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The effects of financial frictions on Slovenian companies: A panel VAR approach

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ABSTRACT

In this paper, we investigate the impact of imperfect financial markets on the business investment of Slovenian non-financial companies. We focus on exploring the borrower's balance sheet channel, through which companies' worsening balance sheets, reduce the availability of external finance. The effects of exogenous shocks are, therefore, amplified through the financial accelerator mechanism and affect the overall economy. Using data from annual reports of Slovenian non-financial companies from 2005 to 2020, we estimate a panel VAR model on various sample definitions. The results confirm the existence of the balance sheet channel, as the impulse response of investment to cash flow shocks is statistically significant. This effect is especially noticeable during the period from 2006 to 2012. Our findings suggest that financial frictions affect the availability of external financing and, consequently, the investment activity of Slovenian non-financial companies. Policymakers should prioritize measures to ensure adequate external financing, particularly for financially constrained firms, to mitigate the negative impact of reduced economic activity during periods of financial distress and economic downturns.

1. Introduction

The Great Recession (2007–2009) renewed the interest of economists and policymakers to understand the transmission channels between the financial and real economy. Theoretical literature (Foglia et al., 2011) suggests the existence of three general groups of such channels, which incorporate either the transmission of shocks originating in the financial markets to the real economy or the amplification of the shocks originating in the real economy by the financial markets: the borrower's balance sheet channel, the bank balance sheet channel, and the liquidity channel.

The borrower's balance sheet channel comes to light due to the inability of the financial sector to fully and promptly evaluate borrowers' creditworthiness and monitor their investment activity, which causes an adjustment in the external finance premium, also as a response to the general macroeconomic conditions. During economic downturns, such adjustments in the costs of external funds directly affect consumption and investment activity, which results in additional worsening of real economic conditions.

Understanding the determinants (fundamental and financial) of business investment is crucial since they account for a significant share of the Slovenian GDP and are regarded as the most volatile component. Furthermore, investment plays a significant role in business cycles and determines the long-run development of an economy, which was also evident in the aftermath of the Great

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Recession. This paper focuses on investigating the borrowers' balance sheet channel from the perspective of Slovenian non-financial companies. This analysis contributes to the literature by observing a relatively long period that includes a significant economic downturn in light of the global financial crisis, allowing us to assess the financing conditions during the economic downturn. We empirically confirm the balance sheet channel between the financial and real economy arising from financial market imperfections. Furthermore, we explicitly test for the presence of external financing frictions by analysing their impact through the external debt rate.

For the analysis, we collected data from the annual reports of 2426 Slovenian non-financial companies from 2005 to 2020, provided by the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES). Additionally, we collected data on the average exchange rate and real price of investment from the database of the Statistical Office of the Republic of Slovenia (SORS). Based on the firm-level data on investment rates, debt rate, the marginal productivity of capital, and cash flow rate, we estimated an identified panel VAR model to uncover the effect of financial frictions on business investment.

The remainder of the paper is organised as follows. Section 2 provides a literature review, while Section 3 presents the data and methodology used in this paper. Finally, the analysis results are presented and discussed in Section 4, followed by a conclusion of the article in Section 5.

2. Literature review

In the economic literature, exploring the balance sheet channel, which assesses the implications of the Modigliani-Miller assumption of perfect capital markets (Modigliani and Miller, 1958) invalidation, typically involves examining how business investment responds to changes in companies' cash flows, a common proxy for their creditworthiness (e.g., Fazzari et al., 1988; Angelopoulou and Gibson, 2009; Hovakimian, and Hovakimian, 2009). However, accurately measuring the fundamental determinants of investment decisions is challenging. Business investment often hinges on the shadow value of an additional unit of capital, expressed as marginal q, which represents the ratio of the expected marginal revenue product of capital to its acquisition cost (Bond and Van Reenen, 2007). Given the unobservability of marginal q, empirical studies typically rely on proxies based on average q, also known as Tobin's q (Tobin, 1969), which represents the ratio of company value to the replacement cost of capital.

However, Bond and Van Reenen (2007) argue that despite q theory's advantages, including explicit expectations modelling and accounting for technological shocks, it has several limitations. Criticisms extend to the foundational assumptions of perfect competition, constant returns to scale, and the functional form of adjustment costs, which may not accurately reflect the reality. Furthermore, measuring marginal q using stock market data that may not align with real fundamental values can limit the effectiveness of Tobin's q in accounting for the fundamental determinants of investment. Consequently, Tobin's q may be influenced by financial variables, potentially distorting the assessment of the balance sheet channel's existence.

In response to this criticism, Gilchrist and Himmelberg (1995, 1998) developed an empirical method, which is a sales-based measure of the marginal productivity of capital (MPK). The method, which was included in the empirical works of, e.g., Love and Zicchino (2006) and Melander et al. (2017), treats cash flow as a composite of two parts: the first part reflects the pure financial part, while the other part may carry some additional information regarding investment opportunities. The latter is summarised in the measurement of MPK, which is orthogonal to the financial aspects of cash flow; therefore, MPK should only represent the fundamental determinants of corporate investment behaviour. By construction, the method is advantageous for inspecting the financial constraints of small companies since it does not rely on stock market measurements of Tobin's q.

There have been several studies assessing the investment cash-flow sensitivities. Martinez-Carrascal and Ferrando (2008) expanded the explanatory variables in investment equations with financial position measures (indebtedness) on a sample of euro area countries, revealing significant differences in the investment-cash flow sensitivities among them, but confirmed the presence of balance sheet effects. Hermet (2003) analysed Korean manufacturing companies and concluded that small (financially constrained) companies' investment dynamics relied solely on internal funds, whereas financially unconstrained companies did not exhibit such pattern. Shabbir (2012) assessed the balance sheet channel in Pakistan and found that restrictive monetary policy disproportionately affected borrowing by financially constrained companies. Similar conclusions emerged from studies by Angelopoulou and Gibson (2009) for the UK and Masuda (2015) for Japan.

However, debates regarding the validity of investment-cash flow sensitivity as a measure of financial constraints persist in the literature. Fazzari et al. (1988) initially suggested that financially constrained companies exhibit larger investment-cash flow sensitivities based on dividend policies. However, numerous studies, including Kaplan and Zingales (1997), Hovakimian (2009), and Hermet (2003), have criticised this finding, highlighting non-monotonic relationships and emphasising the role of cash stocks as a liquidity indicator. Gomes (2001) questioned the sufficiency of investment-cash flow sensitivity as a financial constraint measure, while Chen and Chen (2012) discussed whether investment-cash flow still exists in the last two decades. Conversely, studies such as Whited (1992), Bond and Meghir (1994), and Fazzari et al. (2000) support Fazzari et al. (1988) original findings. In our analysis we follow the latter strand of the literature.

3. Data and methodology

In this analysis, we employ the panel vector autoregressive (VAR) approach using the R package *panelvar* (Sigmund and Ferstl,

2021).[1] Although presented to the economic literature by the seminal work of Holtz-Eakin et al. in 1988, studies incorporating such an approach are still relatively scarce, at least when compared to the usage of the traditional VAR approach.

