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The Collateral Channel within and between Countries

Jérôme Héricourt, Jean Imbs & Lise Patureau

Highlights

- We examine the response of investment to real-estate prices in the universe of French firms over 1994-2015.
- We find that investment sensitivity to real estate prices decreases with firm size.
- We impute these estimates onto other EU and non-EU countries where available data lack firm-level detail.
- Our results indicate significant variation in the sensitivity of aggregate investment to real estate shocks, driven by cross country differences in the size distribution of firms.

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Abstract

We examine the response of investment to real estate prices among French firms from 1994 to 2015. Using newly introduced methods and specifications, we find that investment sensitivity to real estate prices decreases with firm size: The smallest firms are at least three times more responsive to changes in collateral value compared to the largest firms. We impute these estimates onto other countries where available data lack firm-level detail. This approach allows us to assess the aggregate sensitivity of investment to real estate prices across different countries. Our results indicate significant variation in the sensitivity of aggregate investment to real estate shocks, driven by cross country differences in the size distribution of firms.

Keywords

Collateral Channel, Firm Heterogeneity, Cross-Country Study, Micro and Macro Estimates.

JEL

D31, E25, E44, G01.

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The collateral channel within and between countries[*]

Jérôme Héricourt[†] Jean Imbs[‡] Lise Patureau[§]

1 Introduction

In imperfect financial markets, firms' access to external finance is limited by the value of their assets that can be used as collateral (Barro, 1976, Stiglitz & Weiss, 1981, Hart & Moore, 1994). Bernanke & Gertler (1989) and Kiyotaki & Moore (1997) explore the macroeconomic implications of these imperfections: during recessions, the decline in collateral asset values exacerbates financial constraints, further reducing investment and output, thereby triggering a "financial accelerator" mechanism.

The collateral channel depends on each firm's ability to mobilize internal resources. Consequently this channel is inherently heterogeneous and is most pronounced in small, credit-constrained firms. This heterogeneity is interesting in its own right (see Welch, 2021). It is also relevant for understanding the aggregate collateral channel at country level. Differences in firm distributions across countries lead to varying aggregate sensitivities of investment to collateral constraints. Our objective is to develop a methodology that leverages detailed firm-level data from one country to generate estimates of the sensitivity of aggregate investment to financing constraints in other countries, even in the absence of detailed firm-level data there.

We begin by estimating the response of investment to changes in collateral value at the firm level, focusing on quantiles of French firms from 1994 to 2015. The quantiles are chosen to split the universe of French firms into categories with heterogeneous credit constraints. The estimations results are then imputed to other countries where we have data on firm distributions but lack individual balance sheets. We assume that firms in similar positions within their respective distributions exhibit comparable investment responses to changes in collateral values. The assumption allows us to approximate the distribution of investment responses in countries without firm-level balance sheet data and to infer an estimation of the aggregate collateral channel there.

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There are several challenges to address before achieving this objective. Firstly we need firm-level data on investment and collateral values. A common measure of collateral is the value of real estate assets, as used by Chaney et al. (2012) in a sample of listed US companies. However, listed companies are likely the least affected by financial constraints, suggesting that those data provide a lower bound to the actual investment responses. In this paper, we use balance sheet data on the *universe* of French firms for the period 1994-2015 combined with data on real estate prices.

Secondly, there are well-known issues of simultaneity and endogeneity between investment and real estate prices, which we address following Chaney et al. (2012). Their approach came under heavy criticism by Welch (2021), and we incorporate his comments in a battery of alternative specifications that ascertain the existence of a causal and heterogeneous relationship going from real estate prices to investment in the universe of French firms.

Thirdly, to impute the effects estimated from French data to other countries, we need information on firm distributions in those countries. Specifically, we require the distribution of firms across the different quantiles used in the French data estimations, which we obtain from CompNet.[1] We can impute the heterogeneous effects from the French data to other countries with similar financial systems, particularly those with a comparable reliance on bank finance. Beyond France, our analysis includes nine Western European countries: Belgium, Denmark, Finland, Germany, Italy, the Netherlands, Portugal, Spain, and Sweden. For comparison purposes, we also consider the Czech Republic, a former transition country where credit constraints are likely more severe than in Western Europe; Switzerland, which is similar to Western European countries but outside the European Union; and the United Kingdom, known for its significant market finance sector.

We reach two key conclusions. First, the sensitivity of investment to changes in real estate prices among French firm is approximately 0.2. This means that a 10 percentage point increase in the value of real-estate assets results in a 2 percentage point increase in investment. Importantly, the estimates vary considerably with firm size: the smallest firms are at least three times more responsive to changes in collateral value compared to the largest firms. This heterogeneity is evident across different measures of size (such as employment and real value added). The estimates are robust across various data sources and controls. Although the estimated effects are smallest for large firms, which are presumably the least credit constrained, they remain statistically significant.

We observe significant firm heterogeneity both within and across countries in our EU sample. For instance, firms in Italy and Portugal tend to be smaller and less productive on average

[1] The Competitiveness Research Network (CompNet) has been founded by the EU System of Central Banks in 2012. See http://www.comp-net.org/data/. The weights used to aggregate micro estimates to the country level are also sourced from CompNet.

compared to those in the Netherlands and Belgium. Consequently, the characteristics of firms in each percentile vary across countries. This micro-level heterogeneity contributes to the diversity of collateral channels at the aggregate level across Europe.

Implementing this bottom-up approach leads to our second main finding. We identify significant cross-country heterogeneity in estimated reactions to collateral shocks, attributable to differences in firm distributions. Because of substantial cross-country variation in firm distributions, the sensitivity of aggregate investment to collateral shocks ranges from 0.16 in Switzerland to 0.25 in the Czech Republic. Focusing on Euro Area members, the estimates range from 0.18 in Finland to 0.25 in Belgium. These results are robust across various aggregation exercises using different proxies for firm size. Practically, this means that an identical shock to real estate prices (e.g., a monetary policy shock) elicits a 1.3 to 1.4 times greater investment response in Belgium or the Czech Republic compared to Finland or France.

One of the main sources of this heterogeneity is the significant role of small firms in determining the magnitude of the aggregate investment response to a collateral shock. This finding is somewhat unexpected, given the disproportionate influence of large firms on aggregate dynamics, as highlighted by a growing body of literature pioneered by Gabaix (2011). Even though small firms have a relatively minor impact on aggregate dynamics, they are crucial in determining the magnitude of the response of aggregate investment to collateral shocks. Additionally, this finding has interesting policy implications. The pronounced heterogeneous effects of collateral shocks across firms should be a concern for national authorities. And the resulting heterogeneous effects of collateral shocks across countries should be a concern for international policymakers, particularly the European Central Bank.

Our work directly relates to recent studies providing empirical, firm-level evidence of the collateral channel, such as Chaney et al. (2012), Bahaj et al. (2020), and Fougère et al. (2019). These three papers find that firm-level investment is sensitive to the collateral value or real estate assets, with marginal effects in the range of 0.05-0.07. They focus on sub-samples of relatively large firms, in the US, the UK, and France, respectively. Fougère et al. (2019) also document heterogeneous effects of real estate prices on investment depending on the size of real estate holdings. Banerjee & Blickle (2021) find that borrowing, investment, and employment are particularly correlated with house price growth in small and young firms across six European countries.

The heterogeneous prevalence of a collateral channel has significant implications for misallocation and its aggregate consequences: Gopinath et al. (2017) or Grjebine et al. (2023) find that heterogeneous financial frictions can substantially impact aggregate productivity, while Catherine et al. (2022) quantify the resulting aggregate output losses as high as 7 percent. We make two key contributions: First we examine the heterogeneous investment responses across the universe of French firms, including very small ones. Second, we impute the French results to other countries based on their observed firm size distributions, allowing us to estimate the aggregate importance of the collateral channel in those countries.

2 The Collateral Channel Among French Firms

2.1 Theory and Issues

Chaney et al. (2009) and Catherine et al. (2022) propose a simple model of investment under collateral constraint delivering the following reduced form expression for investment by firm i located in location l at time t:

$$\mathcal{I}^l_{i,t} = \rho\, \mathcal{H}^l_{i,t} + \beta\, P^l_t + \varepsilon^l_{i,t}, \tag{1}$$

where $\mathcal{I}^l_{i,t} = \frac{I_{i,t}}{K^l_{i,t-1}}$ and $\mathcal{H}^l_{i,t} = \frac{P^l_t}{P^l_{t_0}} H^l_{i,t_0} \,/K^l_{i,t-1}$. $I_{i,t}$ denotes tangible investment, $K^l_{i,t-1}$ the stock of tangible capital, and H^l_{i,t_0} the t_0 value of real estate holdings bought in t_0. P^l_t is the price of real estate in location l at time t and $\mathcal{H}^l_{i,t}$ is the current market value of real estate holdings bought in t_0, normalized by $K^l_{i,t-1}$. Variation in the value of firm-level real estate holdings comes exclusively from fluctuations in their market price

In the model, ρ maps directly with the degree of financial constraints, which depends on the fraction of firms facing financing constraints, their severity, and the fraction of real estate that can be used as collateral. From the definition of $\mathcal{H}^l_{i,t}$, ρ identifies how investment is affected by changes in real estate prices for firms that hold real estate assets in t_0. Identification comes from comparing firms that hold real estate with those that do not. Naturally cycles in asset prices P^l_t correlate with investment for other reasons, so equation (1) includes a direct control for real estate prices.

Following Chaney et al. (2012) the specification is augmented with firm fixed effects μ_i, a location-specific time effect ν^l_t, and firm's cash flow normalized by $K^l_{i,t-1}$, denoted $CF^l_{i,t}$.[2] Location-specific real estate prices P^l_t are subsumed in the time effects ν^l_t. Equation (1) becomes

$$\mathcal{I}^l_{i,t} = \rho\, \mathcal{H}^l_{i,t} + \delta\, CF^l_{i,t} + \gamma\, X^l_{i,t} + \mu_i + \nu^l_t + \varepsilon^l_{i,t} \tag{2}$$

The vector $X^l_{i,t}$ denotes a battery of interaction terms involving the quintiles of firms' initial age, initial assets, initial return on assets, and two-digit industry dummies, all interacted with P^l_t, meant to control for endogenous selection in real estate ownership at time 0.

For a large enough firm, investment decisions can impact local real estate prices, generating a positive endogeneity bias in the estimates of ρ. Following Chaney et al. (2012), we instrument real estate prices using an interaction between the aggregate housing mortgage rate r_t and the

[2]See Lian & Ma (2021).

elasticity of housing supply in location l, which isolates fluctuations in local real estate prices that are determined by aggregate and geographic factors.[3] With instrumentation, the estimation becomes

$$\mathcal{I}_{i,t}^{l} = \rho\, \widehat{\mathcal{H}}_{i,t}^{l} + \delta\, CF_{i,t}^{l} + \gamma\, \widehat{X}_{i,t} + \mu_i + \nu_t^{l} + \varepsilon_{i,t}^{l}, \tag{3}$$

where $\widehat{\mathcal{H}}_{i,t}^{l} = \frac{\widehat{P}_t^l}{P_{t_0}^l} H_{i,t_0}^l \,/ K_{i,t-1}^l$, $\widehat{P}_t^l$ is the fitted value of P_t^l according to $P_t^l = \kappa\, \eta^l \times r_t + \lambda_t + \nu^l + u_t^l$, and $\widehat{X}_{i,t}$ uses $\widehat{P}_t^l$ in all interactions. η^l measures the elasticity of housing supply in location l and r_t is the aggregate mortgage rate. λ_t and ν^l are respectively time and location fixed effects. All estimations are clustered at the location-year level, see Moulton (1990).[4]

Welch (2021) takes issue with the interpretation of ρ in equations (1)-(3) on grounds that $\mathcal{I}_{i,t}^{l}$ and the main independent variable $\mathcal{H}_{i,t}^{l}$ are normalized by the same quantity $K_{i,t-1}$, which he argues creates a spurious correlation. Our specifications incorporate the alternative specifications discussed by both parties to mitigate this potential bias, as outlined by Chaney et al. (2020). The first adjustment involves including a control for $1/K_{i,t-1}$ in our baseline specifications (2) and (3), following the recommendation in Chaney et al. (2020). Additionally, we further refine the specification to incorporate suggestions from both sides of the debate, as detailed in Section 2.3.

