Online Appendix to "Sovereign Risk and Intangible Investment"

Minjie Deng
Simon Fraser University

Chang Liu
Stony Brook University

September 2024

A Data

A.1 Variables

1. ***Investment***

Our baseline measure of investment in period t is defined as the log difference of intangible fixed assets between period $t+1$ and period t, that is, $\Delta \log(intangibles_{i,t+1})$, which denotes the investment in intangibles of firm i at the end of period t. As investment is highly skewed, we use a log-difference specification rather than a simple linear regression specification (as in Ottonello and Winberry (2020), Deng and Fang (2022), among others). One possible concern about this log-difference measure for intangible investment is the loss of some observations if firms have zero intangible fixed assets in certain years. To ensure that this does not change our results, we also consider the extensive margin of intangible investment in Section B.2. Similarly, tangible investment is defined as the log-difference of tangible fixed assets.

Intangible and tangible fixed assets are scaled by the price of intangibles and tangibles every year. Figure A.1 shows the asset components for tangible assets and intangible assets in the EU KLEMS database. The EU KLEMS database reports the price for each asset type.

We construct the aggregate price for intangible assets as the weighted average price of each component in the right square, weighted by the share of each asset.[1] An identical construction is carried out for the price of tangibles.

Panel (a) of Figure A.2 plots the price of intangibles in Italy for the time period in our sample. The price is increasing steadily but there is not much wild change in a certain year. During the sovereign debt crisis (2011-2013, highlighted with a shade of gray), the growth in price has negligible variation. Similarly, Panel (b) plots the price of tangibles. There is no obvious changes during the the sample period we study. Thus, it is unlikely that price movements lead to the asset reallocation pattern during sovereign debt crisis documented in this paper.

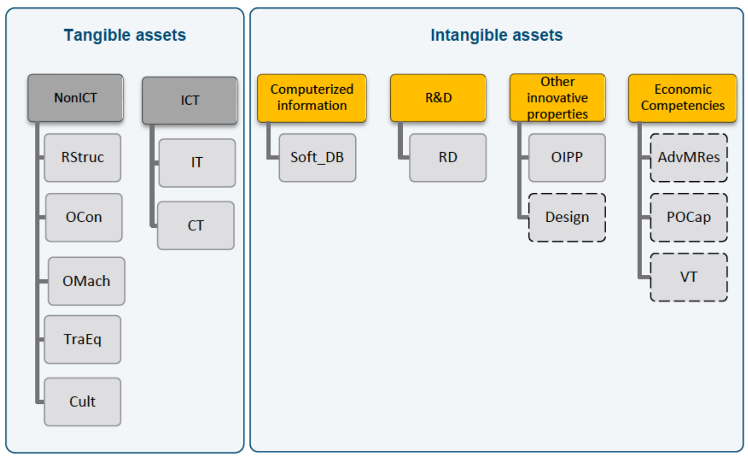
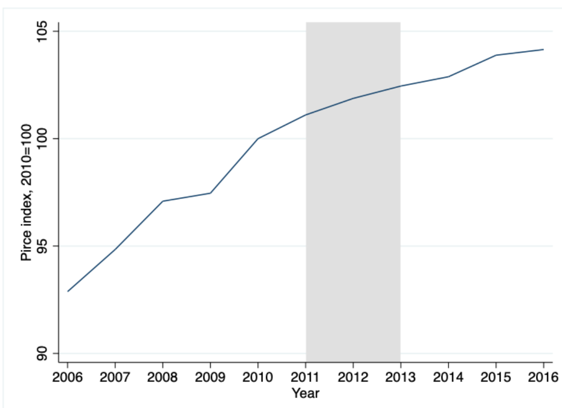
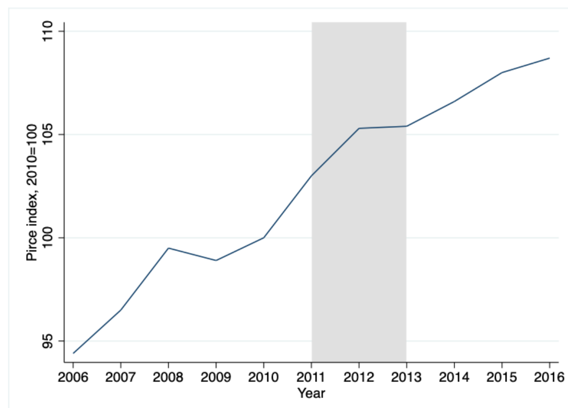


Figure A.1: Aggregates of capital services
Notes: Dashed lines indicate asset types outside the boundaries of National Accounts. Source: Report on methodologies and data construction for the EU KLEMS Release 2019 (Stehrer et al. (2019)).

[1] For example, Software and Database ("Soft_DB") accounts for 15% of intangible assets and R&D ("RD") accounts for 40% of intangible assets.



(a) Price of Intangibles



(b) Price of Tangibles

Figure A.2: Price indices of intangibles and tangibles

Notes: Price of intangibles and tangibles in Italy. Gray shade indicates sovereign debt crisis period.

2. ***Net leverage***

Net leverage is measured as the ratio of firm i's net debt to total assets, where net debt is the sum of short-term loans and long term debt net of net current assets.

3. ***Short leverage***

Short leverage is defined as the ratio of firm i's short-term loans to total assets.

4. ***Total leverage***

Total leverage is defined as the ratio of firm i's total debt to total assets, where total debt is the sum of short-term loans and long-term debt.

5. ***Size***

Size is measured as the log of total assets.

6. ***Liquidity***

Liquidity is measured as the ratio of cash and cash equivalents to total assets.

7. ***Sales growth***

Sales growth is defined as the log difference of sales, i.e. sales growth$_{it} = \log(sales_{it}) - \log(sales_{it-1})$.

8. ***Liability ratio***

The liability ratio is defined as the ratio of total liabilities to total assets, where total liabilities is the difference between total assets and shareholders funds.

9. ***Net current assets ratio***

Net current assets ratio is measured as the ratio of net current assets to total assets.

A.2 Sample selection

Our main sample excludes (in order of operation):

1. Firms not in the manufacturing sector.

2. Firms with negative or zero total assets.

3. Firms with negative intangible fixed assets or tangible fixed assets.

4. Firms which have missing values for total assets, intangible fixed assets, or tangible fixed assets over the sample period.

5. Firms that were not observed in 2006.

After applying the sample selection operations, we winsorize the variables mentioned above at the top and bottom 1% of the distribution.

A.3 Data moments

Firm tangibility We construct the tangibility measure for firm i at period t as:

$$tangibility_{it} = \frac{k^d_{T,it}}{k^d_{T,it} + k^d_{I,it}}.$$

Since our Italian data features an unbalanced sample, we first take the average tangibility across sample period to derive the average tangibility of firm i. Aggregate tangibility is then defined as the mean of tangibility measures across firms.

Correlation between intangible and tangible investments The intangible and tangible investments are constructed as the rates of change in intangible and tangible asset stocks, respectively. We first calculate the average correlation between intangible and tangible investment within each firm. Then, we take the mean correlation across firms as our measure of the correlation between intangible and tangible investments.

