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## Do Specialised Banks Lend to Croatian Zombies?

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**CROATIAN NATIONAL BANK**

EUROSYSTEM

# Do Specialised Banks Lend to Croatian Zombies?

Bono Beriša\*

## Abstract

This paper examines the impact of the Croatian banks' sectoral specialisation on zombie lending. By using multiple zombie definitions, the determinants of the loan growth to private entities were examined on company and bank microdata. The banks with greater specialisation may consider the asymmetry of their portfolio and lend less to companies from the same sector. Also, when banks' specialisation increases, some zombies get less funded compared to healthy firms. It was found that banks lend more to smaller, more liquid, profitable, capitalised and younger companies. Additionally, bank-firm relationships and banks' share in the company's debt may further decrease loan supply, while some zombies may get additionally funded with longer relationships. The analysis also examined the event when zombie companies are seeking a new bank due to the departure of the previous creditor, where depending on the zombie definition, the bank's portfolio quality may deteriorate.

**Keywords:** Croatia, Banking sector, Zombie companies, Bank specialisation

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All remaining errors are the author's own. Any opinions and conclusions expressed herein are those of the author and do not necessarily represent the views of the Croatian National Bank.

# 1. Introduction

After the Global Financial Crisis of 2008, which caused a remarkable decline in global economic activity, bank lending was stimulated by the low-interest rate environment. Although the recovery of global economies has materialised, it has also enabled the emergence of market imperfections, which ensured the existence of zombie companies. A slow and inefficient system for settling insolvencies and a generous system of subsidies without strict controls helped weak companies to survive and remain on the market. However, the issue of zombie companies is also essential because of the corporate sector structure, and the impact of that structure on productivity growth in the economy.

Zombies, as a phenomenon and research topic, have been present in the literature for a long time (Kane, 1987). However, the largest number of studies on zombie behaviour was in Japan at the end of the 20th century, when the increase in these companies, mainly in the construction sector, delivered a strong blow to the Japanese economy. Preliminary evidence also suggests that exposure towards zombies increases moral hazard, which may lead to an additional crediting of zombies at the expense of healthy firms (Bruche and Llobet, 2014; Schepens et al., 2020; Obstfeld and Duval, 2018; Broz and Ridzak, 2017). As a result, banks try to cover up the company's non-performing loans by further funding them while postponing the recognition of losses. Such a credit spiral is an imperfect symbiosis, where banks continue to lend to insolvent companies solely to reduce their bankruptcy probability. On the other hand, zombies enjoy stable financing and have no motivation to change. Consequently, the flow of funds to healthy projects with higher growth potential slows down.

Given that zombie companies need support for their existence, their relationship with banks is particularly important. This is especially true in bank-centric systems where financial markets do not play an essential role in assessing the companies' quality. Although it is somewhat natural in banking, the asymmetry of customer information can lead to increased systemic risks, just as seen during the Global Financial Crisis (Beltran et al., 2017). In such systems, apart from the fact that banks play a more significant role in modelling the economy's structure, there is increasing pressure on bank supervision as it needs to ensure an objective assessment of the health of the banks' credit portfolio.

This paper uses Croatia as a research setting, a bank-based economy where other than equity, companies mostly finance their operations with bank loans. Therefore, by using a unique database with over 6000 corporates that received loans from 33 Croatian banks from 2011 to 2021, this paper also aims to define and quantify the relationship between zombies and banks. In this way, this paper explores whether banks' portfolio structure may favour lending to individual clients for idiosyncratic reasons. Also, the paper investigates the importance of several soft variables for bank lending, such as the length of the relationship and the bank's share in the company's debt, as well as in sector. Finally, the influence of specialisation on lending was observed through the hard variables of profitability, size, liquidity, and capitalisation of the company.

The study's results show weak evidence that banks specialising in a particular sector may reduce their exposure to companies in the same sector. Also, in some cases, when a

company is identified as a zombie, credit contracting is more pronounced, and in the case of higher specialisation, the effect of a decrease in credit is visible for some zombies. Those findings suggest that banks may identify unsustainable companies and thus contract their lending. Additionally, the length of the bank-firm relationship negatively impacts further loan supply, but some zombies obtain greater funding than their healthy counterparts. The companies are also contracted when banks become a more dominant creditor in company's debt, and the effect is even more expressed when the company is a zombie. Profitability, liquidity and capitalisation is found as an argument for further lending to corporates, while with greater specialisation, profitable companies do not obtain further crediting. Lastly, young and small companies receive greater loan supply, but with more significant banks' exposure to a particular sector, large and liquid companies enjoy more funding.

Zombie companies were also monitored after the departure of their parent bank from the market, which is important from the standpoint of financial stability. The analysis of four cases shows that the specialisation and the share of zombies may increase in those banks that took over those clients from the institution that left the market. Thus, a new zombie creditor faces a high marginal impact on portfolio quality. Tracking zombies by focusing on their takeover opens the way for further research, and some directions are highlighted in this paper.

There are three main contributions of this work. First, this work contributes to the zombie literature, as to the author's knowledge, the research on lending to Croatian zombies is scarce (Broz and Ridzak, 2017; Belullo et al., 2017). The second contribution can be seen in the literature on loan portfolio structure, which will also give insight into the Croatian banks' business models and credit portfolio structure. Lastly, this work will point out some channels for further research where the problem of zombie takeover may present a significant threat to financial stability.

The structure of this paper proceeds as follows. Section two will present the relevant literature on zombie companies and specialisation, together with the theoretical concepts of relationship banking, screening and monitoring. The third section will show the data used for this analysis, while the fourth will present the results and possible implications for financial stability. Finally, the fifth section will conclude and indicate channels for future research.

## **2. Literature review**

The term "zombie" was first introduced into the financial literature by Kane (1987) to describe companies with lower solvency but which enjoy financial support from banks or other institutions. Therefore, zombie companies in banks' loan portfolios are those whose general credit terms or lending are not justified by their operating results. Low-interest rates and a system of subsidies from the state additionally support their survival. Such an increase in the share of chronically weak or even marginally solvent companies represents a systemic risk with a significant potential adverse effect on the economy. Therefore, the most common channel for such developments is an increase in the riskiness of the bank portfolio through the share of non-performing loans (NPL) (Gandrud and Hallerberg, 2017).

The impact of bank specialisation on zombie firms, as well as its impact on financial stability, is generally still a relatively new area of research. Moreover, the extraordinary complexity of the relationship between companies and banks raises an additional question about the determinants that condition the company's survival. Therefore, this literature review will cover three aspects that can further explain zombie lending: 1) The concept of information asymmetry, 2) bank portfolio structure, and 3) the impact of portfolio zombification on financial stability.

## **2.1 The concepts of information asymmetry, relationship banking and delegated monitoring**

The relationship between the zombie company and the bank can be viewed through the principal-agent problem<sup>1</sup>, where the bank and the zombie have conflicting goals. Thus, on the one hand, the bank expects safe cash flows with returns, while zombies expect flexibility and secured access to additional lending. The information asymmetry which Akerlof (1970) describes through the market for "lemon" cars depicts the crowding out of good entities by bad ones due to their lower attractiveness. At the same time, Spence (1973) uses a signalling model on the labour market to show how subjects signal their qualities, while Leland and Pyle (1977) find comparable actions in companies, where they present their qualities to the market during the initial public offering, intending to attract capital. On the other hand, a wrong interpretation of the signal or not receiving it can cause adverse selection when lending to companies. As explained by Stiglitz and Weiss (1981), adverse selection causes credit rationing, so with the tightening of financing conditions, creditors crowd out creditworthy agents from the market and reduce their own profitability.

Suppose adverse selection occurs when principal consider refinancing the same agent. In that case, the question arises whether the banks should aim to find better quality agents or continue the relationship with the same entity. The answer to that question is provided by the relationship banking literature. For example, Boot (2000) describes relationship banking where the principal 1) invests in acquiring publicly unavailable information about agents and 2) evaluates them through their numerous interactions, while Berger (1999) adds that 3) information between subjects remains confidential. Diamond (1984) further shows the advantages of a single-bank relationship in which bank has access to information for evaluating clients<sup>2</sup>. However, due to the aforementioned facilitated access to information, two problems arise in the relationship banking: 1) *the hold-up problem* in which the bank can tighten the client's financing conditions, and 2) *the soft budget constraint problem* in which the bank does not establish more rigorous financing conditions when it is necessary (Boot, 2000).

