Revisiting the Effect of Collateral Constraints

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March 26, 2026

Abstract

We revisit the effect of collateral constraints in a general equilibrium model where heterogeneous firms endogenously choose between asset-based and earnings-based borrowing. We discipline the model based on rich financial data and compare its predictions to firm-level employment responses during the 2012-2019 commercial real estate price boom. The model replicates two key patterns in the data. First, asset-based borrowing is concentrated toward smaller firms. Second, firms borrowing against their assets increase employment significantly more than firms borrowing against their earnings when commercial real estate prices rise. Despite sizable cross-sectional effects, the aggregate effects of collateral constraints are small because firms borrowing against their assets represent a limited share of total employment as well as due to offsetting general equilibrium effects.

JEL Classification: E44, G21

Keywords: Asset-Based Borrowing, Earnings-Based Borrowing, Heterogeneous Firms, Collateral Constraints, Real Estate Prices

[0]Acknowledgments: The views expressed in this paper do not reflect the official position of the Board of Governors of the Federal Reserve System or the Federal Reserve Bank of Richmond. We thank Larissa Chan and Samina Stack for excellent research assistance. For helpful discussions, we thank Thomas Dreschel, Yan Bai, Nobu Kiyotaki, Andrea Lanteri, Yueran Ma, Vincenzo Quadrini, Guillermo Ordonez, and Ricardo Reis.

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1 Introduction

Do collateral constraints matter for firms' employment and investment? A central idea in macroeconomics known as the "collateral channel" suggests that a rise in asset values increases the value of collateral backing firms' loans, expands borrowing capacity, and enables firms to increase employment and investment (Kiyotaki and Moore, 1997; Bernanke, Gertler, and Gilchrist, 1999; Jermann and Quadrini, 2012).

Direct evidence in favor of the collateral channel is based on cross-sectional studies showing how a rise in asset prices disproportionately benefits firms with a larger share of collateralizable assets (see for example, Chaney, Sraer, and Thesmar, 2012; Adelino, Schoar, and Severino, 2015; Bahaj, Foulis, and Pinter, 2020). However, these cross-sectional studies are missing the general equilibrium effect (i.e., the missing intercept) which can often undo the partial equilibrium responses (Wolf, 2023). At the same time, existing general equilibrium models with collateral constraints do not capture realistically the heterogeneity in firms' decision to pledge assets as collateral (e.g., Khan and Thomas, 2013; Ottonello and Winberry, 2020; Catherine et al., 2022). In this class of models, only a single way of obtaining funds is possible, typically through asset-based borrowing, even though asset-based borrowing is a common feature of smaller firms while larger firms mostly rely on earnings-based borrowing (Lian and Ma, 2021). Therefore, existing cross-sectional evidence and general equilibrium models provide only a partial view of the role of collateral constraints.

We revisit the role of collateral constraints using a novel general equilibrium model with heterogeneous firms and default risk in the tradition of Khan, Thomas, and Senga (2016). The key innovation is the firm's endogenous choice between asset-based and earnings-based borrowing. Specifically, (i) firms can borrow by pledging their capital in which case lenders obtain the liquidation value of capital in case of default (asset-based borrowing), and (ii) firms can borrow by tying creditor compensation in case of default to future earnings (earnings-based borrowing).[1] Lenders price each type of debt according to the type-specific recovery rate and firms choose the cheapest way of financing.

We discipline the structural model combining supervisory financial data from Y-14 quarterly reports with firm-level employment data from the National Establishment Time Series (NETS).[2] A key feature of our financial data is information on how firms back their loans. We find that about 62 percent of firms borrow by pledging assets as collateral (more promi-

[1] We make the assumption that asset-based debt is resolved under Chapter 7 of the bankruptcy code (firm liquidation) and earnings-based debt is resolved under Chapter 11 of the bankruptcy code (firm re-organization) an assumption justified by empirical evidence.

[2] Our financial data are submitted by banks for supervisory reasons which guarantees their reliability. In addition, the NETS data closely tracks official data on both aggregate employment and cross-sectional differences in firm employment, at least for a subset of the firm distribution that excludes very small and very large firms (Barnatchez, Crane, and Decker (2017)).

nently, real estate) while the remainder obtain loans without pledging any assets, implicitly backing their loans based on their future earnings (e.g., unsecured loans).[3] Firms that rely on asset-based borrowing are predominantly smaller, younger, and riskier.

In addition, we present new evidence about the strength of the collateral channel using cross-sectional variation. Specifically, we compare employment in firms borrowing against their assets to employment in firms borrowing against their earnings across U.S. labor markets during the 2012-2019 commercial real estate price boom. We use various instrumental variables to obtain orthogonal variation in commercial real estate prices (e.g., Saiz, 2010; Guren, Mckay, Nakamura, and Steinsson, 2021). We find that a 10 percent growth in commercial real estate prices is associated with employment growing in firms borrowing against assets by 0.7 percentage points more than firms borrowing against earnings and interest rates being 0.07 percentage points lower. The estimates are stronger when estimated on (i) firms that specifically pledge real estate as collateral and (ii) firms that are financially constrained.

Our model replicates several patterns of the data. First, the model replicates reasonably well (i) the average leverage ratio, (ii) the average default rate, (iii) the average investment rate, (iv) the average and the dispersion of interest rates, and (v) the employment dispersion across firms.

Second, our model matches the size-dependent profile of asset-based borrowing across U.S firms. In our model, lenders prefer to extend asset-based lending to less productive firms and liquidate capital in case of default. On the other hand, lenders are comfortable extending earnings-based lending to more productive firms and relying on their high future profitability to secure their compensation. Since the less (more) productive firms are also the smaller (larger) the model can generate the size-dependent profile of asset-based borrowing through productivity.

Third, the model aligns with the estimated employment responses from the commercial real estate price boom. As in the data, firms that borrow against their assets disproportionately benefit from the rise in real estate prices relative to firms that borrow against their earnings. Asset-based borrowing implies lower interest rates and as a result, higher employment and capital. In response to a 10 percentage points higher real estate price inflation, employment in asset-based borrowing firms expands by 0.5 percentage points more than earnings-based borrowing firms, fairly close to the estimate of 0.7 we found in the data.

We use the calibrated model to measure the aggregate effect of commercial real estate price boom. The aggregate employment increase is an order of magnitude smaller than the cross-sectional response. This occurs for two reasons. First, not all firms benefit from a rise in commercial real estate prices but mostly smaller and unproductive firms. Second, higher

[3]See also Lian and Ma, 2021; Gupta, Sapriza, and Yankov, 2022, Dreschel, 2023.

demand for capital and labor by asset-based borrowing firms increases the price of capital and wages offsetting the partial equilibrium response. Using a model decomposition, we find that partial equilibrium accounts for about 48 percent of the difference between the cross-sectional and the aggregate response while the rest is accounted by the selection of firms between asset- and earnings-based borrowing. In sum, the aggregate effects of collateral constraints are smaller than suggested by either (i) cross-sectional responses and (ii) models without heterogeneity in asset-based borrowing.

Furthermore, we find that modeling the choice between asset-based and earnings-based borrowing as endogenous is important. A model where firms' choice between asset-based and earnings-based borrowing is fixed substantially underestimates the effects of collateral constraints by missing the endogenous switching response: many firms shift to asset-based borrowing when collateral constraints relax, amplifying the aggregate effect.

Our paper contributes to the development of structural models of firm financing by adding an endogenous choice between asset-based and earnings-based borrowing. Traditional models of financial frictions do not feature any heterogeneity and thus cannot speak to the differential exposure of firms to financial shocks (e.g., Kiyotaki and Moore, 1997; Jermann and Quadrini, 2012). On the other hand, in models of firm financing that do feature heterogeneous firms usually only a single way of obtaining funds is possible, typically through asset-based borrowing (e.g., Khan and Thomas, 2013; Ottonello and Winberry, 2020; Catherine et al., 2022; Jeenas, 2025).

There are several recent quantitative models that distinguish between asset- and earnings-based borrowing (e.g., Lian and Ma, 2021; Dreschel, 2023). Yet, in these aforementioned papers the choice is taken as given and not the outcome of an optimal firm decision. This effectively shuts down the important link between firm size and exposure to financial shocks and misses the endogenous switching response that may amplify the aggregate effect.[4]

Our paper also contributes to the growing literature that studies the borrowing decisions of firms. Lian and Ma (2021) use data from publicly listed firms and find an asset-based share slightly lower than ours which is natural since our estimates are based on loans by both private and public businesses. Li (2022) explores the implications of asset- and earnings-based constraints for total factor productivity and misallocation. Dreschel (2023) studies the macroeconomic implications of earnings-based borrowing and finds that positive investment shocks relaxes more earnings-based constraints.

Finally, our paper contributes to the strand of the literature studying collateral constraints

[4]An exception is the paper by Lian, Ma, Martell, and Li (2025) that analyzes the role of borrowing constraints on firm markups and includes a form of selection into asset- and earnings-based borrowing. However, their model abstracts from default risk and cannot map these financial decisions into time-varying interest rates as we do in our paper.

using cross-sectional variation. There are several papers documenting a positive cross-sectional response in investment, employment, and borrowing to real estate prices (Chaney, Sraer, and Thesmar, 2012; Cvijanovic, 2014; Adelino, Schoar, and Severino, 2015; Bahaj, Foulis, and Pinter, 2020 Bahaj, Foulis, Pinter, and Surico, 2022; Gupta, Sapriza, and Yankov (2022); Davis and Haltiwanger, 2024).[5] Most of these studies use indirect measures of firm exposure to real estate prices such as the share of real estate assets in firms' capital or firms' size or age. In contrast, our empirical strategy uses a more direct way to measure exposure based on how firms actually back their loans which also connects more naturally to our structural model of asset- vs. earnings-based borrowing.

The paper is organized as follows. Section 2 documents the empirical patterns regarding asset-based debt and earnings-based debt. Section 3 builds a model, and Section 4 structurally estimates the model. Section 5 performs the main quantitative experiments, and Section 6 empirically tests the quantitative implications of the model. Finally, Section 7 concludes.

2 Empirical Analysis

2.1 Data construction

We combine several firm-level datasets. First, we use the Federal Reserve Y-14Q data (henceforth, Y-14). The Y-14 is a confidential loan-level dataset provided by the largest banks operating in the U.S. with total assets exceeding $100 billion for supervisory and regulatory purposes. Specifically, banks report all outstanding business loans exceeding $1 million alongside the loan characteristics such as maturity, interest rate, credit rating, expected default risk, and importantly for our analysis, the underlying collateral pledged if the loan is secured. The data also provide the borrower's identity, income, and balance sheet information.

We make the following sample restrictions. First, we focus on new loans issued between 2012-2019 to guarantee a large number of observations per year and a relatively stable period. Second, we keep loans obtained from firms headquarted in the U.S. Third, we drop firms in the finance, insurance, real estate, construction, and public administration (see also Chodorow-Reich, 2014). Fourth, we drop loans above $10 billion having in mind that loans exceeding that amount are often used for corporate mergers. Fourth, we drop loans that do not include information of firm's assets. These restrictions leave us with 147,630 loans and 88,030 firms. The total loan volume in our sample represents around 20 percent of commercial and industrial loan volume by all commercial banks.

[5] Campello, Connolly, Kankanhalli, and Steiner (2022) find that publicly listed firms increase corporate borrowing following a CRE value appreciation but new debt is mostly unsecured rather than secured. It is not clear if these patterns hold across the firm-size distribution or are specific to their sample of large corporations.

For employment data we use the National Employment Time-Series (NETS). Since the data is available at the establishment level, we measure firm-level employment by aggregating number of employees across establishment units and assigning the location of the headquarter. We abstract from entry and exit of firms and focus on firms that are continuously on the sample during 2012-2019. Barnatchez, Crane, and Decker (2017) find that measurement error in NETS employment data arises from a high level of imputation at very small and very large firms. As a result, we drop micro-firms with fewer than 10 employees and large firms with more than 25,000 employees (the top one percentile in the NETS employment distribution). As in the Y-14 we drop firms in finance, insurance, real estate, construction, and public administration. The sample consists of 1,132,361 firms. In the appendix we show that the employment share of small and large firms in the NETS data is comparable to that in the Business of Dynamics Statistics (BDS).

2.2 Summary Statistics

Table 1: Summary Statistics

Variable	#Obs	Mean	SD	p(25)	p(50)	p(75)	p(90)
Leverage	173,901	0.34	0.29	0.09	0.29	0.51	0.74
Loan Issuance ($mil.)	173,901	14.2	81.4	1.5	2.8	7.7	25
Interest rate (%)	137,321	3.7	1.3	2.8	3.7	4.5	5.4
Default prob. (%)	141,225	1.8	3.4	0.4	0.8	1.8	3.7
No. of employees	8,741,885	57.3	386.3	12	20	35	75
Firm age	8,664,446	34.3	22.8	18	29	43	63

Notes: Financial statistics are based on the Y-14 sample of 88,030 firms and employment data based on the NETS sample of 1,132,361 firms for the period 2012-2019.