The necessary data for the analysis were collected from the annual reports of 2426 Slovenian non-financial companies from 2005 to 2020, obtained from the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES). The firm-level data include information on investment rates, debt rates, the marginal productivity of capital, and cash flow rates. The final dataset used in the analysis consists of 17,474 firm-year observations from Slovenian manufacturing companies. The data cleaning process involved joining information from annual reports, calculating the variables of interest, and applying restrictions to the sample, such as including only manufacturing companies with at least 15 employees and trimming outliers.[2]

Prior to the estimation, we checked the stationarity of the main variables. Based on the Im–Pesaran–Shin test (Im et al., 2003) and Fisher-type tests, we may conclude that all the variables in the model are stationary. In the estimation procedure we follow Gilchrist and Himmelberg (1998) to a certain extent; however, we chose to add a variable, namely debt rate (*D_tot*), to account for the additional source of financing, which can arise from the supply side of the financial sector. Building from the theoretical foundation, we include the approximation for the Tobin *q* measure to account for changes in the investment demand, and cash flow to test for the presence of balance sheet effects. Furthermore, we included debt rate, denoted by $(D/K)_{i,t}$, in the equation to test the presence of spillover effects through the credit market:[3]

$$\left(\frac{I}{K}\right)_{i,t} = a + \frac{1}{b}Q_{i,t} + \gamma_1\left(\frac{CF}{K}\right)_{i,t} + \gamma_2\left(\frac{D}{K}\right)_{i,t} + \varepsilon_{i,t} \tag{1}$$

Hence, we are interested in the statistical significance of coefficients γ_1 and γ_2. Previous studies, e.g., Melander et al. (2017), found a significant effect of a cash flow shock on business investment. However, they did not test the presence and significance of the credit channel. Therefore, we enhance the approach by controlling for the debt rate endogenously within the model to test for the presence of a credit constraints transmission channel. Notably, including a measure of Tobin *q* is important for measuring appropriate investment demand in isolation of sudden changes in the cash flow. In other words, if financial frictions affect the business investment through other variables (not included in the model), the effect is already reflected in the lower marginal productivity of capital and will not be shown as a balance sheet effect.

The reduced-form panel VAR model takes the following form:

$$y_{i,t} = \mu_i + \sum_{l=1}^{p} A_l y_{i,t-l} + \alpha_t + \varepsilon_{i,t} \tag{2}$$

where A_l represents the matrix of coefficients, $y_{i,t}$ presents a 4×1 vector of endogenous variables, namely the investment rate $I_{i,t}$, debt rate $D\_tot_{i,t}$, the marginal productivity of capital $MPK_{i,t}$, and cash flow rate $CF_{i,t}$:

$$y_{i,t} = \begin{bmatrix} I_{i,t} \\ D\_tot_{i,t} \\ MPK_{i,t} \\ CF_{i,t} \end{bmatrix} \tag{3}$$

and μ_i and α_t refer to the firm-specific and time-specific effects, respectively. The $\varepsilon_{i,t}$ represents the reduced-form disturbances which are independently and identically distributed (i.i.d.) for all *i* and *t* and are assumed to be the combinations of the underlying structural shocks $\nu_{i,t}$, which are identified by the Cholesky decomposition.[4]

By construction, the ordering of the variables follows the rule of increased endogeneity, such that the variables in the system which are placed first affect the subsequent variables both contemporaneously and with lag effects, while the variables located later in the sequence will only affect the preceding variables through the lag effect (Lütkepohl and Krätzig, 2004). Therefore, the ordering of the variables presented above explicitly states the assumption of the contemporaneous effects of the investment rate shocks on the rest of the variables in the system while presuming that the corporate investment decisions do not have an instantaneous response to changes in economic and financial conditions. Conversely, the cash flow rate shocks tend to affect the remainder of the variables only through lag effects. The latter is crucial for investigating the existence of the balance sheet channel since the cash flow rate should not affect the current values of the fundamental determinants of investment rates captured by the *MPK*.

The model is estimated by the two-step generalized method of moments (GMM) procedure, which considers the Windmeijer (2005) finite-sample correction. While the time-specific effects are accounted for by the inclusion of the year dummy variables, the firm-specific effects are accounted for by using the forward orthogonal deviations (FOD) transformation, introduced by the seminal paper of Arellano and Bover (1995).

[1] Canova and Ciccarelli (2013) provide an extensive survey on the panel VAR methodology.
[2] Details on the data utilised in the analysis are available in Appendix A.
[3] Details on the theoretical background are available in Appendix B.
[4] The identification matrix is obtained by calculating the Cholesky decomposition of the variance-covariance matrix of the reduced-form residuals.

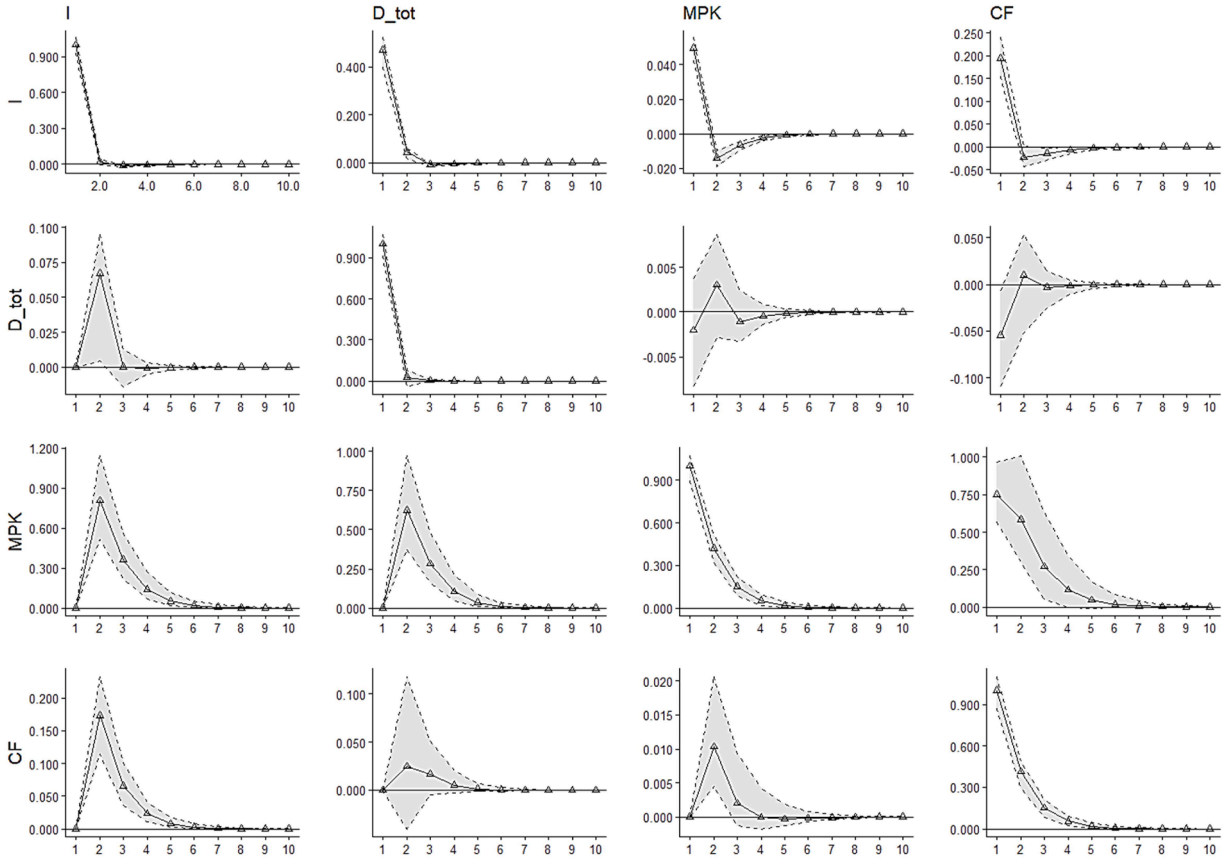

Fig. 1. Impulse response for all companies.
Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90 % confidence intervals generated by 100 draws. Horizontally, we show the respective effects of structural shocks on endogenous variables.

4. Results

This section discusses the main empirical results of the identified panel VAR model.[5] We estimated the impulse response functions to four structural shocks for different baseline specifications of the model. The first specification includes all available observations, and the second builds upon baseline results by decomposing the dataset into a subsample of large companies, which are presumed to be less financially constrained, and a subsample of small companies, for which we assume that are bounded by the financial constraints more severely. Furthermore, the dataset is segmented temporally into two subsamples: 2006–2012, encompassing the financial and sovereign debt crises, and 2013–2020, characterized by relatively stable growth.

