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Scarring and Corporate Debt

Julia Estefania-Flores, Davide Furceri, Pablo Gonzalez-Dominguez, Siddharth Kothari, and Nour Tawk.

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Asia and Pacific Department

Scarring and Corporate Debt

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Abstract:

This paper estimates the scarring effect of recessions on corporates' investment and how it is amplified by the level of corporate debt. Our results suggest that the effect of firms' debt in shaping the response of investment to recessions is statistically significant and economically sizeable, with high debt firms seeing a larger decline in investment than low debt firms. Back-of-the-envelope calculations suggest that firms' debt accounts for at least 28 percent of the average medium-term decline of investment following a recession. This effect is especially larger for firms that are credit constrained—small and less profitable firms, as well as firms with high share of short-term debt—and that therefore may find it more difficult to rollover or raise new funds to invest in new projects. The results are robust to several checks, including to various sub-samples, alternative measures of recessions and explanatory variables, and a large set of controls.

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Keywords:	Scarring; Corporate Debt; Recessions; Firms; Local Projection.

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WORKING PAPERS

Scarring and Corporate Debt

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I. INTRODUCTION

Major headwinds associated with the COVID-19 pandemic have had devastating economic consequences around the world, and the scars from these shocks are likely to be sizeable. According to recent estimates of the IMF World Economic Outlook April 2022, cumulative per capita income losses over 2020–23, compared to pre-pandemic projections, are equivalent to about 2½ percent of 2019 per capita GDP for the world as whole and over 4 percent in emerging markets and developing economies.

These shocks have occurred in a context of rising corporate debt. Corporate debt as a share of GDP increased significantly in the decade following the global financial crisis, both in advanced economies as well as emerging and developing countries. And while there were signs of debt levels moderating after 2016, this trend was reversed in 2020, as debt ratios increased sharply with the pandemic (Figure 1). The fear is that this higher corporate debt may further aggravate the scarring effects associated with the COVID-19 pandemic. The focus of our paper is to shed light on this issue by looking at the role of firm's debt in shaping the response of firms' investment to (past) recessions.

There exists already a well-established literature on the effects of corporate debt on investment and growth. In his seminal paper, Myers (1977) stipulated that highly leveraged firms are unlikely to be able to raise new debt and thus invest in new projects as their profits must be used to pay existing debt holders. His work spawned a literature on the importance of the effect of the level of firm leverage on investment. Research that followed (Hennessy et al.2007) provided further evidence of the negative association between leverage and growth. The onset of the Global Financial Crisis (GFC) revived the literature on the effects of high leverage and credit constraints on economic outcomes, especially in advanced economies. One strand of the literature used country-level data to uncover the effects of debt booms in the private sector on overall economic activity: Dell'Ariccia et al. (2016) find that credit booms often result in financial crises but can also be associated with financial reforms and economic growth. Jorda et al. (2013) find that credit-intensive expansions tend to be followed by deeper recessions and slower recoveries. Another strand of the literature focused on the strength of firms' balance sheet prior to recessions in determining their overall resilience, relying mostly on firm-level data to show that weak balance sheets could constrain investment. Duval et al. (2020)

find that firms with weaker pre-GFC balance sheets, particularly those exposed to rollover risk, experienced a highly persistent decline in post-crisis total factor productivity growth relative to their less vulnerable counterparts. Campello et al. (2010) find that credit constrained firms in the US, Europe and Asia had to undertake deeper cuts in employment, and technological and capital spending in 2008. Buera and Karmakar (2019) find that highly leveraged firms in Portugal contracted more in the aftermath of financial shocks. Kalemli-Özcan et al. (2019) use European firm-bank matched data and find that firms with higher debt levels pre-GFC reduced their investment more after the crisis, with the effect stronger for firms holding short-term debt in countries with sovereign stress. Meanwhile, other researchers highlighted how other characteristics alongside high leverage can amplify the effects of corporate debt buildups. Albuquerque (2021) measures debt accumulation years preceding debt booms in the US and finds that corporate debt overhang is associated with weaker future investment growth in the medium term. He also finds firm vulnerability (defined as both highly leveraged and illiquid firms) exacerbates the negative association between debt and investment in the medium term. Blickle and Santos (2020) find that debt overhang leads to slower asset growth even in ordinary times, and that the effects of debt overhang during crises are more pronounced for firms with greater need for external funding. They also find that the COVID-19 outbreak contributed to an unprecedented number of firms suffering from high debt overhang.

While the literature has extensively studied both the scarring effect of recessions and the effect of leverage on investment, the literature on how leverage can amplify investment scarring after a recession is sparser, usually focusing on a small subset of countries and for the GFC period (e.g. Kalemli-Özcan et al. 2019 which focuses on European countries). This paper contributes to, and expands, the literature in three areas. First, the paper uses a difference-in-difference setup along with local projection methods to estimate the effects of recessions on investment conditional on the level of corporate debt, thus estimating the full dynamics of how corporate debt can add to investment scarring. Second, it employs a larger firm-level sample than commonly used in the literature, consisting of 75 advanced and emerging market and developing economies from 2001Q1 to 2021Q4. The breadth of the sample allows us to exploit variations across countries and types of recessions, as well as to control for a large set of unobservable sector-country-time characteristics, while the high (quarterly) frequency of the data is particularly well-suited to estimate the dynamic effects of recessions. Third, we try to shed light on the channels through which high debt can add to scarring, highlighting the role of financing constraints.

We use Jordà's (2005) local projection method to estimate the scarring effects of recessions and how it is amplified by the level of debt at the firm level. In particular, we proceed in two steps. In the first step, we estimate the average (unconditional) effect of recessions—we use a dummy which takes value 1 for the beginning (quarter) of a technical recession in a given country—on firms' investment. In the second step, we analyze how this response varies with the level of firms' debt, by interacting the recession dummy with a firm time-unvarying dummy which equals to one if the level of the firm's corporate debt is above the median debt of its industry.[1] In this second part of the analysis, we perform an extended difference-in-differences analysis, where we control for country-sector-time fixed effects to account for macro-economic shocks and their differential effect across sectors (such as, for example, the differential effect of recessions) as well as sector-specific shocks at the country level (such as for example, changes in country regulations affecting a given sector).

Our results suggest that recessions are associated with persistent effects on the level of investment. In particular, we find that the average recession in our sample is associated with a reduction in the average level of firm's investment by 30 percent compared to pre-recession trends four quarters after a recession and by about 15 percent 12 quarters after.

This effect, however, masks important heterogeneity across firms depending on the level of debt: the decline in investment for firms with high levels of debt is about 2 percent larger compared to firms with medium-to-low levels of debt four quarters after a recession, with the difference increasing to about 5 percent 12 quarters after. The effect of firms' debt in shaping the investment response to recessions is statistically significant

[1] We use the industry-specific median to isolate the role of debt from other firm characteristics that may vary across sectors. The use of a time-unvarying firm dummy reduces endogeneity due to the potential time-varying response of corporate debt to recessions. In the robustness checks, we show that the results are similar to, and not statistically different from the baseline, when using alternative measures of recessions at the country level and debt dummies at the firm level.

and economically sizeable. In particular, back-of-the-envelope calculations suggest that firms' debt accounts for at least 28 percent of the average medium-term response of investment to recessions. In addition, we find that firms' debt amplifies the effect of recessions specially for firms that are credit constrained—small and less profitable firms, as well as firms with high share of short-term debt—and that therefore may find it more difficult to rollover or raise new funds to invest in new projects.

The results are robust to several checks, including to the use of various sub-samples (across countries and times), alternative measures of recessions and explanatory variables, and controlling for a large set of potential cofounding factors at the macro and firm level that may be correlated with the interaction term of recession and corporate debt and affect the level of firms' investment.

The rest of the paper is organized as follows. Section II presents the data and a few stylized facts. Section III describes the empirical methodology used to assess the (unconditional) effects of recession on firms' investment and how it varies with the level of firms' debt. Section IV discusses the results and the extensive list of robustness checks. Section V concludes.

II. DATA

This section describes the data used in the paper, their sources, descriptive statistics and key stylized facts

A. Firm-level data

Our firm-level data comes from S&P Capital IQ. The database provides extensive balance sheet and income statement information at the firm-level and at the quarterly frequency. It covers 150 countries from 1950Q1 to 2021Q2. In order to reduce significant gaps in the time series, we restrict the sample to 2001Q1- onwards, and to advanced and emerging and developing economies. This leaves us with a sample of 75 countries. Details regarding the sample of countries used in the analysis, by geographic region, are available in Table A1.1 of Annex 1. The data is restricted to non-financial corporations and was cleaned to remove firms which had negative values for assets or debt in any year, and observations with the incorrect sign for revenue, capital expenditure, cash, tangible assets, and interest expenditure were set to missing—see Kim et al. (2020) and Arbatli-Saxegaard et al. (2022) for details. We further restrict the sample to exclude real estate and insurance companies. Tables A1.2 and A1.3 display the number of firms across countries and 20 economic sectors.

We make use of a set of balance sheet and cash-flow statement indicators from S&P Capital IQ to investigate the evolution of firm-level investment following recession episodes, and its heterogeneity depending on firms' characteristics—mainly focusing on firm's debt levels.

As for our investment measure, we use capital expenditures (IQ_CAPEX-2021). This variable refers to funds used by firms to acquire assets—such as property, plant, or equipment—and generally used to undertake new investments.

Our leverage indicator measures the total amount of debt relative to assets owned by a firm. To construct this, we compute the ratio of total debt (IQ_TOTAL_DEBT-4173) to total assets (IQ_TOTAL_ASSETS - 1007). We classify each company to be high or low debt based on whether average leverage for the company over the entire sample is above or below their industries median.

We further make use of a selection of key indicators for firm's characteristics. Their Capital IQ code description and detailed explanation of the calculations are listed below:

- Total Assets (IQ_TOTAL_ASSETS - 1007).
- Return on Assets (IQ_RETURN_ASSETS - 4178): this metric indicates how profitable is a company in relation to its total assets.
- Liquidity ratio: Net working capital ratio that measures firm's ability to pay its short-term liabilities with its current assets. The ratio is computed as the difference between current total assets (IQ_TOTAL_CA - 1008) and current total liabilities (IQ_TOTAL_CL - 1009), divided by total assets (IQ_TOTAL_ASSETS - 1007).
- Firm age (IQ_YEAR_FOUNDED[2]): Difference between the year of the observation and the year in which the firm was founded.

[2] Line details for this variable not available in the Capital IQ Glossary of terms. However, the name of the variable is available in the S&P Capital IQ Formula Index Excel spreadsheet.

- Capital expenditure (IQ_CAPEX-2021) to lagged assets (IQ_NPPE - 1004): Ratio of capital expenditure to lagged net property, plant, and equipment. This ratio depicts how capital intensive a firm is.
- Revenues (IQ_TOTAL_REV-Line - 28): Revenues raised by the firm through its business activities.
- Firm size: Size is defined using the logarithm of total assets.

All firm level variables have been winsorized at the 1st and 99th percentiles to eliminate outliers.[3]

Table A1.4 reports summary statistics for selected firm variables, distinguishing between high and low debt firms. From this table, we can discern that a typical firm, independently of the level of debt, has similar characteristics in terms of changes in capital expenditure, capital expenditure to lagged assets and revenue. Moreover, highly indebted firms are larger in size, have a higher life-spam and present lower liquidity. Table A1.5 of Annex 1 reports the summary statistics of the balance sheet and cash-flow statement variables used in our empirical analysis.

B. Recessions and other macroeconomic data

Our baseline measure for recessions is the start of a technical recession, defined by two consecutive quarters of negative GDP growth. Quarterly real gross domestic product growth from Haver Analytics is the main source used to construct this variable, but we complement it with World Economic Outlook (WEO) data for countries that have limited data in Haver. For these countries, we replace the full country series with WEO data. We then define a dummy where the first observation for each country's recession episode is set to 1. This leaves us with a total of 231 recessions for advanced economies and 336 for emerging market and developing economies.

We also use two alternative measures for recession dummies: banking and financial crises (banking currency and debt) dummies from the Global Crises Data of Reinhart and Rogoff (2009) and peak-to-trough in GDP calculated using the Harding-

[3] All variables have been winsorized at the 1st and 99th percentiles but the average firm age and leverage which have been winsorized at the 5th and 95th percentiles to account for extreme outliers.

Pagan (2006) algorithm.[4] Recessions dummies' data summary statistics are reported in Table A1.6.

C. Stylized facts on scarring and corporate debt

To cross-validate our firm-level investment data we compare it with investment data at the macro level. We do this for the level of investment as well as its growth rate.

We first aggregate our firm-level investment variable (CAPEX) to the country-year level. To control for outliers, we first winsorize 5% tails of our firm level investment variable within each country and set investment to missing when the number of companies reporting CAPEX within a country changes abruptly.[5] Then, we calculate the countries' annual investment growth rate as well as the log level of investment (we use USD values of investment when taking logs to make values comparable across countries).[6] We compare the log levels and growth rates of investment from the firm level dataset to aggregate investment from the WEO database. In particular, we compute these using private gross fixed capital formation from the WEO database. This variable is also converted to USD for the calculations in logarithms.

In Table A1.7 of Annex 1, we report the estimation results of regressing log investment from firm-level data against log-investment from macro-level data. The results shows that the level of investment is highly correlated (R-squared above 0.7) across the two sources. In addition, we find that the relation between these variables remains strong and highly statistically significant when we control for country fixed effects, and when considering growth rates.

III. EMPIRICAL METHODOLOGY

We use Jordà's (2005) local projection method to estimate the scarring effects of recessions and how it is amplified by the level of corporate debt at the firm level. In particular, our empirical approach consists of quantifying the short- and medium-term effect of recessions

[4] These two dummies are originally calculated at yearly frequency and are converted to quarterly frequency using our technical recession variable. If the yearly dummies show a recession for a certain year, we code this variable as 1 for the quarters of such year for which our quarterly variable shows a recession.

[5] To account for extreme changes, we convert to missing when changes are in the 1st and 99th percentile.

