IDB WORKING PAPER SERIES Nº IDB-WP-1316

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Rodrigo Heresi
Andrew Powell

Inter-American Development Bank
Department of Research and Chief Economist

September 2022

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Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Heresi, Rodrigo.
Corporate debt and investment in the post-Covid world / Rodrigo Heresi, Andrew Powell.
p. cm. — (IDB Working Paper Series ; 1316)
Includes bibliographic references.
1. Corporate debt-Latin America. 2. Corporate debt-Caribbean Area. 3. Crisis management-Latin America. 4. Crisis management-Caribbean Area. 5. Financial leverage-Latin America. 6. Financial leverage-Caribbean Area. I. Powell, Andrew. II. Inter-American Development Bank. Department of Research and Chief Economist. III. Title. IV. Series.
IDB-WP-1316

http://www.iadb.org

Corporate Debt and Investment in the Post-Covid World

Rodrigo Heresi (IDB) and Andrew Powell (IDB) *

September 16, 2022

Abstract

We study the relationship between corporate debt, corporate risk and firm-level investment, using a sample of 25,000 listed companies across 47 countries over the last two decades. We find higher leverage reduces investment but show the effect varies with risk, as measured by firm time-varying distance to default. Firms with higher market valuations and lower volatility do not suffer a debt overhang at all, while the effect is exacerbated for riskier firms. Debt overhang effects worsen significantly in economic crises, and the effects may persist for two to three years after the shock. Given the rise in corporate leverage observed during the last decade and as a result of the Covid-19 pandemic, physical investment is expected to remain at low levels for some years to come, with impacts varying considerably depending on the economic sector and other risk determinants.

Keywords: Firm Investment, Corporate Debt, Corporate Risk

JEL Codes: E22, F34, G32

*We would like to thank Eduardo Levy-Yeyati, Ugo Panizza, Teresa Ter-Minassian, and other participants at IDB's seminars for useful comments and suggestions. We also thank Daniela Villacreces Villacis for her excellent research assistance. The views expressed are strictly those of the authors and do not necessarily reflect the views of the Inter-American Development Bank, its Board of Directors or the countries they represent.

1 Introduction

Corporate debt rose sharply during the Covid-19 pandemic, leading to the possibility that investment may suffer due to a debt overhang. The literature suggests that if debt is too high, creditors may not expect full repayment with high confidence, restricting financing and depressing investment (see Myers (1977), Krugman (1988), and Kalemli-Özcan et al. (2018)).

Firms with high debt or high interest payments may find it challenging to raise capital because, in case of default, the proceeds of those investments may benefit existing debt holders instead of new investors;see Philippon (2009). Other articles emphasize that high debts may reduce private investment, especially in bad times, through counter-cyclical default risk (see Gomes et al. (2016); Ottonello and Winberry (2020)).

We study the impact of corporate leverage on firm-level investment in a quarterly sample of listed companies across 47 emerging and developed countries. However, we are also interested in whether, in addition to leverage, corporate risk may exacerbate or reduce a potential debt overhang. Hence, in addition to balance sheet information, we collect daily data on market capitalization for firms and build a quarterly-frequency time-varying, firm-level distance to default measure following Merton (1974) and Gilchrist and Zakrajšek (2012).[1]

Our empirical results are consistent with the classic theory of a debt overhang. In addition, we also document how the negative impact of high initial leverage on investment increases with firms' probability of default, and how the effect tends to vanish when looking at companies with high credit ratings and very low default probability.

We document our debt overhang estimates across geographic regions and economic sector, and we employ different measures of investment including both gross and net investment rates. The results are remarkably consistent and are robust to alternative regression specifications.

We also investigate how the impacts of debt overhangs have evolved in the last decade and quantify how the detrimental effects on investment are amplified during economic recessions.

Finally, we study the sluggish response of firm investment rates after economic recessions, as a function of initial leverage and other firm characteristics. The results on the persistent debt overhang effects during the Global Financial Crisis may shed light on the speed of the recovery after the Covid-19 shock.

Our empirical strategy consists of a series of panel regressions and a difference-in-difference approach to identify the effect of corporate debt on investment. Following Kalemli-Özcan et al. (2018), we use $industry \times country \times quarter$ fixed effects to control for aggregate demand shocks. Firm fixed effects are also included to absorb permanent productivity differences across firms.

Our findings are as follows. First, high initial leverage reduces investment in normal times and especially during crises. Second, the negative relationship between leverage and investment is more pronounced for firms with a high probability of default, after controlling for other firm characteristics such as size, profitability, and roll-over risk (measured through Interest Coverage Ratios). Third, the negative effect of firm leverage on investment may persist for 3-5 years after an economic recession, especially in emerging economies.

[1] Schaefer and Strebulaev (2008) show that distance to default accounts well for variation in corporate bond prices.

2 Data and Descriptive Stats

For the analysis in this paper, we combine estimates of firms' distance to default, generated from stock market valuations and information from firm balance sheets, with more standard firm balance sheet information. We first describe the balance sheet data and then the methodology to estimate the firm-level distance to default measures.

2.1 Balance Sheet Data

We build a quarterly panel of publicly listed firms from 47 countries for the period 2002q1-2021q1. Our comprehensive balance sheet data are sourced from Refinitiv. The advantage of using listed firms is that it allows for a systematic investigation across many advanced[2] and emerging[3] countries using quarterly frequency, thereby gaining significant power and degrees of freedom. We can then include fixed effects in our main econometric specifications with fixed effects. A caveat of our analysis is that the dataset we employ is not representative of firms in most economies. Rather, it consists of the larger firms that account for the majority of investment. As we are interested in how debt levels impact investment, we feel this should be of considerable interest.

2.2 Distance to Default Estimation

We construct firm-level measures of default risk using the distance-to-default framework developed by Merton (1974). This method has been used extensively in the corporate finance literature. An alternative would be to look for direct market estimates such as spreads on credit default swaps, but these are not available or not liquid for many firms.[4] The exposition here closely follows the discussion in Gilchrist and Zakrajšek (2012), Ottonello and Winberry (2020) and Moretti (2020).

Merton's framework relies on two simplifying assumptions. First, the value of a firm (V) follows a geometric Brownian motion (the continuous time analog of a discrete time random walk process):

$$\frac{dV}{V} = \mu_V dt + \sigma_V dW$$

where μ_V represents the expected (continuously-compounded) return on V, σ_V governs the volatility of the process, and dW is a standard Wiener process. Second, for tractability, it is assumed that the firm has issued only 1 discount bond maturing in T periods, thereby ignoring coupons, dividends, penalties to short sales, and so on.

The key insight is that, under these two assumptions, the equity of a firm can be viewed as a call option on the underlying value of the firm (V), with a strike price equal to the face value of

[2]Advanced Countries (28): Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Israel, Italy, Japan, South Korea, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan, United Kingdom and United States of America

[3]Emerging non-LAC countries (19): Brazil, Chile, China, Colombia, India, Indonesia, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Russia, Saudi Arabia, South Africa, Thailand, Turkey, Ukraine and United Arab Emirates

[4]For instance, corporate CDS are only available for a subset of listed firms (the largest ones) and a subset of countries (the most developed ones).

the firm's debt (D). According to the Black-Scholes-Merton option-pricing theory, the value of the firm's equity satisfies:

$$E = V\Phi(\delta_1) - e^{rT}D\Phi(\delta_2) \tag{1}$$

where $\delta_1 = \dfrac{log(V/D) + (r + 0.5\sigma_v^2)T}{\sigma_v^2\sqrt{T}}$, $\delta_2 = \delta_1 - \sigma_v\sqrt{T}$, r is the *daily* risk-free rate (one-year constant maturity Treasury-yield), and Φ denotes the cdf of the standard normal distribution. We solve for V and σ_V given observable variables E (market capitalization) and D.[5]

After solving iteratively for V and σ_V, the firm's distance-to-default can be computed as:

$$dd = \frac{log(V/D) + (\mu_V - 0.5\sigma_V^2)T}{\sigma_V\sqrt{T}} \tag{2}$$

The iterative algorithm is as follows:

- Guess initial value $V = E + D$.
- Get the implied firm's return as the daily log return on assets, $dV = \Delta \log V$
- Estimate the mean μ_V and std. dev. σ_V of the firm's return over a 250-day moving window
- Obtain a new estimate of V using (1) for every day of the 250-day moving window
- Iterate until V converges.
- Get dd using (2) and the probability of default using $pd = \Phi(-dd)$.

In this framework, dd measures the number of standard deviations the log of V/D must deviate from its mean for a default to occur.