The baseline impulse response functions based on the entire sample of companies are presented in Fig. 1. A unit cash flow shock significantly elevates the business investment rate, which increases by approximately 0.18 percentage points during the first year and remains statistically significantly elevated for three years after the initial shock. On the other hand, the fundamental investment demand is only marginally affected by the cash flow shock. The companies' debt rate response is positive but statistically insignificant in the aggregate sample. This result points to the conclusion that companies in Slovenia are, in the aggregate, not financially constrained from the perspective of the companies' accessibility to external financing in the form of financial debt. The effect on investment through the cash flow could, therefore, be affected by other factors. However, we will test this phenomenon on several model specifications to shed some light on it from the perspective of the specific size classes of the companies as well as various periods.

The *MPK* shock significantly increases the companies' investment and debt rates. Such a result is expected as the shifts in capital productivity will likely influence companies' investment decisions independently of the current financial situation. It is evident that the *MPK* shock simultaneously increases the companies' cash flow; hence, it is essential to control for the *MPK* when studying the balance sheet effects on the business investment rate.

[5] Based on the Andrews-Lu model and moment selection criteria (MMSC-BIC and MMSC—HQIC), the suggested lag order is one.

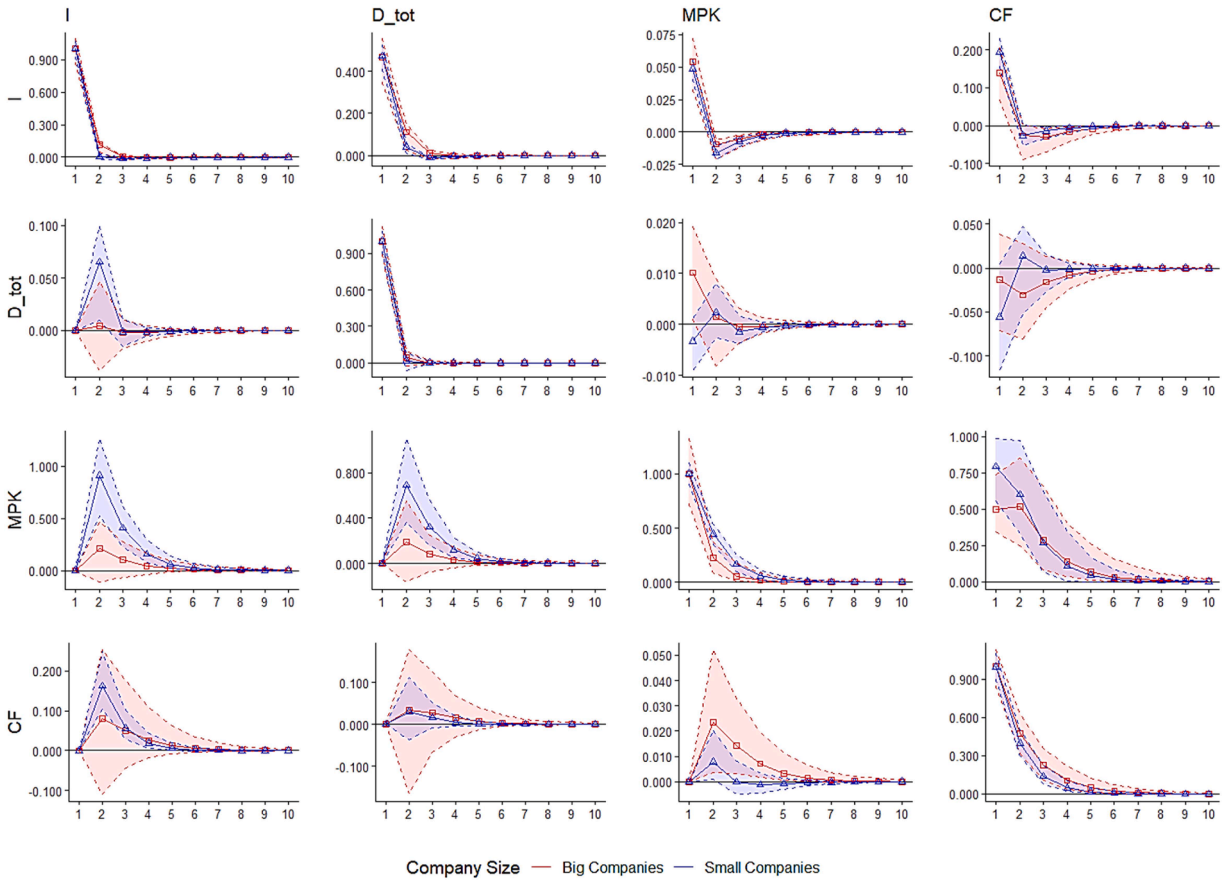

Fig. 2. Impulse responses for the two groups of companies.
Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90 % confidence intervals generated by 100 draws. Horizontally, we show the respective effects of structural shocks on endogenous variables.

Fig. 2 disaggregates the sample to small and large companies. Comparing the results of the cash flow shock, we can observe that a small companies investment rate is affected relatively more than the rate of large companies. However, the debt rate response is similar for both sizes of the companies, suggesting that some other factors, unrelated to the credit constraints, are responsible for the significant transmission of the cash flow shocks to the investment rate. Notably, the investment rate response for the big companies is statistically insignificant, showing that the balance sheet effects are prevalent, especially in the case of smaller companies.

Further analysis focuses on two subperiods: 2006–2012, marked by the financial and the consequent sovereign debt crisis, and 2013–2020, with stable economic growth. Impulse response functions related to those subsamples are presented in Figs. 3 and 4. During 2006–2012, the balance sheet effects are significantly amplified in the case of both large and small companies. The response of the investment rate of large companies is statistically significant and similar in magnitude to the one of small companies. Furthermore, small companies experienced a statistically significant effect of credit constraints during the financial crisis, although this effect seems to be muted in the aggregated sample. The result is consistent with the study by Črnigoj and Verbič (2014), who investigated the financial constraints of Slovenian companies during the financial and economic crisis. From 2013 to 2020, we again observe balance sheet effects only in the case of small companies. The responses to the cash flow shock related to large companies are, on the other hand, statistically insignificant. Nevertheless, we may observe that the median impulse response of debt rate is negative for large companies, pointing to an aggregate decrease in debt levels as internal funds largely finance the business investment.

We checked the robustness of our results by estimating different model specifications and comparing their results with our main specifications presented above. Namely, we controlled for the robustness concerning the ordering of variables and the lag order (we included two lags instead of one). Additionally, we included non-financial companies from other sectors (not only manufacturing) and replaced the debt rate in the model with the long-term debt rate. Our main result of the balance sheet effects on the investment remains robust throughout those specifications. Impulse responses related to the robustness checks are available in Appendix C.

