Anatomy of Corporate Borrowing Constraints*

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March 1, 2018

Abstract

A common perspective in macro-finance analyses links firms' borrowing constraints to the liquidation value of physical assets firms pledge as collateral. We empirically investigate borrowing by non-financial firms in the US. We find that 20% of corporate debt by value is collateralized by specific physical assets ("asset-based lending" in creditor parlance), while 80% is based predominantly on cash flows from firms' operations ("cash flow-based lending"). In this setting, a standard form of borrowing constraint restricts a firm's total debt as a function of cash flows measured using operating earnings ("earnings-based borrowing constraints," or EBCs). The features of corporate borrowing illuminate how financial variables affect firms' borrowing constraints and outcomes on the margin. First, with cash flow-based lending, cash flows in the form of operating earnings directly relax EBCs, and enable firms to both borrow and invest more. Second, as corporate borrowing overall does not rely heavily on physical assets such as real estate, firms could be less vulnerable to collateral damage from asset price shocks, and fire sale amplifications may be mitigated. In the Great Recession, for example, property value declines did not trigger a deleveraging cycle among major US non-financial firms due to collateral damage. Finally, results in the US contrast with those in Japan, where corporate borrowing historically emphasizes physical assets.

*We are grateful to Daron Acemoglu, Marios Angeletos, Ricardo Caballero, Emmanuel Farhi, Fritz Foley, Xavier Gabaix, Ed Glaeser, Robin Greenwood, Sam Hanson, Bengt Holmstrom, Victoria Ivashina, Amir Kermani, James Poterba, David Scharfstein, Jose Scheinkman, Andrei Shleifer, Alp Simsek, Jeremy Stein, David Thesmar, Ivan Werning, Chunhui Yuan, Yao Zeng, and seminar participants at Columbia, Harvard, and MIT for very helpful suggestions. We are also thankful to finance and legal professionals Sarah Johnson, Christopher Mirick, Andrew Troop, Marc Zenner, and especially Kristin Mugford for sharing their knowledge. Please click here for the Internet Appendix. First draft: May 2017.

1 Introduction

Borrowing constraints of firms play a critical role in macroeconomic analyses with financial frictions. What determines these borrowing constraints? In some work, firms' borrowing depends on cash flows from operations and investment (Townsend, 1979; Stiglitz and Weiss, 1981; Holmstrom and Tirole, 1997). More recently, the spotlight fell on the liquidation value of physical assets that firms can pledge as collateral (Hart and Moore, 1994; Shleifer and Vishny, 1992; Kiyotaki and Moore, 1997; Bernanke, Gertler, and Gilchrist, 1999; Brunnermeier and Sannikov, 2014). As the Great Recession inspires growing interest in macro-finance modeling, a key question is what types of constraints apply and in what setting?

In this paper, we collect detailed data and empirically investigate borrowing by non-financial firms in the US. We show two features of corporate borrowing given the legal infrastructure in the US. First, US large non-financial firms primarily borrow based on cash flows from operations ("cash flow-based lending" in creditor parlance), rather than the liquidation value of physical assets ("asset-based lending"). Second, with cash flow-based lending, a standard form of borrowing constraint restricts a firm's total debt as a multiple of a specific measure of cash flows, namely operating earnings.[1] We refer to this type of constraint as "earnings-based borrowing constraint" or EBC.

Building on the features of corporate borrowing, we then study how different financial variables affect firms' borrowing constraints and outcomes on the margin. First, with cash flow-base lending, cash flows in the form of operating earnings relax EBCs, and enable firms to borrow and invest more. This effect is only present when cash flow-based lending prevails and EBCs apply. The mechanism also points to a new channel for firms' investment sensitivity to cash flows, one that arises from cash flows' direct impact on borrowing constraints, rather than effects on internal funds. Second, as corporate borrowing does not rely heavily on physical assets, large US firms' sensitivity to collateral value, such as the value of real estate assets, could be diminished. This low sensitivity may dampen asset price feedback type of financial acceleration through firms' balance sheets (Kiyotaki and Moore, 1997; Bernanke, Gertler, and Gilchrist, 1999). In the Great Recession, for instance, property price drops did not have a detectable impact on major non-financial firms' borrowing and investment through collateral damage. Finally, results in the US reverse in Japan, where corporate borrowing historically emphasizes physical assets (particularly real estate) given different legal environments and lending traditions.

We begin by assembling detailed data on corporate debt, which integrates information from a number of databases (e.g. CapitalIQ, FISD, SDC, DealScan, ABL Advisors, Compustat, Flow of Funds, SBA, Call Reports) and from hand collected data. The first part of our

[1] In particular, earnings before interest, taxes, depreciation, and amortization (EBITDA), over the past twelve months. In this paper, we use the term "operating earnings" to refer to EBITDA.

data focuses on the collateral structure of debt, which covers individual debt for the majority of public non-financial firms since 2002, as well as aggregate estimates for the non-financial corporate sector. The second part of our data focuses on debt limit requirements and sources of these restrictions. The data helps us establish two main facts that point to the central role of cash flows in corporate borrowing in the US.

First, borrowing against cash flows accounts for the majority of US non-financial corporate debt. Specifically, 20% of corporate debt is collateralized by specific physical assets (e.g. real estate, inventory, equipment, receivables, what creditors usually refer to as "asset-based lending"), both in terms of aggregate dollar amount outstanding and for a typical large non-financial firm (assets above Compustat median). The remaining 80% is not tied to specific physical assets, and creditors' payoffs (in both ordinary course and bankruptcy) are driven by cash flows from continuing operations (what creditors refer to as "cash flow-based lending").[2] The composition of corporate debt suggests that the liquidation value of physical assets might not be the defining constraint for large US firms.

Second, borrowing constraints commonly rely on a specific measure of cash flows. They stipulate that a firm's total debt or debt payments cannot exceed a multiple of EBITDA (earnings before interest, taxes, depreciation and amortization) in the past twelve months. These EBCs restrict total debt at the firm level, rather than the size of a particular debt contract. A primary source of EBCs is financial covenants in cash flow-based loans and bonds. Those in loans monitor compliance on a quarterly basis, so the constraint is relevant not just for issuing new debt, but also for maintaining existing debt. Among large public non-financial firms, around 60% have earnings-based covenants explicitly written in their debt contracts. Given contracting constraints, creditors focus on current EBITDA as a principal metric of cash flow value, which is informative as well as observable and verifiable.

Corporate borrowing based on cash flows is not always the norm. Its feasibility and practicality rely on legal infrastructure (e.g. accounting, bankruptcy laws, court enforcement) and on firms generating sufficient cash flows. Once these conditions are met, cash flow-based lending can be more appealing than pledging specific assets, as most corporate assets are specialized, illiquid, or intangible. These factors shape several variations across firm groups, which we revisit later to examine firm behavior under different forms of corporate borrowing. First, cash flow-based lending is less common among small firms, given their low profits (if not sustained losses) and higher likelihood of liquidation: for small public firms, the median share of cash flow-based lending is less than 10%; fewer than 15% of small firms are subject to earnings-based covenants. Second, cash flow-based lending and EBCs are similarly less

[2]The physical assets in asset-based lending are analogous to "land" in Kiyotaki and Moore (1997). Cash flows from firms' operations in cash flow-base lending are analogous to "fruit" in Kiyotaki and Moore (1997). Bankruptcies for cash flow-based debt are primarily resolved through Chapter 11, which focuses on going concern cash flow value instead of liquidation value of specific physical assets.

prevalent among low profit margin firms. Third, while cash flow-based lending dominates in large firms across most industries, airlines and utilities are two exceptions, where firms have a substantial amount of standardized transferable assets (aircraft and power generators) and a significantly higher share of asset-based lending.[3] Finally, the predominant form of corporate borrowing may vary across countries given differences in institutional environments, which we illustrate using the example of Japan.

After documenting the key features of corporate borrowing based on debt contracts, we further investigate how these features shape the way different financial variables affect firms' borrowing constraints and outcomes on the margin. To begin, with cash flow-based lending and EBCs, cash flows in the form of operating earnings directly relax borrowing constraints, and enable firms to both *borrow* and invest more. This mechanism offers a new perspective for the role of financial variables, which is distinct from the influence of physical collateral commonly studied in the macro-finance literature.

We first analyze this mechanism in a baseline regression following traditional investment regressions, with a few modifications. First, we study debt issuance as the outcome variable to investigate the response of borrowing, and then proceed to investment activities. Second, we focus on the role of operating earnings (EBITDA), which directly enter the borrowing constraints. Third, we start with firms where cash flow-based lending and EBCs are most important, specifically large firms with earnings-based covenants, and then analyze several firm groups where EBCs are less relevant. We find that among large firms with EBCs, all else equal, a one dollar increase in EBITDA is on average associated with a 27 cents increase in net long-term debt issuance. Investment activities increase by about 15 cents. These patterns do not exist among other firm groups not bound by EBCs (e.g. unconstrained firms and firms that primarily use asset-based lending, such as small firms, low margin firms, airlines and utilities, Japanese firms, etc.). The set of results across different firm groups is not easy to account for based on standard empirical concerns, which we discuss in detail.

We supplement the baseline test with a natural experiment that contributes to exogenous variations in operating earnings (EBITDA), due to changes in an accounting rule (Financial Accounting Standards Board's rule SFAS 123(r)). Before the adoption of this rule, firms' option compensation expenses do not formally count towards earnings, while the new rule requires their inclusion. Thus the rule affects the calculation of operating earnings, but does not directly affect firms' cash positions or economic fundamentals. As prior research demonstrates, contracting frictions make it hard to neutralize changes in accounting rules, and they tend to have a significant impact on borrowers through debt covenants (Frankel, Lee, and McLaughlin, 2010; Moser, Newberry, and Puckett, 2011; Cohen, Katz, and Sadka, 2012; Shroff, 2017). We instrument operating earnings after the adoption of SFAS 123(r),

[3]The high share of asset-based lending in airlines is consistent with Benmelech and Bergman (2009) and Benmelech and Bergman (2011), who thoroughly analyze the collateral channel in this industry.

using average option compensation expenses in three years prior to the rule announcement. We find strong first-stage results among all firm groups, but only second stage results on debt issuance and investment for firms bound by EBCs. The findings attest to the influence of operating earnings on borrowing constraints and firm outcomes on the margin.

The analysis of earnings-based borrowing constraints also points to a new channel for investment sensitivity to cash flows. It contrasts with the traditional framework in corporate finance analyses (Fazzari, Hubbard, and Petersen, 1988; Froot, Scharfstein, and Stein, 1993; Kaplan and Zingales, 1997): following the pecking order idea (Myers and Majluf, 1984), the main function of cash flows is to increase internal funds, which boost investment but *substitute out* external financing as long as investment has diminishing marginal returns. With cash flow-based lending and EBCs, however, cash flows in the form of operating earnings can directly relax borrowing constraints and crowd in external borrowing.[4]

While lending practices in the US contribute to the sensitivity of corporate borrowing and investment to cash flows (especially earnings), they may diminish the sensitivity to the value of physical assets such as real estate (which accounts for only 7% of US non-financial corporate debt by value). Using both traditional estimates of firm real estate value and hand collected property-level data from company filings, we find that US large non-financial firms' borrowing has relatively small sensitivity to real estate value, concentrated in asset-based debt. For cash flow-based debt, the sensitivity is absent, if not negative and offsetting the response of asset-based debt. Overall, borrowing increases by three to four cents on average for a one dollar increase in property value, consistent with findings by Chaney, Sraer, and Thesmar (2012). The magnitude is considerably smaller than the impact of operating earnings among US large firms.

This observation helps understand aspects of the Great Recession and the transmission of property value declines in this crisis. By exploiting firms' differential exposures to property price declines, we do not find that the drop in the value of real estate assets had a significant impact on borrowing and investment.[5] Such diminished sensitivity may decrease the scope of asset price feedback type of financial acceleration through firms' balance sheets. Meanwhile, the decline in corporate earnings did have a significant impact through EBCs, which accounts for roughly 10% of the drop in debt issuance and capital expenditures among public firms from 2007 to 2009. The magnitude is meaningful but not catastrophic, in line with the view that the US Great Recession is a crisis centered around households and banks rather than

[4]This observation may also provide a new perspective for the debate about whether more constrained firms are more sensitive to cash flows (Kaplan and Zingales, 1997, 2000; Fazzari, Hubbard, and Petersen, 2000): among plausibly more constrained small firms, cash flow-based lending and EBCs are uncommon, which removes one possible channel of cash flow sensitivity (if cash flows are measured based on earnings, which is typical in the literature).

[5]Our result is consistent with indirect evidence from Mian and Sufi (2014) and Giroud and Mueller (2017), and with their proposition that the main effect of the property price collapse was to impair household demand.

major non-financial firms.[6]

The story in the US finds its antithesis in Japan. Unlike the US where cash flow-based lending prevails, Japan historically lacked legal infrastructure for such lending practices, and instead developed a corporate lending tradition focused on physical assets, especially real estate. We show that Japanese firms do not display sensitivity of debt issuance to operating earnings. Japanese firms are, however, very sensitive to declines in the value of real estate assets during the Japanese property price collapse in the early 1990s. Gan (2007) shows the drop in Japanese firms' property value had a substantial and long-lasting impact on their borrowing and investment. Using the specification of Gan (2007), we do not find similar results among US firms during the Great Recession. Recognizing the differences in institutional environments and corporate borrowing practices helps synthesize distinct evidence across different countries.

The domain of our study is *non-financial corporations*. Financial institutions' borrowing constraints may take different forms, and tie to the liquidation value of securities pledged as collateral. The ensuing fire-sale amplifications have been thoroughly analyzed (Shleifer and Vishny, 1997; Gromb and Vayanos, 2002; Coval and Stafford, 2007; Garleanu and Pedersen, 2011), and map closely to models of asset price feedback (Shleifer and Vishny, 1992; Kiyotaki and Moore, 1997; Aiyagari and Gertler, 1999; Bernanke, Gertler, and Gilchrist, 1999; Brunnermeier and Sannikov, 2014). Small businesses' constraints may also be different and significantly dependent on real estate value, making them highly exposed to property price fluctuations due to collateral value (Adelino, Schoar, and Severino, 2015; Schmalz, Sraer, and Thesmar, 2017). For residential mortgages, Greenwald (2017) documents the role of "payment-to-income" constraints, a form of constraint similar to the earnings-based constraints we study among firms.[7]

Related Literature. Our paper relates to several strands of research. First, an important macro-finance literature offers theoretical insights about firms' borrowing constraints and their economic significance (Hart and Moore, 1994, 1998; Shleifer and Vishny, 1992; Kiyotaki and Moore, 1997; Bernanke, Gertler, and Gilchrist, 1999; Holmstrom and Tirole, 1997; Buera and Moll, 2015; Di Tella, 2017; Dávila and Korinek, 2017; Diamond, Hu, and

[6] In Section 4.5, we also study financial acceleration dynamics under different forms of borrowing constraints in a simple general equilibrium framework following Kiyotaki and Moore (1997). Under cash flow based-lending and EBCs, the resale/liquidation value of physical assets does not directly affect a firm's borrowing constraint, asset price feedback dissipates, and financial acceleration is indeed much more limited.

[7] As Greenwald (2017) shows, in residential mortgages the "payment-to-income" (PTI) constraints coexist with the "loan-to-value" (LTV) constraints. In this setting, creditors' claims are primarily tied to the property that serves as collateral, and LTV is the primary constraint. However, seizing and liquidating collateral is not frictionless, so PTI constraints may also be used as a secondary constraint to reduce foreclosure costs (in the cases where seizing collateral is close to costless, e.g. margin loans against financial securities, collateral/margin constraints are first-order and cash flow constraints are absent). In corporate cash flow-based lending, in comparison, creditors' claims are tied predominantly to the firm's cash flow value, cash flows have higher verifiability, and creditors often exert contingent transfers of control rights, so the primary constraints are based on cash flows/earnings, with no substantive constraints on physical collateral value.

Rajan, 2017).[8] These analyses motivate our empirical investigation. We show the prevalence of asset-based versus cash flow-based lending, the pervasiveness of earnings-based borrowing constraints, and variations across firms and countries. We also document that different forms of corporate borrowing can have distinct empirical impact. Macro-finance mechanisms may not apply uniformly across the board, and it is helpful to analyze the form of borrowing in a setting of interest.

Second, our work builds on research on corporate debt to better understand questions in macro-finance. Rauh and Sufi (2010) highlight the importance of studying debt composition and heterogeneity. We perform a systematic analysis of asset-based and cash flow-based lending, and investigate their economic impact. We also draw on studies of financial covenants (Chava and Roberts, 2008; Roberts and Sufi, 2009; Nini, Smith, and Sufi, 2009, 2012; Ivashina, 2009; Murfin, 2012; Becker and Ivashina, 2016) to examine the enforcement of earnings-based borrowing constraints.

Third, our investigation of borrowing constraints sheds new light on how cash flows affect corporate borrowing and investment. Our analysis of earnings-based borrowing constraints also suggests a distinct channel for the widely studied issue of investment sensitivity to cash flows (Fazzari, Hubbard, and Petersen, 1988; Froot, Scharfstein, and Stein, 1993; Kaplan and Zingales, 1997; Rauh, 2006). Sufi (2009) studies earnings-based covenants (cash flow-based financial covenants in his paper) to analyze firms' access to bank lines of credit. He shows these requirements limit low cash flow firms' ability to use credit lines, which tightens their financial constraints and makes them more reliant on cash for liquidity management.

Fourth, our investigation helps understand firms' vulnerability to property value shocks and features of the Great Recession. Building on previous research (Chaney, Sraer, and Thesmar, 2012), we find US firms' borrowing and investment exhibit some sensitivity to real estate value. However, the sensitivity is concentrated in asset-based debt, is less pronounced than the sensitivity to earnings, and appears sufficiently modest to avert severe impact of collateral damage. We also connect to studies of the Great Recession, and use firm property holdings data to further unpack the transmission of property price declines. Our findings illuminate the role of firms' balance sheets in the crisis, and support the centrality of households' and financial institutions' balance sheet impairment in the US experience (Mian and Sufi, 2014; Giroud and Mueller, 2017; Berger, Guerrieri, Lorenzoni, and Vavra, 2017; Kaplan, Mitman, and Violante, 2017; Chodorow-Reich and Falato, 2017; Gertler and Gilchrist, 2017).

Finally, corporate lending practices develop based on legal infrastructure (La Porta,

[8]For more theoretical analyses of the impact of borrowing constraints, see also Mendoza (2010), Bianchi (2011) in international macro; Midrigan and Xu (2014), Catherine, Chaney, Huang, Sraer, and Thesmar (2017) in studies of productivity and misallocation; Bernanke and Gertler (1989), Carlstrom and Fuerst (1997), Gertler and Kiyotaki (2010), Jermann and Quadrini (2012) in business cycle analyses; Rampini and Viswanathan (2010, 2013) in corporate finance, among many others.

Lopez-de Silanes, Shleifer, and Vishny, 1997, 1998; Djankov, Hart, McLiesh, and Shleifer, 2008). We suggest that legal institutions could have a significant impact on the applicability of macro-finance mechanisms.

The rest of the paper is organized as follows. Section 2 documents the features of corporate borrowing in the US. Section 3 studies the impact of cash flows on corporate borrowing and investment; Section 4 studies the impact of property collateral value and implications for the transmission of shocks in the Great Recession. Section 5 concludes.

2 Corporate Borrowing in the US

In this section, we document two main facts about corporate borrowing in the US. First, in the aggregate and among large firms, the majority of corporate debt is based on cash flows from operations ("cash flow-based lending"), as opposed to the liquidation value of physical assets ("asset-based lending"). Second, in this setting, a standard form of borrowing constraint is tied to a specific measure of cash flows, namely operating earnings, which we refer to as earnings-based borrowing constraints (EBCs). At the end, we also discuss determinants of these practices and variations across firms. We then overview the implications of these facts, which we explore in Sections 3 and 4.

To study these facts, we collect and integrate data from a number of sources. We utilize many sources because corporate debt information is often scattered: each dataset covers some specific types of debt, or some specific debt attributes. Combining many sources also allows us to cross check results using different datasets and enhance accuracy. The first part of our data focuses on debt composition, and uses key features such as collateral structure to categorize debt into asset-based and cash flow-based lending. We provide aggregate estimates for the non-financial corporate sector (using Flow of Funds, bond aggregates from FISD, large commercial loan aggregates from SNC, DealScan, and ABL Advisors, small business loan aggregates from SBA and Call Reports, capital lease estimates from Compustat, among others). We also perform firm-level analyses for most public firms since 2002 (using primarily debt-level descriptions from CapitalIQ, supplemented with bond data from FISD, loan data from DealScan, and additional debt information from SDC). The second part of our data focuses on EBCs. We record legally binding constraints specified in firms' debt contracts, including loans (DealScan) and bonds (FISD); we also document indications of such constraints imposed by market norms. We verify that we accurately capture the sources of these constraints by additionally scraping firms' annual report filings, and manually reading firms' disclosures in filings for a sample year of 2005.

2.1 Stylized Facts

2.1.1 Fact 1: Prevalence of Cash Flow-Based Lending

We first study the composition of corporate borrowing, and document the prevalence of asset-based lending and cash flow-based lending.

Asset-Based Lending

In asset-based lending, the debt is collateralized by specific assets (most commonly real estate, inventory, receivable, and certain types of machinery and equipment). Creditors have claims against the underlying assets pledged as collateral, and their payoffs in default depend on the liquidation value of the collateral. Each debt typically has a size limit based on the liquidation value of the specific assets pledged as collateral for that debt. The limit is enforced throughout the duration of the debt in some cases (e.g. revolving credit lines based on working capital), and enforced only at issuance in others (e.g. commercial mortgage).

In the data, we classify a debt as asset-based if one of the following criteria is met: a) we directly observe one of the features above (e.g. collateralized by specific assets or have borrowing limits tied to them); b) the debt belongs to a debt class that is usually asset-based (e.g. secured revolving line of credit, finance company loans, capital leases, small business loans, etc.), or it is labeled as asset-based; c) all other secured debt that does not have features of cash flow-based lending (discussed below) to be conservative (i.e. we may over-estimate rather than under-estimate the amount of asset-based lending). We leave personal loans (from individuals, directors, related parties, etc.), government loans, and miscellaneous loans from vendors and landlords unclassified (neither asset-based nor cash flow-based); their share is less than one percent in the aggregate, but can be more significant among certain small firms. Appendix B provides a detailed description of the categorization procedure.

Among total US non-financial corporate debt outstanding, we find that asset-based lending accounts for roughly 20% of debt by value, of which around 7% are mortgages (secured by real estate) and the rest are other asset-based loans (secured by receivable, inventory, equipment, etc.). For individual firms, results are similar in large non-financial firms: among the larger half of public firms (by assets), the median share of asset-based lending is 12%; among rated firms, the median share is 8%.[9]

Cash Flow-Based Lending

In cash flow-based lending, the debt is not tied to specific physical assets; creditors' payoffs (in ordinary course and in bankruptcy) depend primarily on cash flows from firms' operations,

[9] Rauh and Sufi (2010) study debt structure of 305 rated firms, and provide firm-level data for debt outstanding by debt class (e.g. public bonds, revolvers, mortgages). With assumptions about whether each debt class is asset-based or cash flow-based (e.g. public bonds are cash flow-based, mortgages are asset-based, revolvers are a mix), we can get another estimate of debt composition. This alternative estimate and our firm-level calculations match closely; the median level matches one for one for firm-years in both samples.

as opposed to the liquidation value of physical assets.[10] Examples include corporate bonds and a significant share of corporate loans such as most syndicated loans. The debt is often unsecured; the ones that are secured are secured by a lien on the entire corporate entity or by equity of the borrower (rather than specific physical assets), and the value of this form of collateral in bankruptcy is determined based on the cash flow value from continuing operations (Gilson, 2010). The key function of having security is to establish priority in bankruptcy and restructuring (US bankruptcy laws treat secured creditors as one class who have priority over unsecured creditors), not to liquidate the collateral. In cash flow-based lending, creditors do not focus on the liquidation value of physical assets (which are not key determinants of their payoffs or debt capacity); they focus instead on assessing and monitoring firms' cash flows.

In the data, we categorize a debt as cash flow-based if one of the following criteria is met: a) it is unsecured, or secured by substantially all assets/pledge of stock and does not have any features of asset-based lending; b) the debt belongs to a debt class that is primarily cash flow-based (e.g. corporate bonds other than asset-backed bonds and industrial revenue bonds, term loans in syndicated loans), or it is labeled as cash flow-based. Appendix B provides a detailed explanation of the categorization.

Among total US non-financial corporate debt outstanding, cash flow-based lending accounts for about 80% of debt by value, of which 50% are corporate bonds and 30% are cash flow loans. At the firm level, results are similar in large non-financial firms: among the larger half of public firms, the median share of cash flow-based lending is 83%; among rated firms, the median share is 89%. In Figure 1 Panel A, we also aggregate up firm-level data and plot the share of cash flow-based and asset-based lending by year among large public non-financial firms: the share of cash flow-based lending is consistently 80% and that of asset-based lending is consistently 20%.