[6] These variables are further winsorized at the 1st and 99th percentiles after this computation.

on the level of a firm's investment. We proceed in three steps. In the first step, we estimate the average (unconditional) effect of recessions on firms' investment. Specifically, we estimate the following specification:

$$y_{n,i,t+k} = \alpha_{is}^{k} + \gamma_{nq}^{k} + \sum_{j=-k}^{4} \beta_j^k R_{i,t-j} + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^{k}, \tag{1}$$

where dependent variable, $y_{n,i,t+k}$, is the log difference of capital expenditure in firm *n* of country *i* at time (quarter) *t* over *k* quarters; $R_{i,t}$ is a dummy that denotes the occurrence (beginning) of an economic (technical) recession—defined as two quarters of consecutive of GDP growth—in country *i* at time (quarter) *t*; β_j^k denotes the average firm's level response of investment to recessions after *k* quarter. γ_{nq} indicates firm-quarters dummies to control for unobservable time-unvarying firm characteristics as well as firm-specific seasonality in the level of investment; α_{is}^{k} are country-sector fixed effects to account for cross-sector variations across countries—such as country-specific comparative advantages in specific sectors. Following Teulings and Zubanov (2014), we also include leads of the recession variable in our regressions to control for recessions that fall in the horizon of the local projection.

In the second step, we expand equation (1) to estimate how the scarring effect of recessions on the level of investment varies across firms depending on the degree of corporate debt. In particular, we estimate the following specification:

$$y_{n,i,t+k} = \alpha_{ist}^{k} + \gamma_{nq}^{k} + \sum_{j=-k}^{4} \mu_j^k R_{i,t-j} * D_n + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^{k}, \tag{2}$$

where *D* is a dummy which equals to one if the level of corporate debt associated with the firm is above the median of the industry. We use the average leverage over the entire sample to define this dummy to reduce endogeneity due to the potential time-varying response of corporate debt to recessions. α_{ist}^{k} are country-sector-time fixed effects to account for macro-economic shocks and their differential effect across sectors (such as, for example, the differential effect of recessions) as well as sector-specific shocks at the country level (such as for example, changes in country regulations affecting a given sector).[7] μ_j^k indicates the marginal (additional) response of investment to recessions in quarter k for firms with a high (above-median) level of corporate debt relative to those with low levels of debt.

In the section of robustness checks, we consider alternative versions of equations (1)-(2) based on: changes in the definition of the recession and corporate debt dummies; different functional forms to capture how the response of firm's investment varies with the level of debt; additional controls to include firms characteristic such as total assets, liquidity, ROA, and age; additional interaction terms to control for potential confounding factors that are correlated with recessions and/or corporate debt and that may affect the level of investment.

Finally, in the third step, we further expand equation (2) to test whether the differential effect of recessions on investment for high debt firms depends on other firm characteristics. In particular, we estimate the following triple-interaction specification:

$$y_{n,i,t+k} = \alpha_{ist}^k + \gamma_{nq}^k + \sum_{j=-k}^{4} \mu_j^k R_{i,t-j} * D_n + \sum_{j=-k}^{4} \nu_j^k R_{i,t-j} * D_n * X_{n,i,t-1} + \sum \beta_j^k R_{i,t-j} * X_{n,i,t-1} + \sum \delta_j^k D_n * X_{n,i,t-1} + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^k, \quad (3)$$

where $X_{n,i,t-1}$ is the lagged value (averaged over four quarters to reduce noise) of a firm level characteristic like size, profitability, or share of short-term debt. The coefficient on the triple interaction term ν_j^k measures whether the differential response of investment for high debt firms in quarter k varies depending on the firm characteristic $X_{n,i,t-1}$.

Equation (1)-(3) are estimated using OLS, and standard errors are two-way clustered on firm and country-time, over a panel of over 24,000 firms for the period 2001Q1 to 2020Q4 (for a total of more than 800,000 observations).

IV. Results

Figure 2 presents the evolution of (log) investment following a recession episode. Time (quarter) is indicated on the x-axis; the solid line displays the average estimated

[7] The country-sector-time fixed effects also controls for possible reverse causality concerns, where changes in investment may drive the economic cycle.

response, dashed and dotted areas denote 90 and 68 percent confidence bands, respectively. The results suggest that recessions are associated with persistent effects on the level of investment relative to pre-recession trends. In particular, we find that the average recession in our sample is associated with a reduction in the level of investment of 30 percent four quarters after the recession and by 15 percent after 12 quarters. This effect is statistically significant and economically sizeable. The magnitude of the effect is also consistent with macro evidence on the scarring effect of recessions on investment (e.g., Furceri and Mourougane 2012).

Figure 3 is analogous to Figure 2, but it reports the differential response of investment to recessions between a firm with relatively high corporate debt (above industry median) and firms with medium-to-low corporate debt levels. The results show that the differential investment loss for a firm with high corporate debt compared to a firm with medium-to-low corporate debt is about 2 percent four quarters after a recession and rises to 5 percent 12 quarters after. Also in this case, the effect is statistically significant and precisely estimated.

To give a sense of the role of corporate debt in amplifying the effect of recessions on investment, we perform a back-of-the-envelope calculation. We follow the approach of Arbatli-Saxegaard et al. (2022) and Ciminelli et al. (2018) among others, and we use the coefficients from the estimation of equations (1)- (2) as well as the weights of firms with high corporate debt in the sample.

Since the firms in our analysis are grouped into two buckets (high leveraged firms and low leveraged firms), we can write the average response of capital expenditure as the weighted average of capital expenditure in these two groups:

$$K_{t=} \omega_1 K_t^1 + \omega_2 K_t^2 \quad (4)$$

where K denotes total capital expenditure, ω_i and K_t^i are the capital expenditure share and investment of firms in group i, respectively. Based on (4), we can write response of capital expenditure to recessions as follows:

$$\frac{\partial K_t}{\partial R_t} = \omega_1 \frac{\partial K_t^1}{\partial R_t} + \omega_2 \frac{\partial K_t^2}{\partial R_t} = \omega_1 \left(\frac{\partial K_t^1}{\partial R_t} - \frac{\partial K_t^2}{\partial R_t} \right) + \frac{\partial K_t^2}{\partial R_t}$$

where $\omega_2 = 1 - \omega_1$.

We obtain $\frac{\partial K_t}{\partial R_t}$ from estimating equation (1), while $\left(\frac{\partial K_t^1}{\partial R_t} - \frac{\partial K_t^2}{\partial R_t}\right)$ from estimating equation (2). Using the coefficients from these estimations, we calculate the contribution of leverage as $\frac{\omega_1\left(\frac{\partial K_t^1}{\partial R_t} - \frac{\partial K_t^2}{\partial R_t}\right)}{\frac{\partial K_t}{\partial R_t}}$, assuming that group 2 ($\frac{\partial K_t^2}{\partial R_t}$) does not respond to the shock.

The results of this exercise suggest that firms' leverage contributes significantly to the average medium-term response of firms' investment to recessions and in amplifying scarring (Table 1). In particular, we find that firms' debt account for about 7 percent of the short-term (fourth quarters ahead) response of investment to recessions and about 28 percent of the medium-term (12 quarters ahead) response.

V. Robustness Checks

The results in the previous section highlight the role of corporate debt in amplifying the effect of recessions on firms' investment. This section provides several robustness checks to demonstrate the generality of our results. We provide three types of checks, changing: i) the sample; ii) our key regressors and explanatory variable; and iii) the set of control variables to include potential cofounding factors at the macro and firm level that may be correlated with the interaction term of the recession and corporate debt dummy and that may affect the level of firms' investment.

A. Sample

As a first robustness check, we examine the sensitivity of our results to alternative samples. First, we look at whether the results are driven by important episodes of corporate debt build-up such as those observed in 2009 as the outcome of the global financial crisis and in 2020 because of COVID-19. The results reported in Figure A2.1 of Annex 2 show that the differential response of investment for firm with high corporate debt obtained excluding these two years is similar to, and not statistically different from, the baseline. Second, we check whether the results are driven by specific countries or group of countries. To this end, we re-estimate equation (2) by excluding one country at a time and one region at a time. The results reported in Figure A2.2 and A2.3 of Annex 2 suggest that our baseline results are not driven by specific countries. Next, we repeat the analysis by excluding one 2-digit sector at a time. The results also in this case are almost unchanged compared to those reported for the full sample (Figure A2.4 of Annex 2). Finally, we look at whether the results are determined by influential extreme observations. To this end, we winsorize 0.05 and 5 percent of the tails of the distribution of our dependent variable, respectively. The results obtained are pretty much similar to the baseline (Figure A2.5).

B. Alternative dependent variables, recessions, and debt dummies

We replicate the analysis using alternative dependent variables: (i) the ratio of capital expenditure to total lagged assets; and (ii) log of revenue. The results obtained using these variables confirm that the negative effects of recessions tend to be amplified in firms with high corporate debt (Figure A2.6 of Annex 2). We next look at the sensitivity of results to the definition of recessions. While our approach follows the standard in the literature and in the definition of recessions, we also consider alternative versions of recessions such as: (i) continuous GDP growth (with the sign inverted); (ii) the peak to through changes in GDP growth; (ii) a dummy for financial (banking, debt and currency) crises; and (iii) a dummy for banking crises. The results produced with these variables confirm our main findings (Figure A2.7). Next, we examine the robustness of the results to the way we identify firms with high corporate debt. In our baseline specification, we consider a firm to have high corporate debt if the average level of debt of the firm over the entire sample is above the median of the industry. This assumption tries to isolate the role of debt from other firms' characteristics that may vary across sectors. As an alternative approach, we identify high-corporate-debt-firms as those with average level of debt above the median in the country or the -income group specific industry median. The results reported in Figure A.28 are similar to the baseline.

In our baseline, to mitigate endogeneity concerns, we consider the average leverage of a company over the entire sample so firms cannot switch classification, including in response to recessions.[8] To further mitigate endogeneity, we augmented our

[8] This approach also ensures that the treated and untreated firms are always the same—a key assumption for the validity of the difference-in-difference estimates.

baseline identification to exclude the recessions years in the computation of the firms' average level of corporate debt (Figure 4). Next, we modify the way we estimate the role of firms' debt in amplifying the effect of recessions on investment. Instead of considering an interaction between a dummy which takes one if a firm's level of debt is above the industry-median, we consider high-debt firms as those with debt level above the 4^{th} quartile of the industry distribution. The results in Figure A2.9 are qualitatively similar to those obtained using the industry median as a threshold. Finally, instead of considering only one dummy, we modify equation 2 to consider two interaction terms: one between recessions and a dummy which takes value 1 for firms with level of debt above the 4^{th} quartile of the industry distribution (high-debt firms); one between recessions and a dummy which takes value 1 for firms with level of debt below the 2^{nd} quartile of the industry distribution (low-debt firms). In Figure A2.10 we report the coefficients associated with these terms for each estimation horizon. Note that each of these coefficients captures the marginal effect of being in a high (low) state of debt compared to firms with level of debt between the 2^{nd} and the 4^{th} quartile of the distribution. The results show that the effect of recessions on investment for firms with lower debt is always lower that of firms with higher debt.

C. Additional control variables

We augment our baseline regressions to include additional firm characteristics such as total assets, ROA, liquidity, and age. The results obtained adding these control variables does not change the baseline results (Figure A2.11).

Our baseline regression includes a constellation of sector-country-time fixed effects and therefore effectively controls for all macroeconomic shocks and their effect across sectors. The inclusion of firm fixed effects further controls for unobservable firm characteristics that do not vary over time. While this set of controls should reduce concerns about endogeneity, a possible concern in estimating equation (2) is that the results are biased due to the omission of macroeconomic variables affecting firm-level investment through the level of corporate debt and are at the same time correlated with our recession dummies.

The first obvious candidate is the degree of financial stress (Dell'Ariccia, Detragiache and Rajan 2008). To check whether the inclusion of financial stress alter our results, we augment equation (2) by interacting the new indicator of financial stress of Ahir et al. (2022) with the firms' corporate debt dummy.[9] The results presented in the top left panel of Figure 6 shows that the effect of recessions on firms' investment through corporate debt remains of the expected sign and also statistically significant, even though the point estimates are smaller, especially in the short-term. This is due to the fact that one channel through which recessions affect investment is by increasing financial stress. In addition, and in line with Ahir et al. (2022), we also find that financial stress also a statistically significant effect on investment (Figure A2.12, top-left panel).[10]

Another potential variable that may affect firms' investment through corporate debt is uncertainty (Ahir et al.2022; Choi et al. 2018). According to these studies, fluctuations in uncertainty tend to have larger effects on firms (sectors) that are more financially constrained. To control for the role of uncertainty, we repeat the analysis to include as an additional control variable, the interaction between a measure of country-specific uncertainty—The World Uncertainty Index of Ahir et al. (2022)—and the firm corporate debt dummy.[11] The effect of recessions on firms' investment (top-left panel of Figure 6) also in this case are similar to, and not statistically different from, the baseline results presented in Figure 4. In addition, and consistent with the evidence from Ahir et al. (2022) for sectoral data, we do find that the level of investment falls after uncertainty shocks (Figure A2.12, top-right panel), even more for firms with higher levels of debt and that are therefore more credit constrained (Figure A2.13, top-right panel).

Another variable that may affect firms' investment through corporate debt is inflation. Inflation may lead to capital misallocation and to the extent that more financially dependent firms are those that suffer more from capital misallocation, it may have larger negative effects on firms that have higher corporate debt. Moreover, inflation may affect firms' level of investment by increasing price level uncertainty (Choi et al.,

[9] The authors use a narrative approach, based on the reading of Economist Intelligence Unit (EIU) reports, to construct an indicator of financial stress for 110 developing and advanced countries over the period 1970-2022, on a quarterly basis.

[10] In contrast, we did not find a statistically significant effect of the interaction between financial stress and the corporate debt dummy (Figure A2.13, top-right panel).

[11] The index covers an unbalanced panel of 143 individual countries on a quarterly basis from 1952. It reflects the frequencies of the word "uncertainty" (and its variants) in the EIU country reports.

