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## Sectoral risk assessment: Evidence from Poland<sup>1</sup>

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<sup>1</sup> This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

# Sectoral risk assessment: Evidence from Poland<sup>1</sup>

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## Abstract

The article presents a methodological framework for the analysis of sectoral risk and an evaluation of the financial condition on sectors level. In addition, the hypothesis was verified that the financial constraints of enterprises affect decisions making by prospective exporters and sales in foreign markets. The empirical analysis was based on the individual data from different sources (from the years 2005 to 2016), which are: balance sheet and profit and loss account (F-02 statement), financial and behavioural data (BISNODE POLAND).

The evaluation consists of two parts. The first part presents the financial strength depending on the net value of enterprises. The financial strength defines the financial strength of enterprise. The second part presents PD model. The statistical model is built on logistic regression model, and produces an estimate of the annual Probability of Default of the assessed company. Based on the results of the evaluation of the risk associated with the financial condition of enterprises, it was found that SMEs faced a higher risk. The lowest risk of bankruptcy was observed in the *pharmaceutical industry* (where the probability of bankruptcy did not exceed 0.1%) and the highest risk of bankruptcy - in the *mining sector* (where the PD was equal to or higher than 1%). Exporters were characterised by better financial equipment.

Keywords: Sectoral Risk, Bankruptcy Risk, Scoring Methods, export

JEL classification: C190, G210, L11, L25, G33, M13

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## Introduction

Macroeconomic conditions in which companies operate are an important aspect in the analysis of the factors affecting the financial condition of enterprises, the risk of bankruptcy, and transition of enterprises from the high-risk group to the group of enterprises whose financial condition is good, and vice versa.

The IRB credit risk evaluation concept is based on the assumption that the risk to the credit portfolio may result from two sources:

- *systemic risk*, which is caused by unexpected macroeconomic and market changes. The risk is faced by all borrowers; however, the level of susceptibility of individual borrowers to this risk may be different;
- *idiosyncratic risk*, which is the outcome of various unique threats faced by individual borrowers.

In case of non-financial firms their default display positive correlations within and across industries. Their dependence structure might be driven by sectoral (*systematic*) risk factors. (Das et al. 2007; Saldías 2013).

Sectoral risk is taken into account in credit risk modelling. It includes latent sectoral risk factors influencing the correlation of defaults among firms. Sectoral risk reflects important risk component in credit portfolios, that arises when there is a concentration of borrowers in a sector. Sectoral risk represents the instability of the banking system when capital requirements for exposures to a given sector are inappropriate comparing to those that take into account sectoral risk.

ESRB (2015) shows that a build-up of sectoral vulnerabilities can become a source of systemic risk. For example, if the aim is to slow down credit growth in the real estate sector a reasonable solution would be to consider first instruments that specifically target mortgage lending and not broad credit instruments such as the counter-cyclical capital buffer.

The article presents a methodological framework for the analysis of sectoral risk and an evaluation of the financial condition on sectors level. In addition, the hypothesis was verified that the financial constraints of enterprises affect decisions making by prospective exporters (Chaney, 2013) and sales in foreign markets (Manova, 2013). Individual data from yearly financial reports for the years 2005-2016 is used in the analysis. This research has an original concept and high added value as it was performed using representative micro data for over 50,000 non-financial companies per year. The risk sector results from the current or forecast situation in the sector in which the enterprises operate (Gregoriou et al. 2010). In the present article, sector risk is defined as uncertainty concerning changes in the economic-financial situation of sectors. The sectoral analysis is a risk barometer and determines the indicators of insolvency for all enterprises conducting operations in specific sectors. Measurement of sector risk indirectly affects the significant problem of mutual influence of the economic situation for the country's economic development. These influences are reflected, for example, through profitability, investment opportunities, shaping public sentiment.

Based on the present literature on this subject manner, it can be concluded that the approach used in the present article concerning sectoral risk, which is based on individual data, has not been applied so far. The analysis was performed using logistical regression on categorised variables transformed using the WoE (weight of

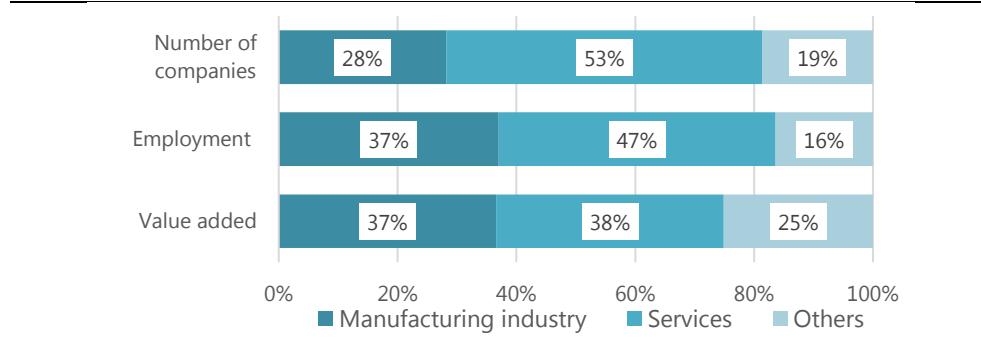
evidence) method. Scoring methods which enable division of enterprises according to their level of risk bankruptcy were used. When other conditions imposed by regulatory authorities are met, the models that were designed could be used among others in the process of calculation of capital requirements. Jankowitsch et al. (2007) demonstrated that such application of the model can bring real benefits for banks.

In 2015, the manufacturing industry enterprises generated 36% of the overall added value in the non-financial sector. They accounted for 28% of companies and employed 37% of employees. Among both large companies and SME, the highest number of employees worked in metal manufactures (24% in total in 2015). In 2015 service providers generated PLN 251 billion of added value (38% of the sector of non-financial enterprises). They accounted for 53% of companies and employed over 2.4 million people (46%). As regards services, the highest employment figures were recorded in the trade sector (43%). In SME, in addition to trade, most people worked in professional, scientific, technical, administration and support service activities (29%). For large companies, the highest employment figures were recorded in transport (25%).

Share of the firms by branch activity (in 2015)

Source: author's own calculation

Graph 1



Large enterprises (4% of the total number of enterprises) generated 52% of the overall added value and employed 38% of staff. The percentage of large enterprises in the manufacturing industry was higher (6% in 2015) than in services (3%).

The structure of the article is the following: the first chapter presents a review of empirical literature on sectoral risk analysis. Next part describes the economic environment. The third chapter presents description of the data, sectoral risk methodology and the last one describes the study performed.

## Literature review

Based on an analysis of the review of the literature concerning sectoral risk, Nguyen (2007) remarked that quite frequently sectoral risk is defined as the average risk of enterprises conducting operations in the sector.

The basic problems with measurement of the risk are identification and definition of an appropriate risk variable. In the case of sectoral risk, various concepts of measurements and various methods of its assessment are used. Falk and Heintz (1975) and Batóć et al. (2017) studied sectoral risk based on sectoral characteristics

that are reflected in the financial indicators. A critique of this approach was presented by Blocher and Chen (1978) who also presented proposals concerning the solution of the problem with the selection of financial indicators. Another group of studies covers profitability and sectoral risk depending on the market structure (Demsetz 1973; Esposito 1985). Nguyen (2007), following Merton's (1974) model of insolvency, performed an assessment of sectoral risk using a measure based on a distribution of cash flow to all companies in a sector level.

A different approach to sectoral analyses is presented in analyses focusing on sectoral concentration. Studies on sectoral concentration have been analysed by Düllmann and Masschelein (2006). The authors studied the extent to which sectoral concentration contributed to an increase in the economic capital and checked the effectiveness of various - other than Monte Carlo simulations - methods of measurement of the risk of sectoral concentration. It was confirmed that economic capital increased with an increase in sectoral concentration. Holub et al. (2015) studied the risk resulting from the sectoral concentration of credit portfolios and found that, due to its level and its impact on the credit risk, banks should establish additional capital requirements. The level of sectoral concentration and its trends were determined using the *HHI indicator*. In the opinion of Accornero et al. (2015), a high concentration of a bank's involvement in sectors of the economy that are more sensitive to the business cycle can significantly contribute to an increase in the credit risk of the bank. This is particularly important in periods of slower economic growth or recession because excessive credit concentration in sectors that are sensitive to the changes in the business cycle in such periods can result in financial losses that pose a threat to the bank's solvency. It was determined that credits granted concentrated in three sectors: the industrial sector (20% of the total credit exposure), the commerce sector (14% of the total credit exposure), and the construction sector (13% of the total credit exposure). Those sectors are the riskiest and are characterised by the highest ratio of unexpected losses in relation to the value of the exposure. The average probability of bankruptcy in each of the sectors is higher.

Heifitfield et al. (2005) presented a study on the impact of systematic and idiosyncratic risk on the distribution of portfolio loss. Saldias (2013) uses panel data to analyse systematic and idiosyncratic determinants of the risk of insolvency in the corporate sector of the Eurozone. The author studies the way that the risk of bankruptcy of entities is transferred between/within the financial sector and the corporate sector. This approach takes into account observable and non-observable factors and presents a different level of sectoral dependence between entities. Iosifidi and Kokas (2015) showed that banks characterised by a higher credit risk grant loans to companies that are riskier and whose financial condition is worse (selection mechanisms). The results of the study point at the need to monitor banks with elevated credit risk.

## Economic environment

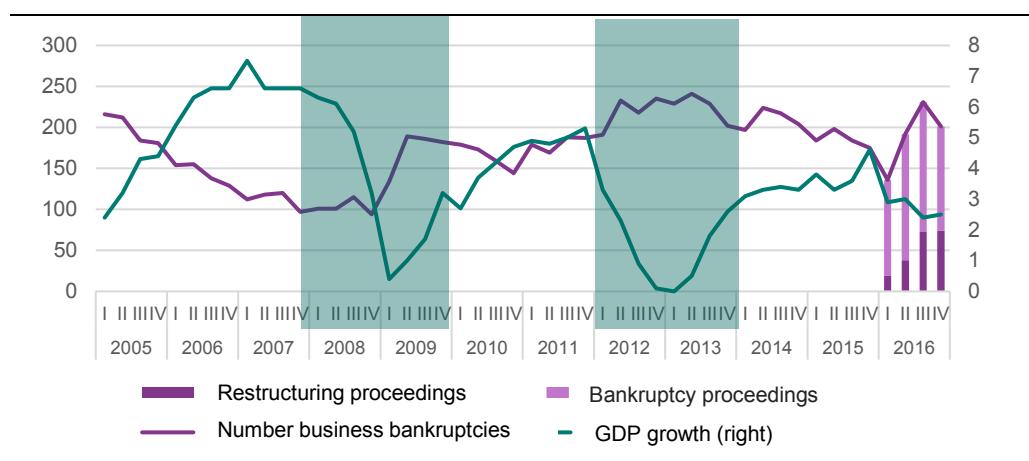
To analyse the links between GDP and the number of business bankruptcies in Poland in the period of 2005-2016, an overview of the dynamics of their changes during this period was made. The author has concluded that there is a negative relation between the GDP growth rate and the number of bankruptcies declared by

courts. It should be noted that the number of actual bankruptcies is frequently much higher as some of the petitions are returned due to formal deficiencies or dismissed as a result of a shortage of assets. In particular, small companies end their business activity without undergoing the bankruptcy procedures.