2.3 Descriptive Statistics

Table 1 provides descriptive statistics on the main variables used in the empirical analysis to follow. There are between 0.7 and 1.5 million observations for each of the variables, as some firms have missing data regarding some of the balance sheet items. The mean (median) debt to assets ratio is 22 (17) percent over the whole sample, and the mean (median) total liabilities to assets is 52 (48) percent, suggesting relatively high average levels of capital for listed companies worldwide. Still, total liabilities may include many types of claims, so we prefer to use (interest-bearing) debt outstanding to construct our baseline measure of leverage. Similarly, to maximize coverage we use total assets reported as the main denominator to scale ratios. Our main left-hand-side variables of interest are investment rates. The mean **gross** investment rate is 6% of total assets and 24% of the stock of capital, while the corresponding medians are 3% and 10%. In turn, the mean **net** investment rate is 2% of assets and 8% of capital, with medians around zero.

[5] We follow the common practice in credit agencies of measuring D as the sum of the firm's short-term debt and one half of long-term debt (see Moretti (2020)).

Table 1: Descriptive Statistics

	Obs.(mm) (1)	Mean (2)	SD (3)	Skew. (4)	Kurt. (5)	p25 (6)	p50 (7)	p75 (8)	Min (9)	Max (10)
Leverage Ratios:										
Total Liabilities/Assets	1.51	0.52	0.36	1.65	6.87	0.28	0.48	0.66	0.04	1.79
Debt Outstanding/Assets	1.51	0.22	0.24	1.69	6.56	0.02	0.17	0.34	0.00	1.14
Total Liabilities/Equity	1.41	1.35	1.53	2.16	7.71	0.36	0.84	1.68	0.04	7.00
Debt Outstanding/Equity	1.42	0.61	0.88	2.36	8.78	0.02	0.29	0.80	0.00	4.13
Investment Rates:										
Real Net Inv./Assets	1.39	0.02	0.13	1.85	9.91	-0.03	-0.00	0.03	-0.30	0.57
Real Net Inv./Capital	0.83	0.08	0.43	2.19	9.45	-0.09	-0.00	0.12	-0.69	1.77
Real Gross Inv./Assets	1.13	0.06	0.08	2.16	7.44	0.01	0.03	0.08	0.00	0.35
Real Gross Inv./Capital	0.72	0.24	0.38	2.58	9.15	0.04	0.10	0.25	0.00	1.64
Other Ratios:										
EBIT/Interest Exp. (ICR)	0.83	26.05	74.06	2.23	7.62	-1.30	4.26	20.72	-65.54	267.45
Market Capitalization/Assets	1.43	1.54	1.84	2.14	7.04	0.42	0.84	1.78	0.08	7.69
Cash & Short-Term Inv./Assets	1.50	0.20	0.22	1.73	5.68	0.05	0.13	0.27	0.00	0.98
Distance-to-default (TCL)	1.28	4.07	3.40	1.03	4.58	1.72	3.54	5.83	-1.98	17.17

Note: Sample: 47 countries. Period: 2002q1-2021q4. All firm-level variables are winsorized such that their kurtosis falls below a threshold of 10. Total liabilities includes (interest-bearing) debt outstanding, trade credit and other obligations. Investment rates are constructed using $y_t = 4 \cdot i_t/k_{t-1}$, where i_t can be gross or net (quarterly) investment, and k can be total assets (our baseline) or the stock of physical capital.

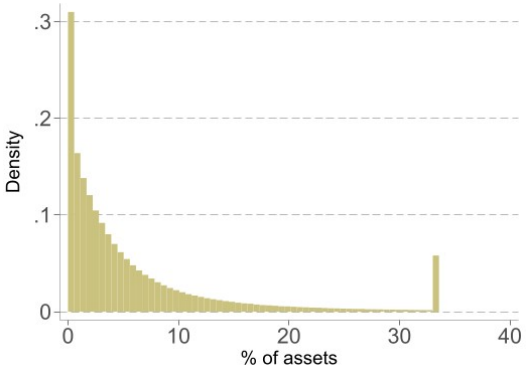
The next key variable for our analysis is corporate risk measured through distance-to-default, with a mean of 4.1 and a standard deviation of 3.4. The distribution of distance-to-default is asymmetric with a ratio p75/p25 of 5.83/1.72=3.4 times. Still, many of these variables have quite asymmetric distributions too; see Figure 1. Many firms have low debt, low cash holdings and low gross investment-to-asset ratios, while there is a tail of firms with much higher ratios for these variables. On the other hand, the distribution of our distance-to-default measure (which is a non-linear transformation of stock market valuations and some balance sheet variables) appears to be close to log normal. We will come back to this point in the discussion of the methodology and the results.

Figure 2 displays the time evolution of key variables for the median firm in our cross-country database. Appendix A reports analogous timelines broken down by geographic regions. Gross investment had been on a declining trend for several years but then collapsed during the Covid crisis, as shown in Panel (a). In addition, as can be seen in Panel (b), debt to assets had been flat for some years and then skyrocketed in 2020. Interestingly, cash to assets rose strongly in Covid, reflecting the increased demand for liquidity (Panel (c)) and distance to default fell sharply, from 4 standard deviations to 2 (Panel (d)). Interestingly, this was a milder fall than during the global financial crisis (which was from four standard deviations to below one).

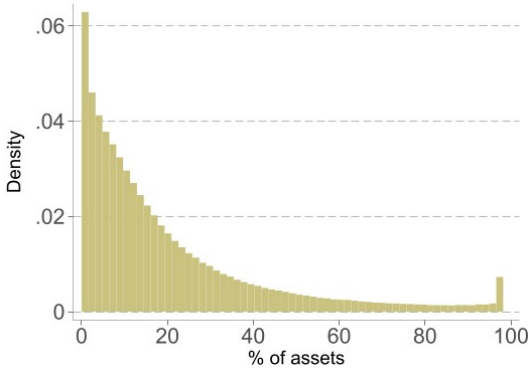
Finally, panel (e) illustrates the interest coverage ratio (ICR = EBIT/Interest Payments) which shows whether a firm is able to cover interest payments with its current earnings; a value below one is often considered a sign of financial distress. Panel (f) shows the share of financial distressed firms, defined as companies with $ICR < 1$. We use the latter as an additional control in our econometric specifications, as is common in the literature (See Kalemli-Özcan et al. (2018) and Borensztein and Ye (2018)).

Figure 1: Distribution of Key Variables

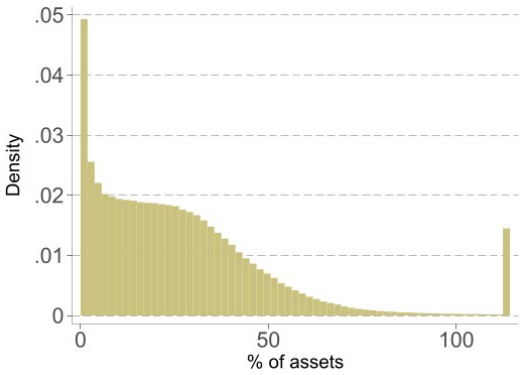
(a) Gross Investment / Assets



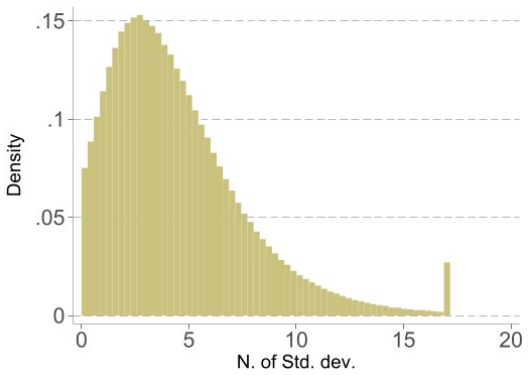
(b) Cash ST / Assets



(c) Debt / Assets



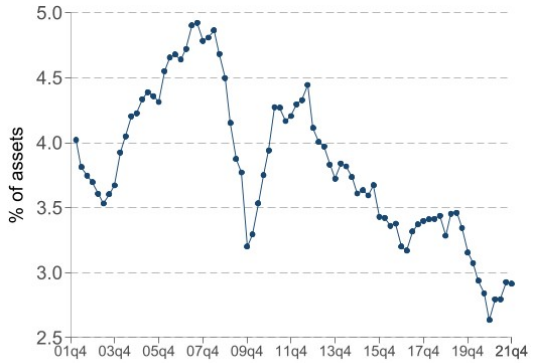
(d) Distance to default



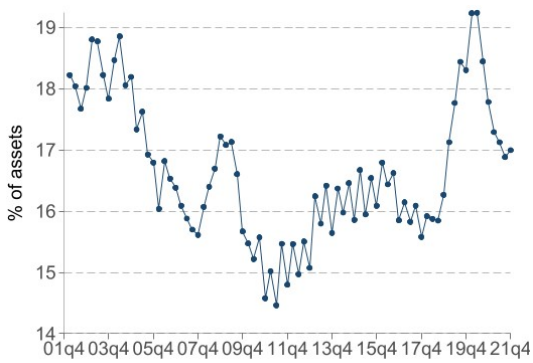
Note: Panels (a), (b) and (c) are in % of total assets. Panel (d) is measured in number of standard deviations. All variables are winsorized at 2%. Panel (c) excludes observations with zero debt outstanding, while Panel (d) excludes a small fraction of observations that numerically yield negative distance to default. These are firms with either large D over the estimated V (see equation (2)) and/or very volatile stock prices (high σ_V).