Standard deviation ratio For real tangible $k_{T,it}$, intangible assets $k_{I,it}$, and sales, we detrend the data series for each firm i assuming a log-linear trend. The standard deviation of tangible assets is calculated as the average standard deviation of detrended tangible assets (cyclical component) across firms. A similar calculation yields the standard deviation of intangible assets and sales.

Leverage Firms in our sample are divided into high- and low-leverage groups based on each firm's leverage in the base year of 2006. We calculate the average leverage within each of these groups.

Government bonds/tax revenue The ratio of government bonds to tax revenue is calculated by the ratio of general government debt to general government revenue, which is 2.595. Data is from the OECD.Stat database.

Credit to firms/credit to government The average ratio of total credit to the private non-financial sector to total credit to the government sector is 0.630 during the sample period, according to Bank for International Settlements statistics.

Moments of spread The spread is defined as the gap between 10-year Italian and German sovereign yields. The mean and standard deviation of spread are calculated based on Italian 10-year government bond spread during the sample period. The average spread is 0.016 and the standard deviation of spread is 0.012.

B Additional empirical results

B.1 Asset reallocation during crises

As an external validation, we demonstrate that the asset reallocation pattern can be applied to a broader range of crises by using macro-level data on tangible and intangible assets. We compile a panel dataset on tangible and intangible assets at the country level from EU KLEMS, covering 30 countries from 1995 to 2020.[2]

Using this cross-country data, we test whether the asset reallocation pattern is broadly evident across economic crises. A crisis is defined as a period with a decline of 2 percent or more in GDP growth. Similar to our tangibles-to-intangibles ratio at the firm level, we construct ratios at the country level. We estimate whether the country-level tangibles-to-intangibles ratios are higher during crises, while controlling for country fixed effects and year fixed effects. The positive coefficient for $\mathcal{I}_{crisis}$ in Table B.1 shows that the tangibles-to-intangibles ratio is indeed higher during crises. This result externally validates our asset reallocation pattern across different crisis periods and countries.

[2]The tangible assets include computing equipment capital stock, communications equipment capital stock, transport equipment capital stock, other machinery and equipment capital stock, total non-residential investment capital stock, residential structures capital stock and cultivated assets capital stock. The intangible assets include computer software and databases capital stock, research and development capital stock, as well as other intellectual property products assets capital stock. The country list includes Austria, Belgium, Bulgaria, Cyprus, Czechia, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Japan, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia, United Kingdom, and United States.

Table B.1: Response of tangibles-to-intangibles at country level

Dependent variable	Tangibles-to-intangibles
I_{crisis}	0.035**
	(0.017)
Constant	1.379***
	(0.004)
Country FE	Yes
Year FE	Yes
Observations	704
R-squared	0.822

Notes: Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. $\mathcal{I}_{crisis}$ is a dummy variable indicating whether the country is in a crisis, defined by a decline of 2 percent or more in GDP growth.

B.2 Robustness

This section shows robustness checks of our baseline empirical findings. None of these robustness checks materially changes our conclusions. To solve the concern that the baseline measure of intangible investment may be subject to sample losses, we construct an alternative DHS investment measure for intangible investment that takes into account both extensive and intensive margin of intangibles, as illustrated in Appendix B.2.1. The results are still consistent with our baseline findings. Appendix B.2.2 replaces the baseline measure of leverage with alternative leverage measures that capture firm's short-run ability to meet its financial obligations and firm's insolvency. The baseline heterogenous responses remain robust. Besides using the DHS investment measure, we estimate a linear probability model to take care of the extensive margin of intangibles, as shown in Appendix B.2.3. Consistent with the intensive margin estimation of intangible assets, small and high-leverage firms are more likely to stop holding intangible assets. Appendix B.2.4 provides results when we allow tangible and intangible assets to depreciate at different rates. Our results are also robust to using continuous standardized measures for size and leverage , as well as alternative group dummies based on sectoral median, instead of sample median (Appendix B.2.5 and B.2.6). Appendix B.2.7 additionally controls for province-year fixed effects, which capture possible geographical differences across the firms. Appendix B.2.8 clusters the standard errors at the sector level. Appendix B.2.9 winsorizes the variables of interest at the top and bottom 0.5% (baseline uses 1%). Appendix B.2.10 shows robustness to deflating intangible and tangible fixed assets by the Producer Price Index, instead of their own prices. Our results are also robust to replacing baseline sovereign spreads with an aggregate-level firm spread, Italian CDS spread (Appendix B.2.11), and sovereign spreads with different maturities (Appendix B.2.12).

B.2.1 Alternative measure for investment

In the baseline regressions, we use the log-difference of assets to measure investment. Although being widely used, one potential concern is that the log-difference measure omits observations with zero assets by construction, which could be more pronounced for intangible assets. To deal with this concern, we further characterize the effects of sovereign risk on the extensive margin of intangible investment.[3] To account for asset changes at both the intensive and extensive margin, we borrow a growth measure from the job creation literature (Davis and Haltiwanger (1992), Davis, Haltiwanger, and Schuh (1998), Huber, Oberhofer, and Pfaffermayr (2013), among others) that accounts for both the intensive and extensive margins. We analogously define a measure of firm investment.

For intangible assets, firms in each year can be classified into three groups:

$$\begin{cases} \text{exiting firms} & G_x = \{i | k_{it} \neq 0, k_{i,t+1} = 0\} \\ \text{continuing firms} & G_c = \{i | k_{it} \neq 0, k_{i,t+1} \neq 0\} \\ \text{entering firms} & G_n = \{i | k_{it} = 0, k_{i,t+1} \neq 0\} \end{cases}$$

where k_{it} denotes intangible fixed assets of firm i at period t. Here "exiting" and "entering" only indicate whether firm i continues to hold intangible fixed assets. Then, investment in intangible assets (which is also the growth rate between two averages) can be defined as:

$$g(intangibles_{i,t+1}) = \frac{k_{i,t+1} - k_{it}}{0.5(k_{i,t+1} + k_{it})} = \begin{cases} -2 & i \in G_x \\ \dfrac{k_{i,t+1}/k_{it} - 1}{0.5(k_{i,t+1}/k_{it} + 1)} & i \in G_c \\ 2 & i \in G_n \end{cases} \tag{B.1}$$

We refer to this measure of investment as DHS (abbreviation for Davis, Haltiwanger, and Schuh (1998)) investment. The main advantage of DHS investment is that it can accommodate both entry (into the asset market, i.e., beginning to hold assets) and exit (from the asset market, i.e., no longer holding assets). It is a second-order approximation of the log-difference growth rate around 0 and it is bounded in the range [–2,2]. We estimate both baseline specifications, Eq. (1) and (2), using DHS investment as the dependent variable. Table B.2 shows that, consistent with our baseline regression results, small firms and high-leverage firms decrease their intangible investment more than other firms during

[3] For tangible assets, using the log-difference to measure investment is less of a concern (if any), because we exclude firms with negative or zero total assets in the baseline sample, and the remaining firms have at least positive tangible assets.

a sovereign debt crisis.

