	–	–	–	–	0 (*0.82*)	-0.02 (*0.89*)	0	0.05	(*0*)

Table 2: Estimation of the regression model of ROA for the group of retail banks (2004)

NR	a0	dPKB	sprGOSP	sprKWIB	sprPRZ	IrLOAN	PPI	WIG	D-N/AKT	R^2	F	p (JB)
1)	-0.02 (*0.77*)	0 (*0.99*)	0 (*0.56*)	–	–	–	–	–	–	0.02	0.31	(*0*)
2)	0.01 (*0.36*)	-0.12 (*0.67*)	–	0 (*0.91*)	–	–	–	–	–	0.01	0.15	(*0*)
3)	0.02 (*0.43*)	-0.14 (*0.57*)	–	–	-0.01 (*0.84*)	–	–	–	–	0.01	0.16	(*0*)
4)	-0.01 (*0.97*)	-0.04 (*0.9*)	–	–	–	0.08 (*0.51*)	–	–	–	0.02	0.36	(*0*)
5)	0.03 (*0.9*)	-0.11 (*0.78*)	–	–	–	–	-0.01 (*0.95*)	–	–	0.01	0.14	(*0*)
6)	0.04 (*0.09*)	0.08 (*0.77*)	–	–	–	–	–	-0.01 (*0.28*)	–	0.05	0.73	(*0*)
7)	0.01 (*0.33*)	-0.12 (*0.62*)	–	–	–	–	–	–	0.01 (*0.77*)	0.01	0.18	(*0*)
8)	-0.02 (*0.63*)	–	0 (*0.47*)	-0.01 (*0.87*)	–	–	–	–	–	0.02	0.32	(*0*)
9)	-0.02 (*0.73*)	–	0 (*0.39*)	–	-0.01 (*0.74*)	–	–	–	–	0.03	0.37	(*0*)
10)	-0.02 (*0.65*)	–	0 (*0.67*)	–	–	0.06 (*0.61*)	–	–	–	0.03	0.44	(*0*)
11)	-0.08 (*0.79*)	–	0 (*0.5*)	–	–	–	0 (*0.83*)	–	–	0.02	0.33	(*0*)
12)	0.03 (*0.62*)	–	0 (*0.96*)	–	–	–	–	-0.01 (*0.39*)	–	0.05	0.69	(*0*)
13)	-0.02 (*0.62*)	–	0 (*0.45*)	–	–	–	–	–	0.01 (*0.78*)	0.02	0.35	(*0*)
14)	0.01 (*0.56*)	–	–	0 (*0.69*)	-0.01 (*0.84*)	–	–	–	–	0	0.08	(*0*)
15)	-0.01 (*0.79*)	–	–	0 (*0.77*)	–	0.08 (*0.41*)	–	–	–	0.03	0.39	(*0*)
16)	0.07 (*0.68*)	–	–	0 (*0.85*)	–	–	-0.01 (*0.72*)	–	–	0.01	0.12	(*0*)
17)	0.05 (*0.15*)	–	–	-0.01 (*0.61*)	–	–	–	-0.01 (*0.22*)	–	0.06	0.83	(*0*)
18)	0 (*0.5*)	–	–	0 (*0.82*)	–	–	–	–	0.01 (*0.82*)	0	0.08	(*0*)
19)	-0.01 (*0.79*)	–	–	–	0 (*0.83*)	0.09 (*0.39*)	–	–	–	0.03	0.37	(*0*)
20)	0.08 (*0.59*)	–	–	–	-0.01 (*0.97*)	–	-0.01 (*0.64*)	–	–	0	0.1	(*0*)
21)	0.06 (*0.15*)	–	–	–	-0.01 (*0.51*)	–	–	-0.01 (*0.18*)	–	0.07	0.91	(*0*)
22)	0.02 (*0.44*)	–	–	–	-0.01 (*0.64*)	–	–	–	0.05 (*0.56*)	0.01	0.16	(*0*)
23)	-0.09 (*0.76*)	–	–	–	–	0.12 (*0.45*)	0 (*0.77*)	–	–	0.03	0.39	(*0*)
24)	0.02 (*0.48*)	–	–	–	–	0.06 (*0.52*)	–	-0.01 (*0.3*)	–	0.07	0.91	(*0*)
25)	-0.03 (*0.35*)	–	–	–	–	0.16 (*0.2*)	–	–	0.07 (*0.3*)	0.07	0.92	(*0*)
26)	0.01 (*0.94*)	–	–	–	–	–	0 (*0.88*)	-0.01 (*0.28*)	–	0.05	0.7	(*0*)
27)	0.09 (*0.55*)	–	–	–	–	–	-0.01 (*0.59*)	–	0.02 (*0.66*)	0.01	0.2	(*0*)
28)	0.04 (*0.17*)	–	–	–	–	–	–	-0.01 (*0.24*)	-0.03 (*0.7*)	0.06	0.76	(*0*)