Some of the literature states that the benefit of relationship banking is that it leads to less credit contraction in turmoil, so banks prefer lending to existing clients. For example,

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<sup>1</sup> The bank or lender is shown as the principal, while companies are shown as agents.

<sup>2</sup> Stein (2002) and Berger and Udell (2002) refer to them as soft information.

Bodenhorn (2003) shows an increase in refinanced loans in the USA during the collapse of the "Ohio Life and Trust Company". The author emphasises that the loan refinancing resulted from a long-term collection of information by the creditor, who used it to evaluate the client and its creditworthiness. Furthermore, Fok et al. (2004) and Jiangli et al. (2008) examined the impact of the Asian crisis on a panel of countries from the same continent. The authors have pointed out that firms with single bank relationships in South Korea and Thailand had a higher probability of obtaining new loans than firms with multiple bank relationships. In this way, the effect of the exclusivity of the relationship between an individual bank and a company provided an additional argument for future lending. Alexandre et al. (2010) showed benefits of relationship banking in the North American and European syndicated loans market, where borrower's interaction with lead bank contributed to lower interest spreads compared to the short-term reference rate. The mentioned works, together with Bongini et al. (2015), Beck et al. (2018) and Bolton et al. (2016), indicate the benefits of relationship banking in financial crises, where the hold-up problem does not materialise. Hence, the relationship banking during turmoil can be interpreted as the bank's soft budget constraint due to the understanding of the temporary company's unsustainability as a short-term condition.

Giving a second chance to companies by increasing the supply of loans in bad times can also be found in the concepts of screening and monitoring. Diamond (1984) explains delegated monitoring as a process where creditors, reduce their screening and monitoring costs by outsourcing the clients' creditworthiness evaluation to an intermediary. In other words, comparing the principle above with the banking system's functioning, depositors delegate their monitoring of the borrower to the bank, which performs the monitoring process as a diversified intermediary at the source of information. However, the link between delegated monitoring and relationship banking in the presence of information asymmetry can lead to an irrational length of the relationship. Primarily, this refers to zombie companies whose business results support the introduction of the hold-up problem. The motive for continuing zombie lending can have different dimensions: from the composition of the bank's loan portfolio to further general lending due to cheaper loans.

## **2.2 Structure of the bank loan portfolio**

"Do not put all your eggs in one basket"<sup>3</sup> is an idiom that is promoted as one of the elementary concepts for understanding portfolio diversification. The idiom is also the primary motivation of the financial intermediation literature, which directed further research on asset diversification (Winton, 1999). For example, Markowitz's (1952) modern portfolio theory and other research, such as Evans and Archer (1968) and Woerheide and Persson (1993), show the benefits of diversification in terms of lower price correlation between portfolio factors. Furthermore, by using the efficient frontier, the portfolio can be optimised concerning the trade-off between risk and return. On the contrary, the corporate finance

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<sup>3</sup> As a source of the idiom, Winton (1999) and other authors refer to: "it is the part of wise men to preserve themselves today for tomorrow, and not risk all in one day" from the book *Don Quixote* by Miguel de Cervantes (pp. 358).

literature contributed by Berger and Ofek (1995), Jensen (1986), and Beck et al. (2021) explains the benefits that bank specialisation brings (Winton, 1999).

As already presented by Diamond's (1984) and Boot's (2000) research, the principal simultaneously retrieves information when directing financial resources from financially surplus to financially deficient entities. In that spirit, Ramakrishnan and Thakor (1984) show that the diversified financial intermediary reduces the cost of information production. Boyd and Prescott (1986) add that diversified financial intermediaries have greater flexibility in issuing receivables with different payment frequencies. On the other hand, some authors also presented the effects of credit portfolio specialisation on bank risks. For instance, Jahn et al. (2016) show that specialised banks have lower shares of non-performing loans in specialised sectors and can establish stricter lending conditions. Beck et al. (2021) further indicate the positive impact of banking specialisation on reducing idiosyncratic and systemic risk. By studying the diversification of Brazilian banks, Tabak et al. (2011) examined the effect of bank specialisation on their riskiness and returns. The same authors conclude that more specialised banks, despite having efficient monitoring, also have higher profitability. Thus, sectoral specialised banks can achieve greater benefits compared to diversified banks. Credit entities may concentrate the development of their services on specialised activities, which could increase the probability of achieving relationship banking (Blickle et al., 2021).

After the Asian and the Global Financial Crisis (GFC), banking regulations aimed to reduce excessive sectoral exposures and systemic risks (EBA, 2019; BCBS, 2014). Most studies that dealt with the impact of bank specialisation in a state of shock observed significant differences in results. For instance, Bebczuk and Galindo (2008) show that sector diversification positively impacted Argentine banks' profitability, while Tabak et al. (2011) show that Brazilian banks in a state of financial shock became more specialised and have reduced their credit exposure in the affected sectors. Regarding banking relationships with businesses, De Jonghe et al. (2020) indicate that in a state of turmoil, banks additionally lend to companies in sectors least affected by the shock. Despite the credit contraction of major US banks, DeYoung et al. (2015) show that some smaller banks increased their specialisation specifically towards small and medium-sized enterprises during the GFC. Also, the same was shown by Liberti and Sturgess (2018), who state that stronger credit relations, a higher non-interest income of banks and a higher pledge of collateral affect the reduction of credit contraction. Relationship banking can therefore be the reason for greater specialisation in a particular activity, making corporate lending less sensitive to financial shocks.

### **2.3 The impact of zombie lending on sector productivity and financial stability**

Japan's economic stagnation at the end of the 20th century prompted further research into the topic of zombies and their survival. For example, Hoshi (2000) and Caballero et al. (2008) indicated the former through the assumption of continued lending to insolvent companies in order to reduce the probability of bank write-offs of capital. The same was

confirmed by Brucha and Llobet (2014), who emphasise that despite the existence of relationship banking in the system and greater availability of information, banks additionally increase the supply of "bad" loans to reduce considerable losses. This type of lending is often referred to as portfolio evergreening, where the bank increases exposure to an existing client to increase the probability of debt collection (Albertazzi and Marchetti, 2010).

The preliminary assessment Croatian zombie lending indicated that lower capitalised banks did evergreen their portfolio after the GFC, where the effect was the most pronounced when the bank had a greater share in the company's debt (Broz and Ridzak, 2017). Additionally, Belullo et al. (2017) show that Croatian zombies did not get more productive with greater bank financing. Increasing the share of zombie companies in the economy, according to Schmidt et al. (2019), worsens the sector's competitiveness and imposes a type of taxation for healthy companies through decreased lending (Caballero et al., 2008). The effect is visible in the reduction of innovations in the industry and in the attraction of credit institutions with lower capital (Giannetti and Simonov, 2013). Regarding the number of zombie companies in the mentioned circumstances, McGowan et al. (2017) state that they successfully survive difficult conditions at the cost of lower sector productivity and growth rates. It was similarly shown by Schivardi et al. (2021) who by studying the Italian banking sector, observe a higher tendency of undercapitalised banks to lend to infected companies, while Acharya et al. (2019) further describe how entities increase their idiosyncratic risks by conduction of such actions. The result of the exposures, as mentioned above, is visible in the increase of the non-performing loan share (Acharya et al., 2021). However, regarding the impact of regulators on zombie maintenance, some research shows that banks reduce their exposure to zombies during inspections; for example, Bonfim et al. (2021) find the above in Portugal. Also, the same authors state that the contraction of lending was reflected in the bankruptcy of companies. Furthermore, Passalacqua et al. (2020) report that Italian banks recognised more NPLs after succumbing to unexpected supervisory inspections, forcing them to change portfolio construction and increase lending to viable companies.

Although the pandemic shock was conducive for tracking and identifying zombie companies, only a small part of the academic literature has managed to explore the shock's impact on zombification. Thus, Schepens et al. (2020) claimed at the beginning of the pandemic that state aid during a longer-lasting shock could increase the probability of zombification. However, current findings do not provide uniform conclusions. Pelosi et al. (2021) show that zombies had a lower probability of receiving Italian public subsidies, while Hoshi et al. (2022) and Ito et al. (2022) state the opposite. The authors mentioned that Japanese support, especially in the sectors affected by the pandemic, was crucial for the zombification of the economy. In addition to the already mentioned pandemic shock, periods accompanied by high energy and input prices could present a substantial challenge for zombies and, open up new research questions about unsustainable companies.

The second chapter of this paper presented the relevant theoretical concepts of zombie companies, screening, monitoring and relationship banking. The same concepts will be key in interpreting the results of this analysis. Table 1 provides the summary of the influential works from this chapter.