2022). To further check the robustness of our results, we include an interaction term between inflation and the corporate debt dummy as a control. The results reported in the middle-left panel of Figure 6 show that effect of recession on firms' investment via corporate debt is unchanged, while the interaction between inflation and corporate debt is negative and statistically significant for some horizons (Figure A2.13, bottom-left panel).

An additional variable that may affect firms' investment level through high corporate debt is fiscal policy—to the extent that expansionary fiscal policy can reduce the magnitude of recessions. In addition, Aghion et al. (2014) and Choi et al. (2022) shows that an increase in a country's degree of fiscal counter-cyclicality raises investment, and more so for industries with higher financial dependence. Also, in this case adding this control variable does not change our results (middle-right panel of Figure 6), and we do not find a significant effect of fiscal policy on investment through firms' corporate debt (Figure A2.14, bottom-right panel).

Finally, the results are also robust when these four controls are included simultaneously (bottom-left panel of Figure 5).

Another possible concern with our results is that recessions affect firms' investment though other firm-specific variables that are correlated with corporate debt. If this is the case, we may wrongly conclude that firms' corporate debt is implying the scarring effect of recessions on investment when de facto other firm characteristics are at play. To address this source of omitted variable bias, we augment our specification to include the interaction between recessions and a dummy (constructed as for debt) for several firms' characteristics: total assets, ROA, liquidity and age. The results obtained adding these variables do not alter our finding that corporate debt is a significant factor affecting the response of investment to recessions (Figure 6). In addition, we find that the effect of recessions on investment tends to be smaller for firms with higher total assets, ROA, liquidity, and that are older, but these effects are not always precisely estimated (Figure A2.14).

VI. NON-LINEARITY

The previous section provided several robustness checks to demonstrate the generality of our baseline result that high debt firms suffer a bigger decline in investment following a recession compared to low debt firms. Next, we estimate equation 3 and test whether this differential effect depends on other firm characteristics.

First, we test the impact of firm size measured by the log of total assets. We find that the coefficient on the triple interaction term in equation 3 is positive and significant (Figure 7, Panel A), indicating that larger firms with high debt see less scarring in investment following recessions compared to smaller firms with high debt. This could reflect the fact that for a given level of debt, credit constraints are more binding for smaller firms than larger firms, potentially because larger firms have more collateral available for borrowing, or because lenders see larger firms as less risky compared to smaller firms (Ghosal and Loungani 2000; Cloyne et al. 2019; Arbatli-Saxegaard et al. 2022). Therefore, larger firms even with high debt are better positioned to take advantage of investment opportunities following a recession compared to similar smaller firms.

Next, we test whether profitability, measured using return on assets, also impacts the differential effect on investment of high versus low debt firms following a recession. We find that the triple interaction term when using return on assets is also positive and significant at longer horizons (Figure 7, Panel B), indicating that more profitable firms with high debt see less scarring compared to less profitable firms. This could reflect the fact that more profitable firms have greater access to internal funds to finance investment activities, thus relaxing credit constraints faced by less profitable high debt firms.

Finally, we test whether the differential effect on investment of high versus low debt firms following a recession depends on the maturity structure of the firms' debt. The hypothesis we want to test is that it is harder for high short-term debt firms to rollover it in the aftermath of a recession, thus making it more difficult for them to invest in new projects. Our results suggest that this is the case, and we find that the triple interaction term when using share of short-term debt is negative (Figure 7, Panel C), indicating that companies with shorter maturity structures of debt see more scarring compared to those with longer maturities.

Annex Figure A2.15 checks the robustness of the triple interaction results to using a smooth transition function (Granger and Terävistra, 1993) to transform the size and return on assets variable before estimating the triple interaction. The results are robust to this alternative specification and generally more precisely estimated.

In contrast, we did not find statistically significant effects for triple interactions with other variables commonly used in the literature to proxy financial constraints such as age and liquidity. While the signs of the estimated effects are consistent with those obtained for size and profitability—that is, the differential investment effect between high and low debt firms is larger for younger and less liquid firms—these effects are not precisely estimated.

VII. CONCLUSIONS

Corporate debt has increased markedly in the last two decades in both advanced and emerging market economies. In this paper, we show that this rising trend will reduce the resilience of economies to recessionary shocks, other things equal. In particular, applying Jordà's (2005) local projection methods to a large panel of more than 24,000 firms, we find that the recessionary shocks that occurred during the period 2001-2020 have resulted in significant and persistent drops in investment, with the effects being larger for firms with higher debt. The effect of firms' leverage in shaping the investment response to recessions is statistically significant, and robust to a wide range of sensitivity checks. It is also economically sizeable: back-of-the-envelope calculations suggest that firms' debt accounts for at least 28 percent of the average medium-term response of investment to recessions.

In addition, we find that these effects are larger for smaller and less profitable firms, suggesting that for a given level of debt, credit constraints are more binding for smaller firms than larger firms, potentially because larger firms have more collateral available for borrowing, or because lenders see larger firms as less risky compared to smaller firms. Moreover, we find that it is harder for high short-term debt firms to rollover debt in the aftermath of a recession, thus making it more difficult for them to invest in new projects.

Our results have important policy implications. They point to the need to adopt improved policy regimes for restructuring unviable firms (see Grigorian and Raei 2010 for lessons from the GFC), avoid firms' zombification, reduce overall leverage at the country-level and promote reallocation of capital and labor toward the more productive firms.

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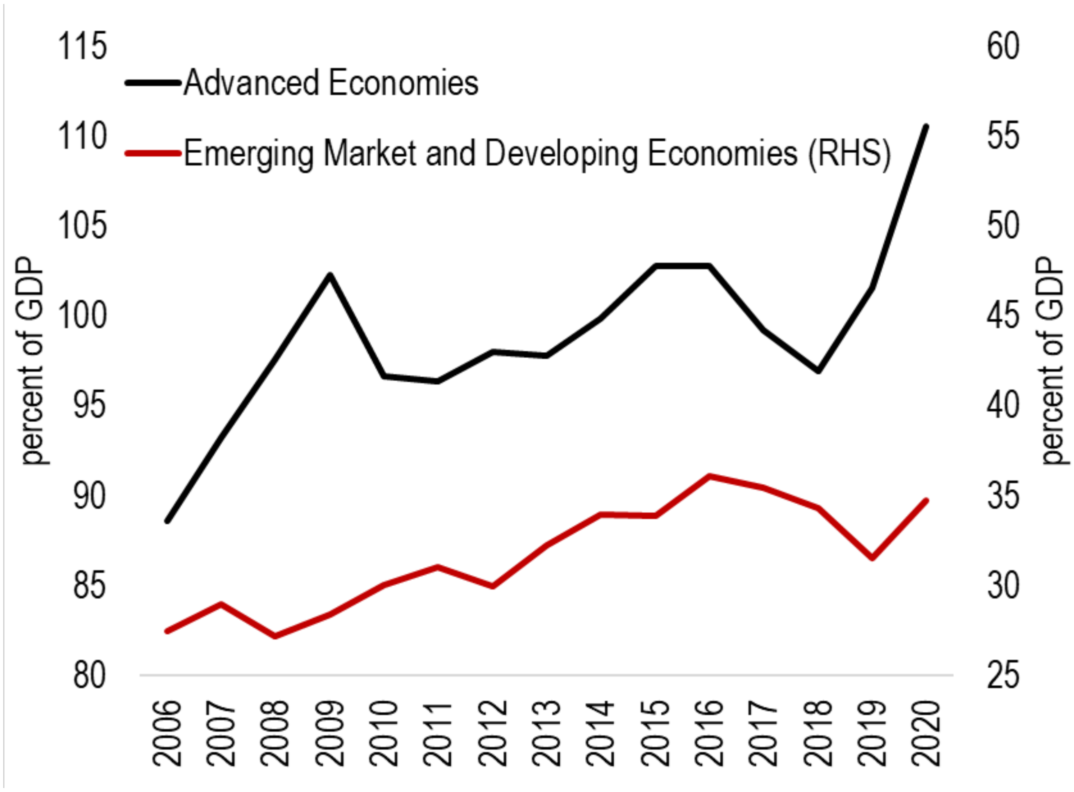
Tables and Figures

Table 1. Contribution of leverage to the average investment response following recessions

	(1)	(2)	(3)
Horizon	**Unconditional impact** $\left(\frac{\partial K_t}{\partial R_t}\right)$	**Impact via leverage** $\left(\frac{\partial K_t^1}{\partial R_t} - \frac{\partial K_t^2}{\partial R_t}\right)$	**Contribution at each horizon**
1	-0.071	-0.006	7.2%
2	-0.188	-0.010	4.5%
3	-0.248	-0.025	8.7%
4	-0.304	-0.024	6.8%
5	-0.300	-0.039	11.0%
6	-0.374	-0.042	9.7%
7	-0.344	-0.042	10.3%
8	-0.303	-0.041	11.4%
9	-0.235	-0.067	24.4%
10	-0.224	-0.047	18.1%
11	-0.208	-0.059	24.3%
12	-0.153	-0.051	28.2%
Share of Capital expenditure	**Low leveraged firms** ω_2	**High leverage firms** ω_1	
	15%	85%	

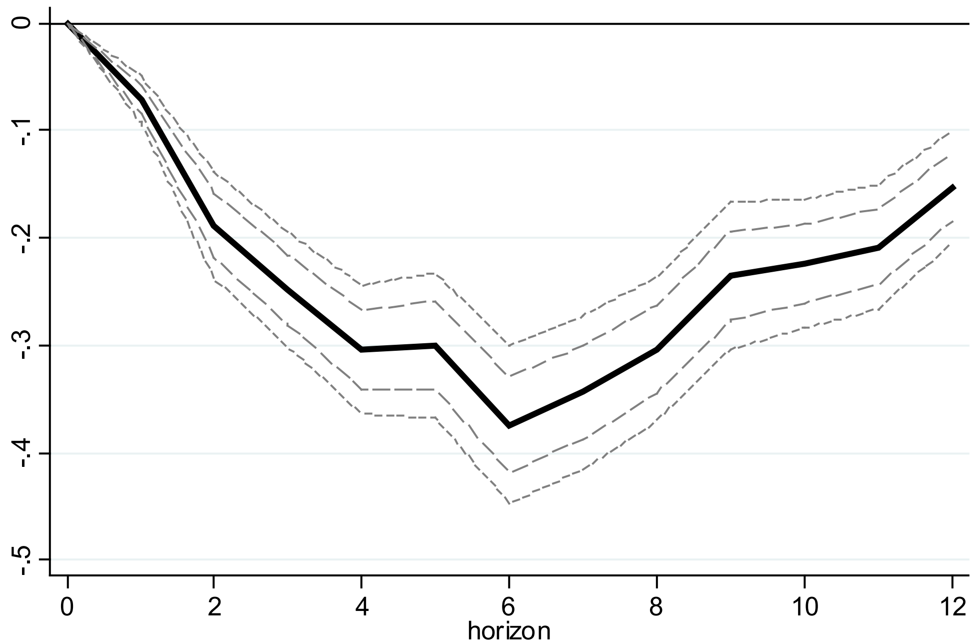
Note: the table reports the coefficient at each horizon from impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from XX countries for the period 2000Q1 to 2020Q4. Estimates for the average investment response reported in column (1) are based on the regression estimated from equation (1), while estimates for the investment response of high-debt companies relative to low-debt companies are reported in column (2) are based on the regression estimated from equation (2). Column (3) estimates the contribution of high-debt companies to the decline in investment following a recessionary shock as equal to: $\omega_1\left(\frac{\partial K_t^1}{\partial R_t} - \frac{\partial K_t^2}{\partial R_t}\right)/\frac{\partial K_t}{\partial R_t}$, assuming that group 2(low-debt companies) does not respond to the shock.

Figure 1: Non-Financial Corporate Debt, Loans and Debt Securities (percent of GDP)



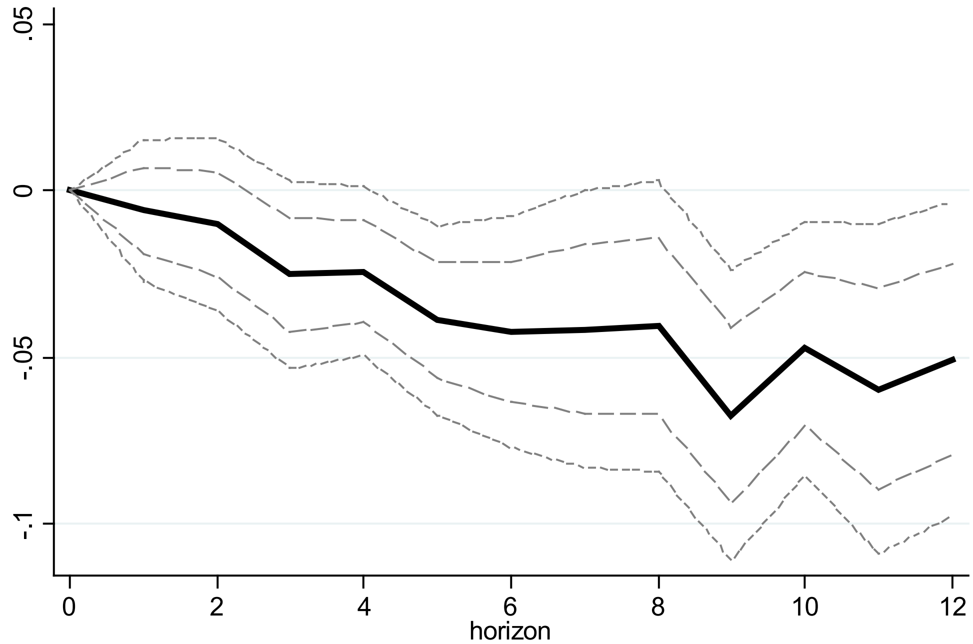
Source: IMF Global Debt Database and authors calculations.
Note: Consistent sample of 70 countries across time: Advanced Economies (35) and Emerging Market and Developing Economies (35). Dotted upper(lower) lines depict the 75th (25th) percentiles of the overall distribution. Solid lines depict the median.