In Appendix B, we further test and verify that cash flow-based debt does not have indirect positive dependence on the value of specific physical assets. Table A3 shows the amount of asset-based debt a firm has is positively correlated with the value of physical assets, whereas the amount of cash flow-based debt is not (if anything, the correlation is typically negative).

Taken together, cash flow-based lending accounts for the majority of US corporate debt, in the aggregate and among large firms. In the following, we document a prevalent form of borrowing constraints in this setting.

[10] In Chapter 11 bankruptcy, which is typical for firms using cash flow-based lending, the payoffs are driven by the cash flow value from continuing operations ("going-concern" value). In the rare cases of ending up in Chapter 7, these debt generally have minimal recovery. Thus creditors' payoffs overall are not tied to the liquidation value of physical assets. Using bankruptcy filing data from CapitalIQ (see Iverson (2017) for a detailed description), about 90% of large public firms' bankruptcies are resolved through Chapter 11.

2.1.2 Fact 2: Prevalence of Earnings-Based Borrowing Constraints

The second stylized fact shows that, in the context of cash flow-based lending, a common form of borrowing constraint stipulates debt limits based on a specific measure of cash flows, operating earnings. We refer to this type of constraints as earnings-based borrowing constraints (EBCs). EBCs follow two main specifications. The first is a limit on the ratio of a firm's debt to its operating earnings:

$$b_t \leq \phi \pi_t \tag{1}$$

where π_t is the firm's annual operating earnings, b_t is the firm's debt, and ϕ is the maximum ratio.[11] The second is a limit on the minimum amount of earnings relative to debt payments:

$$b_t \leq \frac{\theta \pi_t}{r_t} \tag{2}$$

where $r_t b_t$ is interest payments, and θ is the minimum coverage ratio.

EBCs have several features. First, the constraint applies at the firm level: both earnings π_t and the amount of debt b_t (or debt payments $r_t b_t$) are those of the borrowing firm. This is different from, for instance, the "loan-to-value" constraint of a mortgage that applies only to the size of that particular loan. At a given point in time, a firm may face earnings-based borrowing constraints from different sources, as we discuss shortly. Each of these constraints has a parameter ϕ or θ, and the tightest one binds first.[12] Second, the commonly used measure for π_t is EBITDA (earnings before interest, tax, depreciation, and amortization), over the past twelve months. As the name indicates, EBITDA excludes taxes and interest expenses. It also excludes non-operating income and special items (e.g. windfalls, natural disaster losses, earnings from discontinued operations). Third, EBCs apply not just when firms issue new debt; they can also affect the maintenance of existing debt. Even if a firm is not issuing new debt, if its earnings decline significantly, it may need to reduce debt to comply with these constraints imposed by existing debt.

Below we discuss the sources and enforcement of EBCs.

Earnings-Based Debt Covenants

An important source of EBCs is financial covenants in debt contracts. Covenants are legally binding provisions in debt contracts that specify restrictions on borrowers; financial covenants are one type of covenants limiting borrowers' financial conditions, assessed based on financial statements. Violations of covenants trigger "technical defaults," in which case

[11] The debt-to-earnings ratio is a central concept to creditors: in credit agreements, lenders typically use the term "leverage ratio" to refer to the debt-to-earnings ratio (rather than the debt-to-assets ratio).

[12] In Equations (1) and (2), we do not specify a time subscript t for the parameters ϕ or θ. At the firm level, the overall tightness of EBCs may vary over time (as old constraints get replaced by new ones, etc.).

creditors have legal power to accelerate payments or terminate the credit agreement. While such actions are infrequent, creditors use the bargaining power to request fees, increase borrowing costs, restrict borrowers' financial decisions, and replace management teams (Roberts and Sufi, 2009; Nini, Smith, and Sufi, 2009, 2012). Covenant violations prompt transfers of control rights to creditors, and incur significant costs to borrowers.

A common type of financial covenants specify debt limits as a function of EBITDA, which we refer to as earnings-based covenants. They follow the forms in Equations (1) and (2), and share the feature discussed above that the debt limits are at the firm level (so a firm is subject to constraint as long as one of its debt contracts contains such covenants). Earnings-based covenants can be found in both corporate loans and bonds. Those in loans generally monitor compliance on a quarterly basis ("maintenance tests"); thus continuous compliance is relevant for the maintenance of existing loans as well as the issuance of new debt, connected to the third feature discussed above. Those in bonds monitor compliance only when borrowers take certain actions such as issuing debt ("incurrence tests"), and are relevant for new debt issuance.

We study earnings-based covenants using data from three sources: DealScan for commercial loans, FISD for corporate bonds, and scraped and hand collected data from annual reports. DealScan is the most widely used dataset for corporate loans, with comprehensive coverage (Strahan, 1999; Bradley and Roberts, 2015), especially for large syndicated loans (it may not cover small bilateral loans, personal loans, mortgage loans, finance company loans). As we verify below, commercial loans are the primary type of loans with earnings-based covenants. DealScan provides data on covenant specifications and thresholds; Table A5 in Appendix C.1 lists the main specifications and the corresponding accounting variables compiled by Demerjian and Owens (2016). FISD is a comprehensive dataset for corporate bonds, with information on the type of covenant but not the covenant threshold. Finally, to check the comprehensiveness of data from DealScan and FISD and better understand the sources of earnings-based covenants, we scrape firms' annual report filings, and manually read covenant-related discussions for the sample year of 2005. Our sample covers US public non-financial firms from 1996 to 2015, as covenant data is relatively sparse prior to 1996.

Sources. Earnings-based covenants primarily come from debt that belongs to cash flow-based lending. To get a comprehensive picture of the sources of earnings-based covenants, we read firms' filings for the sample year of 2005. Among mentions of earnings-based covenants in filings, 90% come from debt that belongs to cash flow-based lending (or is packaged with cash flow-based debt[13]), such as cash flow-based commercial loans and corporate bonds.

[13] Commercial loans are typically organized in a package that shares the same covenants: the package commonly contains a revolving credit line, which can be asset-based (secured by inventory and receivable, with borrowing limits based on eligible collateral), and cash flow-based term loans. Thus the revolving lines are also subject to earnings-based covenants although we categorize them into asset-based lending.

Less than 10% come from other types of loans (e.g. mortgage loans, equipment loans, capital leases, etc.). These results also verify the validity of using DealScan and FISD data for systematic analyses of earnings-based covenants.

Prevalence. Figure 1 Panel B merges data from DealScan and FISD with Compustat, and shows that earnings-based covenants are prevalent among large firms. Of all large public firms, about 50% to 60% have earnings-based covenants in their debt contracts.[14] If we add mentions of earnings-based covenants scraped from firms' filings, the share of large non-financial firms with EBCs increases by another 5% per year, but the scraped data could contain false positives.[15] Large firms as a whole account for more than 90% of the sales, investment, and employment of all public firms. Those with earnings-based covenants account for about 60%. Some large firms do not have earnings-based covenants written in their debt contracts because they currently have little debt and are far from the constraints (e.g. Apple nowadays). Nonetheless, the constraint still exists and they are likely to have explicit debt covenants if the debt level is higher (e.g. Apple fifteen years ago).

In addition to earnings-based covenants, there are a few other types of financial covenants, mostly in corporate loans. These covenants are less prevalent in comparison, as we show in Internet Appendix Section IA1.[16]

Violations and Tightness. We also examine consequences of covenant violations and covenant tightness. Here we focus on loan covenants, for which we have some information about covenant specifications and thresholds. Figure 2 plots firm-level debt growth in year $t+1$ against distance to the covenant threshold at the end of year t.[17] It shows that debt growth is on average positive when firms are in compliance (to the right of the dashed line), but becomes negative once firms break the covenants.[18] The evidence suggests that

[14]Examples include AAR Corp, AT&T, Barnes & Noble, Best Buy, Caterpillar, CBS Corp, Comcast, Costco, Disney, FedEx, GE, General Mills, Hershey's, HP, IBM, Kohl's, Lear Corp, Macy's, Marriott, Merck, Northrop Grumman, Pfizer, Qualcomm, Rite Aid, Safeway, Sears, Sprint, Staples, Starbucks, Starwood Hotels, Target, Time Warner, US Steel, Verizon, Whole Foods, Yum Brands, among many others.

[15]For instance, the covenant mentioned in the filing may be about a loan that is already paid off. Firms may also discuss, for example, "interest coverage ratio" and "leverage ratio" in general, not in relations to covenant requirements. These cases are hard to cleanly tease out in the scraping process.

[16]Other financial covenants have two main forms. One type specifies an upper bound on book leverage, or relatedly a lower bound on book equity (book net worth). Since book equity is closely related to the accumulation of past earnings, this can be broadly viewed as a variant of EBC. The popularity of this type of covenant has declined in the past twenty years for several reasons that we discuss in the Internet Appendix Section IA1. Currently the prevalence of the book leverage/net worth covenants is less than a third of the prevalence of earnings-based covenants, and violations are uncommon. The other type of financial covenant specifies limits on the ratio of current assets to current liabilities. These covenants are distinct from EBCs.

[17]As shown in Table A5, earnings-based covenants have several variants. Firms sometimes have more than one type of these covenants; different firms may also have different types. For a uniform measure of distance, we first compute the minimum amount of earnings ($\underline{\pi}_{it}$) required such that the firm is in compliance with all of its earnings-based covenants (given the current level of debt). We then compute the difference between the minimum earnings required ($\underline{\pi}_{it}$) and the actual earnings (π_{it}), scaled by lagged assets. We normalize this distance by the standard deviation of ROA in the firm's 2-digit SIC industry.

[18]DealScan's data allows us to observe the threshold set by the initial credit agreement (at loan issuance). Firms may subsequently renegotiate with lenders to amend credit agreements and relax covenants, and these

earnings-based covenants serve as effective borrowing constraints. It is consistent with previous research that provides in-depth analyses of covenant violations and how they restrict corporate borrowing (Chava and Roberts, 2008; Roberts and Sufi, 2009). Figure 3 shows that firms bunch near the constraint, indicating violations are costly and borrowers try to avoid them. For tightness, every year around 10% of large firms with DealScan loans break the thresholds set by earnings-based covenants; another 10% to 15% are within 0.5 standard deviations of the thresholds. The statistics are consistent with prior work (Nini, Smith, and Sufi, 2012). The constraints are tight and relevant.[19]

Other Earnings-Based Borrowing Constraints

The earnings-based borrowing constraints a firm faces are not limited to financial covenants. The corporate credit market has important norms about debt relative to earnings: when a firm wants to issue debt, it can be hard to surpass a reference level of debt to EBITDA ratio lenders are accustomed to. This limit can be tighter than covenants in existing debt or in the new debt (the covenants of the new debt, if there are any, are typically set in a way that they will not be violated immediately). These earnings-based constraints at issuance are especially relevant for non-investment grade firms, which are closer to the limit. Such firms also commonly borrow from the leveraged loan market, where the reference debt to EBITDA ratio is emphasized the most. We document the impact of these additional constraints in Appendix C.2 using measures of the reference level in the leveraged loan market.

In sum, earnings-based borrowing constraints play an important role in US corporate credit markets, and tie closely to the prevalence of cash flow-based lending. In Internet Appendix Section IA2, we provide formal models to analyze the contracting functions of earnings-based covenants in cash flow-based lending, including incentive provision (Innes, 1990) and contingent transfer of control rights (Aghion and Bolton, 1992). We also discuss why creditors focus on current EBITDA: within contracting constraints, creditors use current EBITDA as a metric which is informative about firm performance and cash flow value, as well as observable and verifiable. EBITDA excludes windfalls to focus on cash flow generation by firms' core businesses; it is also available on a regular basis based on financial statements. Thus EBITDA has become a standard, widely used metric, and evaluating borrowing constraints as multiples of EBITDA has evolved to be a credit market norm.

amendments may not be fully captured by DealScan's data. Thus the actual threshold may end up being slightly looser than the ones in our data. Nevertheless, we already observe a pause in debt growth once the initial threshold is reached.

[19] The fraction of firms violating covenants or close to violation does not show strong cyclical patterns. This suggests that firms are not passive; they appear to actively adjust debt level and control their distance to violation.

2.1.3 Heterogeneity in Corporate Borrowing

Our previous discussions focus on large US non-financial firms. Corporate borrowing based on cash flows is not always the norm. The primary form of borrowing varies across large and small firms, in certain industries, and across countries, which we summarize below. These variations are driven by three main factors that affect the feasibility and utilization of cash flow-based lending: legal foundations, firms' cash flow generating ability, and asset specificity. First, the feasibility of lending and contracting based on cash flows relies on legal infrastructure, including reliable financial accounting and auditing, as well as statues (especially bankruptcy laws) and court enforcement that ensure lending based on cash flows can get paid back on average. With weak accounting, weak courts, or bankruptcy regimes that tie creditors' payoffs to the liquidation value of physical assets, cash flow-based lending could be harder to pursue. Second, firms also need to be able to generate sufficient cash flows for cash flow-based lending to be practical. Third, among firms that can access both asset-based and cash flow-based lending, the relative utilization can depend on asset attributes. Most large US firms have a small amount of standardized transferable assets that support low-cost asset-based lending. The majority of assets, however, are specialized, illiquid, or intangible,[20] and the US institutional environment makes cash flow-based lending more appealing.[21] In certain industries, particularly airlines and utilities, firms have a large share of standardized transferable assets, which facilitate asset-based lending.

Variations in the US

Small Firms. Cash flow-based lending and EBCs are much less common among small firms. The median share of cash flow-based lending is about 7% (while the median share of asset-based lending for these firms is 61%; the rest are personal loans from individuals and other miscellaneous borrowing). EBCs are found in only 12% of small firms (assets less than Compustat median). The majority of small firms have little profits if not sustained losses (Denis and McKeon, 2016).[22] In addition, financial distress of small firms is more likely to be resolved through liquidations (Bris, Welch, and Zhu, 2006; Bernstein, Colonnelli, and Iverson, 2017), given the fixed costs of restructuring (e.g. legal and financial personnel) and the uncertain prospects of small firms. This makes it harder for creditors to count on cash flow value from continuing operations. With limited access to cash flow-based lending, small

[20]This is consistent with the observation of Catherine, Chaney, Huang, Sraer, and Thesmar (2017) that the pledgeability of physical assets is low on average.

[21]For instance, Boeing's aircraft production facilities generate high cash flows when producing Boeing aircraft, but the liquidation value of these assets could be very low. In such cases, borrowing against cash flows would be more appealing than borrowing against specific physical assets in the US environment. Correspondingly, the debt is structured to focus on cash flows (e.g. extensive use of financial covenants), rather than enforcing creditors' rights over specific physical assets.

[22]For instance, the median EBITDA to asset ratio among small Compustat firms is -0.01 (while that among large Compustat firms is 0.13).

firms rely significantly on physical assets to obtain credit.

Low Profitability Firms. Similar to the case of small firms, firms with low profitability and low margins also have substantially lower shares of cash flow-based lending (higher shares of asset-based lending), and lower prevalence of EBCs. Among low margin firms (profit margin in the bottom half of all Compustat firms), the median shares of cash flow-based lending and asset-based lending are 41% and 39% respectively, while among high margin firms the median shares are 74% and 19% respectively.

Airlines and Utilities. Figures 4 shows corporate borrowing in different industries, focusing on rated firms so that firms in different industry groups are comparable in size and capital market access. Most industries display similar patterns, with the exception of airlines and utilities. In these two industries, even rated firms have a significant share of asset-based lending and a relatively small share of cash flow-based lending. The prevalence of EBCs is also lower. Airlines and utilities are special cases where firms have a large amount of standardized transferable assets (aircraft and power generators) that facilitate asset-based lending.

Cross-Country Variations

Across countries, lending practices may vary given different legal infrastructure (La Porta, Lopez-de Silanes, Shleifer, and Vishny, 1997, 1998). In most developing countries, high quality accounting information can be a major hurdle. Among developed countries, differences in accounting quality still exist but may not be large enough (especially among established firms) to account for most of the variations. Differences in laws and practices regarding financial distress seem more important. In the US, the tenet of Chapter 11 is to prevent liquidations and preserve cash flow value from continuing operations (i.e. "going-concern value").[23] In Chapter 11, creditors' payoffs are determined by the cash flow value of the firm, distributed according to priority (Gilson, Hotchkiss, and Ruback, 2000; Gilson, 2010). Chapter 11 also has multiple provisions to facilitate the process (e.g. automatic stay, debtor-in-possession, DIP financing[24]), which together make cash flow value central to creditors and attenuate the role of physical collateral. In continental Europe, liquidations are more common and bankruptcy procedures give more power to secured creditors (Djankov, Hart, McLiesh, and Shleifer, 2008; Smith and Stromberg, 2004).[25]

In major developed countries, legal infrastructure and lending practices in Japan tradi-

[23] Bernstein, Colonnelli, and Iverson (2017) provide detailed empirical evidence that the Chapter 11 restructuring procedure prevents loss of value relative to the Chapter 7 liquidation procedure.

[24] The automatic stay prevents creditors from seizing collateral and other debt collection activities after bankruptcy filing. Chapter 11 allows existing management teams to stay (debtor-in-possession) to increase incentives for firms to file and conduct timely restructuring. Firms can also obtain additional high priority debt (DIP financing) to support continued operations and ameliorate debt overhang problems.

[25] In the US, the share of unsecured corporate debt, as one indicator for the prevalence of cash flow-based lending, is fairly high, at around 50%. The figure is about 30% in the UK. It is less than 20% for Germany, France, and EU average, and similarly low for Japan.

tionally lie at the other end of the spectrum from the US. Prior to 2000, bankruptcy courts in Japan were largely dysfunctional, due to limited court capacity and provisions that discouraged companies from filing for bankruptcy protection. Without court supervision, it is harder to contract on cash flow value and enforce corresponding payouts. In addition, there are no stays that prevent creditors from seizing collateral and disrupting efforts for reorganization. Thus, physical collateral that can be seized tends to be central. It is well known that corporate lending in Japan historically focused on hard assets, and real estate is especially popular (Gan, 2007; Peek and Rosengren, 2000; Tan, 2004). Rajan and Zingales (1995) also find that tangible assets have a significantly higher impact on firm leverage in Japan compared to other G-7 countries. In Sections 3 and 4, we contrast our findings in the US with results in Japan, which further illustrates the impact of different forms of corporate borrowing constraints.

2.2 Implications

Section 2.1 documents key features of corporate borrowing based on debt contracts. The findings highlight the prevalence of cash flow-based lending and EBCs among US large non-financial firms. In the following, we further examine how such practices shape the way financial variables affect borrowing constraints and firm outcomes on the margin. In Section 3, we study how they affect the role of cash flows in corporate borrowing and investment. In Section 4, we study the mirror image: how they affect the sensitivity of corporate borrowing and investment to the value of physical assets, specifically real estate, and implications for the transmission of shocks in the Great Recession. The results attest to the contract-level features. With the prevalence of cash flow-based lending, cash flows in the form of operating earnings can play an important role, while the value of physical assets has a mild influence.

3 Cash Flows, Corporate Borrowing, and Investment

In this section, we study how cash flow-based lending and EBCs shape the way cash flows affect corporate borrowing and investment on the margin.

In the presence of EBCs, cash flow in the form of operating earnings (EBITDA) can directly relax borrowing constraints, and enable firms to both borrow and invest more, as further discussed in Section 3.1. We analyze this mechanism using both traditional investment regression specifications as well as an accounting natural experiment that generates exogenous shocks to EBITDA. This mechanism is not present among firms not bound by EBCs, such as unconstrained firms and various firm groups with low presence of cash flow-based lending (e.g. small firms, low margin firms, airlines and utilities, Japan firms).[26]

[26] As a concrete example, US non-financial firms routinely discuss their primary financing constraints in

By studying borrowing constraints, our observation also suggests a new channel for the widely studied issue of investment sensitivity to cash flows (Fazzari, Hubbard, and Petersen, 1988; Froot, Scharfstein, and Stein, 1993; Kaplan and Zingales, 1997; Blanchard, Lopez-de Silanes, and Shleifer, 1994; Rauh, 2006). In the traditional corporate finance framework, the main function of cash flows is to increase internal funds. Following the pecking order idea (Myers and Majluf, 1984), higher internal funds help firms invest more, while *substituting out* external financing as long as investment has diminishing marginal returns. With EBCs, cash flows in the form of operating earnings (EBITDA) also facilitate investment by *crowding in* external borrowing. Meanwhile, holding EBITDA fixed, higher cash receipts boost internal funds but do not relax EBCs, and are associated with higher investment but reductions in borrowing as the conventional pecking order framework would predict.

3.1 Mechanisms

We first provide a simple framework to illustrate the potential channels through which cash flows can affect firms' borrowing constraints and outcomes, in the case with cash flow-based lending and EBCs. The framework is adapted from Froot, Scharfstein, and Stein (1993) and Kaplan and Zingales (1997). Consider a firm that makes investment decisions I and maximizes profits. The investment payoff is $F(I)$, with $F' > 0$ and $F'' \leq 0$. Investment can be financed with internal funds w or external borrowing b. The discount rate on investment is 1 for simplicity.

External borrowing incurs additional costs, due to frictions in capital markets. With EBCs a key feature is that a firm's capacity and effective costs of borrowing depends on cash flows in the form of EBITDA, denoted by π. We can summarize the additional costs of borrowing as a function b and π: $C(b, \pi)$. We assume $C_{b\pi}(b, \pi) \leq 0, \forall b, \pi$, which means that an increase in EBITDA decreases the marginal cost of borrowing for any given level of b. One specific form of $C(b, \pi)$ corresponding to earnings-based covenant $b \leq \theta\pi$ is $C(b, \pi) = 0$ when $b \leq \theta\pi$ and $C(b, \pi) = +\infty$ when $b > \theta\pi$. We use a more general specification of C to capture that the costs of external borrowing could increase as the firm approaches the constraint.[27]

annual reports. These discussions indicate that major US non-financial firms still face borrowing constraints, but the primary constraint could be different from the commonly studied collateral constraint and instead focus on earnings. For instance, in its 2012 report, Coty Inc (one of the largest global beauty product producers) writes: *"We remain dependent upon others for our financing needs, and our debt agreements contain restrictive covenants...[F]inancial covenants may restrict our current and future operations and limit our flexibility and ability to respond to changes or take certain actions...Financial covenants...require us to maintain, at the end of each fiscal quarter, a consolidated leverage ratio of consolidated total debt to consolidated EBITDA."*

[27]For example, in a dynamic setting, even if EBCs do not bind in the current period, more borrowing may increase the probability of violating EBCs in the next period, which adds to the effective cost of external borrowing C.

The firm's optimization problem is

$$(I^*, b^*) = \arg\max_{I,b\geq 0} \; F(I) - C(b;\pi) - I \tag{3}$$
$$s.t. \; I = w + b.$$

In this case, we get two predictions about the influence of cash flow variables on corporate borrowing and investment.

Proposition 1. *Suppose $F'(w) > C_b(0,\pi)$, that is, the optimal external borrowing $b^* > 0$ (an internal solution).*

Prediction 1: *All else equal, EBITDA relaxes EBCs and crowds in borrowing and investment.*

For a given amount of internal funds w, borrowing and investment are weakly increasing in EBITDA $\frac{\partial b^*}{\partial \pi}\mid_w \geq 0$ and $\frac{\partial I^*}{\partial \pi}\mid_w \geq 0$.

Prediction 2: *Holding EBITDA constant, higher internal funds crowd in investment but substitute out borrowing.*

For a given amount of EBITDA π, investment is strictly increasing in internal funds $\frac{\partial I^*}{\partial w}\mid_\pi > 0$, but borrowing is weakly decreasing in internal funds: $\frac{\partial b^*}{\partial w}\mid_\pi \leq 0$ (the inequality holds strictly if the production function F is strictly concave).

In the presence of EBCs, all else equal, an increase in EBITDA π relaxes borrowing constraints and decreases the effective costs of borrowing. Thus this type of cash flows helps *crowd in* corporate borrowing. Meanwhile, holding EBITDA constant, higher internal funds substitutes out borrowing.[28] This substitution between internal funds and external financing holds in the pecking order framework (Myers and Majluf, 1984; Froot, Scharfstein, and Stein, 1993; Kaplan and Zingales, 1997).[29] Without controlling for internal funds, the total impact of an increase in EBITDA π would have two components: the effect on external borrowing and the effect on internal funds:

$$\frac{db^*}{d\pi} = \underbrace{\frac{\partial b^*}{\partial \pi}}_{+} + \underbrace{\frac{\partial b^*}{\partial w}}_{-}\frac{\partial w}{\partial \pi} \quad \text{and} \quad \frac{dI^*}{d\pi} = \underbrace{\frac{\partial I^*}{\partial \pi}}_{+} + \underbrace{\frac{\partial I^*}{\partial w}}_{+}\frac{\partial w}{\partial \pi}. \tag{4}$$

[28]EBITDA and net cash receipts can be different for several reasons, which we discuss in detail in Section 3.2 and Appendix E.