**Table 1:** Summary results of selected research

<b>Author/s</b>	<b>Research question</b>	<b>Results</b>
<i>Leland and Pyle (1977)</i>	Signalling characteristics	During the initial public offering, companies signal their characteristics to the market. Bad interpretation of the signal or not receiving it can cause adverse selection.
<i>Stiglitz and Weiss (1981)</i>	The impact of adverse selection on creditors	Adverse selection leads to credit rationing, where creditors increase lending to bad clients, which reduces the bank's profitability.
<i>Diamond (1984); Stein (2002); Berger and Udell (2002)</i>	Positive impact of single bank borrowing	During the company's relationship with one bank, credit institutions have access to confidential (soft) information through which they can more easily evaluate the client.
<i>Berger (1999); Boot (2000)</i>	The benefits of relationship banking	The principal in the relationship banking: 1) invests in obtaining information about its agents not available to the public, 2) evaluates the same through numerous interactions with agents over time and products, and 3) information between entities remains confidential.
<i>Winton (1999)</i>	Diversification and specialisation impact on loan supply	Diversification of banks has positive effects when the bank portfolio is moderately risky. On the other hand, with the increase in risk, diversified banks have a smaller added value of monitoring, so significant positive effects of it are not visible.
<i>Hoshi (2000)</i>	Continuous bank lending to unsustainable Japanese companies in the 1990s	The first study to examine the importance of zombie lending. Banks in Japan lent to unprofitable companies in the real estate sector so they could pay off outstanding loans.
<i>Caballero et al. (2008)</i>	The emergence of the zombification process in Japan from the banks' perspective	Banks in Japan in the 90s had lower capital adequacy, which ultimately motivated them to lend to insolvent companies at the expense of healthy ones.
<i>Alexandre et al. (2010)</i>	The impact of relationship banking in syndicated loan market during the financial crisis	Companies that developed a relationship with the investment bank had lower interest rates, but with larger loans or those with a longer maturity, no significant positive effects of this relationship are visible.
<i>Jahn et al. (2016)</i>	The impact of banking specialisation and diversification on NPLs	Specialised banks have lower loan loss rates and their standard deviation of NPL rates is lower than diversified banks.
<i>McGowan et al. (2017)</i>	Evaluation of productivity in enterprises in OECD countries with an emphasis on zombies	The more pervasive survival of zombie companies reduces the growth potential of healthy companies.
<i>Broz and Ridzak (2017)</i>	Zombie lending during the GFC	Lower-capitalised banks did evergreen their portfolios and rolled over the loans to firms after the turmoil
<i>Bonfim et al. (2021)</i>	The impact of inspections on zombie bank lending	With banks that have been supervised, the probability of further lending to zombies is 20% lower.
<i>Beck et al. (2021)</i>	The impact of banking sector specialisation, differentiation and exposure to the financial system on idiosyncratic and systemic risk	Banking sector specialisation leads to a negative relationship with both types of risk. Differentiation achieves a positive relationship with idiosyncratic risk, while financial exposure achieves the same with systemic risk.
<i>De Jonghe et al. (2021)</i>	Specialisation and loan supply to zombie companies	Bank specialisation in a particular industry has a negative impact on the supply of loans to zombies.

Source: author's creation

### 3. Methodology and data

Given the complexity of empirical research, the paper uses multiple sources of data as well as the methodology appropriate to the specific research question. By combining two sources, the financial agency's (FINA) database and the supervisory reports of the CNB, a unique set of data was created that describes the relationship between banks and companies and enables the retrieval of microdata from both sides of the credit relationship. Also, in order to assess the impact of lending to zombie firms, this paper relies on the modified methodology of De Jonghe et al. (2021).

#### 3.1 Methodology for assessing the impact of specialisation on the loan supply

The methodology of this work follows the approach of De Jonghe et al. (2021), who studied bank specialisation and the interaction of specialisation and zombies by controlling for soft and hard information. At the same time, soft information are available only to the bank through interactions with the clients, while hard information consists of data from companies' financial statements. However, differently from De Jonghe et al. (2021), whose analysis focused on the lending to those companies that have a relationship with multiple banks, this research additionally included companies that have a relationship with one bank, of which there are over 85% in Croatia. Hence, the equation (1) used standard errors clustered on the bank-sector level, while when concerning the fixed effects, it accounted for loan supply by using Bank  $\times$  Time fixed effects, and Sector  $\times$  Location  $\times$  Size  $\times$  Time fixed effects to account for the loan demand (Degryse et al., 2019)<sup>4</sup>.

$$\begin{aligned}
 Y_{i,b,t} = & \alpha + \beta_1 \text{Specialisation}_{b,s,t-1} + \beta_2 (\text{Specialisation}_{b,s,t-1} \times \text{Zombie}_{i,t}) + \beta_3 \text{Zombie}_{i,t} \\
 & + \sum_{j=1}^3 \beta_4^j \text{Soft information}_{j,t-1} + \sum_{\gamma=1}^3 \beta_5^\gamma \left( \text{Zombie}_{i,t} \times \sum_{j=1}^3 \text{Soft information}_{j,t-1} \right) \\
 & + \sum_{k=1}^5 \beta_6^k \text{Hard information}_{k,t-1} \\
 & + \sum_{\rho=1}^5 \beta_7^\rho \left( \text{Specialisation}_{b,s,t-1} \times \sum_{k=1}^5 \text{Hard information}_{k,t-1} \right) + v_{slat} + \mu_{bt} + \varepsilon_{i,b,t}
 \end{aligned} \tag{1}$$

The same equation will estimate two models. In the first model the dependent variable  $Y_{i,b,t}$  will be  $\frac{\Delta \text{Loans}_{i,b,t}}{\text{Total Assets}_{i,t}}$ , while in the second  $\Delta \ln(\text{Loans})_{i,b,t}$ . The expression,  $\sum \beta \text{Soft information}_{j,t-1}$  represents information between the company and the bank that are not available in the financial reports of business entities. Through the same types of information, this analysis shows the significance of the interaction between the bank and the company on additional loan supply. On the other hand,  $\sum \beta \text{Hard information}_{k,t-1}$  shows a set of variables that make up the

<sup>4</sup> Sector refers to the two-digit NACE code, Size refers to decile of the asset when assessing all firms in the sample, and location is represented by the first two digit of business entity's postal code. The description of identities used are the following:  $b$  - bank,  $i$  - firm,  $l$ -location,  $s$  - industry/sector,  $t$  - time ,  $d$ - Size

components of the financial statements of an individual company. Through those variables, the importance of an individual company's capitalisation, size, age, liquidity and its profitability on loan growth will be indicated. Sector-Location-Size-Time and Bank-Time fixed effects are included through  $v_{slat}$  and  $\mu_{bt}$ , while the model error is denoted by  $\varepsilon_{i,b,t}$ . A detailed description of the variables used in this analysis can be found in Table 2, while their calculation is shown in Appendix A1.

**Table 2:** Used variables

<i>Dependent variables</i> $(Y_{i,b,t})$	<i>Variables of interest</i>	<i>Soft information</i>	<i>Hard information</i>
$\frac{\Delta Loans_{i,b,t}}{Total\ assets_{i,t}}$	$Specialisation_{b,s,t-1}$	$ln(Relationship)_{i,b,t-1}$	$ln(Total\ Asset)_{i,t-1}$
$\Delta ln(Loans)_{i,b,t}$	$Specialisation_{b,s,t-1} \times Zombie_{i,t}$	$Bank\ share\ in\ company_{i,b,t-1}$	$Equity\ to\ assets_{i,t-1}$
	$Zombie_{i,t}$	$Bank\ share\ in\ sector_{b,s,t-1}$	$EBITDA\ to\ assets_{i,t-1}$
			$Current\ ratio_{i,t-1}$
			$Age_{i,t-1}$

Note: the table above shows the variables used in this analysis.  $Y_{i,b,t}$  denotes the dependent variables used in the analysis: the change of total loans to assets and the change of total loans. The second column shows the variables of interest: specialisation, zombie and the interaction of the zombie variable and specialisation whose interpretation will be relevant. Soft information consists of variables available to an individual bank, while hard information includes those available to market participants. Calculation and interpretation of variables is available in Appendix A1.