Number business bankruptcies vs. GDP

Source: author's own calculation based on Coface, GUS data

Graph 2

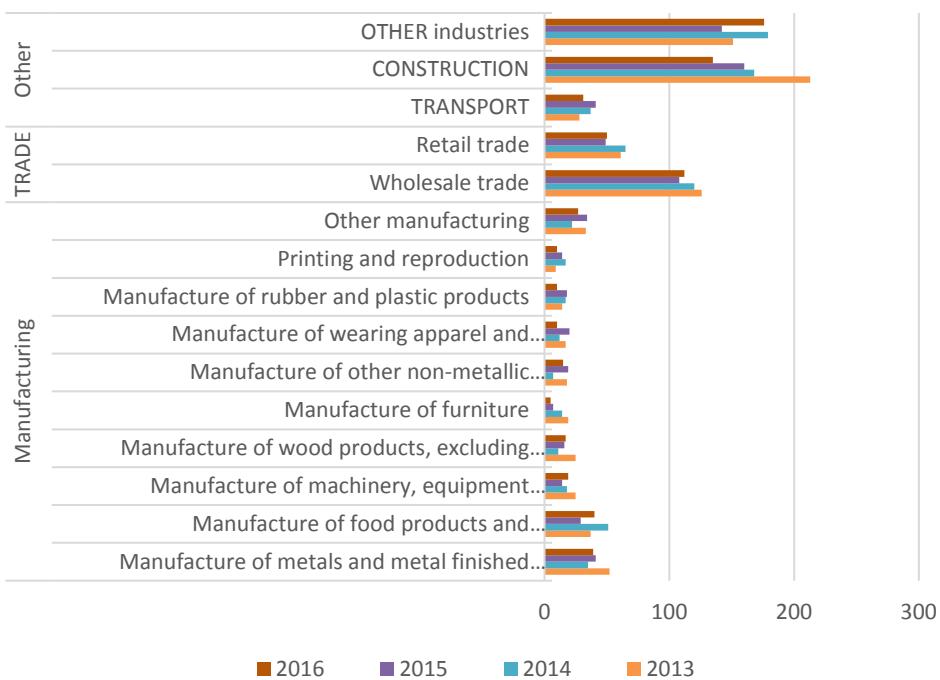


During the global financial market crisis of 2007-2009, GDP growth rate was observed to fall from 6.6% to 3.2% and the number of declared bankruptcies went up by 55% (in 2009 the highest increase was observed in the number of pending bankruptcy proceedings - by 68% compared to the previous year). In 2012, the courts declared 877 enterprises bankrupt, which was the highest number over the last 8 years. This situation can be partially explained by deteriorated economic conditions in 2012 (the GDP growth rate did not exceed 3.3% reaching the level of 0.1% in Q4). By the end of 2015, the GDP growth rate was on the increase, and the improving economic situation was conducive to further decrease in the number of bankruptcies. Despite the improved situation of the construction sector, which has been recorded since 2013, the payment backlogs of those enterprises and their low financial liquidity impacted the production companies cooperating with this industry. Slow stabilisation of the construction sector contributed to increased number of bankruptcies among manufacturers of construction materials and other non-metallic mineral products by 171% (12 enterprises) compared to the previous year. A decrease in the number of bankruptcies among food and drink producers is also noteworthy. This could result from continued improvement on the job market, which supports increased consumption of households, or from the search for new markets after the difficulties in trade with the East experienced in 2014. The improved situation of the construction sector was supported by the good condition of commercial construction, infrastructural construction and the government programme – *"Mieszkanie dla Młodych"* [*"Apartments for the Young"*]. As in 2014, despite low interest rates, decreased oil prices, economic revival in the EURO zone, the situation of transport companies deteriorated. The 11% increase of bankruptcies in this sector was primarily caused by the conflict between Russia and the Ukraine, recession in the Russian economy, the Russian embargo imposed in 2014, and the German minimum pay regulations for carriers, as well as increased competition.

### Number of bankruptcies by branch of activity

Source: author's own calculation based on Coface

Graph 3



## Preliminary analysis of the financial condition of enterprises

The preliminary analysis of the data focuses on the presentation of the financial condition of enterprises in accordance with the categories of return and financial structure, and on analysing the effect of financial leverage and ability to pay interest. It is followed by the presentation of the payment conditions agreed between the customers and the suppliers.

Return on sales is presented using the net margin on sales, which is the quotient of the net operating result and the sales revenue. In nearly the entire period of the analysis, with the exception of the years 2005-2006 and 2010-2011, SMEs had a higher return on sales compared to large enterprises. In 2014, the difference between the net marking on sales of entities in the SME sector and that of large enterprises was equal exactly to 1 p.p., and in the following year it reached the value of 2 p.p. It should be mentioned that in large enterprises the pace of growth of full operating costs has been higher than the pace of growth of their added value in the recent years. In 2015, the return on sales in large enterprises reached the lowest level in history. Entities in this sector are forced to reduce their margins due to international competition.

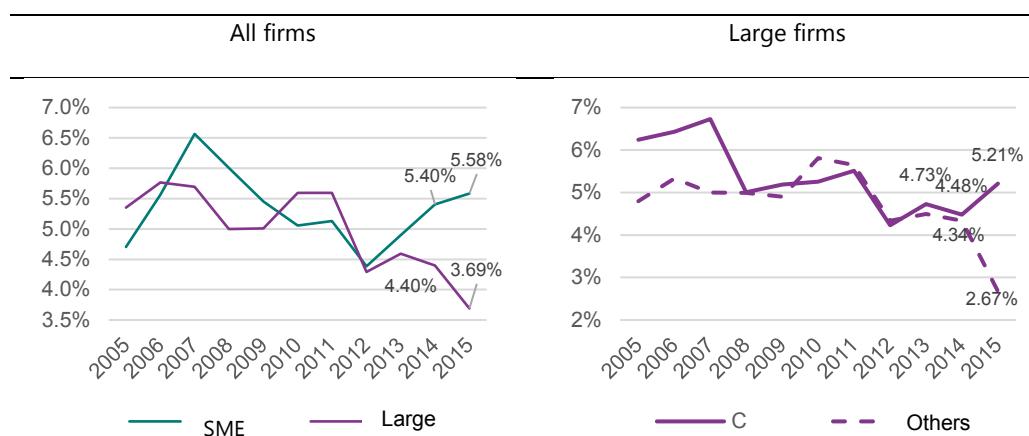
In the years 2005-2009 and 2013-2015, large enterprises in the manufacturing sector had higher net operating margins than entities in other sectors. They achieved their highest margin in 2007 (7%). In 2008, due to the financial crisis, there was a sharp drop in the margin achieved by those entities. On the other hand, the net margin achieved by other entities reached the highest value (6%) in the year after the crisis, i.e. 2010. In the period of slow economic growth (2012), similar to enterprises in the

manufacturing sector, the profitability of the entities in question was sharply reduced. What contributed to this was the increase in the number of declared bankruptcies compared to the previous year.

#### Net margin on sales

Source: author's own calculation

Graph 4

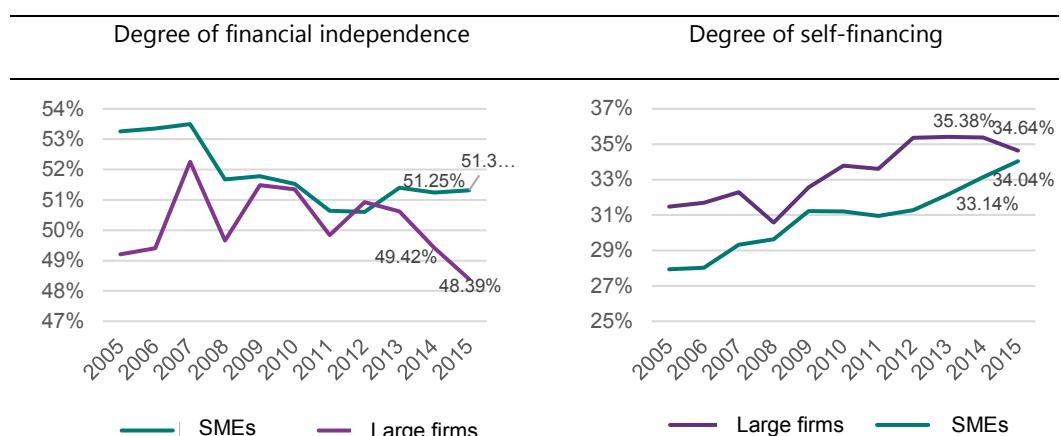


The analysis of solvency was performed using the degree of financial independence measure, which is calculated as the ratio of equity to total assets, and the self-financing level indicator, which is a quotient of the total reserve capital and the profits withheld and the total assets. In the analysed period (with the exception of 2012), SMEs were characterised by higher financial independence. In 2014, the degree of financial independence of those entities was 2 p.p. higher than that of large enterprises and in 2015 the difference increased to nearly 3 p.p. This means that such entities are better able to pay off their debts in the event of bankruptcy and that they financed their operation with equity to a larger extent.

#### Degree of financial independence and self-financing

Source: author's own calculation

Graph 5



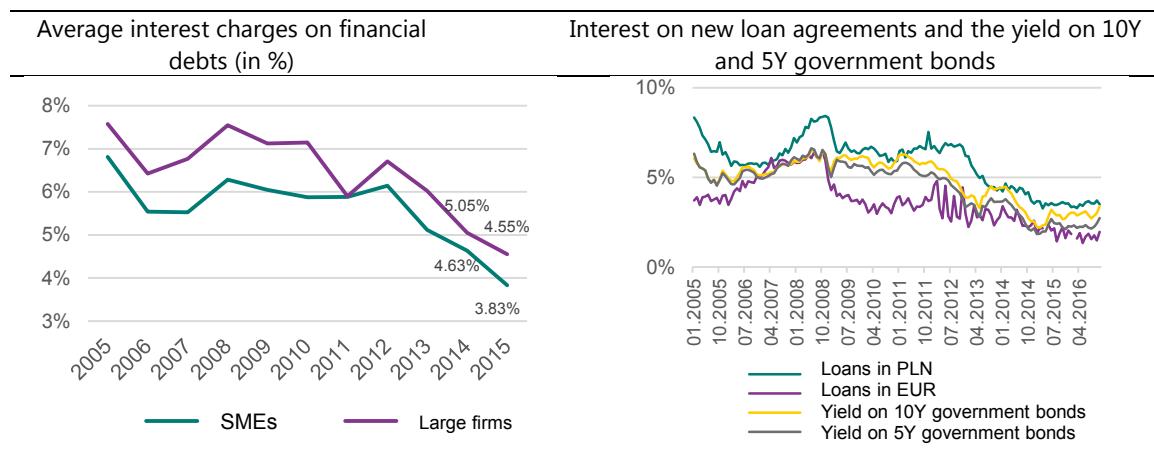
In the years 2005-2015, the degree of financial independence of large enterprises changed more than that of enterprises in the SME sector. The largest changes took place in the years 2007-2008. After an increase by 2.8 p.p. in 2007, when large enterprises reached the highest degree of financial independence, the crisis year of

2008 brought about a drop in the share of equity in the balance sheet total by 2.6 p.p. Since 2012, which was the last year of its increase, this indicator has decreased. As a result of the credit boom, the degree of financing of assets with equity decreased and this trend continued until 2012.

#### Average interest charges on financial debts

Source: author's own calculation

Graph 6



Another important indicator showing possible causes of the decreased interest in external financing is the average cost of debt. The trend of the average interest indicator follows the trend of the weighted average cost applied by Polish banks to new loans and the trend of cost of emission of government bonds. One must also remark that the interest rates of government bonds, due to minimum risk of default, is definitely lower than that of corporate bonds.