Figure 2: Evolution of (log) Investment Following a Recession



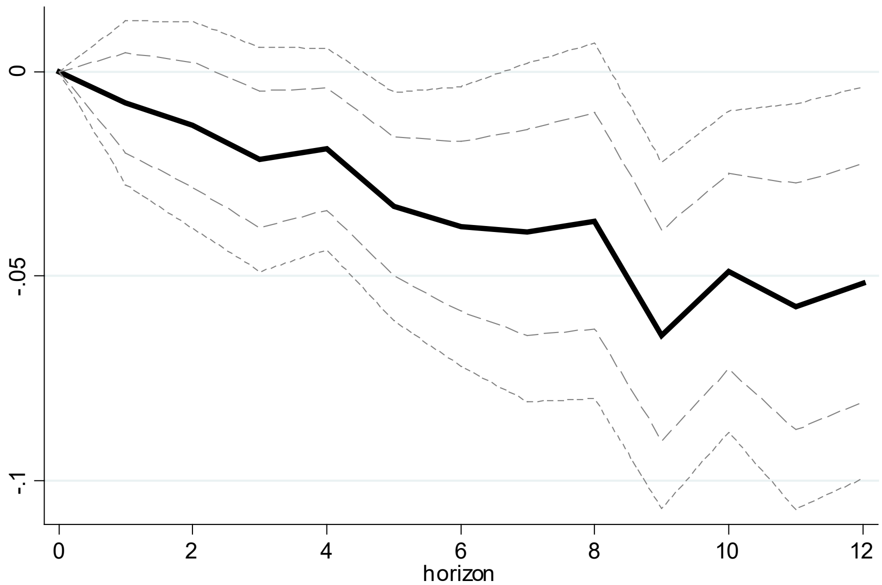
Note: Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha^k_{is} + \gamma^k_{nq} + \sum_{j=-k}^{4} \beta^k_j R_{i,t-j} + \sum_{j=1}^{4} \theta^k_j y_{n,i,t-j} + \varepsilon^k_{n,i,t}$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm *n* in country *i* at time *t* over the next *k* quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession (and is the variable of interest), γ^k_{nq} are firm-quarters fixed effects, and α^k_{is} are country-sector fixed effects. The regression is estimates separately for different horizons *k* (for up to 12 quarters). The solid line shows the point estimate for β^k_0 for different horizons *k*, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure 3: Differential Effect of Recession on (log) Investment for High-Debt Companies Relative to Low-Debt Companies



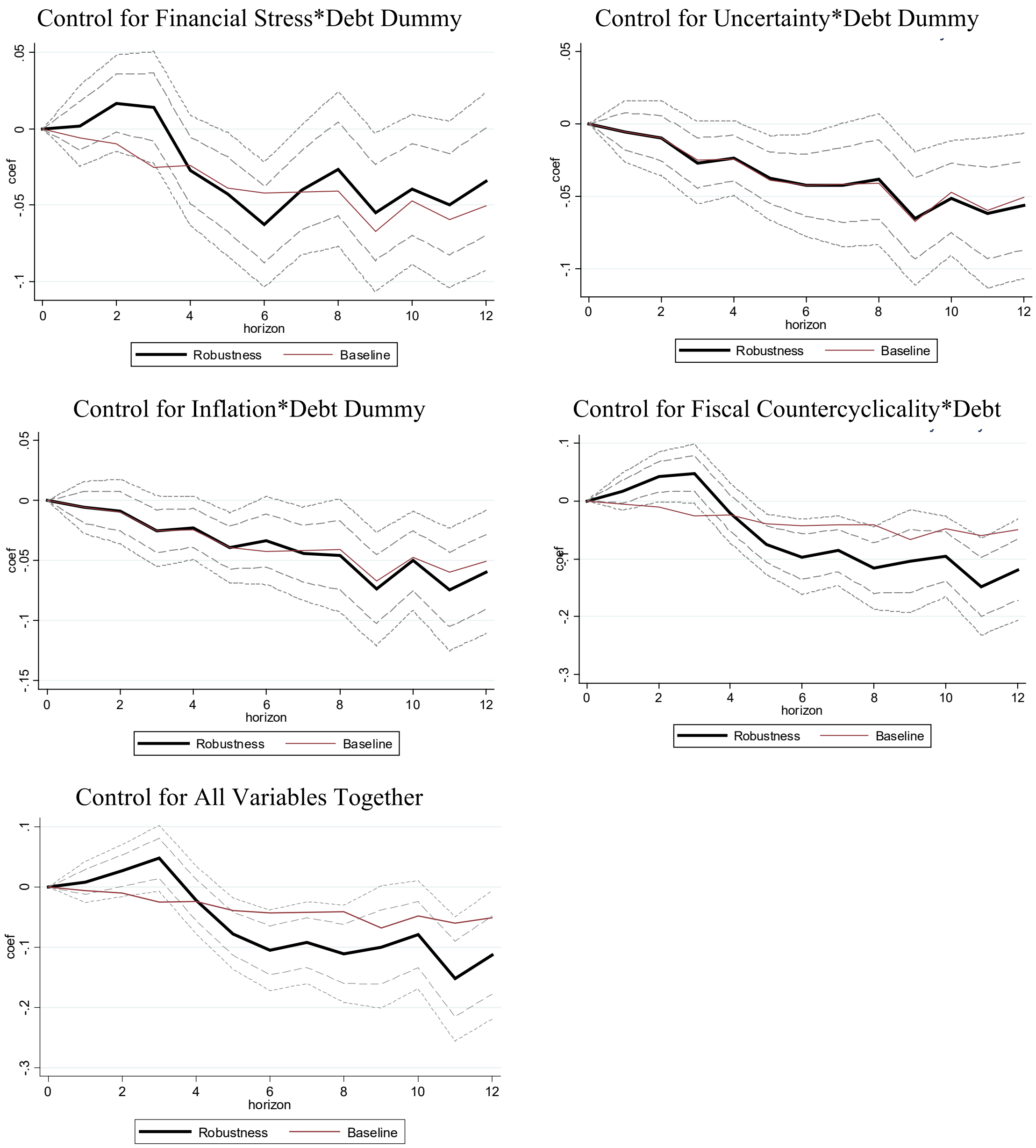
Note: Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^{k} + \gamma_{nq}^{k} + \sum_{j=0}^{4} \mu_j^k R_{i,t-j} * D_n + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^{k}$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession, D_n is a dummy variable if company *n* is a high-debt company (above median leverage within industry), γ_{nq}^{k} are firm-quarters fixed effects, and α_{ist}^{k} are country-sector-time fixed effects. The regression is estimated separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure 4: Robustness: Exclude Recessions Years when Computing High-Debt Dummy



Note: Robustness check where companies are classified into high or low debt based on whether average leverage in all non-recession years is above or below median of their industry. Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^{k} + \gamma_{nq}^{k} + \sum_{j=0}^{4} \mu_j^k R_{i,t-j} * D_n + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^{k}$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession, D_n is a dummy variable if company *n* is a high-debt company (above median leverage in non-recession years within industry), γ_{nq}^{k} are firm-quarters fixed effects, and α_{ist}^{k} are country-sector-time fixed effects. The regression is estimated separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

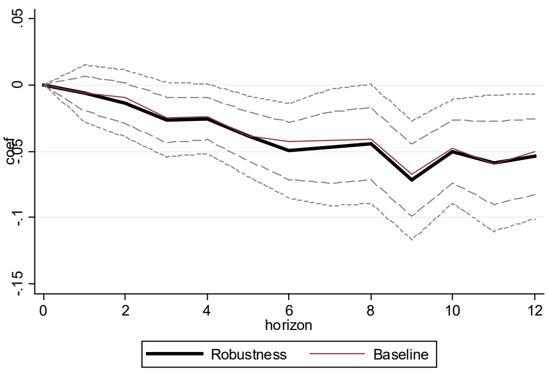
Figure 5: Robustness: Include Interaction of Macro Variables with High-debt Dummy



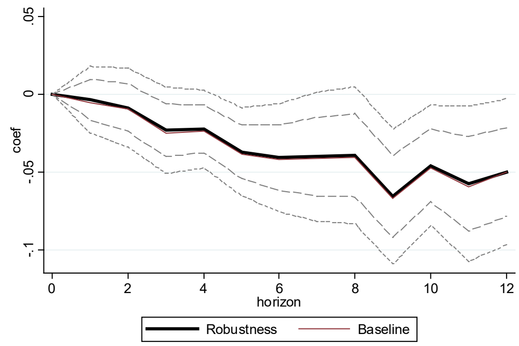
Note: Robustness check where interaction of macro variables with high-debt dummy are included as controls. Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^k + \gamma_{nq}^k + \sum_{j=0}^4 \mu_j^k R_{i,t-j} * D_n + \sum v_j^k M_{i,t-j} * D_n + \sum_{j=1}^4 \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^k$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession, D_n is a dummy variable if company *n* is a high-debt company (above median leverage in non-recession years within industry), γ_{nq}^k are firm-quarters fixed effects, and α_{ist}^k are country-sector-time fixed effects. Interaction of various macro variable $M_{i,t-j}$ with the high-debt dummy are included as controls. The regression is estimated separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure 6: Robustness: Include Interaction of Recession Dummy with Firm Characteristics

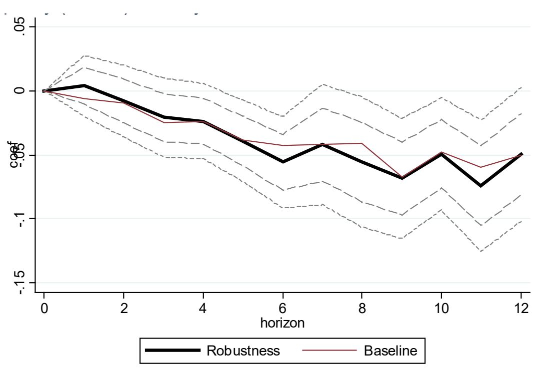
Control for Total Assets*Recession



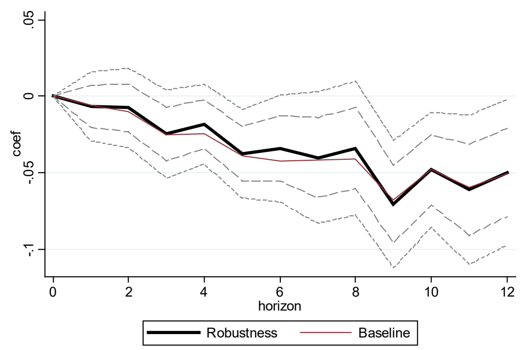
Control for Return on Assets*Recession



Control for Liquidity*Recession



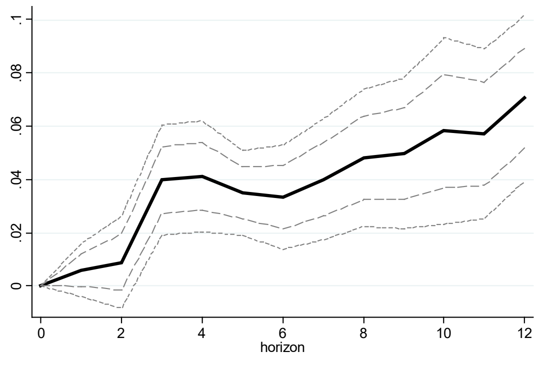
Control for Age*Recession



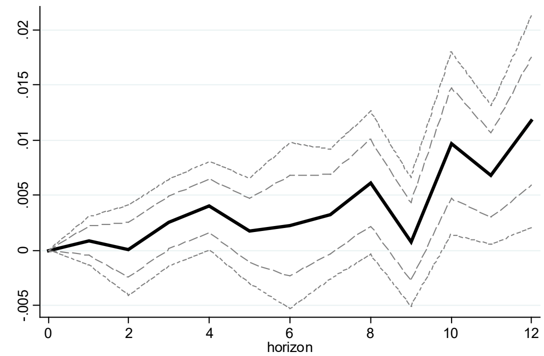
Note: Robustness check where interaction of dummy variables for various firm characteristics and the recession variable are included as controls. Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha^k_{ist} + \gamma^k_{nq} + \sum_{j=0}^{4} \mu^k_j R_{i,t-j} * D_n + \sum \nu^k_j R_{i,t-j} * F_n + \sum_{j=1}^{4} \theta^k_j y_{n,i,t-j} + \varepsilon^k_{n,i,t}$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession, D_n is a dummy variable if company n is a high-debt company (above median leverage within industry), γ^k_{nq} are firm-quarters fixed effects, and α^k_{ist} are country-sector-time fixed effects. F_n is a dummy variable defined analogously to the high debt dummy but for different firm characteristics i.e. firm classified as 1 if it is above the median as per the characteristic when averaged across the entire sample. The regression is estimated separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ^k_o for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure 7: Non-linear Effects with Triple Interaction

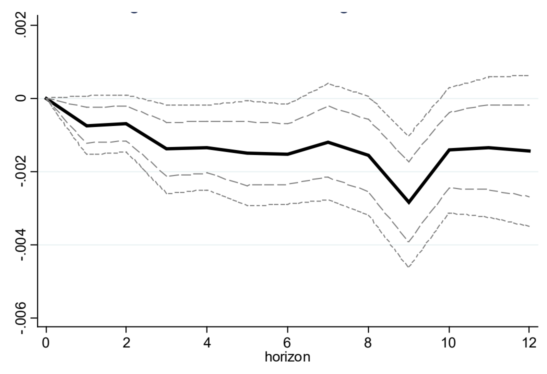
Panel A: Triple Interaction with (log) Assets



Panel B: Triple Interaction with ROA



Panel C: Triple Interaction with Share of Short-term Debt



Note: Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on equation 3 for different horizons ‘k’. The solid line shows the point estimate for ν_o^k, the coefficient on the triple interaction term, for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Annex 1: Data

Table A1.1. Sample of 75 Countries by Region

Africa – AFR (3)
Botswana
Mauritius
South Africa

Middle East and Central Asia - MCD (11)
Bahrain
Egypt
Jordan
Kazakhstan
Kuwait
Oman
Pakistan
Qatar
Saudi Arabia
Tunisia
United Arab Emirates

Western Hemisphere - WHD (10)
Argentina
Brazil
Canada
Chile
Colombia
Jamaica
Mexico
Peru
Trinidad & Tobago
United States