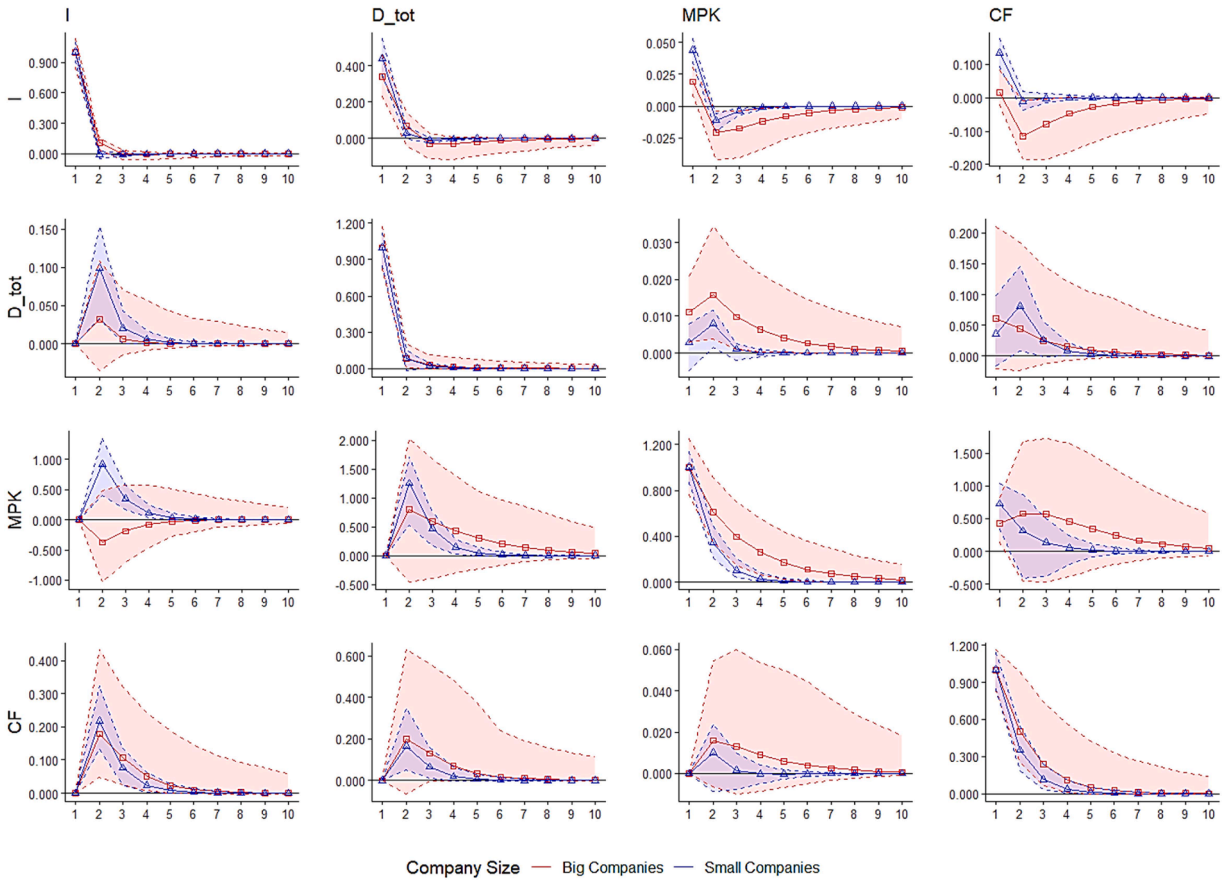

Fig. 3. Impulse responses for the subperiod 2006–2012.
Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90 % confidence intervals generated by 100 draws. Horizontally, we show the respective effects of structural shocks on endogenous variables.

5. Concluding remarks

In this paper, we investigate the borrowers' balance sheet effects on the sample of Slovenian non-financial companies, specifically investigating the impact of indebtedness as a potential factor influencing investment behaviour during financial distress. For this analysis, we utilized the data from the annual reports of 2426 Slovenian non-financial companies from 2005 to 2020 (17,474 firm-year observations) provided by the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES). Firm-level data on investment rates, debt rate, the marginal productivity of capital, and cash flow rate allow us to estimate an identified panel VAR model to uncover the effect of financial frictions on business investment.

Our analysis focused on understanding the effects of imperfect capital markets on business investment. Our results suggest that the balance sheet effects are present in the whole sample of Slovenian non-financial companies. However, in the entire sample, we could not conclude that the transmission mechanism runs through the loan availability as the debt rate remains intact. To gain deeper insight, we decomposed our sample by size (large, presumably financially unconstrained vs. small, presumably financially constrained companies) and time period (economic downturn: 2006–2012 vs. stable economic growth: 2013–2020). We used subsamples to shed some light on the mechanisms that may be relevant, especially for financially constrained companies during the period of financial distress.

Our results confirm those assumptions as financially constrained companies experience a significant response in indebtedness due to their cash flow shock only in periods of low economic growth. No such conclusions could be drawn for financially unconstrained companies. These results imply that the transmission of credit supply is only significant for financially constrained companies during periods of adverse economic conditions. Consequently, policymakers should prioritize implementing certain measures to ensure the availability of external financing and mitigate the negative impacts of reduced economic activity on business performance during economic downturns. Such measures may involve collaboration between the government and financial institutions to facilitate lending

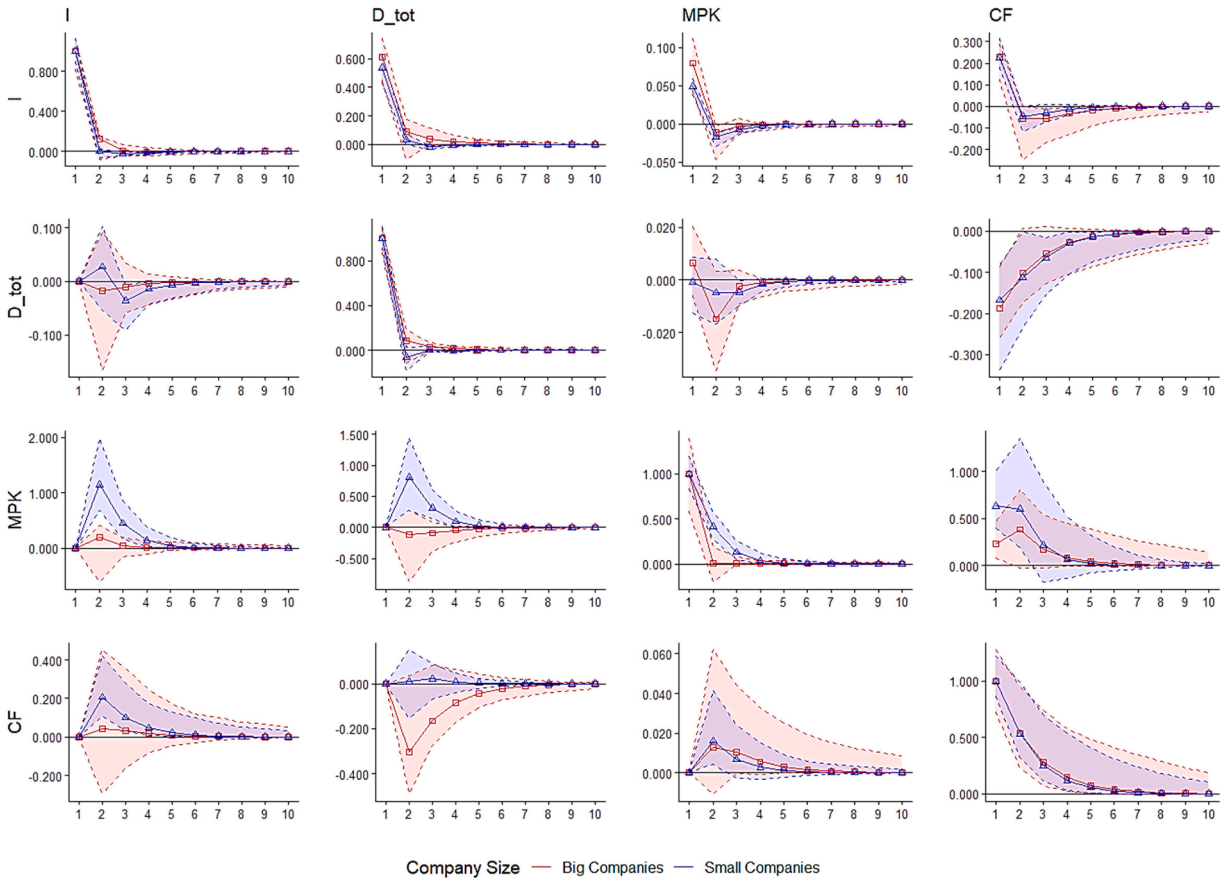

Fig. 4. Impulse responses for the subperiod 2013–2020.
Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90 % confidence intervals generated by 100 draws. Horizontally, we show the respective effects of structural shocks on endogenous variables.

and provide guarantees, insurance schemes, or targeted financial support for financially constrained companies, such as low-interest loans, grants, or tax incentives.