Table 1 provides cross-sectional summary statistics based on the period 2012-2019. The median loan is $14.2 million, has a 3.7 percent interest rate, and the bank institution assigns a 1.8 percent probability of default.[6] The median firm has 20 employees and is 29 years old. The mean leverage ratio of 0.34 is fairly close to the value reported in Crouzet and Mehrotra (2018) based on U.S. Census Bureau survey conducted on manufacturing, retail and wholeshale firms.

We classify firms' borrowing as asset-based or earnings-based. The assignment is relatively straightforward because in the Y-14 data we directly observe what asset type the firm pledges. This asset can be repossessed by the lender in the event of bankruptcy. Thus, our classification

[6]Most of loans in the data are floating rate tied to LIBOR so we report the interest rate at loan issuance.

Table 2: Classification of Loans: Asset- vs Earnings-Based

Type of borrowing	Average amount per issue ($ mil.)	Share (%)	Participation (%)
Asset-based borrowing (AB)			
Real estate	4.79	4.8	14.7
Accounts receivable & Inventories	13.5	23.1	24.9
Cash securities	14.0	2.2	2.2
Fixed assets	6.08	5.9	13.9
Other collateral	17.6	8.6	6.6
Earnings-based borrowing (EB)			
Blanket lien	11.4	20.5	26.2
Unsecured	43.5	34.6	11.3

Notes: Assignment of loans into asset-based borrowing and earnings-based borrowing. For every category we report the average per issue, the fraction of loans that belong to the category and the share of borrowing in each category relative to total borrowing.

is based on the type of claims lenders have in bankruptcy resolution (Lian and Ma, 2021).[7]

In asset-based borrowing (AB) lenders have claims against the collateralized asset and provide borrowing terms based on the expected liquidation value. Following the origination of the loan, the lender registers the pledged asset with the courts. Examples of such collateral reported in Y-14 include real estate, inventories, accounts receivable, cash, and fixed assets such as machinery or vehicles. These assets reflect accumulated economic activity. For example, real estate and fixed assets reflect investment from previous periods while accounts receivable and inventories reflect production from previous periods. Also note that the assets does not have to be necessarily physical but also can be an intangible asset such as a patent.

When firms issue earnings-based debt (EB), the lenders have unsecured claims, and their recovery in case of default is based on the value of the firm as a going concern under reorganization in Chapter 11 or on the residual value of the liquidated firm under Chapter 7 once all obligations to secured lenders are settled. There are two types of loan contracts in our data that fall under the category of earnings-based borrowing. First, there are business loans in which the bank agrees to lend without any underlying security (unsecured loans). Second, business loans in which the underlying security is the firm as a whole (blanket lien). We choose to include blanket liens as part of earnings-based debt for the following reason. In

[7]We also analyze in the robustness section the different type of restrictions imposed by lenders such as covenants (Dreschel (2023)).

asset-based borrowing, an asset is explicitly pledged and cannot be sold by the firm during the period of the contract, as it serves as collateral. In contrast, with blanket liens, there is no explicitly pledged asset. The firm may freely adjust its capital during the period of the contract, so lenders may not be able to recover any remaining assets (see also Lian and Ma, 2021).

Our classification of asset-based versus earnings-based debt is not equivalent to the distinction between secured and unsecured debt.[8] While asset-based debt is predominantly secured, earnings-based debt includes a mix of secured borrowing (e.g., blanket liens) and unsecured borrowing (Lian and Ma, 2021).

In our baseline measures we focus on bank loans and do not consider corporate debt issuance in our earnings-based debt. To account for the issuance of corporate bonds at the largest firms we incorporate data on corporate bonds provided by FISD Mergent. In the robustness section we confirm that corporate debt issuance has minor implications of participation but substantially affects the average debt issuance.

Table 2 describes the loan contracts we observe in our data. Approximately 62 percent of loan contracts are asset-based representing 44 percent of aggregate debt volume. The typical amount in an asset-based loan is lower on average than the average amount in an earnings-based loan. This is explained by larger firms selecting into earnings-based loan contracts as we document below. The most common pledged assets in asset-based loans are account receivable and inventories, real estate, and fixed assets.

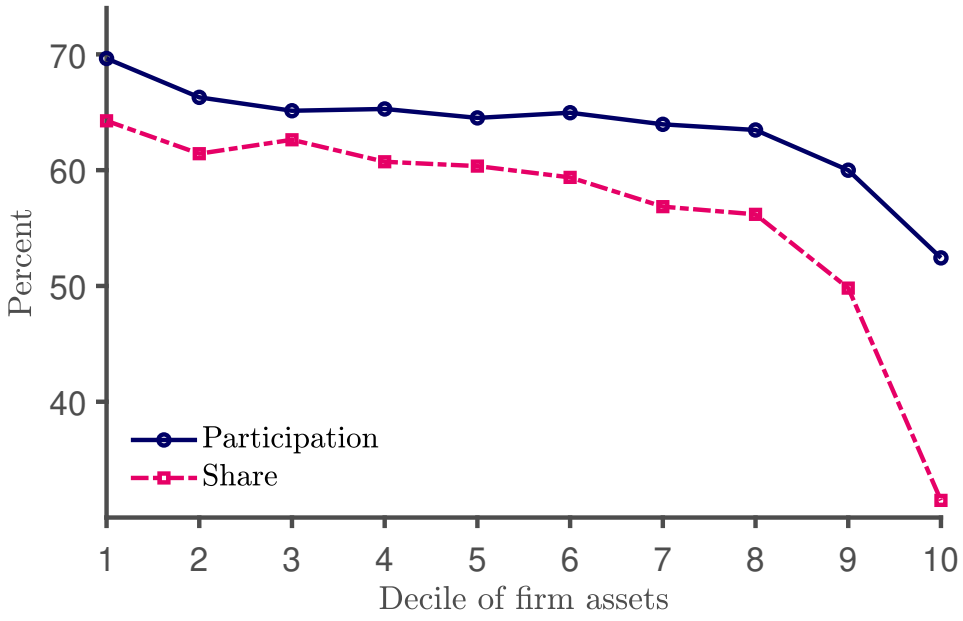
Our goal is to analyze how the asset-based share of borrowing varies across firm size. For firm i, in a quarter t, the share of borrowing that is asset-based is given by the total borrowing amount from asset-based loans relative to the total borrowing amount from all loan contracts. For most firms, in a given quarter, the share is either zero or one but if a firm issues more than one loan in a quarter that differs in type, then the asset-based share can be between zero and one. In this case, the asset-based share is a weighted sum of these loans with weights given by the issuance amounts.

To account for industry differences, such as asset specialization and liquidation, we sort firms by their assets, within every industry group (three-digit NAICS).[9] Figure A-3 plots (i) how many firms participate into asset-based loans and (ii) the average asset-based share of borrowing, across asset deciles. We document a negative relationship between asset-based share and firm size in line with other studies (Lian and Ma, 2021; Gupta, Sapriza, and Yankov, 2022). Participation decreases from 69 percent to 52 percent and the asset-based share from

[8] Rampini and Viswanathan (2022) build a model in which issuing secured debt relaxes the firms' borrowing constraints but also implies additional costs.

[9] In the appendix we document the participation and share of asset-based and earnings-based borrowing across industries.

Figure 1: Asset Based Share and Firm Size



Notes: Asset-based borrowing across asset groups. We rank firms within each three-digit industry by asset size and compute the share of firms that take out an asset-based loan (participation) and the average loan amount of asset-based loans relative to total borrowing (share). Each decile consists of approximately 14,800 loans.

64 percent to 31 percent. As we discussed in the previous table, the participation rate is higher than the asset-based share since some asset classes that are frequently used by firms (e.g., real estate) involve small loans. Smaller firms are mostly pledging real estate and as they grow they turn to unsecured borrowing. Other categories are mostly flat. But larger firms increase unsecured borrowing by decreasing participation in every category, not just real estate, which explains why the profile steeply decreases at the top of the distribution (see appendix for more details).

Next we next turn to our merged Y-14/NETS sample to investigate jointly the role of firm size and firm age in explaining the decision to issue asset-based or earnings-based debt. We run a linear regression with the asset-based share at the firm level as a left-hand side variable, and on the right-hand side, we include the firm's assets and firm age, firm leverage, and the probability of loan default. We also include time and industry dummies. The regression is given by:

$$y_{i,t} = \beta k_{i,t} + \gamma \text{age}_{i,t} + \mathbf{X}'_{i,t}\delta + \lambda_c + \varepsilon_{i,t}, \tag{1}$$

where $y_{i,t,c}$ is the asset-based share of firm i in quarter t that belongs to industry c, defined

Table 3: Asset-based Share of Borrowing and Firm Characteristics

	Asset-based borrowing	
	Participation	Share
	(1)	(2)
Firm assets (log)	−0.02***	−0.03***
	(0.004)	(0.007)
Firm age (log)	−0.02**	−0.06**
	(0.009)	(0.02)
Leverage	0.08***	0.08
	(0.02)	(0.05)
Probability of default	0.10	−0.07
	(0.08)	(0.15)
# Observations	10,425	10,425

Notes: Regression of asset-based borrowing on firm characteristics. Estimates based on unweighted regression are reported in column (1) as participation. Estimates based on the regression weight by the loan amount are reported in column (2) as share. Total number of firms used in the regression is 7,050.

at the three-digit NAICS classification. Variable $k_{i,t}$ is the log of the total assets of firm i in time t. $\text{age}_{i,t}$ is also taken in logs. $\mathbf{X}$ is a vector of control variables that includes the leverage ratio and the probability of default, and finally, λ_c is the industry fixed effect. We show the estimates of the regression in Table 3. When the regression is unweighted, it amounts to the participation decision. When we weigh the regression by the amount of the loan, the left hand-side variable amounts to the asset-based share of borrowing. We find that both the firm's size and the firm's age matter for the choice between asset-based and earnings-based share. Smaller and younger firms tend to select primarily into asset-based borrowing, while larger and older firms predominantly choose earnings-based borrowing.

2.3 Discussion

Bankruptcy Filings and Asset-Based Share The borrowing choice between asset-based and earnings-based debt is closely connected to the Chapter under which the bankruptcy would be resolved in the event of default. For example, asset-based loans are typically resolved under a Chapter 7 liquidation of the bankruptcy code. In contrast, earnings-based loans are typically

undertaken by larger firms that can efficiently reorganize in the event of default. We show this relationship analyzing bankruptcy cases. Specifically, we analyze the share of Chapter 7 versus Chapter 11 bankruptcies across asset deciles. We find that larger firms (that rely relatively more on earnings-based debt) typically file for reorganization under Chapter 11 (see the appendix for more details). We use this empirical evidence to support our model choices in the structural model.

Covenants Loan covenants is a common feature of financial contracts and can be related to firms earnings or firms' assets (e.g., Chodorow-Reich and Fallato, 2022, Dreschel, 2023). Our goal is to understand if the earnings-based loans in our sample are connected to covenants related to firm's assets. In that case, an improvement of asset values may benefit the firm by relaxing the covenant restriction. We use loan information from Thomson Reuters Deaslcan data that includes information about covenants. Merging the Dealscan loans with the Y14 we have 20 percent of loans that include information about covenants. We classify the following covenants as earnings-based: interest coverage ratio, fixed charge coverage ratio, debt to cash flow, senior debt to cash flow, cash interest coverage ratio, and debt service coverage ratio. The asset-based covenants are debt to equity ratio, debt to tangible net worth, leverage ratio, and loan to value ratio. From the loans that are classified as earnings-based in the Y14 we have 25 percent with information about covenants. 17 percent have also an earnings-based covenant while 7 percent has an asset-based covenant. From the loans that are classified as asset-based in the Y14 we have 13 percent with information about covenants. 9 percent have an earnings-based covenant while 1 percent has an asset-based covenant. Therefore, the majority of loan contracts intended to be resolved under liquidation (re-organization) carry an asset-based (earnings-based) covenant.

Bond Issuance One type of firm borrowing particularly relevant for larger firms is corporate debt (Lian and Ma, 2021). We analyze the importance of corporate debt in our data by merging the Y-14 with information on corporate debt issuance. During the sample period we identify 1,558 bond issuances for our Y-14 firms and the average amount of issuance is $1.5 billion. With few issuances the participation rate in asset-based is virtually unchanged. The asset-based share is computed as a cross-sectional mean (instead of a ratio of averages) so it is also modestly affected: the average share at the top decile is 30 percent instead of 31 percent in our benchmark. Our structural model, models the decision between asset-based and earnings based debt as mutually exclusive so targets the participation rate.

2.4 The Response of Firm Employment to the CRE Price Boom

We analyze how employment growth responds to the commercial real estate (CRE) price boom during the period 2012-2019. Our research design compares employment growth in AB firms that are relatively more exposed to the CRE price boom to EB firms in the same labor market. Our baseline regression is

$$y_{ict} = \alpha_i + \alpha_t + \beta \cdot (AB_i \times CREP_{ct}) + \varepsilon_{ict}, \tag{2}$$

where by y_{ict} is employment growth for firm i, in labor market c, at time t relative to employment in the base year 2012. We also consider a regression with the interest rate spread as the outcome variable. The interest spread is equal to the difference between the interest rate paid on loan at origination and the federal funds rate in the same year. Labor market is a metropolitan area, α_i is firm fixed effects, and α_t is year fixed effects.