Figure 2: Evolution of Key Variables (medians)

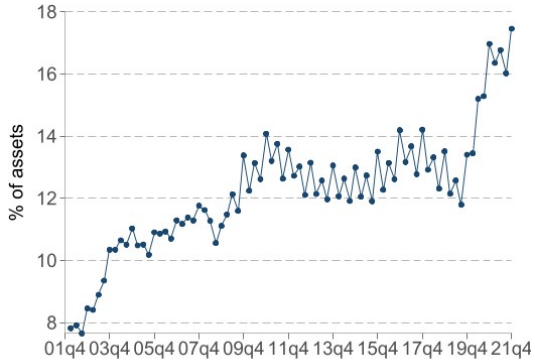
(a) Gross Investment / Assets



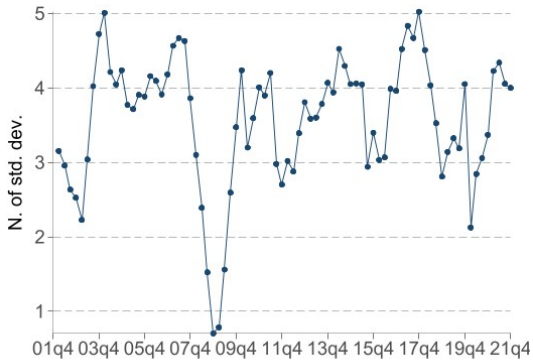
(b) Debt / Assets



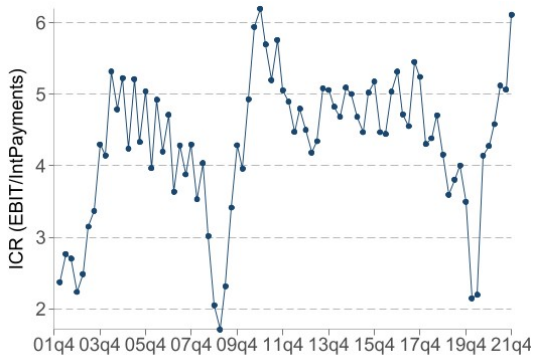
(c) Cash / Assets



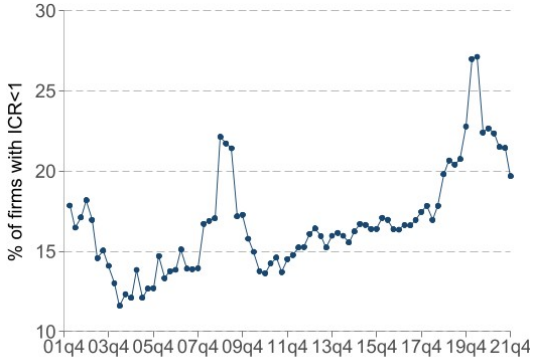
(d) Distance to default



(e) $ICR =$ EBIT / IntPayments



(f) Share of firms with $ICR < 1$



Note: All figures report **medians** by date, pooling firms from all countries in the sample.

3 Models of Corporate Investment

This section documents corporate debt overhang effects in normal times and during economic crises. We document heterogeneous effects of high debt on investment for firms with different degrees of risk. Debt rose during the Covid crisis in Latin America, giving rise to potential debt-overhang impacts on investment, although the latest data reveal some fall in debt levels. Finally, we report persistently negative dynamic responses of investment for firms with ex ante high corporate debt and/or high corporate risk.

3.1 Corporate Investment, Debt and Risk

Let $y_{isc,t} = \frac{i_{isc,t}}{k_{isc,t-1}}$ be the physical investment rate (either gross or net of depreciation) for firm i in quarter t in sector s and country c. To ease notation, we use shorthand $y_{i,t} = y_{isc,t}$ where both sector and country dependence is understood. We extend the baseline model of corporate investment in the literature to include our firm-level measure of corporate risk as follows:

$$y_{i,t} = \beta_1 \ell_{i,t-j} + \beta_2 dd_{i,t-j} + \beta_3 dd_{i,t-j} \times \ell_{i,t-j} + \gamma FIRM_{i,t-j} + \alpha_i + \alpha_{sct} + \varepsilon_{i,t}$$

where $y_{i,t}$ is the investment rate, $\ell_{i,t}$ is corporate leverage (measured as debt/assets) and $dd_{i,t}$ is distance-to-default. The vector of controls $FIRM = \{cash, icr, size\}$ includes standard determinants of investment used in the literature, $cash_{i,t}$ is cash assets and short-term investments, $icr_{i,t}$ is a dummy indicator equal to one when the interest coverage ratio (EBIT/Interest Payments) is above one (zero otherwise), and $size_{i,t}$ is measured as the log of assets. The total effect for leverage is evaluated at the median distance to default $\bar{dd}^{p50}$ and vice versa, as follows:

$$\frac{\partial y_{i,t}}{\partial \ell_{i,t-j}} = \hat{\beta}_1 + \hat{\beta}_3 \bar{dd}^{p50}$$
$$\frac{\partial y_{i,t}}{\partial dd_{i,t-j}} = \hat{\beta}_2 + \hat{\beta}_3 \bar{\ell}^{p50}$$

Table 2 presents the baseline results for alternative specifications of the model and pooling the full sample of countries and time periods 2002q1-2021q4. The results indicate that high leverage and a low distance to default (high corporate risk) have negative impacts on firm investment. For instance, from Column (1), the **total effect** for leverage is -0.020 (-2.0 percentage points), a large effect compared to the mean net investment rate over the estimation sample of 0.0156 (1.56 percent of assets). Analogously, using $y_{i,t}$ gross investment/assets (Column (2)), the total effect for leverage is -0.0060 (-0.6 percentage points), which compares with the mean gross investment rate of 0.0583 (5.83 percent of assets). The same results using a four lag model tend to be stronger, with negative effects of -2.92 p.p. for net investment and -1.75 p.p. for gross investment (columns (3) and (4)).

Regarding corporate risk, the total effects of distance to default are also statistically significant, although the quantitative impacts are lower. For instance, one additional unit of dd (lower risk) is associated with 0.33 percentage points higher net investment and 0.21 percentage points higher gross investment, an economically smaller effect compared again to the mean investment rates of 1.56 (net) and 5.83 (gross) percent of assets (columns (1) and (2)). In this case, the analogous results using a four lag model tend to be weaker, with 0.25 p.p. for net investment and 0.17 p.p. for gross investment (columns (3) and (4)).

All additional control variables enter with the expected sign. For instance, we find that lagged $cash$ and icr enter positively, suggesting a positive effect of profitability, liquidity and debt roll-over capacity on firm investment. As is usual in the corporate finance literature, firm size enters negatively, capturing decreasing returns to scale in investment for already large firms.