Our analysis has presented evidence supporting that balance sheet effects encompass a broader range of factors operating through diverse transmission channels. Future research should prioritize exploring these channels to gain insights into the underlying determinants of business investment in Slovenia and its financing sources, moving beyond the conventional understanding of credit supply and demand dynamics. While our findings offer some understanding of the investment behaviour of Slovenian companies, suggesting that the relatively low investment rate over the past decade is not greatly attributed to external financing constraints, it is important to acknowledge the limitations of this analysis. Specifically, we have not accounted for the potential liquidity preferences of companies and have yet to incorporate an assessment of the risks associated with investment activities and their financing sources. However, these limitations fall outside the scope of this analysis and should be addressed in future research, likely adopting a macroeconomic perspective.

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CRediT authorship contribution statement

Darja Zabavnik: Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing. **Miroslav Verbič:** Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

None.

Data availability

The data are publicly available.

Data related to this article are provided by and available from the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES) and the Statistical Office of the Republic of Slovenia (SORS).

Appendix A. Data

For this analysis, we obtained firm-level data from the annual reports of Slovenian companies (excluding sole proprietors) provided by the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES). Such a large dataset carries at least two advantages regarding the assessment of the existence of the balance sheet channel. Firstly, we observe Slovenian companies over a relatively long period, including a significant economic downturn in light of the global financial crisis, potentially decreasing companies' access to external financing. Second, unlike several previous studies, which focus on examining the balance sheet channel on large publicly traded firms (e.g., Gilchrist and Himmelberg, 1995; Bond et al., 2005), our dataset includes a large set of small firms, where the effects of financial frictions are potentially more binding (Kadapakkam et al., 1998). The data preparation process consisted of several steps: (1) merging the information from the annual reports between the period 2006–2020, (2) calculating the variables of interest, (3) cleaning the dataset, and (4) presentation of descriptive statistics.

Merging the information from the annual reports between the period 2006 and 2020. In the first step, we focused on joining the information from the annual reports into a single dataset. Although the availability of the annual reports spans from 1994 onwards, we choose to disregard the period from 1994 to 2004 in our analysis, as the information available in the reports is greatly limited, which does not allow for calculating the variables of interest. Annual reports consist of the income statements and the balance sheets for each accounting period that coincides with the calendar year. Since the annual reports for each year also include the accounting data for the previous year, this served as a benchmark for merging the separate datasets into one, and we also utilized the data referring to the year 2005 in our analysis.

Due to the Slovenian adoption of the euro currency on January 1st, 2007, we have also transformed the values corresponding to the accounting year 2006 into euro-denominated values, using the average annual exchange rate. After joining the annual databases and deleting some outliers (e.g., excluding firms, which were taken into account twice in a given year), we obtained a single large dataset of more than 870,000 firm-year observations. However, the dataset also contained the accounting information of a large sample of micro companies (with less than five employees), for which we could not calculate the variables of interest due to limited information corresponding to limited business activity. Therefore, we chose to exclude them from the final sample already in this step; hence, the dataset from the first step consists of 167,237 firm-year observations.

Calculating the variables of interest. In the second step, we focused on defining the variables of interest, namely investment rate (I), debt rate (D_tot), long-term debt rate (D_lr), the marginal productivity of capital (MPK), and cash flow rate (CF). All original variables from the annual reports are expressed in EUR. However, for the analysis, we normalize the variables of interest by the total tangible assets (taken at the end of the previous year), which serve as an approximation for capital stock. These variables are calculated in the following way:

- As opposed to the investment (*Inv*, expressed in EUR), investment rate (*I*) denotes an investment to capital ratio and is calculated based on the perpetual inventory method:

$$K_{i,t} = \left(1 - \delta_{i,t}\right) K_{i,t-1} + Inv_{i,t} \tag{.4}$$

implying that *I* is calculated in the following way:

$$I_{i,t} = \frac{K_{i,t} - K_{i,t-1} + \Delta_{i,t}}{K_{i,t-1}} \tag{.5}$$

where $K_{i,t}$ represents the total tangible fixed assets, $\delta_{i,t}$ represents depreciation and amortization rate (depreciation and amortization expense divided by approximation of capital stock), and $\Delta_{i,t}$ represents depreciation and amortization expense.

- Debt rate (*D_tot*) is expressed as a debt to capital ratio, where the debt is defined as the average outstanding long-term financial and operating liabilities and short-term financial and operating liabilities in the current year.
- Long-term debt rate (*D_lr*) is expressed as a long-term debt to capital ratio, where the long-term debt is defined as the average outstanding long-term financial and operating liabilities in the current year.

- The marginal productivity of capital (*MPK*) is defined as a measurement that should take into account the fundamental determinants of investment and, therefore, should not hold any information on the financial aspects of investment decisions. Such a measure ensures the incorporation of the equilibrium condition, stating the equality between the marginal benefit and marginal cost of the additional unit of capital. Gilchrist and Himmelberg (1998) have already proposed a similar measure of controlling for fundamentals in studying the investment-cash flow sensitivities. In our case, the user cost of capital is defined by equation (A.3) (following Angelini et al., 2019), and we assumed it as a proxy of the marginal productivity of capital, thus:

$$MPK = RP_{t-1}\left(R_{i,t} + \delta_{i,t} - \left(1 - \delta_{i,t}\right)\left(\frac{RP_t - RP_{t-1}}{RP_{t-1}}\right)\right) \quad (.6)$$

where RP_t presents the real price of the investment obtained from the database of the Statistical Office of the Republic of Slovenia (SORS), and $R_{i,t}$ presents an approximation for the corporate investment rate, calculated as the ratio between financial expenses for interest and the total debt (*D_tot*). It is worth noting that our measure does not account for the adjustment costs and partially relies on macroeconomic variables under the assumption of some homogeneity across companies.

- The cash flow rate (*CF*) is expressed as a cash flow to capital ratio, where the cash flow is obtained by adding the depreciation and amortization expense to the reported operating profit/loss.

Cleaning the dataset

In this step, we primarily restricted the sample to include only Slovenian non-financial companies, which decreased the sample size to 133,883 firm-year observations. However, in light of previous studies (e.g., Gilchrist and Himmelberg, 1995; Guariglia, 1999; Shcherbakov, 2022), we decided to primarily focus on manufacturing companies since the measurement of capital and investment should be more reliable; we provide the results of the analysis based on the overall sample of non-financial companies as a sensitivity analysis. Consequently, the sample size further dropped to 41,688 firm-year observations.

Next, we further restricted our sample to include only manufacturing companies with at least 15 employees, which is slightly less restrictive than the criterion used by Melander et al. (2017), which was set at companies with at least 20 employees in a given year. Such restriction ensures examining a more stable sample of companies observed over a prolonged period of time, especially during a turbulent economic climate, when we may observe an increased number of bankruptcies and defaults of (particularly) small firms. Next, since we are interested in the effects of the potential existence of the balance sheet channel across companies, we divided the sample of companies into two groups by taking the size of the companies, based on the number of employees, as the sample-split indicator. The sample-split is determined from the 75th percentile (97 employees) of the distribution of the number of employees, which is broadly in line with the study of Gilchrist and Himmelberg (1998), who decided to define large companies by the upper third of the distribution regarding the number of employees; however, for the case of Slovenia, such a split would imply only a small number of large companies.

In addition to deleting the observations with missing values, we further trimmed the outliers to avoid biased results. More precisely, we excluded the upper and lower 1% of observations for each variable separately, as proposed by similar studies, e.g., Chirinko et al. (1999). Hence, we obtained our final sample, which is defined as the unbalanced panel and consists of 17,474 firm-year observations. The significant reduction in the sample size corresponds mostly to restrictions regarding the specific sector and size of companies based on the number of employees; however, the reduction of the sample seems to be in line with several other studies, e.g., Schoder (2013) and Melander et al. (2017). Finally, we have also decided to inspect the potential existence of the balance sheet channel during the two subperiods; the first corresponds to the period primarily driven by the financial crisis (2006–2012), while the second subperiod considers the period of economic recovery.