In the years 2005-2015, the average interest on debt for large corporations was higher than that for enterprises in the SME sector. The interest for large corporations was in the range of 5%-8%, while the average interest for SMEs in the analysed period was 6% (lower than 1 p.p. than that for large enterprises). The average interest on debt paid by large enterprises until 2012 was subject to significant changes. The changes were bigger in the case of large enterprises that use external sources of financing to a larger extent. Their highest value was observed in 2008 (with the exception of 2005), which was naturally related to the outburst of the financial crisis (the cost of loans in Polish zlotys reached 8% in that year and the cost of loans in euros was 6%; the interest paid on corporate bonds reached the highest level since 2005). Since 2012, both in the large enterprise sector and in the SME sector, the average interest paid on debt has decreased. It reached the lowest value in 2015. In the case of large enterprises, it was 32% lower than in 2012 and in the case of SMEs, it decreased by 38%. This was due to the good liquidity of companies and the good credit situation that has been in place since the end of 2013.

The net financial debt indicator, which is the quotient of the financial liabilities minus short-term financial assets and the total assets, is an indicator used by enterprises in their credit policies. The lower the value of net financial debt, the higher the ability to obtain external funds in the future. A constant increase of this measure means that enterprises constantly finance their operations with new credits and loans and avoid financing using their own funds.

In the years 2005-2011, large enterprises had lower values of the net financial debt indicator than SMEs. This was particularly pronounced in 2010 when the value of the indicator was nearly 5 p.p. smaller than in the SME sector (in that year, the short-term financial assets of large enterprises grew much faster than their financial obligations). In the last years of the analysis, the decrease of financial independence among large enterprises was accompanied by an increase in the net financial debt indicator, while the value of this indicator for enterprises in the SME sector was on average 1 p.p. lower. Until 2012, corporations in sectors other than the manufacturing sector achieved much lower values among large enterprises than manufacturing companies (in 2010, the value of cash and cash equivalents was even larger than the value of financial liabilities of those entities - there was a 33% increase in liquid assets of the enterprises in question compared to a 3% increase in the value of financial liabilities). In the years 2013-2015, this trend was reversed: corporations in the manufacturing sectors that were characterised by greater financial independence and had higher values of the self-financing indicator became safer for creditors.

### Net financial debt

Source: author's own calculation

Graph 7



An important indicator demonstrating the degree to which an enterprise is able to pay the interest on loans is the debt coverage ratio. It is calculated as the ratio of the net operating result and the financial revenue to the cost of interest. If the value of the ratio is larger than 1, the enterprise is able to pay the interest from its profit.

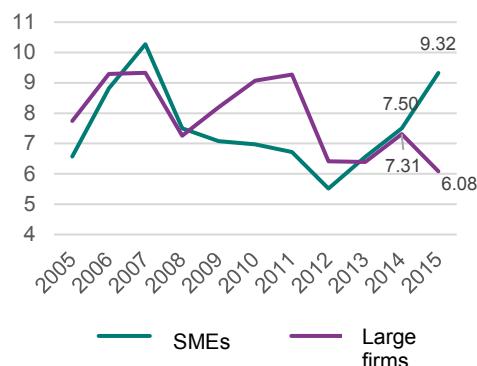
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### The times interest earned ratio

Source: author's own calculation

Graph 8

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In the years 2007-2008 and 2013-2015, SMEs had higher values of the interest coverage ratio. In 2008, both large enterprises and SMEs had a low value of the interest coverage ratio, which was due to the increasing costs of loans and bonds. In the case of large enterprises, after 2009, the value of the ratio started to increase thanks to the decreased cost of credit. An increase in the income of enterprises in 2010 resulted again in increasing values of this ratio.

In 2012, the value of the ratio decreased and reached the lowest level in the entire studied period due to an economic downturn. In the years 2008-2012, SME's experienced decreased values of the interest coverage ratio. In the pre-crisis year of 2007, the highest values of the ratio were observed. In the case of large enterprises, they were 3 p.p. higher than in the last year of the analysis and in the case of SMEs, the difference was a little below 1 p.p. In 2015, a significant difference was observed between the values of the interest coverage ratio in large enterprises and SMEs: the coverage of interest by financial profit and net operating profit in large enterprises was 53% smaller than the coverage in SMEs.

The payment terms agreed between customers and suppliers were determined using two indicators. The first indicator was the days sales outstanding (DSO) ratio, which is the ratio of the difference between the receivables for deliveries and services and the short-term advance payments received for deliveries to the sales revenues, multiplied by 360 days. The lower the value of this ratio, the sooner the company receives its money. The second indicator was the days payable outstanding (DPO), which is the quotient of the liabilities for deliveries and services minus advance payments for deliveries, and the costs of the purchased goods, multiplied by 360 days. The lower the value of this ratio, the sooner the company pays its liabilities to its suppliers.

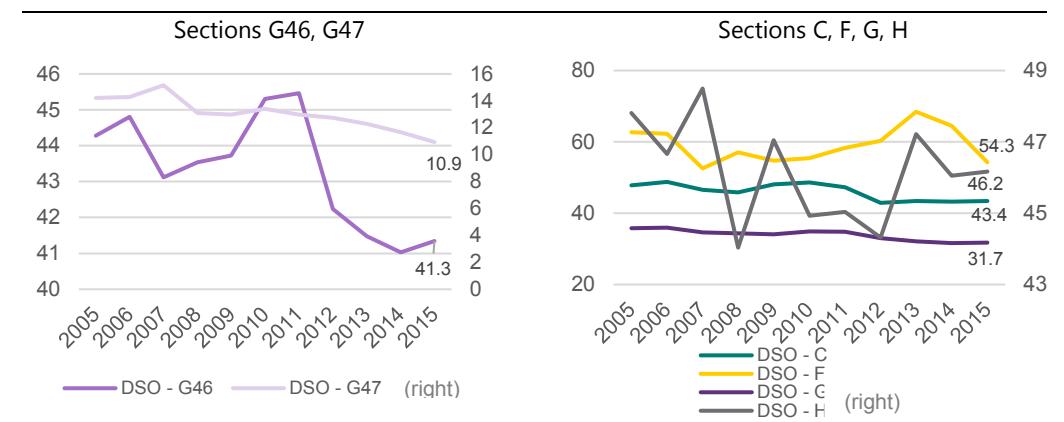
In the years 2005-2015, the value of the days sales outstanding ratio in most non-financial sectors did not change significantly, which means that the proportion of enterprises that received payments within time limits that exceeded the desirable values of the DSO did not change and, moreover, did not noticeably depend on the changing economic conditions. The largest differences between the values of the ratio that were observed in the construction sector (a difference of nearly 16 days; in 2007, the DSO was equal to 53 days and in 2013 it reached the highest level and was equal to 69 days).

More dynamic changes were observed in the case of the DPO ratios. The differences in the time of payment of liabilities to suppliers in the specific sector of enterprises did not, however, exceed 29 days. The largest differences in the observed value of the days payable outstanding ratio in the analysed period were experienced by enterprises in the real estate activities sector (28 days), the construction sector (22 days) and the transportation and storage sector (nearly 21 days).

#### DSO ratio

Source: author's own calculation

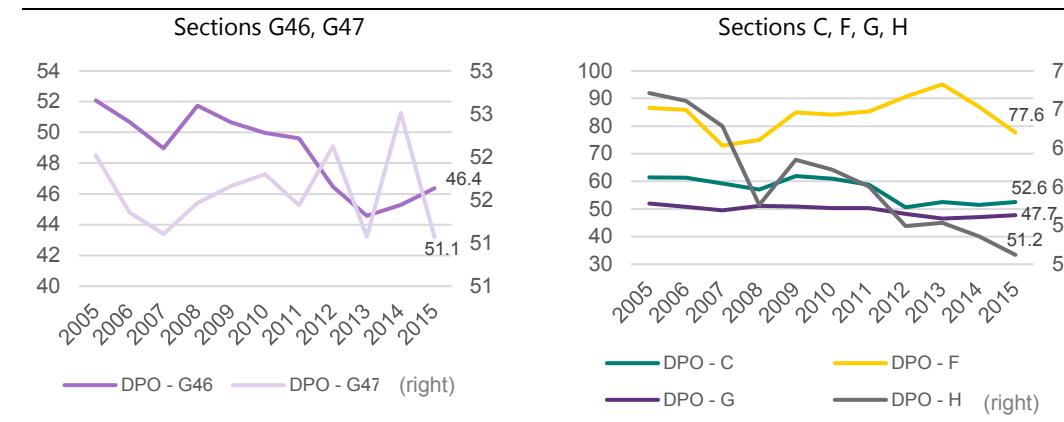
Graph 9



#### DPO ratio

Source: author's own calculation

Graph 10



## Description of the data, sectoral risk assessment methodology and results

To evaluate non-financial enterprises, the author relied on figures from annual financial reports (F-02). The analysis was made for active entities (according to the definition of the Statistical Office). The evaluation consists of two parts: the financial strength and the risk of bankruptcy.

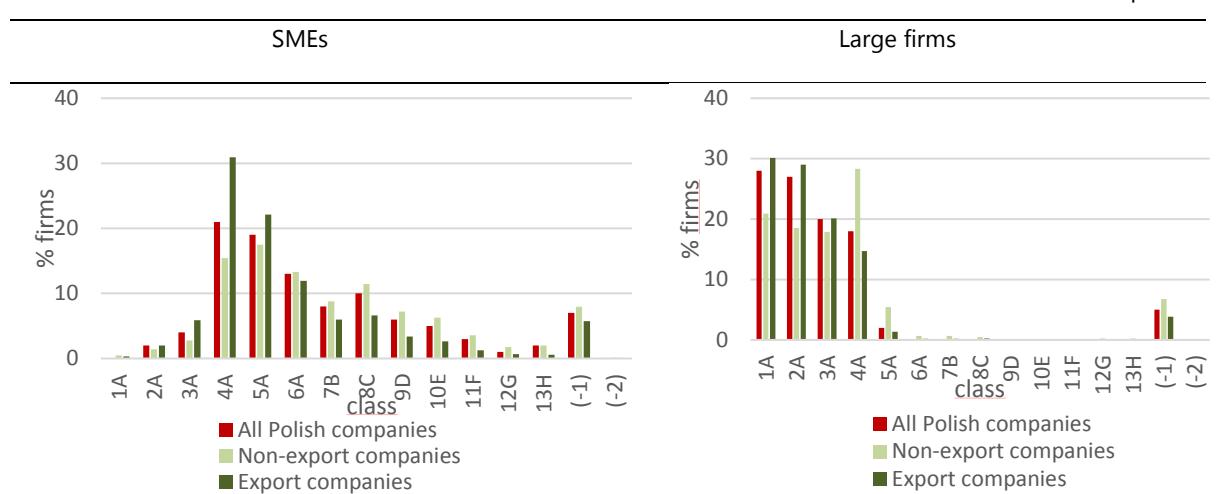
## Financial strength

The first part presents the financial strength depending on the net value of enterprises. The financial strength defines the financial capacity of an enterprise. The defined *classes* 1 – 4 are considered to be low-risk groups, with the first group being the group with the lowest risk. The safety of class 5 is average. Classes 6-13 are considered to have an above-average risk, whereby the 13th group is associated with the highest risk. *Class (-1)* groups enterprises with negative equity. The danger resulting from excessive use of external capital in the form of debt is negative equity, i.e. a situation where the liabilities and provisions exceed the value of the enterprise's assets. If the value of equity is larger than the value of assets, the balance sheet value of the assets decreases, i.e. funds from the liquidation of assets are insufficient to cover liabilities to debtors and provisions for such those liabilities have not occurred but whose value can be credibly estimated. Pursuant to the Code of Commercial Companies, a drop in the value equity, even one that does not lead to negative value of equity, constitutes grounds for declaration of bankruptcy of limited companies, both limited liability companies and joint stock companies (in the case of limited liability companies - a loss that exceed the value of the supplementary capital and a half of the share capital, and in the case of joint stock companies - a loss that exceeds the value of the supplementary capital and one third of the share capital). In the case of businesses established under other legal forms, whose capital requirements are not governed by law, negative equity means that if the business is liquidated its assets will not suffice to pay off the liabilities to all the creditors and owners forced to close business will not recover their contributions and will have to pay off the liabilities to the creditors from their private assets.