Table B.2: Alternative measure for intangible investment: DHS investment

Dependent variable	g(intangibles$_{i,t+1}$)					
	(1)	(2)	(3)	(4)	(5)	(6)
sp_t				-3.122***	-1.354***	-2.781***
				(0.207)	(0.199)	(0.243)
$size_{i,2006} \times sp_t$	2.527***		2.620***	2.733***		2.825***
	(0.272)		(0.274)	(0.271)		(0.273)
$leverage_{i,2006} \times sp_t$		-0.479*	-0.781***		-0.430	-0.764***
		(0.268)	(0.270)		(0.268)	(0.271)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	No	No	No
Observations	392,914	392,914	392,914	392,914	392,914	392,914
R-squared	0.031	0.031	0.031	0.013	0.013	0.013
Number of id	71,795	71,795	71,795	71,795	71,795	71,795

Notes: Results from estimating Eq. (1) and (2) with the dependent variable as DHS investment. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

B.2.2 Alternative measures of leverage

In the baseline results, leverage is defined as the ratio of total debt to total assets. We label this baseline leverage as "total leverage". We also use short-term leverage (the ratio of short-term debt to total assets) and net leverage (the ratio of net debt to total assets, where net debt is the sum of short-term loans and long-term debt minus net current assets) as robustness checks. Short-term leverage measures firm short-run ability to meet its financial obligations and net leverage measures the firms' insolvency. Table B.3 and Table B.4 show that the baseline results are robust to these alternative definitions.

B.2.3 Extensive margin of intangible investment

In this section, we focus on the extensive margin of intangible assets, i.e., whether to continue holding any intangible assets. Denote $\mathbb{1}(intangibles_{i,t+1})$ as an indicator that equals 1 if firm i continues to hold any intangible fixed assets in period $t+1$, and equals

Table B.3: Alternative measure for leverage: net leverage

Dependent variable	$\Delta\log(intangibles_{i,t+1})$		$\Delta\log(tangibles_{i,t+1})$		Tangibles-to-intangibles
	(1)	(2)	(3)	(4)	(5)
sp_t		-0.667**		-0.904***	1.980***
		(0.266)		(0.137)	(0.218)
$size_{i,2006} \times sp_t$	2.153***	2.305***	0.648***	0.671***	-1.261***
	(0.294)	(0.292)	(0.140)	(0.138)	(0.227)
$netlev_{i,2006} \times sp_t$	-0.489*	-0.427	0.373***	0.415***	0.202
	(0.292)	(0.290)	(0.132)	(0.130)	(0.217)
Firm controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No	No
Observations	304,644	304,644	304,644	304,644	299,270
R-squared	0.025	0.013	0.068	0.042	0.212
Number of id	59,939	59,939	59,939	59,939	59,213

Notes: Column (1) shows the heterogeneous effect of spreads on intangible investment by estimating Eq. (1). Column (2) is the corresponding estimation of Eq. (2). Column (3) and (4) are the tangible investment counterparts to Column (1) and (2). Column (5) estimates the heterogeneous effect of spreads on the asset reallocation (tangibles-to-intangibles ratio). Robust standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table B.4: Alternative measure for leverage: short-term leverage

Dependent variable	$\Delta\log(intangibles_{i,t+1})$		$\Delta\log(tangibles_{i,t+1})$		Tangibles-to-intangibles
	(1)	(2)	(3)	(4)	(5)
sp_t		-0.714***		-0.936***	1.959***
		(0.260)		(0.131)	(0.213)
$size_{i,2006} \times sp_t$	2.154***	2.300***	0.615***	0.640***	-1.277***
	(0.295)	(0.293)	(0.141)	(0.138)	(0.228)
$shortlev_{i,2006} \times sp_t$	-0.391	-0.369	0.411***	0.419***	0.231
	(0.292)	(0.292)	(0.132)	(0.131)	(0.220)
Firm controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No	No
Observations	305,895	305,895	305,895	305,895	300,519
R-squared	0.025	0.012	0.068	0.042	0.213
Number of id	60,064	60,064	60,064	60,064	59,340

Notes: Column (1) shows the heterogeneous effect of spreads on intangible investment by estimating Eq. (1). Column (2) is the corresponding estimation of Eq. (2). Column (3) and (4) are the tangible investment counterparts to Column (1) and (2). Column (5) estimates the heterogeneous effect of spreads on the asset reallocation (tangibles-to-intangibles ratio). Robust standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

0 if firm i stops having any intangible fixed assets. Table B.5 reports the results when we substitute the dependent variables with $\mathbb{1}(intangibles_{i,t+1})$ in Eq. (1) and (2). Table B.5 shows that large firms and low-leverage firms are more likely to continue to hold intangible assets, consistent with the intensive margin results.

Table B.5: Extensive margin of intangibles

VARIABLES	$\mathbb{1}(intangibles_{i,t+1})$					
	(1)	(2)	(3)	(4)	(5)	(6)
sp_t				-1.694***	-1.350***	-1.664***
				(0.064)	(0.055)	(0.074)
$size_{i,2006} \times sp_t$	0.567***		0.575***	0.607***		0.616***
	(0.077)		(0.077)	(0.077)		(0.077)
$leverage_{i,2006} \times sp_t$		-0.004	-0.070		0.005	-0.067
		(0.073)	(0.073)		(0.074)	(0.074)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	No	No	No
Observations	383,820	383,820	383,820	383,820	383,820	383,820
R-squared	0.029	0.028	0.029	0.016	0.015	0.016
Number of id	71,610	71,610	71,610	71,610	71,610	71,610

Notes: Results from estimating Eq. (1) and (2) with the dependent variable as an indicator that equals 1 if continuing to hold any intangible assets and equals 0 if ceasing to hold any intangible assets. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

B.2.4 Depreciation

One difference between intangible assets and tangible assets is that they depreciate at different speeds. Relatively little is known about depreciation rates for intangibles. Corrado et al. (2009) estimates the depreciation rate of R&D capital in the U.S. to be 20%. The U.S. Bureau of Economic Analysis (BEA) places its central estimate of the depreciation rate for R&D at 15%. Pakes et al. (1978) gets an average depreciation rate of 25%, using data for several European countries.

Fortunately, the EU KLEMS database provides depreciation rates for each asset type, which allows us to construct depreciation rates for intangible and tangible assets in Italy—at the aggregate level. The depreciation rate for intangible assets is the weighted average of the depreciation rates of: computer software and databases, research and development, and other intellectual property product (IPP) assets, with the weight being the asset share. For tangible assets, the depreciation rate is the weighted average of the depreciation rates of:

computing equipment, communications equipment, transport equipment, other machinery and equipment, total non-residential investment, residential structures and cultivated assets, with the weight being the asset share. The calculated depreciation rate for intangible assets is 24.3% and the depreciation rate for tangible assets is 10.1% in 2006. Our estimates are in line with the rates reported in the existing literature.

Alternatively, we can construct intangible investment as below[4]:

$$\Delta \log(intangibles_{dep,it+1}) = [\log(y_{i,t+1}) - \log((1 - dep_{intangible}) * y_{it})] * (1 - dep_{intangible})$$

where y_{it} denotes the intangible fixed assets of firm i at period t. $dep_{intangible} = 0.243$ is the weighted average depreciation rate for intangible asset. Corresponding tangible investment can be constructed similarly, with a depreciation rate of 0.101. Table B.6 presents the estimation results for investment with depreciation.