Table 2: Determinants of Corporate Investment, 47 Countries, 2002q1-2021q2

	(1)	(2)	(3)	(4)
Dep var: invest./assets	Net Invest.	Gross Invest.	Net Invest.	Gross Invest.
	$j = 1$		$j = 4$	
$\ell_{i,t-j}$	-0.0315***	-0.0137***	-0.0292***	-0.0175***
	(0.0018)	(0.0015)	(0.0019)	(0.0015)
$dd_{i,t-j}$	0.0028***	0.0017***	0.0021***	0.0015***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$\ell_{i,t-j} \times dd_{i,t-j}$	0.0032***	0.0020***	0.0020***	0.0012***
	(0.0003)	(0.0002)	(0.0003)	(0.0002)
$cash_{i,t-j}$	0.0742***	0.0076***	0.0586***	0.0259***
	(0.0019)	(0.0016)	(0.0019)	(0.0016)
$icr_{i,t-j}$	0.0081***	0.0036***	0.0088***	0.0047***
	(0.0005)	(0.0004)	(0.0005)	(0.0004)
$size_{i,t-j}$	-0.0051***	-0.0048***	-0.0120***	-0.0088***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Total Effect:				
$\ell_{i,t-j}$	-0.0200***	-0.0060***	-0.0218***	-0.0131***
	(0.0016)	(0.0014)	(0.0016)	(0.0013)
$dd_{i,t-j}$	0.0033***	0.0021***	0.0025***	0.0017***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Stats:				
Observations	1,232,463	1,013,354	1,123,792	943,170
N. firms	32033	28680	28677	27319
N. countries	47	47	47	47
Dep var mean	0.0156	0.0583	0.0146	0.0573
R^2 Adj.	0.203	0.391	0.203	0.402

Note: Results for regression:

$$y_{i,t} = \beta_1 \ell_{i,t-j} + \beta_2 dd_{i,t-j} + \beta_3 dd_{i,t-j} \times \ell_{i,t-j} + \gamma FIRM_{i,t-j} + \alpha_i + \alpha_{sct} + \varepsilon_{i,t}$$

where $y_{i,t}$ is either net investment rate (columns (1) and (3)) or gross investment (columns (2) and (4)), $\ell_{i,t}$ is leverage (debt/assets), $dd_{i,t}$ is distance-to-default, $FIRM = \{cash, icr, size\}$, $cash_{i,t}$ is cash and short-term investments, $icr_{i,t}$ is the interest coverage ratio dummy equal to one if the ratio of EBIT to interest payments is above one, and $size_{i,t}$ is measured as the log of assets. Standard errors clustered at the firm level in parenthesis. Columns (1) and (2) report results for $j = 1$ lag model and columns (3) and (4) use $j = 4$ lags. The total effects are computed at the medians of the remaining covariates (delta method standard errors). ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 3 reports results cutting the data by geographic region: (1) **Global** is our worldwide data including 47 countries, which is broken down into (2) **Advanced** (28 countries) (3) **Emerging** non-LAC (14 countries), and (4) **LAC-5** (5 countries; Brazil, Chile, Colombia, Mexico, Peru). We focus here on net investment rates as dependent variable and $j = 1$ lag for explanatory variables, so that Column (1) in Table 3 will replicate Column (1) in Table 2, while columns (2) to (4) illustrates the geographic variation.

The results point to significant debt overhang effects in Latin American countries as well as in other emerging economies or developed countries. While the unconditional mean gross investment rate is similar across regions (between 5.5% and 6.0% of total assets), the total effect for leverage is -0.6 p.p. for Global, -0.5 p.p. for Advanced countries, -0.97 p.p. for Emerging countries, and -2.3 p.p. for LAC. On the other hand, total effects for distance-to-default are again one order of magnitude lower in size, and similar across regions.

Table 3: Summary of Total Effects for Leverage and Distance-to-Default, by Geographic Region

Dep var: invest./assets	(1) Global	(2) Advanced	(3) Emerging	(4) LAC-5
	(a) Net investment, $j = 1$ lag			
$\ell_{i,t-1}$	-0.0200***	-0.0202***	-0.0213***	-0.0228**
	(0.0016)	(0.0019)	(0.0032)	(0.0106)
$dd_{i,t-1}$	0.0033***	0.0036***	0.0030***	0.0019***
	(0.0001)	(0.0001)	(0.0002)	(0.0003)
	(b) Net investment, $j = 4$ lags			
$\ell_{i,t-4}$	-0.0218***	-0.0182***	-0.0388***	-0.0364***
	(0.0016)	(0.0019)	(0.0034)	(0.0101)
$dd_{i,t-4}$	0.0025***	0.0026***	0.0024***	0.0014***
	(0.0001)	(0.0001)	(0.0002)	(0.0004)
Dep var mean	0.0156	0.0153	0.0164	0.0126
	(c) Gross investment, $j = 1$ lag			
$\ell_{i,t-1}$	-0.0060***	-0.0052**	-0.0097***	-0.0227**
	(0.0014)	(0.0016)	(0.0026)	(0.0096)
$dd_{i,t-1}$	0.0021***	0.0021***	0.0021***	0.0015***
	(0.0001)	(0.0001)	(0.0001)	(0.0003)
	(d) Gross investment, $j = 4$ lags			
$\ell_{i,t-4}$	-0.0131***	-0.0104***	-0.0222***	-0.0346***
	(0.0013)	(0.0016)	(0.0026)	(0.0100)
$dd_{i,t-4}$	0.0017***	0.0017***	0.0018***	0.0013***
	(0.0001)	(0.0001)	(0.0001)	(0.0003)
Dep var mean	0.0583	0.0598	0.0549	0.0559

Note: See Table 2.

Table 4 shows results for the largest SIC economic sectors, pooling all developed and developing countries, and replacing the crossed fixed effects α_{sct} by α_{ct}. The results indicate that all economic sectors show the same pattern, with a significantly negative total effect for leverage ℓ, a positive effect of distance to default dd, and significant positive interaction between leverage and distance to default $\ell \times dd$. Over the last twenty years, the negative effect of corporate leverage on investment has been more pronounced in the retail trade sector (total effect of -5 percentage points) and, to a lesser extent, in transportation services (-3.7 percentage points).

Table 4: Debt Overhang, by Economic Sector

Dep var: net inv/assets	(1) Construction	(2) Manufacturing	(3) Retail trade	(4) Services	(5) Transportation	(6) Wholesale trade
$\ell_{i,t-1}$	-0.0311***	-0.0363***	-0.0613***	-0.0287***	-0.0463***	-0.0355***
	(0.0065)	(0.0024)	(0.0084)	(0.0031)	(0.0062)	(0.0062)
$dd_{i,t-1}$	0.0008**	0.0024***	0.0029***	0.0019***	0.0023***	0.0014***
	(0.0003)	(0.0001)	(0.0004)	(0.0002)	(0.0003)	(0.0003)
$\ell_{i,t-1} \times dd_{i,t-1}$	0.0040***	0.0045***	0.0028**	0.0026***	0.0024**	0.0033***
	(0.0011)	(0.0005)	(0.0013)	(0.0006)	(0.0010)	(0.0010)
$cash_{i,t-1}$	0.0421***	0.0650***	0.0740***	0.0451***	0.0780***	0.0514***
	(0.0066)	(0.0024)	(0.0099)	(0.0026)	(0.0064)	(0.0070)
$icr_{i,t-1}$	0.0026*	0.0103***	0.0112***	0.0043***	0.0061***	0.0051***
	(0.0014)	(0.0006)	(0.0018)	(0.0010)	(0.0019)	(0.0017)
$size_{i,t-1}$	-0.0022*	-0.0058***	-0.0100***	-0.0041***	-0.0039***	-0.0038***
	(0.0012)	(0.0006)	(0.0020)	(0.0006)	(0.0013)	(0.0013)
Total Effect:						
$\ell_{i,t-1}$	-0.0197**	-0.0188***	-0.0500***	-0.0191***	-0.0369***	-0.0252***
	(0.0061)	(0.0023)	(0.0069)	(0.0029)	(0.0056)	(0.0058)
$dd_{i,t-1}$	0.0018***	0.0032***	0.0035***	0.0022***	0.0029***	0.0020***
	(0.0003)	(0.0001)	(0.0003)	(0.0001)	(0.0003)	(0.0003)
Stats:						
Observations	69,466	591,599	64,993	207,832	112,133	57,288
N. firms	1763	15026	1636	6235	2793	1394
N. countries	44	47	40	45	47	37
Dep var mean	0.00684	0.0114	0.0156	0.00913	0.0175	0.00817
R^2 Adj.	0.0948	0.198	0.255	0.137	0.190	0.124

Note: See Table 2. Here we replace the sector-country-date fixed effect α_{sct} by a country-date α_{ct} term. The number of countries varies across specifications, as some countries do not report firms in some sectors.

Overall, the results reveal that the negative effect of high leverage tends to be one order of magnitude larger than the negative effect of high corporate risk, *when looking at the typical (median) firm*, that is, a company with leverage around 17 percent of assets and distance to default around 3.5 (probability of default around 3%), see Table 1. However, the situation changes significantly when evaluating non-average firms, the purpose of the next section.