Table 3: Estimation of regression model of ROA for all the banks (2004)

NR	a0	dPKB	sprGOSP	sprKWIB	sprPRZ	IrLOAN	PPI	WIG	D-N/AKT	R^2	F	p (JB)
1)	-0.01 (*0.99*)	2.05 (*0.1*)	0 (*0.83*)	–	–	–	–	–	–	0.16	2.28	**(0.45)**
2)	-0.08 (*0.2*)	2.94 **(0)**	–	0.03 **(0.01)**	–	–	–	–	–	0.33	6.16	**(0.4)**
3)	-0.34 **(0)**	2.89 **(0)**	–	–	0.06 **(0)**	–	–	–	–	0.65	23.16	**(0.65)**
4)	0.32 **(0)**	0.36 (*0.51*)	–	–	–	-1.18 **(0)**	–	–	–	0.71	29.94	**(0.53)**
5)	-2.01 **(0.03)**	-0.53 (*0.69*)	–	–	–	–	0.02 **(0.03)**	–	–	0.3	5.35	**(0.38)**
6)	0.25 **(0)**	3.76 **(0)**	–	–	–	–	–	-0.01 **(0)**	–	0.37	7.07	**(0.21)**
7)	-0.34 **(0)**	3.33 **(0)**	–	–	–	–	–	–	1.47 **(0)**	0.45	10.02	**(0.75)**
8)	0.45 **(0)**	–	-0.05 **(0.01)**	0.04 **(0.02)**	–	–	–	–	–	0.23	3.75	**(0.7)**
9)	0.15 (*0.18*)	–	-0.05 **(0)**	–	0.06 **(0)**	–	–	–	–	0.53	14.05	**(0.21)**
10)	0.27 **(0)**	–	0 (*0.43*)	–	–	-1.28 **(0)**	–	–	–	0.71	30.28	**(0.17)**
11)	-3.11 **(0)**	–	0.03 (*0.1*)	–	–	–	0.02 **(0)**	–	–	0.37	7.24	**(0.11)**
12)	0.71 **(0.01)**	–	-0.05 **(0.04)**	–	–	–	–	-0.01 (*0.08*)	–	0.16	2.43	**(0.97)**
13)	0.21 (*0.15*)	–	-0.04 **(0.03)**	–	–	–	–	–	1.11 **(0.02)**	0.24	3.83	**(0.33)**
14)	-0.16 (*0.07*)	–	–	-0.01 (*0.73*)	0.05 **(0)**	–	–	–	–	0.31	5.59	**(0.5)**
15)	0.3 **(0)**	–	–	0.01 (*0.08*)	–	-1.22 **(0)**	–	–	–	0.74	34.84	(*0.03*)
16)	-2.45 **(0)**	–	–	0.03 **(0)**	–	–	0.02 **(0)**	–	–	0.49	11.99	**(0.32)**
17)	0.04 (*0.74*)	–	–	0.01 (*0.39*)	–	–	–	0 (*0.82*)	–	0.03	0.47	**(0.66)**
18)	-0.03 (*0.8*)	–	–	0 (*0.86*)	–	–	–	–	0.59 (*0.3*)	0.07	1.01	**(0.38)**
19)	0.2 **(0.01)**	–	–	–	0.02 **(0.04)**	-1.07 **(0)**	–	–	–	0.75	36.76	**(0.27)**
20)	-2 **(0)**	–	–	–	0.05 **(0)**	–	0.01 **(0)**	–	–	0.61	19.43	**(0.43)**
21)	-0.3 (*0.05*)	–	–	–	0.05 **(0)**	–	–	0 (*0.24*)	–	0.35	6.53	**(0.58)**
22)	-0.1 (*0.29*)	–	–	–	0.07 **(0)**	–	–	–	-0.83 (*0.17*)	0.36	6.94	**(0.81)**
23)	0.49 (*0.35*)	–	–	–	–	-1.27 **(0)**	-0.01 (*0.77*)	–	–	0.7	29.34	**(0.13)**
24)	0.4 **(0)**	–	–	–	–	-1.24 **(0)**	–	-0.01 (*0.22*)	–	0.72	31.87	**(0.08)**
25)	0.22 **(0)**	–	–	–	–	-1.2 **(0)**	–	–	0.48 (*0.05*)	0.75	36.12	**(0.3)**
26)	-2.35 **(0)**	–	–	–	–	–	0.02 **(0)**	-0.01 **(0)**	–	0.48	11.33	**(0.17)**
27)	-2.48 **(0)**	–	–	–	–	–	0.02 **(0)**	–	1.14 **(0)**	0.52	13.03	**(0.43)**
28)	-0.11 (*0.59*)	–	–	–	–	–	–	0 (*0.66*)	0.79 (*0.16*)	0.08	1.1	**(0.31)**