Asia & Pacific APD (17)
Australia
Bangladesh
China
Hong Kong
India
Indonesia
Japan
Macau
Malaysia
New Zealand
Philippines
Singapore
South Korea
Sri Lanka
Taiwan
Thailand
Vietnam

Europe- EUR (34)	
Austria	Lithuania
Belgium	Luxembourg
Bulgaria	Malta
Croatia	Netherlands
Cyprus	Norway
Czech Republic	Poland
Estonia	Portugal
Finland	Romania
France	Russia
Germany	Serbia
Greece	Slovakia
Hungary	Spain
Iceland	Sweden
Ireland	Switzerland
Israel	Turkey
Italy	Ukraine
Latvia	United Kingdom

Table A1.2. Number of Firms and Observations by Country

Country	Number of firms	Obs.
United States	4,740	388,680
China	4,077	334,314
Japan	3,085	252,970
India	2,672	219,104
Canada	2,213	181,466
South Korea	1,747	143,254
Taiwan	1,693	138,826
Australia	1,356	111,192
Hong Kong	1,106	90,692
United Kingdom	870	71,340
Malaysia	771	63,222
Thailand	555	45,510
Sweden	525	43,050
Poland	522	42,804
Singapore	471	38,622
France	467	38,294
Germany	450	36,900
Vietnam	412	33,784
Indonesia	399	32,718
Israel	322	26,404
Pakistan	321	26,322
Turkey	280	22,960
Brazil	246	20,172
Italy	220	18,040
Sri Lanka	183	15,006
Bangladesh	178	14,596
South Africa	178	14,596
Russia	177	14,514
Switzerland	168	13,776
Philippines	157	12,874
Greece	155	12,710
Egypt	134	10,988
Norway	129	10,578
Chile	128	10,496
Spain	119	9,758
Finland	117	9,594
Saudi Arabia	114	9,348

Table A1.2, continued Number of Firms and Observations by Country

Country	Number of firms	Obs.
Netherlands	105	8,610
New Zealand	105	8,610
Mexico	98	8,036
Peru	87	7,134
Jordan	83	6,806
Belgium	75	6,150
Ireland	71	5,822
Oman	71	5,822
Argentina	65	5,330
Romania	63	5,166
Kuwait	61	5,002
Croatia	57	4,674
Bulgaria	54	4,428
Colombia	49	4,018
Austria	45	3,690
Cyprus	45	3,690
United Arab Emirates	45	3,690
Mauritius	44	3,608
Luxembourg	39	3,198
Jamaica	37	3,034
Portugal	36	2,952
Tunisia	27	2,214
Lithuania	23	1,886
Qatar	21	1,722
Malta	20	1,640
Hungary	18	1,476
Bahrain	17	1,394
Kazakhstan	15	1,230
Estonia	14	1,148
Iceland	14	1,148
Latvia	14	1,148
Trinidad & Tobago	14	1,148
Serbia	12	984
Ukraine	11	902
Macau	10	820
Botswana	7	574
Czech Republic	6	492
Slovakia	6	492

Table A1.3. Number of Firms and Observations by Sector

Sector	Number of Firms	Obs.
Materials	5,433	445,506
Capital Goods	4,888	400,816
Technology Hardware and Equipment	2,286	187,452
Consumer Durables and Apparel	2,032	166,624
Software and Services	2,027	166,214
Pharmaceuticals and Biotechnology	1,833	150,306
Food, Beverage and Tobacco	1,800	147,600
Energy	1,714	140,548
Media and Entertainment	1,398	114,636
Consumer Services	1,315	107,830
Retailing	1,291	105,862
Health Care Equipment and Services	1,287	105,534
Professional Services	1,160	95,120
Transportation	933	76,506
Automobiles and Components	865	70,930
Utilities	854	70,028
Semiconductors	774	63,468
Telecommunication Services	407	33,374
Food and Staples Retailing	383	31,406
Household and Personal Products	361	29,602

Table A1.4. Summary Statistics by Leverage

High Debt							
Stat	**Log difference of investment**	**Log difference capex to lag assets**	**Log difference of revenue**	**Return on assets**	**Log of assets (size)**	**Firm average age**	**Net working capital ratio**
Count	578,167	533,674	843,137	760,256	794,191	1,209,254	832,654
Mean	0.02	0.00	0.02	-2.41	1.61	34.59	0.01
Std	1.03	0.09	0.34	28.07	0.55	28.62	0.63
25th	-0.41	-0.01	-0.09	-0.42	1.41	13.76	-0.03
50th	0.01	0.00	0.02	2.66	1.71	24.76	0.09
75th	0.43	0.01	0.12	5.64	1.96	47.76	0.23

Low Debt							
Stat	**Log difference of investment**	**Log difference Capex to Lag Assets**	**Log difference of revenue**	**Return on Assets**	**Log of Assets (Size)**	**Firm average age**	**Net working capital ratio**
Count	556,704	514,915	750,153	773,571	780,024	1,191,542	831,273
Mean	0.01	0.00	0.02	-4.84	1.36	28.44	0.24
Std	1.10	0.12	0.37	30.78	0.63	25.46	0.56
25th	-0.47	-0.02	-0.10	-3.73	1.13	10.76	0.12
50th	0.00	0.00	0.02	2.03	1.51	19.76	0.29
75th	0.49	0.02	0.13	6.31	1.77	37.76	0.47

Table A1.5. Summary Statistics of Firm-Level Database

Variable	Count	Mean	Std	25th	75th
Log difference of investment	1,164,201	0.0	1.1	-0.4	0.5
Log difference Capex to Lag Assets	1,077,027	0.0	0.1	0.0	0.0
Log difference of revenue	1,621,998	0.0	0.4	-0.1	0.1
Return on Assets	1,540,139	-3.7	29.7	-1.8	5.9
Log of Assets (Size)	1,574,488	1.5	0.6	1.3	1.9
Firm average age	2,461,886	31.4	27.2	11.8	42.8
Net working capital ratio	1,664,821	0.1	0.6	0.0	0.4

Table A1.6. Summary Statistics of Macroeconomic Variables

Variable	Source	Countries	Coverage	Obs.	Mean	Std	Min	Max
Start of Technical Recession	Haver Analytics and World Economic Outlook	106	1960Q2-2022Q4	12,011	0.05	0.21	0	1
Peak-to-through periods (converted to quarterly)	Harding-Pagan (2006)	93	1960q2-2018q4	1,108	0.34	0.47	0	1
Banking crises (converted to quarterly)	Reinhart and Rogoff (2009)	68	1960q2-2014q4	6,488	0.04	0.20	0	1
GDP growth (Q-o-Q)	Haver Analytics and World Economic Outlook	106	1960Q2-2022Q4	12,011	0.83	2.95	-38.02	31.71
Financial Stress	Ahir et al. (2022)	110	2000Q1-2018Q4	8,360	0.03	0.12	0.00	2.08
World Uncertainty Index	Ahir, Bloom and Furceri 2022	143	2000Q1-2021Q4	12,441	0.19	0.20	0.00	2.04
Inflation (CPI growth)	World Economic Outlook	71	1996q1-2021q2	6,782	1.17	2.47	-4.67	62.77
Time-varying fiscal measure of fiscal policy countercyclicality (converted to quarterly)	Choi, Furceri and Tovar-Jalles (2020)	61	2000Q1-2016Q4	4,216	0.25	0.34	-0.84	2.17

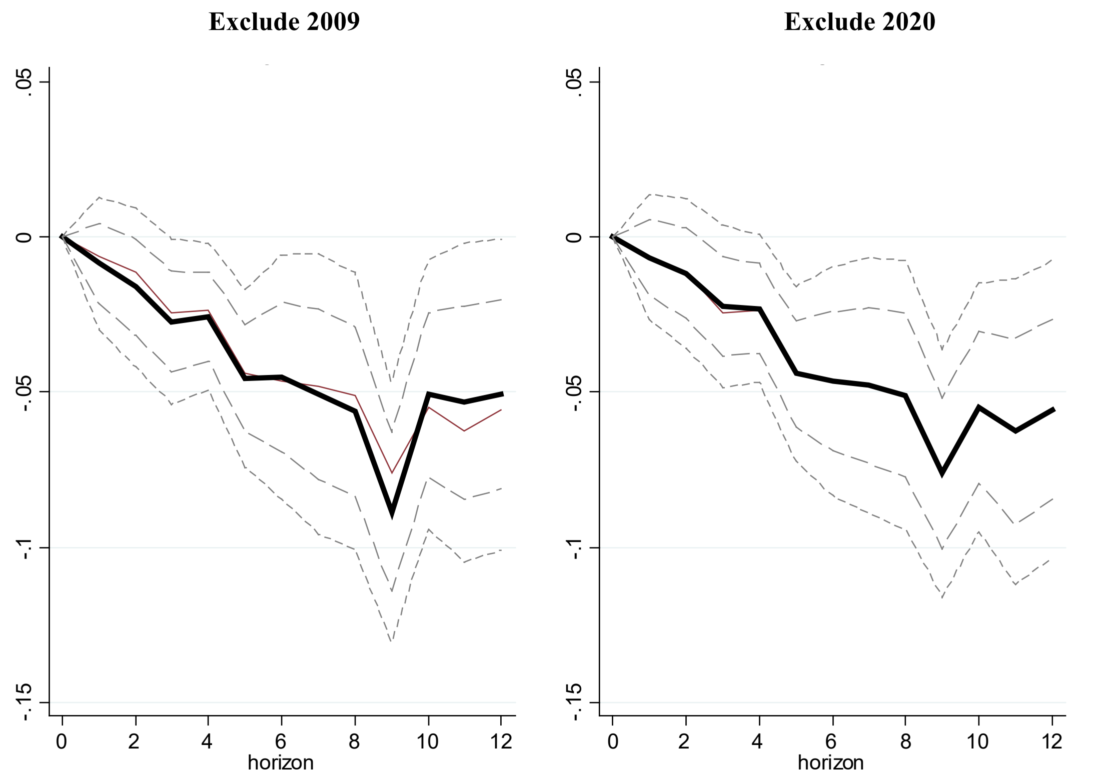
Table A1.7. Correlation of Investment between Capital IQ and World Economic Outlook Data

	(1)	(2)	(3)	(4)
VARIABLES	**Log Investment USD (CIQ)**		**Investment Growth (CIQ)**	
Investment Growth (WEO)			0.942***	0.867***
			(0.207)	(0.211)
Log Investment USD (WEO)	1.173***	1.350***		
	(0.0218)	(0.0693)		
Constant	3.240***	2.556***	14.65***	15.29***
	(0.106)	(0.276)	(2.432)	(2.588)
Observations	1,107	1,107	1,107	1,107
R-squared	0.717	0.925	0.032	0.101
Country FE	NO	YES	NO	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