2.2 Data

We combine accounting data on French firms, their location, and local real estate prices. Accounting data is provided by the French national institute of statistics (INSEE) through several databases: *Bénéfices Réels Normaux* (BRN, 1993-2009), *Fichier complet unifié de Suse* (FICUS, 1994-2007), *Fichier approché des résultats d'Esane* (FARE, 2009-2015) and *Déclaration Annuelle de Données Sociales* (DADS, 1993-2015). The datasets can be merged thanks to a unique firm identifier, which maximises coverage and data availability. The combination of these data sources enables us to collect detailed firm-level information on employment, value added, real estate holdings, investment, a breakdown of asset holdings, and location.[5] As in Chaney et al. (2012) and Fougère et al. (2019), we exclude firms operating in the finance, insurance, real estate, construction, and mining industries as well as those present for fewer than three consecutive years. Like Chaney et al. (2012) we also exclude firms with negative employment values or balance sheet entries. The resulting sample covers 2,159,086 unique firm identifiers over the whole period; On average a firm is present for 4.4 years in the sample. For each firm

[3] The instrument can also account for the measurement error in $\mathcal{H}_{i,t}^{l}$, which denotes the value of commercial real estate but is effectively measured by the price of residential housing

[4] The same strategy is implemented by Fougère et al. (2019) and Hossain et al. (2023)

[5] In practice, BRN provides the most exhaustive data, which we complete whenever necessary with FICUS (or FARE in 2009). Firm location is reported in DADS, which we also use to complete information on the number of employees whenever needed. The dependent variable $\mathcal{I}_{i,t}^{l}$ is missing from BRN so it is collected from FICUS/FARE, which means 2008 is excluded from our analysis. FARE provides information on the universe of French firms, while BRN is restricted to firms whose pre-tax sales are above 763,000 euros.

we collect data on employment and value added, calculating labor productivity as the ratio of the two. Real value added is obtained using the French sectoral value added price index from KLEMS.

We observe the real estate holdings of each firm in our sample under the "land, buildings and equipments" entry in balance sheet statements, where real estate is valued at historical cost. To determine market values, we calculate the vintage of these assets by multiplying the fraction claimed as depreciation by their depreciable life. As we explain in Appendix A.1, this averages 36 years in our sample. We then infer year t value of each firm's real estate holdings by adjusting their historical cost using local housing price inflation from the year of acquisition to the current year t. This approach, following Chaney et al. (2012), has two implications. First since land does not depreciate, we exclude firms that report only land as real estate holdings, which accounts for 3 percent (2 percent) of firms on the full (IV) sample. Second we only consider real estate assets from the first available year in the database, thereby excluding any subsequent purchases that could be co-determined with investment decisions.

Local residential real estate prices are obtained from the French Notary Association and observed at the "*strate*" level. Strates are defined by the Notary Association as geographic areas where prices are relatively homogeneous. A specific housing price is calculated by the Notary Association for each strate where a sufficient number of transactions are realized per year, typically a medium-size municipality. In Paris the price is measured at the district ("*Arrondissement*") level. For small municipalities, the housing price reported by the Notaries is the one calculated at the "*Département*" level. We collect prices for 283 strates at yearly frequency over 2000-2014, available either at district, municipality, or département level, which constitutes unprecedented granularity. Following Chaney et al. (2012), we construct real estate prices before 2000 by retropolating housing prices using CPI inflation rates from INSEE for the period 1949-1999. This method enables us to estimate local real estate prices from the initial year of acquisition for all firms in our sample. Appendix A.1 provides more detail on the construction of $\mathcal{H}^l_{i,t}$.

We obtained the aggregate mortgage rate series r_t from Fougère et al. (2019), whose annual series begins in 1992. For earlier years, we extended the series backwards by applying the growth rate of private bond yields derived from the series on average returns on French private bonds, which have been available since 1950 from Levy-Garboua & Monnet (2016).[6] Additionally, we utilized measures of local housing supply elasticity, as calculated by Chapelle & Eyméoud (2018). The housing supply elasticity is measured at the "urban area" level that does not map with the Notaries' "strates" as locations in sparsely inhabited areas are excluded. Therefore, the instrumental variable is only available for a reduced sample, which covers 712,894 firms (vs. 2,159,086 firms in the complete sample). Figure A.1 in Appendix A.2 proposes a visual rendition

[6] This follows Fougère et al. (2019).

of the resulting geographic coverage.[7]

Table 1: Descriptive statistics on French firms (Full sample)

	Mean	Median	Std	p25	p75
$\mathcal{I}^l_{i,t}$	0.16	0.03	0.41	0.00	0.12
$\mathcal{H}^l_{i,t}$	0.26	0.00	0.54	0.00	0.26
$K^l_{i,t-1}$	194.77	45.06	629.22	15.27	140.10
Firm age	12.48	9.00	11.85	4.00	17.00
Asset	708.43	209.69	1673.31	66.25	599.00
$CF^l_{i,t}$	0.86	0.27	2.54	0.09	0.82
ROA	0.064	0.035	0.180	0.003	0.112
Size & performance variables					
# employees	16.39	6.00	77.24	2.00	13.00
Real labor productivity	39.26	30.42	56.23	18.36	48.10
Real value-added	318.24	99.60	830.82	27.75	296.98

Note: Nominal variables are expressed in thousands of euros. $\mathcal{I}^l_{i,t}$, $\mathcal{H}^l_{i,t}$, $K^l_{i,t-1}$ and $CF^l_{i,t}$ are defined in the text. Age is the number of years since the firm's creation. ROA is the Return on assets defined as operational income divided by total assets. # employees is the number of total employees, labor productivity is the ratio of value added to total employees. Labor productivity and value-added are expressed in real terms using the sectoral VA deflator.

Table 2: Descriptive statistics on French firms depending on holdings of real estate

Sample:	RE	NoRE	RE	NoRE	RE	NoRE	RE	NoRE	RE	NoRE
Statistic:	Mean		Median		Std		p25		p75	
Variable										
$\mathcal{I}^l_{i,t}$	0.11	0.19	0.03	0.03	0.30	0.45	0.00	0.00	0.08	0.16
$\mathcal{H}^l_{i,t}$	0.82	0.00	0.61	0.00	0.69	0.00	0.32	0.00	1.19	0.00
$K^l_{i,t-1}$	323.24	134.82	57.48	42.46	906.10	431.55	15.63	15.22	228.00	114.55
Firm age	14.09	11.72	10.00	9.00	13.37	10.98	4.00	4.00	20.00	16.00
Asset	890.14	623.63	180.00	219.00	2109.25	1416.97	47.28	85.97	692.80	567.48
$CF^l_{i,t}$	0.41	1.04	0.17	0.36	1.34	2.86	0.08	0.09	0.39	1.04
ROA	0.045	0.073	0.018	0.049	0.134	0.197	0.003	0.003	0.070	0.130
Performance variables										
# employees	19.88	15.18	8.00	5.00	67.52	80.30	3.00	2.00	19.00	12.00
Real L prod.	37.17	40.00	30.07	30.57	74.28	48.22	18.80	18.20	45.71	49.05
Real VA	354.28	302.00	76.89	107.25	887.70	803.35	6.28	37.00	314.66	291.03

Note: "RE" refers to the sample of firms with real estate holdings. "NoRE" refers to the sample of firms with no RE holdings. Nominal variables are expressed in thousands of euros. $\mathcal{I}^l_{i,t}$, $\mathcal{H}^l_{i,t}$, $K^l_{i,t-1}$ and $CF^l_{i,t}$ are defined in the text. Age is the number of years since the firm's creation. ROA: Return on assets, defined as operational income divided by total assets. # employees is the number of total employees. L prod: Labor productivity, as the ratio of value added to total employees. VA: Value-added. Labor productivity and value-added are expressed in real terms using the sectoral VA deflator.

Table 1 reports summary statistics for some key variables. Several results are noteworthy. First, there is an extreme skewness in real estate holdings: the majority of firms do not hold any, while a small number of firms possess large stocks of real estate. For some, it is very large: The maximum value of $\mathcal{H}$ is 5.35, i.e., real-estate holdings more than five times larger than

[7] We thank Denis Fougère, Rémy Lecat, Simon Ray, Guillaume Chapelle, and Jean-Baptiste Eymeoud for sharing these data with us.

the stock of tangible capital. The skewness observed in firm size, measured by assets, sales, number of employees, and labor productivity, is well-known. Investment and cash-flow also exhibit rightward skewness. The return on assets, however, shows little asymmetry. Table A.1 in Appendix A.2 presents key descriptive statistics comparing the full and the IV samples. It confirms that firms characteristics are similar across both samples.

As a first pass to characterizing the behavior of different firms based on collateral value, Table 2 presents the same descriptive statistics as in Table 1, distinguishing between firms with and without real estate assets. Firms with real estate assets are generally larger, with higher sales and assets. However they are also less productive, less profitable, they invest less as a share of their capital stock, and have lower cash flow. This indicates that firms with lower profitability and limited internal financing are more inclined to leverage real estate holdings as collateral. The conclusion aligns with the results shown in Table A.2 in Appendix A.3, which explores the factors influencing the decision to hold real estate.[8]

2.3 Results

Table 3 presents the results from estimating equations (2) and (3). Columns (1) and (2) report OLS estimates for the entire sample, while columns (3) and (4) display OLS and IV results using data available for the IV estimation. Estimates of ρ are positive, significant, and barely affected by the inclusion of a control for $\frac{1}{K^l_{i,t-1}}$, the change in sample size, or the instrumentation.[9] This last point suggests that endogeneity is a minimal concern in French data, possibly because firms' investment decisions are generally too small to affect real estate prices. Therefore, for simplicity the remainder of the paper will focus on OLS estimates. With $\rho = 0.2$, one standard deviation increase in $\mathcal{H}^l_{i,t}$ results in an eleven percent increase in the investment ratio. We also note that firms with higher cash flow invest more than the others, a classic result in this literature.

The estimates of ρ in Table 3 are significantly higher than those reported by Chaney et al. (2012), who estimated ρ to be around 0.06. However, their sample is limited to listed firms, which are generally larger and presumably less constrained than the average firm in our sample. When we restrict our sample to listed French firms, our estimates of ρ decrease slightly but remain significantly higher than 0.06. This likely reflects the fact that the average listed French firm has more constrained access to external finance compared to the average listed US company.

[8] Table A.2 also confirms that the elements in $X^l_{i,t}$ are good predictors of the decision to own real estate.

[9] Estimates from the first-stage regressions are reported in Table B.1 in Appendix B.