Variable AB_i is set to the firm's average asset-based share during the period 2012-2019.[10] $CREP_{ct}$ is the percentage change in the CRE price index in labor market c and time t relative to the base year 2012. We are interested in estimating the coefficient β, which captures how employment growth (or the interest rate spread) varies in AB firms compared to EB firms when CRE prices increase. We cluster standard errors at the labor market and year level.

Commercial real estate prices are higher in cities that are relatively productive. Otherwise, firms would not be willing to pay the higher real estate prices and live in highly densely-populated areas (Redding, 2023). Consistent estimation of β requires that in cities that experience the fastest growth in CRE prices, AB and EB firms experience similar productivity growth. If this is not the case, high AB employment growth in areas with fast-growing CRE prices can be explained by AB productivity growing faster than neighboring EB firms and subsequently driving up prices in the local real estate market. To address the possibility of reverse causation, we use an instrumental variable to obtain CRE price growth orthogonal to local productivity effects. Let Z_{ct} is the instrument for local CRE prices. Then the first-stage regression is:

$$CREP_{ct} = \alpha_c + \alpha_t + \gamma \cdot Z_{ct} + u_{ct}, \tag{3}$$

where α_c and α_t are local market and time fixed effects.

The standard instrument in the literature is based on the real estate supply elasticities constructed by Saiz (2010). Nonetheless, the instrument has been criticized by a number of studies (see for example, Davidoff, 2016). High house price growth in some cities may arise not just from restrictions in supply but also from high demand to live in these cities (e.g.,

[10] During the period of analysis, 56 percent of firms borrows only based on assets, 31 percent of firms borrows only based on earnings and the rest choose a mix of loan contracts.

cities next to the coast) which can reflect positively on firm productivity.[11] For this reason as a baseline we rely on the "sensitivity instrument" of Guren, Mckay, Nakamura, and Steinsson (2021) applied to CRE prices. The idea behind the instrument is that every city responds differently to the regional CRE cycle and the historical sensitivity is a proxy of the underlying supply elasticity of the local real estate market. In the robustness section we show that the Saiz (2010) instrument yields fairly similar results as the our baseline instrument.

To obtain the sensitivity instrument we use CRE price data from 1989-2019. For each metropolitan area c that belongs to Census region r we estimate the following regression:

$$\log CREP_{crt} = \alpha + \lambda_c \ \log CREP_{rt} + \nu_{crt}, \tag{4}$$

where $CREP_{crt}$ is the local CRE price index at time t and $CREP_{rt}$ denotes the CRE prices at the Census region r at time t, with $c \in r$. The statistical model in regression 4 helps to construct a proxy for the local supply elasticity. Metropolitan areas historically more sensitive to the regional real estate price cycle (higher $\widehat{\lambda}_c$) have a lower implied supply elasticity and vice versa. Since the instrument differs by geographical area but not time, we interact the estimated $\widehat{\lambda}_c$ with CRE prices at the Census region r at time t, i.e., $Z_{ct} = \widehat{\lambda}_c \times CREP_{rt}$, transform (its exponent) as a percentage change from the base year 2012, and apply it in equation 3. The instrument is powerful with an F-statistic above 10 (see table in the appendix for more information).

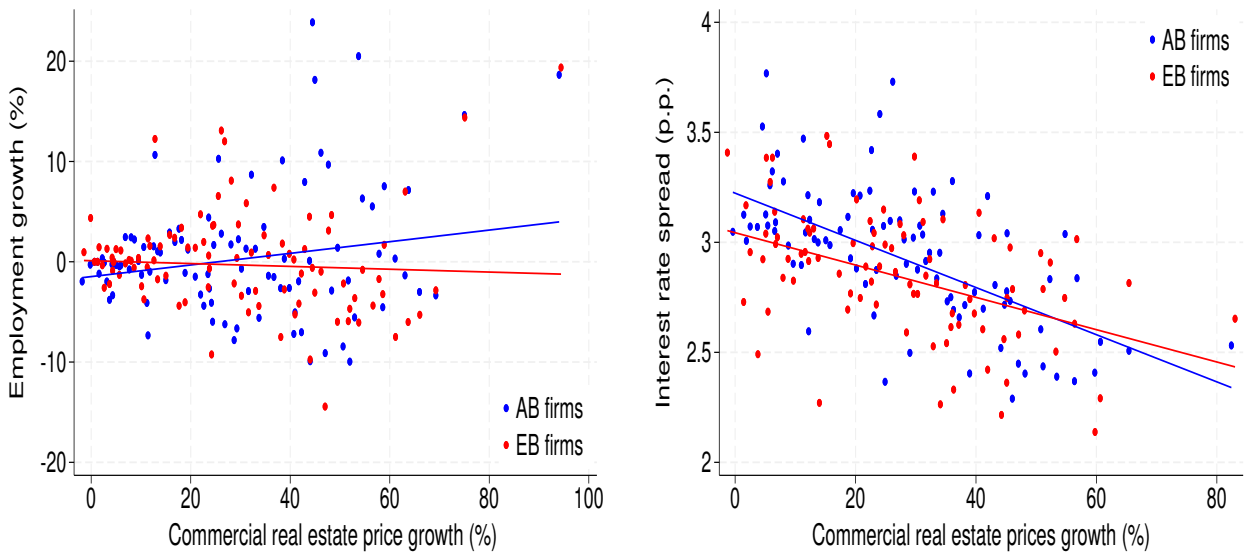
Finally, we should note another potential source of bias in regression 2. Firms do not randomly select into asset-based or earnings-based borrowing. As we documented, asset-based borrowing is concentrated in smaller, younger, and riskier firms. These firms plausibly grow at different rates, and are relatively more financially constrained than the typical firm. Therefore, it is not clear to what extent estimates reflect the collateral channel per se or the specific composition of firms that benefit from relaxing collateral constraints. Hence, we are cautious to interpret our estimates as causal. Instead, we use these estimates as a reference for the structural model that incorporates an endogenous margin of selection between asset-based and earnings-based borrowing.

Results The left panel of Figure 2 plots a binscatter of CRE price growth and employment growth in AB versus EB firms.[12] The right panel of Figure 2 plots a binscatter of CRE price growth and interest rate spread in AB versus EB firms. Both employment and interest rates are detrended from their national averages. We find that in labor markets with higher growth

[11] Higher demand to live in an area should to some extent reflect positively on employment of both neighboring AB and EB firms. Therefore, our research design should mitigate this concern to some extent.

[12] For these graphs, a firm is classified as AB if the average asset-based share is higher than 50 percent.

Figure 2: Asset-Based vs. Earnings-Based Borrowers: Response in Employment (Left Panel) and Interest Rates (Right Panel) to CRE prices



Notes: Binscatter of commercial real estate price growth (x–axis) to employment growth and interest rate spread (left panel and right panel y–axis, respectively). Left panel is based on 5,201 firms with 2,733 firms classified as AB and 2,468 firms classified as EB. Right panel is based on 4,266 firms with 2,312 firms classified as AB and 1,954 firms classified as EB. In either graph each dot includes at least 200 firms.

in CRE prices employment growth is larger and interest rates are lower in AB firms relative to EB firms. Thus, a simple inspection of the data confirms a differential response of firms that borrow against on their assets versus firms that borrow against their earnings.

Table 4 shows the estimates for β from regression 2. We show OLS and IV estimates for employment and interest rate spread, respectively. For employment we find an estimate equal to 0.09 for OLS which means that a 10 percent growth in CRE prices is associated with employment growing in AB firms by 0.9 percentage points more than EB firms. The IV estimate is slightly lower and equals 0.07. In addition, with OLS estimation we find that a 10 percent growth in CRE prices is associated with 0.034 percentage points lower interest rates in AB firms relative to EB firms. With the instrument the estimate is 0.074 percentage points. All estimates are statistically significant at the 5 percent level.

Firms Pledging Real Estate Respond More Our benchmark analysis compares firms pledging their assets (which includes real estate) vs. firms that borrow against their earnings. We analyze if firms that specifically pledged their real estate increase their employment more than firms that pledge assets but not real estate. Specifically, we modify regression 2 to include two interaction terms: one interacting CRE inflation with a dummy variable taking the value of one if the firm used real estate as collateral and a second interacting CRE inflation

Table 4: Estimation of Asset-Based vs. Earnings-Based Firm Responses to CRE prices

	Employment		Interest rate (× 100)	
	OLS	IV	OLS	IV
$AB \times$ CRE prices	0.09^{***}	0.07^{**}	-0.34^{**}	-0.77^{***}
	(0.03)	(0.03)	(0.19)	(0.19)
# Obs.	42,776	42,776	6,196	6,196

Notes: Employment regression is based on 5,201 firms with 2,733 firms classified as AB and 2,468 firms classified as EB. Interest rate regression is based on 4,266 firms with 2,312 firms classified as AB and 1,954 firms classified as EB. The standard errors are given in parentheses and are clustered at the metro area and year level. One, two, and three stars denote significance at the 10%, 5%, and 1% levels, respectively.

with a dummy taking the value of one if the firm pledged non-real estate assets. We find the employment estimate in firms pledging real estate equal to 0.10 and equal to 0.06 for firms pledging assets but not real estate (both relative to firms borrowing against their earnings). Thus, as expected, commercial real estate prices benefit firms who explicitly pledge real estate the most. Yet, firms that pledge assets other than real estate also benefit at least relative to firms that borrow against their earnings.

Financially Constrained Firms Respond More According to the collateral channel a rise in CRE prices expands firms' borrowing capacity and may increase employment if the firm is financially constrained. We follow Gupta, Sapriza, and Yankov (2022) and divide the sample into financially constrained and financially unconstrained firms based on their dependence on bank credit. We measure bank credit dependence by dividing the amount of outstanding loan at time t to the total firm liabilities. Firms that have higher ratio are more dependent on bank credit and thus more likely to respond to an improvement in their balance sheets. We assign the value of bank dependence equal to zero for firms that are publicly listed or have issued a bond during the period of analysis.

We run regression 2 separately for firms with bank dependence ratio above 75 percent (financially constrained) and firms below this threshold (financially unconstrained). The instrumental variable estimate is equal to 0.08 for financially constrained firms which is statistically significant at the 5 percent. For the financially unconstrained we find a negative estimate implying that unconstrained EB firms are outperforming unconstrained AB firms in fast-growing CRE price areas. Thus, it is the financially constrained AB firms that are responding more than financially constrained EB firms when CRE prices expand.

AB Firms in Low-Growth CREP Labor Markets Do not Respond We test how effects of CRE prices vary across labor markets. Specifically, we split labor markets into labor markets that experienced CRE price growth below the 33^{th} percentile, between 33^{th} and 66^{th} percentile, and above the 66^{th} percentile. In labor markets with modest CRE price growth increase, AB firms did not significantly increase their employment relative to EB firms. It is the high CRE growth labor markets that drive the overall response. Therefore, the effects do not show up for small changes in real estate prices.

Saiz (2010) instrument We show results for the real estate supply elasticity instrument constructed by Saiz (2010). This instrument is standard in the literature and has been applied in a number of studies (e.g., Mian and Sufi, 2011; Chaney, Sraer, and Thesmar, 2012; Adelino, Schoar, and Severino, 2015; Campello, Connolly, Kankanhalli, and Steiner, 2022, to name a few). Since the instrument differs by geographical area but not time, we interact the housing supply elasticity with the 30-year mortgage rate, i.e., $Z_t = \text{Supply Elasticity}_c \times \text{30-year MR}_t$. When the 30-year mortgage rate decreases the demand for commercial real estate price should increase so we should expect a negative relationship, in general. However, in labor markets with more flexible geographical landscape (high supply elasticity) the increase in CRE prices should be smaller which means an estimated positive coefficient for γ (see table in the appendix for more information). The estimated coefficient for β is 0.09 slightly higher than 0.07 with the baseline instrument.

3 Model

Time is discrete and there is a continuum of firms that make investment, employment, borrowing, and dividend issuance decisions. Firms issue one-period defaultable debt, which can be secured either by pledging physical capital (asset-based borrowing) or by tying borrowing to their earnings (earnings-based borrowing). Therefore, our model integrates two strands of the firm-financing literature. First, models of borrowing and default risk (e.g., Khan, Thomas, and Senga, 2016) and second, the growing literature on the different types of borrowing constraints (e.g., Lian and Ma, 2021).