Table B.6: Results for investment with depreciation

Dependent variable	$\Delta \log(intangibles_{dep,it+1})$		$\Delta \log(tangibles_{dep,it+1})$	
	(1)	(2)	(3)	(4)
sp_t		-0.461**		-0.785***
		(0.197)		(0.120)
$size_{i,2006} \times sp_t$	1.665***	1.781***	0.553***	0.575***
	(0.224)	(0.223)	(0.126)	(0.124)
$leverage_{i,2006} \times sp_t$	-0.456**	-0.432*	0.305**	0.325***
	(0.223)	(0.223)	(0.120)	(0.119)
Firm controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No
Observations	304,458	304,458	304,458	304,458
R-squared	0.025	0.013	0.068	0.042
Number of id	59,922	59,922	59,922	59,922

Notes: Column (1) shows the heterogeneous effect of spreads on intangible investment by estimating Eq. (1) using $\Delta \log(intangibles_{dep,it})$ as the dependent variable. Column (2) is the corresponding estimation of Eq. (2). Column (3) and (4) are the tangible investment counterparts to Column (1) and (2). Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table B.7 displays the results using $\Delta \log(intangibles_{dep,it+1})$ with alternative depreciation rates as dependent variables. The baseline results are robust to all choices of depreciation rate.

[4] $\text{intangible investment}_{it}/y_{it} = [y_{i,t+1} - (1 - dep_{intangible}) * y_{it}]/y_{it} \approx [\log(y_{i,t+1}) - \log((1 - dep_{intangible}) * y_{it}] * (1 - dep_{intangible})$

Table B.7: Intangible investment with alternative depreciation rate

Dependent variable	$\Delta\log(intangibles_{CHS2009_dep,it+1})$		$\Delta\log(intangibles_{BM2006_dep,it+1})$		$\Delta\log(intangibles_{PS1978_dep,it+1})$	
	(1) heterogeneity	(2) average	(3) heterogeneity	(4) average	(5) heterogeneity	(6) average
sp_t		-0.487**		-0.499**		-0.457**
		(0.209)		(0.214)		(0.196)
$size_{i,2006} \times sp_t$	1.760***	1.882***	1.804***	1.929***	1.650***	1.764***
	(0.237)	(0.236)	(0.243)	(0.242)	(0.222)	(0.221)
$leverage_{i,2006} \times sp_t$	-0.482**	-0.456*	-0.494**	-0.468*	-0.452**	-0.428*
	(0.235)	(0.235)	(0.241)	(0.241)	(0.221)	(0.221)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No	Yes	No
Observations	304,458	304,458	304,458	304,458	304,458	304,458
R-squared	0.025	0.013	0.025	0.013	0.025	0.013
Number of id	59,922	59,922	59,922	59,922	59,922	59,922

Notes: Column (1) and (2) are results using an intangible depreciation rate of 0.2 (Corrado et al. (2009)). Column (3) and (4) are results using an intangible depreciation rate of 0.18 (Bernstein and Mamuneas (2006)). Column (5) and (6) are results using an intangible depreciation rate of 0.25 (Pakes et al. (1978)). Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

B.2.5 Standardized size and leverage

Instead of using binary variables for size and leverage in 2006, we replace the firm heterogeneity measures with continuous standardized size and leverage in 2006. Eq. (1) and (2) are modified as:

$$\Delta\log(assets_{i,t+1}) = \beta(Cx_i \times sp_t) + Controls + \delta_i + \eta_{st} + \epsilon_{it}, \tag{B.2}$$

$$\Delta\log(assets_{i,t+1}) = \beta_0 sp_t + \beta_1(Cx_i \times sp_t) + Controls + AggControls + \delta_i + \epsilon_{it}, \tag{B.3}$$

where $Cx_i \in \{Csize_{i,2006}, Cleverage_{i,2006}\}$ are the standardized firm size or leverage in the year 2006. The baseline results hold for these alternative measures of firm size and leverage, as shown in Table B.8.

B.2.6 Group dummies based on sector median

There are concerns for grouping firms by sample median because firm distribution in size or leverage may be highly skewed in some specific sectors. Therefore, we use sector median as the criteria to construct binary indicators for size and leverage. For Eq. (1) and (2), $dsize_{i,2006}$ is 1 if the size of firm i is larger than the sector median in 2006, and 0 otherwise. $dleverage_{i,2006}$ is 1 if the leverage of firm i is higher than the sector median in 2006, and 0

Table B.8: Standardized size and leverage

Dependent variable	$\Delta \log(intangibles_{i,t+1})$		$\Delta \log(tangibles_{i,t+1})$		Tangibles-to-intangibles
	(1)	(2)	(3)	(4)	(5)
sp_t		0.184		-0.415***	1.510***
		(0.147)		(0.071)	(0.115)
$Csize_{i,2006} \times sp_t$	1.587***	1.659***	0.556***	0.557***	-0.920***
	(0.167)	(0.165)	(0.080)	(0.078)	(0.123)
$Cleverage_{i,2006} \times sp_t$	-0.492***	-0.477***	0.143**	0.157**	0.200*
	(0.148)	(0.148)	(0.066)	(0.066)	(0.114)
Firm controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No	No
Observations	303,253	303,253	303,253	303,253	297,901
R-squared	0.026	0.013	0.068	0.042	0.212
Number of id	59,548	59,548	59,548	59,548	58,828

Notes: Column (1) shows the heterogeneous effect of spreads on intangible investment by estimating Eq. (B.2). Column (2) is the corresponding estimation of Eq. (B.3). Column (3) and (4) are the tangible investment counterparts to Column (1) and (2). Column (5) estimates the heterogeneous effect of spreads on the asset reallocation (tangibles-to-intangibles ratio). Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

otherwise. The baseline results are also robust to this redefinition of the group dummies.

B.2.7 Province-year fixed effects

We further add province-year fixed effects into our baseline regressions, controlling for any geographical differences. For example, firms near the border may be highly exposed to foreign trade, which could be less affected by the Italian sovereign debt crisis. Table B.10 show that our baseline results are robust to including province-year fixed effects.

B.2.8 Clustering at sector-level

The baseline results are robust to clustering the standard errors at sector level.

B.2.9 Winsorizing at 0.5%

The baseline sample winsorizes the variables of interest at the top and bottom 1%. This section shows that the baseline estimation results are robust if we instead winsorize the variables of interest at the top and bottom 0.5%.

Table B.9: Group dummies based on sector median

Dependent variable	$\Delta \log(intangibles_{i,t+1})$		$\Delta \log(tangibles_{i,t+1})$		Tangibles-to-intangibles
	(1)	(2)	(3)	(4)	(5)
sp_t		-0.595**		-0.855***	2.007***
		(0.259)		(0.132)	(0.214)
$dsize_{i,2006} \times sp_t$	2.270***	2.265***	0.656***	0.638***	-1.354***
	(0.294)	(0.294)	(0.138)	(0.138)	(0.228)
$dleverage_{i,2006} \times sp_t$	-0.501*	-0.489*	0.308**	0.326**	0.232
	(0.294)	(0.294)	(0.133)	(0.132)	(0.221)
Firm controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No	No
Observations	304,432	304,432	304,432	304,432	299,068
R-squared	0.025	0.013	0.068	0.042	0.212
Number of id	59,913	59,913	59,913	59,913	59,188