Table 3: Baseline specification

	(1)	(2)	(3)	(4)
Dep. Var		$\mathcal{I}^l_{i,t}$		
Estimator	OLS	OLS	OLS	IV
$\mathcal{H}^l_{i,t}$	0.22^a	0.2^a	0.2^a	0.21^a
	(0.0041)	(0.0039)	(0.0047)	(0.0048)
$CF^l_{i,t}$	0.03^a	0.024^a	0.023^a	0.023^a
	(0.00026)	(0.00024)	(0.00031)	(0.0003)
$1/K^l_{i,t-1}$		0.63^a	0.63^a	0.63^a
		(0.0085)	(0.0013)	(0.0013)
# Obs.	7,998,967	7,998,967	2,483,951	2,483,951
Adj. R^2	0.19	0.21	0.21	0.21

Notes: $\mathcal{I}^l_{i,t}$, $\mathcal{H}^l_{i,t}$, $CF^l_{i,t}$, and$K^l_{i,t-1}$ are defined in the text. All estimations include the controls in $X^l_{i,t}$ (or $\widehat{X}_{i,t}$ in column (4)) as well as firm- and location-year-fixed effects. Standard errors in parentheses are clustered at the location-year level. ^{c}, ^{b}, ^{a} denote, respectively, significance at the 10%, 5%, and 1% levels.

Welch (2021) takes issue with the specification in Chaney et al. (2012) for reasons that are summarized in Chaney et al. (2020). We present some of the alternative specifications that were proposed during this exchange, introducing the following amendments to the estimation of equation (2):

1. We neutralize the normalization of the independent variable, replacing $\mathcal{H}^l_{i,t}$ by a dummy variable $\mathcal{D}_0$ taking value 1 if the firm owns some real estate assets at time 0 (column (1)).

2. We replace the denominators of $\mathcal{I}^l_{i,t}$, $\mathcal{H}^l_{i,t}$, and $CF^l_{i,t}$ with the value of tangible capital stock the first year of entry in the database K_{i,t_0} (columns (2) and (3)).

3. We replace $\mathcal{H}^l_{i,t}$ by the inverse hyperbolic sine of the value of real estate holdings in euros, i.e., $asinh(\frac{P^l_t}{P^l_{t_0}} H_{i,t_0}) = \log\left(\frac{P^l_t}{P^l_{t_0}} H_{i,t_0} + \sqrt{1 + (\frac{P^l_t}{P^l_{t_0}} H_{i,t_0})^2}\right)$ (column (4)).

4. We perform the estimation without normalization, i.e., replacing $\mathcal{I}^l_{i,t}$ with $\ln(1 + I_{i,t})$, $\mathcal{H}^l_{i,t}$ with $\ln(1 + \frac{P^l_t}{P^l_{t_0}} H_{i,t_0})$, and $CF^l_{i,t}$ with $\ln(1 + CF^l_{i,t} \times K^l_{i,t-1})$ (column (5)).

5. We implement placebo regressions where $\mathcal{I}^l_{i,t}$ is regressed on $\mathcal{H}^l_{i,t+\tau} = \frac{P^l_{t+\tau}}{P^l_{t_0}} H_{i,t_0}/K_{i,t+\tau-1}$ for $\tau = -1, 1$ (columns (6) and (7)).

Table 4 presents the estimation results for all these modifications. The Table confirms that French firms use real estate holdings as collateral to finance their investment decisions. The alternative specifications in the table significantly affect the magnitude of the estimates of ρ, but they also introduce deviations from the theory that allows ρ to be interpretable as a measure of the extent of collateral constraints. This interpretation, based on the theory in Catherine et al., 2022, is only valid in a specification similar to the one in equation (2) with estimates in Table 3. In the following sections, we build on the estimates for ρ from Table 3.

Table 4: Robustness to alternative specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dep. var:		$\mathcal{I}^l_{i,t}$			$log(1+I_{i,t})$	$\mathcal{I}^l_{i,t}$	
$\frac{P^l_t}{P^l_{t_0}} \times \mathcal{D}_0$	0.07^a						
	(0.003)						
$\mathcal{H}^l_{i,0}$		0.025^a	0.027^a				
		(0.0009)	(0.0009)				
$asinh(\frac{P^l_t}{P^l_{t_0}} H_{i,t_0})$				0.056^a			
				(0.002)			
$\ln(1+\frac{P^l_t}{P^l_{t_0}} H_{i,t_0})$					0.029^a		
					(0.0078)		
$\mathcal{H}^l_{i,t-1}$						0.089^a	
						(0.002)	
$\mathcal{H}^l_{i,t+1}$							-0.13^a
							(0.0032)
$\frac{1}{K^l_{i,t-1}}$		0.65^a	0.78^a	0.65^a		0.81^a	1.2^a
		(0.0088)	(0.0092)	(0.0088)		(0.016)	(0.017)
$\log(K^l_{i,t-1})$					-0.066^a		
					(0.0047)		
$CF^l_{i,t}$	0.031^a	0.024^a		0.024^a		0.023^a	0.027^a
	(0.0003)	(0.0002)		(0.0002)		(0.0003)	(0.0003)
$CF^l_{i,0}$			0.0007^a				
			(0.0001)				
$\ln(1+CF^l_{i,t} \times K^l_{i,t-1})$					0.12^a		
					(0.0015)		
# Obs.	7998967	7998967	7998967	7998967	6574808	6020862	6019188
Adj. R^2	0.19	0.17	0.2	0.21	0.54	0.16	0.2

Notes: All variables are defined in the text. All estimations include the controls in $X^l_{i,t}$ as well as firm- and location-year-fixed effects. Standard errors in parentheses are clustered at the location-year level. ^{c}, ^{b}, ^{a} denote, respectively, significance at the 10%, 5%, and 1% levels.

2.4 Estimating Heterogeneous Effect in French Data

We now turn to documenting the heterogeneous responses of firm-level investment to changes in collateral value. This is motivated by the idea that smaller and less productive firms typically face greater challenges in accessing external finance (see Asdrubali et al., 2022, Barth et al., 2011, Beck et al., 2005, Driver & Muñoz-Bugarin, 2019). We estimate an augmented version of Equation (2) that incorporates interaction terms between the value of firms' real estate holdings and a comprehensive set of dummy variables indicating their position in the distribution of a given size metric. The estimated equation becomes

$$\mathcal{I}^l_{i,t} = \sum_{j=1}^{n} \rho^j \, \mathcal{H}^l_{i,t} \times \mathcal{D}^j_i + \delta \, CF^l_{i,t} + \gamma \, X^l_{i,t} + \beta \, \frac{1}{K^l_{i,t-1}} + \mu_i + \nu^l_t + \varepsilon^l_{i,t}, \tag{4}$$

where $j = \{1, ...n\}$ denotes the position of each firm in the distribution and $\mathcal{D}^j_i$ is a dummy variable indicating if firm i belongs to the j^{th} bin in this distribution. The estimates of ρ^j capture the extent to which financial constraints depend on the position of each firm in the distribution implicitly defined by $\mathcal{D}_i^j$.[10]

The firm's position within its distribution is measured in the first year it appears in our dataset, as real estate price movements are likely to endogenously alter that position. We discretize each distribution to maintain comparability between European countries. Depending on the variable considered we split the distribution into deciles or bins based on fixed thresholds. Our primary focus is on the number of employees, using the five categories with fixed thresholds proposed by CompNet: 1-9 employees, 10-19 employees, 20-49 employees, 50-249 employees, and above 250 employees. Since CompNet data include only firms with at least one employee, we limit our analysis to firms with at least one employee.[11]

2.5 Results

We first examine the significance of firm size for the collateral channel by estimating versions of equation (2) where all variables are weighted by different measures of size. We estimate:

$$W_{i,t}^l \mathcal{I}_{i,t}^l = \rho \, W_{i,t}^l \mathcal{H}_{i,t}^l + \delta \, W_{i,t}^l CF_{i,t}^l + \gamma \, W_{i,t}^l X_{i,t}^l + \mu_i + \nu_t^l + \varepsilon_{i,t}^l,$$

where $W_{i,t}^l$ represents a measure of firm size. Table 5 shows the results with $W_{i,t}^l$ defined by balance-sheet size (column (2)), number of employees (column (3)), and the inverse of the capital stock (column (4)). Compared to the baseline estimates in column (1) all results support the idea that smaller firms are more responsive to a collateral shock. The estimated value of ρ decreases when larger firms are given more weight (columns (2) and (3)), and increases when smaller firms are given higher weights (column (4)).

[10] Fougère et al. (2019) also explore heterogeneity in financial constraints, but they focus on the distribution of real estate holdings across firms.

[11] France has many very small companies with only an owner, who is not considered an employee.

Table 5: Collateral channel and size: weighted estimates

	(1)	(2)	(3)	(4)
Dep. Var.:	$\mathcal{I}^l_{i,t}$			
	Baseline	Weight by		
		Asset	Employment	$\frac{1}{K^l_{i,t-1}}$
$\mathcal{H}^l_{i,t}$	0.2^a	0.12^a	0.15^a	0.3^a
	(0.004)	(0.002)	(0.006)	(0.006)
$1/K^l_{i,t-1}$	0.63^a	1.2^a	1.4^a	
	(0.009)	(0.02)	(0.079)	
$CF^l_{i,t}$	0.024^a	0.021^a	0.025^a	0.017^a
	(0.0002)	(0.0004)	(0.001)	(0.0002)
Obs.	7,998,967	7,967,121	5,956,409	7,998,967
Adj. R^2	0.21	0.18	0.22	0.43

Notes: All variables are defined in the text. All estimations include the controls in $X^l_{i,t}$ as well as firm- and location-year-fixed effects. Standard errors in parentheses are clustered at the location-year level. ^{c}, ^{b}, ^{a} denote, respectively, significance at the 10%, 5%, and 1% levels.

Table 6 illustrates the heterogeneous impact of the collateral channel on investment by estimating equation (4), where real-estate holdings are divided into employment size bins. We consider two employment data samples, corresponding to two different firm partitions. In specifications (1) and (2), the sample includes all firms with at least one employee, partitioned along five fixed threshold levels of the employment distribution. In specifications (3) and (4), the sample is limited to firms with at least 20 employees, accounting for the extreme skewness in the French firm size distribution documented in Table 1. The median French firm has fewer than 6 employees, and the lower bound of the top quartile has 13 employees. This estimation therefore focuses the analysis of heterogeneity in the collateral channel on mid-sized French firms.[12] Practically, the sample of firms with more than 20 employees is divided into deciles based on employment size. For comparability, we also report the single estimate for ρ in this reduced sample.

All estimates indicate a significantly heterogeneous impact of collateral on investment, depending on firm size. In the sample including all firms with at least one employee, the average estimate of 0.2 conceals substantial differences across firms. For example, the smallest firms react three times more than the largest ones (0.34 vs. 0.12). Between these extremes, the estimated parameter decreases monotonically with firm size. The estimates based on employment deciles for the restricted sample of firms with at least 20 employees are qualitatively similar but show notable quantitative differences. The average impact (0.12) is significantly smaller than in the full sample (0.2), reflecting the exclusion of smaller, more financially constrained firms. However, there remains considerable heterogeneity across the employment distribution, with estimates ranging from 0.12 in the top 10 percent to twice as much (0.23-0.26) in the bottom

[12] This truncation also allows us to extend the estimates in Table 6 to Germany, where data enforces this lower threshold.

two deciles.