Source: created by the author

## 3.2 Data

Given that individual data on companies' results and data on lending by individual banks are vital for this research, two primary data sources were used: the FINA database which collects the financial positions of the companies at the end of each year, and yearly supervisory data of the Croatian National Bank which comprise of banks' gross loans to particular entities. Financial as well as insurance companies and those that did not have a loan from a bank in Croatia were not included in the analysis, whereby the development banks are also omitted. To mitigate the influence of relatively small companies, it was decided only to include companies whose assets were greater than 10 000 EUR. By using the above filter, most companies with unusually extreme values were eliminated. Ultimately, the sample for assessing the equation 1) will cover over 6,000 entities financed by 33 Croatian banks from 2011 to 2021, while for the determining the zombie transmission within the four banks no filters will be applied.

Table 3 shows the summary statistics of the main variables in the research. The first two variables, the change in total loans in company's assets and the difference in the natural logarithm of total loans, are dependent and since they have a negative average value, it can be indicated that bank loans were not the main driver of company growth in the observed period of 11 years. Furthermore, the specialisation variable, which represents the share of loans to a particular two-digit NACE sector to the total loan portfolio, has an average value of 0.04, while the bank, when competing with other institutions, has an average share in the sector of 13%.

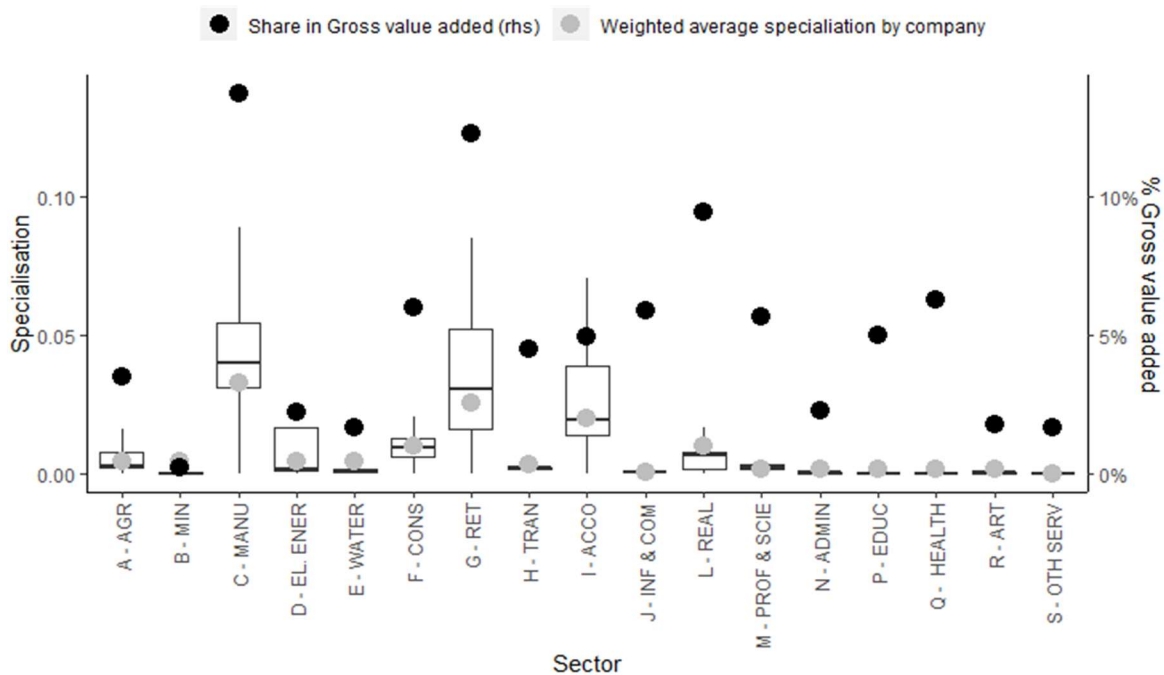
**Table 3:** Descriptive statistics

<b>Variable</b>	<b>N</b>	<b>mean</b>	<b>p1</b>	<b>p25</b>	<b>p50</b>	<b>p75</b>	<b>p99</b>
<i><math>\Delta \ln(\text{Loan})</math></i>	37,301	-0.20	-2.83	-0.49	-0.16	0.01	2.78
<i><math>\frac{\Delta \text{Loan}}{\text{Total Asset}}</math></i>	40,854	-0.03	-0.40	-0.05	-0.01	0.00	0.28
<i>Specialisation</i>	40,572	0.04	0.00	0.00	0.02	0.07	0.20
<i><math>\ln(\text{Relationship})</math></i>	40,854	1.26	0.69	0.69	1.10	1.61	2.40
<i>Bank share in company</i>	38,959	0.90	0.00	1.00	1.00	1.00	1.00
<i>Bank share in the sector</i>	40,854	0.13	0.00	0.05	0.10	0.18	0.51
<i>EBITDA to asset</i>	40,854	0.01	-0.06	0.00	0.01	0.02	0.08
<i>Equity to asset</i>	40,854	0.01	-2.74	0.06	0.27	0.52	0.93
<i>Current ratio</i>	40,819	17.63	0.02	0.71	1.24	2.21	20.98
<i>Age</i>	40,854	14.46	1	7	14	21	36
<i><math>\ln(\text{Total Asset})</math></i>	40,718	14.60	11.28	13.28	14.41	15.70	19.71

The variable  $\ln(\text{Relationship})$ , which measures the natural logarithm of the duration of the relationship in years in the specified period, has an average value of 1.26, and the 99th percentile lies at 2.40. In other words, on average, companies were tied to banks for more than three years, while in extreme cases, some companies were tied throughout all years of analysis. Also, the average value of the variable bank share in company indicates that Croatian corporates mostly rely on single bank relationship. The variables  $\ln(\text{Total assets})$ , Equity-to-assets ratio, EBITDA-to-assets ratio (ROA), as well as the current liquidity ratio represent hard information about companies that are available in their financial statements. The average operating profitability in assets is 1%, while current assets are, on average, more than seventeen times as high as current liabilities. The average capitalisation of the company amounted to 1%, while the average of the natural logarithm of total assets contains a value of 14.6, that is, the average assets of the company amount to 291 thousand EUR. The variable age shows the approximation of the company's age, accounting for the actual company age or the number of repetitions in the FINA sample since 2002. The same variable indicates that the average company is older than 14 years, while the age range was from 1 to 45 years.

Since the behaviour of the specialisation variable is of great significance for this analysis, it is important to indicate how banks' exposure compares with the drivers of the Croatian economy. Figure 1 shows the distribution of the specialisation variable and gross value added by NACE activity in 2021. From the figure, it is evident that banks' focus is significantly expressed in the accommodation, retail and manufacturing sectors. The same was confirmed when controlling the specialisation variable with the significance of the company in the industry. However, bank specialisation is not directly related to the overall importance of the industry in terms of GVA. Namely, when controlling for total loans in the industry as well as for loans in the entire banking system, it is evident that banks are highly specialised in the sector of offering accommodation compared to real estate. The same sector has a five p.p. lower share in GVA. Similar is evident in the energy sector compared to agriculture and transport. The above shows that the significance of sectors in the GVA do not necessarily represent importance for banks. Apart from the fact that individual banks do not lend to certain sectors, some sectors do not establish a great demand for bank financing.

**Figure 1:** Specialisation by NACE activities and share of the same in GVA in 2021



Source: author's calculation based on data from Fina, Croatian Bureau of Statistics (CBS) and CNB

Note: the above graph shows the distribution of the measure of specialisation of companies calculated by banks' loan share in 17 NACE activities and the share in GVA in 2021. The bank sectoral specialisation variable is squared to minimise the extreme values and collapsed to the firm level by using the weights on banks' share in company's loans. The average weighted specialisation by the company represents an additional weighted variable within an individual activity that accounts for the significance of an individual company through its share in total loans to that activity. Definitions of NACE abbreviations are available in Appendix A2

Identifying zombies is of great importance since it can affect the main results of the research questions. For example, De Jonghe et al. (2021), Storz (2017), Kane (1987) and McGowan et al. (2017) for zombie identification direct their focus towards the entity's ability to service the debt. Identifications defined in this way are of vital importance since they directly reflect in the credit risk of particular bank. Also, some other definitions such as

Bonfim et al. (2021) focus on capital management, while Acharya et al. (2020) identify zombies through their leverage intensity. Since this analysis will be focusing on bank lending, it was particularly important to include the definitions encompassing the debt servicing criteria. Therefore, for assessing equation (1), this paper will consist of the zombie company identifications proposed by Storz et al. (2017), De Jonghe et al. (2021), McGowan et al. (2017), Kane (1987), but also Bonfim et al. (2021) which have evaluated the impact on bank inspection to further zombie lending. In a technical sense, all the variables are binary and are used in the same models in order to make a conclusion about the robustness of the coefficients. The criteria for identification is made available in Table 4.