Notes: Column (1) shows the heterogeneous effect of spreads on intangible investment by estimating Eq. (1). Column (2) is the corresponding estimation of Eq. (2). Column (3) and (4) are the tangible investment counterparts to Column (1) and (2). Column (5) estimates the heterogeneous effect of spreads on the asset reallocation (tangibles-to-intangibles ratio). Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table B.10: Province-year FE

Dependent variable	$\Delta \log(intangibles_{i,t+1})$		$\Delta \log(tangibles_{i,t+1})$		Tangibles-to-intangibles
	(1)	(2)	(3)	(4)	(5)
sp_t		5.332		-1.408	-6.443
		(7.626)		(4.507)	(7.300)
$size_{i,2006} \times sp_t$	2.148***	2.253***	0.631***	0.684***	-1.261***
	(0.298)	(0.296)	(0.142)	(0.140)	(0.229)
$leverage_{i,2006} \times sp_t$	-0.604**	-0.587**	0.326**	0.330**	0.383*
	(0.297)	(0.297)	(0.134)	(0.134)	(0.222)
Firm controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No	No
Observations	304,458	304,458	304,458	304,458	299,090
R-squared	0.028	0.027	0.071	0.070	0.219
Number of id	59,922	59,922	59,922	59,922	59,197

Notes: Column (1) shows the heterogeneous effect of spreads on intangible investment by estimating Eq. (1). Column (2) is the corresponding estimation of Eq. (2). Column (3) and (4) are the tangible investment counterparts to Column (1) and (2). Column (5) estimates the heterogeneous effect of spreads on the asset reallocation (tangibles-to-intangibles ratio). Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table B.11: Clustering at sector-level

Dependent variable	$\Delta\log(intangibles_{i,t+1})$		$\Delta\log(tangibles_{i,t+1})$		Tangibles-to-intangibles
	(1)	(2)	(3)	(4)	(5)
sp_t		-0.609**		-0.873***	1.900***
		(0.278)		(0.172)	(0.232)
$size_{i,2006} \times sp_t$	2.200***	2.352***	0.615***	0.639***	-1.297***
	(0.400)	(0.372)	(0.209)	(0.217)	(0.272)
$leverage_{i,2006} \times sp_t$	-0.602	-0.570	0.340**	0.362***	0.384
	(0.413)	(0.416)	(0.126)	(0.123)	(0.249)
Firm controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No	No
Observations	304,458	304,458	304,458	304,458	299,090
R-squared	0.025	0.013	0.068	0.042	0.212
Number of id	59,922	59,922	59,922	59,922	59,197

Notes: Column (1) shows the heterogeneous effect of spreads on intangible investment by estimating Eq. (1). Column (2) is the corresponding estimation of Eq. (2). Column (3) and (4) are the tangible investment counterparts to Column (1) and (2). Column (5) estimates the heterogeneous effect of spreads on the asset reallocation (tangibles-to-intangibles ratio). Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table B.12: 0.5% winsorizing

Dependent variable	$\Delta\log(intangibles_{i,t+1})$		$\Delta\log(tangibles_{i,t+1})$		Tangibles-to-intangibles
	(1)	(2)	(3)	(4)	(5)
sp_t		-1.013***		-1.007***	2.526***
		(0.274)		(0.140)	(0.341)
$size_{i,2006} \times sp_t$	2.432***	2.643***	0.795***	0.819***	-1.666***
	(0.311)	(0.309)	(0.147)	(0.145)	(0.359)
$leverage_{i,2006} \times sp_t$	-0.578*	-0.547*	0.160	0.163	0.044
	(0.307)	(0.306)	(0.138)	(0.137)	(0.339)
Firm controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No	No
Observations	341,737	341,737	341,737	341,737	337,653
R-squared	0.026	0.014	0.066	0.043	0.070
Number of id	63,792	63,792	63,792	63,792	63,367

Notes: Column (1) shows the heterogeneous effect of spreads on intangible investment by estimating Eq. (1). Column (2) is the corresponding estimation of Eq. (2). Column (3) and (4) are the tangible investment counterparts to Column (1) and (2). Column (5) estimates the heterogeneous effect of spreads on the asset reallocation (tangibles-to-intangibles ratio). Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

B.2.10 Deflating intangible and tangible fixed assets with PPI

The baseline estimation deflates intangible (tangible) fixed assets by the price of intangible (tangible) assets. We replace the price of investment with the PPI and the results remain robust.

Table B.13: PPI deflation

Dependent variable	$\Delta\log(intangibles_{i,t+1})$		$\Delta\log(tangibles_{i,t+1})$		Tangibles-to-intangibles
	(1)	(2)	(3)	(4)	(5)
sp_t		-0.927***		-0.878***	1.963***
		(0.261)		(0.134)	(0.209)
$size_{i,2006} \times sp_t$	2.181***	2.329***	0.614***	0.638***	-1.322***
	(0.296)	(0.295)	(0.141)	(0.139)	(0.225)
$leverage_{i,2006} \times sp_t$	-0.584**	-0.550*	0.343**	0.361***	0.387*
	(0.294)	(0.294)	(0.133)	(0.132)	(0.217)
Firm controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No	No
Observations	304,472	304,472	304,472	304,472	299,173
R-squared	0.025	0.012	0.064	0.041	0.215
Number of id	59,922	59,922	59,922	59,922	59,194

Notes: Column (1) shows the heterogeneous effect of spreads on intangible investment by estimating Eq. (1). Column (2) is the corresponding estimation of Eq. (2). Column (3) and (4) are the tangible investment counterparts to Column (1) and (2). Column (5) estimates the heterogeneous effect of spreads on the asset reallocation (tangibles-to-intangibles ratio). Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

B.2.11 Alternative measure of debt crisis severity: firm spreads and CDS spread

Figure B.3 and B.4 plot the Italian firm-level spread, which is defined as the gap between the interest rate for loans (other than bank overdrafts) to non-financial corporations and the risk-free interest rate, and Italian 5-year CDS spread, respectively. The nominal risk-free rate is given by the Eurosystem main refinancing operations interest rate. Data is accessed via the Bank of Italy Statistical Database. During the Italian sovereign debt crisis, the interest rate spread for firms and the CDS spread also increased. We replace the sovereign spread with the firm spread and the CDS spread. The baseline results do not vary too much.

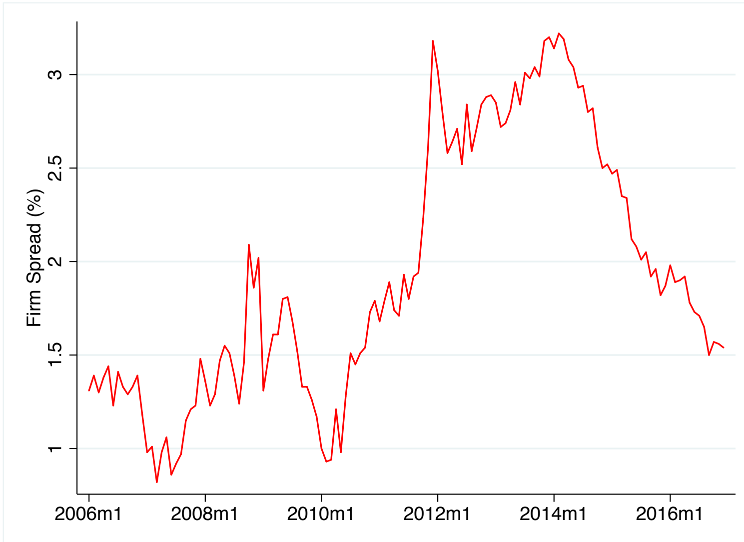


Figure B.3: Italy, firm spreads

Notes: A measure of average interest rate spreads for firms. The series is given by the spread over the risk-free rate of the interest rate for Italian non-financial corporations on non-overdraft loans (total maturity). The nominal risk-free rate is given by the Eurosystem main refinancing operations interest rate. Data source: Bank of Italy Statistical Database.