3.2 Leverage and Heterogeneous Corporate Risk

The debt overhang literature has focused narrowly on firm leverage. However, leverage by itself likely does not capture the impacts of carrying higher debt on investment. Firms in very stable sectors or that are well-diversified may be able to carry more debt without negative impacts on

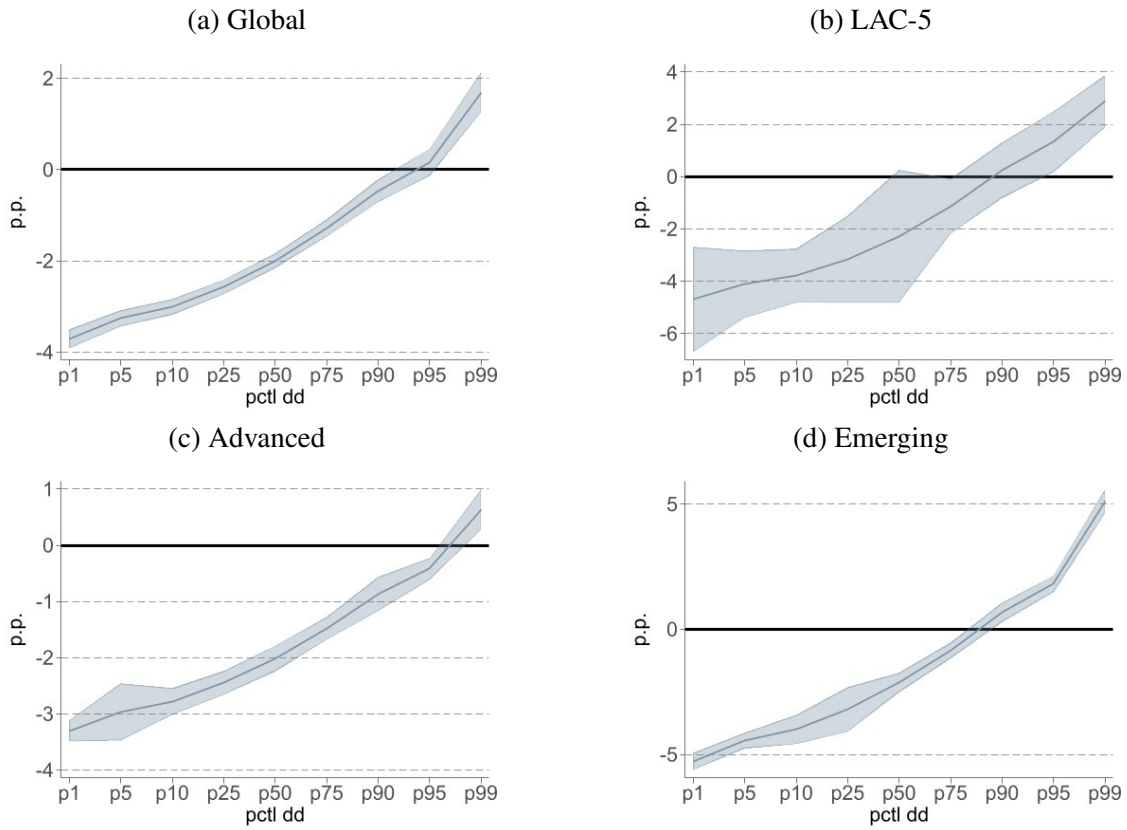
firm investment and growth. The distance-to-default measure incorporates firm debt levels but also a measure of the market value of firm assets and the risk to firm valuations as measured by stock price volatility through the medium of option pricing theory. Even though two firms may have the same level of debt, one may have a high current market value of assets and low volatility, implying a low default probability and a high distance to default, while the other may score badly on these measures. The latter may then suffer from a debt overhang, while the former may escape such an effect entirely. We test this hypothesis in this subsection by evaluating the total effect of leverage on investment at different values of the distribution of distance to default, as follows:

$$\frac{\partial y_{isc,t}}{\partial \ell_{isc,t-j}} = \hat{\beta}_1 + \hat{\beta}_3 \bar{dd}^p$$

for $p \in \{p1, p5, p10, p25, p50, p75, p90, p95, p99\}$. The baseline results in the previous section were computed as total effects at the median ($p50$) distance-to-default.

Figure 3 illustrates the results using $y_{i,t}$ = net investment rate as the dependent variable and $j = 1$ lag for right-hand-side regressors. For the full sample of countries in panel (a), the total overhang effect ranges from -3.8p.p. for dd^{p1} (riskiest firms) to +1.8 p.p. for firms at dd^{p99} (safest firms). These are again large and significant effects compared to the mean net investment of 1.56 percent of assets. The impact of a debt overhang is increasing in corporate risk. Moreover, there may be no debt overhang at all at the right tail of the dd distribution, as more debt may even lead to higher future investment for very low-risk firms (see all panels).

Figure 3: Total Effects: Leverage, by Percentile of Distance-to-Default



Note: Dependent Variable: **Net** Investment / Assets. Total effects for leverage evaluated at different percentiles of distance to default. Results in percentage points (p.p.). of total assets.

Panel (b) illustrates the results for firms in Latin America (5 countries). The analogous results range from -4.5 p.p. for dd^{p1} to 2.9 p.p for dd^{p99}, which compares with a regional unconditional mean$(y_{i,t}) = 1.26$ percent of assets. Other emerging economies display similar overhang effects as LAC-5 for the riskier firms, -4.8 p.p. for dd^{p1}, although much larger positive effects at the right tail of safer firms, 5 p.p. for dd^{p99} (panel (c)). Unlike emerging countries, in advanced economies only 1% of the firm distribution escape from a negative debt overhang effect (panel (d)). These results are a consequence of the positive complementarity between leverage and decreasing risk (significant $\hat{\beta}_3 > 0$), which may then offset the debt overhang effect via $\hat{\beta}_1 < 0$.

One of the contributions of this paper is then to show that potential debt overhang effects should be analyzed taking into account corporate risk. In particular, we find the distance-to-default measure, which takes into account not only debt but also the franchise value of the firm as summarized in the firm's market valuation and volatility, as a convenient representation of that risk.

3.3 Debt Overhang during Economic Crises

In this section we re-estimate our preferred specification using 3-year sub-samples around two deep economic crises: the Global Financial Crisis (GFC sample: 2007q2-2010q2) and the Covid-19 crisis (C19 sample 2019q1-2021q4). Table 5 summarizes the main results by geographic region focusing on net investment as dependent variable and $j = 1$ lag for explanatory variables.

The table reveals that the negative effect of high ex ante debt on investment increases significantly during economic crises. As documented above, in the global set of countries (column (1)), the impact for a unit rise in debt to assets was -2 percentage points of assets using the twenty years of data, while the impact measured during the GFC (C19) sub-sample increases to -6.35 (-9.75) percentage points. All these estimated effects are significant compared to the global mean net investment rate of 1.56 percent of assets. Under this metric, the empirical debt overhang effect worsened by about 3 (5) times during the GFC (C19) recession.

Table 5: Total Effects Leverage, Global Financial Crisis vs. Covid-19

Dep var: net inv/assets	(1) Global	(2) Advanced	(3) Emerging	(4) LAC
GFC Sample	-0.0635***	-0.0665***	-0.0439***	-0.0233
	(0.0060)	(0.0070)	(0.0127)	(0.0460)
Covid Sample	-0.0975***	-0.0994***	-0.0867***	-0.1576***
	(0.0048)	(0.0056)	(0.0092)	(0.0424)
Full Sample	-0.0200***	-0.0202***	-0.0213***	-0.0228**
	(0.0016)	(0.0019)	(0.0032)	(0.0106)
Dep var mean	0.0156	0.0153	0.0164	0.0126