Table 6: The collateral channel and firm size in France

Dep. Var.:	$\mathcal{I}^l_{i,t}$				
Min 1 employee			Min 20 employees		
	(1)	(2)		(3)	(4)
Baseline					
$\mathcal{H}^l_{i,t}$		0.2^a	$\mathcal{H}^l_{i,t}$		0.12^a
		(0.004)			(0.003)
$\mathcal{H}^l_{i,t} \times$ Bin of:					
1-9 employees	0.34^a		$\leq$ P10	0.23^a	
	(0.008)			(0.026)	
10-19 employees	0.28^a		P10-P20	0.26^a	
	(0.009)			(0.027)	
20-49 employees	0.19^a		P20-P30	0.2^a	
	(0.008)			(0.021)	
50-249 employees	0.12^a		P30-P40	0.21^a	
	(0.007)			(0.021)	
$\geq$ 250 employees	0.12^a		P40-P50	0.18^a	
	(0.002)			(0.021)	
			P50-P60	0.2^a	
				(0.021)	
			P60-P70	0.15^a	
				(0.021)	
			P70-P80	0.13^a	
				(0.012)	
			P80-P90	0.12^a	
				(0.013)	
			>P90	0.12^a	
				(0.014)	
$\text{CF}_{i,t}$	0.025^a	0.025^a		0.023^a	0.029^a
	(0.00026)	(0.00026)		(0.00084)	(0.00064)
$1/K^l_{i,t-1}$	0.85^a	0.86^a		1.3^a	1.2^a
	(0.014)	(0.014)		(0.061)	(0.071)
Obs.	6,054,463	6,221,601		1,114,719	1,114,719
Adj.R^2	0.21	0.2	0.22	0.26	

Notes: All variables are defined in the text. All estimations include the controls in $X^l_{i,t}$ as well as firm- and location-year-fixed effects. Standard errors in parentheses are clustered at the location-year level. ^{c}, ^{b}, ^{a} denote, respectively, significance at the 10%, 5%, and 1% levels.

3 The Collateral Channel between countries

3.1 Approach

Our purpose is to introduce a method that allows micro-level estimates from detailed firm-level data in one country to be applied in other countries to approximate the aggregate collateral channel there. The approach requires only a coarse summary of firm size distribution so that it can be used to estimate the aggregate collateral channel in countries lacking detailed firm-level data.

By definition, $\hat{\rho}^j = \frac{\partial \mathcal{I}_t^j}{\partial \mathcal{H}_t^j}$, i.e., the estimate of ρ in bin j of the firm size distribution captures the conditional response of investment to changes in real estate prices for these firms. Define now aggregate investment $\mathcal{I}_t = \sum_j \mathcal{I}_t^j$ and the value of the aggregate real estate stock $\mathcal{H}_t = \sum_j \mathcal{H}_t^j$. It follows that

$$\begin{aligned} \frac{\partial \mathcal{I}_t}{\partial \mathcal{H}_t} &= \sum_j \frac{\partial \mathcal{I}_t^j}{\partial \mathcal{H}_t^j} \times \frac{\partial \mathcal{H}_t^j}{\sum_j \partial \mathcal{H}_t^j} \\ &= \sum_j \hat{\rho}^j \times \omega^j, \end{aligned} \tag{5}$$

where $\omega_j = \mathcal{H}_t^j / \sum_j \mathcal{H}_t^j$ denotes the share of $\mathcal{H}_t$ that is held by firms in the j^{th} bin of the distribution. With measures for ω^j and estimates of $\hat{\rho}^j$ it becomes straightforward to compute the aggregate sensitivity of investment to collateral value across countries.

The key assumption is that the estimates of $\hat{\rho}^j$ are applicable to other countries than France. This requires that (i) financial systems in these countries be sufficiently similar to France's, and (ii) real estate assets be comparably acceptable as collateral as they are in France. Ehrmann et al. (2001) compare financial systems and conclude that European countries are relatively homogeneous in their reliance on bank finance, unlike the US. This conclusion is supported by Allen & Gale (2001), who emphasize that continental European countries have chosen bank-dominated systems. Consequently, we focus on applying the French estimated effects to a set of comparable European economies.

Of course, some differences in financial systems persist within the European Union (EU), and even within the Euro Area (EA). For example, Badarau-Semenescu & Levieuge (2013) document the multi-dimensional differences within the EA regarding banks concentration and capitalization, and aggregate dependence on banking credit. Badarau-Semenescu & Levieuge (2010) find that the bank lending channel is more prevalent in Germany, Italy, and the Netherlands than in Finland, France, and Spain. Ehrmann et al. (2001) report that the percentage of corporate finance done via bank loans in the EU was 37.2 percent in France at the end of the 1990s, compared to higher percentages in other large EU economies (Germany, Italy, Spain) and an EU average of 45.2 percent. A decade later, European Central Bank (2012) highlights the unequal recovery of loans to non-financial corporations following the 2008-2009 financial crisis: In countries undergoing an EU-IMF adjustment program (Greece, Ireland, and Spain), loan supply had not recovered by 2012, while it had in other EA countries. These statistics suggest that bank lending is an even more crucial source of external finance in other European countries than in France. Therefore, French estimates likely represent a lower bound of what they are in those countries.

A second condition necessary to apply French estimates to other countries is that real estate holdings are also used as collateral there. Banerjee & Blickle (2021) investigate the importance of housing as collateral for firm borrowing, investment, and employment in six European countries (France, Italy, Portugal, Spain, Sweden, and the UK) between 2004 and 2012. Using firm-level data, they find that the relationship between regional house price growth and small firm activity is stronger in Sweden, Spain, Portugal, and Italy than in France and the UK, although the differences are not large. The 2015 ECB Survey on the Access to Finance of Enterprises finds that about 80 percent of small companies (with fewer than 50 employees) reported needing collateral in Spain, compared to 60 percent in Italy and only 44 percent in France. Across these countries, two-thirds of surveyed firms with fewer than 50 employees reported needing collateral to raise external finance, with half using personal assets, including their own house, as collateral. The proportion is just 5 percent for large firms, highlighting the importance of including small, non-listed firms in the analysis. These statistics suggest that the need for housing collateral is a common characteristic throughout Europe and that financial frictions in the rest of Europe are likely more severe than in France.

These two criteria, combined with data availability, led us to focus on the following European countries: Belgium, Denmark, Finland, Italy, the Netherlands, Portugal, Spain, and Sweden. We also include Germany, noting again that CompNet only covers firms with at least 20 employees there. In these countries, the investment reactions to real estate value estimated from French data should reflect similar firm-level heterogeneity, given comparable levels of financial constraints. For comparison, we also include the Czech Republic, a former transition country; Switzerland, known for its large banking sector, and the United Kingdom, with its prominent financial services industry.

3.2 Data and Results

Our primary source for empirically implementing the calculations in equation (5) is the ninth vintage of the CompNet database. CompNet compiles international indicators of firm distribution from firm-level data collected by national providers, which are then aggregated and harmonized for cross-country comparisons. Various distributions are reported, with information on means, variances, and percentiles. We first gather information relevant to approximating the weights ω^j

for each country in the sample. Since there is no data source providing international information on the distribution of real estate holdings across firms, we approximate ω^j using the share of the stock of physical capital held by firms in the j^{th} bin of the firm size distribution, available from CompNet for various measures of size.[13]

Since the definitions of the bins j differ across countries in CompNet, we sometimes need to return to French data to obtain new estimates of $\hat{\rho}^j$ that correspond to the information available for each country. For example, when CompNet reports deciles of the firm size distribution, the threshold levels vary across countries due to differences in size distributions. This requires re-estimating $\hat{\rho}^j$ on French data for all bins j defined in a specific country.

In practice, the data on firm distributions are collected over different time periods across countries.[14] Since the definition of bins j is time invariant for each country, and since we use time averages of our proxy for ω^j, these differences in coverage do not affect the final result. We stop the sample in 2015 to remain consistent with the period of estimation for France.

Table 7: Capital shares by employment category

Employment size class	1-9	10-19	20-49	50-249	≥250
Belgium	0.53	0.08	0.08	0.12	0.19
Czech Republic	0.59	0.03	0.04	0.10	0.24
Denmark	0.28	0.06	0.10	0.22	0.33
Finland	0.21	0.04	0.07	0.14	0.54
France	0.25	0.04	0.06	0.13	0.51
Italy	0.50	0.08	0.08	0.12	0.21
Netherlands	0.48	0.05	0.07	0.12	0.28
Portugal	0.33	0.06	0.10	0.20	0.31
Spain	0.44	0.06	0.07	0.13	0.29
Sweden	0.30	0.04	0.06	0.13	0.47
Switzerland	0.10	0.07	0.11	0.18	0.55
United Kingdom	0.16	0.06	0.07	0.17	0.53

Notes: Authors' computations, based on CompNet 9^{th} version database.

Table 7 underscores the substantial cross-country heterogeneity within our sample. Capital shares exhibit notable granularity across several countries: in Finland, France, Sweden, Switzerland and the UK, the largest firms account for around 50 percent or more of the total capital stock. Conversely, in countries such as Belgium, the Czech Republic, Italy, the Netherlands

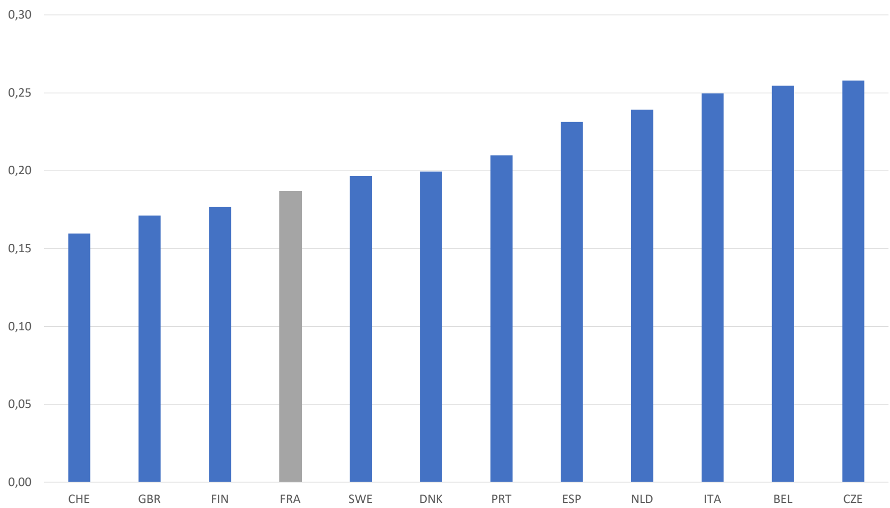
[13] Specifically, CompNet provides sector-level information on the average stock of capital by size category. For each sector, category, and country-year, we compute the total stock of capital by multiplying the mean stock of capital by the number of firms in the underlying population. We then aggregate the stock of capital across all sectors (excluding real estate and finance) to determine the capital stock by category. The total capital stock is calculated as the sum across all employment categories for each country year. We compute the ratio ω^j as the average over the available time period.

[14] Belgium (2000-2015), the Czech Republic (2005–2015), Denmark (2001-2015), Finland (1999-2015), Germany (2001-2015), Italy (2006-2015), Netherlands (2007-2015), Portugal (2004-2015), Spain (2008-2015), Sweden (2003-2015), Switzerland (2009–2015), and the United Kingdom (1997-2015).

and Spain, smaller firms tend to hold a larger share of the aggregate capital stock. Table 6 highlighted the heterogeneous impact of collateral on investment based on firm size: It is the interplay of the two types of heterogeneity documented in Tables 6 and 7 that can have significant aggregate level consequences.

Figure 1 displays a histogram of $\frac{\partial \mathcal{I}_t}{\partial \mathcal{H}_t}$ calculated across countries using equation (5), taking into account the cross-country differences in the distribution of capital shares that proxy for ω^j. There are notable differences across European countries, with $\frac{\partial \mathcal{I}_t}{\partial \mathcal{H}_t}$ values ranging from 0.16 in Switzerland to 0.26 in the Czech Republic. This represents a substantial disparity: A global real estate boom would impact aggregate investment approximately 62 percent more in the Czech Republic than in Switzerland. Among Euro Area members, the estimates vary from 0.18 in Finland to 0.25 in Belgium, indicating that investment is 39 percent more sensitive to a real estate boom in Belgium than in Finland (or France). This differences are significant for macroeconomic management aiming at stabilization.