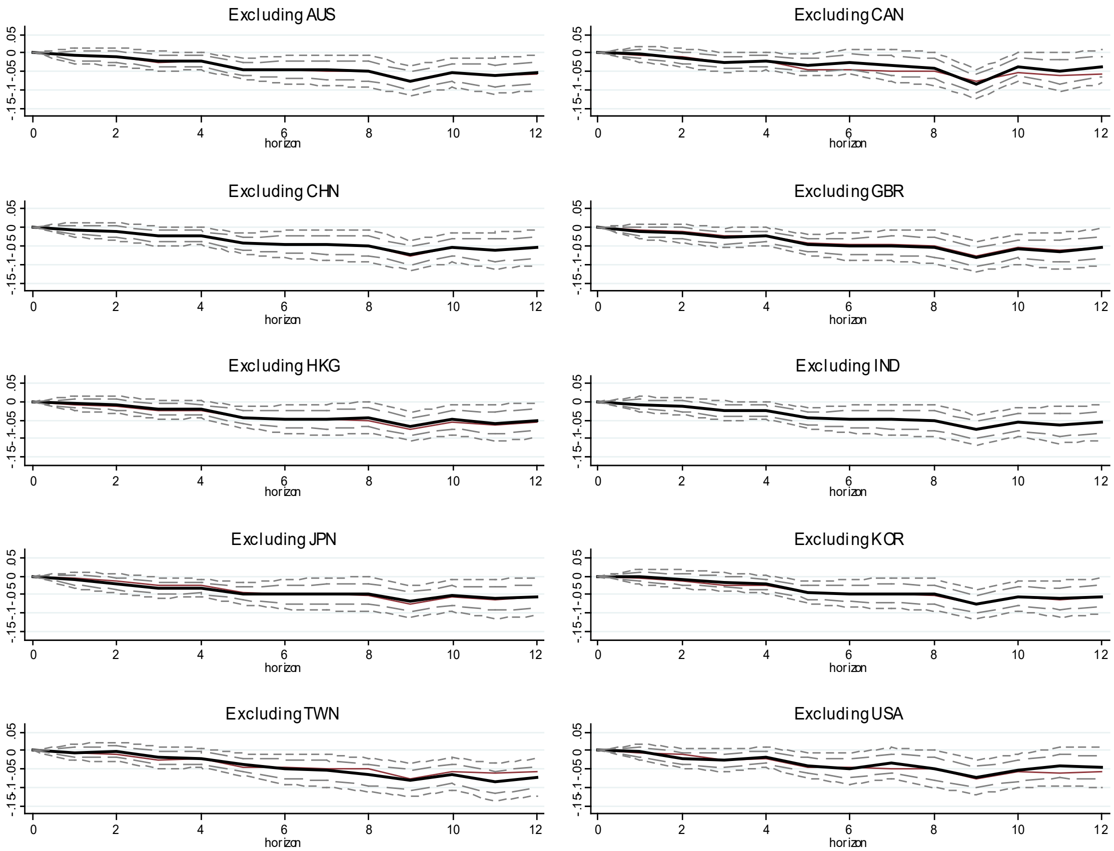
ANNEX 2: ADDITIONAL RESULTS

Figure A2.1: Robustness: Excluding GFC and COVID-19



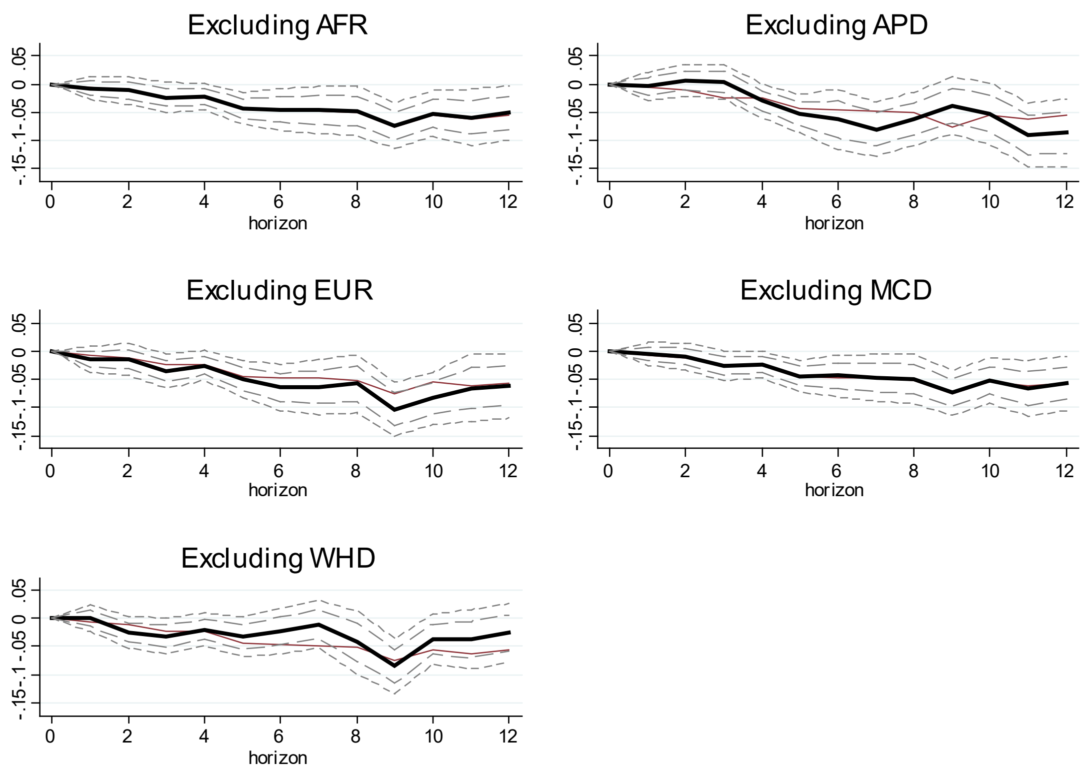
Note: Left panel excludes the year 2009 from the estimation while the right panel excludes the year 2020. Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^k + \gamma_{nq}^k + \sum_{j=0}^{4} \mu_j^k R_{i,t-j} * D_n + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^k$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession, D_n is a dummy variable if company *n* is a high-debt company (above median leverage within industry), γ_{nq}^k are firm-quarters fixed effects, and α_{ist}^k are country-sector-time fixed effects. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure A2.2: Robustness: Excluding Countries with Most Observations



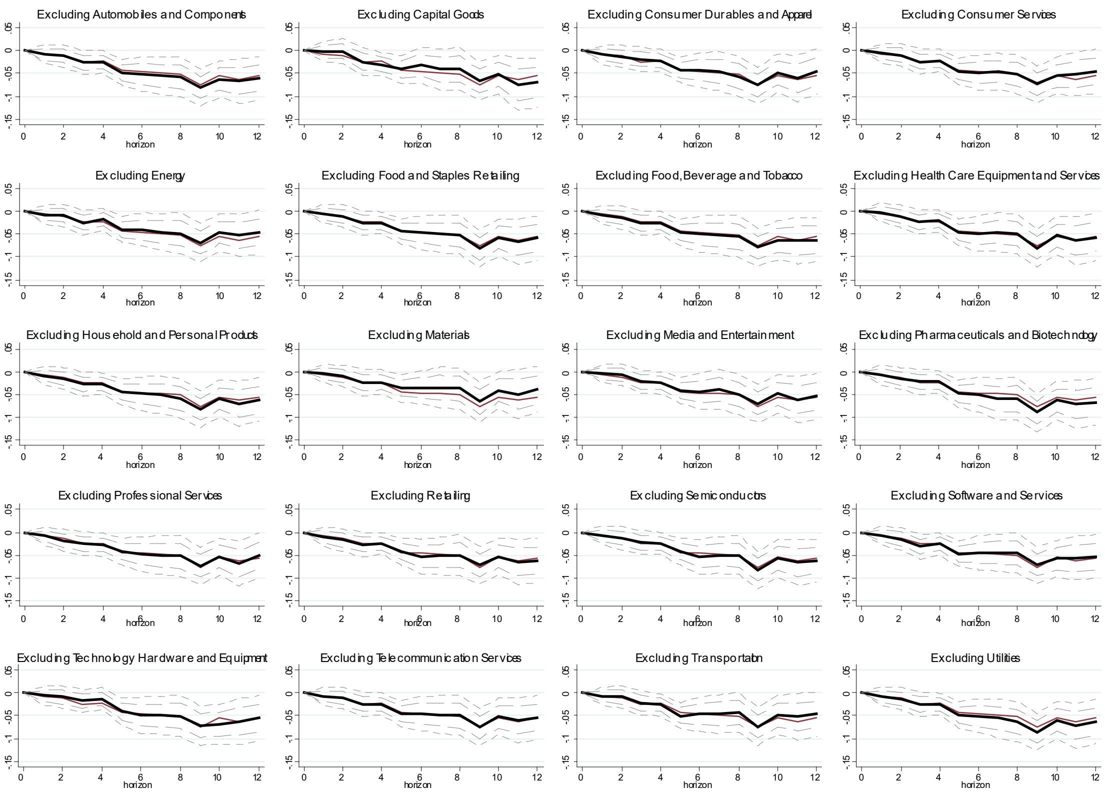
Note: Each impulse response checks robustness to excluding one country from the baseline regression—the 10 countries with the most observations in the sample are excluded one at a time. Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^{k} + \gamma_{nq}^{k} + \sum_{j=0}^{4} \mu_j^k R_{i,t-j} * D_n + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^{k}$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession, D_n is a dummy variable if company n is a high-debt company (above median leverage within industry), γ_{nq}^{k} are firm-quarters fixed effects, and α_{ist}^{k} are country-sector-time fixed effects. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure A2.3: Robustness: Excluding One Region at a Time



Note: Each impulse response checks robustness to excluding one region at a time. Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^{k} + \gamma_{nq}^{k} + \sum_{j=0}^{4} \mu_j^k R_{i,t-j} * D_n + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^{k}$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession, D_n is a dummy variable if company *n* is a high-debt company (above median leverage within industry), γ_{nq}^{k} are firm-quarters fixed effects, and α_{ist}^{k} are country-sector-time fixed effects. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

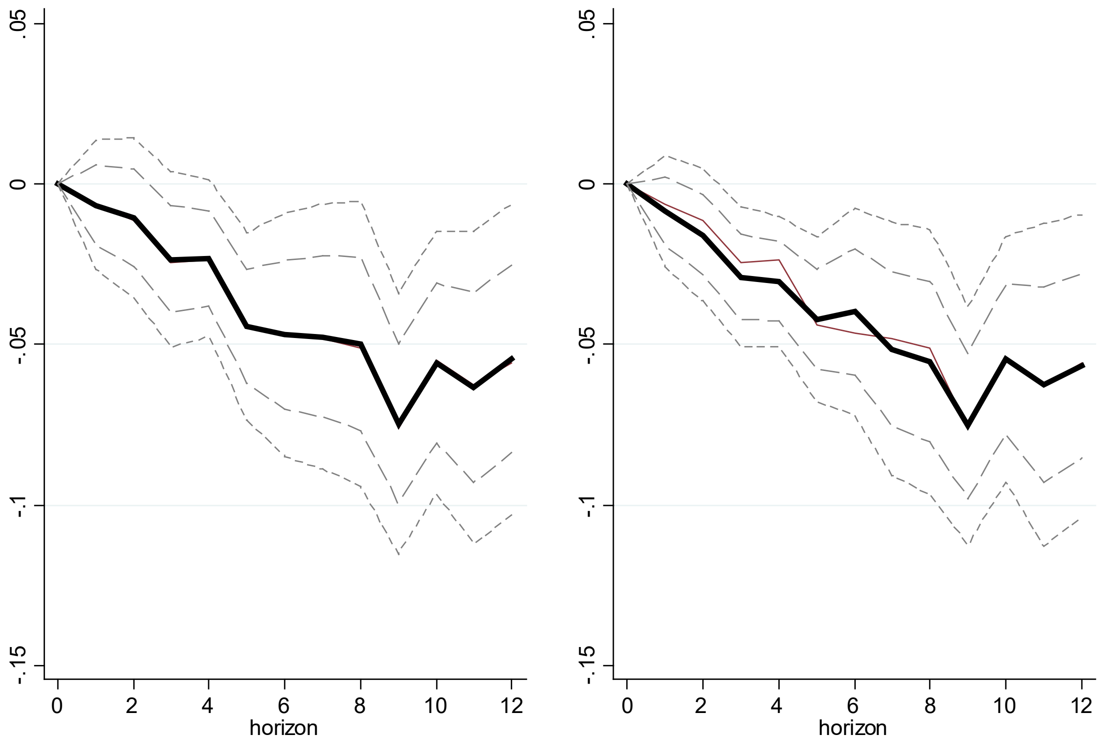
Figure A2.4: Robustness: Excluding One Sector at a Time



Note: Each impulse response checks robustness to excluding one 2-digit sector at a time. Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^{k} + \gamma_{nq}^{k} + \sum_{j=0}^{4} \mu_j^k R_{i,t-j} * D_n + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^{k}$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession, D_n is a dummy variable if company *n* is a high-debt company (above median leverage within industry), γ_{nq}^{k} are firm-quarters fixed effects, and α_{ist}^{k} are country-sector-time fixed effects. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure A2.5: Robustness: Different Winsorizing Schemes

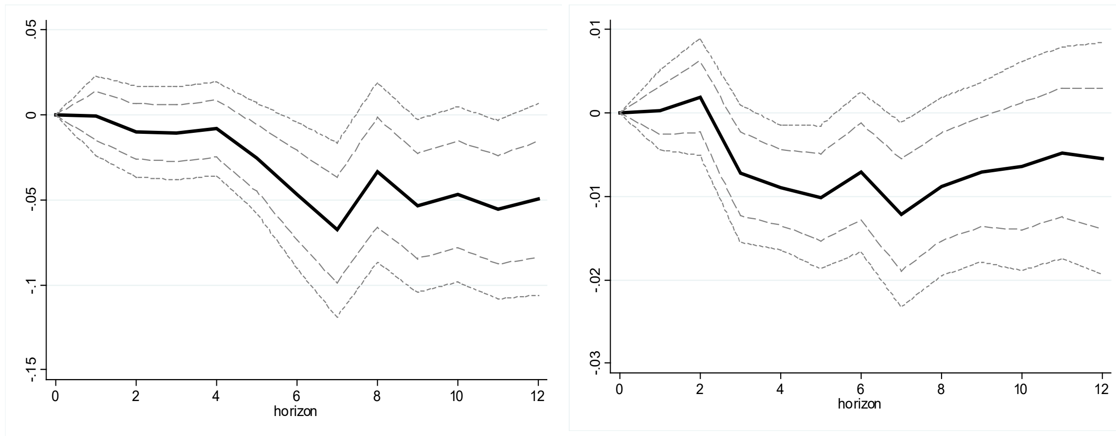
Winsorize 0.05 percent Tails | **Winsorize 5 percent Tails**



Note: Left panel winsorizes 0.05 percent tails of the dependent variable while the right panel winsorizes 5 percent tails of the dependent variable (compared to the baseline which winsorizes 1 percent tails). Impulse response function based on local projection methods following Jorda (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^{k} + \gamma_{nq}^{k} + \sum_{j=0}^{4} \mu_j^k R_{i,t-j} * D_n + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^{k}$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession, D_n is a dummy variable if company *n* is a high-debt company (above median leverage within industry), γ_{nq}^{k} are firm-quarters fixed effects, and α_{ist}^{k} are country-sector-time fixed effects. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure A2.6: Robustness: Different Dependent Variables

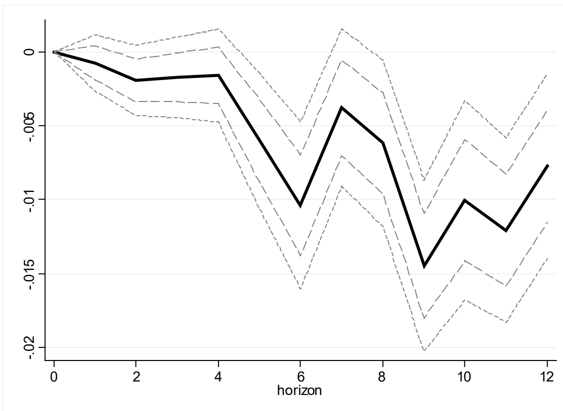
Capex to Lag Assets (log) **Revenues (log)**



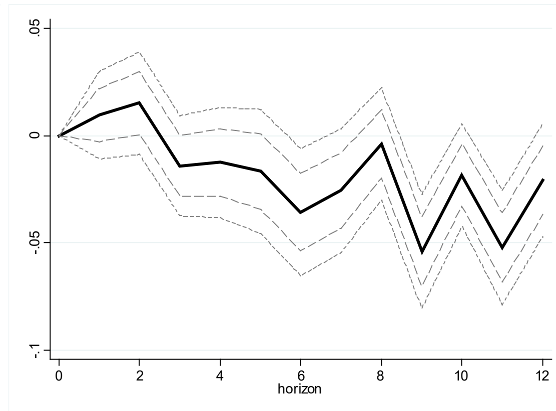
Note: Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^k + \gamma_{nq}^k + \sum_{j=0}^4 \mu_j^k R_{i,t-j} * D_n + \sum_{j=1}^4 \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^k$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession, D_n is a dummy variable if company *n* is a high-debt company (above median leverage within industry), γ_{nq}^k are firm-quarters fixed effects, and α_{ist}^k are country-sector-time fixed effects. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure A2.7: Robustness: Alternate Recessions Variables