Financial strength in 2015 (% firms)

Source: author's own calculation

Graph 11



The analysis of the aforesaid data led to a conclusion that in 2005-2015, in terms of financial strength, all non-financial enterprises fell under the risk classes 4 to 8 (in 2015, the median of the financial strength was in class 5 (financial capacity from EUR 750,000 to EUR 1,750,000), while the first quartile of financial strength was in class 8 (financial capacity from EUR 165,000 to EUR 300,000)). In 2015, 16% of enterprises were below class 8 . The trend was set by the SME sector, dominant in terms of the number of enterprises. The situation of large entities was different. They usually (in

more than 90%) fell under the first four (safer) risk classes. The SME sector featured a higher percentage of enterprises with negative goodwill. Among large enterprises, the percentage of companies with negative goodwill was 2-3 percentage points lower on average than among SME, and it has remained at the level of 5% since 2008. Exporters were characterised by better financial equipment.

### Small and medium-sized enterprises

In 2015, the sector of small and medium-sized non-financial enterprises was dominated by entities classified in groups with above-average risk (classes 6-13). The highest percentage of such enterprises (above 50%) was present in the retail sector, companies providing business services, the construction sector, and the transportation and storage sector. The lowest percentage of such enterprises was present in the pharmaceutical sector (17%), and the real estate activities sector.

The enterprises that constituted the highest percentage in the group of enterprises with the highest financial capacity (classes 1-4) was small and medium-sized enterprises in the real estate activities sector (above 66%), the energy, water and waste sector (54%), and the pharmaceutical sector (52.2%). The enterprises that constituted the lowest percentage in the lowest-risk group (below 10%) was enterprises in the retail sector.

In 2015, the largest group of enterprises with negative net goodwill was service companies. Those were enterprises active in the accommodation and food service activities sector (15%), the information and communication sector (13%), the retail sector (11%), and the business services sector (11%). The enterprises in the manufacturing industry included those in the pharmaceutical sector (9), the textiles, clothing and footwear sector (8%), and the metallurgy sector (7%). The smallest percentage of enterprises with negative net goodwill was present in the energy, water and waste sector (2%) and the real estate activities sector (3%).

### Large enterprises

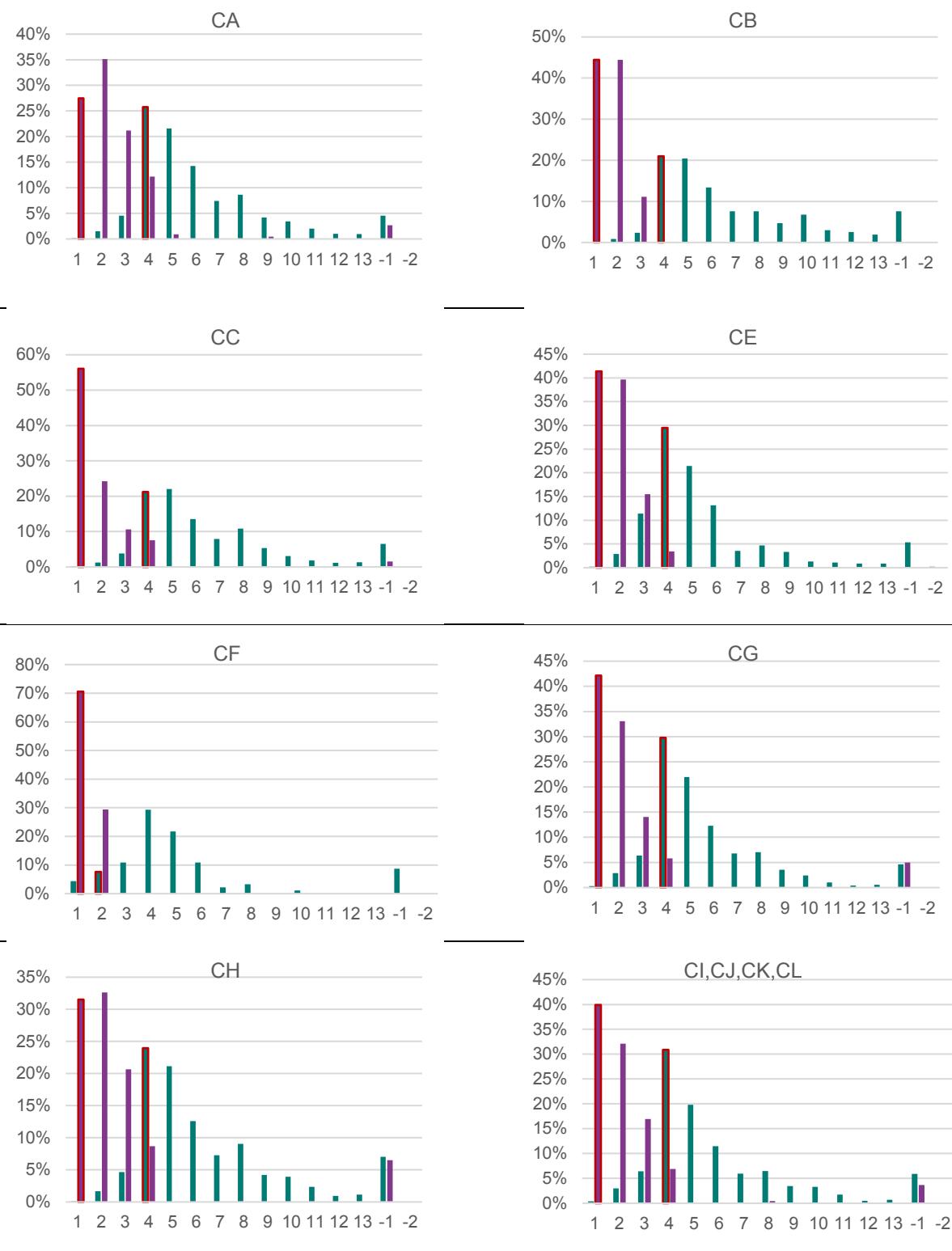
The situation in the last year of the analysis was different in the large enterprise sector. More than 80% of large non-financial enterprises were classified in the low-risk group that is characterised by the highest financial strength. Among the enterprises in the manufacturing industry, this share did not drop below 93%. All enterprises in the first four risk classes were present in the case of the textiles, clothing and footwear sector, the chemical industry, the pharmaceutical sector, as well as the accommodation and food service activities sector and the real estate activities sector. The smallest percentage of enterprises in the lowest-risk groups was present among service enterprises providing business services (less than 84%).

An analysis of the above-average risk group indicated that the largest percentage in the risk classes 6-13 in 2015 was present among enterprises in the business services sector (8%). The largest percentage of entities with negative goodwill was observed among service enterprises in the information and communication sector (12%) and in the mining and quarrying sector (11%). A share of entities with negative net goodwill that was higher than 5% was also observed in the transportation and storage sector, the retail sector, the metallurgy and metalworking sector, and in the construction sector.

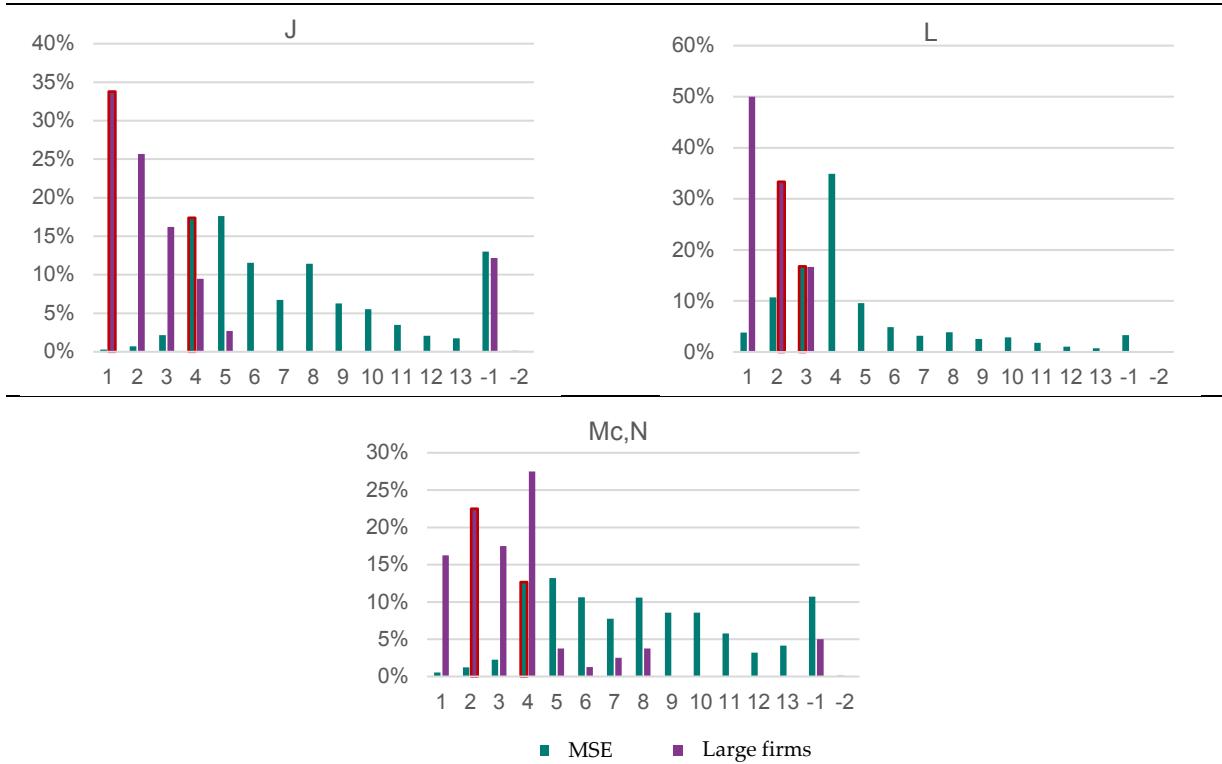
Financial strength in 2015 according to the section in which business is conducted

Source: author's own calculation

Graph 12







## Risk of bankruptcy

The second part of the evaluation concerns the risk of bankruptcy. At a given time, each of the studied companies could have one of the following four statuses of legal and economic activity: active entity conducting activities, an active entity in construction, an active entity in liquidation, and active entity in bankruptcy. Consequently, failure forecasting applies to entities that, as of 31 December, are in bankruptcy but continue their activities and had revenue from the activities in the period covered by the report.

Probability of default **PD** model consists of the next part:

- **Quantitative** – financial factors,
- **Qualitative** – behavioral factors,
- **Sector riskiness**.

The models were estimated on databases which included all companies that went bankrupt and randomly chosen healthy companies. Companies that declared bankruptcies made up for 20% of the created samples. This approach is common for scoring methods where 'bad' subject constitute only a small share of the whole population and it has the purpose of improving the statistical characteristics of the applied tools. Before estimating the model it was tested whether the constructed sample is representative following the results of the non-parametric *Wilcoxon-Mann-Whitney test*, *Kolmogorov-Smirnov test* and the parametric *t-Student* test for equality of averages for the continuous variables and the  $\chi^2$  *Pearson* test and the *Population Stability Index* (PSI) for the discrete variables. The PSI coefficient is applied in order to investigate the differences in distribution of two categorized variables.