Technology and Productivity Firms are perfectly competitive and produce a single homogeneous good. The firm's production function is

$$f(x, z, k, n) = xz \left[k^{\alpha} n^{1-\alpha}\right]^{\nu},$$

where k denotes capital, n denotes labor, x is an idiosyncratic permanent productivity component (ex-ante heterogeneity), and z is an idiosyncratic transitory productivity component (ex-post heterogeneity). The permanent component is drawn at firm birth and distributed as $\log x \sim N(0, \sigma_x^2)$, while the transitory component follows the autoregressive process

$$\ln z' = \rho_z \ln z + \varepsilon, \quad \varepsilon \sim N(0, (1-\rho_z^2)\sigma_z^2)$$

where ε is an i.i.d. shock.[13] We include both ex-ante and ex-post heterogeneity in productivity to allow greater flexibility to fit our empirical facts (see also Sterk, Sedlacek, and Pugsley, 2021). The production function exhibits decreasing returns to scale (i.e., we assume $\nu \in (0,1)$).[14] Firms hire labor in a perfectly competitive labor market so that profits are given by

$$\pi(x,z,k) = \max_n \{f(x,z,k,n) - wn\}.$$

where w is the wage. Finally, capital depreciates at the rate $\delta \in (0,1)$ and can be sold and purchased at the price p_k (which equals one in the steady state). In order to produce, firms pay a fixed cost of operation c_o every period.

Firm Borrowing Firms borrow by issuing one-period loans b' and choose (i) the amount of the loan b and (ii) if these loans are backed based on their assets ($j = a$) or their earnings ($j = y$). Because we model firm debt as one-period loans, it is natural to exclude the possibility for firms to issue a mix of types.[15] Firms borrow b' in the current period at price $q_j(x,z,k',b')$. The firm decides to issue asset-based debt if $q_a(x,z,k',b') < q_y(x,z,k',b')$ and vice-versa. The firm then either pays back b' units in the next period or defaults. The loan is priced by risk-neutral lenders, whose problem is described below. We do not allow firms to issue any equity ($d \geq 0$) since our sample includes mostly private businesses. In addition we do not allow firms to save ($b' \geq 0$).[16]

Recovery Rates The two types of borrowing lead to different payoffs for lenders in the case of default. In the case of asset-based borrowing, lenders expect to recover $(1-\xi)[(1-\delta)p_k' + \omega p_h']k'$, where ξ reflects the loss that occurs during the liquidation of the assets (Kermani and

[13] The transition matrix, which describes the autoregressive process, is given by $\Gamma(z'|z)$.

[14] According to the "span of control" models of Lucas (1978) and Rosen (1982), diminishing returns to scale can be interpreted as a consequence of the diminishing returns to entrepreneurs in managing larger operations.

[15] This is a rare event in the data as well: about 11 percent of firms have outstanding asset-based and earnings-based loans.

[16] In typical models, firms are allowed to save up to a lower bound (minimum saving policy, see Khan, Thomas, and Senga, 2016 and Ottonello and Winberry, 2020). In our model, firms have incentives to issue debt even if they have "sufficient" amounts of internal equity since there always exists some positive probability of default.

Ma, 2023). The liquidation loss is assumed to be incurred by the lenders. We assume that housing stock is related to capital as $h'/k' = \omega$. The total value of assets depemds on the endogenous capital price p'_k, and the exogenous shifter p'_h which represents in our case real estate prices (see also Liu, Wang, and Zha, 2013 and Catherine et al., 2022). Note that only p_k enters the firm's budget constraint. This simple formulation is equivalent to a financial shock that directly influences firms' borrowing capacity as in Jermann and Quadrini (2012).

With earnings-based borrowing, creditors have claims against the firm as a going concern. The payoffs in default are based on the expected cash flows from the firm's continuing operations. However, having an accurate measure of the firm's value going forward is difficult, especially for small and private firms. Thus, in practice, lenders use a multiple of the firm's EBITDA to value the business (Lian and Ma, 2021; Dreschel, 2023). Therefore, we assume that when earnings-based debt is in default, lenders recover $\theta\pi(x, z', k') - c_y$, where θ is used to project the value of the firm based on observed profits and c_y is a fixed cost associated with the bankruptcy process and firm acquisition that is incurred by the lenders (see more discussion below).

To summarize, these assumptions imply that for debt issued today with collateral type $j \in \{a, y\}$, lenders anticipate different recovery values tomorrow in default:

$$R_j(x, z', k') = \begin{cases} (1-\xi)[(1-\delta)p'_k + \omega p'_h]k' & \text{if } j = a \\ \theta\pi(x, z', k') - c_y & \text{if } j = y. \end{cases} \tag{5}$$

Default and Bankruptcy Firms are owned by the representative household. Every period, firms return dividends d to the household, with $d \geq 0$. We assume that firms default if they cannot satisfy the non-negativity constraint (e.g., Ottonello and Winberry, 2020).

As is common in this class of models, other than for the very small firms, the default risk is negligible. However, absent default risk, we cannot have a meaningful choice between asset and earnings-based debt. For this reason, we assume that default can also occur for all firms (independently of their dividend level) with an exogenous probability π_d. This assumption aligns well with our data in which financial institutions assign a positive probability of default even for the largest firms.

What happens in default depends on the type of borrowing. When borrowing is asset-based, the defaulting firm is liquidated and exits the economy. It is immediately replaced by a new entering firm so that the mass of firms remains constant. When borrowing is earnings-based, the firm continues its operations with a restructured level of equity. Our modeling choices imply that the bankruptcy process is pre-determined when the firm decides whether to issue asset-based or earnings-based debt.[17] When a firm issues asset-based debt, we assume

[17] Corbae and D'Ersamo (2021) analyze firm choices between bankruptcy procedures upon default. In their

that the bankruptcy resolution is firm liquidation, as in Chapter 7 of the bankruptcy code. When the firm issues earnings-based debt, the bankruptcy resolution is reorganization, as in Chapter 11 of the bankruptcy code. As we documented in Section 2, these choices are supported empirically. This also justifies the interpretation of c_y as the fixed cost incurred by the lenders during the re-organization process.

Note that in both asset-based and earnings-based debt, the firm continuation value is zero if default occurs. With asset-based borrowing, it is because the firm shuts down. With earnings-based borrowing, it is because the firm changes ownership which is a typical restructuring mechanism in Chapter 11 reorganizations.

Firm Exit In each period, firms may exit the economy via one of two routes. First, with an exogenous probability π_x, firms exogenously exit the economy. In this case, the firm's value is its equity. Second, as discussed above, firms who default with asset-based debt also exit the economy with value equal to zero.

Switching Costs At birth, we assume that a fraction of firms $\chi \in (0, 1)$ choose asset-based debt, while the rest choose earnings-based debt. Following this, firms are free to choose either type of borrowing, subject to stochastic switching costs. That is, suppose a firm has issues debt with collateral $j \in \{a, y\}$ this period. Next period, the firm will be free to choose the same collateral type. But switching to the other type, requires a a one-time i.i.d. switching cost $\kappa \sim \text{Logistic}(\mu_\kappa, \sigma_\kappa)$. This implies that we need to track j as a state variable. Switching costs reflect borrowing relationships that are sticky (Chodorow-Reich, 2014). For example, both asset-based and earnings-based borrowing require costly and time consuming income and balance sheet evaluations.

Timing and Firm's Optimization Problem In the beginning of the period firms learn their productivity z, and whether they have to exit exogenously or not. If they do not exit firms choose whether they default or not. If the firm does not default, it makes a discrete choice between borrowing type $j = \{a, y\}$ and a continuous choice for dividends d, capital k' (at price p_k) and the amount of debt b' (at price q_j). Instead of separately tracking firm's capital k and debt b, we track a single state variable, the firm's internal equity e. We write recursively the dynamic program of a firm, given that it has already chosen in this period borrowing type $j \in \{a, y\}$:

model lenders have an expectation over possible bankruptcy outcomes while in our case the the bankruptcy regime is predetermined. Second, in their case Chapter 11 involves debt renegotiation based on bargaining between firms and lenders while we assume an exogenous restructured level of equity. Nonetheless, in their Chapter 11 resolution, there is no reference to repayment based on firms' earnings from continuing operations, a common feature of firm re-organizations. This is a key point of our paper.

$$
\begin{aligned}
V_j(x,z,e) = \max_{d,k',b'} \; & \left\{ d + \frac{1-\pi_d}{1+r} \mathbb{E}_{z'|z} \left[\widehat{V}_j(x,z',e') \right] \right\} \\
\text{s.t.} \quad & d = e + q_j(x,z,k',b')b' - p_k k' \\
& e' = \pi(x,z',k') + (1-\delta)p_k' k' - b' - c_o \\
& d \geq 0
\end{aligned} \tag{6}
$$

where the firm's continuation value tomorrow is denoted by

$$
\widehat{V}_j(x,z',e') = (1-\pi_x)(1-\Lambda_j^c(x,z',e'))V_j^c(x,z',e') + \pi_x(1-\Lambda^x(e'))V^x(e').
$$

The continuation value can be explained as follows. First, the firm exits exogenously with probability π_x in which case the firm receives value $V^x(e') = e'$ provided equity is positive. The indicator function $\Lambda^x(e') = \mathbb{1}\{e' < 0\}$ takes the value of one if equity is negative. Second, a firm that does not exit exogenously, may choose to default on its debt. As noted earlier, the firm defaults next period if it is not feasible for the firm to issue non-negative dividends. This implies that there is a threshold for equity such that the firm defaults if $e' < \underline{e}_j(x,z')$. In this case the indicator function $\Lambda_j^c(x,z',e') = \mathbb{1}\{e' < \underline{e}_j(x,z')\}$ takes the value of one. Note that the threshold depends on current choice for borrowing type j. When the firm defaults the continuation value is zero. Finally, with probability $(1-\pi_x)(1-\Lambda_j^c(x,z',e'))$ the firm does not exit exogenously and does not default. In this case the continuation value is

$$
V_j^c(x,z',e') = \mathbb{E}_\kappa \left[\max \left(\underbrace{V_j(x,z',e')}_{\text{stay}}, \underbrace{V_{-j}(x,z',e') - \kappa}_{\text{switch}} \right) \right].
$$

Next period the firm choose between staying with borrowing type j, or switching to the other type (denoted by $-j$) and incurring the stochastic switching cost.

Households The representative household is risk-neutral and derives utility from consumption C_t and disutility from supplying H_t units of labor. Households' preferences are represented by a time-separable utility function of the form

$$
U = \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(C_t - \psi \frac{H_t^{1+\gamma}}{1+\gamma} \right) \right] \tag{7}
$$

where ψ affects the disutility from work, $1/\gamma$ is the Frisch elasticity of labor supply, and β is the household's discount factor. We assume a constant one-year real interest rate because inflation adjusted securities between 2012-2019 remain persistently low with fairly small volatility. The

household budget constraint is given by:

$$C_t + B_{t+1} = w_t H_t + (1+r)B_t + \int d(x,z,e)d\mu \ + \Pi_t^K + \Pi_t^B + T. \tag{8}$$

The household saves B_{t+1} in the financial intermediary (see below) and receives the risk-free interest rate r. The household also supplies labor H_t at the real wage w_t. The representative household owns all firms in the economy (producing goods, capital, and the financial intermediaries). The distribution of goods-producing firms over all states is denoted by μ. From these firms the households receives total dividends equal to $\int d(x,z,e)d\mu$. These dividends are provided only by the non-defaulting firms. The defaulting asset-based firms ($j = a$) give the liquidated part of capital to lenders, so it is in Π_t^B, while the part of capital not recovered by the lenders is given as a direct transfer to households, so it is part of T. The defaulting earnings-based firms ($j = y$) are transferred to the lenders who are the new owners (increase in Π_t^B) and immediately repurchased by the households (decrease in T by the same amount).

Lenders There is a representative, risk-neutral financial intermediary. Lenders take deposits B_{t+1} from the household and pay households $(1+r)B_t$. Lenders give to firms total loans equal to $\int q_a(x,z,k',b')b' + q_y(x,z,k',b')b' \ d\mu$ and receive from non-defaulting firms $\int b \ d\mu$. From the defaulting asset-based loan $j = a$ lenders recover their undepreciated capital subject to liquidation loss and from the defaulting earnings-based loans lenders recover the value of the firm (as a multiple of EBITDA) subject to bankruptcy costs. We denote all these payments to lenders as $\mathcal{R}$. Thus, profits of the lenders are given by:

$$\Pi_t^B = B_{t+1} - (1+r_t)B_t - \int \sum_j q_j(x,z,k',b')b' \ d\mu + \int b \ d\mu + \mathcal{R}.$$

The bond price is given by

$$q_j(x,z,k',b') = \frac{\phi(b'/k')}{1+r}\mathbb{E}_{z'|z}\left[1 - \Lambda_j(x,z',e'(x,z',k',b'))\left(1 - \frac{\min(R_j(x,z',k'),b')}{b'}\right)\right], \tag{9}$$

where $e'(x,z',k',b')$ is tomorrow's equity and $\Lambda_j(x,z',e') = (1-\pi_x)\Lambda_j^c(x,z',e') + \pi_x\Lambda^x(e')$. Moreover, $\phi(b/k')$ is an additional external premium that helps generate variation in loan credit spreads, defined by

$$\phi\left(\frac{b'}{k'}\right) = \frac{1}{1+\phi_1\left(\frac{b'}{k'}\right)^{\phi_2}}.$$

This premium can be rationalized based on bank regulations that restrict lending to firms with distressed balance sheet.