Presentation of descriptive statistics

In the final step, we present the descriptive statistics of the variables of interest in Table A.1. It is evident from the table that we take into consideration 2426 Slovenian manufacturing firms, with the average number of employees standing at 117.26, which sheds light on the economic structure of the Slovenian economy, where we observe a large number of relatively small companies. Given the sample size, it is evident that, on average, we observe each company for approximately 7.2 years. From comparing the investment and cash flow rates, we may already observe the differences between small and large companies since the rates tend to be higher for small companies during the observed period.

Table A.1
Summary statistics of the variables included in the baseline analysis.

Sample	Variable	Mean	Std. deviation	Percentiles			Firm-year observations			Number of companies	Average number of employees
				25th	Median	75th	Total sample	Subsample 2006–2012	Subsample 2013–2020		
All companies	I	0.29	0.64	0.04	0.12	0.30	17,474	7967	9507	2426	117.26
	D_tot	0.11	0.71	−0.10	0.00	0.13					
	MPK	0.14	0.14	0.11	0.16	0.24					
	CF	0.81	0.81	0.14	0.25	0.45					
Large companies	I	0.20	0.29	0.05	0.12	0.26	4350	2194	2156	441	351.77
	D_tot	0.04	0.34	−0.21	−0.09	0.00					
	MPK	0.18	0.10	0.12	0.16	0.20					
	CF	0.31	0.42	0.13	0.23	0.38					
Small companies	I	0.32	0.72	0.03	0.12	0.32	13,124	5773	7351	1985	39.53
	D_tot	0.13	0.79	−0.10	0.00	0.14					
	MPK	0.20	0.15	0.11	0.16	0.25					
	CF	0.44	0.90	0.14	0.26	0.48					

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio).
Sources: AJPES, authors' calculations.

Appendix B. Theoretical framework

In the studies investigating the borrowers' balance sheet channel, the starting point usually draws from the basic neoclassical investment model developed by Hayashi (1982), which, according to Eberly et al. (2008), offers a good benchmark investment model since it efficiently portrays companies' investment behaviour. The outline of the investment model presented below follows Cummins et al. (2006).

The underlying assumption of the model relies on the rational behaviour of companies who seek to maximize the expected discounted value of future payouts to shareholders:

$$V_{i,t} = E_t\left[\sum_{s=0}^{\infty}\beta_{t+s}\prod\nolimits_{i,t+s}\right] \tag{.7}$$

where β_{t+s} and $\Pi_{i,t+s}$ present a discount factor and a payout in given periods, respectively. Under the assumption of capital being the only quasi-fixed factor and that variable factors have been maximized out of $\Pi_{i,t+s}$, the payout function can be presented in the following manner:

$$\prod\nolimits_{i,t}\left(K_{i,t}, I_{i,t}\right) = p_t\left[F\left(K_{i,t}\right) - G\left(K_{i,t}, I_{i,t}\right)\right] - p_t^k I_{i,t} \tag{.8}$$

where $K_{i,t}$ refers to the companies' stock of capital, $I_{i,t}$ presents gross investment, p_t^k denotes the price of capital goods, p_t refers to the price of the companies' output, and $F(K_{i,t})$ and $G(K_{i,t}, I_{i,t})$ present the production and the adjustment cost functions, respectively. To derive the final investment equation, we should take into account some further assumptions regarding the production and adjustment cost function, namely that the functions exhibit constant returns to scale, there is perfect competition in all markets, the depreciation rate δ is constant over time, and that the adjustment costs are quadratic and assume the technological shock $\varepsilon_{i,t}$:

$$G\left(I_{i,t}, K_{i,t}\right) = \frac{b}{2}\left(\frac{I_{i,t}}{K_{i,t}} - a - \varepsilon_{i,t}\right)^2 K_{i,t} \tag{.9}$$

where a represents a constant, and b stands for the inverse of the slope parameter. Given the above assumptions, the companies' investment behaviour can be summarized by the following standard formulation of the neoclassical investment model:

$$\left(\frac{I}{K}\right)_{i,t} = a + \frac{1}{b}\left[\frac{V_{i,t}}{p_t^k(1-\delta)K_{i,t-1}} - 1\right]\frac{p_t^k}{p_t} + \varepsilon_{i,t} = a + \frac{1}{b}Q_{i,t} + \varepsilon_{i,t} \tag{.10}$$

where δ represents the depreciation rate and $Q_{i,t}$ presents the average q, which is a relation between the total value of companies to the replacement costs of their capital and coincides with the marginal q under the abovementioned assumptions. Therefore, the investment equation (B.4) is based on the assumption of perfect capital markets; however, to test the assumption, the empirical literature usually relies on augmenting the given investment equation by adding additional explanatory variables to capture companies' financial position. The typical approach in such a procedure is to include the companies' current cash flow $CF_{i,t}$ normalized by the current stock of capital $K_{i,t}$, implying that the existence of the financial frictions in the economy is inspected through the lens of the investment-cash flow sensitivity:

$$\left(\frac{I}{K}\right)_{i,t} = a + \frac{1}{b}Q_{i,t} + \gamma\left(\frac{CF}{K}\right)_{i,t} + \varepsilon_{i,t} \quad (.11)$$

Thus, the key interest lies in inspecting the statistical significance, magnitude, and sign of the estimated coefficient γ. A positive and statistically significant estimate should, in principle, confirm the existence of financial constraints; however, the proxies for measuring the companies' liquidity positions (such as cash flow) may carry some additional information correlated with the fundamental determinants of corporate investment. In addition, as discussed in, e.g., Blanchard et al. (1993), the $Q_{i,t}$ is potentially mismeasured, which may arise as a response to the excess stock market volatility. Consequently, the capability of such a measure to efficiently seize the non-financial determinants of the investment opportunities is significantly decreased.

The effects of financial frictions on the real economy can also be examined from a theoretical standpoint. This strand of literature commonly refers to the balance sheet channel as the so-called financial accelerator mechanism, a concept which is attributed to the contributions of Bernanke and Gertler (1989), Kiyotaki and Moore (1997), and Bernanke et al. (1999). The latter provides a representative theoretical model with financial frictions based on the dynamic stochastic general equilibrium (DSGE) model, which served as a starting point for numerous studies (see, e.g., Christensen and Dib, 2006; Merola, 2015; Bäurle et al., 2016). However, in this paper, we focus on presenting the empirical testing of financial frictions, as the theoretical modelling of these frictions falls outside our scope.

Appendix C. Robustness checks

Table C.1
Summary statistics of the variables included in the analysis with additional sectors.

Sample	Variable	Mean	Std. deviation	Percentiles			Firm-year observations	Number of companies	Average number of employees
				25th	Median	75th			
All companies	I	0.36	0.91	0.04	0.13	0.35	42,834	6708	94.38
	D_tot	0.17	1.23	−0.10	0.00	0.16			
	MPK	0.22	0.21	0.11	0.17	0.27			
	CF	0.56	1.51	0.13	0.27	0.53			
Big companies	I	0.25	0.61	0.05	0.12	0.27	7651	788	361.28
	D_tot	0.08	0.65	−0.09	0.00	0.12			
	MPK	0.19	0.17	0.11	0.15	0.22			
	CF	0.36	0.60	0.11	0.22	0.40			
Small companies	I	0.38	0.96	0.03	0.13	0.37	35,183	5920	36.34
	D_tot	0.19	1.32	−0.11	0.00	0.17			
	MPK	0.23	0.22	0.11	0.17	0.29			
	CF	0.61	1.64	0.14	0.28	0.56			

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio).
Sources: AJPES, authors' calculations.

Table C.2
Summary statistics of the variables with long-term debt.