Table 4: Estimation of regression model of ROE for the group of universal banks (2004)

NR	a0	dPKB	sprGOSP	sprKWIB	sprPRZ	IrLOAN	PPI	WIG	D-N/AKT	R^2	F	p (JB)
1)	-12.84	60.97	1.06	–	–	–	–	–	–	0.13	1.81	(*0*)
	(*0.06*)	(*0.09*)	(*0.08*)									
2)	-3.01	34.12	–	0.6	–	–	–	–	–	0.06	0.9	(*0*)
	(*0.13*)	(*0.26*)		(*0.25*)								
3)	-0.36	15.87	–	–	-0.14	–	–	–	–	0.02	0.24	(*0*)
	(*0.91*)	(*0.58*)			(*0.81*)							
4)	-1.63	20.74	–	–	–	2.13	–	–	–	0.02	0.26	(*0*)
	(*0.4*)	(*0.47*)				(*0.75*)						
5)	34.94	60.07	–	–	–	–	-0.36	–	–	0.07	0.97	(*0*)
	(*0.24*)	(*0.18*)					(*0.23*)					
6)	0.65	34.25	–	–	–	–	–	-0.01	–	0.03	0.46	(*0*)
	(*0.81*)	(*0.34*)						(*0.48*)				
7)	-0.03	14.85	–	–	–	–	–	–	-1.38	0.01	0.22	(*0*)
	(*0.99*)	(*0.74*)							(*0.93*)			
8)	-3.23	–	0.24	0.17	–	–	–	–	–	0.02	0.32	(*0*)
	(*0.51*)		(*0.67*)	(*0.76*)								
9)	-2.91	–	0.47	–	-0.41	–	–	–	–	0.04	0.57	(*0*)
	(*0.53*)		(*0.33*)		(*0.46*)							
10)	-3.82	–	0.35	–	–	-0.42	–	–	–	0.02	0.28	(*0*)
	(*0.4*)		(*0.45*)			(*0.94*)						
11)	-24.34	–	0.67	–	–	–	0.16	–	–	0.03	0.46	(*0*)
	(*0.49*)		(*0.35*)				(*0.55*)					
12)	-7.72	–	0.56	–	–	–	–	0	–	0.03	0.43	(*0*)
	(*0.37*)		(*0.36*)					(*0.59*)				
13)	2.71	–	0.69	–	–	–	–	–	-13.71	0.07	1.02	(*0*)
	(*0.69*)		(*0.2*)						(*0.24*)			
14)	0.82	–	–	0.5	-0.46	–	–	–	–	0.04	0.57	(*0*)