Capital Good Producer There is a representative capital goods producer. We assume that new capital is produced subject to adjustment costs which implies fluctuations in the price of capital in response to macroeconomic shocks (Bernanke, Gertler, and Gilchrist, 1999). Specifically, the producer purchases I_t units of the final output good and uses it, along with existing capital K_t, to produce new investment, selling it at price p_t^k. The transformation of investment and existing capital into new investment occurs through the production function $\Phi\left(\frac{I_t}{K_t}\right) K_t$. We assume

$$\Phi\left(\frac{I_t}{K_t}\right) = \frac{\delta^{1/\phi_k}}{1-1/\phi_k}\left(\frac{I_t}{K_t}\right)^{1-1/\phi_k} - \frac{\delta}{\phi_k - 1}, \tag{10}$$

where $K_t = \int k d\mu$ is the aggregate capital stock in the beginning of the period, and δ is the steady-state investment rate. Profits of a representative capital goods producer are given by:

$$\Pi_t^K = p_t^k \Phi\left(\frac{I_t}{K_t}\right) K_t - I_t.$$

Profit maximization pins down the price of capital $p_t^k = \left(\frac{I_t/K_t}{\delta}\right)^{1/\phi_k}$, which at the steady state equals one.

Equilibrium We define the stationary equilibrium of the model, which consists of a set of firm value and policy functions $\{V, k', d, b, n, j\}$, a set of household choices $\{C, H\}$, a set of market prices $\{w, r, p^k\}$, an interest rate schedule q, and a measure of firms over productivity and equity μ such that

1) The firm value and policy functions solve the firm's optimization problem;

2) Labor supply H solves the household's maximization problem;

3) The interest rate schedule q solves the lender's zero-profit condition;

4) Capital market goods clear: $\int k' d\mu = K_{t+1}$;

5) Labor market clears: $\int n d\mu = H_t$;

6) The allocation of states across firms μ evolves based on firms' policy functions and the autoregressive process for firm productivity.

3.1 Basic Mechanism in a Simpler Version of the Model

We build a simple version of our model to show how the firm determines the optimal choice of capital k' and the optimal choice between asset-based vs. earnings-based debt $j' = \{a, y\}$.

The simple model also highlights how the choice between asset-based or earnings-based debt impacts the aggregate (macro) response of investment (and correspondingly employment) to a change in the price of real estate.

In this version of the model, the production function is given by $f(z,k) = z^{1-a}k^a$ where z is stochastic idiosyncratic productivity. As in the full model, every period firms choose k' and whether to issue asset-based or earnings-based debt $j' = \{a, y\}$. However, we assume that the amount of debt is exogenous and equal to $b' = b_0$. There are no switching costs, and default can only occur exogenously with probability $\pi_d \in (0,1)$. Like in the baseline model, lenders anticipate recovery values for asset-based and earnings-based borrowing:

$$R_j(x, z', k') = \begin{cases} (1-\xi)(1-\delta)k' & \text{if } j = a \\ \theta\pi(x, z', k') - c_y & \text{if } j = y. \end{cases}$$

Notice that we have made the assumption $\omega = 0$ and $p_k = 1$. This poses no problem as an increase in the real estate price acts in the same way as an increase in the recovery value of firms' assets. Therefore, to make the comparative statics more transparent, we analyze how capital k' responds to a change in ξ. The problem of the firm is

$$\begin{aligned} V(z,e) = \max_{d,k',j} & \left\{ d + \frac{1-\pi_d}{1+r}\mathbb{E}_{z'|z} \max\{V(z', e')\} \right\} \\ \text{s.t.} \quad & d = e + q_j(z', k')b_0(j) - k' \\ & e = \pi(z,k) + (1-\delta)k - b_0(j_{-1}) \\ & d \geq 0. \end{aligned} \tag{11}$$

The first order condition for k' yields:

$$-1 + \frac{\partial q_j(z,k')}{\partial k'}b_0 + \frac{1-\pi_d}{1+r}\mathbb{E}_{z'|z}\left[\frac{\partial f(z,k')}{\partial k'} + (1-\delta)\right]$$

Lenders are risk-neutral, so we have:

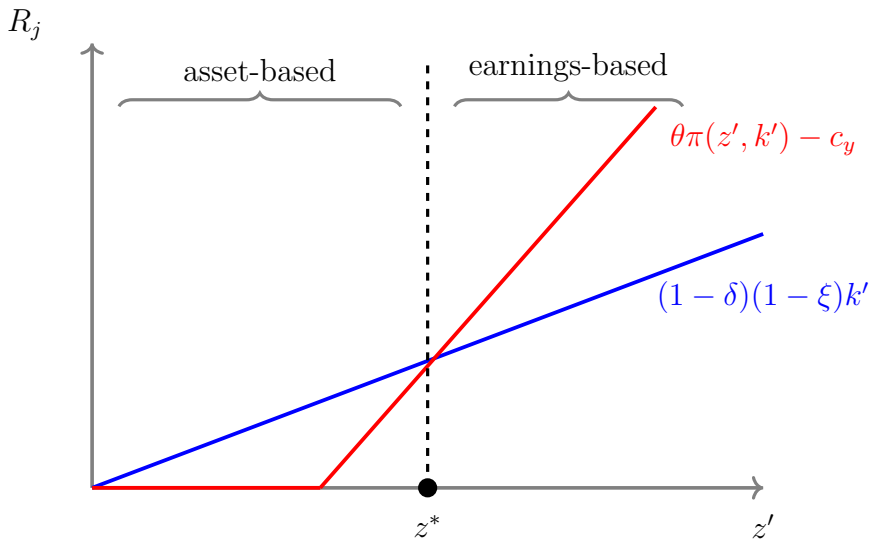
$$q_j(z', k') = \frac{1}{1+r}\left[1 - \pi_d + \pi_d \frac{\mathbb{E}_{z'|z} R_j(z', k')}{b_0}\right],$$

so that:

$$\frac{\partial q_j}{\partial k'} = \frac{1}{1+r}\frac{\pi_d}{b_0}\mathbb{E}_{z'|z}\left[\frac{\partial R_j(z', k')}{\partial k'}\right] \text{ with } \frac{\partial R_j(z', k')}{\partial k'} = \begin{cases} (1-\xi)(1-\delta) & \text{if } j = a \\ \theta\partial\pi/\partial k' & \text{if } j = y. \end{cases}$$

Plugging these expressions into the first-order condition for capital, we can derive the optimal

Figure 3: Simple illustration of Asset- versus Earnings-Based Choice



Note: Illustration of the relationship between firm productivity and recovery values under different collateral types.

choice of k' if the firm chooses asset-based debt and earnings-based debt, respectively:

$$k' = \begin{cases} \left[\frac{\alpha[(1-\pi_d)]}{r+\delta+\pi_d\xi(1-\delta)}\right]^{\frac{1}{1-\alpha}} \mathbb{E}[z'|z] & \text{if } j = a \\ \left[\frac{\alpha[(1-\pi_d)+\theta\pi_d]}{r+\delta+(1-\delta)\pi_d}\right]^{\frac{1}{1-\alpha}} \mathbb{E}[z'|z] & \text{if } j = y. \end{cases}$$

So far, we have analyzed the optimal choice of capital given the type of debt. But how is the debt type determined? In default, the maximum a lender can recover under asset-based and earnings-based borrowing is $R_a = (1-\xi)(1-\delta)k'$ and $R_y = \theta\pi(z', k') - c_y$, respectively. Therefore, a firm receives two interest rate options, one for each debt type and associated recovery value. The firm chooses the cheapest way to finance its investment. For example, it issue earnings-based debt if it is the cheaper financing choice, or equivalently $E_{z'|z}R_y(z', k') \geq E_{z'|z}R_a(k')$. Note that R_a depends on z' through k'.

Figure 3 shows the recovery payoffs for asset-based borrowing, R_a, and earnings-based borrowing, R_y, across tomorrow's productivity z'. Both recovery payoffs are increasing in z' but R_y is increasing faster than R_a. Define s_j as the slope of k' with respect to z' for $j = \{a, y\}$. Then we have $\frac{\partial R_a}{\partial z} = (1-\delta)(1-\xi)s_a^{\frac{1}{1-a}}$ and $\frac{\partial R_y}{\partial z} = \theta s_y^{\frac{a}{1-a}}$. Assuming for simplicity that $s_a = s_y$, then $\frac{\partial R_y}{\partial z} > \frac{\partial R_y}{\partial z}$ as long as $\theta > (1-\delta)(1-\xi)s_a$. Under a reasonable parameterization (also followed in our quantitative model) that sets $\theta = 4, \delta = 0.10, \xi = 0.65$, and implies $s_a \approx 1$ this condition is satisfied.

Our model implies that firms prefer to pledge their future earnings (proxied by a multiple of profits at the time of default) relative to pledging their assets. The reason not all firms are able to do so is the fixed cost c_y associated with reorganizing the firm. As a result, there is a productivity cutoff z^* determining the borrowing choice. For relatively low productivity firms $z' < z^*$ lenders would prefer to liquidate the firm's capital rather than rely on the future earnings while simultaneously incurring the fixed cost of reorganizing the firm. For firms with relatively high productivity $z' > z^*$ lenders feel comfortable relying on the firm's high future earnings instead of its capital.

An increase in the recovery value of assets (lower ξ) has the following effects. First, it decreases interest rates and expands investment for asset-based firms. Second, it increases the threshold z^* so that some marginal earnings-based firms switch to asset-based borrowing and take advantage of the lower interest rates. These two effects increase aggregate capital. Nonetheless, earnings-based firms that do not switch do not benefit. Therefore, the larger the share of earnings-based firms that do not switch to asset-based borrowing the more limited the aggregate effects are. Finally, this simple model is solved in partial equilibrium. In the next section we show that taking general equilibrium effects into account can further limit the aggregate response.

4 Quantitative Results

4.1 Calibration

In this section, we discuss the parameterization of our quantitative model. Parameter values and targets are reported in Table 5 and Table 6. The model is computed at an annual frequency. The discount factor reflects an annual risk-free rate r equal to 4%. The production function coefficient on capital $\alpha = 0.30$ and the returns to scale $\nu = 0.85$ reflect typical values in the literature (Burnside, Eichenbaum, and Rebelo, 1995; Khan and Thomas, 2013). The depreciation rate is set to $\delta = 0.10$ to match the average investment rate in our data. Accountants use a multiple of EBITDA between 3 to 4 to estimate the value of a business (Lian and Ma, 2021). Therefore, we set the valuation multiple $\theta = 3.5$ which is also relative close to the multiple of earnings used to determine maximum borrowing in loan covenants (Dreschel, 2023). According to Chaney, Sraer, and Thesmar (2012), real estate values are on average 85 percent of the value of firms' plant, property and equipment. Therefore, we set ω which represents the value of real estate over the value of capital net of real estate assets equal to 5.2. Finally, we set the exogenous default probability rate, π_d, based on the expected default of business loans. Even the loans given to the top 10 percent of firms in terms of size face a default probability equal to 2 percent.

Table 5: Externally set parameters and their values

Parameter	Notation	Value	Target / Source
Risk-free rate	r	0.04	–
Capital returns to scale	α	0.30	–
Returns to scale	ν	0.85	Burnside, Eichenbaum, and Rebelo (1995)
Depreciation rate	δ	0.10	Average i/k
Firm valuation multiple	θ	3.5	Lian and Ma (2021)
Real estate value/Capital	ω	5.2	Chaney et al. (2012)
Exogenous default prob.	π_d	0.018	Default prob. in top-10 firms by assets

Notes: Parameter values that are fixed when computing the model. Values are taken from the literature or from the financial data in Y14.

Table 6: Calibrated Parameter Values

Parameters	Notation	Value
Depreciation rate	δ	0.105
Liquidation loss	ξ	0.726
Exogenous exit rate	π_x	0.028
Exogenous default rate	π_d	0.018
External bond premium	ϕ_1	0.015
	ϕ_2	2.00
Productivity process	σ_z	0.20
	ρ_z	0.65
	σ_x	0.086
Initial capital	k_0	0.20
Fixed operating cost	c_o	0.022
Fixed cost of earnings-based debt	c_y	1.52
Initial asset-based share	χ	0.56
Switching cost probabilities	μ_κ	0.065
	σ_κ	0.001

Notes: Parameter values that are calibrated within the model. We describe in the text the statistics we used for these moments.

We calibrate the remaining parameters by targeting salient features of our data (Table 6). To make the calibration more transparent, we link each set of parameters with statistics that we find to be the most informative of their values.

The external bond premium parameters ϕ_1, ϕ_2 influence firms' cost of borrowing. Therefore, we use (i) the average credit spread, (ii) the standard deviation of credit spreads, and

(iii) the average leverage as main targets to calibrate these two parameters.