[29]In the corporate finance literature on investment cash flow sensitivity, the traditional framework (Froot, Scharfstein, and Stein, 1993) specifies the cost of external financing as $C(b)$, a convex function of the amount of borrowing. For a given amount of borrowing, financial variables, e.g. cash flows and physical collateral, do not have an independent impact on C. In this case, the role of cash flows is to increase internal funds (but do not relax borrowing constraints). Accordingly, they boost investment but *decrease* external borrowing. As the firm expands investment using cheaper internal funds, the marginal product of investment drops as long as $F(I)$ is concave, and the firm would reduce costly external financing so the marginal cost of investment decreases accordingly. Here controlling for internal funds, EBITDA does not have an independent role. Without controlling for internal funds, EBITDA would be negatively correlated with borrowing.

To the extent that π and w are positively correlated, the two effects work in different directions for borrowing, and work in the same direction for investment.

In the above, we use a simple one-period setting for illustration. In a multi-period setting, we can specify b in Equation (3) as net debt issuance in a particular period. We can then write the cost of external borrowing as $C\left(b + b^{old}, \pi\right)$, where b^{old} is the firm's existing debt and $b + b^{old}$ is total debt. Then the results in Proposition 1 should also condition on b^{old}.[30]

In the rest of this section, we empirically investigate how cash flows in the form of operating earnings affect firms' borrowing and investment on the margin. We focus on the borrowing constraint channel, and differentiate it from the internal funds channel.

3.2 Baseline Results

We begin with standard OLS regressions, following the traditional investment regression specifications since Fazzari, Hubbard, and Petersen (1988). We explain the set-up, lay out the findings, and address possible concerns. In Section 3.3, we further study exogenous variations in operating earnings due to an accounting natural experiment.

3.2.1 Empirical Specification

The baseline test follows standard investment regressions (Fazzari, Hubbard, and Petersen, 1988; Hoshi, Kashyap, and Scharfstein, 1991; Kaplan and Zingales, 1997), and performs annual regressions:

$$\begin{aligned} Y_{it} &= \alpha_i + \eta_t + \lambda \text{EBITDA}_{it} + X_{it}'\zeta + \epsilon_{it} \\ Y_{it} &= \alpha_i + \eta_t + \beta \text{EBITDA}_{it} + \kappa \text{OCF}_{it} + X_{it}'\gamma + \epsilon_{it} \end{aligned} \tag{5}$$

We make several modifications to the traditional set-up, as we explain below.

Outcome variables. For the outcome variables, prior research typically focuses on investment. We start instead with borrowing, which is key to understanding the mechanisms; we then proceed to the impact on investment activities. The main debt issuance variable we use is net long-term debt issuance from the statement of cash flows, defined as issuance minus reduction of long-term debt (Compustat item DLTIS - DLTR). We focus on long-term debt

[30] In the macro-finance literature that focuses on the general equilibrium feedback between firms' borrowing capacity and economic output (Kiyotaki and Moore, 1997; Bernanke, Gertler, and Gilchrist, 1999), models link a firm's borrowing capacity directly to the liquidation value of physical assets. In this case, the cost of external borrowing does not depend on cash flows directly. It is possible that higher cash flows may increase borrowing indirectly as they increase firms' internal funds ("net worth"), allow firms to acquire more physical assets, and relax borrowing constraints. However, here all components of *internal funds* have the same positive impact on borrowing; EBITDA does not play an independent role after controlling for internal funds. In addition, this channel only applies to debt that is tied to physical collateral. We provide a more detailed discussion in Appendix D about how financial variables affect corporate borrowing and investment in classic models including Kiyotaki and Moore (1997), Bernanke, Gertler, and Gilchrist (1999) and Holmstrom and Tirole (1997) and Tirole (2006).

because it is most closely tied to investment activities. We also present results for several other debt issuance variables, including changes in total book debt, and changes in both secured debt and unsecured debt (using additional data from CapitalIQ). Since EBCs apply at the firm level, all types of debt may be affected. For investment activities, we examine capital expenditures (spending on plant, property, and equipment) as well as R&D spending.

Independent variables. The main independent variable of interest is operating earnings (EBITDA), which directly affect EBCs. We use the Compustat variable EBITDA.[31] We start with the first line in Equation (5), which includes EBITDA and controls. This specification mimics traditional investment regressions which have one central cash flow variable, usually measured using earnings (e.g. income before extraordinary items plus depreciation and amortization or EBITDA). Here the EBITDA coefficient λ picks up both the impact through relaxing EBCs, and the impact through increasing cash receipts/internal funds.

To isolate the impact of EBITDA through borrowing constraints, we then control for measures of internal funds. We control for net cash receipts, measured using Compustat variable OANCF (adding back interest expenses XINT to prevent mechanical correlation with debt issuance). Net cash receipts OCF captures the actual amount of cash a firm gets from its operations (it does not include cash receipts/outlays due to financing or investment activities). For a firm over time, EBITDA and OCF are about 0.6 correlated. These two variables are different for several reasons. First, there are timing differences between earnings recognition (when goods/services are provided to customers) and cash payments (which can be before, during, or after earnings recognition). Second, OCF includes net cash receipts due to non-operating income, special items, and taxes, which may not count towards EBITDA. Third, accounting rules may stipulate additional exclusions or inclusions to earnings. Appendix E provides a detailed discussion of the definitions of EBITDA and OCF and their relationships. We also control for cash holdings at the beginning of period t in X_{it}.

Other control variables include Q and past 12 months stock returns that some work found to be a useful empirical proxy for Q (Barro, 1990; Lamont, 2000). We also control book leverage (which corresponds to b^{old} in the discussion in Section 3.1) and other balance sheet characteristics (e.g. tangible assets such as book PPE and inventory), all measured at the beginning of period t. Finally, we control for size (log assets) and lagged EBITDA to focus on the impact of current EBITDA. We use firm fixed effects and year fixed effects in our baseline specifications. Internet Appendix Table IA1 shows specifications with industry-year fixed effects. Table IA2 shows specifications using lagged dependent variables instead of firm fixed effects. The results are similar.

Samples. We start with firms where EBCs are most relevant. We first examine large

[31] The Compustat EBITDA variable is defined as sales minus operating expenses (Cost of Goods Sold plus Selling, General & Administrative Expense). The specific definitions of EBITDA may vary slightly in different debt contracts, but share the core component captured by the Compustat variable.

firms with earnings-based covenants, which provide a clear indication of the presence of such constraints. We use covenant information from DealScan and FISD, as described in Section 2.1.2. Table 2 Panel A provides summary statistics of these firms. They have high earnings, with a median EBITDA to assets ratio of 0.13, and primarily use cash flow-based lending (median is 88%). They also have a reasonable amount of debt, so the constraint becomes relevant: the median debt to EBITDA ratio is 2.2 (typical constraint is maximum debt to EBITDA around 3 or 4), and the median debt to assets ratio is 0.3.

We then examine several firm groups where EBCs are less relevant. Their summary statistics are presented in Table 2 Panel B. First, we analyze large firms without earnings-based covenants. These firms use cash flow-based lending (median share is 88%), but have a low level of debt and are far from the constraint. Second, we analyze a number of firm groups that rely on asset-based lending, where cash flow variables are not key determinants of borrowing constraints. As explained in 2.1.3, several distinct factors affect the prevalence of asset-based versus cash flow-based lending, including size, profitability, asset attributes, and legal environments. Correspondingly, we study small firms, low margin firms, airlines and utilities, and Japanese firms later in Section 3.4, where asset-based lending dominates.

The positive sensitivity of corporate borrowing and investment to EBITDA is absent in all these cases where EBCs are not prevalent. Although the comparison firms are not assigned *randomly*, EBCs are less relevant to them for distinct reasons analyzed in Section 2.1.3, which are not tied to a systematic omitted variable bias story. Table 2 Panel B shows these firm groups display rich heterogeneity in terms of size, profitability, leverage, asset composition, etc. As we discuss in more detail in Section 3.2.3, it appears hard to account for the different impact of EBITDA across all these comparison groups based on common alternative explanations. We also do not find significant results among these firms in the accounting natural experiment in Section 3.3.

Our main sample covers 1996 to 2015, since data on financial covenants were sparse prior to 1996. We can also examine comparisons of firm groups (e.g. large vs. small firms, high vs. low profitability firms, airlines and utilities) using a longer sample since 1985 (when statement of cash flow variables became systematically available in Compustat), which we show in Internet Appendix Section IA3.1.

3.2.2 Results

Table 3 reports the results of the baseline regressions for large firms with EBCs.

Debt Issuance

Table 3 Panel A presents results on debt issuance. Columns (1) and (2) look at our main debt issuance measure, net long-term debt issuance (from the statement of cash flows). Column (1) follows the first line of Equation (5) and includes EBITDA alone. In this case, for a one dollar increase in EBITDA, net long-term debt issuance increases by 21 cents on average. As Section 3.1 Equation (4) suggests, the EBITDA coefficient here captures two components: EBITDA's impact through relaxing EBCs and EBITDA's correlation with changes in internal funds ($\frac{db^*}{d\pi} = \frac{\partial b^*}{\partial \pi} + \frac{\partial b^*}{\partial w}\frac{\partial w}{\partial \pi}$). To the extent that higher internal funds may substitute out external borrowing ($\frac{\partial b^*}{\partial w} < 0$), the coefficient in Column (1) would *understate* EBITDA's impact through relaxing EBCs. In Column (2), we control for net cash receipts OCF. In this case, for a one dollar increase in EBITDA, net long-term debt issuance increases by 27 cents on average.

The magnitude of this effect is large. As a comparison, for instance, Chaney, Sraer, and Thesmar (2012) find that for a one dollar increase in firms' property value, net long-term debt issuance increases by about 4 cents. The sensitivity of 27 cents on a dollar is still lower than a typical maximum debt-to-earnings constraint of around 4, as most firms are not exactly at the constraint. As discussed in Section 3.1, in such cases the sensitivity of debt issuance to earnings would be less than what is specified by the constraint.

Results on the impact of EBITDA are similar using other measures of debt issuance. The response to EBITDA is 41 cents when the outcome variable is changes in book debt, holding constant OCF. Columns (5) to (8) show that secured debt and unsecured debt both respond: issuance of secured debt increases by 13 cents for a one dollar increase in EBITDA, and that of unsecured debt increases by 23 cents (the sample here is restricted to firms with data from CapitalIQ). The magnitudes of these two coefficients are roughly proportional to the share of secured to unsecured debt among this sample (40% secured and 60% unsecured for the median firm). The results suggest that EBITDA, by relaxing firm-level EBCs, expands the capacity for all types of debt.

Holding EBITDA constant, we find that firms with higher net cash receipts OCF borrow less: when OCF is higher by one dollar, net long-term debt issuance on average decreases by 11 cents. Other measures of debt issuance also show reductions in borrowing. The results suggest that holding fixed the tightness of EBCs, more internal funds do substitute out external borrowing on average.[32] The evidence is consistent with findings by Rauh (2006), who studies a shock (due to mandatory contributions to employee pension plans) that affects a firm's cash positions but does not affect its earnings. He finds that firms with higher cash positions (lower mandatory pension contributions) have lower net debt issuance.

Investment Activities

Table 3 Panel B turns to investment activities. In column (1), without controlling for OCF, a one dollar increase in EBITDA is on average associated with a 13 cents increase in

[32]Given accounting practices, net cash receipts from operations (OCF) are affected by inventory purchases: all else equal, a firm that buys more inventory has a lower OCF. It is possible that such a firm also needs to borrow more, which may lead to a negative relationship between OCF and debt issuance. In Internet Appendix Table IA4, we present results controlling for inventory purchase, which show similar findings.

capital expenditures. The magnitude is consistent with findings in recent studies (Baker, Stein, and Wurgler, 2003; Rauh, 2006), which usually measures cash flows using earnings (most commonly net income or income before extraordinary items plus depreciation and amortization). Again, following Section 3.1 Equation (4), the EBITDA coefficient has two components: EBITDA's impact through relaxing EBCs and EBITDA's correlation with changes in internal funds ($\frac{dI^*}{d\pi} = \frac{\partial I^*}{\partial \pi} + \frac{\partial I^*}{\partial w}\frac{\partial w}{\partial \pi}$). We decompose these two pieces in column (2) by controlling for OCF. We find a coefficient on EBITDA of 10 cents on average, while the coefficient on OCF is about 5 cents on average.[33] Among firms bound by EBCs, the effect of the borrowing constraint channel appears as important as, if not economically larger, than the internal funds channel.

In addition to traditional capital expenditures, we also examine the impact on R&D spending. We find a positive correlation between EBITDA and R&D expenditures. R&D expenses, unlike CAPX, are required to be included in operating expenses, which would produce a negative link between R&D and EBITDA. Despite this negative link, in this sample of firms bound by EBCs, increases in EBITDA can crowd in R&D spending (and these expenditures do not fully offset the initial increase in EBITDA). This pattern is unique to firms with EBCs.[34]

Firm Groups with Low Prevalence of EBCs

In Table 4, we study four groups of firms where EBCs should be less relevant, as explained in Section 3.2.1: 1) large firms w/o EBCs, which use cash flow-based lending but are far from the constraints; 2) small firms, where cash flow-based lending and EBCs are less prevalent; 3) low margin firms, where cash flow-based lending and EBCs are similarly less prevalent; 4) airlines and utilities, which utilize asset-based lending given their asset attributes and have a lower prevalence of EBCs. We also examine Japan firms in Section 3.4.

Across all these comparison groups, EBITDA does not have a significant impact on debt issuance. For all groups, the coefficient on EBITDA is *negative and significant* without controlling for net cash receipts OCF. This contrasts sharply with the results among firms bound by EBCs shown in Table 3. After controlling for OCF, the EBITDA coefficient is about zero. EBITDA also does not have an independent positive impact on capital expenditures once we control for OCF.

[33]The coefficients represent the magnitude of the average response, not necessarily that of the conditional response. For example, suppose the constraints are binding 10% of the time and firms are unconstrained 90% of the time (where investment is close to first best). Then in the 10% constrained cases, the response to EBITDA and OCF would be ten times the size of the average response.

[34]We also analyze the response of cash holdings and other outcomes. Controlling for OCF, cash holdings on average increase by about 1 cent for a one dollar increase in EBITDA; they increase by 40 cents for a one dollar increase in OCF. Thus most of the association between EBITDA and cash holdings documented by Almeida, Campello, and Weisbach (2004) comes from the correlation between EBITDA and net cash receipts, not from EBITDA's role in relaxing borrowing constraints. A one dollar increase in EBITDA is also on average associated with a 4 cents increase in payout and a 15 cents increase in acquisitions.

Among these firms, the impact of OCF is overall similar to that among firms with EBCs. OCF substitutes out borrowing in all cases. It has a positive impact on investment, which is more pronounced among capital intensive firms (e.g. airlines and utilities) and weaker among capital light firms (e.g. small firms).

3.2.3 Checks for Alternative Explanations

Results in the baseline regressions line up with predictions in Section 3.1. In the following, we discuss potential alternative explanations and provide empirical checks. These alternative explanations also cannot account for findings from a natural experiment we study in Section 3.3 due to changes in accounting rules.

Mismeasurement of Marginal Q

A central empirical issue in testing responses to cash flow variables is whether these variables are proxying for Q, due to mismeasurement of marginal Q. Specifically, firms may increase borrowing and investment because of good investment opportunities and high marginal Q. Measured Q, however, could be imprecise, and coefficients on EBITDA and other cash flow variables may be biased upward if these variables are positively correlated with marginal Q.

We do not find that mismeasurement of Q can easily account for our results. First, in Section 3.2.2, we show that the positive relationship between EBITDA and borrowing and investment does not exist among various groups of firms that are not bound by EBCs. For mismeasurement of Q to explain these findings, it needs to be that Q is less mismeasured or EBITDA is less informative across all these comparison groups, which does not appear to be the case in the data. In the Internet Appendix Section IA3.2, we perform detailed tests to study the informativeness of EBITDA and Q across all firm groups, including standard tests of accounting quality (e.g. net operating assets (Hirshleifer, Hou, Teoh, and Zhang, 2004), accrual quality (Dechow and Dichev, 2002; Francis, LaFond, Olsson, and Schipper, 2005), loss avoidance (Bhattacharya, Daouk, and Welker, 2003), etc.), as well as predictive regressions of future earnings and cash receipts. As shown in Table IA8, we do not find evidence that EBITDA is less informative or Q is less mismeasured in comparison groups. If anything, in several comparison groups, we find the reverse: EBITDA appears *more informative* (e.g. more predictive of future profitability and cash receipts) and Q is *more mismeasured* (e.g. less predictive of future profitability and cash receipts). We also use the higher order cumulant estimators of Erickson, Jiang, and Whited (2014). We still only find significant impact of EBITDA for firms bound by EBCs and not for the other firm groups (the magnitude of the coefficients is larger and varies with the parameters used).

Second, if EBITDA simply proxies for Q and corresponding demand for external financing, we may also expect to see impact on other types of financing activities. Thus we also study the response of net equity issuance to EBITDA. While net debt issuance increases significantly with EBITDA among firms with EBCs, we do not observe such a relationship for net equity issuance. Thus it does not appear that firms have a higher demand for external financing in general with an increase in EBITDA.

Collateral Value

We also check that the sensitivity of borrowing and investment to EBITDA is not driven by EBITDA being correlated with the value of physical collateral. In particular, we look at the issuance of unsecured debt, which is unlikely to be affected by the collateral channel. Previous research and our analysis in Appendix B confirm that this type of borrowing does not respond to the value of physical assets. On the other hand, since EBCs restrict total debt of the firm, EBITDA can affect all types of debt (including unsecured debt). As we find in Table 3 Panel A, the issuance of unsecured debt responds significantly to EBITDA for firms bound by EBCs. We can also directly control for measures of collateral value, such as the value of real estate assets, which does not affect the coefficient on EBITDA, as shown in Internet Appendix Table IA5. We also examine the effect of property collateral value on corporate borrowing and investment in more detail in Section 4. In sum, the evidence suggests that EBITDA has an important impact on corporate borrowing that is separate from the collateral value channel.

Trade-Off Theory

One view of corporate financial structure is that firms choose the amount of debt by trading off the costs of having more debt against the benefits of debt. The costs of debt may include expected costs of insolvency, costs of debt overhang, etc. The benefits of debt may include tax advantage or mitigation of agency problems (e.g. debt requires firms to periodically pay out cash, which can restrict empire building).

With EBCs, violations of earnings-based covenants are an important source of the costs associated with a high level of debt. EBCs thus lead to a form of trade-off that is tied to the level of EBITDA. When a firm has higher EBITDA, it gets further away from violating earnings-based covenants, which lowers the effective costs of having more debt, as discussed in Section 3.1. EBITDA drives this this type of trade-off that originates from EBCs, which is part of our central mechanism.

One question is whether EBITDA may also be associated with other costs/benefits of debt, such as expected costs of insolvency/payment default, expected costs of general debt overhang problems, or benefits of committing to regularly pay out cash. First, these considerations apply to all firms. Relative to the various comparison groups, they are not uniquely relevant to firms bound by EBCs (if anything, airlines and utilities have a higher level of debt, and small firms and low margin firms have a higher likelihood of insolvency; trade-off considerations could be more significant for them). Second, we include net cash receipts, and we also examine the impact of non-operating/miscellaneous income in Internet Appendix Table IA6. These other types of income can also reduce expected costs of insolvency or increase the benefits of cash payouts, although they do not relax EBCs. In the data, they do not have a significant positive impact on borrowing, but instead substitute out borrowing.

3.3 Exogenous Variations in Operating Earnings: An Accounting Natural Experiment

In this section, we supplement the tests above and further study the impact of EBITDA using a natural experiment due to an accounting rule change. The accounting rule modifies the calculation of earnings, and contributes to changes in EBITDA that are not related to changes in economic fundamentals or internal funds. As a result, it helps us further isolate the impact of EBITDA due to earnings-based borrowing constraints.

The accounting rule change we study is SFAS 123(r) issued by the Financial Accounting Standard Board (FASB) regarding the accounting of stock-based compensation. Before the adoption of this rule, firms' option compensation expenses do not formally count towards operating expenses, a component of earnings. Instead, firms make footnote disclosures at the end of their financial statements. The new rule requires firms to include option compensation expenses in operating expenses, thus they would affect earnings. As a result, the new rule can decrease EBITDA for firms that use option compensation, but does not have a direct impact on cash positions or company fundamentals.[35] A number of studies show that contracting frictions make it hard to neutralize changes in accounting rules, and they tend to have a significant impact on firms' financial and real decisions due to debt contracting and covenant restrictions (Brown and Lee, 2007; Frankel, Lee, and McLaughlin, 2010; Moser, Newberry, and Puckett, 2011; Cohen, Katz, and Sadka, 2012; Shroff, 2017).[36] SFAS 123(r) is most relevant to our study, as it directly relates to the calculation of earnings. The rule is issued

[35]SFAS 123(r) requires firms to record an expense when options are granted, based on its Black-Scholes value. It also requires firms to recognize an expense for previously granted options that vest after the adoption date of SFAS 123(r).

[36]There are two issues about EBITDA definitions in debt contracts that we need to examine. The first issue is whether covenants calculate EBITDA using fixed accounting methods ("fixed GAAP," in which case accounting changes do not affect covenant tightness), or latest accounting methods ("floating GAAP," in which case accounting changes do matter). Reviews of sample contracts show that "floating GAAP" is common (Moser, Newberry, and Puckett, 2011; Shroff, 2017), given transaction costs for applying "fixed GAAP" (firms' official financial statements comply with latest accounting methods, thus to implement "fixed GAAP" the borrower needs to prepare an additional set of financial statements). The second issue is certain debt contracts allow borrowers to exclude all expenses with no cash impact ("non-cash charges," such as depreciation, amortization, stock-based compensation, etc.) from the calculation of EBITDA, in which case SFAS 123(r) may not affect covenant tightness (since stock-based compensation is excluded). We read a set of publicly available debt contracts during this period, and do not find such exclusions to be very common.

in December 2004; it becomes effective for public companies for accounting periods that began after June 15, 2005, and fiscal 2006 is the first fiscal year affected by the new rule.

We study the impact of the rule change in Table 5. We instrument EBITDA in 2006 (post-adoption) with the average option compensation expenses in the three years prior to the issuance of SFAS 123(r) in 2004, controlling for lags of EBITDA, lags of the dependent variable, as well as a set of firm characteristics (including the same controls as in Tables 3, book-to-market ratio, and longer lags of firm stock returns). We also control for sales and OCF given that the accounting rule change affects EBITDA through operating expenses, not sales or net cash receipts.

$$\mathrm{Y}_i^{2006} = \alpha + \beta \widehat{\mathrm{EBITDA}}_i^{2006} + X_i'\gamma + \epsilon_i \tag{6}$$

We study both net long-term debt issuance and capital expenditures as the outcome variable. We present results for large firms bound by EBCs, large firms without EBCs, and small firms.

Table 5 Panel A shows strong first-stage responses among all firms. Panel B shows the second stage: debt issuance and investment are significantly affected among firms with EBCs, but not among other firm groups.[37] The results are consistent with our findings above that, in the presence of EBCs, EBITDA has a key impact on firms' borrowing and investment by affecting the tightness of their borrowing constraints. In Table 5, the second stage coefficients on EBITDA among firms with EBCs are higher than the baseline results in Table 3. The estimates here are local average treatment effect (LATE), and it appears that firms which are most intensively treated (those that use a significant amount of option compensation) are more responsive. In addition, the accounting rule change induces a nearly permanent shock to earnings (the new rule permanently eliminates one way of compensating employees without booking an operating expense, while the average persistence of innovations in EBITDA in our baseline tests is about 0.3), which could make the effect size larger. In the Internet Appendix Section IA3.3, we perform placebo tests using other years, and verify that the first-stage and reduced form results do not hold in these cases.[38]

3.4 Additional Implications

Results above suggest that cash flows in the form of operating earnings have an important impact on firm borrowing constraints and outcomes when firms are bound by EBCs. We

[37] The exclusion restriction here is the following: among firms bound by EBCs in particular, prior option compensation expenses do not affect subsequent borrowing and investment through channels other than EBCs. To account for our results using alternative explanations, it has to be that there are certain links between prior option compensation and subsequent borrowing and investment which are *unique to firms bound by EBCs* but are not related to EBCs. We do not find a strong reason for such channels.

[38] A special case is fiscal year 2005, which is after the rule issuance but before its implementation. In this year, we find some impact on debt issuance and a modestly significant impact on investment among firms bound by EBCs. This could result from preemptive adjustments smoothing out the impact of the new rule.

now discuss further applications of this observation.