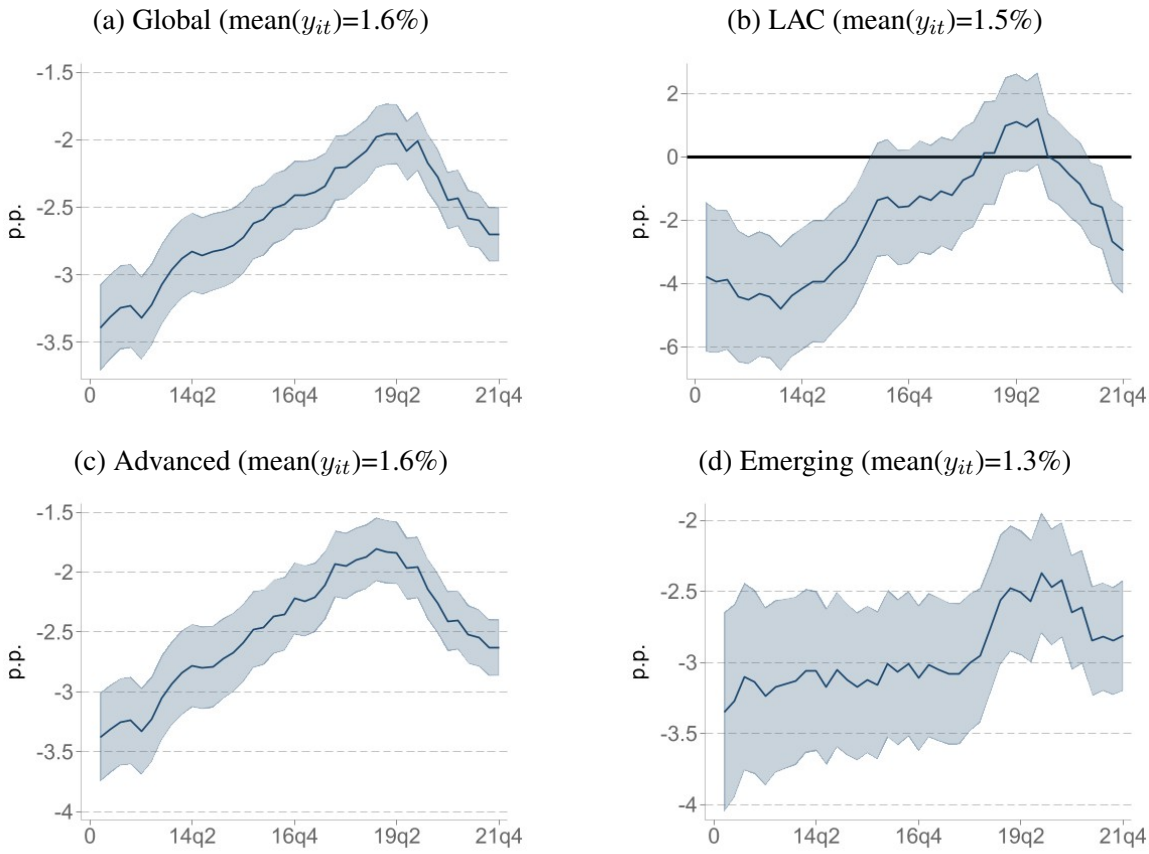
Note: Dependent Variable: **Net** Investment / Assets. Total effects for leverage evaluated at the median distance to default. Results in percentage points (p.p.). of total assets. The Global Financial Crisis (GFC) sample is 2007q2-2010q2, while the Covid-19 (C19) sample considered is 2019q1-2021q4.

The GFC crisis hit harder in advanced economies (-6.65 p.p.) compared to emerging countries (-4.39 p.p.), while the Covid-19 pandemic hit harder compared to the GFC in both regions (-9.94 p.p. in advanced and -8.67 p.p. in emerging countries), see columns (2) and (3). Notably, Latin America in column (4) displays no significant overhang in the GFC sample, although the region displays the largest overhang during Covid-19 (-15.8 p.p.).

3.4 How Has the Debt Overhang Effect Evolved over Time?

We have established debt overhang effects can harm corporate investment in normal times and specially during economic crises. In this section, we evaluate systenatically how the estimated effect has evolved during the last decade. To do so, Figure 4 illustrates the estimated total effects of leverage on investment using a rolling window sample of 10 years (40 quarters), starting in 2002q1. The date on the horizontal axis corresponds to the last point in each 10-year rolling sample, from the first window (2002q1-2011q4) to the last (2012q3-2021q4). As before, the results are measured in percentage points (p.p.) and should be directly compared to the mean of the dependent variable included in the title of each panel.

Figure 4: Total Effects for Leverage, Rolling Window (40 quarters)



Note: Dependent variable used is gross investment/assets. The figures show the total effects for leverage estimated using a rolling window sample of 10 years (40 quarters). The date reported in the x-axis corresponds to the last quarter in the 10-year rolling sample: the first window is 2002q1-2011q4, and the last window is 2012q3-2021q2.

The results indicate an overall declining trend in the estimated debt overhang effects over the last decade: the coefficient becomes less negative for most of the decade, although the declining trend seems to have stopped in the recent years, most likely due to the pandemic. For instance, using all countries (Panel (a)), the debt overhang effect is estimated at almost -3.5 p.p. if estimated with the first window (2002q1-2011q4), right after the GFC, and then increases until 2018 to a level of -2 percentage points. In the last couple of years, including the pandemic shock, the overhang effect has increased again to levels close to -3 p.p. in the final window (2012q3-2021q2).

The decreasing overhang effect documented globally in panel (a) is largely explained by the behavior within advanced economies during 2014-2018 (Panel (c)), while emerging economies display a relatively stable point estimator around -3 p.p. for most of the decade (Panel (d)). Finally, in Latin America and the Caribbean (panel (b)), we observe the largest debt overhang effects of around -4 p.p. in the initial window (2002q1-2011q4), and at the same time the largest improvements in the second half of the decade, even recording statistically zero overhang right before Covid-19. Still, the region follows a similar worsening as the other regions when internalizing the last couple of pandemic years, with overhang deteriorating from zero to -3 percentage points.

3.5 Heterogeneous Responses to Crises Depending on Ex Ante Leverage

During economic crises leverage may change quite differently depending on the particular characteristics of the recession. In some crises, including the Global Financial Crisis of 2008-2009, there was widespread deleveraging in many countries, while during the Covid-19 crisis firms were able to lever up. Even within the same crisis, firms with high initial leverage may underperform after the recession relative to a company with low leverage, ceteris paribus.

In this section, we run an alternative specification aimed at isolating the effects of *initial leverage* from the effects of *changes in leverage during* the underlying recession. Let $post_t^{crisis}$ be a dummy variable equal to one for all periods **after** a crisis hit the economy (zero otherwise). If the crisis being considered is the GFC, the dummy equals one starting in 2008q3 (zero otherwise). If the crisis is the Covid-19 pandemic, then the dummy equals one starting in 2020q2. Also let ℓ_i^0 be a "high-leverage" dummy equal to one if the pre-crisis firm leverage is above the median leverage in the sample (zero otherwise). We use the year immediately before the start of the recession as the pre-crisis period to classify a firm as high- or low-leverage. We then estimate:

$$y_{i,t} = \beta \ell_i^0 \times post_t^{crisis} + \gamma FIRM_{i,t-4} + \alpha_i + \alpha_{sct} + e_{i,t}$$

where $crisis \in \{GFC, C19\}$, and as before, $FIRM = \{dd, cash, icr, size\}$ are firm-level time-varying controls. A negative value of coefficient β would imply that **firms with high ex ante leverage decrease their investment rate by a greater degree in the post-crisis period, compared to otherwise similar firms but with low ex-ante leverage.**

The results in panel (a) of Table 6 indicate a significant impact of initial levels of debt on investment during the GFC. For all firms across the world, firms with high initial leverage reduce investment significantly more than firms with low leverage: the quantitative magnitudes of the effect ranges from -0.6 percentage points to -1.03 depending on the specification considered (see column (1)). Again, these figures can be compared to the mean net investment rate of 1.56 percent of assets. The estimated coefficients are higher in emerging economies compared to advanced countries (columns (2) and (3)), while the results during the GFC for Latin America are negative, although sometimes not significant (column (4)).

Panel (b) of Table 6 also reveals considerable overhang effects on investment during the Covid-19 crisis. In the global sample, firms reduced their investment rates by 1.37 percentage points for each unit increase in leverage and the effect is statistically significant. The effect is larger in emerging economies (-1.54 percentage points) relative to firms in advanced economies (-1.33 percentage points). In the case of Latin America and the Caribbean, the negative impact during the pandemic ranges from -0.66 to -1.13 percentage points of assets depending on the specification considered, and in this crisis, the effects are always statistically significant. The results for the COVID crisis are particularly interesting give that debt increased sharply during this crisis, as opposed to the behavior of leverage during the GFC.