To pin down the parameters governing the stochastic process of the persistent component of the productivity process (ρ_z, σ_z), we estimate a first-order autoregressive process in log sales based on Compustat data, controlling for firm fixed effects, and target the persistence and the standard deviation of the residual. We make the assumption that the stochastic process of the persistent idiosyncratic productivity shock is similar for small and larger firms. We calibrate the fixed productivity type x based on the employment distribution in NETS. According to Table 1 the firm at the top 90^{th} percentile has 3.9 times the number of employees than the median firm. We use this statistic to calculate the dispersion in the permanent component σ_x.

A higher fixed cost of operation c_o makes default more likely and borrowing more risky. Thus, we target the average default rate in our data. The probability of exit π_x targets the average age of firms in the data. The initial capital k_0 targets the share of employment in new born firms which in the Business Dynamics Statistics is 0.35.

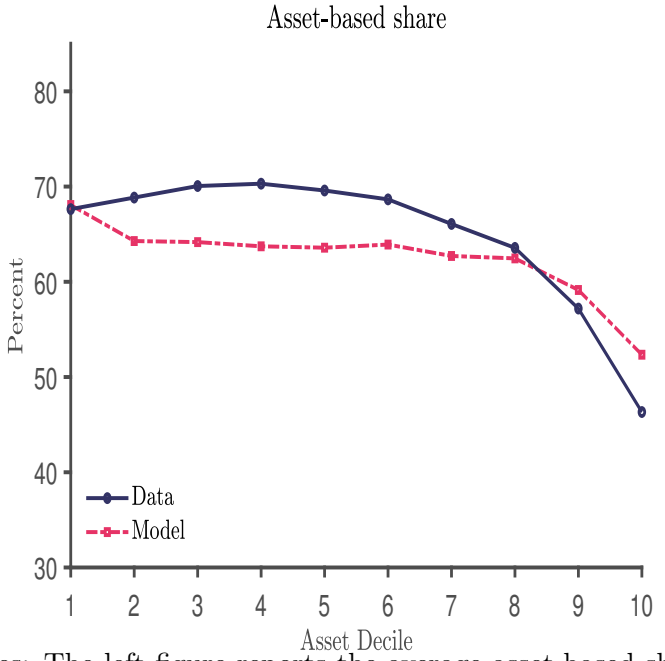
Parameter ξ reflects the loss upon default in asset-based loans. We set this parameter to match an expected recovery rate upon loss in the loans in our data equal to 35 percent. Our estimates are close to Kermani and Ma (2023) who find a recovery rate from 35 to 50 percent analyzing different assets and industries. Ottonello and Winberry (2020) use a higher value of 0.50.

It is important to capture the size-dependence in asset-based borrowing we document in the data. We use three parameters to capture the asset-based profile across asset deciles. First, the fixed cost associated with earnings-based borrowing, c_y, targets the average asset-based share of loans equal to 62 percent. Second, the initial distribution of newborns across types, χ, helps to match the asset-based share in the first decile (the younger firms). Third, the mean of the switching cost distribution μ_κ helps to match the asset-based share for the larger firms. Regarding, the dispersion of these switching costs, σ_κ, we find that the influence the standard deviation of credit spreads.

4.2 Model Fit

We evaluate how well the model represents the data by comparing selected moments in the data with those generated by the model. Figure 4 shows the share of firms that issue asset-based loans (participation) in the data and in the model. The model replicates the gradually decreasing profile across asset sizes. The model generates the negative relationship between asset-based share and size through productivity: more productive (and thus larger) firms choose earnings-based loans. The lenders feel comfortable extending these type of loans to productive firms with relatively low interest rates because in the eventuality of default the

Figure 4: Model Fit



Statistic	Model	Data
Autocorr. log (y)	0.75	0.75
SD innov. log (y)	0.50	0.50
Median i/k	0.10	0.10
SD i/k	0.37	0.38
Mean leverage	0.30	0.34
SD leverage	0.21	0.28
Mean credit spr.	1.2%	2.2%
SD credit spr.	0.8%	1.1%
Labor p90/p50	3.9	3.9

Notes: The left figure reports the average asset-based share for every asset decile in the model and the data. The right table reports selected moments from the data and the model.

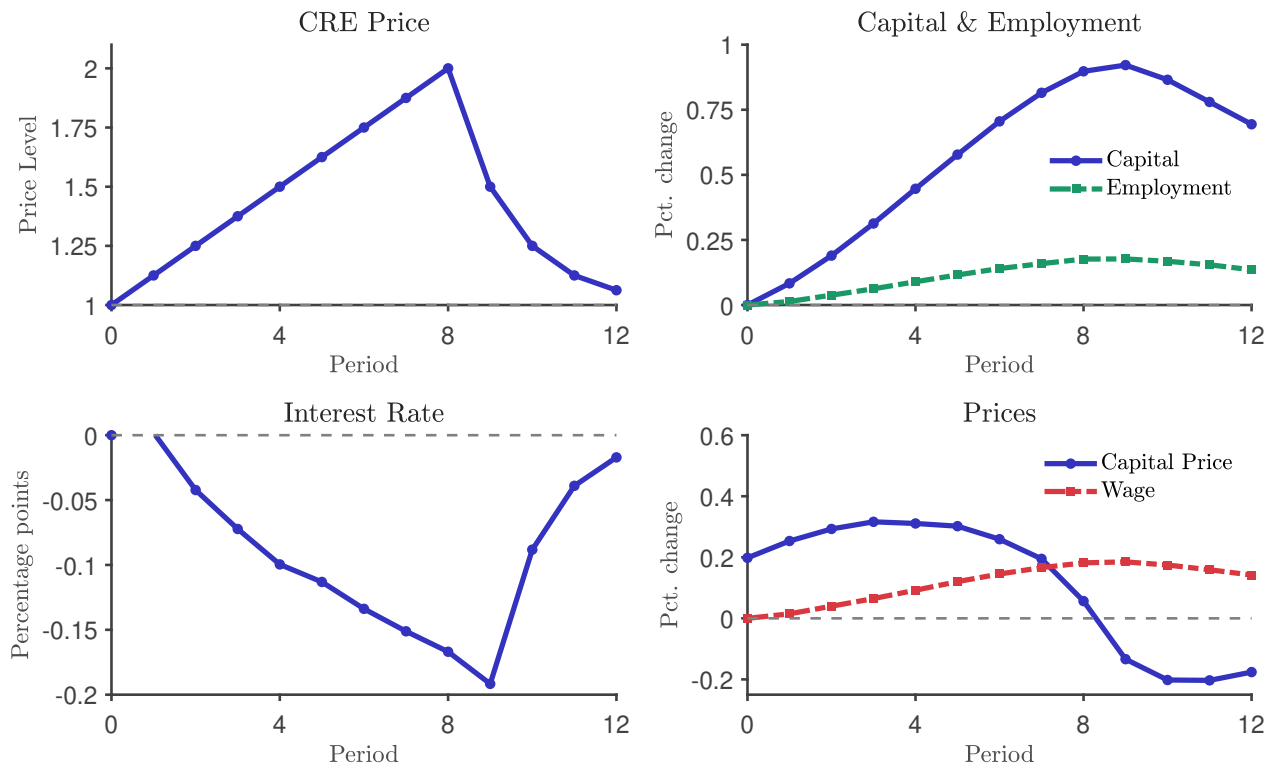
recovery rate is large relative to a case where the firm had pledged its assets. With the help of our internally calibrated parameters, especially the fixed cost of earnings-based borrowing and the average switching cost, we are able to closely match the gradual decline in the profile we document in the data.

The right Table 4 shows selected moments in the model versus the data. The model matches well with the autocorrelation and standard deviation of sales growth. The standard deviation of investment rates is 0.37 vs. 0.38 in the data. The mean credit spreads in the model is 1 percentage point lower than the data and the standard deviation of credit spreads in 0.3 percentage points lower than the data. The leverage ratio is also somewhat lower than the data as well. Finally, the model produces employment for a firm at the 90^{th} percentile versus employment at the median firm equal to 3.9 as in the data.

5 Quantifying the Effects of a CRE Price Boom

We use our model to analyze the aggregate and heterogeneous effects of the rise in commercial real estate prices between 2012-2019. Specifically, we simulate a rise in commercial real estate price in the model similar to the 2012-2019 boom and analyze (i) if the cross-sectional behavior in the model is consistent with the cross-sectional employment estimates from the data, and (ii) the aggregate effects of collateral constraints taking into account the composi-

Figure 5: Aggregate Responses to CRE Price Shock



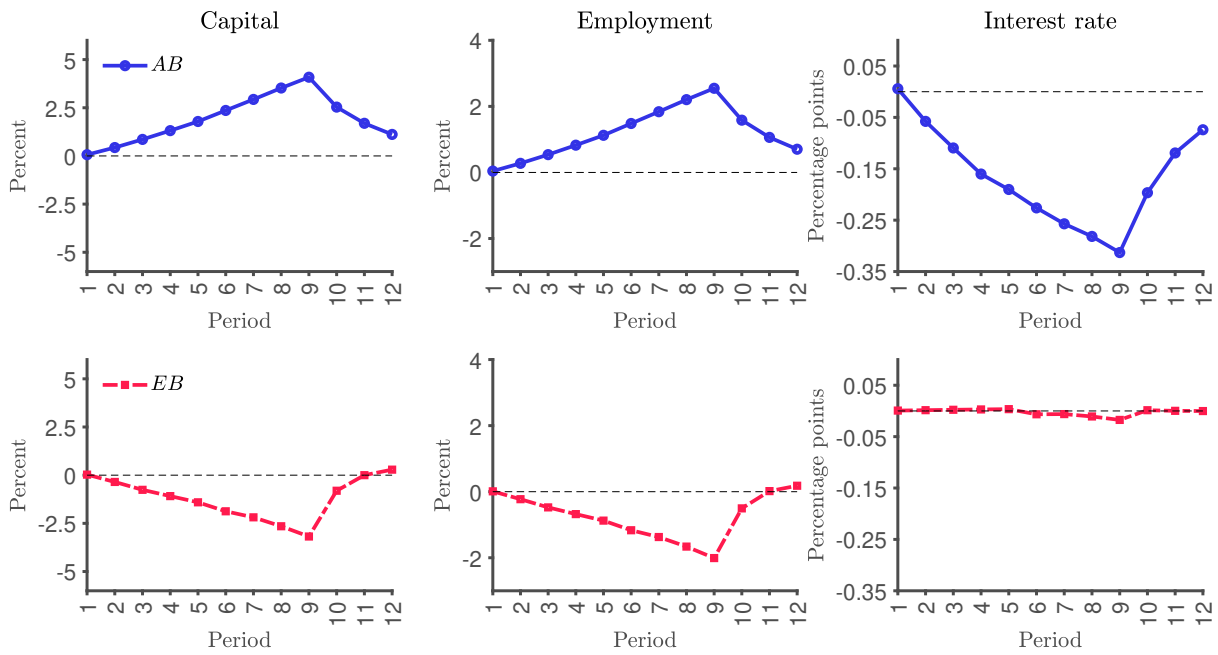
Notes: Impulse responses for main macroeconomic variables for benchmark model.

tion of firms between asset-based and earnings-based borrowing as well as general equilibrium effects.

The upper left panel of Figure 5 shows the rise in commercial real estate prices (p_h) in the model that matches the observed rise in CRE prices during 2012-2019. The rise in real estate prices is modeled as an unanticipated shock that occurs in period 2012. Once the shock occurs households, firms, and lenders can perfectly foresee the transition path of the CRE price back to the steady state. We assume that p_h declines back to the steady state according to an AR(1) process with persistence $\rho_p = 0.8$.

Figure 5 also plots impulse response functions for aggregate variables. The increase in real estate prices decreases interest rates (lower-left panel). This is the collateral channel working. With a higher value of collateral backing firm loans, lenders expand firms' borrowing at lower interest rates. With expanded borrowing capacity firms increase capital and employment (upper-right panel). Overall, capital increases by around 1 percent and employment by 0.2 percent relative to their steady state values. The larger demand for capital and labor increases the capital price and the wage (lower-right panel).

Figure 6: Model Responses to CRE Price Shock by Firm Type



Notes: Capital, employment, and interest rate responses for AB and EB firms in the model.

In Figure 6 we plot the impulse response functions for AB and EB firms separately.[18] The increase in real estate prices benefits directly AB firms that experience lower interest rates, higher capital by around 4 percent and higher employment by around 2.5 percent. Yet, the larger demand for capital and labor on behalf of AB firms increases the price of capital and the wage. As a result, EB firms are negatively impacted by the rise in CRE price. Their capital decreases by around 3 percent and their employment by around 2 percent.

Using the model-generated data we replicate the empirical research design to test how closely the model estimates align with the data. Table 7 shows the results. Although we do not explicitly target these responses, the model aligns reasonably well with the employment estimates. In the model, the estimate of employment to real estate prices is 0.05 (which can be quickly derived by looking at Figure 6 and taking the difference in the AB and EB response at period 8 when the CRE price doubles). This estimate in the data is 0.07. The model is less successful to replicate quantitatively the interest rate decline. In the model it decreases by 0.020 percentage points while it decreases by 0.077 percentage points in the data.

[18] As in the data, we track the same set of firms over time that operate continuously during the real estate price boom. We also make sure that firms do not switch type, i.e., AB (EB) firms remain AB (EB) firms during the transition.