Are Financially More Constrained Firms More Sensitive to "Cash Flows"? A point of contention in research about investment sensitivity to cash flows is whether such sensitivity is higher among firms that are more financially constrained (Fazzari, Hubbard, and Petersen, 1988, 2000; Kaplan and Zingales, 1997, 2000). In previous empirical analyses, the emphasis is cash flows increase internal funds, and the key to this debate is whether financially more constrained firms are more sensitive to *internal funds*. Nonetheless, cash flow sensitivity could arise not just because cash flows increase internal funds. As we demonstrate above, for firms bound by EBCs, cash flows in the form of operating earnings also directly affect borrowing constraints. This second channel is largely absent, for instance, among small firms (and low profitability firms), where cash flow-based lending and EBCs are much less prevalent. While consensus measures of financial constraint are also subject to debate (Farre-Mensa and Ljungqvist, 2016), small firms are plausibly more constrained than large firms (so are low profitability firms). Thus, for some of the reasonably more constrained firms, there is one less channel of cash flow sensitivity, which could contribute to empirical findings that more "financially constrained" firms may not display higher cash flow sensitivity. This observation is especially relevant when cash flows are measured based on earnings, which is common in empirical research.

Table 6 provides an illustration, and compares all large non-financial firms as a group with all small firms as a group. Panel A shows that among large firms, debt issuance increases significantly with EBITDA, driven by the large share of firms with EBCs. Among small firms, however, the coefficient on EBITDA is negative and significant when not controlling for net cash receipts OCF. The coefficient on EBITDA is about zero when OCF is added. Similarly, as shown in Section 3.3 and Table 5, small firms' borrowing also does not respond significantly to changes in EBITDA due to the accounting natural experiment. The results suggest that, with the absence of EBCs, small firms may have one less source of cash flow sensitivity which operates through external borrowing.

Table 6 Panel B presents results for capital expenditures. Columns (1) and (3) include EBITDA but not OCF, a specification similar to typical investment cash flow sensitivity regressions that measure "cash flows" using earnings. In this case, the coefficient on EBITDA is positive and significant for large firms, and insignificant for small firms. The interpretation of this result, however, is not necessarily that small firms are not sensitive to *internal funds*. Rather, it results from the absence of the EBC channel among small firms, as Panel A indicates. In Columns (2) and (4), we add OCF and its coefficient is positive in both groups, though smaller among small firms.[39]

[39] Capital expenditures capture spending on plant, property, and equipment, and the investment structure of large and small firms could be different. Small firms may invest more in labor and human capital or R&D, and less in traditional hard assets. Thus the empirical magnitude of the cash flow sensitivity of *capital*

US vs. Japan. We also contrast the US with Japan, where corporate borrowing historically relies on physical collateral, especially real estate. While cash flows in the form of operating earnings have a significant impact on debt issuance and investment among large US firms, this relationship does not hold among Japanese firms.

Table 7 reruns the baseline regressions among large non-financial firms (i.e. assets above median among public firms in the respective country) in the US and Japan. A majority of firms in the US large firm sample have EBCs, as shown in Section 2.1.2, while cash flow-based lending and EBCs are less common in Japan (Tan, 2004). Table 7 Panel A first tabulates the summary statistics for the US and Japan samples. For Japanese firms, we use data from Compustat Global, supplemented with stock price information from Datastream. Net long-term debt issuance from the statement of cash flows is not available for the Japan sample, so we measure debt issuance here using changes in total book debt. Capital expenditures and net cash receipts (OCF) are also available for a smaller set of Japan firms before 2000, and we fill in the gap using additional data from WorldScope. Firms in the US and Japan samples are similar in size as measured by assets. US firms have higher EBITDA relative to assets, as well as higher equity valuations. US firms have higher debt relative to assets, and Japanese firms have higher debt relative to EBITDA (as Japanese firms are not bound by debt to EBITDA constraints).

Table 7 Panel B performs the baseline regressions in the US and Japan samples. There is a strong positive relationship between debt issuance and EBITDA in the US sample (driven by firms bound by EBCs), which is absent in the Japan sample. As shown by Panel B column (3), in the Japan sample, debt issuance decreases with EBITDA in when not controlling for net cash receipts OCF. Once we control for OCF in column (4), the EBITDA coefficient becomes close to zero and OCF has a significantly negative coefficient. Similarly, EBITDA does not have an independent impact on investment in the Japan sample.

Borrowing Constraints and Cash Flow Value. Results in this section suggest that, with cash flow-based lending and EBCs, cash flows in the form of operating earnings (EBITDA) relax borrowing constraints and help firms borrow and invest more. These effects are not present, however, when asset-based lending prevails. Given contracting frictions discussed in Section 2.1.2, current EBITDA is central to commonly used, legally binding borrowing constraints (EBCs), and exhibits a disproportionate impact. While current EBITDA is an important factor and an anchor of EBCs, other factors such as expected present value of future cash flows may also play a role. For instance, a firm with high future cash flow prospects could be able to get a larger loan relative to its current EBITDA, and a higher debt to EBITDA multiple for its covenant constraints. We focus on the effect of current EBITDA as an illustration of the central role of cash flow value in corporate borrowing in

expenditures may also differ among these two groups for other reasons.

the US, both because it has a disproportionate impact due to contracting frictions, and because it is directly observable in the data (the present value of future cash flows, on the other hand, is hard to empirically measure; it is also empirically hardly separable from investment opportunities).

After investigating how corporate borrowing practices shape the role of cash flows, in the next section we examine how they affect the role of physical assets to provide a fuller picture and lay out additional implications.

4 Property Prices, Firm Outcomes, and Financial Acceleration

In this section, we study how corporate borrowing practices also help understand firms' sensitivity to collateral value, specifically property prices, and illuminate the transmission of shocks during the Great Recession.

We first examine the general sensitivity of US firms' borrowing to property collateral value. We find that borrowing increases by about three cents for a one dollar increase in the value of real estate assets, consistent with prior research (Chaney, Sraer, and Thesmar, 2012; Cvijanović, 2014). Moreover, this positive sensitivity is concentrated in asset-based debt; it is absent (if not negative) among cash flow-based debt. Thus the overall sensitivity to real estate value appears modest. The magnitude is smaller than the average sensitivity of debt issuance to operating earnings among US large non-financial firms (about 20 cents). The magnitude also suggests that a 20% property price drop would have a limited impact on the median firm with real estate holdings.

We then use this observation to shed further light on the transmission of property price declines during the Great Recession. Since the Great Recession, a vibrant literature studies the transmission of the property price collapse through household balance sheets and household demand. Much less attention is paid to firms, who in principle are also owners of real estate capital and may suffer similar collateral damage. Indeed, collateral damage to firms plays a critical role both in theories of financial acceleration (Kiyotaki and Moore, 1997; Bernanke, Gertler, and Gilchrist, 1999)[40] and in some international experiences such as Japan in the early 1990s (Peek and Rosengren, 2000; Gan, 2007). Figure 5 shows that Japanese corporate debt experienced a sizable boom-bust cycle together with real estate value (Panel A). In sharp contrast, during the US property price cycle in the 2000s, corporate debt only budged relative to property prices and household debt (Panel B).

[40] In these models, firms' debt capacity is driven by the liquidation value of physical capital, and financial acceleration operates through fire-sale amplifications: a drop in the liquidation value of physical assets tightens borrowing constraints, squeezes firms' ability to hold capital, further compresses the price of assets, and triggers an asset price feedback loop.

We tie these threads together by examining how collateral damage due to property price declines affected major US non-financial firms during the Great Recessions. We use firm property holdings data to further unpack the transmission of property price shocks. Consistent with our initial observation, we do not find that property price drops led to significant declines in borrowing and investment due to collateral damage. At the end, we also examine financial acceleration dynamics under different forms of borrowing constraints in a simple general equilibrium framework, following Kiyotaki and Moore (1997). Under cash flow-based lending and EBCs, financial acceleration among firms could be dampened as asset-price feedback dissipates. At the end, we compare results in the US with prior findings in Japan. The contrast suggests the transmission of property price shocks may differ depending on the predominant form of corporate borrowing.

4.1 Property Value and Corporate Borrowing

We first investigate the general sensitivity of corporate borrowing to real estate value, and the role of asset-based lending versus cash flow-based lending.

We follow the empirical specifications in prior research (Chaney, Sraer, and Thesmar, 2012; Cvijanović, 2014):

$$Y_{it} = \alpha_i + \beta \mathrm{RE}_{it} + X_{it}' \gamma + \epsilon_{it} \tag{7}$$

For the outcome variable, we study both net debt issuance as in previous work, and the issuance of cash flow-based versus asset-based debt. Since we only have detailed firm-level categorization of cash flow-based and asset-based debt starting in 2002, we focus on the sample period of 2002 to 2015; the results for overall net debt issuance are similar in a longer sample. The main independent variable RE_{it} is the market value of real estate assets, measured at the beginning of year t using two procedures described in detail below. We control for firms' operating earnings (EBITDA), net cash receipts (OCF), cash holdings, Q, and additional balance sheet characteristics such as book leverage, size (log assets), other tangible assets (measured at the beginning of year t).

A standard empirical concern in this setting is property prices might be correlated with local demand in firms' locations. To address this problem, a commonly used approach is to instrument property prices with land supply elasticity. However, as Mian and Sufi (2014) demonstrate, land supply elasticity is a strong instrument for household housing net worth and household demand, thus correlated with local demand. Therefore, we instead draw on Mian and Sufi (2014)'s observation that tradable firms' demand is national (or global), and not systematically exposed to conditions in their locations. We present additional results for tradable firms only to further tease out potential impact of local demand.

Measuring Firms' Real Estate Value

Firms' financial statements report the book value of property (based on historical cost) rather than the market value. We estimate the market value in two ways.

Method 1: Traditional Estimates. Chaney, Sraer, and Thesmar (2012) provide a standard procedure to estimate the market value of real estate using accounting data. The estimate is calculated based on the book value of real estate, accumulated depreciation, and historical property value in the firm's headquarters location. Because accumulated depreciation on real estate assets is no longer reported after 1993, this procedure requires firms to be public since 1993, which restricts the sample size. The key assumption in this estimate is that most of the real estate firms own are located near their headquarters, which is plausible as we discuss in more detail below (most firms' owned properties, such as offices and main production facilities, tend to concentrate in the headquarters region). Appendix F explains the construction of our estimates by step.

Table 8 presents the characteristics of this sample. Given the data requirement of this method, the sample tilts towards large firms (70%). 56% of the sample have earnings-based covenants. Median market value of real estate normalized by book assets is 0.20; median market value of real estate relative to the market value of equity 0.20, very similar to Chaney, Sraer, and Thesmar (2012). Table 8 also shows the characteristics of all public firms that own real estate (around 66% of Compustat own some real estate), measured during the same period. In comparison, firms in the Method 1 sample are slightly larger in size, but generally similar in terms of the amount of book PPE, profitability and book leverage.

Method 2: Property Ownership Information from Annual Reports. US non-financial firms are required to discuss their physical properties in annual reports. About one third of firms with real estate provide a detailed list of their owned properties, including location, property type, and square footage. We hand collect these data from 2006 filings to get more refined information about firms' property holdings. For the panel analysis in this section, we assume firms own a fixed set of properties as shown by 2006 filings, estimate the market value of each property in each year, and sum up to the firm level. Our baseline results use property locations in 2006 filings to align with the cross-sectional analysis in Section 4.2 (we also read filings in 2002, which produce similar results; estimates using locations in 2002 and 2006 filings are about 0.85 correlated). For the cross-sectional analysis in Section 4.2 focusing on the crisis period, we directly take the properties owned by the end of 2006 reported in the 2006 filings, and calculate their values through the crisis. We restrict to owned real estate located in the US, and keep firms that have information for substantially all owned properties in the US. Appendix F provides examples of property holding information from 10-K filings, and detailed explanations of variable construction.

The market value of real estate measured using Method 1 and Method 2 is consistent. For firms in both samples, the estimates are 0.7 correlated. The levels also match up. The similarity is high because most firms' owned properties are limited and are concentrated in the headquarters location, so the assumption used in traditional estimates largely holds (e.g. as of 2006 Starbucks only owns some headquarters office space and four roasting facilities).

Table 8 also reports the characteristics of firms in the Method 2 sample. These firms are slightly smaller than those in the Method 1 sample (60% of the sample are large firms). They utilize more asset-based lending compared to the Method 1 sample, although cash flow-based lending still accounts for the majority of their debt (median share is 65%); 47% have earnings-based covenants. They are similar to other firms with real estate in terms of book PPE and profitability, and have slightly lower book leverage.

Results

Table 9 presents the results, for all firms where real estate value measures are available as well as the subsample consisting of tradable firms only. We get similar results across different samples. A one dollar increase in real estate value is on average associated with an increase in net long-term debt issuance of about three cents. The positive response is concentrated in asset-based debt. It is absent among cash flow-based debt. We can further break down cash flow-based debt into cash flow-based loans and bonds, and the positive sensitivity is absent in both categories. These patterns hold not just for debt issuance, but also for the level of debt, as shown in Appendix B Table A3.

Results in Table 9 are similar whether we restrict to tradable firms or not. Public non-financial firms in our samples are generally sufficiently large that their product demand may not be concentrated in areas where they own properties, even for some of the non-tradable firms (e.g. Starbucks is categorized as a non-tradable firm, but it owns primarily roasting facilities that are far from its product markets; however, caveats may apply to services firms that are real estate heavy and have few locations, like casinos and amusement parks, where property location and product market overlap). For most firms, property price shocks at firms' real estate locations seem sufficiently exogenous to their product demand.

In Table 9 the coefficients on EBITDA are significant, and the magnitudes are comparable with our findings in Section 3 (the EBITDA coefficients in Table 9 are about 0.15 to 0.2, driven by the roughly 60% of firms in these samples with EBCs). In our samples which primarily consist of large firms that borrow through cash flow-based lending, EBITDA appears to have a bigger average impact on borrowing than property collateral value (0.03).

Taken together, the results suggest that a substantial portion of large non-financial firms' debt does not rely significantly on real estate value. With these alternative venues for borrowing, the overall sensitivity to property prices appears limited. For instance, for a firm with a median level of real estate holdings (real estate value is 0.2 times book asset value), a 20% decline in property price would decrease its real estate value by about 0.04 of book asset value, and reduce its borrowing by about 0.001 of assets (0.04×0.03). This effect is small relative to a median investment rate (CAPX normalized by assets) of 0.05 and a median EBITDA to assets ratio of 0.13 among large firms. In the following, we use this observation to shed light on features of the Great Recession, and further unpack the transmission of property price declines.

4.2 The Great Recession: Unpacking the Property Price Effect

Since the Great Recession, a vibrant strand of research investigates the impact of the property value collapse. The key insight is that property price declines damaged household balance sheets, dried up aggregate demand, and led to drops in investment and employment (Mian and Sufi, 2014; Giroud and Mueller, 2017). Property price declines, however, may also transmit through collateral damage to firms. Less is known about the role of this second channel in the Great Recession. Such a mechanism could be powerful if firms' debt capacity relies heavily on property collateral value; it could be attenuated if firms primarily utilize cash flow-based lending.

In the following, we examine the impact of corporate property value in the Great Recession. We proceed in two steps. We first note that the limited impact due to declines in firms' property value could be inferred from insights in the household demand channel. Specifically, Mian and Sufi (2014) study the impact of property prices on local employment growth during the Great Recession, and propose a comparison of tradable versus non-tradable industries. The key idea is that property prices affect local household demand: firms in non-tradable industries are exposed to local demand, so they should be more sensitive to local property price changes. Firms in tradable industries, on the other hand, face demand from a larger market, so they should be less sensitive. Consistent with the hypothesis, Mian and Sufi (2014) find strong responses of local employment to local house prices among non-tradable firms. They do not find any relationship among tradable firms. Giroud and Mueller (2017) find similar strong relationships among non-tradable firms, and no relationship among tradable firms.

Nonetheless, property price declines at a firm's location affect not only local demand, but also the value of the firm's real estate assets. This channel through property collateral value is relevant for *both* tradable and non-tradable firms. If this channel is strong, we would expect that *tradable firms* also display some sensitivity to local property price changes. The null result from prior work thus hints at the muted impact of property collateral damage among US non-financial firms in the Great Recession.

We then further unpack the transmission of property price declines in the Great Recession in Table 10. We disentangle the firm-side property collateral value channel using firm property holdings data. We exploit firms' differential exposures to property value shocks through the following cross-sectional specification:

$$\Delta Y_i^{07-09} = \alpha + \lambda \Delta \mathrm{RE}_i^{07-09} + \eta \mathrm{RE}_i^{06} + \phi \Delta P_i^{07-09} + \beta \Delta \mathrm{EBITDA}_i^{07-09} + X_i' \gamma + u_i \quad (8)$$

The left hand side variable Y_i^{07-09} is outcomes of firm i from 2007 to 2009. In Panel A, ΔY_i^{07-09} is the change in net long-term debt issuance from 2007 to 2009. In Panel B, ΔY_i^{07-09} is the change in capital expenditures. On the right hand side, the key variable of interest is $\Delta \mathrm{RE}_{i,06}^{07-09}$, which captures changes in firm i's real estate value from 2007 to 2009. It is measured as the market value gain/loss of firm i's pre-crisis (end of 2006) real estate holdings during the Great Recession, normalized by assets in 2006. This variable is the main focus for analyzing the property collateral channel. We also include RE_i^{06}, which controls for firm i's pre-crisis real estate holdings (normalized by assets in 2006). In addition, we control for ΔP_i^{07-09}, the percentage change in property prices in firm i's locations, which captures the impact of property prices that may work through local household demand. We also control for changes in EBITDA, net cash receipts, and Q from 2007 to 2009, as well as Q, leverage, cash holdings, size (log assets) by the end of 2006, among others.

We measure firms' real estate value using both of the methods described in the previous section. For Method 1, we calculate firm-level RE_i^{06}, $\Delta \mathrm{RE}_{i,06}^{07-09}$, and ΔP_i^{07-09} all using headquarters information. Specifically, RE_i^{06} is constructed based on the regular headquarters-based procedure, ΔP_i^{07-09} is the percent change in property prices in the headquarters location from 2007 to 2009, and $\Delta \mathrm{RE}_{i,06}^{07-09} = \mathrm{RE}_i^{06} \times \Delta P_i^{07-09}$. For Method 2, we calculate firm-level RE_i^{06}, $\Delta \mathrm{RE}_{i,06}^{07-09}$, and ΔP_i^{07-09} by aggregating information from each owned property j of firm i. Specifically, we then sum across these properties to obtain $\mathrm{RE}_i^{06} = \sum_j \mathrm{RE}_{i,j}^{06}$ and $\Delta \mathrm{RE}_{i,06}^{07-09} = \sum_j \mathrm{RE}_{i,j}^{06} \times \Delta P_{i,j}^{07-09}$, where $\Delta P_{i,j}^{07-09}$ is the percentage change in property prices in the location of owned property j of firm i. In this case, we calculate ΔP_i^{07-09} as the average of $\Delta P_{i,j}^{07-09}$; we can alternatively calculate firm-level ΔP_i^{07-09} using property price changes in firm i's headquarters or average across all locations (owned and leased), and the results are similar. The bottom of Table 8 shows additional summary statistics during the crisis. For firms in our sample, the median property price decline from 2007 to 2009, ΔP_i^{07-09}, is about 8%. The median decline in the market value of real estate assets from 2007 to 2009 (normalized by 2006 assets), $\Delta \mathrm{RE}_{i,06}^{07-09}$, is about 0.01.

In this setting, there could still be concerns about property prices being correlated with local demand. In our current cross-sectional set-up, this issue can drive down λ if firms that own more real estate are systematically *less* sensitive to local demand. As discussed in Section 4.1, the local demand issue does not appear severe for large public firms whose demand is generally not local. Nonetheless, we also perform additional checks in Internet Appendix Table IA10 using tradable firms only.

Table 10 presents results using different estimates. We tease out the outliers and make sure they do not drive our results. We also report both OLS estimates and least absolute deviation (LAD) estimates (following Gan (2007)) to further alleviate the influence of outliers and skewness in the cross-sectional data. Across different estimates, we do not find evidence that declines in firms' real estate value drove down debt issuance or capital expenditures during the Great Recession. The lack of significant results could be in part because the sensitivity is very small (as discussed in Section 4.1), which makes it hard to detect in a regular cross section. It could also be related to the structure of loans backed by real estate, where loan-to-value constraints affect issuance but do not always affect maintenance of existing loans.[41] Finally, in Table 10 the coefficients on EBITDA and OCF have the same signs and comparable magnitudes as results in Section 3.

In summary, our analysis suggests that property price declines during the Great Recession did not have a significant impact on firms' outcomes due to collateral damage. In the following, we compare and contrast results from the US housing collapse with previous research on Japan's housing collapse. We highlight substantial differences in the transmission of property price shocks under different regimes of corporate lending.

4.3 Property Price Declines and the Firm Collateral Channel: US and Japan

In the late 1980s and early 1990s, Japan experienced a major boom-bust cycle in property prices. The collapse of property prices had a far-reaching impact on Japan's economy. As discussed earlier, corporate borrowing in Japan traditionally relies on real estate collateral, especially before the bankruptcy reforms in the early 2000s. Thus Japan's real estate collapse took place in an environment where property value is central for corporate credit.

With the collapse of property prices, Japanese firms' debt capacity and investment activities suffered significantly, as documented by Gan (2007). Gan (2007) studies public manufacturing firms in Japan, and uses the value of firms' real estate prior to the collapse as the main measure of exposures to property price shocks (she estimates the market value of real estate from accounting data through a procedure similar to method 1 above). She finds that Japanese firms that owned more property pre-collapse suffered particularly severely during the bust: for a one dollar increase in a firm's pre-collapse land holdings in 1989, average CAPX investment is lower by 13 to 16 cents from 1994 to 1998. The impact is substantial, especially that property prices peaked around 1990, and the outcome is measured as the average over five years after 1994.

[41] Accordingly, when property value increases, a firm can take out a larger loan based on a given loan to property value ratio that is evaluated at issuance. When the property value declines, however, the firm would not be forced to shrink the size of existing loans. The option to take out larger loans when property prices increase, coupled with the lack of forced debt reduction when property prices drop, could contribute to less sensitivity to property value in recessions than in normal times.

In Table 11, we present results in the US sample using the same regression specifications as Table 2 column (2) of Gan (2007):

$$\text{CAPX}_i^{post} = \alpha + \beta \text{RE}_i^{pre} + X_i'\gamma + v_i \tag{9}$$

where CAPX_i^{post} is firm i's average annual investment rate over a period of time during the property price collapse; RE_i^{pre} is the value of firm i's real estate holdings prior to the collapse, which captures firms' exposures to real estate; X_i includes firm level controls (cash flows during the post period, Q, cash holdings, a dummy indicating firms with above median real estate holdings, and interactions of cash flows and cash holdings with this dummy). This specification is different from our tests in Equation (8) above and provides an alternative test. As Table 11 shows, in the US Great Recession, we do not find results similar to what Gan (2007) found in Japan. There is no significant correlation between a firms' pre-crisis real estate holdings and its subsequent outcome. The sharp contrast suggests that the transmission mechanisms of a property price collapse could be different in different settings, depending on the lending regime and the central determinants of firms' debt capacity.

4.4 Earnings Drop and Firm Outcomes in the Great Recession

Below we perform a basic assessment of the impact of earnings-based borrowing constraints during the Great Recession.

In our data, total earnings of large public firms with EBCs fell by \$123 billion from 2007 to 2009. Based on baseline results in Table 3, this is associated with a \$33.5 billion decline in long-term net debt issuance due to EBCs, which accounts for 10.6% of the issuance decline among all public firms. It is associated with a \$14 billion reduction in CAPX due to EBCs, which accounts for 8.7% of CAPX declines among public firms. If we augment the baseline regression with two dummy variables indicating covenant violation and within 0.5 standard deviations of violation to allow for discontinuity in outcome variables due to violations, the total impact increases slightly to 14.4% of declines in net long-term debt issuance and 9.5% of declines in CAPX. Finally, if we instead estimate a cross-sectional regression for firms with EBCs focusing on the Great Recession period, results are similar (EBCs account for 10.7% of declines in net long-term debt issuance and 9% of declines in CAPX).[42] Overall,

[42]For Estimate 1, we use the regression in Table 3, and calculate the change in the outcome variable predicted by the change in EBITDA. We renormalize the outcome to dollar amounts and sum across all large firms with EBCs. For Estimate 2, the procedure is the same, except we add two dummies to capture potential non-linear impact when firms violate earnings-based covenants or are very close to violation. For Estimate 3, we instead use cross-sectional regressions restricted to the Great Recession period. We run a cross-sectional regression among large non-financial firms with EBCs: $\Delta Y_i^{07-09} = \alpha + \beta \Delta \text{EBITDA}_i^{07-09} + \kappa \Delta \text{OCF}_i^{07-09} + X_i'\gamma + u_i$, where ΔY_i^{07-09} is firm i's change in net debt issuance (or CAPX) from 2007 to 2009, $\Delta \text{EBITDA}_i^{07-09}$ is its change in EBITDA; controls include changes in Q and pre-crisis Q, as well as cash holdings, book leverage, book PPE, size, among other firm characteristics measured at the end of 2006.

the estimated impact due to EBCs is meaningful but not catastrophic.