Figure 1: Estimates of country-level aggregate investment sensitivity



Notes: CHE = Switzerland; GBR = United Kingdom; FIN = Finland; FRA = France; SWE = Sweden; DNK = Denmark; PRT = Portugal; ESP = Spain; NLD = the Netherlands ; ITA = Italy; BEL = Belgium. CZE = Czech Republic.

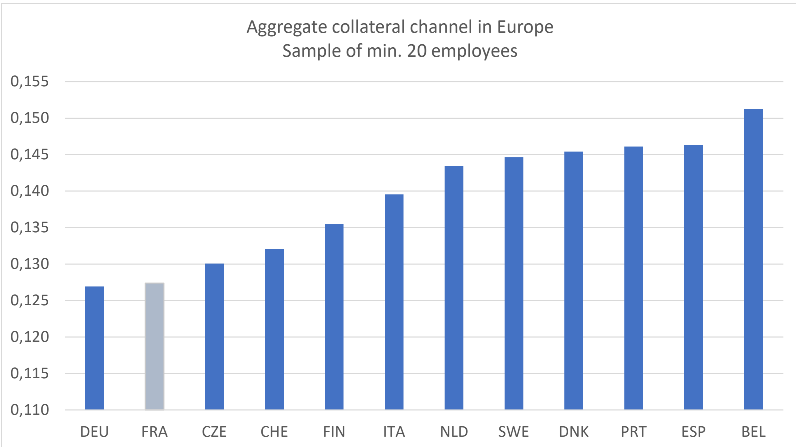
Given the significance of the German economy within the European Union, we aim to include Germany in our cross-country comparisons. To achieve this, we replicate our analysis using a sample limited to firms with at least 20 employees, as constructed by CompNet for Germany. Figure 2 shows the cross-country estimates of $\frac{\partial \mathcal{I}_t}{\partial \mathcal{H}_t}$ for this reduced sample.[15] Aggregate in-

[15]Tables C.2 and C.3 in Appendix C.1 provide the underlying distribution of capital shares and the estimated reactions to collateral by employment deciles for all countries in the sample. CompNet does not provide employ-

vestment sensitivity is less varied in this sample, ranging from 0.127 in Germany to 0.151 in Belgium, still a 19 percent difference.

This result underscores the significant role of very small firms, with fewer than 20 employees, in driving cross-country differences. The finding is somewhat surprising, given the increasingly prevalent view in the literature that aggregates are typically driven by large firms. It appears that the sensitivity of aggregate investment to the value of collateral heavily depends on the presence and importance of these very small firms. In the restricted sample, the top 10 percent firms own between 51 and 79 percent of the total capital stock (see Table C.2). Thus the aggregation is driven by large firms to a much greater extent than in Figure 1. Despite this, however, the 19 percent difference in investment sensitivity between Germany and Belgium is still quite significant.

Figure 2: Estimates of country-level investment sensitivity - restricted sample



Notes: Restricted sample: estimates are produced on samples including firms with at least 20 employees. DEU = Germany; CHE = Switzerland; GBR = United Kingdom; FIN = Finland; FRA = France; SWE = Sweden; DNK = Denmark; PRT = Portugal; ESP = Spain; NLD = Netherlands ; ITA = Italy; BEL = Belgium. CZE = Czeck Republic.

Appendix D presents results from additional aggregation exercises using alternative measures of firm size, real value added and labor productivity. The Appendix documents cross-country thresholds in real value added (Table D.1) and labor productivity (Table D.2), as implied by the deciles reported by CompNet. We then report estimates of equation (4) performed on French

ment breakdowns for the United Kingdom that allow for the exclusion of firms with fewer that 20 employees. The only available employment class sizes for the UK are those listed in Table 7. Consequently we cannot include the UK in our analysis of this reduced sample.

data by the deciles across countries of value added (Table D.3) and labor productivity (Table D.4). Finally, Figure D.1 shows estimates of aggregate collateral channels across countries.

Several results stand out. Firstly, the heterogeneity in estimates of ρ^j is more pronounced for value added than for employment, with a factor between 3 and 9 between the first and last deciles. The ratios are smaller for labor productivity, with a factor between 2 and 3 between the extreme deciles. This heterogeneity extends to cross-country estimates of the collateral channel. For value added, the largest value (0.16 in Spain) is more than double that in Switzerland (0.07). The dispersion is less pronounced for labor productivity as a measure of firm size, ranging from 0.20 (Denmark) to 0.25 (Portugal), a gap of 25 percent. We conclude that cross-country dispersion in the collateral channel is rooted in within-country firm-size heterogeneity for measures others than employment, making it a robust feature of the data.

4 Conclusion

This paper introduces a straightforward methodology to construct a country-level measure of the sensitivity of investment to collateral values, as indicated by real estate prices. We utilize detailed firm-level data from France to estimate investment sensitivity in different bins of the firm size distribution. The estimation addresses the prevalent endogeneity issues in this literature by employing an established instrumentation approach and contributes to recent debates about potentially incorrect specifications. We then use these estimated bin-level elasticities, combined with coarse information on the distribution of firm sizes, to derive estimates of the sensitivity of aggregate investment to real estate prices in other countries. This approach can be implemented without firm-level information and with very limited information on the firm size distribution.

Our findings reveal that the collateral channel exhibits heterogeneity across firms within France, with substantial differences based on firm size. Specifically, small firms are at least three times more sensitive to the value of their collateral compared to large firms. This heterogeneity, combined with the diverse firm size distributions across countries, results in significant cross-country differences in the aggregate importance of the collateral channel, even within relatively homogeneous groups like the Euro area. We show that a large portion of this cross-country heterogeneity stems from the presence of very small firms, with fewer than 20 employees, which we find to be highly relevant for the aggregate elasticity of investment to real estate prices.

References

Allen, F. & Gale, D. (2001). *Comparing Financial Systems*, volume 1 of *MIT Press Books*. The MIT Press.

Asdrubali, P., Hallak, I., & Harastoszi, P. (2022). *Financial Constraints of EU firms: A Sectoral Analysis*. JRC Research Reports JRC130317, Joint Research Centre (Seville site).

Badarau-Semenescu, C. & Levieuge, G. (2010). Assessing the Potential Strength of a Bank Capital Channel in Europe: A Principal Component Analysis. *The Review of Finance and Banking*, 2(1), 005–016.

Badarau-Semenescu, C. & Levieuge, G. (2013). Financial Heterogeneity in a Monetary Union. *Journal of Economic Integration*, 28, 482–506.

Bahaj, S., Foulis, A., & Pinter, G. (2020). Home values and firm behavior. *The American Economic Review*, 110(7), 2225–2270.

Banerjee, R. & Blickle, K. (2021). Financial frictions, real estate collateral and small firm activity in europe. *European Economic Review*, 138, 103823.

Barro, R. J. (1976). The Loan Market, Collateral, and Rates of Interest. *Journal of Money, Credit and Banking*, 8(4), 439–456.

Barth, J., Lin, D., & Yost, K. (2011). Small and Medium Enterprise Financing in Transition Economies. *Atlantic Economic Journal*, 39(1), 19–38.

Beck, T., Demirgüç-kunt, A., & Maksimovic, V. (2005). Financial and legal constraints to growth: Does firm size matter? *Journal of Finance*, 60(1), 137–177.

Bernanke, B. & Gertler, M. (1989). Agency Costs, Net Worth, and Business Fluctuations. *American Economic Review*, 79(1), 14–31.

Catherine, S., Chaney, T., Huang, Z., Sraer, D., & Thesmar, D. (2022). Quantifying reduced-form evidence on collateral constraints. *Journal of Finance*, 77(4), 2143–2181.

Chaney, T., Sraer, D., & Thesmar, D. (2009). *The Collateral Channel: How Real Estate Shocks Affect Corporate Investment*. Technical report.

Chaney, T., Sraer, D., & Thesmar, D. (2012). The collateral channel: How real estate shocks affect corporate investment. *American Economic Review*, 102(6), 2381–2409.

Chaney, T., Sraer, D., & Thesmar, D. (2020). *Response to Welch (2020) Real Estate Collateral Does Affect Investment*. Ssrn working papers.

Chapelle, G. & Eyméoud, J.-B. (2018). *The cost of agglomeration and the housing supply elasticity : The extensive and intensive margin housing supply elasticities*. Technical report.

Driver, C. & Muñoz-Bugarin, J. (2019). Financial constraints on investment: Effects of firm size and the financial crisis. *Research in International Business and Finance*, 47(C), 441–457.

Ehrmann, M., Gambacorta, L., Martínez Pagés, J., Sevestre, P., & Worms, A. (2001). *Financial systems and the role of banks in monetary policy transmission in the euro area.* Working Paper Series 105, European Central Bank.

European Central Bank (2012). *Heterogeneity in Euro Area: Financial Conditions and Policy Implications.* Ecb monthly bulletin, European Central Bank.

Fougère, D., Lecat, R., & Ray, S. (2019). Real estate prices and corporate investment: Theory and evidence of heterogeneous effects across firms. *Journal of Money, Credit and Banking*, 51(6), 1503–1546.

Gabaix, X. (2011). The granular origins of aggregate fluctuations. *Econometrica*, 79, 733–772.

Gopinath, G., Kalemli-Özcan, Ş., Karabarbounis, L., & Villegas-Sanchez, C. (2017). Capital allocation and productivity in south europe. *The Quarterly Journal of Economics*, 132(4), 1915–1967.

Grjebine, T., Héricourt, J., & Tripier, F. (2023). Sectoral reallocations, real estate shocks, and productivity divergence in europe. *Review of World Economics (Weltwirtschaftliches Archiv)*, 159(1), 101–132.

Hart, O. & Moore, J. (1994). A theory of debt based on the inalienability of human capital. *The Quarterly Journal of Economics*, 109(4), 841–879.

Hossain, M. I., Duong, H. N., Al Mamun, M., & Docherty, P. (2023). Collateral shocks and m&a decisions. *Journal of Corporate Finance*, 82.

Kiyotaki, N. & Moore, J. (1997). Credit Cycles. *Journal of Political Economy*, 105(2), 211–248.

Levy-Garboua, V. & Monnet, E. (2016). Les taux d'intérêt en france : une perspective historique. *Revue d'économie financière*, 2016/1(121), 35–58.

Lian, C. & Ma, Y. (2021). Anatomy of corporate borrowing constraints. *The Quarterly Journal of Economics*, 136(1), 229–291.

Moulton, B. R. (1990). An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Unit. *The Review of Economics and Statistics*, 72(2), 334–338.

Stiglitz, J. & Weiss, A. (1981). Credit rationing in markets with imperfect information. *American Economic Review*, 71(3), 393–410.

Welch, I. (2021). *Spurious Inference Caused by Time-Series Variation in Scaling: Real Estate Shocks Did Not Affect Corporate Investment.* Ssrn working papers.

A The French Data

A.1 Constructing the Value of Real Estate Holdings

Three major categories of property, plant, and equipment are considered real estate assets: buildings, land, and equipment. On firms' balance sheets, these assets are reported at historical cost rather than marked-to-market. Following Chaney et al. (2012) or Fougère et al. (2019), we adopt a two-step procedure to convert historical cost to market value. First, we estimate the age of the properties, or equivalently, the year of acquisition. Second, we determine the market value of real estate assets based on local housing price series obtained from French notaries.

We now describe the method for determining the age of properties in more detail. The age of the property is calculated as the product of its depreciable life and the proportion of the property claimed as depreciation. We extract both pieces of information from the firm's accounting data. Since land does not depreciate, we exclude firms that declare real estate assets solely as land.