**Table 4:** The criteria for identification of zombie companies

		Zombie company identification				
		Storz <i>et al.</i> (2017)	De Jonghe <i>et al.</i> (2021)	OECD/ McGowan <i>et al.</i> (2017)	Kane (1987)	Bonfim <i>et al.</i> (2021)
Company characteristic	Negative profitability (Net income to asset) for two consecutive years		Company is at least 10 years old	Company is at least 10 years old	Unable to cover the imputed 5% interest expense for three years in a row	Negative equity in the previous period
	Reduction of fixed tangible assets for two consecutive years		The three-year sum of interest expenses is greater than the three-year sum of EBITDA	EBIT < Interest expense for three consecutive years	-	-
	Unable to cover the imputed 5% interest expense for two consecutive years		EBITDA < Interest expense for at least 2 out of 3 years	-	-	-

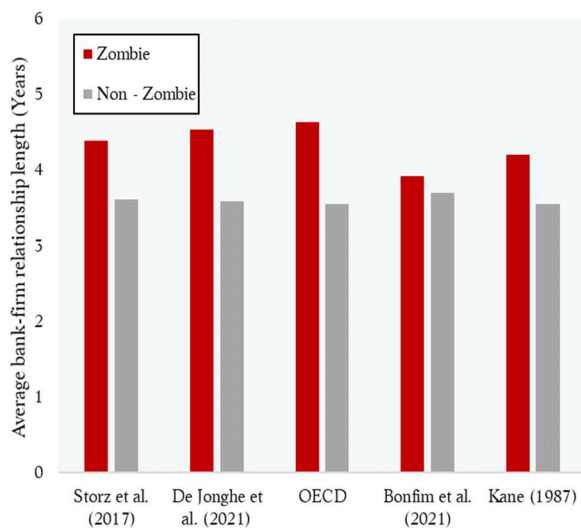
Source: Author's compilation based on the cited literature

Zombie characteristic, according to some authors (De Jonghe et al., 2021; McGowan et al., 2017) is that they are a mature company which is present in the market for a long time. Therefore, it is not surprising that, throughout their life cycle, they have established a long relationship with a particular credit institution. This is visible in Figure 2 which shows that zombies have a longer relationship with their banks regardless of the definition used. Longer relationship, although it may benefit a company through the exclusivity of the bank-firm relationship, may also give banks valuable information about business entities and the sector in general. Hence, that information is vital for this analysis since banks' lending to a particular company may be determined by the understanding the corporate dynamics of a particular sector, which banks mainly gain through increasing sectoral exposure.

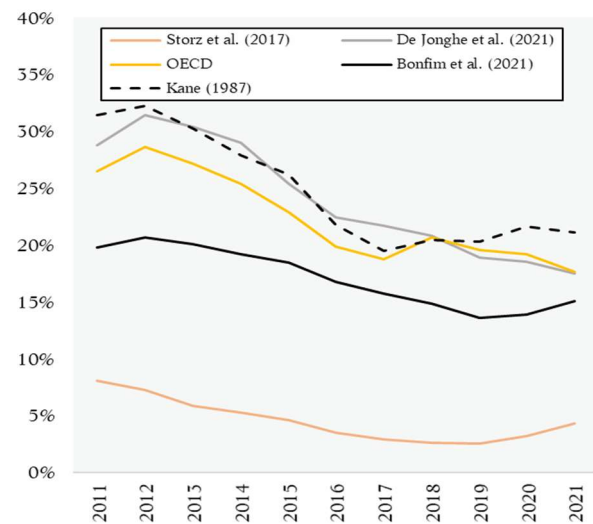
Although all zombies are, on average, more connected with the banks than healthy companies, they do not only differ in their definition but also in their company, sector and asset coverage. For example, Figure 3 shows that all definitions followed the same decreasing trend from 2011, which could be the result of better operating profitability in these years,

further incentivising investments. Interestingly, there has to be emphasised that for this sample, the number of criteria used for zombie identification may not determine the share of zombie companies in the economy. For instance, the strict criteria of Storz et al.'s (2017) definition of zombie companies have resulted in the lowest zombie coverage among all other identification. On the other hand, zombie definition provided by De Jonghe et al. (2021), shows a different coverage compared to what the same authors observed in their analysis. Although their definition should present stricter criteria than McGowan et al. (2017)<sup>5</sup>, in the Croatian economy it comoves with the same definition. The reason may be that the second criterion by De Jonghe et al. (2021) covered substantial number of insolvent corporates, in which the third criterion further amplified their number.

**Figure 2:** Years of zombie relationships with the banks



**Figure 3:** The share of bank funded zombies in the Croatian economy



Source: author's calculation based on data from FINA and CNB

Source: author's calculation based on data from FINA and CNB

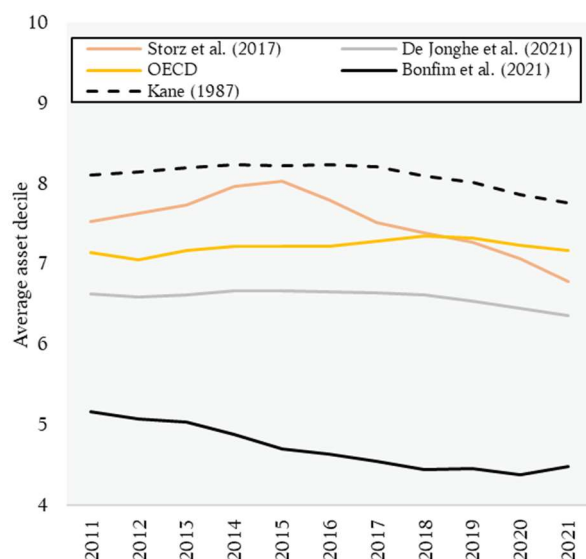
Note: The graphs above include all companies, regardless of the filters used, which have obtained a loan in the period 2010-2021.

However, Figure 4 shows that some zombie definitions, such as Kane (1987) and OECD, covered much larger companies as zombies, whereas Bonfim et al. (2021) primarily included smaller companies. Hence, it is visible that on average smaller companies have greater liabilities than assets, while large companies mostly had challenges with debt servicing.

Although this observation is determined by the criteria used for the identification, the answer to why this may be observed is shown in Figure 5. It is visible that zombie definitions which have covered larger companies, mainly cover the input-intensive sectors. For instance, OECD's and Kane's (1987) coverage mainly was based on the energy and manufacturing sectors, whereas Bonfim et al. (2021) covered the named industries significantly less. Based on shown insights, equation (1) results will be discussed regarding the specific components of each zombie methodology.

<sup>5</sup> For simplicity, the definition given by McGowan et al. (2017) will be referred as OECD

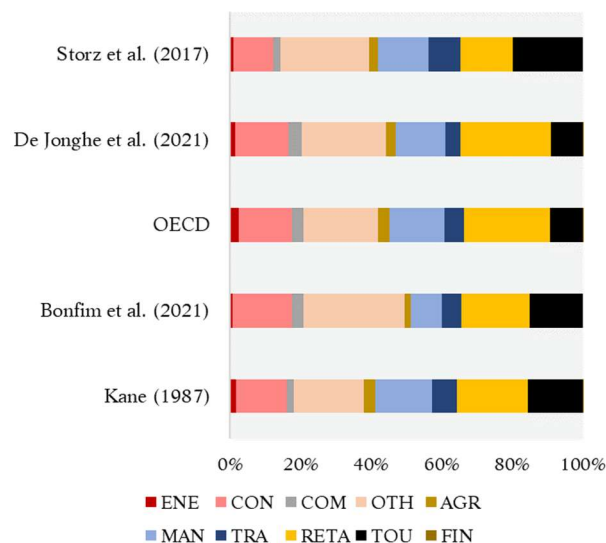
**Figure 4:** The coverage of asset size by zombie definition



Source: author's calculation based on data from FINA and CNB

Note: The sample consists of all companies that have reported an interest expense. The right graph covers the companies operating in 2021.

**Figure 5:** The coverage of sectors by zombie definition



Source: author's calculation based on data from FINA and CNB

## 4. Results

The main results show a weak significance that the greater bank sectoral specialisation leads to a decrease in the lending intensity to clients from that industry, while the negative effect is also present when lending to some zombie companies. Significant effects on lending in the presence of soft and hard information were also observed. It is also presented that banks which take on clients from institutions that left the market become more exposed to some zombies, which may pose a threat to financial stability in terms of credit risk and loan portfolio quality.