4.5 Financial Acceleration in General Equilibrium: A Simple Comparison

Finally, we perform a simple analysis of financial acceleration dynamics under different forms of borrowing constraints, based on a standard general equilibrium framework following Kiyotaki and Moore (1997). We examine both collateral-based constraints (borrowing limit depends on the liquidation value of physical assets) as in the original work, and earnings-based constraints (borrowing limit depends on a multiple of cash flows/earnings). We compare the equilibrium impact of a shock to productive firms' net worth in these two scenarios (the same shock as considered by Kiyotaki and Moore (1997)), starting from the same steady state in both cases.

The results show that, after the shock hits, the impact on productive firms' capital holding and aggregate output are much stronger with collateral-based constraints, due to the well-known asset-price feedback. This mechanism is muted with EBCs: when the market/liquidation value falls, a firm's borrowing constraint is not automatically tightened, and fire sale amplifications are not present. Using the parameterization in Kiyotaki and Moore (1997), we find the impact on productive firms' capital holding and aggregate output under collateral-based constraint is about ten times as large as that under earnings-based constraint. Dampening the asset-price feedback could be quantitatively very important. We present the details of the set-up, equilibrium dynamics, and quantitative analysis in Appendix G.

This analysis is admittedly stylized. It highlights that with non-financial firms and EBCs alone, financial acceleration and amplification may be dampened. The balance sheets of firms alone may not be the key financial accelerator. Nonetheless, asset-price feedback can be very important among financial institutions and households. In a fully fledged model, it could also be interesting to explore the interactions among different sectors (households, financial institutions, non-financial firms) that face different types of borrowing constraints.

Taken together, results in this section show that major US non-financial firms did not appear to suffer from significant collateral damage due to property price declines in the Great Recession. In the US setting, the impairment of banks' balance sheets (Chodorow-Reich, 2014; Becker and Ivashina, 2014; Acharya, Almeida, Ippolito, and Perez-Orive, 2014; Chodorow-Reich and Falato, 2017) and household demand (Mian and Sufi, 2014) can be the primary sources of vulnerability, and non-financial firms were not the epicenter of the crisis (Gertler and Gilchrist, 2017). Our analysis of corporate borrowing helps to put this into

We then calculate changes in the outcome variable predicted by changes in EBITDA. Finally, we sum up the firm level impact across all large non-financial firms with EBCs.

perspective: the experiences in the US are not taken for granted; firms could have suffered more significantly from collateral damage and possibly fire sale amplifications if asset-based lending against real estate were central, like in the case of Japan.

5 Conclusion

In this paper, we study borrowing constraints of non-financial firms. We show that cash flow-based lending accounts for the vast majority of US large non-financial firms' debt. With cash flow-based lending, a standard borrowing constraint restraint restricts a firm's total debt based on a particular measure of cash flows, namely operating earnings. We lay out determinants of these borrowing practices, and delineate differences in the predominant form of corporate borrowing across firm groups.

These features of corporate borrowing help tie together several issues. The prevalence of cash flow-based lending and EBCs shapes the way cash flows affect corporate borrowing. In particular, cash flows in the form of operating earnings directly relax EBCs and can facilitate borrowing. This mechanism further suggests a new channel for the sensitivity of firms' investment to cash flows which operates through external borrowing. Among firms where asset-based lending prevails for a variety of reasons, these effects are absent, which helps account for variations in firm behavior. The prevalence of cash flow-based lending also alleviates firms' dependence on the value of physical assets. Correspondingly, large US firms' borrowing and investment were not particularly vulnerable to property price declines in the Great Recession through collateral damage. The results suggest that corporate balance sheets may not be the central amplifier of financial shocks in the US setting, and shed light on why the Great Recession is a crisis centered around households and banks rather than major non-financial firms.

Taken together, major US non-financial firms do face borrowing constraints, but the primary constraint appears different from the commonly studied collateral constraint; instead, cash flow-based lending and earnings-based constraints play an important role. The form of borrowing constraints can shape the impact of different financial variables and the applicability of macro-finance mechanisms.

Our study analyzes non-financial firms. A question for future work is to investigate the form of borrowing constraints among various types of financial institutions, how they differ, why, and the corresponding implications.

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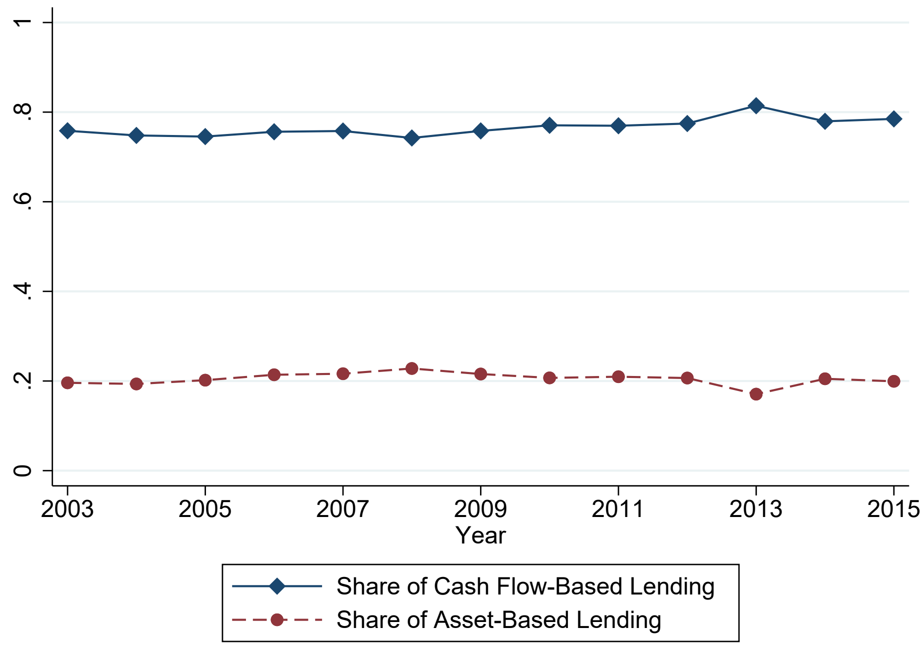
A Main Figures and Tables

Figure 1: Prevalence of Cash Flow-Based Lending and EBCs: Large Public Firms

This figure shows the prevalence of cash flow-based lending and EBCs among large US public non-financial firms. In Panel A, we sum up firm-level estimates of asset-based and cash flow-based lending across all large firms (assets above Compustat median), and plot the share of each type among total debt of these firms in each year. Large public firms account for more than 95% of debt, sales, investment, and employment among all public firms. The solid line with diamond represents the share of cash flow-based lending; the dashed line with circle represents the share of asset-based lending. In Panel B, we merge covenant data from DealScan and FISD with Compustat, and plot the fraction of large firms with earnings-based covenants each year.

Panel A. Share of Cash Flow-Based Lending in Total Debt Outstanding



Panel B. Fraction of Firms with Earnings-Based Covenants

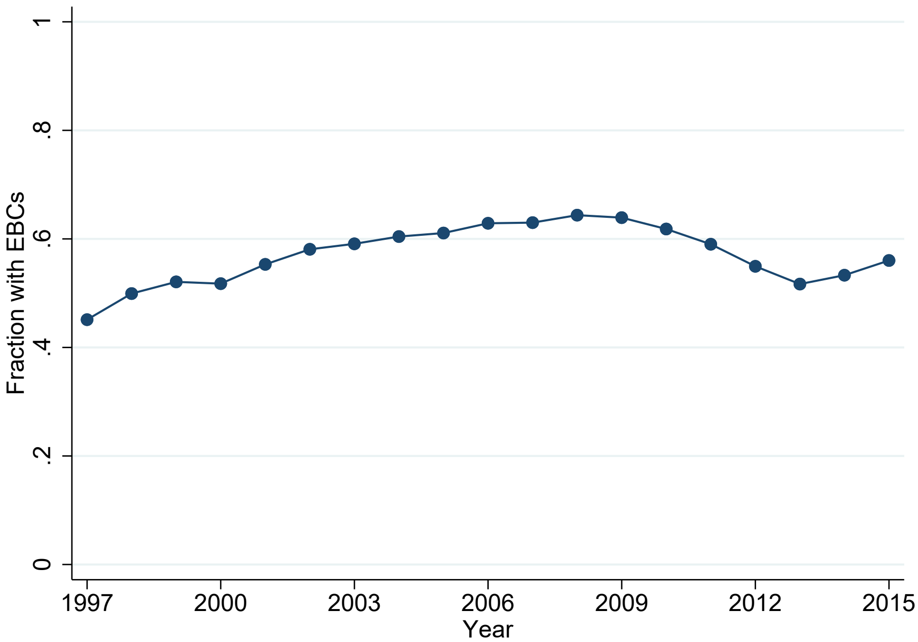


Figure 2: Debt Growth and Earnings-Based Covenants

This plot shows the relationship between debt growth and compliance with earnings-based covenants in DealScan loans. The x-axis is 20 bins based on distance to violation by year end, and the y-axis is the average debt growth in the next year in each bin. As shown in Table A5, there are several variants of earnings-based covenants. Firms sometimes have more than one type, and different firms can also use different types. To find a uniform measure of distance, we first compute the minimum amount of earnings ($\underline{\pi}_{it}$) required such that the firm is in compliance with all of its earnings-based covenants (given the current level of debt and debt payments). We then compute the difference between the minimum earnings required ($\underline{\pi}_{it}$) and the actual earnings (π_{it}), scaled by lagged assets. We normalize this distance by the standard deviation of ROA in the firm's 2-digit SIC industry. We take the firm-year observations that are within +/- 2 standard deviations, and group them into 20 equally spaced bins. The first bin on the right on the dashed line at zero includes firms within 0 to 0.2 standard deviations, so on so forth. Firms in the shaded region to the left of zero are those that are not in compliance with at least one earnings-based covenant based on DealScan data; those to the right of zero are in compliance with all such covenants.

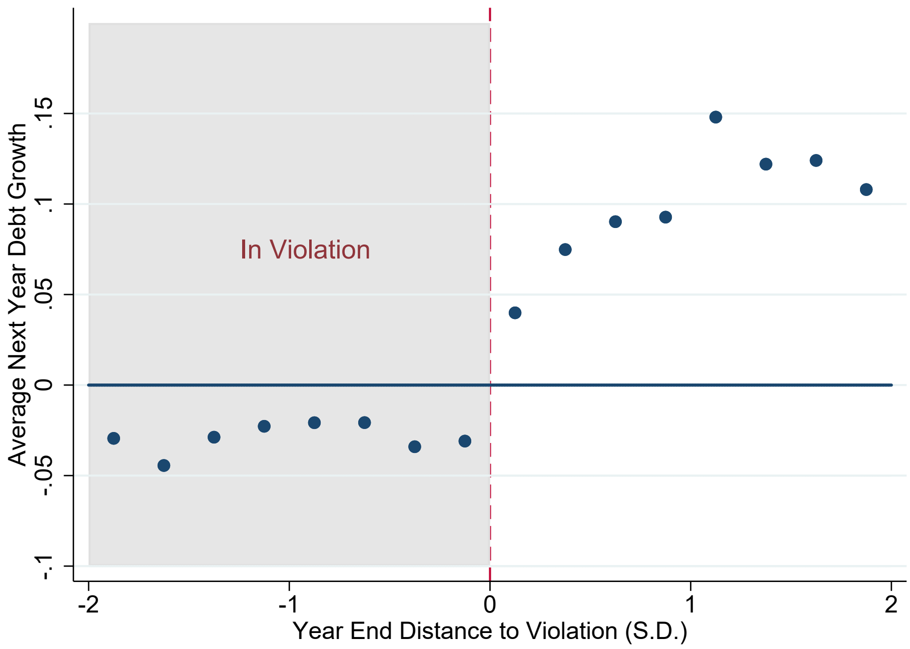


Figure 3: Bunching around Earnings-Based Covenant Threshold

This plot shows the histogram of firm-year observations across the same bins as in Figures 2. The bins measure the distance to violating earnings-based loan covenants in DealScan data. Firms to the right of zero are in compliance with all earnings-based covenants.

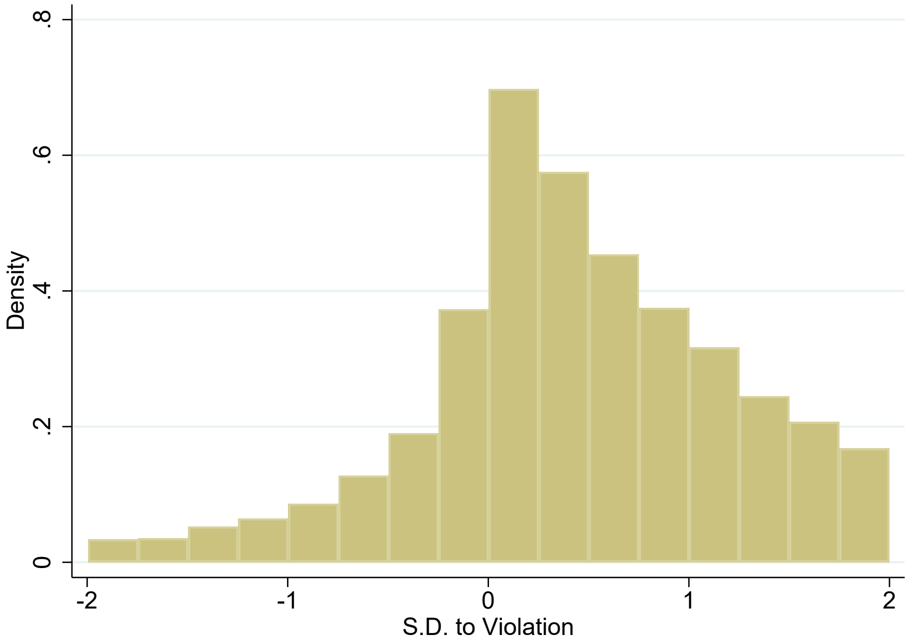
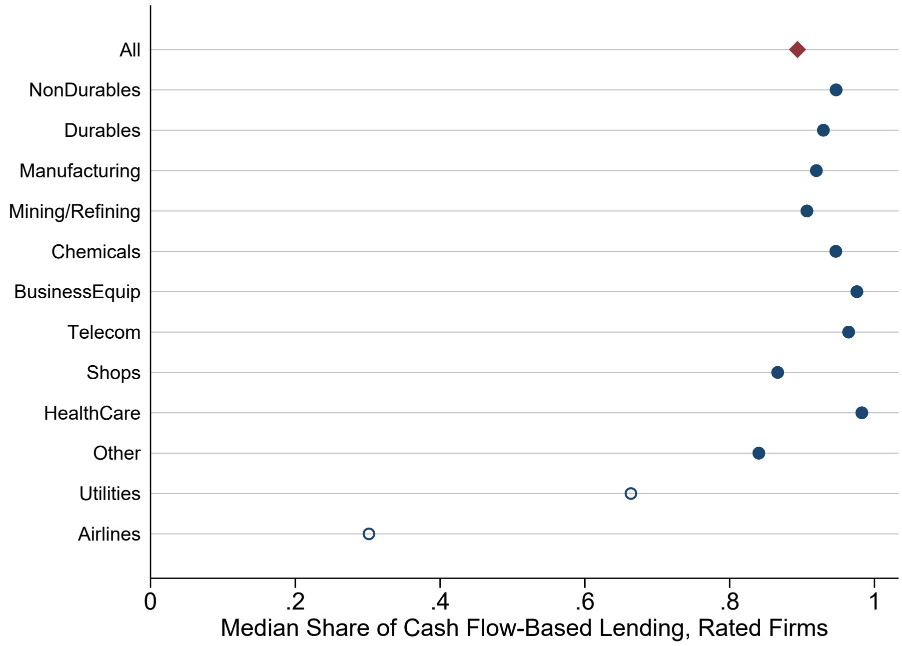


Figure 4: Prevalence of Cash Flow-Based Lending and EBCs: Rated Firms by Industry

This figure shows the prevalence of cash flow-based lending and EBCs across major industry groups. We focus on rated firms to make firm size and capital market access more comparable across industries. The industry groups are Fama-French 12 industries plus airlines (two digit SIC is 45). Panel A shows the median share of cash flow-based lending in all rated firms and in rated firms of each industry group. Panel B shows the fraction of firms with earnings-based covenants in each group.

Panel A. Median Share of Cash Flow-Based Lending



Panel B. Fraction of Firms with EBCs

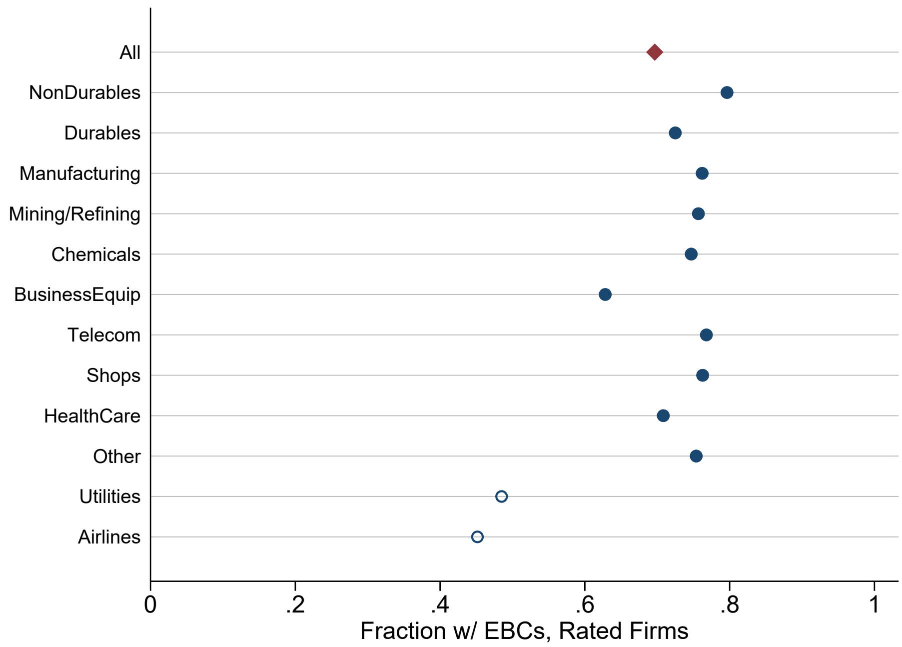
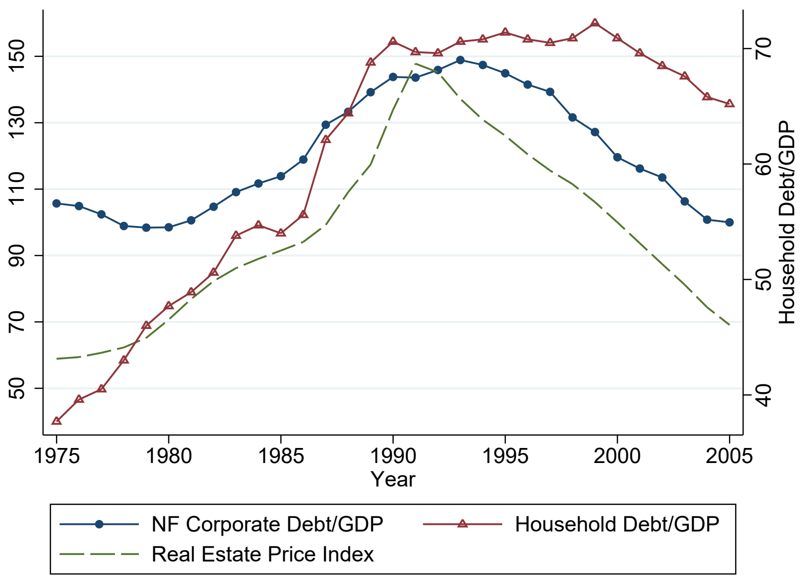


Figure 5: Property Price Cycle and Corporate Debt Cycle: Japan vs. US

This plot shows the dynamics of non-financial corporate debt and household debt over the property price cycle in Japan (1975 to 2005) and the US (1990 to 2015). In each plot, the green dashed line is the real estate price index in each country. The blue line with circles is non-financial corporate debt scaled by GDP. The red ling is household debt scaled by GDP. The real estate price index in Japan uses urban land price index from the Statistic Bureau in the Ministry of Internal Affairs and Communications. The real estate price index in the US uses the Case-Shiller price index. The debt data are from the BIS database on credit to the non-financial sector.

Panel A. Japan



Panel B. US

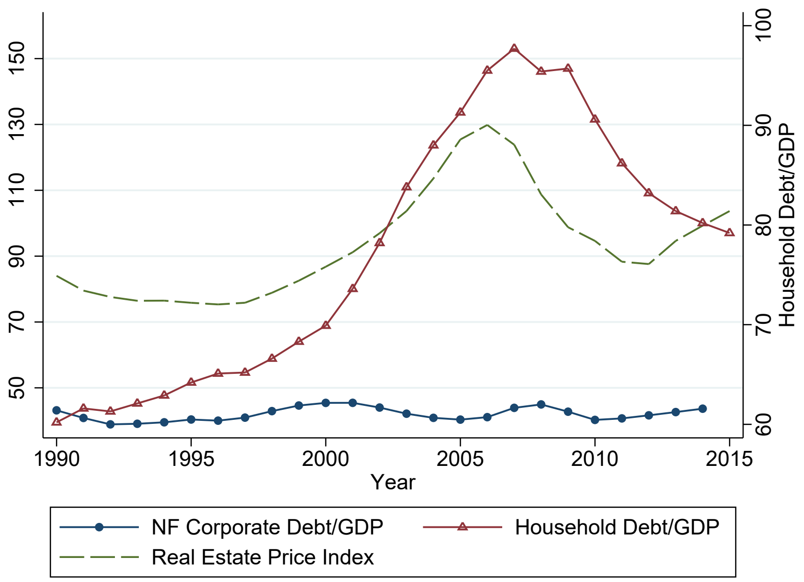


Table 1: Composition of Corporate Borrowing

This table summarizes the composition of corporate debt. Panel A shows aggregate estimates by debt type. Panel B shows median share by firm group (among public non-financial firms). Procedures for aggregate estimates and firm-level analyses are explained in detail in Appendix B.

Panel A. Aggregate Corporate Debt Share by Type:

Category	Debt Type	Share
Asset-based lending (20%)	Mortgage	6.5%
	Asset-based loans	13.5%
Cash flow-based lending (80%)	Corporate bond	48.0%
	Cash flow-based loans	32.0%

Panel B. Firm-Level Median Share by Group (Public Firms)

	Large Firms	Rated Firms	Small Firms
Asset-based lending	12.4%	8.0%	61.0%
Cash flow-based lending	83.0%	89.0%	7.2%

Table 2: Summary Statistics of US Non-Financial Firms

Summary statistics of non-financial firm samples. Panel A shows statistics for large firms with EBCs. Large firms are those with size (assets) above Compustat median, and EBCs are based on DealScan and FISD data. Mean, median, standard deviation, and selected percentiles are presented. Panel B shows statistics for several firm groups that are not bound by EBCs, including large firms without earnings-based covenants (primarily use cash flow-based lending but are far from constraints), as well as small firms, low margin firms, and airlines and utilities that rely more on asset-based lending. Medians are presented for each group. EBITDA is earnings before interest, taxes, and depreciation. OCF is net cash receipts from operations. MTB is market equity to book equity. Q is calculated as the sum of market value of equity and book value of debt, divided by book assets. EDF is expected default frequency. AR stands for accounts receivable, PPE is the book value of property, plant, and equipment, CAPX is capital expenditures (spending on property, plant, and equipment). As is customary, flow variables are normalized by lagged assets and stock variables are normalized by contemporaneous assets throughout the paper. CFL share is median share of cash flow-based lending in each firm group. The sample period is 1996 to 2015 because comprehensive data on financial covenants from DealScan began in 1996.