First, consider the depreciable life. As defined by Chaney et al. (2012), it is equal to the building cost divided by annual depreciation. We proxy the building cost using tangible assets on buildings (*immobilisations corporelles sur les constructions*). For the denominator, we use the depreciation and amortization expenses for total fixed assets (*amortissement sur immobilisations totales*), multiplied by the ratio of tangible assets on buildings to total fixed assets (*immobilisations corporelles sur les constructions/immobilisations totales*). This approximates annual depreciation for buildings. The depreciable life of real estate assets is then given by the ratio of building cost to annual depreciation, computed by firm-year. We obtain an average value of 36 years, which is close to the 40 years obtained by Chaney et al. (2012).

Second, we calculate the proportion of buildings claimed as depreciation. This is equal to the accumulated depreciation on buildings divided by their gross book value, which is directly available from BRN data under (*amortissement sur constructions*). In FARE data, we only have information on accumulated depreciations and allowances for depreciation on tangible assets (*amortissements et provisions sur immobilisations corporelles*). We proxy the accumulated depreciation on buildings by multiplying the depreciation on tangible assets by the ratio of tangible assets on buildings to total tangible assets. We then divide accumulated depreciation on buildings by their gross book value (*immobilisations corporelles sur les constructions*). On average, the proportion of buildings claimed as depreciation is 0.38. Thanks to the richness of the French data, we are able to retrieve this information for all firms from 1994 to 2015. Therefore we can include firms whenever they enter the dataset, even if that is not the first year of our sample. This contrasts with Chaney et al. (2012) who had to include only firms present in 1993 as the item used to calculate the claimed depreciation on buildings is no longer available in Compustat after 1993.

As a final step, we calculate the age of the properties as the proportion claimed for depreciation times the average depreciable life. All these steps are performed for the properties declared by the firm in the first year of entry in the database. Taking the difference between this year and the age of the building gives us the year of acquisition. For each year in the database, we then infer the market value of real estate holdings by inflating their historical cost with strate-level residential real estate inflation between the year of acquisition and the current year of observation.

A.2 The IV sample

The housing supply elasticity is measured at the "urban area" level, which does not correspond with the Notaries' "strates". In particular, locations in sparsely populated areas are excluded from the urban area coverage. This is made explicit in Figure A.1.

Figure A.1: Strates and Urban Areas

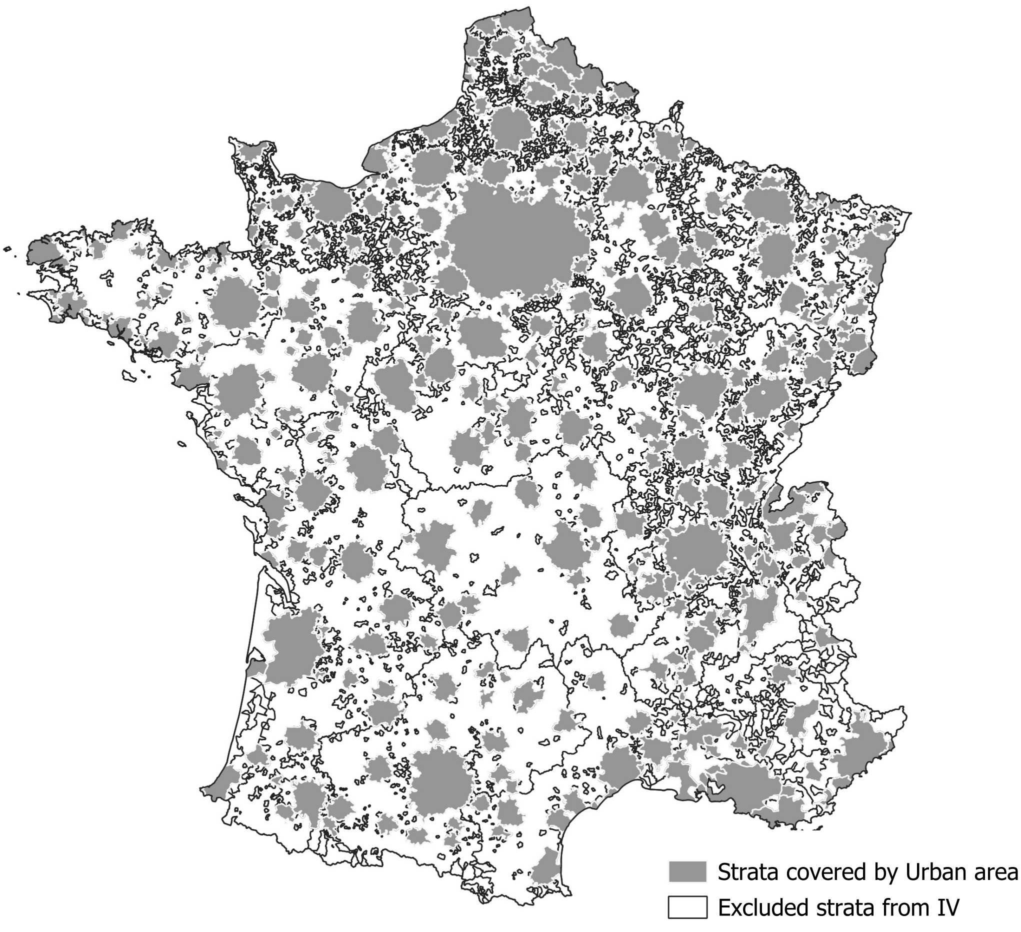


Table A.1 then provides key summary statistics comparing the IV sample to the full sample.

Table A.1: Descriptive statistics on French firms: Full vs IV Sample

	Mean		Median		Std Dev.		P25		P75	
Sample:	Full	IV	Full	IV	Full	IV	Full	IV	Full	IV
$\mathcal{I}^l_{i,t}$	0.16	0.18	0.03	0.03	0.41	0.43	0.00	0.00	0.12	0.13
$\mathcal{H}^l_{i,t}$	0.26	0.22	0.00	0.00	0.54	0.52	0.00	0.00	0.26	0.04
$K^l_{i,t-1}$	194.77	159.50	45.06	36.40	629.22	567.68	15.27	13.43	140.10	112.00
Firm age	12.48	11.83	9.00	8.00	11.85	11.62	4.00	4.00	17.00	16.00
Asset	708.43	722.18	209.69	208.00	1673.31	1734.44	66.25	65.42	599.00	598.21
$CF^l_{i,t}$	0.86	1.00	0.27	0.31	2.54	2.88	0.09	0.08	0.82	0.98
ROA	0.06	0.06	0.04	0.03	0.18	0.18	0.00	0.00	0.11	0.11
Size & performance variables										
# employees	16.39	18.01	6.00	6.00	77.24	88.13	2.00	2.00	13.00	13.00
Real L prod.	37.77	39.53	29.26	30.00	53.16	66.97	17.59	17.24	46.24	48.73
Real VA	3.18	3.52	1.00	1.08	8.31	9.35	0.28	0.29	2.97	3.17

Note: Nominal variables are expressed in thousands of euros. $\mathcal{I}^l_{i,t}$, $\mathcal{H}^l_{i,t}$, $K^l_{i,t-1}$ and $CF^l_{i,t}$ are defined in the text. Age is the number of years since the firm's creation. ROA: Return on assets, defined as operational income divided by total assets. # employees is the number of total employees. Real L prod: Real labor productivity, as the ratio of value added to total employees. VA: Value-added. Labor productivity and value-added are expressed in real terms using the sectoral VA deflator.

A.3 The Determinants of real-estate holding decisions

Comparing the samples of firms with and without holdings suggests that the decision to acquire real estate is not exogenous to firms characteristics. This makes equation (1) potentially problematic. We use the variables proposed by Chaney et al. (2012) to control for endogenous selection in real estate ownership at time 0, which includes the distribution of age, assets, return on assets, as well as 2-digit sectoral dummies. Table A.2 confirms that these are good predictors of the magnitude of real estate holdings (Column (1)) and of the decision to hold real estate (Column (2)).

Table A.2: Determinants of Real Estate ownership

	(1) $\mathcal{H}^l_{i,t}$	(2) Ownership (1 if $\mathcal{H}$ >0)
2nd quintile of asset	0.084^a	0.13^a
	(0.00064)	(0.00048)
3rd quintile of asset	0.17^a	0.18^a
	(0.00063)	(0.00049)
4th quintile of asset	0.084^a	0.082^a
	(0.00064)	(0.00049)
5th quintile of asset	0.19^a	0.18^a
	(0.0007)	(0.00053)
2nd quintile of ROA	0.21^a	0.28^a
	(0.00054)	(0.00039)
3rd quintile of ROA	0.14^a	0.23^a
	(0.00056)	(0.00042)
4th quintile of ROA	0.012^a	0.042^a
	(0.00054)	(0.0004)
5th quintile of ROA	-0.004^a	-0.004^a
	(0.00053)	(0.00039)
2nd quintile of age	0.032^a	-0.026^a
	(0.00047)	(0.00035)
3rd quintile of age	0.11^a	0.029^a
	(0.00053)	(0.0004)
4th quintile of age	0.2^a	0.081^a
	(0.00056)	(0.00042)
5th quintile of age	0.35^a	0.17^a
	(0.00061)	(0.00047)
Observations	9,307,373	11,717,067
Adjusted R^2	0.12	0.17

Standard errors in parentheses. Sector and strate fixed effects included. The firm's position in the distribution of ROA, asset and age is measured on the first observed year. ^{c} $p < 0.1$, ^{b} $p < 0.05$, ^{a} $p < 0.01$

B IV estimation: First stage results

Table B.1 reports the first stage estimation results corresponding to equation (3).

Table B.1: First stage estimates

	(1)	(2)
Dependent variable	P_t^l	
$\eta_l \times r_t$	0.0062^a	0.0062^a
	(0.001)	(0.001)
Urban Area FE	No	Yes
Obs.	23,929	23,929
Adj.R^2	0.99	0.99
F-stat	40.10	87.04

Regression run at the strate-year level. Strate- and year-specific fixed effects are included. Standard errors in parenthesis. ^{c} $p < 0.1$, ^{b} $p < 0.05$, ^{a} $p < 0.01$.

The coefficient attached to the instrument is positive and significant, in line with Chaney et al. (2012). The F-stat is well above 10, indicating that the instrument is a strong predictor of real estate prices.

C Heterogeneity across EU countries

C.1 Restricted sample of firms with 20 employees or more

In the restricted sample, CompNet provides information on firm distribution based on deciles. Therefore, for each country, we need to retrieve the threshold values specific to each employment decile from CompNet. We then re-estimate equation (4) on French data using these new country-specific threshold values in our French firm-level dataset. Table C.1 reports the employment thresholds by deciles for each country as implied by CompNet data averaged over the sampled period.

For each decile j of employment, CompNet reports the mean value of the capital stock and the number of firms for each country year. The total stock of capital per decile is calculated as their product, and the aggregate capital stock is summed over all deciles in a given country-year. The weights ω^j are given by the average over time of the ratio of capital per employment decile, relative to the aggregate capital stock. Table C.2 reports the results obtained for each country by employment decile.

We then estimate equation (4) on French data while choosing the bins j in light of the threshold values specific to each country. The coefficient estimates are reported in Table C.3.