Table B.14: Alternative measure of debt crisis severity: firm spreads

Dependent variable	$\Delta \log(intangibles_{i,t+1})$		$\Delta \log(tangibles_{i,t+1})$		Tangibles-to-intangibles
	(1)	(2)	(3)	(4)	(5)
sp_t		-2.884***		-0.591***	2.052***
		(0.283)		(0.151)	(0.243)
$size_{i,2006} \times sp_t$	1.264***	0.924***	0.151	-0.099	-0.751***
	(0.323)	(0.318)	(0.158)	(0.156)	(0.258)
$leverage_{i,2006} \times sp_t$	-0.336	-0.218	0.248*	0.263*	0.540**
	(0.320)	(0.317)	(0.150)	(0.148)	(0.249)
Firm controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No	No
Observations	304,458	304,458	304,458	304,458	299,090
R-squared	0.025	0.014	0.068	0.042	0.212
Number of id	59,922	59,922	59,922	59,922	59,197

Notes: Column (1) shows the heterogeneous effect of spreads on intangible investment by estimating Eq. (1). Column (2) is the corresponding estimation of Eq. (2). Column (3) and (4) are the tangible investment counterparts to Column (1) and (2). Column (5) estimates the heterogeneous effect of spreads on the asset reallocation (tangibles-to-intangibles ratio). Robust standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

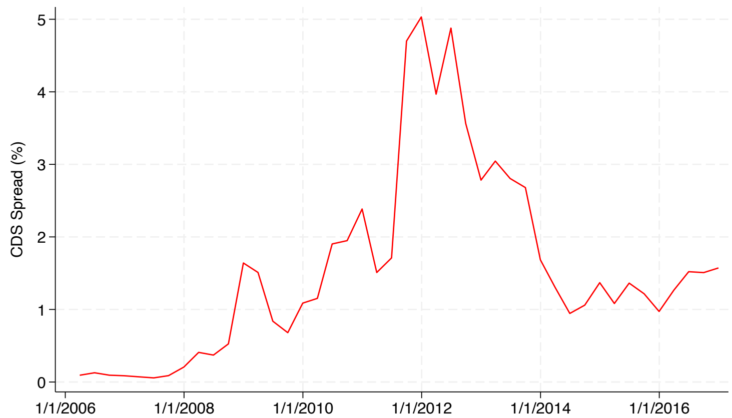


Figure B.4: Italy, CDS spread

Notes: The series is quarterly 5-year CDS spread, last price. Data source: Bloomberg.

Table B.15: Alternative measure of debt crisis severity: CDS spread

Dependent variable	$\Delta \log(intangibles_{i,t+1})$		$\Delta \log(tangibles_{i,t+1})$		Tangibles-to-intangibles
	(1)	(2)	(3)	(4)	(5)
sp_t		0.061		-0.718***	1.616***
		(0.256)		(0.132)	(0.209)
$size_{i,2006} \times sp_t$	2.154***	2.399***	0.622***	0.724***	-1.264***
	(0.291)	(0.290)	(0.138)	(0.136)	(0.224)
$leverage_{i,2006} \times sp_t$	-0.636**	-0.625**	0.298**	0.313**	0.288
	(0.289)	(0.289)	(0.131)	(0.130)	(0.217)
Firm controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No	No
Observations	304,458	304,458	304,458	304,458	299,090
R-squared	0.025	0.013	0.068	0.042	0.212
Number of id	59,922	59,922	59,922	59,922	59,197

Notes: Column (1) shows the heterogeneous effect of spreads on intangible investment by estimating Eq. (1). Column (2) is the corresponding estimation of Eq. (2). Column (3) and (4) are the tangible investment counterparts to Column (1) and (2). Column (5) estimates the heterogeneous effect of spreads on the asset reallocation (tangibles-to-intangibles ratio). Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

B.2.12 Alternative measure of debt crisis severity: spreads using yields of government bonds with different maturities

Using statistics from the Bank of Italy, Italian general government debt had 7.3 years average maturity estimated at the end of 2012. Debt with a residual maturity of over 5 years constituted 42.27% of the gross debt. Therefore, we use the 10-year spread as our baseline measure for the severity of the sovereign debt crisis. In this section, we demonstrate that our baseline results are robust when replacing the baseline 10-year government bond spread with 5-year and 30-year government bond spreads, as shown in Table B.16 and B.17, respectively.

Table B.16: Results using 5-year government bond yield spreads

Dependent variable	$\Delta \log(intangibles_{i,t+1})$		$\Delta \log(tangibles_{i,t+1})$		Tangibles-to-intangibles
	(1)	(2)	(3)	(4)	(5)
sp_t		-0.076		-0.690***	1.449***
		(0.238)		(0.122)	(0.194)
$size_{i,2006} \times sp_t$	1.929***	2.121***	0.570***	0.624***	-1.123***
	(0.270)	(0.269)	(0.128)	(0.126)	(0.208)
$leverage_{i,2006} \times sp_t$	-0.517*	-0.506*	0.306**	0.325***	0.331
	(0.268)	(0.268)	(0.121)	(0.121)	(0.201)
Firm controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No	No
Observations	304,458	304,458	304,458	304,458	299,090
R-squared	0.025	0.013	0.068	0.042	0.212
Number of id	59,922	59,922	59,922	59,922	59,197

Notes: Column (1) shows the heterogeneous effect of spreads on intangible investment by estimating Eq. (1). Column (2) is the corresponding estimation of Eq. (2). Column (3) and (4) are the tangible investment counterparts to Column (1) and (2). Column (5) estimates the heterogeneous effect of spreads on the asset reallocation (tangibles-to-intangibles ratio). Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table B.17: Results using 30-year government bond yield spreads

Dependent variable	$\Delta\log(intangibles_{i,t+1})$		$\Delta\log(tangibles_{i,t+1})$		Tangibles-to-intangibles
	(1)	(2)	(3)	(4)	(5)
sp_t		-1.360***		-1.300***	2.720***
		(0.292)		(0.150)	(0.241)
$size_{i,2006} \times sp_t$	2.700***	2.848***	0.702***	0.738***	-1.653***
	(0.332)	(0.330)	(0.157)	(0.155)	(0.259)
$leverage_{i,2006} \times sp_t$	-0.818**	-0.753**	0.343**	0.368**	0.337
	(0.330)	(0.329)	(0.150)	(0.148)	(0.251)
Firm controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	No	Yes	No	No
Observations	304,458	304,458	304,458	304,458	299,090
R-squared	0.025	0.013	0.068	0.042	0.213
Number of id	59,922	59,922	59,922	59,922	59,197

Notes: Column (1) shows the heterogeneous effect of spreads on intangible investment by estimating Eq. (1). Column (2) is the corresponding estimation of Eq. (2). Column (3) and (4) are the tangible investment counterparts to Column (1) and (2). Column (5) estimates the heterogeneous effect of spreads on the asset reallocation (tangibles-to-intangibles ratio). Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

C Model

C.1 Households

The problem of the households is to maximize their preferences, subject to the budget constraint (9). The FOCs are given as:

$$[C_t] \qquad \beta^t = \xi_t \tag{C.4}$$

$$[M_t] \qquad \xi_{t+1} = q_t^m \xi_t \tag{C.5}$$

where ξ_t is the Lagrange multiplier on the budget constraint (9). Then we obtain:

$$q_t^m = \beta \tag{C.6}$$

Notice the price of deposits is constant over time.