Panel A. Large Firms w/ EBCs

Variable	p25	p50	p75	mean	s.d.	N
Log assets	6.36	7.16	8.15	7.33	1.33	17,458
Log market cap	5.94	6.91	7.95	6.95	1.57	17,458
EBITDA	68.39	172.15	464.44	611.98	2110.27	17,458
EBITDA/l.assets	0.09	0.13	0.19	0.14	0.09	17,458
EBITDA/sales	0.08	0.14	0.21	0.14	0.52	17,458
Debt/EBITDA	1.03	2.18	3.80	2.70	3.49	17,458
Debt/assets	0.17	0.29	0.43	0.31	0.22	17,458
EDF	0.00	0.00	0.07	0.13	0.26	17,458
Q	0.79	1.06	1.54	1.30	0.87	17,458
MTB	1.13	1.86	3.00	2.44	2.89	17,150
OCF/l.assets	0.08	0.12	0.16	0.12	0.08	17,445
Cash/assets	0.02	0.05	0.12	0.09	0.10	17,458
PPE/assets	0.13	0.26	0.48	0.32	0.24	17,458
Inventory/assets	0.01	0.08	0.18	0.12	0.12	17,458
AR/assets	0.07	0.12	0.20	0.15	0.11	17,458
Intangible/assets	0.05	0.16	0.34	0.22	0.20	17,458
Net LT debt issuance/l.assets	-0.02	0.00	0.05	0.03	0.15	16,186
CAPX/l.assets	0.02	0.04	0.07	0.06	0.07	17,371
R&D/l.assets	0.00	0.01	0.04	0.03	0.05	8,826
CFL share	0.46	0.88	0.99	0.69	0.36	10,855

Panel B. Other Firm Groups

	Large w/o EBCs		Small		Low Margin		Air & Utilities	
Variable	p50	N	p50	N	p50	N	p50	N
Log assets	6.85	11,382	4.09	22,336	5.08	25,676	7.98	2,584
Log market cap	7.05	11,382	4.08	22,336	4.88	25,676	7.18	2,584
EBITDA	119.58	11,382	2.19	22,336	5.37	25,676	282.15	2,584
EBITDA/l.assets	0.12	11,382	0.06	22,336	0.06	25,676	0.10	2,584
EBITDA/sales	0.14	11,382	0.04	22,336	0.03	25,676	0.21	2,584
Debt/EBITDA	0.99	11,382	0.00	22,336	0.48	25,676	3.61	2,584
Debt/assets	0.18	11,382	0.07	22,336	0.18	25,676	0.36	2,584
EDF	0.00	11,382	0.01	22,336	0.02	25,676	0.00	2,584
Q	1.25	11,382	1.23	22,336	0.99	25,676	0.86	2,584
MTB	2.07	11,382	1.78	22,336	1.55	25,676	1.63	2,584
OCF/l.assets	0.11	11,377	0.05	22,289	0.06	25,631	0.10	2,580
Cash/assets	0.13	11,382	0.19	22,336	0.12	25,676	0.02	2,584
PPE/assets	0.21	11,382	0.13	22,336	0.17	25,676	0.63	2,584
Inventory/assets	0.06	11,382	0.08	22,336	0.07	25,676	0.02	2,584
AR/assets	0.11	11,382	0.15	22,336	0.13	25,676	0.06	2,584
Intangible/assets	0.08	11,382	0.04	22,336	0.07	25,676	0.02	2,584
Net LT debt issuance/l.assets	0.00	10,778	0.00	21,166	0.00	24,151	0.00	2,518
CAPX/l.assets	0.04	11,309	0.03	22,150	0.03	25,488	0.07	2,569
R&D/l.assets	0.05	7,085	0.08	15,485	0.07	16,474	0.01	89
CFL share	0.88	5,277	0.00	8,634	0.47	12,256	0.66	1,531

Table 3: Debt Issuance and Investment Activities: Large Firms w/ EBCs

Firm-level annual regressions of debt issuance and investment activities:

$$Y_{it} = \alpha_i + \eta_t + \beta \text{EBITDA}_{it} + \kappa \text{OCF}_{it} + X'_{it}\gamma + \epsilon_{it}$$

In Panel A the outcome variable Y_{it} is net debt issuance. In Columns (1) and (2) Y_{it} is our main debt issuance measure: net debt issuance in year t from the statement of cash flows, calculated as issuance minus reduction of long-term debt (Compustat item DLTIS - DLTR), normalized by assets at the end of year $t-1$. In Columns (3) to (4) Y_{it} is changes in total book debt in year t. In Columns (5) to (8), Y_{it} is changes in both secured debt and unsecured debt, using data from CapitalIQ. In Panel B, the outcome variable Y_{it} is investment activities. In Columns (1) and (2), Y_{it} is capital expenditures (Compustat variable CAPX, which covers purchases of plant, property, and equipment) in year t, normalized by assets at the end of year $t-1$. In Columns (3) and (4), Y_{it} is R&D expenditures (Compustat variable XRD, only non-missing for a subset of firms). EBITDA_{it} is earnings before interest, taxes, depreciation and amortization (Compustat item EBITDA) in year t, normalized by assets at the end of year $t-1$. OCF_{it} is net cash receipts from operating activities (Compustat item OANCF + XINT) in year t. Control variables X_{it} include Q (market value of equity plus book value of debt normalized by book assets) as of the beginning of year t, stock returns in year $t-1$, as well as cash holdings, book leverage (debt/assets), book PPE (plan, property, equipment), intangible assets, margin, size (log assets) at the end of $t-1$. We also control for net operating assets at the end of year $t-1$ as a proxy for accounting quality (Hirshleifer, Hou, Teoh, and Zhang, 2004), and lagged EBITDA to focus on the impact of current EBITDA. Firm fixed effects and year fixed effects are included (R^2 does not include fixed effects). Sample period is 1996 to 2015. The sample is restricted to large US non-financial firms that have earnings-based covenants in year t. Standard errors are clustered by firm and time.

Panel A. Debt Issuance

	Net LT Debt Iss.		Δ Book Debt		Δ Unsec. Debt		Δ Secured Debt	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EBITDA	0.216***	0.273***	0.345***	0.412***	0.209***	0.232***	0.103***	0.125***
	(0.030)	(0.034)	(0.039)	(0.042)	(0.037)	(0.041)	(0.031)	(0.033)
OCF		-0.111***		-0.135***		-0.048		-0.045*
		(0.033)		(0.045)		(0.033)		(0.027)
Q	0.010**	0.011**	0.004	0.005	0.010**	0.011**	0.005	0.005
	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)
Past 12m stock ret	-0.003	-0.003	0.002	0.001	0.002	0.002	-0.008***	-0.008***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
L.Cash holding	-0.033	-0.033	0.039	0.039	-0.117***	-0.117***	0.052	0.052
	(0.043)	(0.044)	(0.051)	(0.052)	(0.044)	(0.043)	(0.045)	(0.045)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Obs	15,642	15,642	15,576	15,576	11,693	11,693	11,678	11,678
R^2	0.114	0.116	0.152	0.154	0.069	0.069	0.030	0.030

Standard errors in parentheses, clustered by firm and time

Panel B. Investment Activities

	CAPX		R&D	
	(1)	(2)	(3)	(4)
EBITDA	0.129***	0.101***	0.031***	0.035***
	(0.017)	(0.019)	(0.012)	(0.013)
OCF		0.053***		-0.007
		(0.013)		(0.011)
Q	0.011***	0.011***	0.004***	0.004***
	(0.002)	(0.002)	(0.002)	(0.002)
Past 12m stock ret	0.004*	0.004*	-0.003***	-0.003***
	(0.002)	(0.002)	(0.001)	(0.001)
L.Cash holding	0.015	0.015	-0.005	-0.004
	(0.013)	(0.013)	(0.012)	(0.012)
Controls	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Obs	16,907	16,907	8,588	8,586
R^2	0.156	0.160	0.108	0.108

Standard errors in parentheses, clustered by firm and time

Table 4: Debt Issuance and Investment Activities: Firms w/ Low Prevalence of EBCs

Firm-level annual panel regressions of debt issuance and investment activities on EBITDA:

$$Y_{it} = \alpha_i + \eta_t + \beta \text{EBITDA}_{it} + \kappa \text{OCF}_{it} + X'_{it}\gamma + \epsilon_{it}$$

The regressions are the same as those in Table 3. In Panel A, the outcome variable is net long-term debt issuance; in Panel B, the outcome variable is capital expenditures. Results are presented for several groups not bound by EBCs: large firms without earnings-based covenants, which use cash flow-based lending but have lower debt and are far from constraints; small firms, which have low prevalence of cash flow-based lending and EBCs; low margin firms, which have low prevalence of cash flow-based lending and EBCs; airlines and utilities, which have low prevalence of cash flow-based lending and EBCs. Sample period is 1996 to 2015. Standard errors are clustered by firm and time.

Panel A. Net LT Debt Issuance

	Large w/o EBCs		Small		Low Margin		Air & Utilities	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EBITDA	-0.059***	0.023	-0.019***	0.001	-0.025***	-0.001	-0.093**	-0.059
	(0.021)	(0.027)	(0.007)	(0.009)	(0.008)	(0.010)	(0.045)	(0.061)
OCF		-0.127***		-0.033***		-0.039***		-0.050
		(0.027)		(0.011)		(0.010)		(0.079)
Q	0.007***	0.007***	0.004***	0.004***	0.007***	0.007***	0.042**	0.044**
	(0.003)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.018)	(0.019)
Past 12m stock ret	0.001	0.001	0.002	0.002	0.003	0.003	0.003	0.002
	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.010)	(0.010)
L.Cash holding	-0.048**	-0.042*	-0.055***	-0.059***	-0.071***	-0.076***	-0.109**	-0.130**
	(0.024)	(0.024)	(0.016)	(0.017)	(0.019)	(0.020)	(0.055)	(0.063)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Obs	10,137	10,136	20,153	20,129	22,557	22,534	2,475	2,474
R^2	0.073	0.078	0.029	0.030	0.036	0.038	0.087	0.088

Standard errors in parentheses, clustered by firm and time

Panel B. CAPX Investment

	Large w/o EBCs		Small		Low Margin		Air & Utilities	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EBITDA	0.053***	0.033*	0.001	-0.002	0.002	-0.004	0.079	0.025
	(0.012)	(0.019)	(0.004)	(0.004)	(0.005)	(0.004)	(0.049)	(0.046)
OCF		0.024**		0.005		0.011**		0.158***
		(0.011)		(0.004)		(0.005)		(0.038)
Q	0.004***	0.004***	0.006***	0.006***	0.006***	0.006***	0.029***	0.026***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.010)	(0.010)
Past 12m stock ret	0.006***	0.006***	0.004***	0.004***	0.004***	0.004***	0.007	0.006
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.006)	(0.006)
L.Cash holding	-0.019*	-0.019*	0.005	0.006	0.002	0.003	-0.018	-0.004
	(0.011)	(0.011)	(0.006)	(0.006)	(0.005)	(0.005)	(0.056)	(0.056)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Obs	10,683	10,681	21,249	21,222	24,045	24,020	2,535	2,534
R^2	0.107	0.108	0.043	0.043	0.046	0.047	0.122	0.144

Standard errors in parentheses, clustered by firm and time

Table 5: Changes in EBITDA: Accounting Natural Experiment

Cross-sectional instrumental variable regression

$$Y_i^{06} = \alpha + \beta \widehat{\text{EBITDA}}_i^{06} + X_i'\gamma + \epsilon_i$$

where EBITDA_i^{06} is EBITDA in fiscal year 2006 (normalized by beginning of year assets), and is instrumented with average option compensation expense (Compustat XINTOPT, normalized by assets) in fiscal years 2002 to 2004. Control variables include sales and OCF (which are not affected by the rule change), as well as three lags of the outcome variable, EBITDA, annual stock returns, and market to book ratio by 2004, as well as all the control variables in Table 3 as of 2004. Industry (Fama-French 12 industries) fixed effects are included; R^2 does not include fixed effects. Panel A presents the first stage. Panel B presents the IV results. In columns (1) to (3), Y is net long-term debt issuance in fiscal year 2006; in columns (4) and (6), Y is capital expenditures in fiscal year 2006. Results are presented separately for large firms with EBCs, large firms without EBCs, and small firms. Robust standard errors in parentheses.

Panel A. First Stage

	EBITDA_i^{06}		
	Large w/ EBCs	Large w/o EBCs	Small
Avg. option comp expense 02-04	-0.857***	-0.721***	-0.520**
	(0.212)	(0.134)	(0.208)
Obs	686	435	727

Standard errors in parentheses

Panel B. IV

	Net LT Debt Iss			CAPX		
	Large w/ EBCs	Large w/o EBCs	Small	Large w/ EBCs	Large w/o EBCs	Small
$\widehat{\text{EBITDA}}_i^{06}$	0.869**	-0.327	0.225	0.497**	0.014	0.002
	(0.451)	(0.344)	(0.366)	(0.225)	(0.169)	(0.136)
1st stage F	16.39	23.42	9.08	16.39	23.42	9.08
Obs	686	435	727	686	435	727

Standard errors in parentheses

Table 6: Debt Issuance and Investment Activities: Large vs. Small Firms

Firm-level annual panel regressions of debt issuance and investment activities on EBITDA:

$$Y_{it} = \alpha_i + \eta_t + \beta \text{EBITDA}_{it} + \kappa \text{OCF}_{it} + X_{it}'\gamma + \epsilon_{it}$$

The outcome variable is net long-term debt issuance in Panel A, and capital expenditures in Panel B. Control variables are the same as those in Table 3. Regression results are presented separately for all large firms (assets above Compustat median) and all small firms. Firm fixed effects and year fixed effects are included (R^2 does not include fixed effects). Sample period is 1996 to 2015. Standard errors are clustered by firm and time.

Panel A. Net LT Debt Issuance

	Large Firm		Small Firm	
	(1)	(2)	(3)	(4)
EBITDA	0.092***	0.173***	-0.019***	0.001
	(0.020)	(0.023)	(0.007)	(0.009)
OCF		-0.141***		-0.033***
		(0.022)		(0.011)
Q	0.007***	0.007***	0.004***	0.004***
	(0.002)	(0.002)	(0.001)	(0.001)
Past 12m stock ret	0.001	0.000	0.002	0.002
	(0.003)	(0.003)	(0.002)	(0.002)
L.Cash holding	-0.027	-0.026	-0.055***	-0.059***
	(0.020)	(0.021)	(0.016)	(0.017)
Controls	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Obs	26,165	26,164	20,153	20,129
R^2	0.076	0.080	0.029	0.030

Standard errors in parentheses, clustered by firm and time

Panel B. CAPX Investment

	Large Firm		Small Firm	
	(1)	(2)	(3)	(4)
EBITDA	0.099***	0.078***	0.001	-0.002
	(0.011)	(0.012)	(0.004)	(0.004)
OCF		0.038***		0.005
		(0.008)		(0.004)
Q	0.006***	0.006***	0.006***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Past 12m stock ret	0.005***	0.005***	0.004***	0.004***
	(0.002)	(0.002)	(0.001)	(0.001)
L.Cash holding	0.013*	0.014*	0.005	0.006
	(0.007)	(0.008)	(0.006)	(0.006)
Controls	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Obs	27,982	27,980	21,249	21,222
R^2	0.129	0.131	0.043	0.043

Standard errors in parentheses, clustered by firm and time

Table 7: Firm Outcomes and EBITDA: US vs. Japan

Comparison of the sensitivity to EBITDA in US and Japan. Panel A presents summary statistics of the US and Japan sample. The sample covers all large non-financial firms in US and Japan (asset above Compustat median in the respective country). Panel B presents firm-level annual regressions of debt issuance and investment activities on EBITDA:

$$Y_{it} = \alpha_i + \eta_t + \beta \text{EBITDA}_{it} + \kappa \text{OCF}_{it} + X'_{it}\gamma + \epsilon_{it}$$

The right hand side variables are the same as those in Table 3. The outcome variables Y_{it} include change in book debt and capital expenditures in year t, normalized by assets at the end of year $t-1$. Here we do not use net long-term debt issuance from the statement of cash flows because it is not available for Japan. Firm fixed effects and year fixed effects are included (R^2 does not include fixed effects). Sample period is 1996 to 2015. Standard errors are clustered by firm and time.

Panel A. Summary Statistics

	US					Japan				
Variables	p25	p50	p75	mean	N	p25	p50	p75	mean	N
Log assets	6.20	7.06	8.19	7.30	28,840	6.34	6.93	7.83	7.25	20,567
Log market cap	5.97	6.97	8.09	7.06	28,840	5.23	6.06	7.16	6.28	20,567
EBITDA	52.83	153.91	493.51	789.55	28,840	37.11	79.89	216.46	357.67	20,567
EBITDA/l.assets	0.08	0.13	0.19	0.13	28,840	0.05	0.08	0.11	0.08	20,567
EBITDA/sales	0.08	0.14	0.22	0.06	28,840	0.04	0.08	0.12	0.09	20,567
Debt/EBITDA	0.47	1.78	3.53	2.10	28,840	0.74	2.51	5.49	4.40	20,567
Debt/assets	0.10	0.26	0.39	0.27	28,840	0.07	0.20	0.35	0.23	20,567
Q’	0.80	1.12	1.70	1.46	28,840	0.50	0.66	0.85	0.74	20,567
MTB	1.20	1.94	3.18	2.62	28,840	0.66	0.97	1.45	1.21	20,567
OCF/l.assets	0.07	0.12	0.16	0.12	28,822	0.03	0.06	0.09	0.06	20,491
Cash/assets	0.02	0.07	0.19	0.14	28,840	0.07	0.12	0.19	0.14	20,567
PPE/assets	0.11	0.24	0.46	0.31	28,840	0.20	0.30	0.41	0.32	20,567
Inventory/assets	0.01	0.07	0.17	0.11	28,840	0.06	0.11	0.16	0.12	20,567
AR/assets	0.06	0.12	0.19	0.14	28,840	0.14	0.21	0.29	0.23	20,567
Intangible/assets	0.03	0.13	0.30	0.19	28,840	0.00	0.01	0.02	0.02	20,567
Δbook debt/l.assets	-0.02	0.00	0.05	0.03	28,783	-0.02	0.00	0.01	0.00	20,438
CAPX/l.assets	0.02	0.04	0.07	0.06	28,680	0.02	0.03	0.05	0.04	20,195

Panel B. Results

	Change in Book Debt				CAPX Investment			
	US Large NF		JPN Large NF		US Large NF		JPN Large NF	
EBITDA	0.160***	0.283***	-0.178***	-0.022	0.099***	0.078***	0.037***	0.017
	(0.028)	(0.025)	(0.021)	(0.016)	(0.011)	(0.012)	(0.012)	(0.011)
OCF		-0.194***		-0.329***		0.038***		0.020**
		(0.030)		(0.020)		(0.008)		(0.010)
Q	0.003*	0.003*	0.013***	0.011***	0.006***	0.006***	0.008***	0.008***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)
Past 12m stock ret	0.003	0.003	-0.004***	-0.004***	0.005***	0.005***	-0.001	-0.001
	(0.003)	(0.003)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
L.Cash holding	0.020	0.023	-0.072***	-0.081***	0.013*	0.014*	-0.012	-0.012
	(0.028)	(0.028)	(0.016)	(0.017)	(0.007)	(0.008)	(0.008)	(0.007)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Obs	27,936	27,919	20,422	20,338	27,982	27,980	20,176	20,086
R^2	0.116	0.123	0.112	0.169	0.129	0.131	0.071	0.070

Standard errors in parentheses, clustered by firm and time

Table 8: Summary Statistics: Firm Property Value

Summary statistics of firms in the samples with market value of real estate measures. The column labeled "Method 1" refers to the sample where market value of real estate estimates are available using Method 1 described in Section 4.1 and Appendix F, which follows the traditional procedure (Chaney et al., 2012). The column labeled "Method 2" refers to the sample where market value of real estate estimates are available using Method 2 described in Section 4.1 and Appendix F, which uses hand collected information from 10-K filings. The column labeled "All w/ RE" includes all non-financial firms with non-zero real estate holdings. Panel A displays statistics for the period 2002 to 2015 (sample period in Table 9), for which we have firm-level measures of asset-based and cash flow-based lending. Panel B displays additional statistics for the period 2007 to 2019 (sample period in Table 10). $\Delta \text{RE}_{06}^{07-09}/\text{sssets}_{06}$ is the gain/loss on 2006 real estate holdings during the crisis, normalized by assets in 2006. $\Delta P^{07-09}(\text{HQ})$ is the percentage change in property price index in headquarters CBSA from 2007 to 2009. The remaining statistics are changes in EBITDA, net long-term debt issuance, and capital expenditures between 2007 and 2009, normalized by assets in 2006.

	Sample		
	Method 1	Method 2	All w/ RE
	Panel A. 2002—2015		
Market Value RE/assets	0.21	0.13	-
Market Value RE/market cap	0.21	0.12	-
Book PPE/assets	0.25	0.21	0.25
EBITDA/l.assets	0.14	0.13	0.12
Q	1.15	1.14	1.10
Debt/assets	0.22	0.19	0.24
Log assets	7.08	6.30	6.84
Asset-based lending/debt	0.12	0.25	0.22
Cash flow-based lending/debt	0.85	0.66	0.74
Asset-based lending/assets	0.02	0.02	0.03
Cash flow-based lending/assets	0.16	0.09	0.14
Net LT Debt issuance/assets	0.00	0.00	0.00
CAPX/l.assets	0.04	0.04	0.04
Fraction of large firms	0.76	0.63	0.71
Fraction w/ EBCs	0.60	0.55	0.56
	Panel B. 2007—2009		
$\Delta \text{RE}_{06}^{07-09}/\text{assets}_{06}$	-0.01	-0.01	-
$\Delta P^{07-09}(\text{HQ})$	-0.07	-0.08	-0.07
$\Delta \text{EBITDA}_{06}^{07-09}/\text{assets}_{06}$	-0.02	-0.01	-0.01
$\Delta \text{Net LT Debt Iss}_{06}^{07-09}/\text{assets}_{06}$	0.00	0.00	0.00
$\Delta \text{CAPX}_{06}^{07-09}/\text{assets}_{06}$	-0.01	-0.01	-0.01

Table 9: Corporate Borrowing and Property Collateral Value

Firm-level panel regressions of debt issuance on real estate value:

$$Y_{it} = \alpha_i + \beta \text{RE}_{it} + X'_{it}\gamma + \epsilon_{it}$$

The outcome variable Y_{it} is net long-term debt issuance in columns (1) and (2), change in asset-based lending in columns (3) and (4), change in cash flow-based lending in columns (5) and (6), all normalized by beginning-of-year assets. The main independent variable is RE_{it}, which is beginning-of-year market value of real estate calculated using two methods described in Section 4.1 and Appendix F. Other independent variables include EBITDA and net cash receipts OCF in year t, Q, cash holdings, book leverage, inventory and receivables, and size (log assets) at the beginning of year t. Firm fixed effects and year fixed effects are included (R^2 does not include fixed effects). Panel A presents results for all firms where market value of real estate estimates are available. Panel B restricts to the subsample with firms in tradable industries only. Sample period is 2002 to 2015. Standard errors are clustered by firm and time.

Panel A. All Sample Firms

	Net LT Debt Iss		Δ Asset-Based		Δ CF-Based	
	(1)	(2)	(3)	(4)	(5)	(6)
RE (Method 1)	0.030**		0.042**		-0.007	
	(0.014)		(0.021)		(0.022)	
RE (Method 2)		0.029**		0.030**		-0.002
		(0.014)		(0.016)		(0.026)
EBITDA	0.216***	0.173***	0.151***	0.105***	0.130*	0.093***
	(0.053)	(0.029)	(0.040)	(0.031)	(0.069)	(0.035)
OCF	-0.157***	-0.194***	-0.120***	-0.152***	-0.088**	-0.072
	(0.035)	(0.043)	(0.025)	(0.030)	(0.038)	(0.047)
Q	0.011**	0.014***	-0.004	0.000	0.006	0.015***
	(0.005)	(0.005)	(0.002)	(0.004)	(0.006)	(0.005)
L.Cash holding	-0.095***	-0.073***	-0.075***	-0.044**	0.012	-0.019
	(0.027)	(0.021)	(0.027)	(0.022)	(0.032)	(0.035)
Controls	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Obs	4,999	4,551	4,999	4,551	4,999	4,551
R^2	0.116	0.120	0.196	0.217	0.193	0.244

Standard errors in parentheses, clustered by firm and time

Panel B. Tradable Firms Only

	Net LT Debt Iss		Δ Asset-Based		Δ CF-Based	
	(1)	(2)	(3)	(4)	(5)	(6)
RE (Method 1)	0.024		0.060**		-0.090***	
	(0.031)		(0.030)		(0.027)	
RE (Method 2)		0.063**		0.075*		-0.003
		(0.031)		(0.040)		(0.022)
EBITDA	0.182***	0.136***	0.119***	0.065**	0.121*	0.109**
	(0.055)	(0.043)	(0.046)	(0.033)	(0.071)	(0.050)
OCF	-0.155***	-0.170***	-0.109***	-0.141***	-0.097**	-0.089*
	(0.035)	(0.045)	(0.039)	(0.035)	(0.047)	(0.048)
Q	0.006	0.016**	-0.005*	0.003	0.002	0.013
	(0.005)	(0.007)	(0.003)	(0.003)	(0.008)	(0.008)
L.Cash holding	-0.047	-0.074***	-0.081***	-0.063**	0.040	-0.020
	(0.038)	(0.027)	(0.030)	(0.029)	(0.040)	(0.036)
Controls	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Obs	3,174	2,820	3,174	2,820	3,174	2,820
R^2	0.111	0.122	0.212	0.234	0.211	0.195

Standard errors in parentheses, clustered by firm and time

Table 10: The Great Recession: Unpacking the Property Price Effect

Cross-sectional regression of firm outcomes in the Great Recession and value of firm real estate:

$$\Delta Y_i^{07-09} = \alpha + \lambda \Delta \text{RE}_{i,06}^{07-09} + \eta \text{RE}_i^{06} + \phi \Delta P_i^{07-09} + X_i' \gamma + u_i$$

Y_i^{07-09} is firm-level outcome from 2007 to 2009: in Panel A ΔY_i^{07-09} is the change in net long-term debt issuance between 2007 and 2009, in Panel B Y_i^{07-09} is the change in CAPX between 2007 and 2009, normalized by assets by the end of 2006. The main independent variable $\Delta \text{RE}_i^{07-09}$ is the estimated gain/loss on firm i's 2006 real estate holdings during the Great Recession, normalized by assets at the end of 2006. RE_i^{06} is the estimated market value of firm i's real estate at the end of 2006, normalized by assets at the end of 2006. ΔP_i^{07-09} is the percentage change in property value in firm i's location. The market value of firms' real estate is estimated using two different methods (labeled in the columns), as described in Section 4.1 and Appendix F. Controls include changes in EBITDA and OCF from 2007 to 2009 (normalized by assets by the end of 2006), pre-crisis Q and change in Q from 2007 to 2009, cash holdings, book leverage (debt/assets), inventory, receivables, and size by the end of 2006. Industry (Fama-French 12 industries) fixed effects are included; R^2 does not include fixed effects. Estimates using both OLS and LAD are presented. Robust standard errors in parentheses.