Table 7: Employment Responses in AB vs. EB firms: Model vs. Data

$AB \times$ CRE prices	Data	Model
Employment	0.07	0.05
Interest rate ($\times$ 100)	-0.77	-0.20

Notes: The table compares estimates of regression in the model versus the data for employment and interest rates.

5.1 Inspecting the Aggregate Employment Response

In response to the rise in CRE prices, AB firms increase their employment by around 2 percent in period 8. However, EB firms decrease their employment by almost the same amount. As a result, aggregate employment increases by only 0.2 percent.

The aggregate effects of collateral constraints are smaller than estimated by the cross-sectional responses for two reasons. First, AB firms demand more capital and labor, increase the price of capital and the wage, and crowd out capital and labor demand for EB firms. These general equilibrium effects are missed in cross-sectional studies of the collateral channel (see for example, Chaney, Sraer, and Thesmar, 2012; Adelino, Schoar, and Severino, 2015; Bahaj, Foulis, and Pinter, 2020).

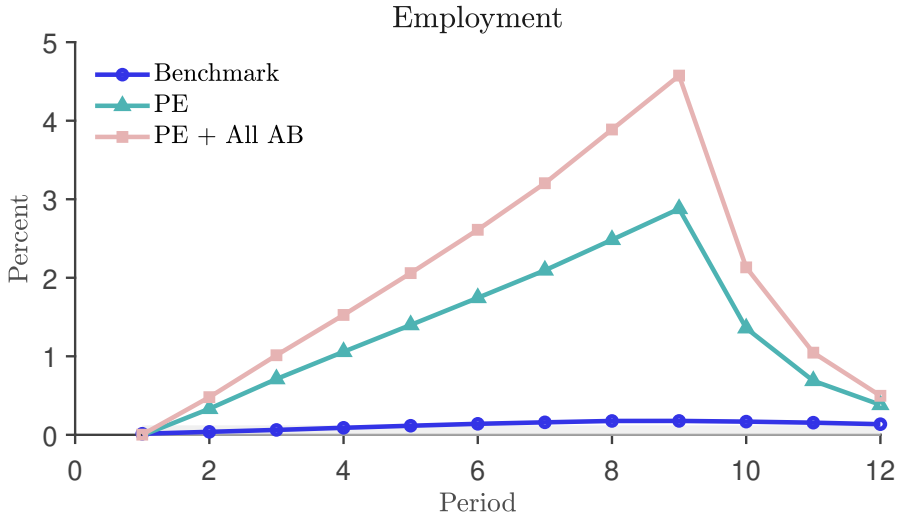
Second, the aggregate change depends on the relative employment share of AB vs. EB firms. According to our calibrated model employment in AB firms is 55 percent of the total. Since employment is almost equally shared between AB and EB firms the opposing movements in employment almost cancel out.

This is where our model differentiates from existing general equilibrium models with collateral constraints. In these class of models, typically only asset-based borrowing is available (e.g., Khan and Thomas, 2013; Ottonello and Winberry, 2020; Catherine et al., 2022). Therefore, a positive real estate price shock benefits all firms in the economy. In contrast, in our model a rise in CRE prices (i) benefits only half of the economy and (ii) negatively impacts the other half through general equilibrium effects.

We quantitatively evaluate the role of (i) endogenous selection into borrowing types and (ii) general equilibrium by considering two alternative versions of the benchmark model. In the first model, we shut down the general equilibrium responses and leave the capital price and the wage rate at their steady state level (partial equilibrium model, or "PE"). In the second model, we maintain the partial equilibrium assumption and at the same time we force

all firms to select into asset-based debt. Figure 7 shows the results.

Figure 7: Decomposition of Employment Responses



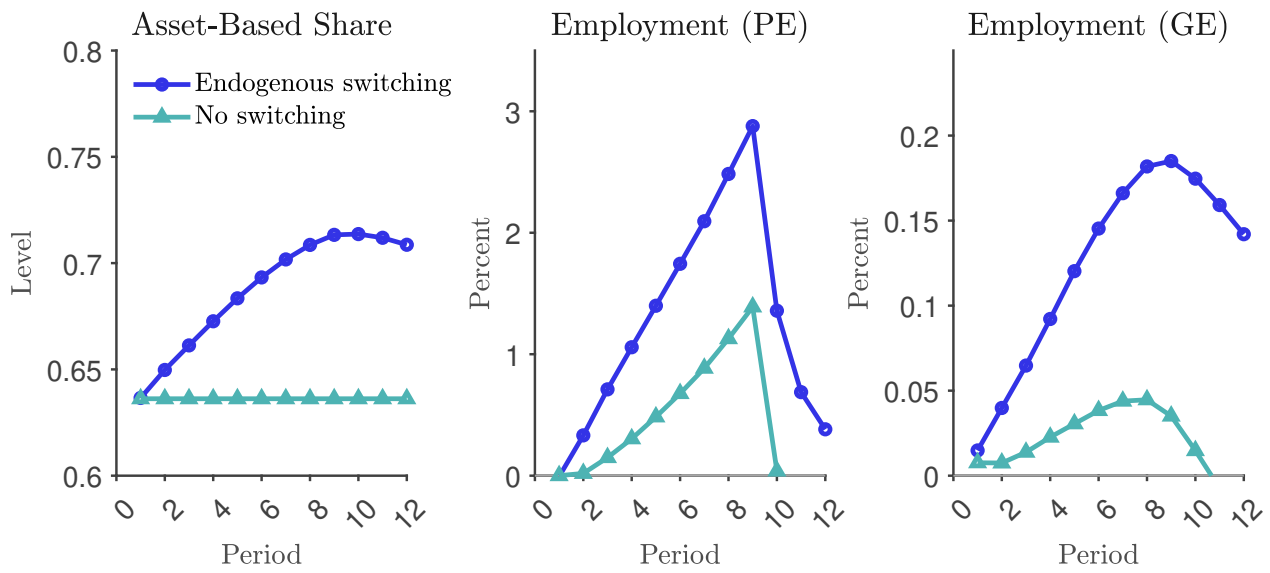
Notes: Decomposition of employment responses in baseline mode, partial equilibrium model, and model with all firms issuing asset-based borrowing.

In partial equilibrium, employment increases by 2.5 percent in response to CRE price increase. When we force all firms to issue asset based debt, employment increases by around 5 percent. This is about the same as our cross-sectional employment response. Overall, the aggregate effects of collateral constraints are smaller than suggested by either (i) cross-sectional responses and (ii) models without heterogeneity in asset-based borrowing. General equilibrium effect dampen the response by about half while the composition of firms into asset-based and earnings-based dampen the response by almost a half as well. We conclude that the combination of earnings-based firms in the model and general equilibrium effects can substantially mitigate the impact of a financial shock.

5.2 The Role of Endogenous AB vs EB Choice

When asset prices rise, a larger share of firms endogenously choose asset-based borrowing over earnings-based borrowing. The left panel in Figure 8 shows that in response to the CRE price shock, the average asset-based share increases from 63 percent to around 72 percent. To understand the role of endogenous choice in asset-based versus earnings-based borrowing we consider an alternative model where firms are not allowed to switch during the transition ("No Switching" model). We achieve this by setting the switching cost to a large value during the transition period.

Figure 8: The Role of Endogenous Choice



Notes: The benchmark model allows for endogenous choice between asset-based and earnings-based borrowing. The "no switching model" imposes a high transition cost during the the periods of the price shock to keep firms at their steady state selection of asset-based or earnings-based borrowing.

The left panel in Figure 8 shows that in this model, the average asset-based share does not respond to the CRE price shock and remains at 63 percent. The middle and right panel in Figure 8 shows the aggregate employment response in the Benchmark model and the "No Switching" model for partial equilibrium and general equilibrium, respectively.

Endogenous switching plays an important role in amplifying the employment response. Firms that switch from earnings-based to asset-based borrowing are relatively productive. The decrease in their interest rates allows these firms to increase their employment. Without switching the partial equilibrium employment response 8 periods ahead of the shock is 1.3 percent versus 2.8 percent in the benchmark while the general equilibrium employment response is 0.04 percent versus 0.2 percent in the benchmark.

Therefore, modeling the distinction between asset-based and earnings-based borrowing as exogenous underestimates the effects of collateral constraints by missing the endogenous switching response: many firms shift to asset-based borrowing when collateral constraints relax, amplifying the aggregate effect.

6 Conclusion

We revisit the effect of collateral constraints using a general equilibrium, heterogeneous firms models with an endogenous decision between asset-based and earnings-based borrowing. We discipline our structural model combining administrative financial data on business loans from Y14 reports combined with firm-level employment data from NETS.

First, we document that about 62 percent of firms borrow by pledging assets as collateral and it is the smaller, younger, and riskier firms that predominantly rely on asset-based borrowing. Second, we analyze firm employment responses during the 2012-2019 commercial real estate price boom. We show that expansions in commercial real estate prices disproportionately benefit firms that borrow against their assets relative to similarly located firms that borrow against their earnings. Our model replicates quantitatively these two key patterns in the data.

The aggregate effects of collateral constraints are small for two reasons. First, the asset-based borrowing firms represent a smaller part of economic activity. Second, expansions in credit and employment are offset from general equilibrium effects. We find that each of these channels have quantitatively similar role in dampening the aggregate employment response.

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Appendix: For Online Publication

A Empirical Analysis

A.1 NETS data

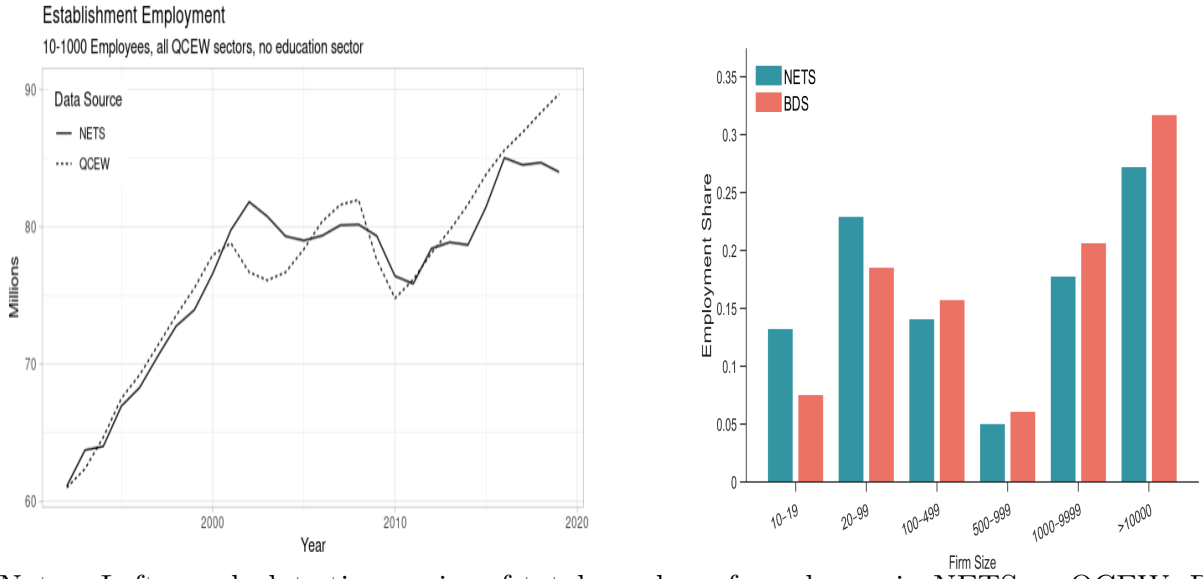
We provide more details about the National Establishment Time Series (NETS) data which is a survey conducted by Dunn & Bradstreet. The data are sold to third-parties which implies an incentive to compile data accurately. Nonetheless, individual businesses' may not report accurately their employment. NETS contains annual data on firm-linked, private U.S. establishments. Establishments are defined as a specific line of business at a specific location within a firm. Additional establishment-level data include employment, street address, zip code, a 6-digit NAICS industry code, and a headquarter ID that links establishments to the firm-level and to the headquarter establishment within the firm. Because NETS often includes business owners in its count of employees, we subtract one from the employment count at each headquarter establishment. Establishments are further characterized by size: small-sized establishments are those with less than 10 employees; medium-sized establishments are those with 10 - 1000 employees, inclusive; and large-sized establishments are those with greater than 1000 employees.

Following Barnatchez, Crane, and Decker (2017) we assess the quality of NETS data and compare it to official data. First, we compare NETS to the Quarterly Census of Employment and Wages (QCEW) which includes employment data for million of establishments based on administrative records of state unemployment insurance programs. In order to match the QCEW's definition of "lines of business", NETS establishments are grouped and merged if they have the same headquarter, 6-character street address, and zip code. Employment at these establishments is summed and the NAICS code of the headquarter establishment or the establishment with the most employees is kept. Second, we compare the distribution of employees across establishment sizes using the Business Dynamics Statistics (BDS) data which is an annual data collected by the Census that tracks dynamics at the establishment level.