### 4.1 Specialisation of banks and lending to companies of different quality in normal business

Tables 5 and 6 present the impact of banks' specialisation and further lending to zombies. When observing different zombie definitions with the dependent variable  $\frac{\Delta Loans_{i,b,t}}{Total\ assets_{i,t}}$ , there is no evidence that banks with greater specialisation in a particular sector differently finance the companies from that sector, while with the dependent variable  $\Delta \ln(Loans)_{i,b,t}$  and zombie definition of De Jonghe et al. (2021), there is a piece of weak evidence that specialisation decreases lending to firms in the sector. When considering the interaction between specialisation and zombies, in Table 5 for zombie firms defined by Bonfim (2021) and Kane (1987) it is visible that banks do decrease their further lending. This result is in line with De Jonghe et al. (2021), which could describe that credit institutions, with greater exposure in some sectors, obtain more information and thus can distinguish between healthy and zombie companies. The Table 6 further presents strong evidence that banks decrease zombie lending when using identification from Kane (1987). On the other



hand, in Table 5, there is weak evidence that some zombies, as defined by Bonfim et al. (2021), may be funded to a greater extent than healthy companies. The reason for that may be that zombies defined by negative equity are relatively small in size, and the impact of an additional loan on their asset could be more pronounced than in other definitions.

More significant determinants of company lending are seen in soft information, which describes the information available in the bank-firm interaction. For instance, it is visible that banks will contract their lending to companies when the length of bank-firm relationship increases and when the bank has a greater share in the company's debt. One of the reasons is that young companies, while using secondary funding sources, substantially increase debt and create a base effect in the future periods when they pay off their loan. Also, if the company is doing well and growing over time, other financing options open up, such as foreign debt, using organic growth, or issuing bonds. But on the other hand, if the company is not doing well, the reason may be bank rejection.

When concerning majority of zombies, it is noticeable that they are being further contracted for additional credit when the banks increase their share in companies' debt, while zombies in Table 6 defined by Kane (1987) get funded. In that way, when a bank's exposure towards insolvent clients increases, creditors become more tied up towards them and impose the *hold-up*. Table 6 also shows that zombies defined by Kane (1987) and De Jonghe et al. (2021) may achieve a greater additional credit with a longer relationship than non-zombies. Therefore, when funding some zombies, a longer relationship, may reflect greater credit risk in banks' balance sheets. In Table 5 it is visible that greater banks' presence in sector can positively impact companies' funding, while there is conflicting evidence that greater bank presence may positively impact on lending to zombies defined by Bonfim (2021), and contract the lending to the OECD zombies.

Hard information indicate that banks will mainly finance smaller companies, while when considering different zombie definitions, there is some evidence that more profitable, capitalised, younger and liquid companies will achieve greater credit. Some of named hard information may signal to credit institution a company's safety and greater probability of loan repayment. For instance, the capitalisation variable indirectly shows the long-term profitability of the business entity, so the above can be interpreted as how losers, including some zombies, are contracted for an additional unit of credit.

Furthermore, growing and liquid firms achieve greater credit levels when banks specialise in their sector, which may serve as an essential bank indicator of a company's potential to grow and safety. On the other hand, a high-level ROA and the greater bank specialisation in the sector harm further lending, while no uniform effect is seen with firm's capitalisation. This may suggest that profitable companies may rely on their internal funding channels and, therefore, not apply for loans.

The size of the coefficients of the variables of interest provides a clear message that banks, in case of specialisation in a particular sector, may reduce their exposure to a particular business subject and could additionally contract lending to some zombies. The mentioned mechanism thus has a favourable effect on financial stability.

**Table 5:** Equation estimation results for zombie firms with dependent variable change in loans to asset

	(1) $\Delta$ Loans Assets	(2) $\Delta$ Loans Assets	(3) $\Delta$ Loans Assets	(4) $\Delta$ Loans Assets	(5) $\Delta$ Loans Assets
	Storz et al. (2017)	De Jonghe et al. (2021)	OECD	Bonfim et al. (2021)	Kane (1987)
Specialisation	-0.00622 (0.0191)	0.0247 (0.0418)	0.0241 (0.0413)	0.0248 (0.0399)	-8.97e-05 (0.0163)
Zombie × Specialisation	0.00270 (0.00523)	0.00193 (0.00343)	0.00170 (0.00328)	-0.0494*** (0.0140)	-0.00636* (0.00339)
Zombie	0.0279 (0.0294)	0.0544 (0.0361)	0.0359 (0.0371)	0.0803* (0.0426)	0.00574 (0.00893)
ln(Relationship)	-0.0114** (0.00447)	-0.00540 (0.00492)	-0.00970 (0.00685)	-0.00793* (0.00414)	-0.00564** (0.00262)
Zombie × ln(Relationship)	-0.00753 (0.0148)	-0.0312 (0.0215)	-0.0157 (0.0219)	-0.0872*** (0.0328)	-0.00622 (0.00487)
Bank share in company	-0.0365*** (0.00407)	-0.0356*** (0.00426)	-0.0391*** (0.00407)	-0.0335*** (0.00456)	-0.0327*** (0.00385)
Zombie × Bank share in company	-0.00841 (0.0131)	-0.0175** (0.00883)	-0.00845 (0.00877)	-0.0426*** (0.0163)	-0.00126 (0.0263)
Bank share in sector	0.0114 (0.0126)	0.0598* (0.0315)	0.0692** (0.0322)	0.0158 (0.0230)	0.0230 (0.0159)
Zombie × Bank share in sector	-0.110 (0.0829)	-0.0598 (0.0581)	-0.0973* (0.0555)	0.109* (0.0587)	-0.00142 (0.0263)
ROA × Specialisation	-0.184** (0.0782)	-0.226** (0.106)	-0.224** (0.110)	0.232 (0.161)	-0.216** (0.0856)
Equity to assets × Specialisation	0.0156** (0.00678)	0.0273 (0.0174)	0.0278 (0.0180)	-0.0810*** (0.0153)	0.00443 (0.00535)
Current ratio × Specialisation	1.05e-05** (4.39e-06)	-5.02e-06 (6.72e-06)	-5.10e-06 (6.86e-06)	1.12e-05** (4.51e-06)	-1.52e-07 (7.32e-06)
Age × Specialisation	-0.000252 (0.000180)	-0.000257 (0.000293)	-0.000263 (0.000290)	0.000344* (0.000190)	-0.000138 (0.000142)
ln(Assets) × Specialisation	0.000540 (0.00124)	-0.00129 (0.00242)	-0.00124 (0.00239)	-9.81e-05 (0.00251)	0.000378 (0.00108)
ROA	-0.0276 (0.0707)	0.120 (0.117)	0.144 (0.119)	0.543*** (0.176)	0.0467 (0.0967)
Equity to assets	0.0264*** (0.00569)	0.0276 (0.0232)	0.0279 (0.0234)	-0.0327*** (0.00704)	0.0242*** (0.00450)
Current ratio	8.93e-06** (3.84e-06)	-4.56e-06 (5.87e-06)	-4.63e-06 (6.00e-06)	9.47e-06** (3.96e-06)	-3.76e-07 (6.39e-06)
Age	-0.000132 (0.000164)	0.000381 (0.000331)	0.000337 (0.000302)	0.000498** (0.000239)	-1.21e-05 (0.000138)
ln(Assets)	-0.0225*** (0.00635)	-0.0339*** (0.0116)	-0.0343*** (0.0116)	-0.0354*** (0.0114)	-0.0156*** (0.00248)
Constant	0.352*** (0.101)	0.495*** (0.164)	0.506*** (0.166)	0.534*** (0.167)	0.238*** (0.0369)
FE (Bank × Time)	<b>YES</b>	<b>YES</b>	<b>YES</b>	<b>YES</b>	<b>YES</b>
FE (Industry × Location × Size × Time)	<b>YES</b>	<b>YES</b>	<b>YES</b>	<b>YES</b>	<b>YES</b>
Observations	21,344	26,032	25,941	27,729	22,123
R-squared	0.445	0.495	0.494	0.528	0.317

Note: Specialisation variable is standardised. Robust standard errors are in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