The higher the value of the coefficient, the greater the statistical distance between the distributions.

In order to construct an indicator (*probability of default - PD*) which would enable assessing the probability of a company to go bankrupt, a logistic regression was used. Due to a high number of financial indicators of a company's condition (explanatory variables) in the initial analysis the predicting force of each was determined (*Gini coefficient, Information Value Indicator*) followed by clustering in order to limit the size of the analysis. Thanks to this variable selection procedure it was possible to avoid the collinearity problem, which was assured by calculating the appropriate *Variance Inflation Factor* statistics. The model was estimated on categorized variables transformed using the Weight of Evidence (*WoE*) approach. The WoE transformation is often used for the creation of scoring models using logistic regression, because such a transformation allows maintaining linear dependence in regard to the logistic function. In addition, *WoE* conveys information on the relative risk associated with each category of the particular variable, with a large negative value indicating a higher risk of bankruptcy.

$$WoE_i = \ln \left( \frac{p_i^{\text{non bankrupts}}}{p_i^{\text{bankrupts}}} \right)$$

where:

- $i$  - category
- $p_i^{\text{non bankrupts}}$  - the percentage of not bankrupt companies that belong to category  $i$
- $p_i^{\text{bankrupts}}$  - the percentage of bankrupt companies that belong to category  $i$ .

The categorisation was based on the division with the highest Information Value (*IV*), which measures the statistical *Kullback – Leibler* distance ( $H$ ) between the bankrupts and non-bankrupts. The *IV statistic*, based on the *WOE*, allows measuring the predicting force of a particular characteristic. The *IV* value depends on the number of categories and division points. The variables for which the *IV* does not exceed 0.1 are assumed to be weak in their relative predicting force, while values exceeding 0.3 bear evidence of a strong discriminating force (Anderson, 2007).

$$\begin{aligned} IV &= H(q^{\text{non bankrupts}} || q^{\text{bankrupts}}) + H(q^{\text{bankrupts}} || q^{\text{non bankrupts}}) \\ &= \sum_i (p_i^{\text{non bankrupts}} - p_i^{\text{bankrupts}}) WoE_i \end{aligned}$$

where:

- $q$  - density function.

The final model was created following the top-down approach. Based on the estimated parameters, weights for particular explanatory variables were determined. As a result, a set of financial indicators allowing to grade companies was obtained and bankruptcy probabilities were assigned to companies.

The first included companies observed in 2014. In this model the probability of default (*PD*) was predicted for a one year horizon. The greatest weight was assigned to the indicator of industry sector (21%). The great weight also was assigned to the indicator of ability to cover financial costs (17%). This indicator was also mentioned

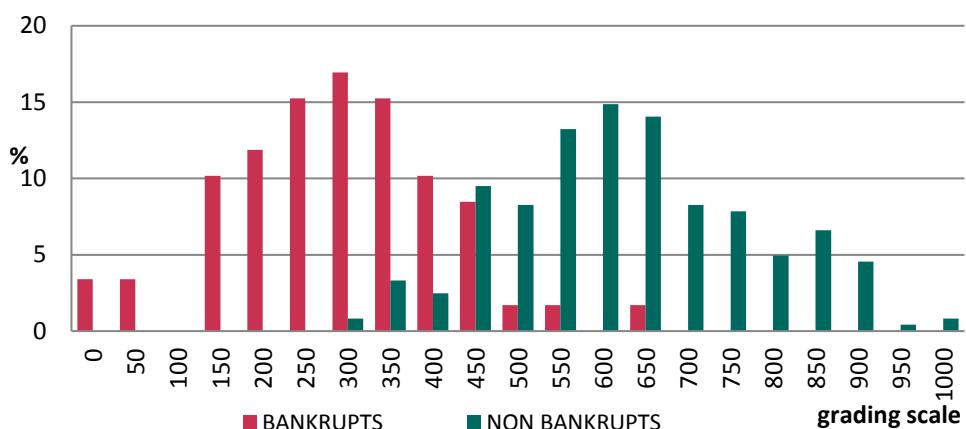
by Mączyńska and Zawadzki (2006) as significant for forecasting firm bankruptcy, because it reflects the degree in which operating profits can decrease without preventing the company from covering its financial costs. A higher value of this indicator translates to higher financial security of a company (Görgi and Spaliara, 2009). The indicator for net-assets structure (weight of 19%) is the second most important characteristic that can signal a potential bankruptcy. The share of current liabilities in total assets, direction of sales, size of companies and *ROA* are also good bankruptcy predictors. In line with the results of Chaney (2013) specialized exporters are considered to be performing best.

---

Distribution of company grades based on the model  
for "Bankrupts" and "Non bankrupts"

Source: author's own calculation

Graph 13



The distribution of grades across companies which have or have not gone bankrupt shows that the selected indicators (explanatory variables) allow identifying a potential bankruptcy to a significant degree (Figure 13). The information collected in the database indicated that no company that obtained more than 650 points went bankrupt within a year. However, for companies with less than 200 points bankruptcy was almost certain. Bankruptcy was predominant among companies from the 200-300 points interval.

In accordance with the guidelines of Basel III, the decision to implement the scoring model should be determined by the results of the validation process: the discriminatory power and calibration quality. The *GINI* and *K – S value* of the model were equal to, respectively, 94 and 84, which means satisfactory discrimination. The hypothesis on the combined insignificance of explanatory variables in the model was rejected (*p – value* = 0.000). While using the Wald method, tests were carried out on the significance of individual variables separately and the p-value for each of them was below the established 5% significance level. There are also no grounds to reject the zero hypothesis on the good adjustment of the model to the data (*p – value* = 0.19). The *VIF* (*Variance Inflation Factor*) value does not indicate any issues of excessive collinearity. While using the bootstrap method, the stability of the calculated *GINI value* was verified. To achieve this, a sample was drawn and returned a thousand times, which contained 2/3 observations from the original set. The

operation of the model was verified with the use of a validation set. The hypothesis on the combined insignificance of the parameters was rejected. There are also no grounds to reject the zero hypothesis on the insignificance of individual explanatory variables in the model.

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### Bankruptcy rate (% of the total number of enterprises) during one year (2015)

Source: author's own calculation

Table 1

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Total
Total	0	0	0,01	0,01	0,02	0,18	0,76	1	1,5	6,19	0,06

---

The defined classes 1-4 are considered to be low-risk groups, with the first group being the group with the lowest risk. The safety of class 5 is average. Classes 6-10 are considered to have an above-average risk, whereby the 10th group is associated with the highest risk.

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### Evaluation of the risk of bankruptcy (% of the total number of enterprises) in 2015

Source: author's own calculation

Table 2

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	TOTAL
Total	7,26	14,29	28,87	25,32	14,22	7,57	0,89	0,88	0,26	0,44	100
B	6,91	10,55	24,73	24,73	17,82	11,27	0,73	1,82	0	1,45	100
CA	12,52	16,94	26,39	25,78	12,87	4,64	0,13	0,39	0	0,35	100
CB	6,23	16,77	28,21	20,33	14,1	10,93	1,27	1,02	0,64	0,51	100
CC	7,44	9,15	28,5	26,71	16,37	8,93	0,67	1,41	0,37	0,45	100
CE	8,99	9,89	30,79	24,04	18,2	5,84	1,12	0,9	0	0,22	100
CF	14,89	18,09	18,09	25,53	17,02	4,26	1,06	1,06	0	0	100
CG	8,62	10,41	27,49	23,69	17,85	9,69	0,92	0,82	0,21	0,31	100
CH	7,37	11,85	28,15	24,13	15,96	9,7	0,89	0,76	0,38	0,8	100
CI,CJ,CK,CL	8,38	11,39	29,06	22,68	17,72	7,38	1	1,38	0,19	0,81	100
DE	9,45	16,38	29,68	27,52	12,07	3,73	0,23	0,76	0	0,17	100
F	5,16	10,77	23,04	25,3	19,45	12,34	1,38	1,45	0,51	0,6	100
G45	2,98	5,73	23,23	31,32	18,92	12,87	2,2	1,41	0,78	0,55	100
G46	6,12	9,66	29,9	26,37	16,44	8,23	1,15	1,26	0,4	0,47	100
G47	6,71	15,71	36,61	24,08	9,71	5,28	0,96	0,46	0,17	0,3	100
H	9,02	11,24	32	29,82	10,34	6,42	0,66	0,43	0,04	0,04	100
I	4,6	14,96	26,34	35,29	10,23	7,29	0,38	0,64	0	0,26	100
J	8,44	22,55	27,13	20	12,15	7,42	0,87	0,58	0,15	0,73	100
L	4,16	21,8	29,16	28,68	12,42	2,77	0,11	0,59	0	0,32	100
Mc,N	8,06	21,36	28,89	22,83	10,46	6,49	0,67	0,58	0,2	0,46	100

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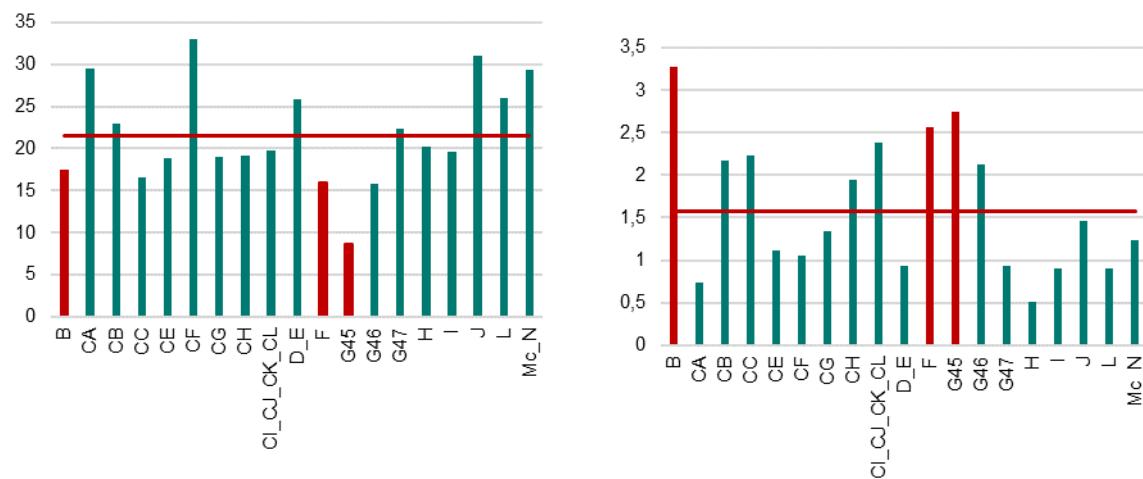
Based on the results, it was found that the small and medium-sized enterprises faced a higher risk of bankruptcy than large enterprises, which was due to the fact that large enterprises have a higher rate of self-financing. About 76% of enterprises were included in classes 1-4, which are characterised by low risk; those enterprises employed 76% of all employees.

## Evaluation of the risk

Source: author's own calculation

Graph 14

in the first two classes in which the PD does not exceed 0.01% (% of the total number of enterprises) in 2015	in the last three classes in which the PD is equal to or higher than 1% (% of the total number of enterprises) in 2015
---	--



Figures 14-15 show a ranking of the sections of activities, which was determined based on the percentage of enterprises included in the categories where the probability of bankruptcy did not exceed 0.1% and those where it was equal to or higher than 1%. The lowest risk of bankruptcy was identified in the case of the pharmaceutical sector (especially large enterprises) which, as has been mentioned, did not finance its activities with debt to such a high extent as other sectors. Of note is the fact that the pharmaceutical sector is one of the fastest growing manufacturing sectors both in Poland and abroad. The sector with the highest risk, where the PD was equal to or higher than 1%, was the mining section. Based on the Polish Financial Supervision Authority, the industry with the lowest credit quality was recorded in mining (the share of non-performing loans exceeded 20%). It was followed by the motor vehicles trade sector and the construction sector. The liquidity risk in the construction industry is still present and concerns mostly smaller entities, which are dependent on timely payments by general contractors or owners. This sector still generates many overdue liabilities, which also affects the situation of companies from other sectors of the economy that cooperate with construction companies.