Panel A. Net LT Debt Issuance

	Method 1		Method 2	
ΔLT Debt Iss$^{07-09}$	OLS	LAD	OLS	LAD
$\Delta \text{RE}_{06}^{07-09}$	-0.121	-0.086	-0.135	-0.028
	(0.362)	(0.239)	(0.241)	(0.079)
RE_{06}	-0.042	-0.004	-0.009	-0.007
	(0.030)	(0.024)	(0.032)	(0.013)
ΔP^{07-09}	0.076	0.024	-0.020	0.003
	(0.082)	(0.045)	(0.059)	(0.023)
$\Delta \text{EBITDA}^{07-09}$	0.189**	0.160**	0.109*	0.044
	(0.085)	(0.066)	(0.065)	(0.028)
$\Delta \text{OCF}^{07-09}$	-0.189***	-0.168***	-0.218***	-0.070**
	(0.073)	(0.047)	(0.055)	(0.033)
ΔQ^{07-09}	0.019**	0.005	0.013**	0.004
	(0.007)	(0.007)	(0.006)	(0.004)
Q_{06}	-0.001	-0.005	0.006	0.002
	(0.008)	(0.005)	(0.004)	(0.006)
Cash_{06}	-0.018	0.006	0.041	0.012
	(0.053)	(0.043)	(0.037)	(0.022)
Obs	384	384	466	466
R^2	0.108	-	0.161	-

Standard errors in parentheses

Panel B. Capital Expenditures

	Method 1		Method 2	
$\Delta \text{CAPX}^{07-09}$	OLS	LAD	OLS	LAD
$\Delta \text{RE}_{06}^{07-09}$	0.086	-0.008	0.078	0.030
	(0.120)	(0.104)	(0.075)	(0.062)
RE_{06}	0.005	-0.003	0.012	0.013
	(0.012)	(0.012)	(0.012)	(0.010)
ΔP^{07-09}	0.037	0.018	0.001	0.009
	(0.025)	(0.020)	(0.017)	(0.009)
$\Delta \text{EBITDA}^{07-09}$	0.101***	0.098***	0.064**	0.061***
	(0.024)	(0.018)	(0.025)	(0.015)
$\Delta \text{OCF}^{07-09}$	-0.032	-0.028*	-0.041**	-0.027**
	(0.021)	(0.015)	(0.019)	(0.013)
ΔQ^{07-09}	0.014***	0.008***	0.010***	0.007***
	(0.003)	(0.002)	(0.002)	(0.002)
Q_{06}	0.003	0.002	0.002	0.002
	(0.002)	(0.002)	(0.001)	(0.002)
Cash_{06}	-0.021	-0.016	0.002	0.013*
	(0.016)	(0.014)	(0.013)	(0.008)
Obs	380	380	464	464
R^2	0.262	-	0.218	-

Standard errors in parentheses

Table 11: Property Price Collapse and Firm Investment: US vs. Japan

This table compares results in Gan (2007)'s analysis of Japanese firms during Japan's property price collapse and similar specifications using US firms during the Great Recession. The specification follows Table 2 column (2) of Gan (2007):

$$\text{CAPX}_i^{post} = \alpha + \beta \text{RE}_i^{pre} + X_i'\gamma + v_i$$

CAPX_i^{post} is firm i's average annual investment rate (CAPX normalized by assets) over a period of time during the property price collapse, and the period is labeled in row "Outcome Period." RE_i^{pre} is firm i's real estate holdings prior to the collapse (normalized by pre-collapse assets). Gan (2007) uses the estimated market value of land holdings in 1989. In the US sample, we use the market value of real estate in 2006 measured using methods described in Section 4.1 and Appendix F. Controls X_i include cash flows (contemporaneous with investment), as well as Q, cash holdings and book leverage (measured prior to the outcome variable). The regression also follows Gan (2007) to include a dummy variable that is equal to one if the firm's pre-collapse real estate holdings fall into the top industry quartile, and interactions of this dummy with cash flows and cash holdings. Gan (2007) uses least absolute deviation (LAD) estimate, and we report both OLS and LAD estimates.

	CAPX Investment						
	Japan (Gan 07)			US			
Outcome Period	1994—1998	2007-2009		2007-2011		2009-2013	
Specification	LAD	OLS	LAD	OLS	LAD	OLS	LAD
RE 1989	-0.165***						
	(0.016)						
RE 2006	-	0.007	0.014	-0.001	0.007	-0.01	0.004
Method 1	-	(0.009)	(0.008)	(0.008)	(0.005)	(0.009)	(0.004)
RE 2006	-	0.007	0.002	0.008	0.005	-0.005	-0.004
Method 2	-	(0.007)	(0.004)	(0.007)	(0.005)	(0.005)	(0.005)

Standard errors in parentheses

B Cash Flow-Based Lending and Asset-Based Lending

In this section, we explain in detail the categorization of cash flow-based lending and asset-based lending. We first lay out the main types of debt in each category. We then describe our categorization procedure in the aggregate and at the firm level.[43]

Cash Flow-Based Lending

Cash flow-based lending consists of debt where creditors' payoffs primarily come from the value of cash flows from firms' operations, rather than the liquidation value of physical collateral (both in ordinary course and in bankruptcy). The debt has several features: 1) it is unsecured, or secured by a lien on the entire corporate entity (substantially all assets, excluding those pledged for asset-based loans) or by equity, rather than by specific physical assets; 2) they closely monitor borrower's cash flows (e.g. through financial covenants), rather than the liquidation value of physical assets.

In US bankruptcy procedures, claims are grouped into secured claims and unsecured claims, with secured claims ranking before unsecured claims in priority. The portion of a secured debt up to the value of its collateral is treated as a secured claim; the rest is treated as an unsecured claim. For unsecured claims, in both Chapter 11 reorganization and Chapter 7 liquidation, the payoffs are not closely related to the liquidation value of physical assets (payoffs depend on the cash flow value from continuing operations in Chapter 11, and are generally minimal in Chapter 7). For debt secured by the entire corporate entity or by equity, creditors' collateral value and payoffs are based on the cash flow value from continuing operations in Chapter 11. Payoffs in Chapter 7 may be affected by the liquidation value of physical assets, but they are generally small and Chapter 7 cases are rare for large firms that extensively use cash-flow based lending (according to CapitalIQ data, more than 90% of large firms' bankruptcies are resolved through Chapter 11).

There are two main components of cash flow-based lending: corporate bonds and cash flow-based loans.

1. Corporate bonds

   Corporate bonds are generally backed by borrowers' future cash flows and are commonly unsecured. FISD data shows that less than 1% of corporate debt issuance by US non-financial firms is asset backed. About 10% is secured; a very small portion (e.g. industrial revenue bonds) is backed by physical assets, while most secured bonds are still cash flow-based.

2. Cash flow-based loans

   Cash flow-based loans comprise of commercial loans that are primarily backed by borrowers' cash flows. The prototypical cash flow-based loans do not use specific physical assets as collateral. Rather, the collateral is a lien on the entire corporate entity, and

[43] In the categorization, we do not include commercial papers, which are short-term unsecured debt for liquidity purposes.

the collateral value is calculated based on the cash flows of the borrower. Creditors perform detailed cash flow analyses, and closely monitor borrowers' cash flows. These loans use earnings-based covenants extensively (e.g. debt to EBITDA ratio, interest coverage ratio). They typically take the form of a term loan and are widely used among large firms.

Among large firms, revolving lines of credit ("revolver"), is a class of debt that can be in between cash flow-based lending and asset-based lending. For large firms with high credit quality, the revolvers are generally unsecured. For those with higher risks, the revolvers are typically secured by inventory and accounts receivable (and some other eligible assets). In these cases, the revolvers do rely on physical assets as collateral, and specify borrowing limits of the revolvers that depend on the liquidation value of the physical collateral ("borrowing base," discussed more below). However, due to institutional reasons the revolvers are typically bundled together with prototypical cash flow loans (e.g. term loans) in a single loan package, and share the earnings-based covenants. For small firms, many revolvers are instead stand-alone asset-based loans.

Asset-Based Lending

Asset-based lending consists of debt where creditors' payoffs in default tie to the liquidation value of physical assets that serve as collateral. The debt has the following features: 1) it is secured by specific physical assets as collateral; 2) it restricts the size of the debt based on the value of the given collateral, and creditors focus on the liquidation value of the specific assets that serve as collateral; 3) the debt may also have some liquidity tests, but place less emphasis on the borrower's cash flow performance and related financial covenants.

In US bankruptcy procedures, the portion of the debt up to the liquidation value of the given collateral is considered a secured claim, which is the primary source of recovery for asset-based lenders; the rest ("under-collateralized" portion) is treated as an unsecured claim. In Chapter 7, creditors' payoffs almost entirely come from the liquidation value of the assets; unsecured claims get no or minimal payments. In Chapter 11, creditors' secured claims (up to the collateral value of the assets) can be paid in full;[44] they may get some additional recovery if they are "under-collateralized" and unsecured claims get some payments, but this portion is typically small in comparison.

The most important components of asset-based lending are commercial mortgages and business loans secured by specific assets such as inventory, accounts receivable, and certain types of equipment (often referred to as asset-based loans). We also include capital leases, but the total amount is small.[45]

1. Commercial mortgages

[44] Section 1129(a)(7)(A) of the Bankruptcy Code requires that for a Chapter 11 reorganization to be approved, it must be established that each secured claim holder would receive at least the amount he/she would get if the borrower were liquidated under Chapter 7.

[45] The term "asset-based lending" is sometimes used narrowly to refer to asset-based loans with inventory and receivables as collateral. Here we use the term more broadly.

Commercial mortgages are corporate debt backed by real estate. For larger firms, the collateral is typically commercial real estate, mostly office buildings/corporate headquarters and sometimes retail properties like shopping malls and hotels. Very small firms may also use residential mortgages.

2. Asset-based loans

   Asset-based loans are business (non-mortgage) loans backed by physical assets as collateral, such as inventory, receivable, some machinery and equipment, and some specialized assets such as oil and gas reserves. Asset-based loans specify a "borrowing base," calculated based on the liquidation value of eligible collateral. Creditors regularly monitor the borrowing base and require that the loan size cannot exceed a fraction of the borrowing base. Asset-based loans can be originated by banks, as well as finance companies that specialize in lending against specific types of collateral.

3. Capitalized leases

   In a capital lease, the leased asset shows up on the asset side of the lessee's balance sheet, and the lease shows up on the liability side. Capital leases are often treated as debt (Compustat includes capitalized lease as part of the debt variable). This contrasts with operating leases (e.g. rent), in which case the lease and the lease asset do not appear on the lessee's balance sheet. A lease is recognized as a capital lease when the lessee has exposures to the ownership of the asset, e.g. the lease specifies a transfer of ownership from the lessor to the lessee at the end of the lease period, or that the lease period covers a substantial amount of the life of the asset. US GAAP specifies rules about recognizing capital leases. A well known example of capital lease is used in aircraft financing and studied in Benmelech and Bergman (2011). In this case, a trust purchases the aircraft, leases it to the airline, and finances the purchase by issuing secured notes backed by the aircraft. The trust is sometimes set up by the airline, but is bankruptcy remote. Because the financing of assets in capital leases is often tied to the assets' liquidation value, we categorize capital leases as asset-based lending. As the size of this portion is relatively small (about $70 billion among Compustat public firms), in the following calculations we merge capital leases with asset-based loans.

B.1 Aggregate Composition

In the following, we estimate the share of cash flow-based and asset-based lending among aggregate US non-financial corporate debt outstanding. Here we primarily rely on aggregate sources, so the estimates are not confined to public firms.

Cash Flow-Based Lending: around 80% of debt outstanding

1. Corporate bonds

   - Share in total non-financial corporate debt outstanding: 49%

- Data source: Flow of Funds, FISD, CapitalIQ
- Calculation: According to Flow of Funds data, corporate bond outstanding by US non-financial firms is about $4.5 trillion. Based on FISD and CapitalIQ data, which provide more information on the structure of individual corporate bonds, only a small portion of corporate bonds are backed by specific physical assets (<2%). Thus in the aggregate, we categorize all corporate bonds into cash flow-based lending.

2. Cash flow-based loans

   - Share in total non-financial corporate debt outstanding: 32%
   - Data sources: DealScan, ABL Advisor, Shared National Credits Program (SNC)
   - Calculation: We approximate the volume of cash flow loans using the cash flow-based portion of syndicated loans, which cover the vast majority of cash flow loans by dollar volume. We proceed in two steps. We first estimate the share of cash flow loans versus asset-based loans in syndicated loans, using data from the DealScan and ABL Advisor. In particular, ABL Advisor reports the volume of issuance in DealScan that can be classified as asset-base loans, and we can compare this to the volume of all DealScan issuance to get the asset-based share, and the remainder is the cash flow-based share. We can alternatively calculate (directly using DealScan data) the share of DealScan loans that do not have borrowing base requirements, and the results are very similar. The estimated share of cash flow loans is roughly 95% (annual syndicated loan issuance is about $1,500B to $2,000B, of which $60B to $100B is asset-based). We then turn to the volume of syndicated loans outstanding. Volume outstanding in not included in DealScan. Thus we instead use data on syndicated loans outstanding from SNC, and estimate the amount to be about $3 trillion.

Asset-Based Lending: around 20% of debt outstanding

1. Commercial mortgages

   - Share in total non-financial debt outstanding: 7%
   - Data sources: Flow of Funds
   - Calculation: We use commercial mortgage outstanding from the Flow of Funds, which is around $0.6 trillion.

2. Asset-based loans:

   - Share in total non-financial debt outstanding: 12%
   - Data sources: DealScan, ABL Advisor, SNC, SBA/Call Report

- Calculation: We first estimate asset-based loans to large firms. For this part, we start with data from DealScan, ABL advisor, and SNC data, which proxies the portion of syndicated loans (representative of loans to large firms) that are asset-based. We use the procedure described above: we find that around 5% of syndicated loans are asset-based and multiply it with the size of the syndicated loan market (roughly $3 trillion).

  We then estimate asset-based loans to small businesses. For this part, we use debt outstanding of loans to small businesses compiled by the SBA based on Call Report data. These are loans under $1 million, and we categorize all of small business lending as asset-based loans. A small fraction of small business lending can also be cash flow-loans, but detailed loan-level information is much harder to get and we take a conservative approach. Total loans outstanding to small businesses is about $0.6 trillion.

  For asset-based loans originated by finance companies, we use the Flow of Funds data and estimate the outstanding amount to be about $0.3 trillion. For capitalized leases, the total amount in Compustat public non-financial firms is around $70 billion, and we estimate the total amount in all non-financial firms to be around $0.1 trillion.

  Putting these parts together, we get an estimate of asset-based loans of around $1.2 trillion.

Table A1: Summary of Cash Flow-Based Lending and Asset-Based Lending

Debt Type	Category	Amount ($ Tr)	Share
Corporate bond	Cash flow-based lending	$4.5	48%
Cash flow loans	Cash flow-based lending	$3	32%
Commercial mortgages	Asset-based ledning	$0.6	6.5%
Asset-based loans	Asset-based ledning	$1.2	13%

B.2 Firm-Level Composition

We now discuss the firm-level composition of cash flow-based and asset-based lending, based on debt-level data for public non-financial firms.

We begin with debt-level information from CapitalIQ, which is available starting in 2002. For each debt, CapitalIQ provides information about the amount outstanding, whether it is secured, and some basic descriptions of the debt (with more details about the debt type, collateral structure, lender, etc.). CapitalIQ is very helpful because it covers all types of debt and tracks the amount outstanding for each debt in each firm-quarter, which facilitates a comprehensive analysis. CapitalIQ assembles these data from many types of firm filings. It covers about 75% of Compustat firms and total debt value matches well with Compustat data.

We supplement CapitalIQ data with additional information on debt attributes from DealScan, SDC, and FISD. We categorize firms' debt into four groups: 1) asset-based lending, 2) cash flow-based lending, 3) personal loans, 4) miscellaneous and unclassified borrowing.

We proceed in several steps:

1. We assign a debt to asset-based lending if
   - the debt information contains the following key words (and their variants): borrowing base, mortgage, real estate/building/property, equipment, machine, receivable, inventory, working capital, automobile/vehicle, aircraft, asset-based, capital lease, SBA (small business administration), oil/drill/rig, reserve-based, factoring, industrial revenue bond, fixed asset, finance company, construction, project finance;
   - it is a revolver and is not explicitly unsecured or designated cash flow-based in debt documents.
2. We assign a debt as personal loan if
   - the lender is an individual (Mr./Ms., etc);
   - it is from directors/executive/chairman/founder/shareholders/related parties.
3. We assign a debt to the miscellaneous/unclassified category if it is
   - borrowing from governments (not specifically asset-based);
   - borrowing from vendor/seller/supplier/landlord;
   - insurance-related borrowing;
   - borrowing from parent or affiliates;
   - pollution control bonds.
4. We assign a debt to cash flow-based lending if it **does not belong to any of the categories above** and
   - the debt is unsecured/un-collateralized, is a "debenture", or explicitly says "cash flow-based"/"cash flow loan";
   - it contains the following key words and their variants, which are representative of cash flow-based loans: substantially all assets, first lien/second lien/third lien, term facility/term loan facility/term loan a, b, c..., syndicated, tranche, acquisition line, bridge loan;
   - it is a bond or it contains standard key words for bonds, such as senior subordinated, senior notes, x% notes due, private placement, medium term notes;
   - it is a convertible bond.
5. We assign all remaining secured debt to asset-based lending to be conservative.

In Table A3 below, we show that the amount of asset-based lending a firm has is positively correlated with the amount of physical assets, while the amount of cash flow-based lending is not (generally negatively correlated with physical assets). The results confirm that cash flow-based lending does not appear to depend on the value of physical assets.

Table A2: Median Debt Share across Firm Groups

	Large Firms	Rated Firms	Small Firms
Asset-Based Lending	12.4%	8.0%	61.0%
Cash Flow-Based Lending	83.0%	89.0%	7.2%

Table A3: Properties of Debt in Asset-Based Lending and Cash Flow-Based Lending

Firm-level annual panel regressions of debt in each category on the amount of specific assets (all normalized by book assets). In Panel A, the right-hand-side variables include all cash flow based lending, as well as cash flow-based loans in particular. In Panel B, the right-hand-side variables include all asset-based lending, as well as mortgages and non-mortgage asset-based loans. Controls include size (log assets) and cash holdings. Columns (3) and (4) include firm fixed effects. Sample period is 2002 to 2015, and all public firms which have CapitalIQ debt detail data are included. Standard errors are clustered by firm and type. t-statistics in brackets.

Panel A. Cash Flow-Based Lending

	Cash Flow-Based Lending/Assets			
Book PPE	-0.100***		-0.057**	
	(0.013)		(0.024)	
Market value real estate		-0.019		-0.071**
		(0.020)		(0.028)
Book inventory	-0.240***	-0.203***	-0.135***	-0.135*
	(0.019)	(0.044)	(0.036)	(0.071)
Receivable	-0.328***	-0.230***	-0.127***	-0.087
	(0.024)	(0.052)	(0.032)	(0.069)
Firm FE	N	N	Y	Y
Obs	45,820	6,359	44,794	6,266
R^2	0.068	0.169	0.006	0.010
	Cash Flow Loans/Assets			
Book PPE	-0.055***		-0.026**	
	(0.009)		(0.010)	
Market value real estate		-0.021**		-0.002
		(0.010)		(0.019)
Book inventory	-0.089***	-0.096***	-0.051***	0.004
	(0.011)	(0.023)	(0.014)	(0.041)
Receivable	-0.092***	-0.016	-0.042***	-0.017
	(0.011)	(0.030)	(0.013)	(0.045)
Firm FE	N	N	Y	Y
Obs	45,773	6,354	44,746	6,261
R^2	0.037	0.036	0.007	0.008

t-statistics in brackets.

Panel B. Asset-Based Lending

	Asset-Based Lending/Assets			
Book PPE	0.126***		0.116***	
	(0.010)		(0.014)	
Market value real estate		0.036**		-0.006
		(0.018)		(0.021)
Book inventory	0.050***	-0.071**	0.085***	-0.037
	(0.018)	(0.036)	(0.031)	(0.070)
Receivable	0.061***	-0.134***	0.043**	-0.049
	(0.017)	(0.038)	(0.022)	(0.070)
Firm FE	N	N	Y	Y
Obs	45,830	6,359	44,803	6,266
R^2	0.077	0.146	0.025	0.017
	Mortgages/Assets			
Book PPE	0.038***		0.022***	
	(0.003)		(0.003)	
Market value real estate		0.017***		0.019***
		(0.004)		(0.006)
Book inventory	0.003	0.009	0.003	-0.020
	(0.003)	(0.008)	(0.004)	(0.017)
Receivable	-0.006***	-0.020*	-0.000	-0.009
	(0.002)	(0.011)	(0.002)	(0.011)
Firm FE	N	N	Y	Y
Obs	45,406	6,329	44,380	6,239
R^2	0.075	0.079	0.009	0.018
	Non-Mortgage ABL/Assets			
Book PPE	0.066***		0.081***	
	(0.009)		(0.013)	
Market value real estate		0.007		-0.026
		(0.017)		(0.021)
Book inventory	0.055***	-0.056*	0.082***	-0.011
	(0.016)	(0.032)	(0.029)	(0.070)
Receivable	0.074***	-0.083**	0.041*	-0.033
	(0.017)	(0.034)	(0.022)	(0.073)
Firm FE	N	N	Y	Y
Obs	45,798	6,358	44,772	6,266
R^2	0.059	0.106	0.020	0.018

t-statistics in brackets.

C Earnings-Based Borrowing Constraints

C.1 Specifications of Earnings-Based Covenant

Table A5: Variants of Earnings-Based Covenants

This table lists the main variants of earnings-based covenants and the construction using Compustat variables compiled by Demerjian and Owens (2016). The first column displays the covenant type, which is reported in DealScan data, and the second column describes the form of the covenant. The third column shows how to compute the metric used in each type of covenant using Compustat data. The fourth column tabulates the fraction of DealScan loans to US non-financial that have the specific type of covenant. The final column shows a check of the Compustat formula. For some types of covenants, the formula and details of the components may not be fully standardized across different debt contracts. Demerjian and Owens (2016) study a subset of DealScan loans where details of the covenant formula are provided by the Tearsheets dataset, and they calculate the frequency of cases where the Compustat formula listed is matches with details provided by the Tearsheets data.

Covenant Type	Standard denition	Compustat implementation	Fraction of loans	Exact match in Demerjian and Owens (2016)
Max. Debt-to-EBITDA	Debt/EBITDA	(DLTT+DLC)/EBITDA	29.7%	91.0%
Max. Senior Debt-to-EBITDA	Senior Debt/EBITDA	(DLTT+DLCDS)/EBITDA	5.2%	89.4%
Min. Interest Coverage	EBITDA/Interest Expense	EBITDA/XINT	20.8%	76.3%
Min. Cash Interest Coverage	EBITDA/Interest Paid	EBITDA/INTPN	0.7%	76.8%
Min. Debt Service Coverage	EBITDA /(Interest Expense+ST Debt)	EBITDA/(XINT+L.DLC)	4.5%	37.9%
Min. Fixed Charge Coverage	EBITDA/(Interest Expense+ST Debt+Rent Expense)	EBITDA/(XINT+L.DLC+XRENT)	18.5%	2.7%
Min. EBITDA	EBITDA	EBITDA	5.0%	97.4%

C.2 Other Earnings-Based Constraints

This section provides more information about other forms of earnings-based borrowing constraints discussed in Section 2.1.2. As mentioned in Section 2.1.2, when a firm wants to raise debt, it can be hard to surpass a reference level of debt to EBITDA ratio. This type of credit market norms are most pronounced in the leveraged loan market and especially relevant for non-investment grade borrowers.