**Table 6:** Equation estimation results for zombie firms with dependent variable change in ln(loans)

	(1)	(2)	(3)	(4)	(5)
	$\Delta \ln(\text{Loans})$	$\Delta \ln(\text{Loans})$	$\Delta \ln(\text{Loans})$	$\Delta \ln(\text{Loans})$	$\Delta \ln(\text{Loans})$
	<b>Storz et al. (2017)</b>	<b>De Jonghe et al. (2021)</b>	<b>OECD</b>	<b>Bonfim et al. (2021)</b>	<b>Kane (1987)</b>
Specialisation	-0.0614 (0.111)	-0.160* (0.0963)	-0.157 (0.0966)	-0.158 (0.0969)	-0.0444 (0.109)
Zombie $\times$ Specialisation	0.0141 (0.0250)	-0.000528 (0.0236)	0.00133 (0.0200)	-0.00582 (0.0212)	-0.000628 (0.0179)
Zombie	0.0299 (0.181)	-0.122 (0.0967)	-0.106 (0.0980)	-0.0603 (0.134)	-0.244*** (0.0909)
ln(Relationship)	-0.0699*** (0.0232)	-0.0770*** (0.0269)	-0.0665** (0.0264)	-0.0572** (0.0268)	-0.0944*** (0.0265)
Zombie $\times$ ln(Relationship)	-0.0190 (0.0627)	0.104*** (0.0374)	0.0598 (0.0369)	-0.0346 (0.0503)	0.0862** (0.0371)
Bank share in company	-0.117* (0.0643)	-0.135** (0.0615)	-0.146** (0.0605)	-0.123* (0.0631)	-0.181** (0.0731)
Zombie $\times$ Bank share in company	0.0363 (0.179)	0.0218 (0.0836)	0.0604 (0.0875)	0.0812 (0.116)	0.219*** (0.0787)
Bank share in sector	0.124 (0.115)	-0.0486 (0.143)	-0.0971 (0.131)	-0.0617 (0.120)	0.145 (0.137)
Zombie $\times$ Bank share in sector	-0.173 (0.356)	-0.0711 (0.198)	0.128 (0.176)	0.100 (0.203)	-0.113 (0.210)
ROA $\times$ Specialisation	-0.226 (0.396)	0.0400 (0.340)	0.0109 (0.345)	-0.250 (0.340)	-0.284 (0.405)
Equity to assets $\times$ Specialisation	0.0174 (0.0152)	0.00311 (0.0171)	0.00364 (0.0177)	0.00571 (0.0130)	0.0183 (0.0146)
Current ratio $\times$ Specialisation	1.49e-05 (1.33e-05)	-5.59e-06 (2.05e-05)	-3.24e-06 (1.99e-05)	-2.57e-06 (3.21e-05)	-3.78e-05 (4.13e-05)
Age $\times$ Specialisation	0.00170 (0.00149)	0.000923 (0.00152)	0.000853 (0.00146)	0.000268 (0.00124)	0.00136 (0.00144)
ln(Assets) $\times$ Specialisation	0.00376 (0.00755)	0.0115* (0.00643)	0.0113* (0.00648)	0.0122* (0.00647)	0.00310 (0.00757)
ROA	0.442 (0.338)	0.724** (0.308)	0.819*** (0.300)	0.336 (0.249)	0.485* (0.294)
Equity to assets	0.0118 (0.0149)	0.00340 (0.00499)	0.00186 (0.00426)	0.000955 (0.00399)	0.00901 (0.0135)
Current ratio	9.83e-06 (1.16e-05)	-8.02e-06 (1.79e-05)	-5.95e-06 (1.74e-05)	-5.84e-06 (2.81e-05)	-3.64e-05 (3.61e-05)
Age	-0.00458*** (0.00116)	-0.00380*** (0.00143)	-0.00421*** (0.00131)	-0.00454*** (0.00121)	-0.00372*** (0.00118)
ln(Assets)	-0.0588*** (0.0146)	-0.0571*** (0.0134)	-0.0579*** (0.0134)	-0.0620*** (0.0123)	-0.0521*** (0.0137)
Constant	0.918*** (0.213)	0.902*** (0.213)	0.918*** (0.213)	0.971*** (0.194)	0.880*** (0.204)
FE (Bank $\times$ Time)	<b>YES</b>	<b>YES</b>	<b>YES</b>	<b>YES</b>	<b>YES</b>
FE (Industry $\times$ Location $\times$ Size $\times$ Time)	<b>YES</b>	<b>YES</b>	<b>YES</b>	<b>YES</b>	<b>YES</b>
Observations	20,113	24,002	23,914	25,609	20,843
R-squared	0.289	0.289	0.289	0.284	0.287

Note: Specialisation variable is standardised. Robust standard errors are in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 4.2 Zombie takeover: a potential threat?

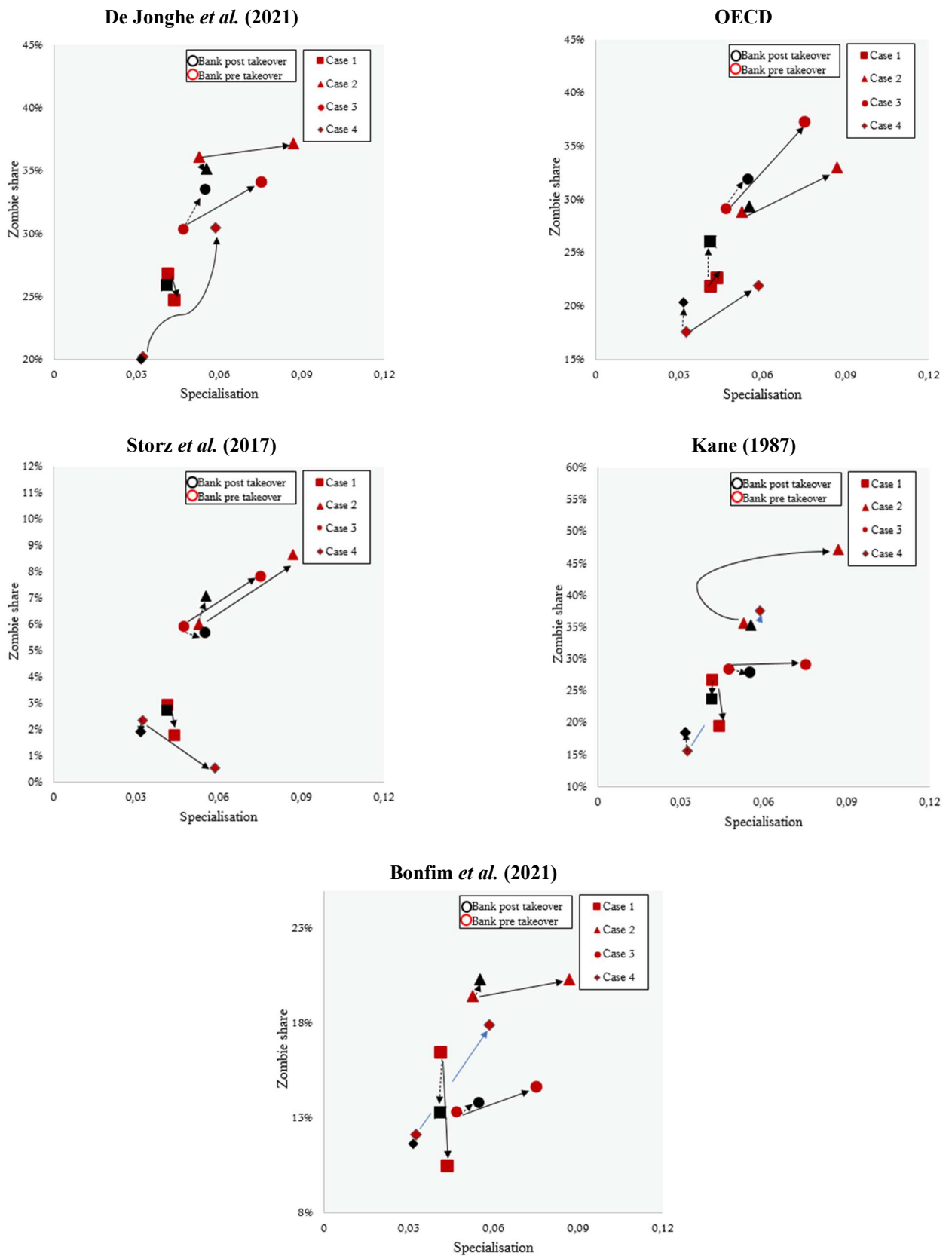
The previous subchapter indicated that bank specialisation and zombification do not significantly threaten financial stability during regular, everyday business. However, the question arises as to what happens to the financing of zombie companies if their creditor leaves the market, goes bankrupt, or through a merger with another bank, it stops existing. Some of the existing literature on bank switching state that firms may achieve significant discount at the beginning of the relationship, and that the firm's repayment behaviour may be one of the indicators for better loan conditions (Ioannidou and Ongena, 2010; Bonfim et al., 2020). However, the question of zombie switching much is less researched. In such a scenario, other institutions, especially the acquiring bank, in addition to adjusting their exposures during the peaceful time, take over those companies that may have led credit institutions to losses. To the knowledge of the author of this paper, the impact of forced exposure to zombies of banks who left the market has yet to be investigated, especially in terms of the complete takeover of clients by one bank. The above could provide essential conclusions regarding the issue of financial stability, as it would also evaluate if the mere takeover of a bank's insolvent clients also leads to increased credit risk, that is, specialisation in zombies themselves.