	(*0.76*)			(*0.33*)	(*0.42*)							
15)	-1.56	–	–	0.34	–	1.56	–	–	–	0.02	0.26	(*0*)
	(*0.41*)			(*0.47*)		(*0.81*)						
16)	-3.08	–	–	0.34	–	–	0.01	–	–	0.01	0.24	(*0*)
	(*0.88*)			(*0.51*)			(*0.93*)					
17)	-3.07	–	–	0.5	–	–	–	0	–	0.02	0.34	(*0*)
	(*0.48*)			(*0.41*)				(*0.65*)				
18)	3.73	–	–	0.38	–	–	–	–	-7.06	0.03	0.49	(*0*)
	(*0.6*)			(*0.42*)					(*0.48*)			
19)	1.24	–	–	–	-0.29	-1.34	–	–	–	0	0.1	(*0*)
	(*0.77*)				(*0.66*)	(*0.86*)						
20)	4.33	–	–	–	-0.22	–	-0.04	–	–	0	0.1	(*0*)
	(*0.82*)				(*0.67*)		(*0.85*)					
21)	2.06	–	–	–	-0.31	–	–	-0.01	–	0.01	0.14	(*0*)
	(*0.69*)				(*0.6*)			(*0.74*)				
22)	3.78	–	–	–	-0.15	–	–	–	-4.92	0.01	0.2	(*0*)
	(*0.6*)				(*0.79*)				(*0.64*)			
23)	3.56	–	–	–	–	-0.2	-0.04	–	–	0	0.01	(*0*)
	(*0.88*)					(*0.98*)	(*0.87*)					
24)	-0.36	–	–	–	–	0.71	–	-0.01	–	0	0.01	(*0*)
	(*0.89*)					(*0.91*)		(*0.91*)				
25)	4.05	–	–	–	–	2.15	–	–	-6.92	0.01	0.21	(*0*)
	(*0.58*)					(*0.75*)			(*0.51*)			
26)	3.22	–	–	–	–	–	-0.04	0	–	0	0.01	(*0*)
	(*0.88*)						(*0.86*)	(*0.99*)				
27)	32.66	–	–	–	–	–	-0.22	–	-14.14	0.04	0.54	(*0*)
	(*0.35*)						(*0.39*)		(*0.31*)			
28)	5.59	–	–	–	–	–	–	-0.01	-7.17	0.01	0.22	(*0*)
	(*0.54*)							(*0.73*)	(*0.51*)			

Table 5: Estimation of the regression model of ROE for the group of retail banks (2004)