Table 6: The Impact of Initial Leverage on Investment during the GFC

	(1) Global	(2) Advanced	(3) Emerging	(4) LAC
	(a) $\ell_i^0 \times post_t^{GFC}$			
Net investment, $j = 1$ lag	-0.0103***	-0.0078***	-0.0173***	-0.0092
	(0.0012)	(0.0016)	(0.0020)	(0.0056)
Gross investment, $j = 1$ lag	-0.0060***	-0.0036***	-0.0119***	-0.0094*
	(0.0011)	(0.0014)	(0.0017)	(0.0049)
Net investment, $j = 4$ lags	-0.0081***	-0.0053***	-0.0150***	-0.0074
	(0.0012)	(0.0016)	(0.0020)	(0.0057)
Gross investment, $j = 4$ lags	-0.0059***	-0.0039***	-0.0107***	-0.0111**
	(0.0011)	(0.0014)	(0.0018)	(0.0050)
	(b) $\ell_i^0 \times post_t^{C19}$			
Net investment, $j = 1$ lag	-0.0137***	-0.0133***	-0.0154***	-0.0113**
	(0.0008)	(0.0010)	(0.0013)	(0.0045)
Gross investment, $j = 1$ lag	-0.0060***	-0.0049***	-0.0080***	-0.0080***
	(0.0006)	(0.0008)	(0.0010)	(0.0028)
Net investment, $j = 4$ lag	-0.0124***	-0.0122***	-0.0135***	-0.0079*
	(0.0008)	(0.0010)	(0.0013)	(0.0043)
Gross investment, $j = 4$ lag	-0.0050***	-0.0042***	-0.0065***	-0.0066**
	(0.0006)	(0.0008)	(0.0009)	(0.0028)

Note: Results for regression:

$$y_{i,t} = \beta \ell_i^0 \times post_t^{crisis} + \gamma FIRM_{i,t-4} + \alpha_i + \alpha_{sct} + e_{i,t}$$

where $y_{i,t}$ is either net or gross investment over total assets, ℓ_i^0 is an indicator equal to one if firm i is high-leverage before the crisis under analysis, $post_t^{crisis}$ is a dummy equal to one for all the periods **after** the crisis (zero otherwise), $crisis \in \{GFC, C19\}$, and $FIRM = \{dd, cash, icr, size\}$ are firm-level time-varying controls: $dd_{i,t}$ is distance-to-default, $cash_{i,t}$ is cash and short-term investments, $icr_{i,t}$ is the interest coverage ratio dummy equal to one if the ratio of EBIT over interest payments is above one (zero otherwise), and $size_{i,t}$ is measured as the log of assets. Standard errors clustered at the firm level in parenthesis. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

3.6 The Persistence of Debt Overhangs and Slow Recoveries

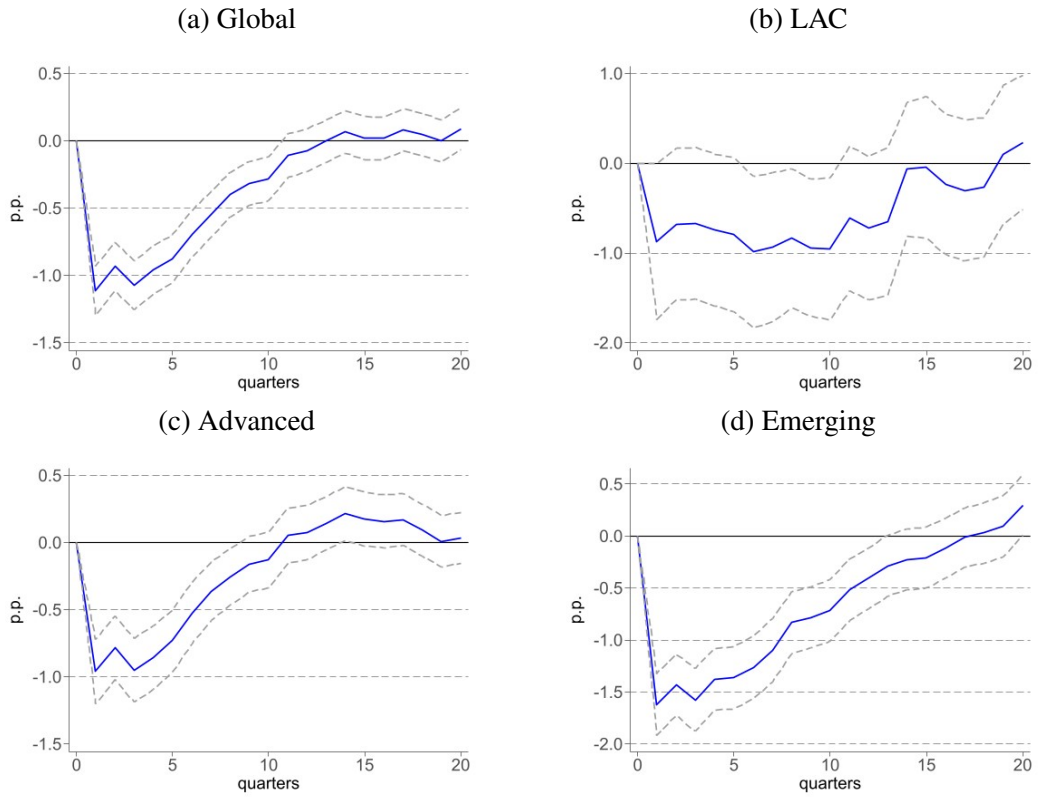
How persistent is the debt overhang effect, and how might higher levels of corporate debt impact the speed of an economic recovery? Corporate deleveraging tends to be a relatively slow process, and hence it seems likely that the effects could be quite persistent. To investigate this more deeply, we employ a panel local-projections analysis à la Jordà (2005) and Kalemli-Özcan et al. (2018). More specifically, for each $h = 1, ..., H$, we estimate:

$$y_{i,t+h} = \beta_h \ell_i^0 \times post_t^{crisis} + \gamma FIRM_{i,t-1} + \alpha_i + \alpha_{sct} + e_{it}$$

where as before, $post_t^{crisis}$ is a dummy equal to one for all periods **after** a crisis hit the economy (zero otherwise), ℓ_i^0 is a time-invariant "High Leverage" dummy equal to one for firms with above-median leverage in the year **before** the crisis, and $FIRM = \{dd, cash, icr, size\}$ are time-varying firm characteristics.

Notice that, while large recessions typically induce lower investment across the board, the estimated sequence of $\{\beta_h\}_{h=1}^{H}$ in this exercise is intended to capture the differential investment performance after the crisis comparing firms entering the recession with high leverage versus firms entering with low leverage.

Figure 5: Investment Dynamics after the Global Financial Crisis, by Ex Ante Leverage



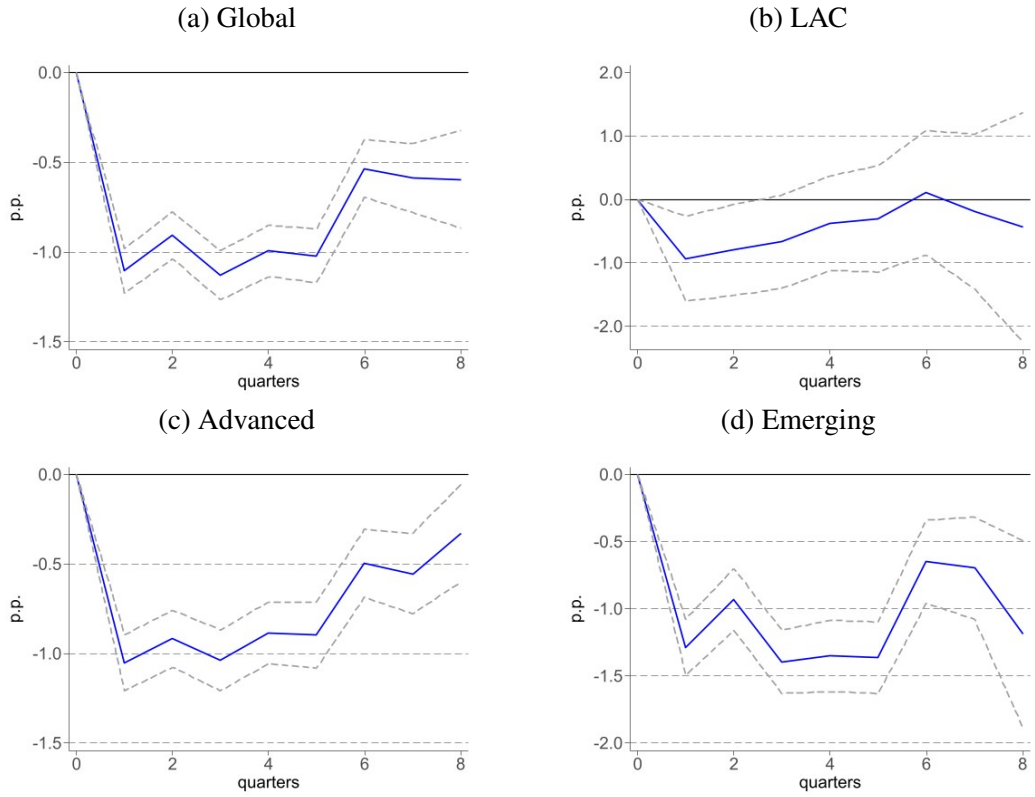
Note: The figures report dynamic coefficients based on Local Projections (Jordà, 2005), measuring the differential investment performance in the aftermath of a crisis of firms with high leverage versus firms with low leverage, in percentage points (p.p.) of total assets. The x-axis represents quarters after the crisis shock in period $t = 0$. For the Global Financial Crisis (GFC), the shock period $t = 0$ is set to 2008q3. Investment rates are measured as net capital expenditures over total assets.