Barnatchez, Crane, and Decker (2017) find that measurement error in employment data arises from a high level of imputation at small and large sized establishments as well as the education industry (NAICS 61). Following their findings we exclude from the sample businesses with fewer than 10 employees.[19] The left panel in Figure A-1 compares total employment count between NETS and QCEW data. Within the sample we are looking NETS data compare well with official data. Employment rises until early 2000 and declines in two recessionary episodes of 2001 and 2008. For the period of our analysis NETS data track well official data until 2016 but diverge for the last three years. The right panel in Figure A-1 compares the share of establishments by employee size in NETS and BDS. NETS data has more density on relatively smaller establishments (below 100 employees) but overall captures reasonably the distribution of establishments across size.

[19] We also exclude in establishments in the religion, agriculture industry, and education.

Figure A-1: Comparison of NETS with official data: QCEW and BDS



Notes: Left panel plots time series of total number of employees in NETS vs QCEW. Right panel plots share of employment by firm size.

A.2 Financial Data

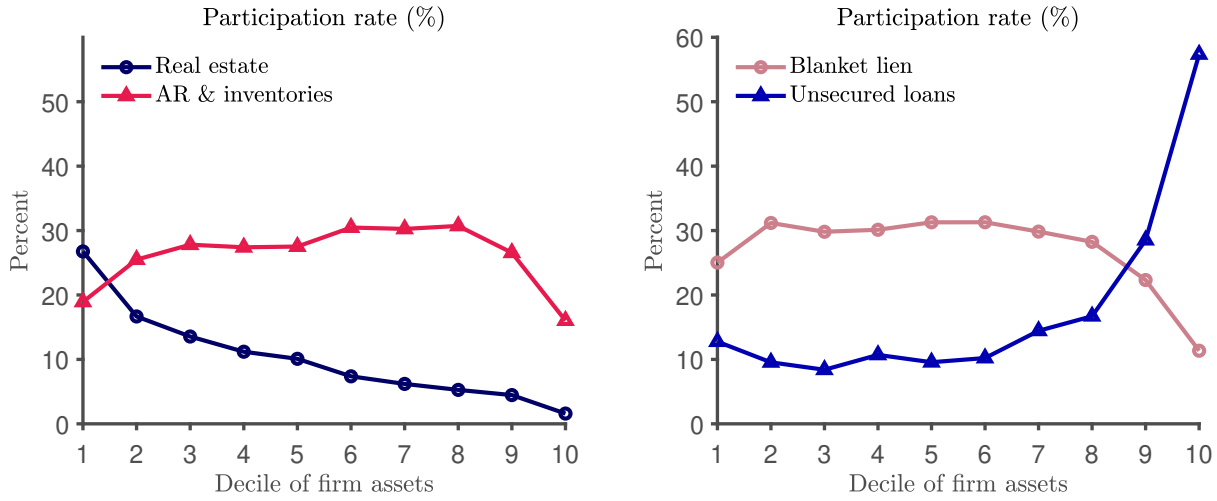
In the left panel of Figure A-2 we report the fraction of firms selecting into asset-based loans by pledging real estate as well as accounts receivables and inventories. The right panel of Figure A-2 reports the fraction of firms selecting into earnings-based loans using a blanket lien or issuing unsecured loans. The overall decreasing shape of participation into asset-based loans arises from specific types of loans: as firms grow larger they substitute away from loans pledging real estate into unsecured loans. Both accounts receivable and inventories and blanket lien don't feature a clear or strong pattern with respect to firm size.

In addition, we analyze if there is substantial differences in the asset-based and earnings-based mix across industries. In Table A-2 we report the minimum industry and the maximum industry share and participation for each category. With regards to the issuance share there is relatively more variation in accounts receivable and inventories, blanket lien, and unsecured debt across industries. For participation there is relatively more variation in unsecured debt across industries. Overall, the range of share and participation across industries is not substantial.

Our sample from the Federal Reserve Y-14Q data (henceforth, Y-14) includes 173,901 loans and 88,700 firms. The share of these firms that also appear at the NETS data is relatively limited around 10 percent. As a result, when me merge our sample with employment data from the National Employment Time-Series (NETS) the number of firms reduces to 8,000 firms. The basic financial facts regarding asset- and earnings-based borrowing are computed based on the broader sample of firms. Thus, we explore in this section if the main statistics when we focus on the merged sample with smaller number of firms.

Table A-2 describes the loan contracts we observe in the merged sample. Average participation

Figure A-2: Participation into Asset- and Earnings-based Loans



Notes: Participation into asset-based and earnings-based categories across asset size. We rank firms by asset size and compute the share of firms that pledge real estate and accounts receivable and inventories (left panel) and the share of firms that use a blanket lien or take unsecured loans (right panel).

Table A-1: Asset- vs Earnings-Based Loans: Industry Variation

Type of borrowing	Share Min/Max	Participation Min/Max
Asset-based borrowing (AB)		
Real estate	0.04-0.05	0.13-0.16
Accounts receivable	0.19-0.24	0.22-0.26
Cash securities	0.01-0.03	0.01-0.02
Fixed assets	0.05-0.07	0.12-0.15
Other collateral	0.07-0.11	0.05-0.09
Earnings-based borrowing (EB)		
Blanket lien	0.22-0.28	0.20-0.22
Unsecured	0.29-0.36	0.10-0.15

Notes: Assignment of loans into asset-based borrowing and earnings-based borrowing. For every category we report the average per issue, the fraction of loans that belong to the category (participation) and the share of borrowing in each category relative to total borrowing.

in the merged sample is similar to the broader sample and equal to 62 percent. The asset-based share is 50 percent in the merged sample versus 44 percent in the broader sample. Figure **??** plots

how many firms participate into asset-based loans and the average asset-based share of borrowing, across asset deciles based on the merged sample. The negative relationship between participation in asset-based borrowing and firm size remains intact. However, the relationship is less pronounced with respect to average asset-based share.

Table A-2: Classification of Loans: Asset- vs Earnings-Based in Merged Sample

Type of borrowing	Average amount per issue ($ mil.)	Share (%)	Participation (%)
Asset-based borrowing (AB)			
Real estate	4.84	5.18	14.6
Accounts receivable	13.7	24.3	24.3
Cash securities	17.8	2.7	1.9
Fixed assets	5.54	5.9	14.1
Other collateral	20.4	10.8	6.7
Earnings-based borrowing (EB)			
Blanket lien	11.2	21.1	25.8
Unsecured	32.0	29.6	12.3

Notes: Assignment of loans into asset-based borrowing and earnings-based borrowing. For every category we report the average per issue, the fraction of loans that belong to the category (participation) and the share of borrowing in each category relative to total borrowing.

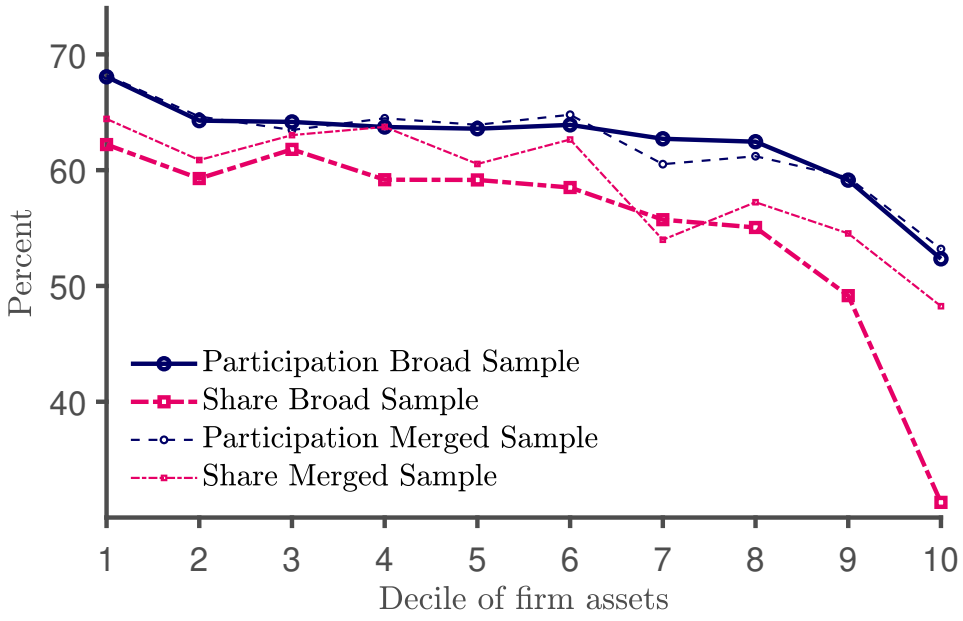
A.3 Bankruptcy Filings and Covenants

The choice of collateral type, e.g., asset-based versus earnings-based collateral, is closely connected to the Chapter under which the borrower would be resolved in the event of default. For example, earnings-based loans are typically undertaken by larger firms that can efficiently reorganize in the event of default. We show this relationship using bankruptcy data. Specifically, we analyze the share of Chapter 7 versus Chapter 11 bankruptcies across asset deciles. Smaller firms (that rely more heavily on asset-based debt) typically file for liquidation under Chapter 7 of the Bankruptcy code. Larger firms (that rely relatively more on earnings-based debt) typically file for reorganization under Chapter 11. We use this empirical evidence to support our model choices in the structural model.

We obtain information on covenants using Thomson Reuters Dealscan data. (see also Chodorow-Reich and Fallato, 2022, Dreschel, 2023). Loan covenants is a common feature of financial contracts and can be related to firms earnings or firms' assets.

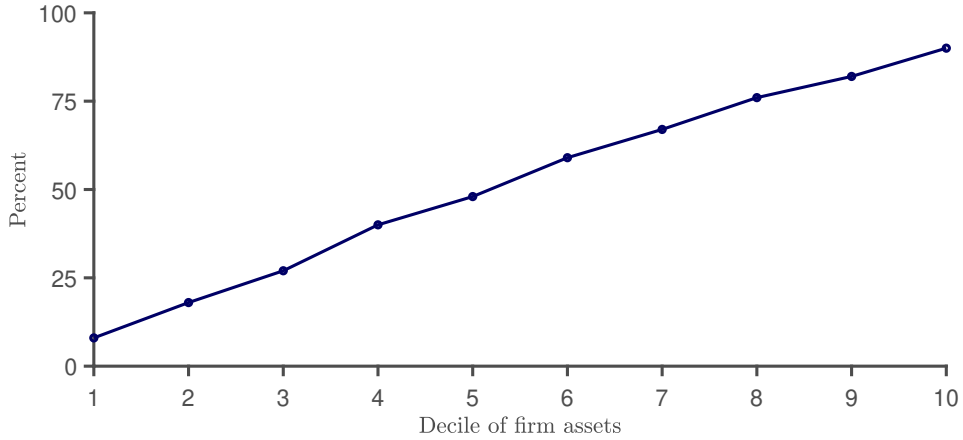
We classify the following covenants as earnings-based: interest coverage ratio, fixed charge cov-

Figure A-3: Asset Based Share and Firm Size: Broad vs. Merged Sample



Notes: Asset-based borrowing across asset groups. We rank firms by asset size and compute (i) the share of firms that take out an asset-based loan (participation) and the average loan amount of asset-based loans relative to total borrowing.

Figure A-4: Bankruptcy Filing by Asset Size



NOTE: Share of bankruptcies into Chapter 7 versus Chapter 11 by asset. SOURCE: WRDS FJC Bankruptcy and the authors' construction.

erage ratio, debt to cash flow, senior debt to cash flow, cash interest coverage ratio, and debt service coverage ratio. The asset-based covenants are debt to equity ratio, debt to tangible net worth, leverage ratio, and loan to value ratio. From the loans that are classified as earnings-based in the Y14 we

have 25 percent with information about covenants. 17 percent have also an earnings-based covenant while 7 percent has an asset-based covenant. From the loans that are classified as asset-based in the Y14 we have 13 percent with information about covenants. 9 percent have an earnings-based covenant while 1 percent has an asset-based covenant.

Loan covenants is a common feature of financial contracts and can be related to firms earnings or firms' assets (e.g., Chodorow-Reich and Fallato, 2022, Dreschel, 2023). Our goal is to understand if the earnings-based loans in our sample are connected to covenants related to firm's assets. In that case, an improvement of asset values may benefit the firm by relaxing the covenant restriction. We use loan information from Thomson Reuters Deaslcan data that includes information about covenants. Merging the Dealscan loans with the Y14 we have 20 percent of loans that include information about covenants. We classify the following covenants as earnings-based: interest coverage ratio, fixed charge coverage ratio, debt to cash flow, senior debt to cash flow, cash interest coverage ratio, and debt service coverage ratio. The asset-based covenants are debt to equity ratio, debt to tangible net worth, leverage ratio, and loan to value ratio. From the loans that are classified as earnings-based in the Y14 we have 25 percent with information about covenants. 17 percent have also an earnings-based covenant while 7 percent has an asset-based covenant. From the loans that are classified as asset-based in the Y14 we have 13 percent with information about covenants. 9 percent have an earnings-based covenant while 1 percent has an asset-based covenant.