NR	a0	dPKB	sprGOSP	sprKWIB	sprPRZ	IrLOAN	PPI	WIG	D-N/AKT	R^2	F	p (JB)
1)	-1.16 (*0.63*)	16.41 (*0.2*)	0.05 (*0.8*)	–	–	–	–	–	–	0.09	1.22	(*0*)
2)	-0.02 (*0.97*)	9.55 (*0.35*)	–	-0.18 (*0.34*)	–	–	–	–	–	0.12	1.7	(*0*)
3)	-0.71 (*0.54*)	14.57 (*0.14*)	–	–	0.02 (*0.89*)	–	–	–	–	0.09	1.19	(*0*)
4)	1.26 (*0.25*)	4.98 (*0.62*)	–	–	–	-8.16 (*0.09*)	–	–	–	0.19	2.89	(*0*)
5)	-4.48 (*0.66*)	9.61 (*0.53*)	–	–	–	–	0.03 (*0.7*)	–	–	0.09	1.26	(*0*)
6)	-0.11 (*0.91*)	18.37 (*0.14*)	–	–	–	–	–	-0.01 (*0.6*)	–	0.1	1.33	(*0*)
7)	-1.01 (*0.08*)	15.39 (*0.1*)	–	–	–	–	–	–	2.55 (*0.3*)	0.13	1.8	(*0*)
8)	0.36 (*0.82*)	–	0.01 (*0.94*)	-0.26 (*0.2*)	–	–	–	–	–	0.09	1.22	(*0*)
9)	1.26 (*0.44*)	–	-0.14 (*0.43*)	–	-0.01 (*0.99*)	–	–	–	–	0.02	0.36	(*0*)
10)	1.27 (*0.38*)	–	0.05 (*0.76*)	–	–	-10.06 (**0.03**)	–	–	–	0.18	2.8	(*0*)
11)	-13.07 (*0.28*)	–	0.08 (*0.72*)	–	–	–	0.11 (*0.23*)	–	–	0.08	1.11	(*0*)
12)	1.14 (*0.7*)	–	-0.14 (*0.54*)	–	–	–	–	0 (*0.96*)	–	0.02	0.36	(*0*)
13)	1.03 (*0.51*)	–	-0.16 (*0.35*)	–	–	–	–	–	2.27 (*0.37*)	0.06	0.78	(*0*)
14)	0.14 (*0.87*)	–	–	-0.29 (*0.12*)	0.07 (*0.69*)	–	–	–	–	0.09	1.3	(*0*)
15)	2.06 (**0.01**)	–	–	-0.23 (*0.13*)	–	-8.9 (**0.02**)	–	–	–	0.26	4.23	(*0*)
16)	-6.15 (*0.39*)	–	–	-0.19 (*0.28*)	–	–	0.06 (*0.36*)	–	–	0.12	1.69	(*0*)
17)	1.17 (*0.42*)	–	–	-0.32 (*0.14*)	–	–	–	-0.01 (*0.62*)	–	0.1	1.35	(*0*)
18)	0.05 (*0.9*)	–	–	-0.37 (**0.03**)	–	–	–	–	4.3 (*0.1*)	0.19	2.82	(*0*)
19)	2.78 (**0.04**)	–	–	–	-0.18 (*0.31*)	-10.47 (**0.01**)	–	–	–	0.22	3.4	(*0*)
20)	-9.27 (*0.17*)	–	–	–	-0.06 (*0.75*)	–	0.09 (*0.15*)	–	–	0.08	1.1	(*0*)
21)	-0.54 (*0.76*)	–	–	–	-0.01 (*0.97*)	–	–	0 (*0.61*)	–	0.01	0.17	(*0*)
22)	1.09 (*0.31*)	–	–	–	-0.42 (*0.14*)	–	–	–	6.43 (*0.1*)	0.11	1.5	(*0*)
23)	6.25 (*0.56*)	–	–	–	–	-11.44 (*0.08*)	-0.05 (*0.66*)	–	–	0.19	2.86	(*0*)
24)	1.45 (*0.24*)	–	–	–	–	-9.18 (**0.03**)	–	0 (*0.84*)	–	0.18	2.76	(*0*)
25)	2.21 (*0.08*)	–	–	–	–	-10.98 (**0.03**)	–	–	-1.65 (*0.56*)	0.19	2.95	(*0*)
26)	-9.97 (*0.17*)	–	–	–	–	–	0.09 (*0.19*)	-0.01 (*0.88*)	–	0.08	1.05	(*0*)
27)	-9.09 (*0.17*)	–	–	–	–	–	0.08 (*0.19*)	–	1.43 (*0.56*)	0.09	1.22	(*0*)
28)	-2.13 (*0.13*)	–	–	–	–	–	–	0 (*0.19*)	4.27 (*0.16*)	0.09	1.22	(*0*)

Table 6: Estimation of the regression model of ROE for all the banks (2004)