Table C.1: Employment thresholds (Compnet data, Min 20 employees sample)

Country	$P10$	$P20$	$P30$	$P40$	$P50$	$P60$	$P70$	$P80$	$P90$
Belgium	22	26	29	34	39	44	52	82	155
Czech Republic	22	24	29	34	41	49	70	108	192
Denmark	22	24	27	31	36	44	58	83	152
Finland	22	25	28	32	38	47	63	93	188
France	22	24	28	31	37	43	54	83	159
Germany	23	27	32	38	45	57	79	121	211
Italy	21	24	27	30	35	41	51	72	127
Netherlands	22	25	29	33	39	48	62	87	151
Portugal	21	24	27	31	36	43	54	75	133
Spain	21	23	26	29	33	40	51	72	133
Sweden	22	24	27	31	37	46	59	85	160
Switzerland	23	27	32	38	44	48	60	91	163

Authors' calculations, from CompNet dataset (9^{th} version). Results are average over the period covered by each country, ending in 2015.

Table C.2: Relative share of capital by employment decile, EU countries (min 20 employees)

Country:	BEL	DNK	ITA	FIN	CZE	DEU	NLD	PRT	ESP	SWE	CHE	FRA
<P10	0.026	0.014	0.014	0.008	0.011	0.008	0.011	0.014	0.014	0.013	0.014	0.007
P10-20	0.030	0.018	0.015	0.009	0.013	0.011	0.012	0.016	0.015	0.016	0.021	0.009
P20-30	0.035	0.023	0.018	0.011	0.016	0.012	0.014	0.018	0.016	0.018	0.019	0.010
P30-40	0.039	0.023	0.020	0.013	0.020	0.015	0.016	0.025	0.018	0.020	0.027	0.012
P40-50	0.046	0.029	0.024	0.015	0.024	0.017	0.019	0.030	0.021	0.029	0.031	0.015
P50-60	0.051	0.036	0.028	0.021	0.031	0.019	0.022	0.034	0.025	0.037	0.028	0.018
P60-70	0.057	0.050	0.036	0.030	0.038	0.028	0.029	0.045	0.034	0.043	0.037	0.024
P70-P80	0.075	0.088	0.047	0.044	0.060	0.041	0.040	0.067	0.046	0.069	0.053	0.043
P80-90	0.129	0.116	0.078	0.085	0.101	0.062	0.065	0.105	0.096	0.117	0.091	0.098
≥P90	0.512	0.602	0.718	0.763	0.686	0.789	0.770	0.647	0.715	0.637	0.679	0.764

Notes: Authors' computations, based on Compnet 9^{th} version database. Sample restricted to Min 20 employees.

Table C.3: The collateral channel by employment decile in the sample of European countries (min 20 employees)

	BEL	DNK	ITA	FIN	CZE	DEU	NLD	PRT	ESP	SWE	CHE
$\mathcal{H}^l_{i,t}\times$ Employment decile											
<P10	0.24^a	0.28^a	0.28^a	0.24^a	0.28^a	0.28^a	0.28^a	0.25^a	0.28^a	0.28^a	0.24^a
	(0.022)	(0.029)	(0.029)	(0.022)	(0.029)	(0.038)	(0.029)	(0.02)	(0.029)	(0.029)	(0.022)
P10-20	0.26^a	0.24^a	0.22^a	0.26^a	0.22^a	0.22^a	0.22^a	0.24^a	0.24^a	0.24^a	0.25^a
	(0.027)	(0.024)	(0.029)	(0.027)	(0.029)	(0.027)	(0.029)	(0.022)	(0.024)	(0.024)	(.021)
P20-30	0.21^a	$.23^a$	0.23^a	0.23^a	0.23^a	0.26^a	0.24^a	0.19^a	0.23^a	0.23^a	0.2^a
	(0.021)	(0.024)	(0.025)	(0.027)	(0.025)	(0.027)	(0.022)	(0.023)	(0.022)	(0.024)	(0.02)
P30-40	0.17^a	0.19^a	0.19^a	0.17^a	0.19^a	0.23^a	0.19^a	0.17^a	0.17^a	0.2^a	0.17^a
	(0.022)	(0.023)	(0.019)	(0.02)	(0.019)	(0.027)	(0.023)	(0.019)	(0.019)	(0.02)	(0.019)
P40-50	0.2^a	0.17^a	0.18^a	0.2^a	0.19^a	0.17^a	0.17^a	0.18^a	0.19^a	0.17^a	0.17^a
	(0.021)	(0.02)	(0.029)	(0.02)	(0.024)	(0.02)	(0.019)	(0.02)	(0.018)	(0.019)	(0.022)
P50-60	0.16^a	$.18^a$	0.19^a	0.17^a	0.17^a	0.18^a	0.18^a	0.15^a	0.17^a	0.18^a	0.19^a
	(0.023)	(0.019)	(0.018)	(0.023)	(0.019)	(0.018)	(0.023)	(0.019)	(0.028)	(0.023)	(0.05)
P60-70	0.16^a	0.14^a	0.17^a	0.13^a	0.16^a	0.18^a	0.13^a	0.11^a	0.14^a	0.13^a	0.13^a
	(0.022)	(0.016)	(0.021)	(0.012)	(0.019)	(0.023)	(0.013)	(0.01)	(0.01)	(0.012)	(0.012)
P70-80	0.11^a	0.11^a	0.12^a	0.11^a	0.12^a	0.13^a	0.11^a	0.13^a	0.12^a	0.12^a	0.12^a
	(0.0092)	(0.011)	(0.01)	(0.012)	(0.01)	(0.01)	(0.011)	(0.014)	(0.013)	(0.012)	(0.012)
P80-90	0.13^a	0.13^a	0.12^a	0.12^a	0.12^a	0.11^a	0.13^a	0.14^a	0.12^a	0.13^a	0.13^a
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)	(0.012)	(0.017)	(0.015)	(0.013)	(0.014)
≥P90	0.14^a	0.14^a	0.13^a	$.14^a$	0.14^a	0.14^a	0.14^a	0.12^a	0.12^a	0.13^a	0.12^a
	(0.022)	(0.021)	(0.017)	(0.022)	(0.018)	(0.018)	(0.022)	(0.026)	(0.025)	(0.024)	(0.021)
CF_{it-1}	0.023^a	0.023^a	0.023^a	0.023^a	0.023^a	0.023^a	0.023^a	0.023^a	0.023^a	0.023^a	0.023^a
	(0.00084)	(0.00084)	(0.00084)	(0.00084)	(0.00084)	(0.00084)	(0.00084)	(0.00084)	(0.00084)	(0.00084)	(0.00084)
$1/K_{it-1}$	1.3^a	1.3^a	1.3^a	1.3^a	1.3^a	1.3^a	1.3^a	1.3^a	1.3^a	1.3^a	1.3^a
	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)
Obs.	353109	353109	353109	353109	353109	353109	353109	353109	353109	353109	353109
Adj.R^2	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22

Notes: Country-specific estimates of equation (4). All estimations include the controls in $X^l_{i,t}$ as well as firm- and location-year-fixed effects. Standard errors in parentheses, clustered at the location-year level. ^{c}, ^{b}, ^{a} denote, respectively, significance at the 10%, 5%, and 1% levels.

D Alternative measures of firm size

The main text classifies firms — and the associated estimations of the collateral effect — based on employment, an immediately observable and available measure of firm size. Two alternatives that are readily available from CompNet are firm-specific (real) value added and labor productivity. We now present the results associated with these alternatives.

Tables D.1 show the threshold values in firm-level real value added across the sampled countries, based on the deciles reported in CompNet. Similarly, D.2 presents the thresholds for labor productivity. Note that CompNet data for real value added are not available for Portugal, and labor productivity data are missing for Switzerland, Czech Republic and Finland.

Table D.1: Real Value Added distribution, European countries

Country	$P10$	$P20$	$P30$	$P40$	$P50$	$P60$	$P70$	$P80$	$P90$
Belgium	34.48	55.63	79.48	109.27	150.22	210.67	309.30	509.46	1089.87
Czech Republic	10.89	20.40	31.46	44.04	59.30	78.24	104.59	150.87	272.55
Denmark	46.48	69.43	92.87	120.26	154.36	199.50	264.82	372.85	651.61
Finland	34.39	51.15	68.21	87.53	112.10	145.55	194.57	275.25	470.15
Italy	20.79	36.53	53.12	72.47	96.10	126.17	166.79	227.77	350.75
Netherlands	65.49	105.58	144.67	188.04	238.75	300.17	379.34	495.31	735.10
Spain	17.75	29.86	42.79	57.63	75.45	98.12	128.81	175.35	271.38
Sweden	69.35	107.58	148.90	198.46	261.89	348.41	477.55	702.57	1266.35
Switzerland	84.90	133.56	184.37	242.53	314.86	420.38	584.54	916.73	1970.51

Notes: Authors' computations, based on the Compnet 9^{th} database. Values averaged over the longest available period until 2015 by country.

Table D.2: Real Labor Productivity distribution, European countries

Country	$P10$	$P20$	$P30$	$P40$	$P50$	$P60$	$P70$	$P80$	$P90$
Belgium	22.14	30.70	38.23	46.21	55.45	68.26	86.78	119.86	201.88
Denmark	19.21	27.89	35.12	41.79	48.62	56.39	66.47	81.77	112.52
Italy	10.03	15.65	20.37	24.85	29.44	34.58	41.05	50.53	69.81
Netherlands	22.43	34.25	43.96	53.04	62.66	73.95	89.20	112.66	160.66
Portugal	3.12	5.85	8.01	9.93	11.97	14.41	17.64	22.63	33.00
Spain	10.42	15.02	18.50	21.75	25.11	29.05	34.15	41.89	57.79
Sweden	39.67	54.69	68.84	84.10	102.01	124.84	156.86	208.20	319.72

Notes: Authors' computations, based on the Compnet 9^{th} database. Values averaged over the longest available period until 2015 by country.

We then estimate again equation (4) on French data while choosing the bins j in light of the threshold values specific to each country for value added and labor productivity. The corresponding coefficient estimates are reported in Tables D.3 and D.4.

Table D.3: The collateral channel by real value added decile in the sample of European countries