C.2 Financial intermediaries

The financial intermediary's problem is:

$$\max_{\{M_t, B_{t+1}, b_{it}\}} E_t[\beta F_{t+1}] \tag{C.7}$$

where

$$F_{t+1} = (1 - d_{t+1} f)[\vartheta B_{t+1} + q_{t+1}(1-\vartheta)B_{t+1}] + \int R_{it} b_{it} di - M_t.$$

subject to

$$(\mu_t) \qquad q_t B_{t+1} + \int b_{it} di \leq N_t + q_t^m M_t, \tag{C.8}$$

$$(\zeta_t) \qquad \int (1 - \theta_{it}) b_{it} di \leq N_t. \tag{C.9}$$

The FOCs are:

$$[b_{it}] \qquad \beta R_{it} - \mu_t - (1-\theta_{it})\zeta_t = 0 \tag{C.10}$$

$$[B_{t+1}] \qquad \beta \mathbb{E}_t[(1-d_{t+1}f)(\vartheta + q_{t+1}(1-\vartheta)] - \mu_t q_t = 0 \tag{C.11}$$

$$[M_t] \qquad -\beta + \mu_t q_t^m = 0 \tag{C.12}$$

Using the FOC from the households' problem $q_t^m = \beta$, we can get the pricing conditions for government bonds (13) and firm loans (14).

D Numerical solution

For any state (s, B, d), net worth is given by $N(s, B, d) = \bar{n} + (1-df)(1-\vartheta)q(s)B$. When government defaults ($d = 1$) or the default risk increases so that the bond price q decreases, financial intermediaries' net worth N decreases. With lower net worth N, the leverage constraint $\int(1-\theta_{it})b_{it}di \leq N_t$ becomes more binding. A tighter leverage constraint increases the shadow price of borrowing (Lagrange multiplier ζ_t), and thus increases the firm loan interest rate $R_{it} = \frac{1+(1-\theta_{it})\zeta_t}{\beta}$. From each firm's perspective, ζ_t summarizes the impacts of the aggregate shocks. Here we describe the computation algorithm in steps.

Step 1: Preparation. Create grid points for the default risk process s, government bonds B, and an indicator d to denote whether the government is in default or not. Create grid points for the productivity shock z, financing needs λ, tangible capital k_T, intangible capital k_I, and the Lagrange multiplier $\zeta \in [0, \zeta_{max}]$.

Step 2: Iterate for the government bond price. Guess the initial government bond price $q(s)$. Update the bond price using Eq. (13). Iterate until the bond price converges. Since government default process does not depend on firms, we iterate it separately from the rest of the loops.

Step 3: Iterate for the firms and the aggregates.

1. Guess firm value function $V_0(z, \lambda, k_T, k_I, \zeta)$ and aggregate output $Y_0(\Lambda(z, \lambda, k_T, k_I), \zeta)$.
2. Following Krusell and Smith (1998), we specify a forecasting function for ζ and iterate until the coefficients in the forecasting function converge. We assume $\zeta' = \phi_0 + \phi_1\zeta$ and

guess for ϕ_0 and ϕ_1: ϕ_0^0 and ϕ_1^0.

3. Solve the firm's maximization problem and update the value function $V_1(z, \lambda, k_T, k_I, \zeta)$ and the associated policy functions $k_T'(z, \lambda, k_T, k_I, \zeta)$, $k_I'(z, \lambda, k_T, k_I, \zeta)$ and $b(z, \lambda, k_T, k_I, \zeta)$. Compute the distance between the guessed value function and the updated value function.

4. Compute the associated firm output $y(z, \lambda, k_T, k_I, \zeta)$ and the term that summarizes firm loan demand b: $x(z, \lambda, k_T, k_I, \zeta) = (1 - \theta(k_T))b(z, \lambda, k_T, k_I, \zeta)$, where $\theta(k_T) = k_T/\bar{k}$. Compute the distribution of the firms.

5. Update aggregate output $Y_1(\Lambda(z, \lambda, k_T, k_I), \zeta) = \int y(z, \lambda, k_T, k_I, \zeta) d\Lambda$ and an aggregate term that summarizes firm loan demand b: $X(\Lambda(z, \lambda, k_T, k_I), \zeta) = \int x(z, \lambda, k_T, k_I, \zeta) d\Lambda$. Compute the distance between the guessed aggregate output and the updated aggregate output.

6. Compute the equilibrium Lagrange multiplier $\zeta(s, B, d)$: if $X(\Lambda(z, \lambda, k_T, k_I), 0) \leq N(s, B, d)$, then $\zeta = 0$, otherwise, ζ is chosen such that $X(\Lambda(z, \lambda, k_T, k_I), \zeta) = N(s, B, d)$.

7. Implement the simulation. Using the simulated paths to run OLS regression to obtain the new set of coefficients for the forecasting function ϕ_0^1 and ϕ_1^1.

8. Iterate until the distances between ϕ_0^0 and ϕ_0^1, ϕ_1^0 and ϕ_1^1, V_0 and V_1, Y_0 and Y_1 are all less than the tolerance level.

E Model with a representative firm

In this section, we abandon the assumption of heterogeneous firms and instead assume a representative firm and compare the results. Instead of assuming firm-specific financing needs λ_i, we consider a representative firm with working capital requirement λ. Quantitatively, we set λ such that the model generates the average leverage in the data. We keep the other parameters the same as those in the benchmark model. Table E.18 reports the parameters and the generated moments in the model with a representative firm.

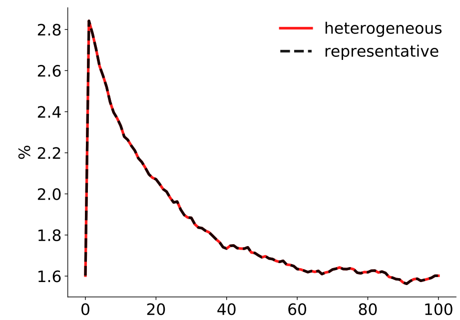
The moments generated by the representative model are not too far off from those in the benchmark model. However, the representative model generates a significant different level of responses when hit by shocks. Figure E.5 plots the IRFs to an increase in sovereign spreads for the model with heterogeneous firms and the model with a representative firm.