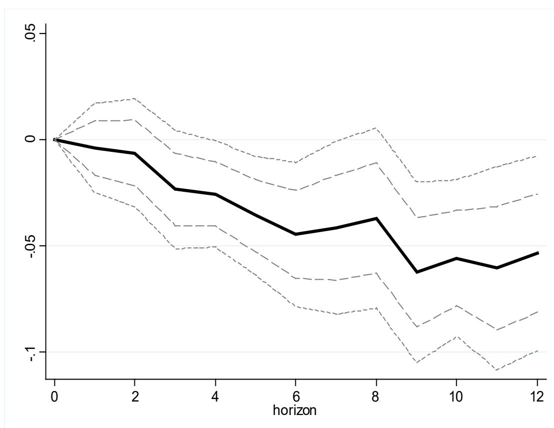
Continuous growth variable (inverted)



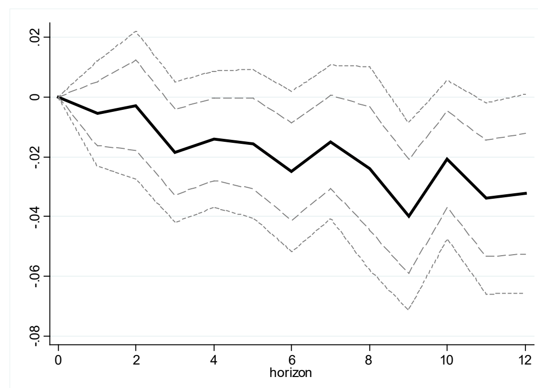
Peaks and troughs in economic activity



Start of financial crises



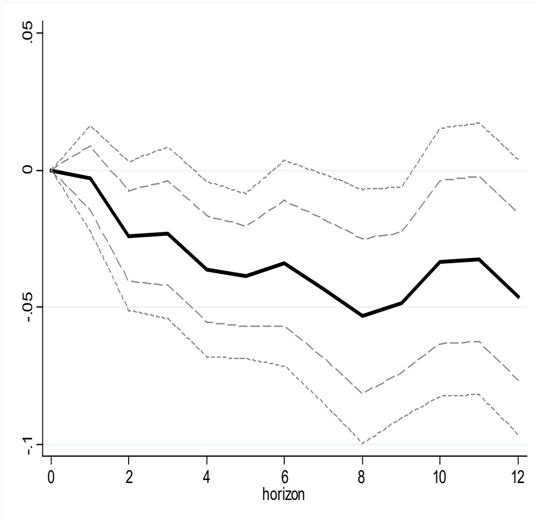
Start of banking crises



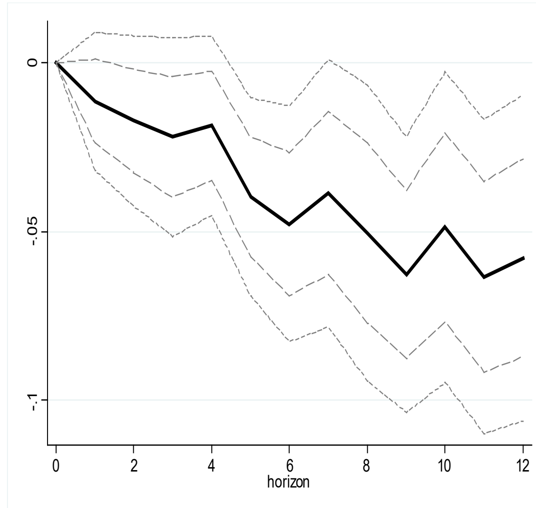
Note: Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^k + \gamma_{nq}^k + \sum_{j=0}^{4} \mu_j^k R_{i,t-j} * D_n + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^k$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 to denote a recession, D_n is a dummy variable if company n is a high-debt company (above median leverage within industry), γ_{nq}^k are firm-quarters fixed effects, and α_{ist}^k are country-sector-time fixed effects. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level. Periods of banking crises are identified as the quarters during which a banking crisis-led recession occurred. Periods of peaks and troughs in economic activity are identified using the Harding-Pagan algorithm applied to real GDP. Periods of negative growth correspond to those where quarterly real GDP growth was negative.

Figure A2.8: Robustness: Alternate Debt Dummies

Above median leverage within country



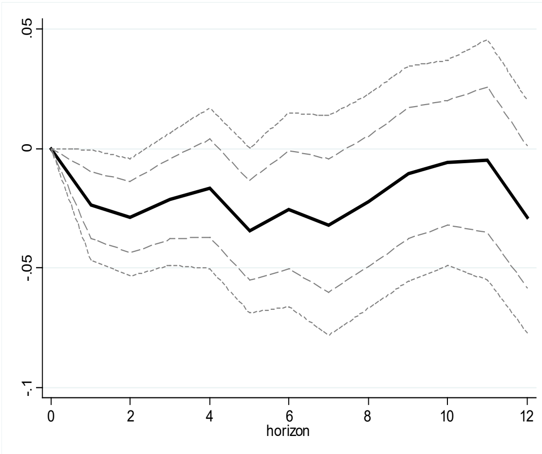
Above median leverage within income group and industry



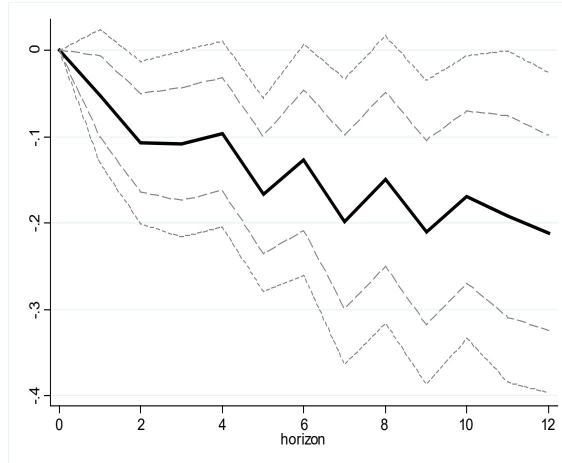
Note: Impulse response functions based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^k + \gamma_{nq}^k + \sum_{j=0}^{4} \mu_j^k R_{i,t-j} * D_n + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^k$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 to denote a recession, D_n is a dummy variable if company *n* is a high-debt company. A high-debt company is identified if its leverage is above the median leverage within country (left-hand graph), or above the median leverage within countries that are advanced economies or EMDEs respectively (right-hand graph). γ_{nq}^k are firm-quarters fixed effects, and α_{ist}^k are country-sector-time fixed effects. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure A2.9: Robustness: Alternate Specifications for High Debt Dummies II

Highest quartile leverage within industry

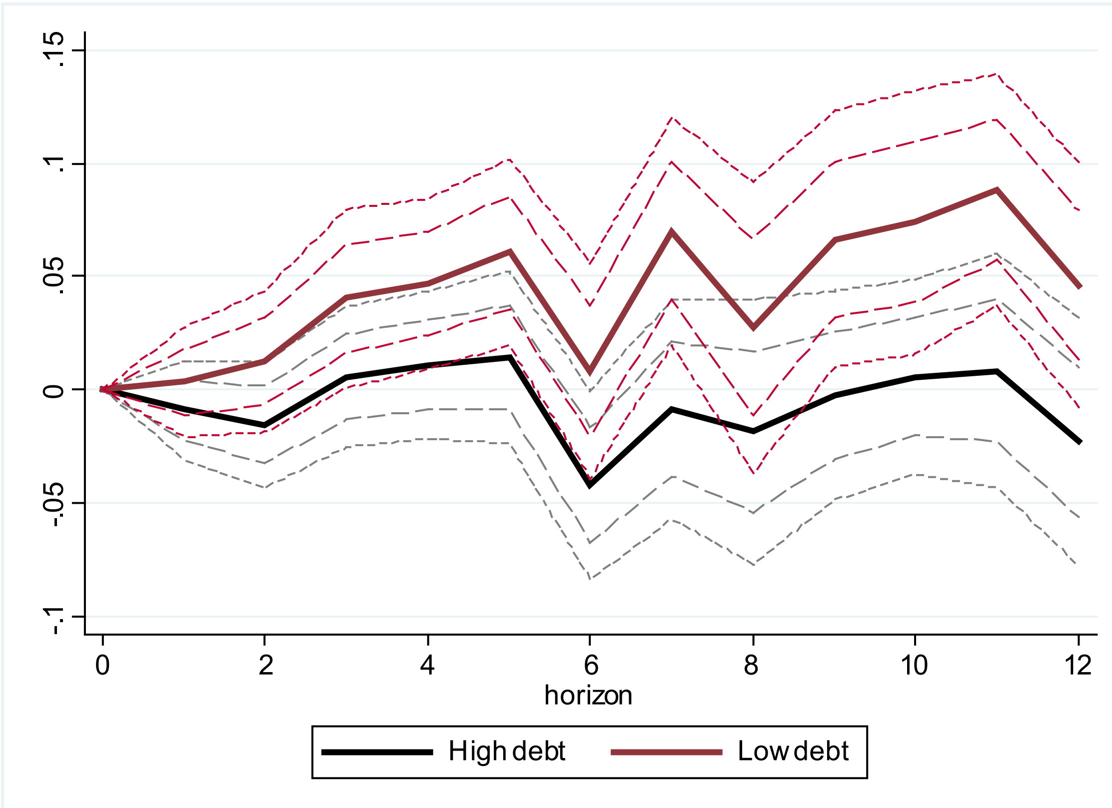


Mean of leverage over time (continuous variable)



Note: Impulse response functions based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^k + \gamma_{nq}^k + \sum_{j=0}^4 \mu_j^k R_{i,t-j} * D_n + \sum_{j=1}^4 \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^k$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 to denote a recession, D_n is a dummy variable if company n is a high-debt company. A high-debt company is identified if its leverage is above the highest tercile (quartile) leverage within industry. γ_{nq}^k are firm-quarters fixed effects, and α_{ist}^k are country-sector-time fixed effects. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

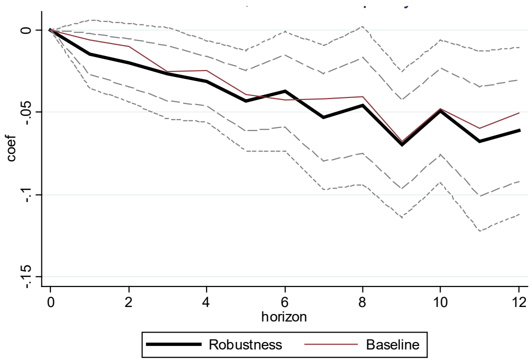
Figure A2.10: Alternative High Debt Specification: Companies in the 2nd Quartiles vs Companies in the 4th quartile



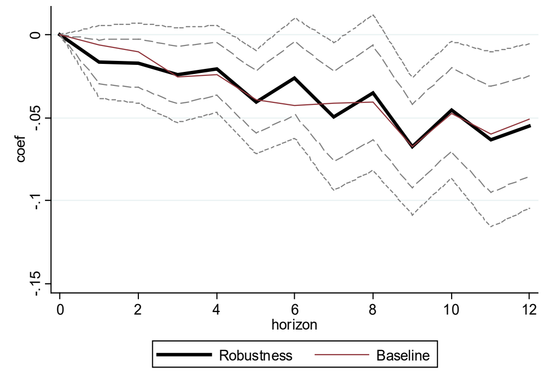
Note: Note: Impulse response functions based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha^k_{ist} + \gamma^k_{nq} + \sum_{j=0}^{4} \mu^k_j R_{i,t-j} * D_n + \sum_{j=1}^{4} \theta^k_j y_{n,i,t-j} + \varepsilon^k_{n,i,t}$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 to denote a recession, D_n is a dummy variable if company n is a high-debt company. A high (low) debt company is identified if its leverage is above (below) the highest (second) quartile leverage within industry. γ^k_{nq} are firm-quarters fixed effects, and α^k_{ist} are country-sector-time fixed effects. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ^k_o for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure A2.11: Robustness: Additional Firm-Level Controls