Country	BEL (1)	CZE (2)	DNK (3)	FIN (4)	ITA (5)	NLD (6)	ESP (7)	SWE (8)	CHE (9)	FRA (10)
$\mathcal{H}\times$ Real Value-Added Decile										
$\leq$ P10	0.53^a	0.53^a	0.49^a	0.53^a	0.6^a	0.43^a	0.59^a	0.42^a	0.4^a	0.2^a
	(0.013)	(0.017)	(0.011)	(0.013)	(0.016)	(0.0097)	(0.016)	(0.0095)	(0.0088)	(.0094)
P10-20	0.27^a	0.66^a	0.19^a	0.28^a	0.42^a	0.18^a	0.51^a	0.18^a	0.16^a	0.22^a
	(0.0098)	(0.02)	(0.0078)	(0.011)	(0.012)	(0.0063)	(0.015)	(0.0067)	(0.0057)	(.0098)
P20-30	0.17^a	0.47^a	0.18^a	0.18^a	0.28^a	0.15^a	0.29^a	0.15^a	0.16^a	0.32^a
	(0.0073)	(0.014)	(0.008)	(0.0085)	(0.011)	(0.0062)	(0.012)	(0.0059)	(0.0056)	(.0095)
P30-40	0.19^a	0.28^a	0.17^a	0.19^a	0.17^a	0.16^a	0.25^a	0.17^a	0.15^a	0.42^a
	(0.0076)	(0.011)	(0.0071)	(0.0091)	(0.008)	(0.0061)	(0.011)	(0.006)	(0.0058)	(.012)
P40-50	0.15^a	0.22^a	0.16^a	0.17^a	0.18^a	0.15^a	0.17^a	0.14^a	0.13^a	0.2^a
	(0.0059)	(0.01)	(0.0066)	(0.0077)	(0.0079)	(0.0062)	(0.0085)	(0.0054)	(0.0047)	(.0056)
P50-60	0.16^a	0.17^a	0.17^a	0.15^a	0.16^a	0.13^a	0.18^a	0.13^a	0.12^a	0.15^a
	(0.0055)	(0.0079)	(0.0063)	(0.0064)	(0.0072)	(0.005)	(0.0081)	(0.0045)	(0.0045)	(.0045)
P60-70	0.14^a	0.18^a	0.14^a	0.17^a	0.16^a	0.13^a	0.16^a	0.12^a	0.11^a	0.13^a
	(0.0043)	(0.0076)	(0.0052)	(0.0058)	(0.0059)	(0.005)	(0.0072)	(0.0044)	(0.0039)	(.0042)
P70-80	0.12^a	0.16^a	0.13^a	0.14^a	0.15^a	0.11^a	0.16^a	0.096^a	0.089^a	0.11^a
	(0.0034)	(0.0058)	(0.0043)	(0.0048)	(0.0042)	(0.0045)	(0.0056)	(0.0035)	(0.0032)	(.0038)
P80-90	0.092^a	0.15^a	0.1^a	0.13^a	0.13^a	0.095^a	0.15^a	0.086^a	0.076^a	0.1^a
	(0.0027)	(0.0039)	(0.0031)	(0.0034)	(0.005)	(0.0035)	(0.0043)	(0.0029)	(0.0028)	(.0032)
>P90	0.063^a	0.095^a	0.074^a	0.079^a	0.088^a	0.073^a	0.095^a	0.062^a	0.058^a	0.068^a
	(0.0022)	(0.0018)	(0.0019)	(0.0018)	(0.0018)	(0.002)	(0.0018)	(0.0024)	(0.0028)	(.0025)
CF^l_{it}	0.025^a	0.025^a	0.025^a	0.025^a	0.025^a	0.025^a	0.025^a	0.025^a	0.025^a	0.025^a
	(0.00027)	(0.00027)	(0.00027)	(0.00027)	(0.00027)	(0.00027)	(0.00027)	(0.00027)	(0.00027)	(.00027)
$1/K^l_{i,t-1}$	0.85^a	0.85^a	0.85^a	0.85^a	0.85^a	0.85^a	0.85^a	0.85^a	0.85^a	0.85^a
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(.015)
Obs.	5859905	5859905	5859905	5859905	5859905	5859905	5859905	5859905	5859905	5883790
Adj. R^2	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	.21

Notes: Country-specific estimates of equation (4). All estimations include the controls in $X^l_{i,t}$ as well as firm- and location-year-fixed effects. Standard errors in parentheses, clustered at the location-year level. ^{c}, ^{b}, ^{a} denote, respectively, significance at the 10%, 5%, and 1% levels.

Using data from CompNet, we compute the proxies for ω^j corresponding to each decile of the firm size distribution. The associated capital shares are shown in Table D.5 when it is measured by real value added, and in Table D.6 when firm size is measured by real labor productivity. Finally, Figure D.1 reports the cross-country estimates of $\frac{\partial \mathcal{I}_t}{\partial \mathcal{H}_t}$ for value added and labor productivity, along with the estimates in the main text building from employment data.

Table D.4: The collateral channel by labor prod. decile in the sample of European countries

Country:	BEL (1)	DNK (2)	ITA (3)	NLD (4)	PRT (5)	ESP (6)	SWE (7)	FRA (8)
$\mathcal{H}\times$ Real Labor Prod. Decile								
$\leq P10$	0.45^a	0.69^a	0.6^a	0.51^a	0.71^a	0.61^a	0.58^a	0.58^a
	(0.011)	(0.019)	(0.016)	(0.013)	(0.022)	(0.016)	(0.015)	(.016)
$P10-P20$	0.21^a	0.42^a	0.35^a	0.24^a	0.57^a	0.36^a	0.29^a	0.34^a
	(0.0081)	(0.016)	(0.013)	(0.0078)	(0.021)	(0.013)	(0.0094)	(.012)
$P20-P30$	0.21^a	0.31^a	0.26^a	0.21^a	0.41^a	0.26^a	0.23^a	0 $.26^a$
	(0.009)	(0.01)	(0.011)	(0.0081)	(0.02)	(0.011)	(0.0094)	(.01)
$P30-P40$	0.18^a	0.24^a	0.25^a	0.17^a	0.37^a	0.25^a	0.21^a	0.22^a
	(0.0095)	(0.009)	(0.012)	(0.0083)	(0.019)	(0.012)	(0.0098)	(.01)
$P40-P50$	0.16^a	0.22^a	0.21^a	0.17^a	0.33^a	0.21^a	0.21^a	0.22^a
	(0.01)	(0.0095)	(0.011)	(0.0094)	(0.016)	(0.011)	(0.01)	(.0098)
$P50-P60$	0.18^a	0.21^a	0.21^a	0.17^a	0.26^a	0.21^a	0.18^a	0.2^a
	(0.011)	(0.0099)	(0.011)	(0.01)	(0.013)	(0.011)	(0.0096)	(.0094)
$P60-P70$	0.16^a	0.17^a	0.21^a	0.18^a	0.25^a	0.2^a	0.16^a	0.15^a
	(0.011)	(0.0093)	(0.0099)	(0.013)	(0.012)	(0.0096)	(0.0097)	(.0085)
$P70-P80$	0.18^a	0.16^a	0.18^a	0.18^a	0.22^a	0.17^a	0.18^a	0.2^a
	(0.013)	(0.0094)	(0.0086)	(0.013)	(0.0088)	(0.0086)	(0.0092)	(.011)
$P80-P90$	0.2^a	0.18^a	0.17^a	0.22^a	0.2^a	0.17^a	0.17^a	0.16^a
	(0.015)	(0.0087)	(0.0073)	(0.017)	(0.0067)	(0.0073)	(0.01)	(.009)
$> P90$	0.24^a	0.2^a	0.2^a	0.26^a	0.18^a	0.2^a	0.22^a	0.21^a
	(0.017)	(0.0084)	(0.0078)	(0.024)	(0.0056)	(0.0081)	(0.011)	(.011)
CF^l_{it}	0.025^a	0.025^a	0.025^a	0.025^a	0.025^a	0.025^a	0.025^a	0.025^a
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(.0003)
$1/K^l_{i,t-1}$	0.88^a	0.88^a	0.88^a	0.88^a	0.88^a	0.88^a	0.88^a	0.88^a
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(.016)
Obs.	4021988	4021988	4021988	4021988	4021988	4021988	4021988	4021988
Adj. R^2	0.19	0.19	0.19	0.19	0.19	0.19	0.19	.19

Notes: Country-specific estimates of equation (4). All estimations include the controls in $X^l_{i,t}$ as well as firm- and location-year-fixed effects. Standard errors in parentheses, clustered at the location-year level. ^{c}, ^{b}, ^{a} denote, respectively, significance at the 10%, 5%, and 1% levels.

Table D.5: Share of capital by decile of real value added

	$\leq P10$	P10-20	P20-30	P30-40	P40-50	P50-60	P60-70	P70-80	P80-90	$> P90$
Belgium	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.07	0.12	0.62
Czech Republic	0.02	0.02	0.02	0.02	0.03	0.04	0.04	0.06	0.13	0.62
Denmark	0.02	0.02	0.02	0.03	0.04	0.04	0.06	0.07	0.12	0.58
Finland	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.06	0.80
France	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.05	0.07	0.75
Italy	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.11	0.58
Netherlands	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.09	0.61
Spain	0.03	0.03	0.03	0.04	0.04	0.05	0.06	0.07	0.10	0.56
Sweden	0.01	0.01	0.02	0.02	0.03	0.03	0.05	0.06	0.10	0.68
Switzerland	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.06	0.09	0.73

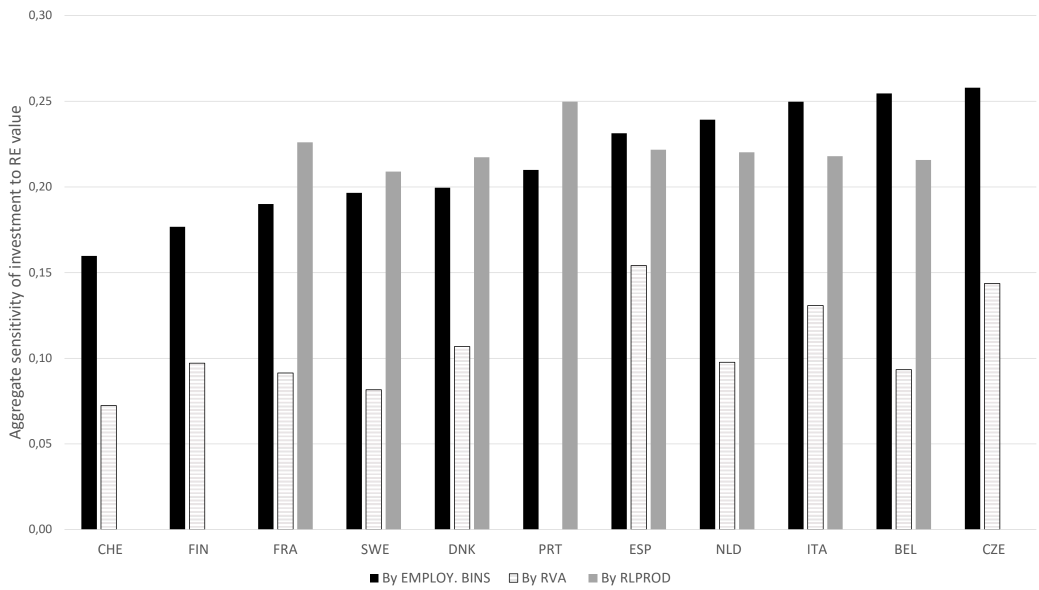
Notes: Authors' calculation, from Compnet joint distribution dataset (9^{th} and 6^{th} versions).

Table D.6: Share of capital by decile of real labor productivity

	$\leq P10$	P10-20	P20-30	P30-40	P40-50	P50-60	P60-70	P70-80	P80-90	$> P90$
Belgium	0.015	0.017	0.021	0.027	0.037	0.049	0.068	0.099	0.183	0.485
Denmark	0.025	0.030	0.034	0.037	0.046	0.056	0.070	0.090	0.120	0.492
France	0.026	0.034	0.048	0.064	0.081	0.099	0.112	0.122	0.140	0.273
Italy	0.032	0.036	0.042	0.051	0.062	0.075	0.093	0.122	0.174	0.313
Netherlands	0.039	0.059	0.062	0.074	0.087	0.098	0.102	0.108	0.131	0.239
Portugal	0.030	0.034	0.035	0.038	0.045	0.058	0.081	0.113	0.173	0.393
Spain	0.045	0.034	0.034	0.040	0.046	0.054	0.071	0.100	0.141	0.435
Sweden	0.017	0.024	0.029	0.039	0.042	0.050	0.063	0.092	0.176	0.469

Notes: Authors' calculations, from Compnet joint distribution dataset, 9^{th} and 6^{th} versions.

Figure D.1: Estimates of the heterogeneous collateral channel - Alternative measures



Notes: RVA = Real Value-Added ; RLPROD = Real Labor Productivity. EMPLOY. BINS = the underlying heterogeneity regressions are based on the five employment categories used for the main estimates, and presented in the main text. Missing bars indicate corresponding estimation is not available. BEL = Belgium; CZE = Czech Republic; DNK = Denmark; FIN = Finland; FRA = France; ITA = Italy; NLD = Netherlands; PRT = Portugal ESP = Spain; SWE = Sweden ; CHE = Switzerland.