Figures 5 and 6 display the responses after the GFC and the Covid-19 pandemic, respectively; for the case of the GFC we local project 5 years in the future ($H = 20$ quarters), while given the shorter availability of recent data, for the pandemic we are able to project 2 years ($H = 8$ quarters) only. Both figures reveal that these crises are associated with a much larger investment decline for firms that enter the recession with high leverage. The estimated effect tend to peak at around one percentage point of assets during the first year after the crisis, and the statistically significant effect persists for at least two to three years.

The results comparing different types of countries are quite robust in both recessions analyzed, although emerging countries (panel (d)) tend to display a more protracted effect compared to ad-

vanced economies (panel (c)). Finally, the results for Latin America (panel (d)) tend to be more persistent than in other regions, although the results are less precisely estimated, especially during the pandemic, due to the smaller sample and resurgences of Covid variants.

Figure 6: Investment Dynamics after the Covid-19 Pandemic, by Ex Ante Leverage



Note: See Figure 5. The x-axis represents quarters after the crisis shock in period $t = 0$. For the Covid-19 pandemic, the shock period $t = 0$ is set to 2020q4. Investment rates are measured as net capital expenditures over total assets.

4 Conclusion

For this paper, we built a data set with quarterly, individual firm balance-sheet data for 25,000 firms over a 20 year period covering 47 advanced and emerging economies. The data set focuses on listed firms, which implies it is not representative but rather includes larger firms that account for the vast majority of investment in each economy.

One reason to focus on listed firms is that we wanted to analyze whether the debt overhang effect may depend on firm risk. To do this we constructed distance to default measures for each firm using the balance sheet data combined with stock market valuations and estimates of stock price volatility. This is only feasible for listed firms. One of the contributions of the paper is thus to show that corporate risk is critical to assessing the debt overhang effect. Indeed, on the one hand the debt overhang effect disappears entirely (indeed higher debt may even be positive for future investment) if firm risk is particularly low. On the other hand, the debt overhang effect is severely exacerbated when firm risk, as indicated by a low distance to default, is high.

In addition, we also show that the debt overhang effect increases through economic crises and that the debt overhang is present when considering only the debt of the firm prior to the actual crisis period. A further set of results, using the local projection methodology, indicates that the debt overhang effect may be highly persistent, and inherited higher firm debt may impact investment for 3-5 years.

Corporate debt rose strongly during the Covid crisis and, while firms built up liquidity buffers, our results suggest this will not eliminate the impact of debt on investment looking forward. Still, the increases in corporate debt are concentrated in particular sectors, particularly travel, hospitality, retail and the more capital-intensive manufacturing sectors, and corporate debt levels appear to have peaked and subsequently fallen for many firms in the latest quarter of available data.

During the pandemic, policymakers were very active in seeking ways to assist firms to ensure that the productive sector remained viable once the war against the virus had been won. For example, many countries introduced loan moratoria and offered partial loan guarantees to banks that extended new credit to firms. Central banks found ways to provide additional liquidity, particularly to banks and to governments to provide additional credit and further support. As such schemes are phased out, our results indicate that some continuing assistance to the most affected firms may be warranted.

While it is often stated that firms that are not viable should not be assisted and that it is inefficient to assist firms that are viable anyway, it is of course hard to assess viability ex ante. Rather, and as our results reflect, there is a continuum of risk. Moreover, risk goes beyond simply considering leverage. We have shown that distance to default may be a useful variable to summarize risk for listed firms, and that appears to be important for gauging the extent of the debt overhang effect on investment. The design of particular interventions is beyond the scope of this paper, but policymakers may wish to consider their tolerance for risk as well as leverage levels to design policies to counter the debt overhang effects of Covid-19 and boost investment and hence growth in the coming years.

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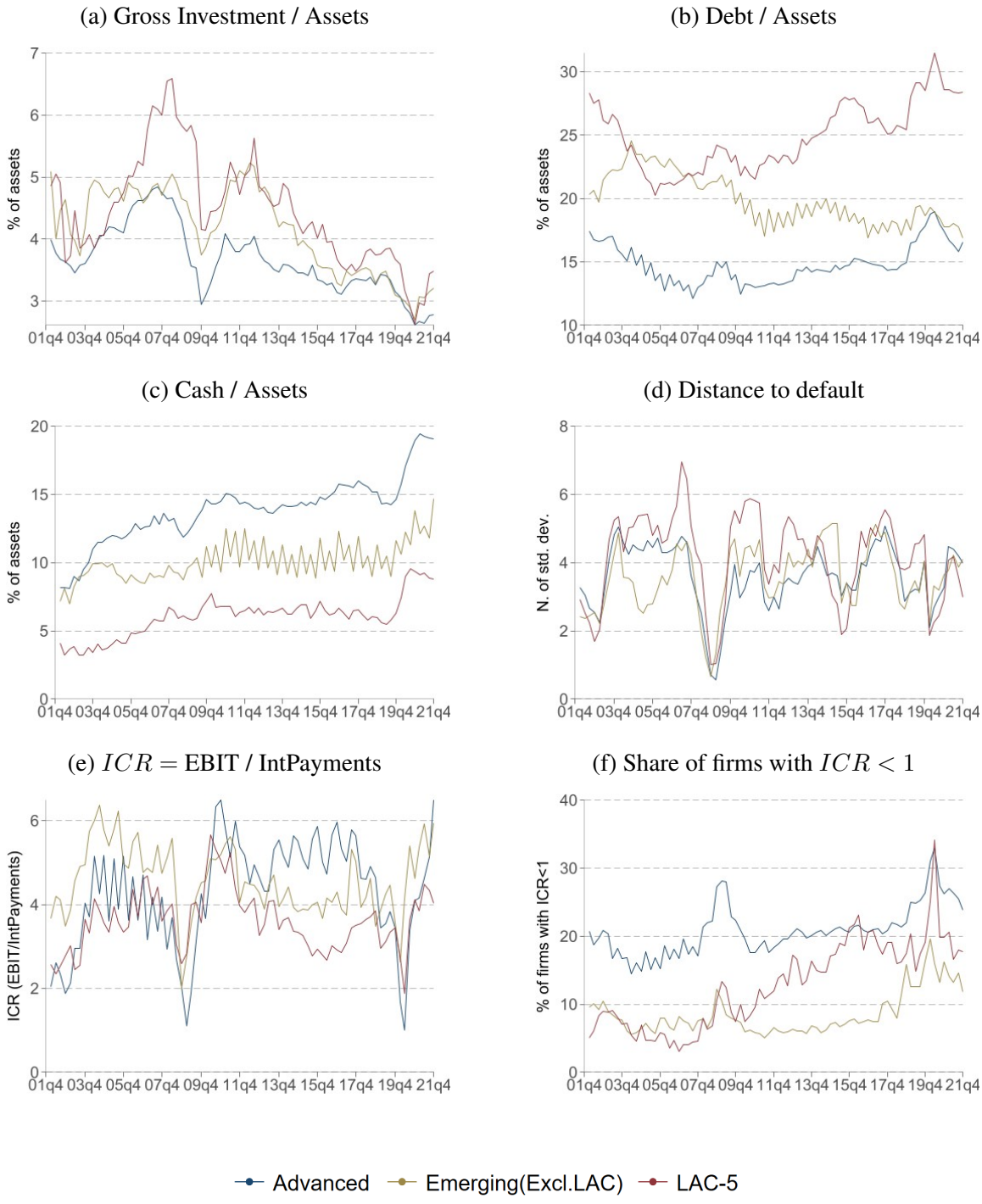
A Descriptive Statistics

Figure 7: Evolution of Key Variables by Geographic Region (medians)



Note: All figures report **medians** by date, pooling firms from all countries in the sample.