## Evaluation of the risk of bankruptcy (% of the total number of employees) in 2015

Source: author's own calculation

Table 2

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	TOTAL
Total	9,78	7,00	31,84	26,62	20,47	3,19	0,40	0,36	0,08	0,26	100
B	1,82	1,50	28,66	16,33	48,44	1,37	0,07	0,07	0,00	1,73	100
CA	12,98	7,42	28,60	31,66	16,80	2,16	0,06	0,20	0,00	0,12	100
CB	11,13	12,98	28,97	21,44	17,00	6,38	0,79	0,49	0,45	0,37	100
CC	11,36	5,76	34,71	26,10	16,31	4,65	0,28	0,59	0,09	0,16	100
CE	16,48	4,67	29,49	19,01	28,65	1,12	0,42	0,13	0,00	0,03	100
CF	20,90	10,42	17,28	17,53	32,24	0,35	0,48	0,79	0,00	0,00	100
CG	10,99	4,70	32,58	23,08	23,83	3,94	0,35	0,36	0,10	0,07	100
CH	8,79	7,11	27,62	26,84	23,95	4,28	0,36	0,48	0,20	0,37	100
CI,CJ,CK,CL	9,94	4,94	28,78	26,05	26,79	2,41	0,37	0,31	0,02	0,40	100
DE	7,74	5,72	49,34	25,83	9,61	1,35	0,19	0,18	0,00	0,04	100
F	12,06	5,68	20,84	24,06	27,56	7,41	0,93	0,85	0,30	0,30	100
G45	2,43	2,56	23,77	35,46	24,51	8,16	1,45	0,93	0,39	0,33	100
G46	5,97	5,57	28,80	29,25	23,65	4,75	0,73	0,74	0,19	0,35	100
G47	8,37	4,72	26,02	36,77	21,43	1,78	0,38	0,23	0,05	0,25	100
H	6,92	4,92	44,91	31,31	9,37	2,04	0,34	0,16	0,01	0,02	100
I	14,19	6,02	28,63	28,76	19,28	2,49	0,43	0,15	0,00	0,06	100
J	14,95	10,67	27,33	14,63	29,64	2,02	0,24	0,14	0,02	0,36	100
L	8,80	16,91	36,05	24,83	10,97	1,42	0,07	0,75	0,00	0,19	100
Mc,N	11,58	12,18	38,78	21,12	12,53	3,06	0,23	0,18	0,04	0,28	100

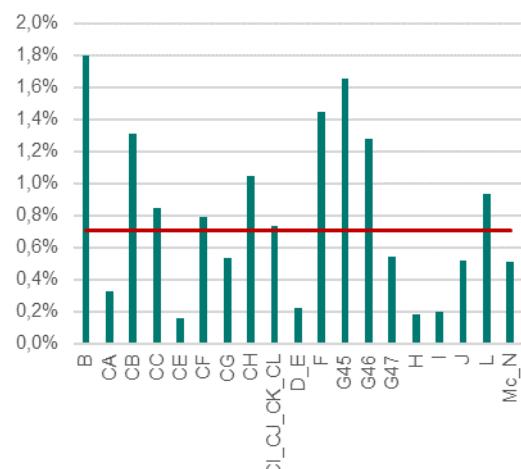
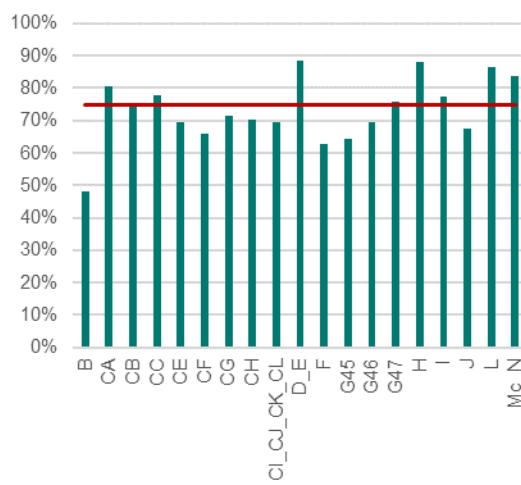
## Evaluation of the risk

Source: author's own calculation

Graph 15

in the first two classes in which the PD does not exceed 0.01% (% of the total number of employees) in 2015

in the last three classes in which the PD is equal to or higher than 1% (% of the total number of employees) in 2015



## Do financial constraints affect decisions making by prospective exporters?

In addition, the hypothesis was verified that the financial constraints of enterprises affect decisions making by prospective exporters (Chaney, 2013) and sales in foreign markets (Manova, 2013). Manova (2013) claims that enterprises need to borrow to cover part of the variable costs related to production for export. This results in a decrease in export intensity in relation to a situation where the company would only aim to maximize profits. However according to Chaney (2013), that companies cover production costs with the use of profits obtained as a result of sales on the domestic market, which suggests that the company's productivity is more important in the case of export intensity.

The results of studies conducted so far are not conclusive. Bellone et. al. (2010), when analysing new French exporters, did not obtain the impact of investment financing on export intensity, while they received a strong dependency indicating the impact of financial constraints on entering foreign markets. Similar results for Chinese companies were obtained by Egger and Kesina (2014). However, Minetti and Zhu (2010) research on Italian companies supports the Manova hypothesis. The authors prove the negative impact of credit restrictions on both the export decision and the size of export sales. The same conclusions are drawn by Kiendrebeogo and Minea (2013), which study concerns Egyptian companies. Therefore, both for developed and developing countries, the results of research are not conclusive, which makes the study on Polish data becomes a very interesting research topic.

The empirical analysis of export decision and export intensity was conducted based on unit panel data, unbalanced, originating from balance sheets and profit and loss accounts of Polish enterprises, presented in the Statistical Office reports. As far as financial leases are concerned, data annual statements of the period 2005–2015 (about 50,000 enterprises each year).

Parameters were estimated using the robust system GMM (Generalised Methods of Moments) estimator (see: Arellano & Bover, 1995; Blundell & Bond, 1998). In addition, a resistant variance-covariance matrix was used. The estimation method was selected correspondingly to the definition of response variables and the problem of endogeneity identified and confirmed in tests. The correctness of the instrument mix was verified by means of the Sargan test, conducted to check if the condition of orthogonality between the instruments and the random component was satisfied. This condition was verified using a test for autocorrelation in differences of remainders from the model. The model design assumption require that there can be no correlation of the remainder component of degree 2 and higher degrees.

Using a large panel data of Polish firms, there was evidence that financial constraints matter for export participation and sales in foreign markets. This result corroborates the idea that the relevance of financial constraints was due to the presence of sunk entry costs. Enterprises need to borrow to cover part of the variable costs related to production for export.

---

Do financial constraints affect decisions making by prospective exporters?

Source: author's own calculation

Table 4

Variables	<i>Export decision</i>		<i>Export intensity</i>	
	$\begin{cases} 1 & \text{if Export sales} > 0 \\ 0 & \text{otherwise} \end{cases}$		$\frac{\text{Export sales}}{\text{Sales}}$	
Export decision ( $t - 1$ )	0,699	(0,048)***		
Export intensity ( $t - 1$ )			0,639	(0,044) ***
$PD$ (Indicator built on the basis $PD$ model)	-0,177	(0,056)***	-0,184	(0,073) **
$\text{Size} = \ln(\text{Number of Employees})$	0,048	(0,006)***	0,040	(0,008)***
$\text{Productivity} = \ln((\text{Value Added})/\text{Employee})$	0,039	(0,006)***	0,028	(0,008)***
$\text{Wage per employee} = \ln(\frac{\text{Wage}}{\text{Employee}})$	-0,019	(0,014)	-0,023	(0,008)***
<b>Test</b>				
Time Dummies	156,01	[0,0000]	99,01	[0,0000]
Sargan Test	67,21	[0,6054]	93,63	[0,2214]
Arellano-Bond Test $m1(p)$	-4,58	[0,0000]	-4,08	[0,0000]
Arellano-Bond Test $m2(p)$	0,79	[0,4245]	0,23	[0,8138]

\* Significant at 10%, \*\* Significant at 5%, \*\*\* Significant at 1%. Mean error values are enclosed in round brackets, p values – in square brackets.

## Conclusion

The article presents a methodological framework for the analysis of sectoral risk and an evaluation of the financial condition in sectoral level and assess the contribution of different sectors to the overall level of risk.

In 2015, the net operating margin achieved by large enterprises decreased to the lowest level since 2005. Its continuous increase has been observed in the SME sector since 2013. The highest margin, in the case of both large enterprises and small and medium-sized enterprises, was observed in the last year of the analysis in the manufacturing industry (especially in the case of large enterprises in the wood, paper products and printing sector a, and in the case of small and medium-sized enterprises in the pharmaceutical sector). In the remaining sections, the energy, water and waste services sector was the most prominent. On the other hand, among service companies, the highest margins among large enterprises were achieved by entities providing services in the real estate market and among SME - by entities providing accommodation and communication services.

In 2015, mining was not profitable, in the case of both large enterprises and small and medium-sized enterprises. Negative financial profits were also achieved by large energy, water and waste enterprises. High values of economic and financial returns were achieved in the manufacturing industry (especially the textiles, clothing and footwear sector and the metallurgical sector - in the case of SMEs, and the textiles, clothing and footwear sector - in the case of large enterprises) and in the construction industry.

In 2015, companies in the SME sector were characterised by higher financial independence. In the last years of the analysis, the decrease of financial independence among large enterprises was accompanied by an increase in the net financial debt indicator. In the case of both large enterprises and small and medium-sized enterprises, the highest levels of financial independence were present among enterprises in the manufacturing industry (especially the pharmaceutical sector). As for other sections, in the case of large enterprises, high values of financial independence were also observed in energy, water and waste services, and in the case of SMEs - in the energy, water and waste sector.

In the case of service enterprises, companies providing services to the real estate market were characterised by the highest level of financial independence. On the other hand, higher values of the self-financing indicator were observed among large enterprises. This was due to, most of all, the situation of industrial enterprises (in the textiles, clothing and footwear sector and the pharmaceutical sector) and energy, water and waste sector.

The highest costs of debt servicing were faced by large enterprises. In 2015, the highest average interest was observed in the case of service companies (especially in the information and communication section) and mining and quarrying companies. A large majority of the companies was able to cover the interest with the profits they earned (with the exception of large mining and quarrying companies). Higher values of the interest coverage ratio were achieved by enterprises in the SME sector.

In 2015, credits and loans and deferred revenue had the largest share in long-term financing sources. In the case of large enterprises, credit was used mostly by service companies, especially companies conducting activity related to accommodation and food service activities services. In the SME sector, credits were the largest part of liabilities in the mining sector. In the case of large enterprises, the largest share of deferred revenue in liabilities was observed in the service sector (especially among companies providing services to the real estate market and companies in the transportation and storage sector); in the case of small and medium-sized enterprises, it was energy, water and waste services.