In a situation where a zombie changes banks, especially when the cause is the resolution of an existing institution, the role of specialisation may differ, and the credit risk may be higher. The goal of the analysis is to show that banks may acquire the zombified portfolio of an institution at a significant discount, but could also face with considerable deterioration in the quality of the loan portfolio. It will be shown that the results of zombie takeover by the four banks indeed differ, depending on the zombie identification.

Panel 1 shows the impact of bank zombie takeover on specialisation and zombie shares in the portfolio. It is visible that banks' specialisation either significantly increased or stayed close to the previous period, but the zombie share, when using different definitions, gives different results. For example, zombie definitions provided by the OECD, show that banks increased their exposure towards the same after the zombie takeover. This further shows that a possible threat to the financial system comes precisely from banks that have directly or indirectly accepted zombie clients. However, concerning other zombie definitions, a strong link with the zombie takeover is not as straightforward as with the OECD definition.

Although the shown results may be influenced by the fact that some companies became zombies in the following year, it is notable that banks in at least one out of four cases have recorded an increase in zombie share in their balance sheet. Further assessing this impact may present a significant challenge for future research, as the greater distinction between the zombie company and sector coverage may be of crucial importance. Such information may not only give an insight into whether new creditors treat new zombies differently from those who were their clients in pre-takeover period, but also on whether the same zombies decide to stay with the bank or seek for a new one.

**Panel 1: Zombie client takeover**



Source: author's calculation based on data from FINA and CNB

Note: Solid arrow represents the direction of takeover, while dashed arrow indicates the direction of acquirer after the takeover. The specialisation and the zombie share are averages weighted by the loan to particular business entity and sector. Red symbols show the bank one year before takeover, while black symbol represent a bank after takeover

## 5. Conclusion

In this paper, an attempt was made to answer whether greater specialisation of banks leads to greater zombie exposure, or on the contrary, whether greater specialisation leads to better risk recognition and lower lending to such companies. Theories on monitoring, information asymmetry and portfolio concentration, which are interwoven in the paper, influenced the methodological conceptualisation of the research. When using a rich data set on business entities and modifying the methodology of De Jonghe et al. (2021), there is weak evidence that increased sector specialisation negatively affects companies' additional lending. Also, when it comes to zombie companies, to some credit contraction is pronounced, while some are getting contracted with greater bank specialisation.

The soft information in the results implies that during the regular operation of banks, with a longer firm-bank relationship, the loan supply to companies decreases, while some zombies obtain greater further lending with more extended bank interaction than non-zombies. With an increase in the bank's share in the company's debt banks primarily decrease their exposure, while with greater share in sector, some business entities obtain more funding. Zombies are mostly contracted for further credit when banks' increase share in their debt, but there is conflicting evidence on the impact on zombie lending when bank increase its share in sector. Furthermore, the security of the company, described through hard information of capitalisation, liquidity, and profitability, is recognised as an argument for additional lending. Also, greater bank specialisation in a particular sector leads to additional lending with a simultaneous increase in the company's assets and liquidity but also in contraction with greater profitability, while no uniform evidence is visible when companies increase their capitalisation. On the other hand, the company's age and size show a negative sign.

The relationship between credit institutions and companies with operational difficulties is complex. However, the same relationship can be evaluated through interactions of banks with existing as well as with new clients. By considering current zombie literature, this paper makes a step forward in terms of observing the interaction of zombies with new banks. Further research could therefore be focused on zombie takeover issue since the behaviour of the new creditor in these circumstances provides valuable information about the former and current creditor, the zombie company, and the economy in general. Although the relationship between zombie companies and banks is structured and inert, in the case of the bank's departure from the market, this relationship becomes dynamized, which, in addition to creating challenges for micro and macro supervision, enables answering several research questions. Further developing of that zombie area could be beneficial because zombie-prone banks, with their actions, harm healthy companies since they negatively affect the adequacy of the supply of loans to healthy companies, which reduces the efficiency of the entire financial industry and represents a threat to financial stability and limits economic growth.

Due to the data's nature, this paper could not include the aforementioned in an econometric model. However, further research could direct its efforts towards the takeover of zombie companies because, with higher bank specialisation to riskier clients, the potential negative impacts on accumulating systemic risks grow.

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## APPENDIX

### Appendix Tables A1 & A2: Used variables and detailed interpretation of the NKD sectors

Appendix Table A1: Used variables and their description

	Variable	Calculation
	$\frac{\Delta \text{Loan}}{\text{Total Asset}}$	$\frac{\text{Loan}_{i,b,t} - \text{Loan}_{i,b,t-1}}{\text{Total Asset}_{i,t}}$
	$\Delta \ln(\text{Loan})$	$\ln(\text{Loan}_{i,b,t}) - \ln(\text{Loan}_{i,b,t-1})$
	<i>Specialisation</i>	$\left( \frac{\text{Loan}_{b,s,t}}{\text{Loan}_{b,t}} \right)$
Soft information	<i>Bank share in the sector</i>	$\frac{\text{Loan}_{b,s,t}}{\text{Loan}_{s,t}}$
	$\ln(\text{Relationship})$	$\ln(\text{Relationship length with bank in years}_{i,b,t})$
	<i>Bank share in company</i>	$\left( \frac{\text{Loan}_{i,b,t}}{\text{Loan}_{i,t}} \right)$
Hard Information	<i>Equity to asset</i>	$\frac{\text{Equity}_{i,t}}{\text{Assets}_{i,t}}$
	<i>EBITDA to asset</i>	$\frac{\text{EBITDA}_{i,t}}{\text{Total Asset}_{i,t}}$
	<i>Current ratio</i>	$\frac{\text{Current Asset}_{i,t}}{\text{Current Liabilities}_{i,t}}$
	$\ln(\text{Total Asset})$	$\ln(\text{Total Asset})_{i,t}$
	<i>Age</i>	Age of the company or number of years from 2002 at the earliest, for which the company submits financial statements

Note: The table shows the variables used in the analysis. The same variables are further used to estimate equation (1). In the calculations, b- denotes the identity of the bank, i- denotes the identity of the company, t- the identity of time and s- the identity of the two-digit NACE sector. In the analysis, all independent variables (except *Zombie*) are lagged by one period

**Appendix Table A2: detailed interpretation of the NACE sectors**

<b>no.</b>	<b>NACE Sector Short</b>	<b>Sector description</b>	<b>Sector group</b>	<b>NACE Code</b>
1	A - AGR	Agriculture, forestry and fishing	AGR	A
2	B - MIN	Mining and quarrying	ENER	B
3	C - MANU	Manufacturing	MANU	C
4	D - EL. ENER	Electricity, gas, steam and air conditioning supply	ENER	D
5	E - WATER	Water supply; sewerage, waste management and remediation activities	ENER	E
6	F - CONS	Construction	CONS	F
7	G - RET	Wholesale and retail trade; repair of motor vehicles and motorcycles	RETA	G
8	H - TRAN	Transportation and storage	TRAN	H
9	I - ACCO	Accommodation and food service activities	TURI	I
10	J - INF & COM	Information and communication	COMM	J
11	L - REAL	Real estate activities	CONS	L
12	M - PROF & SCIE	Professional, scientific and technical activities	OTH	M
13	N - ADMIN	Administrative and support service activities	OTH	N
14	P - EDUC	Education	OTH	P
15	Q - HEALTH	Human health and social work activities	OTH	Q
16	R - ART	Arts, entertainment and recreation	OTH	R
17	S - OTH SERV	Other service activities	-	S