Sample	Variable	Mean	Std. deviation	Percentiles			Firm-year observations	Number of companies	Average number of employees
				25th	Median	75th			
All companies	I	0.29	0.64	0.04	0.12	0.30	17,474	2426	117.26
	D_lr	0.06	0.45	−0.08	0.11	0.05			
	MPK	0.14	0.14	0.11	0.16	0.24			
	CF	0.81	0.81	0.14	0.25	0.45			
Big companies	I	0.20	0.29	0.05	0.12	0.26	4350	441	351.77
	D_lr	0.02	0.24	−0.15	−0.07	0.00			
	MPK	0.18	0.10	0.12	0.16	0.20			
	CF	0.31	0.42	0.13	0.23	0.38			
Small companies	I	0.32	0.72	0.03	0.12	0.32	13,124	1985	39.53
	D_lr	0.08	0.5	−0.08	0.00	0.05			
	MPK	0.20	0.15	0.11	0.16	0.25			
	CF	0.44	0.90	0.14	0.26	0.48			

Note: I – investment rate (investment to capital ratio), D_lr – long-term debt rate (long-term debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio).
Sources: AJPES, authors' calculations.

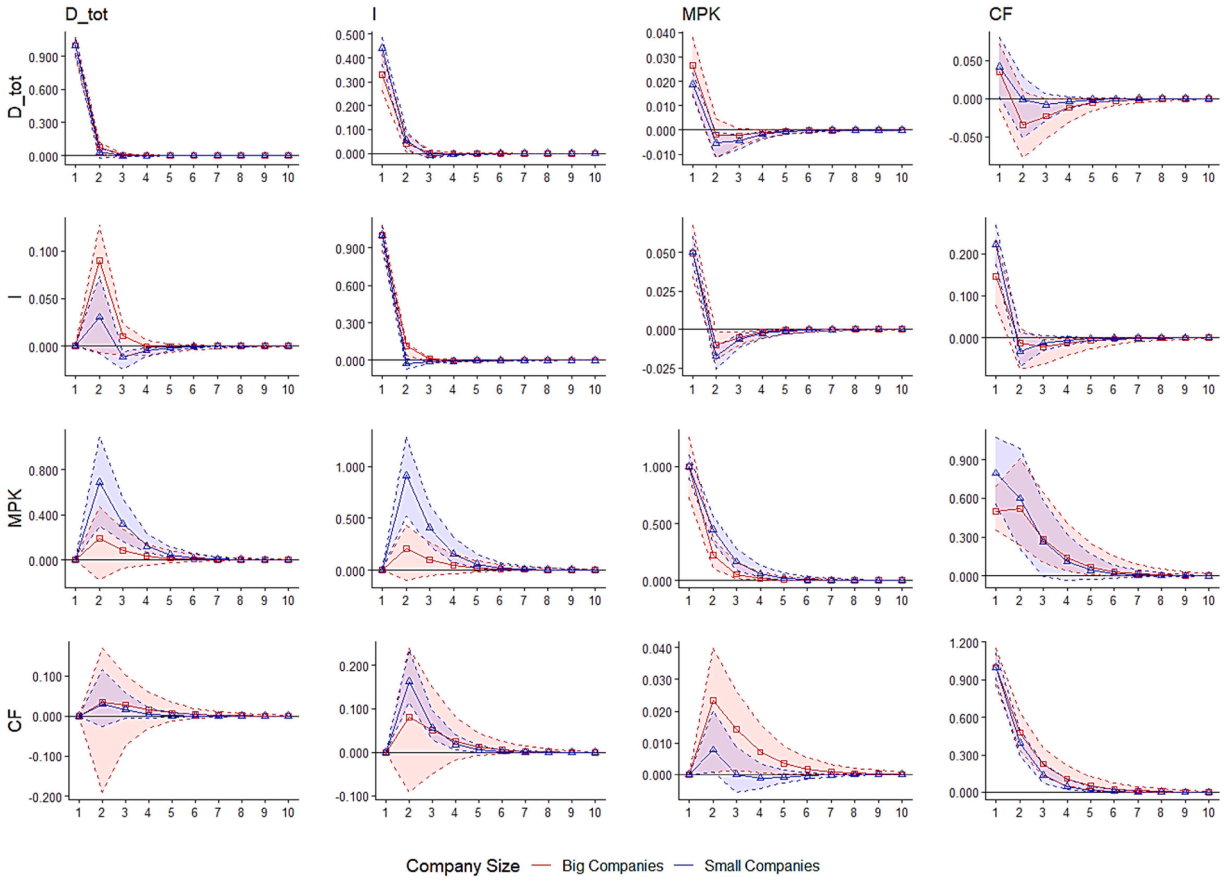

Fig. C.1. Impulse responses for the estimation with alternative ordering.
Note: D_tot – debt rate (total debt to capital ratio), I – investment rate (investment to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90 % confidence intervals generated by 100 draws. Horizontally, we show the respective effects of structural shocks on endogenous variables.

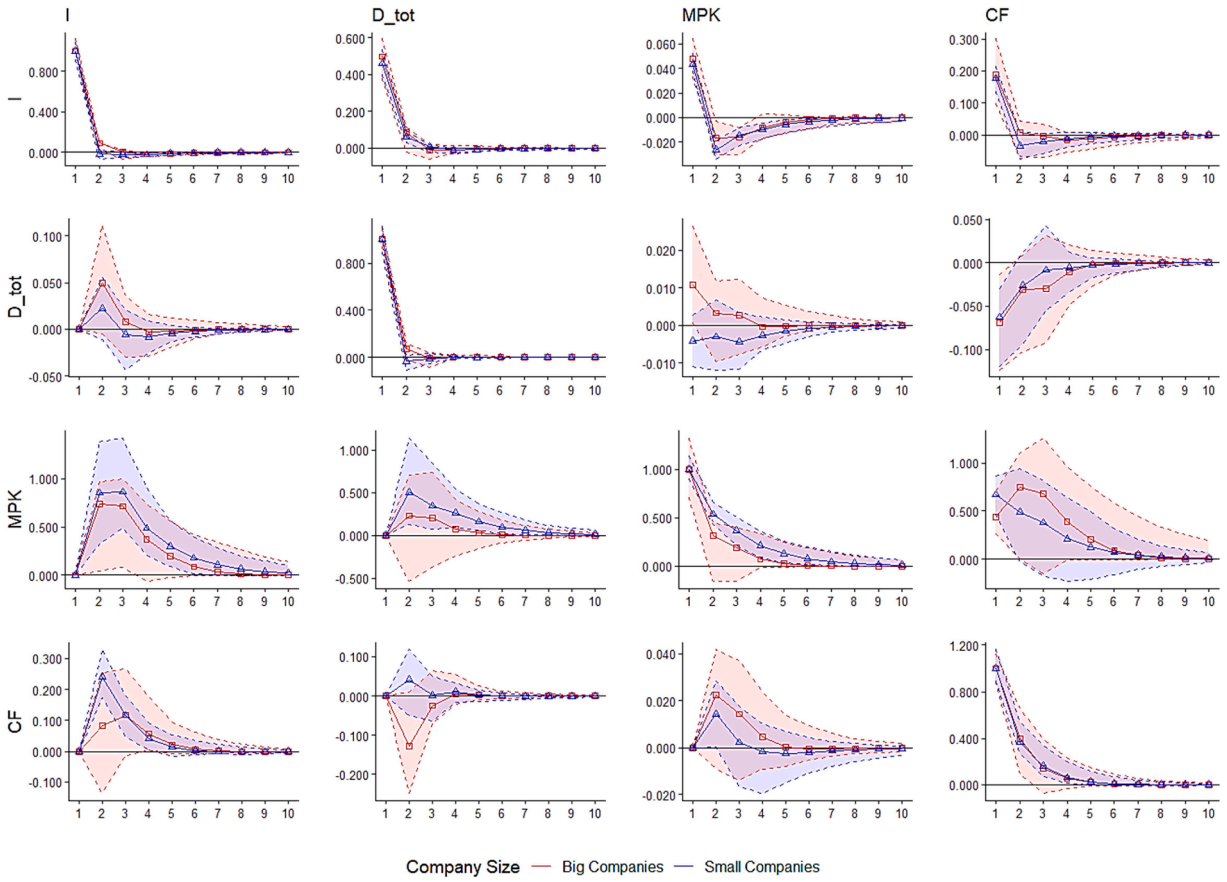

Fig. C.2. Impulse responses for the estimation with two lags.
Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90 % confidence intervals generated by 100 draws. Horizontally, we show the respective effects of structural shocks on endogenous variables.