The most important element of short-term liabilities were liabilities on account deliveries and services and liabilities on account of credits and loans. Commercial credits constituted the highest share of liabilities in the construction industry and in the manufacturing industry, especially the textiles, closing and footwear sector. Short-term loans constituted the highest share of liabilities, both in the large enterprise sector and in the small and medium-sized enterprise sector, in the manufacturing industry, while they constituted the lowest share of liabilities in the energy, water and waste sector.

In 2015, the value of the days sales outstanding ratio decreased only slightly. The average period in which enterprises had their funds blocked in receivables was equal to 39 days. The highest values of the ratio were observed in the case of enterprises providing business services, companies active in the information and communication

sector, and construction companies. The smallest problems with debt collection were observed in the case of entities that conducted activities in the accommodation and food service activities sector. The average time after which non-financial enterprises paid their liabilities was 52 days. The highest value of the days payable outstanding ratio was achieved by companies providing services to the real estate market and by mining companies. On the other hand, energy, water and waste sector companies paid their liabilities the quickest.

Based on the results of the evaluation of the risk associated with the financial condition of enterprises, it was found that small and medium-sized enterprises faced a higher risk (the evaluation consisted of two parts: evaluation of the financial strength and prediction of bankruptcy). In 2015, the highest percentage of small and medium-sized enterprises with negative value of net goodwill was observed in the service sector (the accommodation and food service activities sector, the information and communication sector, and the business service sector); in the case of large enterprises, it was observed in the information and communication sector and in the mining sector. In 2015, the lowest risk of bankruptcy was observed in the *pharmaceutical industry* (where the probability of bankruptcy did not exceed 0.1%) and the highest risk of bankruptcy - in the *mining sector* (where the PD was equal to or higher than 1%).

Based on the literature review two stylised facts emerge: exporters perform substantially better than their non-exporting competitors; there are wide cross-country differences in enterprise export behaviour. Exporters were characterised by better financial equipment. Using a large panel data of Polish firms, there was evidence that financial constraints matter for export participation and sales in foreign markets. This result corroborates the idea that the relevance of financial constraints was due to the presence of sunk entry costs. Enterprises need to borrow to cover part of the variable costs related to production for export.

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## Annex

### Sectoral groupings

#### 1. Manufacturing industry:

NACE	Sectoral groupings
CA	Agri-food industries
CB	Textiles, clothing and footwear
CC	Wood, paper products and printing
CE	Chemicals industry
CF	Pharmaceuticals industry
CG	Manufacture of rubber and plastics products
CH	Metallurgy and metalworking
CI,CJ,CK,CL	Metal manufactures

#### 2. Services:

NACE	Sectoral groupings
G	Wholesale and retail trade, repair of motor vehicles and motorcycles
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
L	Real estate activities
Mc,N	Business service sector: professional, scientific, technical, administration and support service activities

#### 3. Others:

NACE	Sectoral groupings
B	Mining and quarrying
D, E	Energy, water and waste
F	Construction



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Dilijan, Armenia, 11-12 June 2018

## Sectoral risk assessment: Evidence from Poland<sup>1</sup>

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<sup>1</sup> This presentation was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

NBP

Narodowy Bank Polski

dr Natalia Nehrebecka

## **Sectoral risk assessment: Evidence from Poland**

IFC – Central Bank of Armenia workshop on „External Sector Statistics”  
Armenia, Dilijan, 11-12 June 2018



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## Aim and Motivation

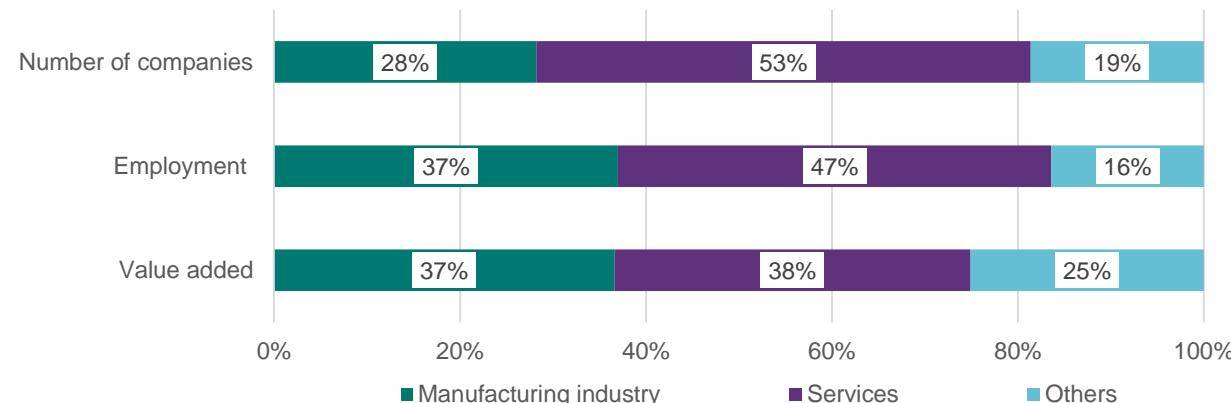
- Macroeconomic conditions in which companies operate are an important aspect in the analysis of the factors affecting the *financial condition* of enterprises, *the risk of bankruptcy*, and *transition of enterprises from the high-risk group to the group of enterprises whose financial condition is good, and vice versa*.
- The *IRB* credit risk evaluation concept is based on the assumption that the risk to the credit portfolio may result from two sources:
  - *systemic risk*, which is caused by unexpected macroeconomic and market changes. The risk is faced by all borrowers; however, the level of susceptibility of individual borrowers to this risk may be different;
  - *idiosyncratic risk*, which is the outcome of various unique threats faced by individual borrowers.
- In case of non-financial firms *their default display positive correlations within and across industries*. Their dependence structure might be driven by *sectoral (systematic) risk factors*. (Das et al. 2007; Saldías 2013).

## Aim and Motivation

- This study presents a methodological framework for the analysis of sectoral risk and an evaluation of the financial condition on sectors level.
  - This study also presents the **Probability of Default (PD) Model** for non-financial corporations in Poland.
- In addition, the hypothesis was verified that the financial constraints of enterprises affect decisions making by prospective exporters (Chaney, 2013) and sales in foreign markets (Manova, 2013).
  - Manova (2013) claims that enterprises need to borrow to cover part of the variable costs related to production for export. This results in a decrease in export intensity in relation to a situation where the company would only aim to maximize profits.
  - However according to Chaney (2013), that companies cover production costs with the use of profits obtained as a result of sales on the domestic market, which suggests that the company's productivity is more important in the case of export intensity.

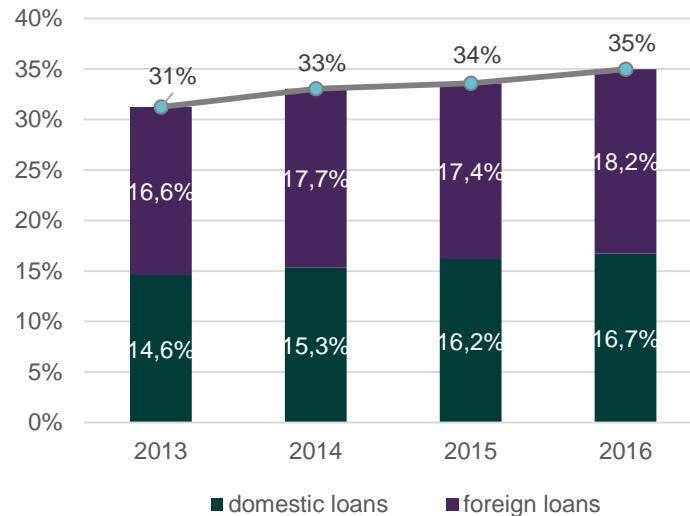
## Data sources

- The empirical analysis is based on individual data on:
  - Balance sheet and profit and loss account (**F-02 statement**) – (*source: Statistical Office*)
  - Prudential Reporting (**NB300**) – (*source: Narodowy Bank Polski*)
  - Balance of payments – (*source: Narodowy Bank Polski*)
  - Financial and behavioral data – (*source: BISNODE POLAND*)

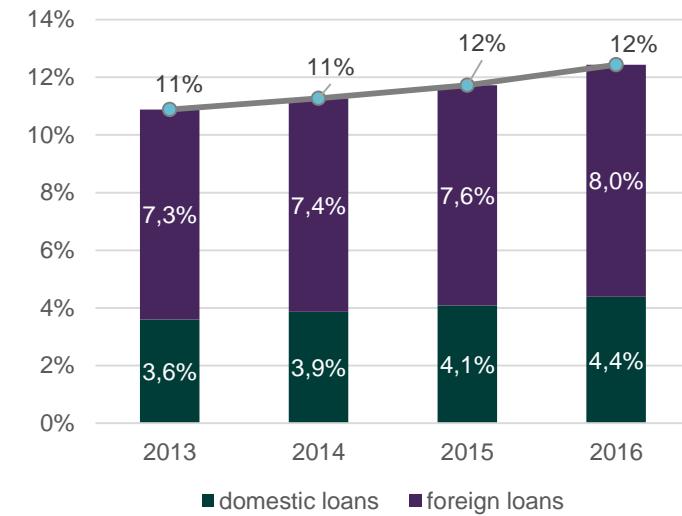


**Figure 1.** Share of firms by sector activity

## Data sources



**Figure 2.** Domestic and foreign debt non-financial enterprises (% of GDP)



**Figure 3.** Non-financial corporations having both domestic and foreign debt

(domestic and foreign debt non-financial enterprises as % of GDP)

Source: Balance of payments, Prudential Reporting (NB300)

## Data sources

**Table 1. Insolvency rate and Default rate**

Year	Number of obligors	Thereof Insolvent	Thereof defaulted with at least one bank	Insolvency rate	Default rate
2007	8 164	54	307	0,66	3,76
2008	9 938	18	507	0,18	5,10
2009	11 494	68	918	0,59	7,99
2010	10 824	37	635	0,34	5,87
2011	11 286	46	619	0,41	5,48
2012	12 302	111	731	0,90	5,94
2013	12 450	80	681	0,64	5,47
2014	12 376	64	624	0,52	5,04
2015	13 091	47	501	0,36	3,83
2016	14 191	31	504	0,22	3,55