Control for Size (ln), ROA, and Liquidity

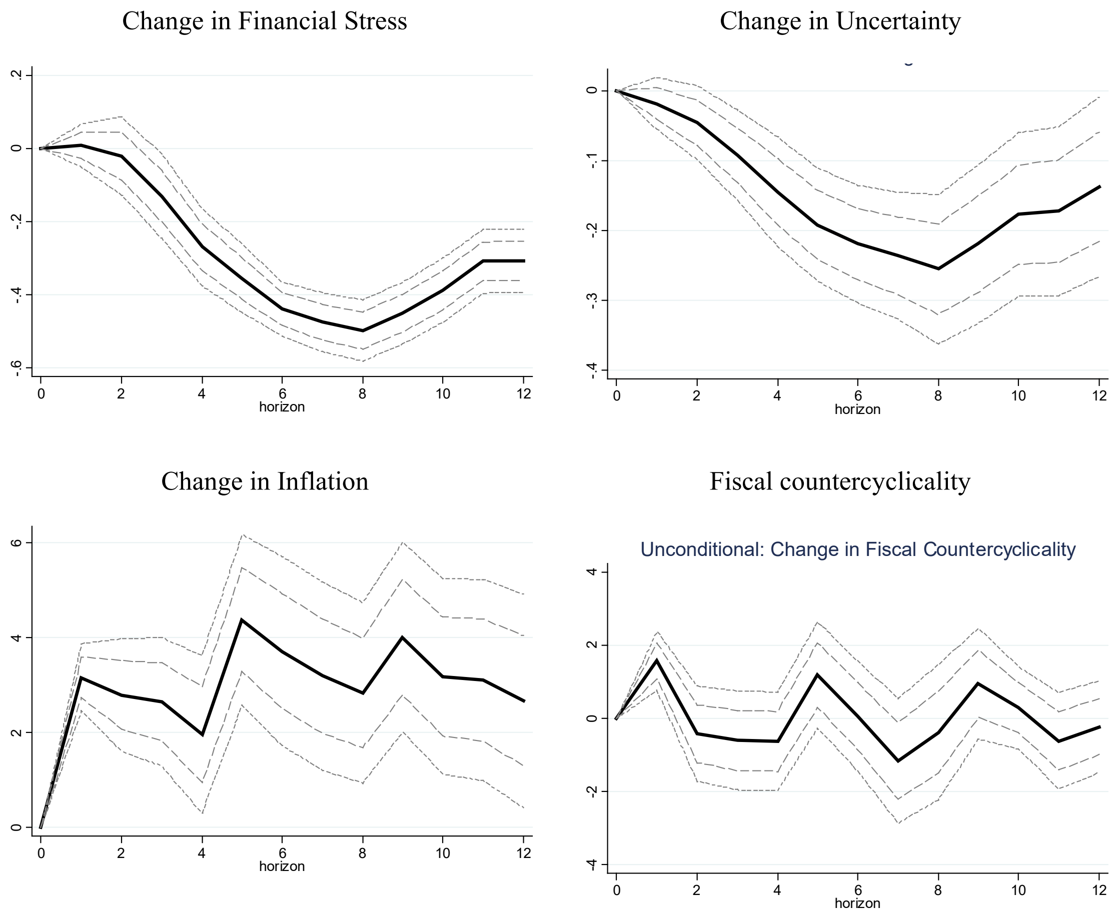


Add Age as Controls



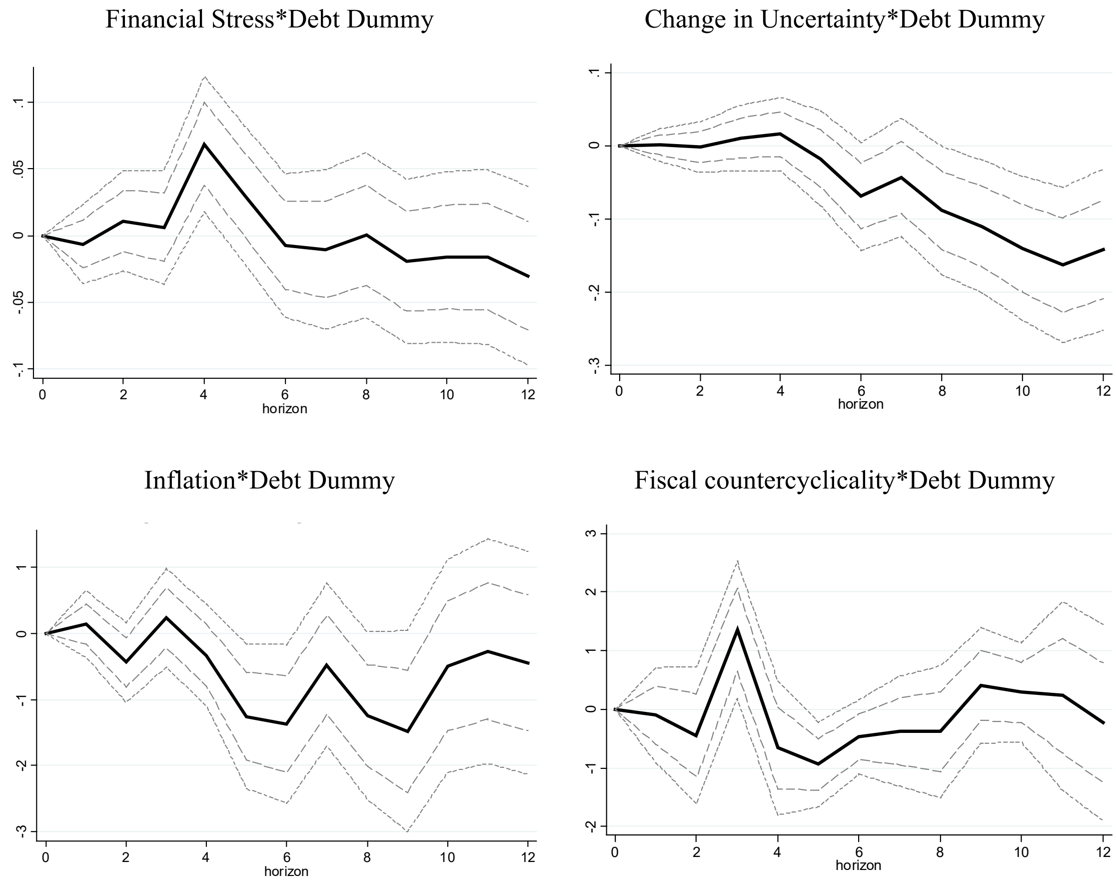
Note: Robustness to adding firm level controls to the baseline. Impulse response function based on local projection methods following Jorda (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^{k} + \gamma_{nq}^{k} + \sum_{j=0}^{4} \mu_j^k R_{i,t-j} * D_n + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \sum_{j=1}^{4} \theta_j^k x_{n,i,t-j} + \varepsilon_{n,i,t}^{k}$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession, D_n is a dummy variable if company *n* is a high-debt company (above median leverage within industry), γ_{nq}^{k} are firm-quarters fixed effects, and α_{ist}^{k} are country-sector-time fixed effects. $x_{n,i,t}$ are additional firm level controls. Left panel includes lags of firm size (ln assets), return on assets, and a measure of liquidity (current assets minus liabilities as a share of assets) as additional controls. The right panel also adds log revenues and the firms age as controls. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for μ_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure A2.12: Unconditional Response of log (Investment) to Macro Variables



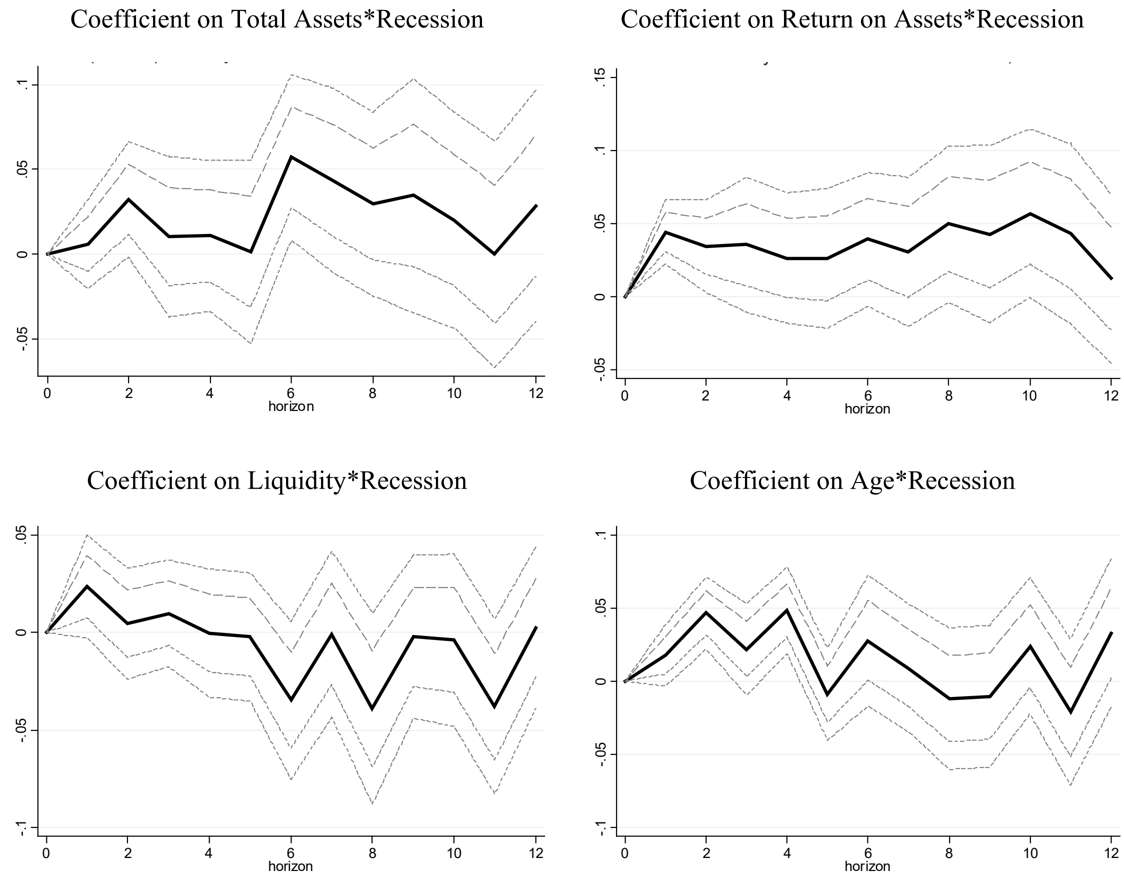
Note: Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{is}^k + \gamma_{nq}^k + \sum_{j=0}^4 \beta_j^k M_{i,t-j} + \sum_{j=1}^4 \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^k$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm *n* in country *i* at time *t* over the next *k* quarters, $M_{i,t-j}$ is different macro variable in different panels, γ_{nq}^k are firm-quarters fixed effects, and α_{is}^k are country-sector fixed effects. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for β_0^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure A2.13: Coefficients on Interaction of Macro Variables with High-debt Dummy as Controls



Note: Robustness check where interaction of macro variables with high-debt dummy are included as controls. Impulse response function based on local projection methods following Jorda (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha_{ist}^k + \gamma_{nq}^k + \sum_{j=0}^4 \mu_j^k R_{i,t-j} * D_n + \sum \nu_j^k M_{i,t-j} * D_n + \sum_{j=1}^4 \theta_j^k y_{n,i,t-j} + \varepsilon_{n,i,t}^k$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession, D_n is a dummy variable if company *n* is a high-debt company (above median leverage in non-recession years within industry), γ_{nq}^k are firm-quarters fixed effects, and α_{ist}^k are country-sector-time fixed effects. Interaction of various macro variable $M_{i,t-j}$ with the high-debt dummy are included as controls. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for ν_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

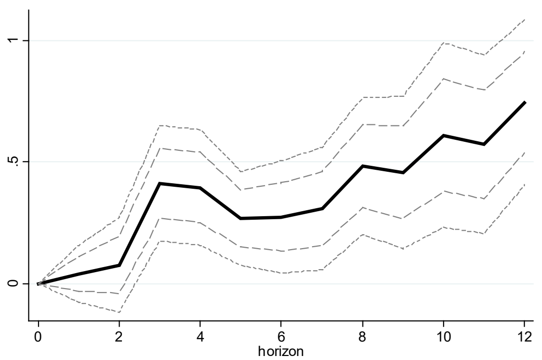
Figure A2.14: Robustness: Coefficient on Interaction of Recession Dummy with Firm Characteristic Dummies



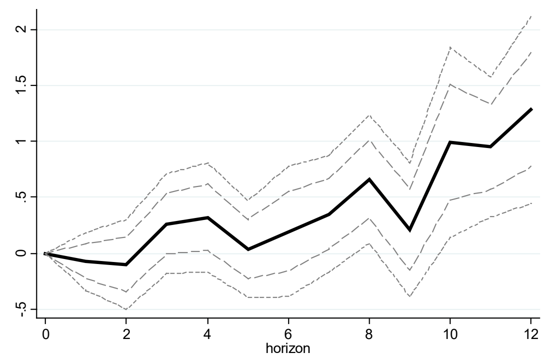
Note: Robustness check where interaction of dummy variables for various firm characteristics and the recession variable are included as controls. Impulse response function based on local projection methods following Jorda (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on the regression $y_{n,i,t+k} = \alpha^k_{ist} + \gamma^k_{nq} + \sum_{j=0}^{4} \mu_j^k R_{i,t-j} * D_n + \sum \nu_j^k R_{i,t-j} * F_n + \sum_{j=1}^{4} \theta_j^k y_{n,i,t-j} + \varepsilon^k_{n,i,t}$ for different horizons 'k', where $y_{n,i,t+k}$ is the log change in capital expenditure of firm n in country i at time t over the next k quarters, $R_{i,t-j}$ is a dummy which takes value 1 at the start of a technical recession, D_n is a dummy variable if company n is a high-debt company (above median leverage within industry), γ^k_{nq} are firm-quarters fixed effects, and α^k_{ist} are country-sector-time fixed effects. F_n is a dummy variable defined analogously to the high debt dummy but for different firm characteristics i.e. firm classified as 1 if it is above the median as per the characteristic when averaged across the entire sample. The regression is estimates separately for different horizons k (for up to 12 quarters). The solid line shows the point estimate for ν_o^k for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

Figure A2.15: Non-linear Effects with Triple Interaction using Smooth Transition Functions

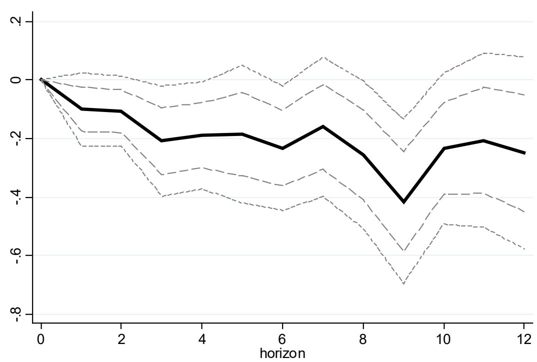
Panel A: Triple Interaction with (log) Assets



Panel B: Triple Interaction with ROA



Panel C: Triple Interaction with Share of Short-term Debt



Note: Impulse response function based on local projection methods following Jordà (2005) using firm-level quarterly data from 75 countries for the period 2001Q1 to 2020Q4. Estimates based on equation 3 for different horizons 'k', where the firm level characteristic $X_{n,i,t}$ is transformed using a smooth transition function $G(X_{n,i,t}) = \frac{1}{1+\exp(-X_{n,i,t})}$ before interacting with the debt and recession dummies. The solid line shows the point estimate for ν_o^k, the coefficient on the triple interaction term, for different horizons k, while the dotted lines are the 68 percent and 90 percent confidence intervals. Standard errors are clustered at two-way at the firm and country-time level.

PUBLICATIONS

Scarring and Corporate Debt
Working Paper No. **WP/2022/211**