Table E.18: Parameters and moments in the model with a representative firm

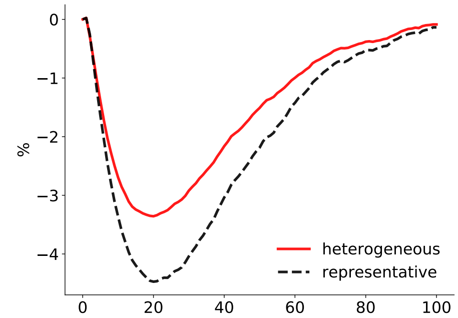
	benchmark	representative firm
Parameters changed from benchmark		
Working capital requirements	$[\lambda_l, \lambda_h]$ =[0.122,1.72]	$\lambda = 1.1$
Model moments		
mean(firm tangibility)	0.727	0.713
corr(intangible investment, tangible investment)	0.206	0.157
std(tangible capital)/std(sales)	1.514	1.412
std(intangible capital)/std(sales)	3.283	3.167
mean(leverage) for low-leverage firms	0.023	-
mean(leverage) for high-leverage firms	0.339	-
mean(leverage)	-	0.184
government bonds/tax revenue	2.476	2.674
credit to firms/credit to government	0.690	0.698
mean(spread)	0.016	0.016
std(spread)	0.012	0.012

Following an increase in sovereign spreads (Panel a), the model with a representative firm shows larger declines in both tangible and intangible capital (Panels b and c) and exhibits a larger pattern of reallocation (Panel d). The representative model also exhibits a larger decrease in output and TFP (Panels e and f).

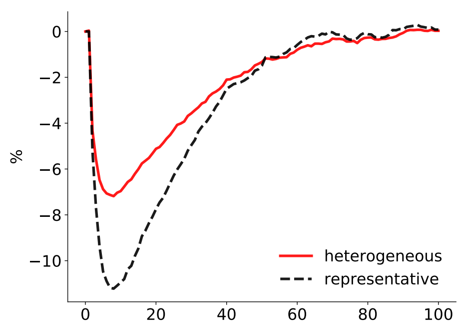
However, the representative firm model fails to generate the observed heterogeneous asset reallocation pattern seen in the data. We simulate the model multiple times to create a panel of firms. The firms are homogeneous ex-ante but with different realizations of stochastic productivity. Using this model-simulated sample, we run the same regressions as those in Table 4, where the dependent variable is the tangibles-to-intangibles ratio. Table E.19 compares the estimated coefficients in the benchmark model and the representative firm model. We maintain the same number of firms in both models. The representative model can generate an asset reallocation pattern (regression coefficient for sp_t), but the magnitude is excessively large. More importantly, it fails to capture the data observation where high-leverage firms reallocate more towards tangible investment compared to other firms (regression coefficient for $leverage_{i,2006} \times sp_t$) as in the data.



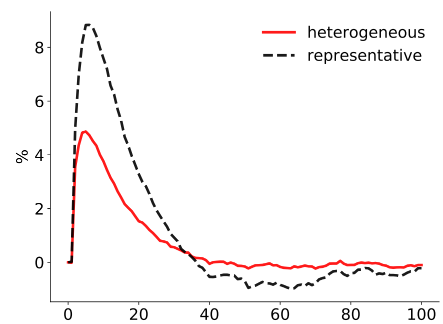
(a) Sovereign spreads



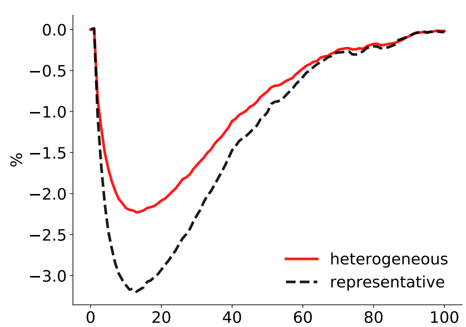
(b) Tangible asset



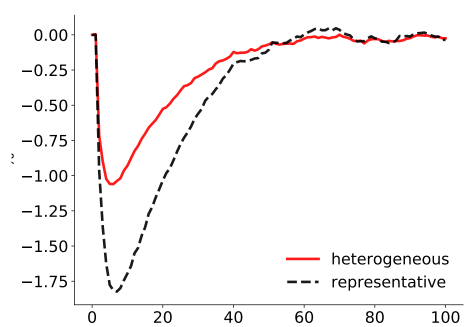
(c) Intangible asset



(d) Tangibles-to-intangibles ratio



(e) Output



(f) TFP

Figure E.5: IRFs in benchmark model and reference models

Notes: Impulse response functions to a positive s shock (so that the sovereign spread increases by one standard deviation) in the benchmark model where the firms are heterogeneous (red solid lines) and the model with a representative firm (black dashed lines). Before the shock, s follows its underlying Markov chain. In period 1, there is a positive shock to s so that the government spread increases by 1 standard deviation. After period 1, the s shocks follow the conditional Markov process. The impulse responses plot the average across the simulations.

Table E.19: Regression results: data, benchmark model, and representative firm model

	Data	Benchmark	Representative
sp_t	1.900***	1.428***	17.330***
$size_{i,2006} \times sp_t$	-1.297***	-0.883***	-8.227***
$leverage_{i,2006} \times sp_t$	0.384*	1.811***	-3.167***

Notes: Regression coefficients for the data, the benchmark model, and the representative firm model. The coefficients from the data are taken from column (6) in Table 4. The model regression specification mimics the data regression as much as possible. The sample time length is consistent with data regression.

F Substitutability between tangible and intangible capital

The strength of the crises depends on the degree of substitutability of intangible and tangible capital. When we assume a Cobb-Douglas production function, where the elasticity of substitution is one (higher than 0.51 calibrated in the benchmark model), elevated sovereign risk accounts for 40% (compared to 45% in the paper) of the observed output losses and 22% (compared to 31% in paper) of TFP losses in Italy from 2011 to 2016.

References

Bernstein, J. I. and T. P. Mamuneas (2006). R&D depreciation, stocks, user costs and productivity growth for US R&D intensive industries. *Structural Change and Economic Dynamics 17*(1), 70–98.

Corrado, C., C. Hulten, and D. Sichel (2009). Intangible capital and US economic growth. *Review of Income and Wealth 55*(3), 661–685.

Davis, S. J. and J. Haltiwanger (1992). Gross job creation, gross job destruction, and employment reallocation. *The Quarterly Journal of Economics 107*(3), 819–863.

Davis, S. J., J. C. Haltiwanger, and S. Schuh (1998). Job creation and destruction. *MIT Press Books 1*.

Deng, M. and M. Fang (2022). Debt maturity heterogeneity and investment responses to monetary policy. *European Economic Review 144*, 104095.

Huber, P., H. Oberhofer, and M. Pfaffermayr (2013). Who creates jobs? Estimating job creation rates at the firm level. *University of Salzburg, Economics and Finance Working Paper* (2013-05).

Krusell, P. and A. A. Smith, Jr (1998). Income and wealth heterogeneity in the macroeconomy. *Journal of political Economy 106*(5), 867–896.

Ottonello, P. and T. Winberry (2020). Financial heterogeneity and the investment channel of monetary policy. *Econometrica 88*(6), 2473–2502.

Pakes, A., M. A. Schankerman, et al. (1978). The rate of obsolescence of knowledge, research gestation labs, and the private rate of return to research resources. Technical report.

Stehrer, R., A. Bykova, K. Jäger, O. Reiter, and M. Schwarzhappel (2019). Industry level growth and productivity data with special focus on intangible assets. Report on methodologies and data construction for the EU KLEMS release 2019. *The Vienna Institute for International Economic Studies*.