Source: Prudential Reporting (NB300), BISNODE

# Risk assessment

- The evaluation consists of two parts.
  - **The first part** presents the financial strength depending on the **net value of enterprises**.
    - The financial strength defines the financial capacity of enterprise.
  - **The second part** presents **PD** model.
    - **PD** model consists of the next part:
      - **Quantitative** – financial factors
      - **Qualitative** – behavioral factors
        - Localization of the entity, industry, size of employment, legal form, year of establishing, description of the owner, payment morality
    - **Sector riskiness**
      - Industry variables
    - **Combined**

$$y = F^\alpha B^\beta S^\gamma$$

## Main steps in developing a rating system

Definition of default

Data collection,  
sampling  
and  
methodolo-  
gical  
approach

Univariate  
analyses

Mulivariate  
analyses

Validation –  
PD  
discriminatory  
power tests

Calibration  
and  
mapping to  
the master  
scale

Validation –  
PD calibration  
tests

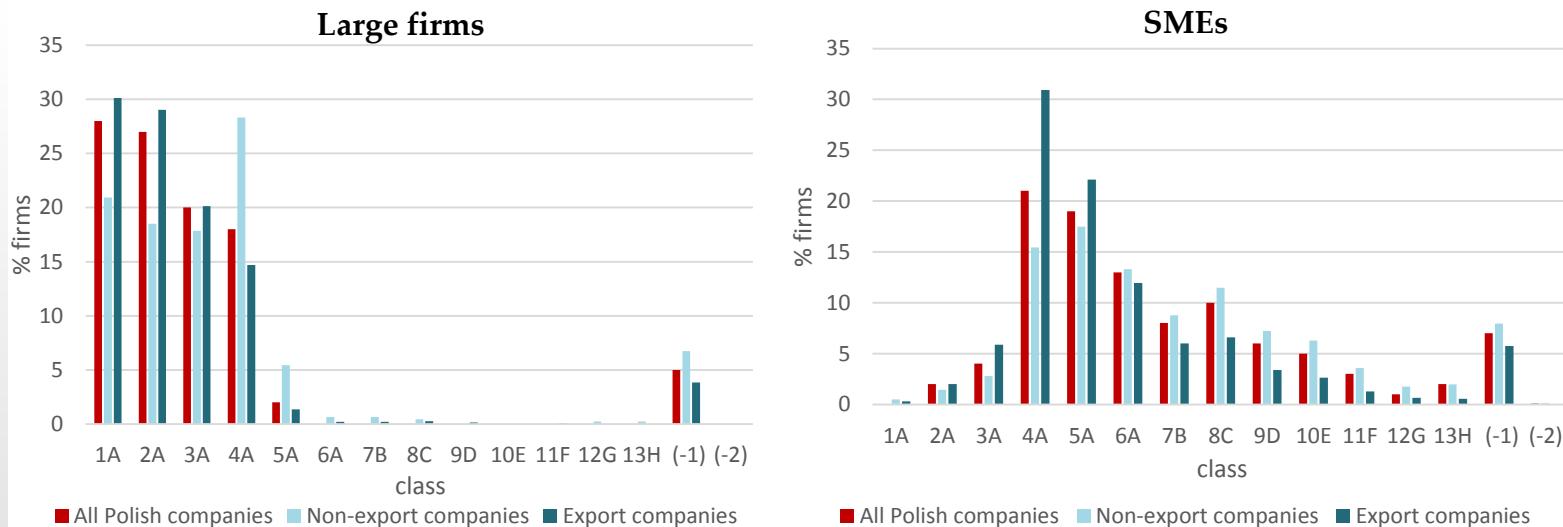
## Sample design

- Models were estimated on databases which included *all companies that went default as well as randomly chosen healthy companies*.
- Companies that declared defaults made up for 20% of the created samples.
  - This approach is common for scoring methods where 'bad' entity constitute only a small share of the whole population and it has the purpose of improving the statistical characteristics of the applied tools.
- Then the dataset was randomly split into **development** and **validation sample** containing 70% and 30% of the data, respectively.
- Prior to the estimation of the model, it was tested in order to ascertain whether the constructed sample was representative, following the results of:
  - the non-parametric *Wilcoxon-Mann-Whitney* test, *Kologomorow-Smirnow* test and the parametric *t-Student* test for equality of averages for the continuous variables
  - and the  $\chi^2$  *Pearson* test, the *Population Stability Index (PSI)* for the discrete variables.

## Methodology

- In order to construct a default prediction for a company **a logistic regression was used**. Models were estimated on categorized variables transformed using the weight of evidence (*WoE*) approach.
- The categorisation was based on the division with the highest Information Value (*IV*), which measures the statistical Kullback-Leibler distance (*H*) between the *defaults* and *non-defaults*.
- Due to **a high number of financial indicators describing a company's condition** (explanatory variables) in the initial analysis, the predicting power of each was determined firstly (*Gini coefficient, Information Value Indicator*) followed by clustering in order to limit the size of the analysis.
  - Thanks to this variable selection procedure it was possible to avoid the collinearity problem, which was assured by calculating the appropriate *Variance Inflation Factor* statistics.

## Financial strength



**Figure 4.** Financial strength in 2015 - non-export/export companies (% firms)

## PD model

**Table 2.** Bankruptcy rate (% of the total number of enterprises) during one year (2015)

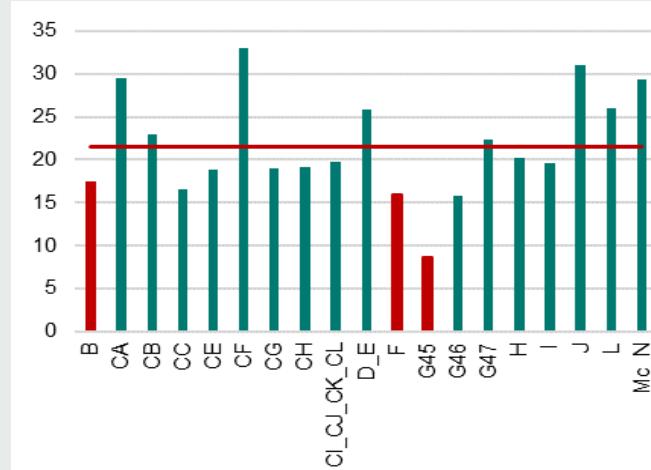
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Total
Total	0	0	0,01	0,015	0,02	0,18	0,76	1	1,5	6,19	0,36

**Table 3.** Evaluation of the risk of bankruptcy (% of the total number of enterprises) in 2015

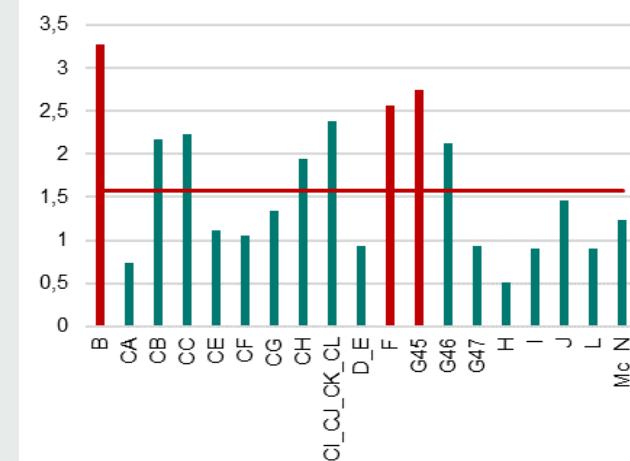
Sectors	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Total
<b>Total</b>	7,26	14,29	28,87	25,32	14,22	7,57	0,89	0,88	0,26	0,44	100
<b>B - Mining and quarrying</b>	6,91	10,55	24,73	24,73	17,82	11,27	0,73	1,82	0	1,45	100
<b>CA - Agri-food industries</b>	12,52	16,94	26,39	25,78	12,87	4,64	0,13	0,39	0	0,35	100
<b>CB - Textiles, clothing and footwear</b>	6,23	16,77	28,21	20,33	14,1	10,93	1,27	1,02	0,64	0,51	100
<b>CC - Wood, paper products and printing</b>	7,44	9,15	28,5	26,71	16,37	8,93	0,67	1,41	0,37	0,45	100
<b>CE - Chemicals industry</b>	8,99	9,89	30,79	24,04	18,2	5,84	1,12	0,9	0	0,22	100
<b>CF - Pharmaceuticals industry</b>	14,89	18,09	18,09	25,53	17,02	4,26	1,06	1,06	0	0	100
<b>CG - Manufacture of rubber and plastics</b>	8,62	10,41	27,49	23,69	17,85	9,69	0,92	0,82	0,21	0,31	100
<b>CH - Metallurgy and metalworking</b>	7,37	11,85	28,15	24,13	15,96	9,7	0,89	0,76	0,38	0,8	100
<b>CI,CJ,CK,CL - Metal manufactures</b>	8,38	11,39	29,06	22,68	17,72	7,38	1	1,38	0,19	0,81	100
<b>DE - Energy, water and waste</b>	9,45	16,38	29,68	27,52	12,07	3,73	0,23	0,76	0	0,17	100
<b>F - Construction</b>	5,16	10,77	23,04	25,3	19,45	12,34	1,38	1,45	0,51	0,6	100
<b>G45 - Motor vehicles trade</b>	2,98	5,73	23,23	31,32	18,92	12,87	2,2	1,41	0,78	0,55	100
<b>G46 - Wholesale trade</b>	6,12	9,66	29,9	26,37	16,44	8,23	1,15	1,26	0,4	0,47	100
<b>G47 - Retail trade</b>	6,71	15,71	36,61	24,08	9,71	5,28	0,96	0,46	0,17	0,3	100
<b>H - Transportation and storage</b>	9,02	11,24	32	29,82	10,34	6,42	0,66	0,43	0,04	0,04	100
<b>I - Accommodation and food service activities</b>	4,6	14,96	26,34	35,29	10,23	7,29	0,38	0,64	0	0,26	100
<b>J - Information and communication</b>	8,44	22,55	27,13	20	12,15	7,42	0,87	0,58	0,15	0,73	100
<b>L - Real estate activities</b>	4,16	21,8	29,16	28,68	12,42	2,77	0,11	0,59	0	0,32	100
<b>Mc,N - Professional, scientific, technical, administration and support service activities</b>	8,06	21,36	28,89	22,83	10,46	6,49	0,67	0,58	0,2	0,46	100

## PD model

**Figure 5.** Evaluation of the risk in the first two classes in which the PD does not exceed 0.01% (% of the total number of enterprises) in 2015



**Figure 6.** Evaluation of the risk in the last three classes in which the PD is equal to or higher than 1% (% of the total number of enterprises) in 2015



## Do financial constraints affect decisions making by prospective exporters?

<i>Variables</i>	<i>Export decision =</i>		<i>Export intensity =</i>	
	$\begin{cases} 1 & \text{if Export sales} > 0 \\ 0 & \text{otherwise} \end{cases}$		$\frac{\text{Export sales}}{\text{Sales}}$	
Export decision ( $t - 1$ )	0,699	(0,048)***		
Export intensity ( $t - 1$ )			0,639	(0,044) ***
<b>PD (Indicator built on the basis PD model)</b>	-0,177	(0,056)***	-0,184	(0,073) **
Size = $\ln(\text{Number of Employees})$	0,048	(0,006)***	0,040	(0,008)***
Productivity = $\ln((\text{Value Added})/\text{Employee})$	0,039	(0,006)***	0,028	(0,008)***
Wage per employee = $\ln(\frac{\text{Wage}}{\text{Employee}})$	-0,019	(0,014)	-0,023	(0,008)***
Time Dummies	156,01	[0,0000]		
Test Sargan	67,21	[0,6054]	93,63	[0,2214]
Test Arellano-Bond $m1(p)$	-4,58	[0,0000]	-4,08	[0,0000]
Test Arellano-Bond $m2(p)$	0,79	[0,4245]	0,23	[0,8138]
estimated by <i>System GMM</i>				

## Conclusions

- Based on the results of the evaluation of the risk associated with the financial condition of enterprises, it was found that ***small and medium – sized enterprises*** faced a higher risk (*the evaluation consisted of two parts: evaluation of the financial strength and prediction of bankruptcy*).
- In 2015, the highest percentage of ***small and medium – sized*** enterprises with negative net value of enterprises was observed in the service sector (*the accommodation and food service activities sector, the information and communication sector, and the business service sector*); in the case of ***large enterprises***, it was observed in the information and communication sector and in the mining sector.
- In 2015, the lowest risk of bankruptcy was observed in the *pharmaceutical industry* (especially in the case of large enterprises) and the highest risk of bankruptcy - in the *mining sector*.

## Conclusions

- Based on the literature review two stylised facts emerge:
  - exporters perform substantially better than their non-exporting competitors;
  - there are wide cross-country differences in enterprise export behaviour.
- Exporters were characterised by better financial equipment.
- Using a large panel data of Polish firms, there was evidence that financial constraints matter for export participation and sales in foreign markets.
  - This result corroborates the idea that the relevance of financial constraints was due to the presence of sunk entry costs.
  - Enterprises need to borrow to cover part of the variable costs related to production for export.

DZIĘKUJĘ BARDZO!