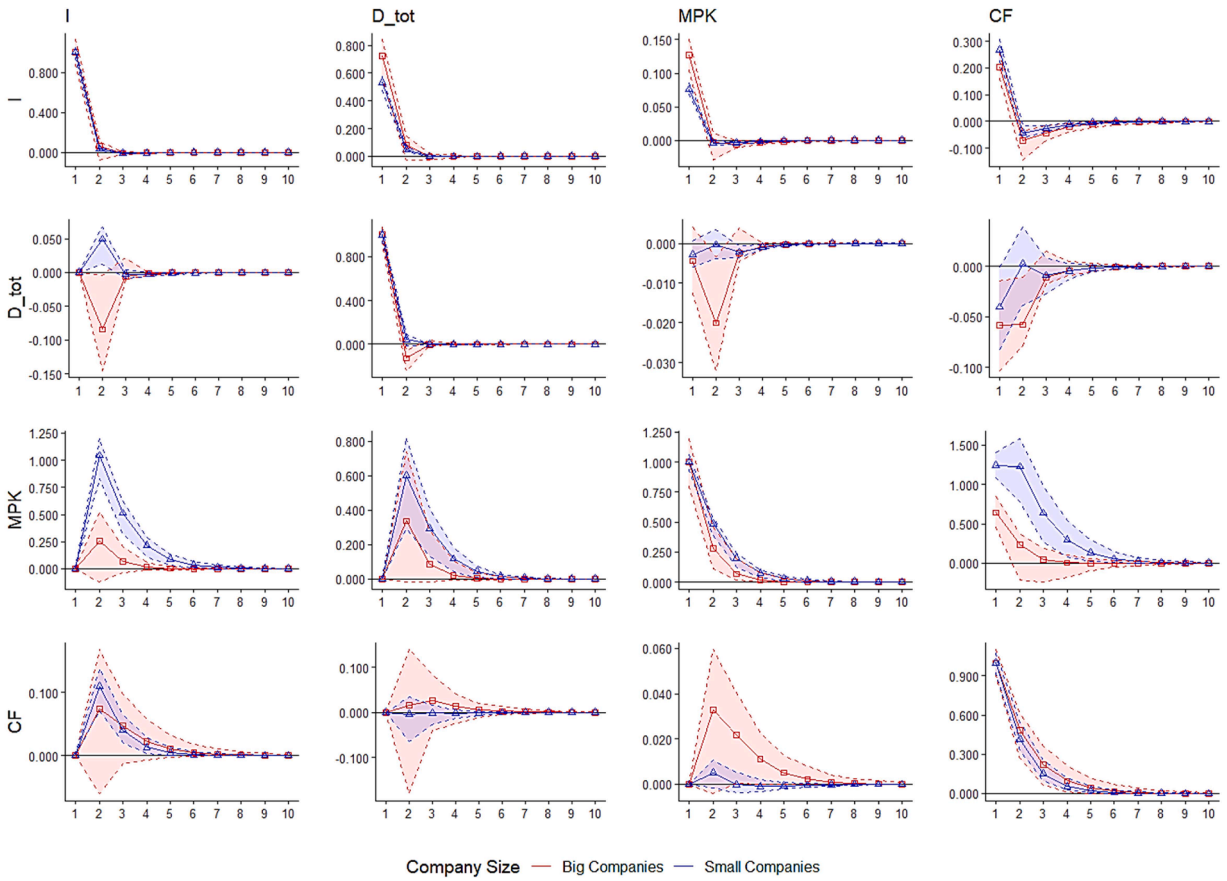

Fig. C.3. Impulse responses for the estimation with additional sectors.
Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90 % confidence intervals generated by 100 draws. Horizontally, we show the respective effects of structural shocks on endogenous variables.

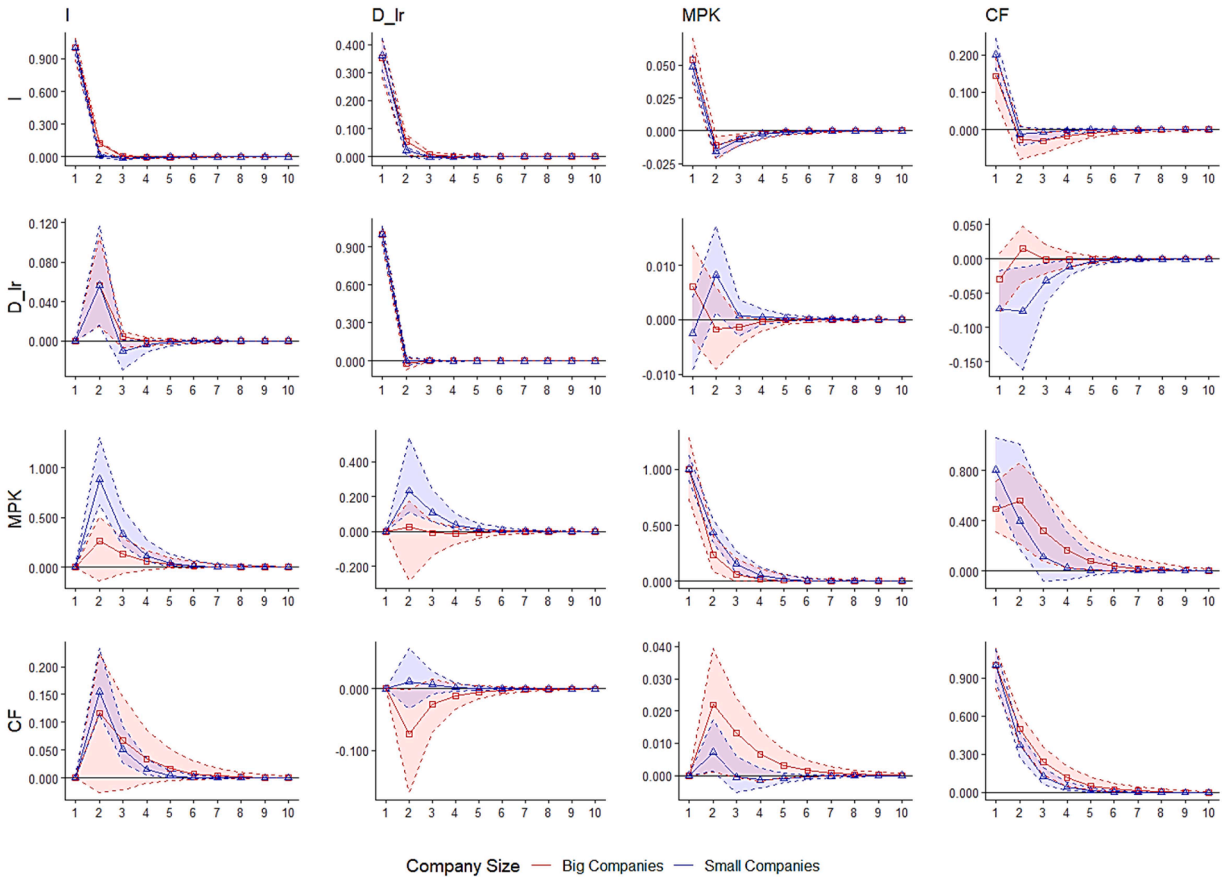

Fig. C.4. Impulse responses for the estimation with long-term debt.
Note: I – investment rate (investment to capital ratio), D_lr – long-term debt rate (long-term debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90% confidence intervals generated by 100 draws. Horizontally, we show the respective effects of structural shocks on endogenous variables.

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