Figure A1 below shows a time series of reference debt to EBITDA ratio in the leveraged loan market for large firms. It is an indicator of the mean debt to EBITDA ratio lenders are willing to allow when large firms raise debt. Unlike financial covenants, this is primarily a market reference, and not legally binding. Nonetheless, to the extent that firms need to comply to such norms when they borrow, their debt to EBITDA ratio may end up being sensitive to the market norm.

Table A6 shows the sensitivity of firm-level debt to EBITDA to the reference level of Debt to EBITDA, based on a regression:

$$\text{Debt/EBITDA}_{it} = \alpha + \theta \text{Ref Debt/EBITDA}_t + X_{it}'\gamma + Z_t'\rho + v_{it} \quad \text{(A1)}$$

where Debt/EBITDA_{it} is firm i's debt to EBITDA at time t, Ref Debt/EBITDA is the reference debt to EBITDA at time t (which LCD compiles based on the mean debt to EBITDA ratio of firms completing leveraged loan deals during period t), X_{it} is firm-level controls, and Z_t is macro controls including interest rates and business cycle proxies (credit spread, term spread, GDP growth). The regressions are separately estimated for firms in different ratings categories: those below the investment grade cut-off (BB+ and below), and those above the investment grade cut-off (BBB- and above). We show the sensitivity to the reference debt/EBITDA at both annual and quarterly frequencies.

Figure A1: Debt/EBITDA Reference Level for Large Issuers

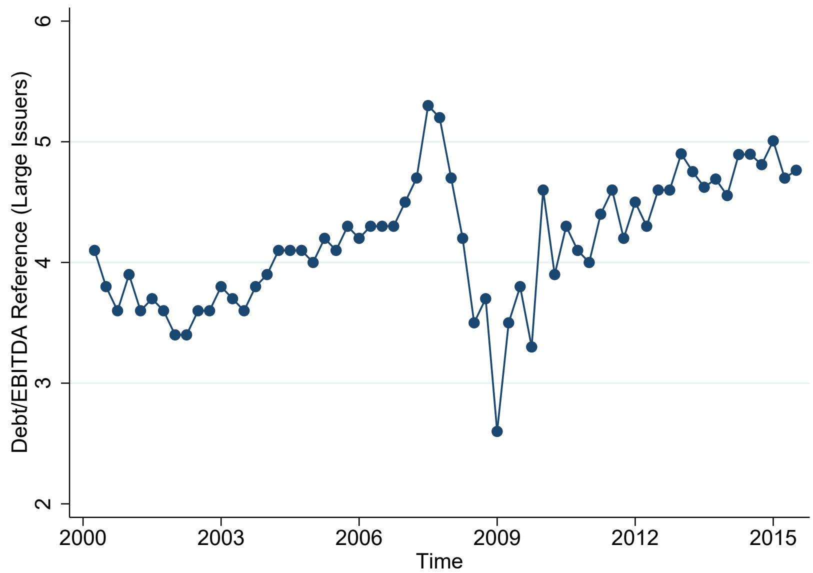


Table A6: Sensitivity to Reference Debt/EBITDA

This table summarizes the regression coefficient θ from:

$$\text{Debt/EBITDA}_{it} = \alpha + \theta \text{Ref Debt/EBITDA}_t + X_{it}'\gamma + Z_t'\rho + v_{it}$$

where Debt/EBITDA_{it} is firm i's debt to EBITDA at time t, Ref Debt/EBITDA is the reference debt to EBITDA at time t. Firm level controls X_{it} include lagged debt/EBITDA, as well as Q, past 12 months stock returns, and book leverage (debt/asset), cash holdings, accounts receivable, inventory, book PPE, log assets at the end of time $t-1$. Macro controls include term spread (spread between 10-year Treasury and 3-month Treasury), credit spreads (spread between BAA bond yield and 10-year Treasury yield, as well as spread between high yield bond yield and 10-year Treasury yield), and real GDP growth at time t. For the annual regression, firm-level debt to earnings ratio is debt in year t over EBITDA in year t, and observations where EBITDA is negative are dropped; reference debt to EBITDA is the annual average in year t. For the quarterly regressions, firm-level debt to earnings ratio is debt in quarter t over total EBITDA in the past 12 months, and observations where past 12 month EBITDA is negative are dropped; reference debt to EBITDA is measured in quarter t. We also exclude firms that are in violation of earnings-based covenants (earnings-based covenant binding) at the beginning of time t. Standard errors are clustered by both firm and time.

	Non IG		IG	
	All BB	BB+	BBB-	All BBB
	Annual Frequency			
θ	0.55	0.61	0.47	0.48
s.e.	(0.242)	(0.274)	(0.250)	(0.483)
	Quarterly Frequency			
θ	0.15	0.10	0.06	0.06
s.e.	(0.049)	(0.044)	(0.035)	(0.040)

D Classic Models of Corporate Borrowing

In this appendix, we further discuss several strands of literature on costly external financing and their predictions about how cash flows influence corporate borrowing and investment. We clarify the differences between predictions based on EBCs and predictions in these models. As discussed in Section 3.1, in these other models, cash flows only affect corporate borrowing through the impact on internal funds; EBITDA does not have an independent role after controlling for internal funds. We summarize the detailed predictions below.

1. This paper
   - Determinant of cost/capacity for external borrowing: Operating earnings.
   - Formulation: $C(b, \pi)$; π is operating earnings (EBITDA).
   - How cash flows influence borrowing and investment: Cash flows in the form of EBITDA relax borrowing constraints/decrease cost of external borrowing, and crowd in borrowing and investment. Holding EBITDA constant, cash receipts increase internal funds, but do not relax borrowing constraints/decrease cost of external borrowing. They boost investment but substitute out external borrowing.
   - EBITDA plays an independent role controlling for internal funds.

2. Froot, Scharfstein, and Stein (1993), Kaplan and Zingales (1997)

- Determinant of cost/capacity for external borrowing: Exogenous (not dependent on financial variables).
- Formulation: $C(b)$.
- How cash flows influence borrowing and investment: Cash flows increase internal funds, but do not relax borrowing constraints/decrease cost of external borrowing. They boost investment but substitute out external borrowing.
- EBITDA does not play an independent role controlling for internal funds.

3. Kiyotaki and Moore (1997), Bernanke, Gertler, and Gilchrist (1999)

- Determinant of cost/capacity for external borrowing: Liquidation value of physical assets.
- Formulation: $C(b, qk)$. k is the amount of physical capital the firm owns, q is the liquidation value per unit of capital measured at the time of debt repayment.
- How cash flows influence borrowing and investment: Borrowing constraints/cost of external borrowing do not directly depend on cash flows. Higher cash flows may increase borrowing indirectly as they increase firms' internal funds ("net worth"), allow firms to acquire more physical assets, and relax firms' borrowing constraints/decreases cost of external financing.
- EBITDA does not play an independent role controlling for internal funds.

4. Holmstrom and Tirole (1997)

- Determinant of cost/capacity for external borrowing: Pledgeable income.
- Formulation: $C(b, P)$. P is the amount of pledgeable income a firm has.
- How cash flows influence borrowing and investment: Borrowing constraints/cost of external borrowing do not directly depend on cash flows. Higher cash flows may increase borrowing indirectly as they increase firms' internal funds ("net worth"), allow firms to acquire more projects, and therefore generate more pledgeable income and relax firms' borrowing constraints/decreases its cost of external financing.
- EBITDA does not play an independent role controlling for internal funds.

The concept "net worth channel" is used in both the third case and the fourth case. "Net worth" is defined as the firm's maximum amount of funds available that can be used to acquire new assets and projects (Bernanke, Gertler, and Gilchrist, 1999). This is equivalent to internal funds w in our framework.

In the case of Kiyotaki and Moore (1997) and Bernanke, Gertler, and Gilchrist (1999), the net worth channel means that an increase in internal funds w allows firms to acquire more physical assets and relax its borrowing constraints, as discussed above. In the case of Holmstrom and Tirole (1997), the net worth channel then means that an increase in internal funds w allows firms to acquire more projects, generate more pledgeable income and relax its borrowing constraints, as discussed above. Taken together, the net worth channel captures how internal funds influence borrowing; EBITDA does not play an independent role after controlling for internal funds in this case.

E Accounting

E.1 EBITDA and OCF

Definition and Construction

1. EBITDA

   - Compustat variable: EBITDA (equivalently OIBDP)
   - EBITDA is a measure of operating earnings
   - EBITDA = revenue - operating expenses = sales (SALE) - cost of goods sold (COGS) - selling, general and administrative expense (XSGA)
   - Does not include capital expenditures (CAPX), which is separately accounted as cash flows from investment activities. Does include R&D expenses, which count towards operating expenses (included in COGS and XSGA); R&D spending is required to be immediately expensed.

2. OCF

   - Compustat variable: OANCF + XINT
     - XINT: Interest Expenses. The Compustat variable OANCF subtracts interest expenses. We add them back to avoid mechanical correlations with debt issuance.
   - OCF is a measure of the net cash receipts (inflows minus outflows) a firm gets from operating activities (as opposed to investing activities or financing activities).
   - OCF is typically calculated via the indirect method, i.e. starting with earnings and add back/subtract non-cash components. Based on Compustat variable definitions, the following relation holds:

$$\begin{aligned} \text{OCF} = \ & \text{EBITDA} \underbrace{+(\text{NOPI}+\text{SPI})+\text{SPPE}}_{\text{non-operating \& other income}} \underbrace{-(\text{TAX}-\text{DTAX}-\Delta\text{ATAX})}_{\text{cash taxes paid}} \\ & \underbrace{+\Delta\text{AP}-\Delta\text{AR}-\Delta\text{INV}}_{\Delta\text{NWC}} + \underbrace{\Delta\text{UR}-\Delta\text{PX}}_{\substack{\text{cash income/cost} \\ \text{not in earnings}}} + \text{OCFO} \end{aligned} \tag{A2}$$

     - NOPI: Nonoperating Income (e.g. dividend, interest, rental, royalty income).

- SPI: Special Item (e.g. windfalls, natural disaster damages, earnings from discontinued operations, litigation reserves). Based on the Compustat definition, variables XIDOC (cash flows from extraordinary items & discontinued operations) and MII (noncontrolling interest) are also added back.
- SPPE: Sale of Property, Plant and Equipment.
- TXT: Total Income Taxes; TXD: Deferred Taxes; ΔTXA: Changes in Accrued Taxes. TXT − TXD − ΔTXA is cash payment of taxes.
- ΔAP: Changes in Accounts Payable.
- ΔAR: Changes in Accounts Receivable.
- ΔINV: Changes in Inventory.
- ΔUR: Changes in unearned revenue. For instance, if a firm receives cash for purchases of goods and services to be delivered in the future (e.g. membership, subscription, gift card), it does not record any earnings but gets more cash. This leads to an increase in unearned revenue. ΔUR: Changes in prepaid expenses. Similarly, if a firm pays for goods or services to be delivered to it in the future (e.g. insurance), it does not record an expense but has less cash. This leads to an increase in prepaid expenses. OCFO: other miscellaneous cash flows from operations. See Compustat definitions of OANCF.

- Does not include capital expenditures (CAPX), which is separately accounted in cash flows from investment activities. Does include R&D expenses, which count towards operating expenses (included in COGS and XSGA); R&D spending is required to be immediately expensed. Does not include the effect of payouts and securities issuance, which are separately accounted in cash flows from financing activities.

3. Difference between EBITDA and OCF

- There are two main differences between the EBITDA and OCF variables.

  First, OCF takes into account the cash receipts due to non-operating income, asset sales, windfalls, minority interests, etc., which are items not included in EBITDA.

  Second, due to accounting principles, earnings recognition and cash payments may not happen concurrently. Cash payments may occur before, at the same time, or after earnings recognition. For instance, it is customary for companies to make sales and receive payments from customers later. Companies may also receive payments first before delivering goods and services (e.g. customers purchase gift cards and only use them later, or customers purchase membership/subscription that they use later).

Discussion

In the baseline regression of Section 3.2, we first have a specification where the right hand side is EBITDA (with other controls but no OCF). Variations in EBITDA come from sales and operating expenses: EBITDA is high either because sales are high or because expenses are low. When EBITDA is high, the firm may also receive more cash. Suppose firm A has EBITDA 20 and firm B has EBITDA 10. With EBC, firm A's debt capacity expands more than firm B, helping firm A to borrow more and investment more. But firm A may also receive more cash than firm B: more cash may lead to less borrowing and more investment spending (using the cash) based on the traditional mechanisms in Froot, Scharfstein, and Stein (1993). Accordingly, the positive comovement between EBITDA and cash receipts may push the EBITDA coefficient downward when the outcome variable is debt issuance; it may push the EBITDA coefficient upward when the outcome variable is investment.

Thus we then use a specification where the right hand side includes EBITDA, and we also control for OCF to take into account the impact of literal cash receipts on debt issuance/investment. Given that EBITDA and OCF are related (as shown by Equation (A2), below we discuss how to understand variations in each of the two variables.

1. Coefficient on EBITDA

    - Based on the definition of EBITDA discussed above, variations in EBITDA come from either sales or operating expenses. Whether cash associated with sales/expenses comes in advance, concurrently, or later does not affect EBITDA.
    - If two firms end up with same OCF, but have different EBITDA, there will be accompanying differences in the second to last terms of Equation (A2). But they do not *cause* differences in EBITDA.
        - For example, consider firm A with EBITDA 20, NOPI 0, and OCF 20, and firm B with EBITDA 10, NOPI 10, and OCF 20. They happen to have the same OCF and different EBIDA because they have different NOPI. The different NOPI does not cause differences in EBITDA, because by the definition of EBITDA, it is not affected by NOPI.
        - For another example, consider firm A with EBITDA 20 and firm B with EBITDA 10. Firm B happens to receive payments of 10 from customers for previous purchases. In this case, both firms have OCF 20: firm A has more EBITDA and firm B has some idiosyncratic cash receipts to get the same OCF despite lower EBITDA.
    - One question is whether some components of the second to last terms of Equation (A2) may themselves cause variations in debt issuance/investment. In the example above, for two firms with *the same* OCF, would *lower* NOPI be a driver of *higher* debt issuance/investment?

      This type of issue does not seem obvious for NOPI. It could be more relevant in a few cases, which we discuss below.

We first consider changes in accounts receivable ΔAR. Suppose firm A has EBITDA 20, ΔAR 0 (all the earnings are concurrently received in cash), and OCF 20, while firm B has EBITDA 30, ΔAR 10 (20 of the EBITDA is received in cash, while 10 is booked as receivable), and OCF 20. One concern is firm B expects to receive 10 in the next period, and it could pledge the receivable as collateral to borrow more. Even in the absence of EBCs, if firms borrow by pledging receivable, we may see firm B borrow more than firm A.[46] Such borrowing based on receivable is more likely to be short term, so we focus on the issuance of long-term debt. In addition, such borrowing is also secured debt, while our results also hold among unsecured debt.

Another case worth considering is changes in inventory. Changes in inventory ΔINV has several components: $\Delta\text{INV} = (\text{INVP}_t^{t+1} + \text{INVP}_t^t) - (\text{INVP}_t^t + \text{INVP}_{t-1}^t)$.

- INVP_t^{t+1} denotes inventory purchased in period t for future production. It counts toward OCF in period t but does not affect EBITDA in period t.
- INVP_t^t denotes inventory purchased in period t for period t production. It affects both EBITDA and OCF by the same amount in period t.
- INVP_{t-1}^t denotes inventory purchased before period t use in period t production. It affects the EBITDA of period t (counts toward cost of goods sold in period t, but does not affect OCF in period t.
- The sum $\text{INVP}_t^{t+1} + \text{INVP}_t^t$ is inventory purchase in period t. The sum $\text{INVP}_t^t + \text{INVP}_{t-1}^t$ is reported as cost of goods sold in period t (a component of EBITDA).

As shown above, changes in the inventory balance can come from two sources: 1) usage of old inventory, and 2) purchase of inventory for future production. There are two corresponding situations to consider. The first situation focuses on usage of old inventory. Suppose firm A makes sales of 30, which uses *old* inventory (INVP_{t-1}^t) 10, and it purchases additional inventory of 10 for *future* production (INVP_t^{t+1}). Accordingly, firm A has EBITDA 20, OCF 20, and ΔINV 0. Firm B makes sales of 30, which used *old* inventory (INVP_{t-1}^t) 20, and it purchases additional inventory of 10 for *future* production (INVP_t^{t+1}). So firm B has EBITDA 10, OCF 20, and ΔINV -10. In this situation, firm A and firm B have the same OCF and different EBITDA. The difference in EBITDA is driven by the fact that firm A produced the same amount of goods using less (old) material. This variation in EBITDA is fine, except we need to be careful about the investment opportunity issue which was addressed extensively in Section 3.2.

The second situation focuses on purchases of new inventory. Suppose firm A makes sales of 30, which uses old inventory (INVP_{t-1}^t) 10, and it purchases additional

[46] This issue with accounts receivable could exist even when we do not control for OCF. Consider a limiting case where all sales are paid by receivable rather then cash. Then variations in sales are entirely variations in receivable.

inventory of 20 for future production (INVP_t^{t+1}). Accordingly, it has EBITDA 20, OCF 10, and ΔINV 10. Firm B makes sales of 20, which uses old inventory (INVP_{t-1}^{t}) 10, and it purchases additional inventory of 10 for future production (INVP_t^{t+1}). Thus firm B has EBITDA 10, OCF 10, and ΔINV 0. Now firm A and firm B have the same OCF, different EBITDA, and firm A purchased more inventory. To the extent that investment opportunities are well measured, inventory purchase would not add additional information about investment decisions. As we discuss below, inventory purchase is more likely to affect the OCF coefficient, so in the Internet Appendix Table IA4, we also provide results controlling for inventory purchase.

2. Coefficient on OCF

- As shown by Equation (A2), if two firms have the same EBITDA but different OCF, it would be due to the second term to the last term.
  - For example, suppose firm A and firm B both have EBITDA 20, while firm A has NOPI 10 and firm B has NOPI 0, then firm A will have OCF 30 and firm B will have OCF 20.
  - For another example, suppose firm A and firm B both have EBITDA 20, while firm A happens to receive payments of 10 from customers for previous purchases. In this case, firm A has OCF 30 and firm B has OCF 20; firm A has gets more OCF due to idiosyncratic cash receipts.
- In both of the above cases, firm A gets more internal funds at its disposal. It may borrow less or invest more (using these internal funds), which reflect the mechanism of Froot, Scharfstein, and Stein (1993). This would lead to a negative coefficient on OCF when the outcome variable is debt issuance, and a positive coefficient on OCF when the outcome variable is investment, as predicted by Froot, Scharfstein, and Stein (1993).
- There are several cases where we need to be more careful about movements in OCF, which we discuss below.

  First, consider a case about accounts receivable: suppose firm A and firm B have the same EBITDA, and firm A receives cash while firm B gets receivables. In this situation, firm A gets more internal resources than firm B. Firm A may use the internal resources and borrow less than firm B, as predicted by Froot, Scharfstein, and Stein (1993). A caveat is firm B, which has less OCF, may pledge its receivables as collateral to borrow more. This can attenuate the predictions of Froot, Scharfstein, and Stein (1993). As discussed above, we focus on long-term debt and also study unsecured debt to minimize potential issues related to receivables.

  Second, consider a case about accounts payable: suppose firm A and firm B have the same EBITDA, but firm A decides to pay its suppliers more slowly. In this case, firm A will have an increase in ΔAP as well as more OCF. Effectively firm A is borrowing from suppliers; it now has more internal cash and may raise less money from capital markets. To the extent that borrowing from suppliers is less costly than external financing in capital markets, stretching accounts payable is one way of generating internal funds and using them as substitutes for external financing. This is consistent with the mechanism of Froot, Scharfstein, and Stein (1993).

Finally, consider a case related to inventory purchases: suppose firm A and firm B have the same EBITDA, but firm A purchases more inventory for future production (INVP_t^{t+1}), then firm A will have lower OCF. These purchases of inventories may require more external financing and are associated with more debt issuance. Thus we also present results controlling for inventory purchases.

E.2 Earnings Management

In the baseline regressions in Section 3.2, one driver of variations in EBITDA could be earnings management. For example, when EBCs become binding, firms may recognize earnings more aggressively (e.g. under-estimate operating expenses, or over-estimate sales or accounts receivable) so they can keep more debt. The survey of managers by Graham, Harvey, and Rajgopal (2005) suggests such earnings management can happen when firms are close to violating debt covenants.

How does the possibility of earnings management affect the interpretation of the baseline regressions in Section 3.2? The objective in these tests is to study the sensitivity of external borrowing to accounting EBITDA. Whether the EBITDA comes from "true" operating earnings or from earnings management, both affect accounting EBITDA and can help us estimate the sensitivity of borrowing to accounting EBITDA.

The earnings management motive also speaks directly to the impact of accounting earnings on borrowing. Due to EBCs, current EBITDA plays a key role in firm's ability to borrow. Thus managers sometimes resort to earnings management to boost EBIDA and debt capacity.

F Estimates of Market Value of Firm Real Estate

Because accounting data only report the value of firm properties at historical cost, not market value, we need to estimate or collect additional data to know the market value of firm real estate. We use three different methods, which are described in detail below.

F.1 Method 1: Traditional Estimates

The first estimate we use builds on Chaney, Sraer, and Thesmar (2012). Firm real estate include buildings, land and improvements, and construction in progress. The steps to estimate market value are as follows:

1. We estimate the market value of firm real estate in 1993 RE_i^{93}. After 1993, the net book value and accumulated depreciation of real estate assets (buildings, land and improvements, and construction in progress) are no longer reported.

   - We calculate the net book value of firm real estate (sum of the net book value of buildings, land and improvements, and construction in progress). Net book value is equal to gross book value minus accumulated depreciation.
   - We estimate the average purchase year of firm real estate as in Chaney, Sraer, and Thesmar (2012). We compare accumulated depreciation and gross book value to estimate the fraction depreciated by 1993. Assuming linear depreciation and a 40 year depreciation horizon, we estimate the purchase year to be 1993 minus (percent depreciated times 40).
   - We estimate the market value in 1993 by inflating the net book value in 1993 (which is assumed to reflect the nominal value benchmarked to the purchase year) by the cumulative property price inflation between the purchase year and 1993. The cumulative property price inflation is calculated using state-level residential real estate index between 1975 and 1993 and CPI inflation before 1975 as in Chaney, Sraer, and Thesmar (2012).
   - If the book value of real estate or the net book value of PPE is zero in 1993, we enter zero as the market value of firm real estate in 1993.

2. We estimate the market value of firm real estate for each year after 1993.

   - Starting from 1994, we estimate the market value of firm real estate from two parts: appreciation of existing holdings and acquisition/disposition of holdings. Specifically we calculate $\text{RE}_{i,t+1}$ as $\text{RE}_{i,t} \times P_{it+1}/P_{it} \times 97.5\%$ plus change in the gross book value of real estate, where P_{it} is the property price index in firm i's headquarters county in year t and real estate is assumed to depreciate at 2.5% per year (again following a depreciation horizon of 40 years).
   - If in a given year, the firm's gross book value of real estate or net book value of PPE becomes zero, we assume the firm no longer owns real estate and reset the market value of real estate to zero.

   By using P_{it} as the property price index in firm i's headquarter county, this method assumes that most of the real estate owned by a firm is near its headquarter county. The premise of this assumption is that corporate offices or properties near the headquarter are the most common type of owned real estate. Chaney, Sraer, and Thesmar (2012) verify that this is not an unreasonable assumption. As discussed in Section 4, we also find this assumption to be plausible for most US non-financial firms.

F.2 Method 2: Property Information from Firm 10-K Filings

In US non-financial firms' annual report filings (form 10-K), Item 2 is called "Properties" where firms discuss property holdings and leases. A number of firms provide detailed information about the location, size, ownership, and usage of their properties.

For example, AVX Corporation's 2006 10-K filing provides the following table of properties in the US (a large international manufacturer of electronic connectors with 10 thousand employees, headquartered in Myrtle Beach, SC):

Properties of AVX Corporation

Location	Size	Type of Interest	Usage
Myrtle Beach, SC	535,000	Owned	Manufacturing/Research/HQ
Myrtle Beach, SC	69,000	Owned	Office/Warehouse
Conway, SC	71,000	Owned	Manufacturing/Office
Biddeford, ME	73,000	Owned	Manufacturing
Colorado Springs, CO	15,000	Owned	Manufacturing
Atlanta, GA	49,000	Leased	Office/Warehouse
Olean, NY	113,000	Owned	Manufacturing
Raleigh, NC	203,000	Owned	Manufacturing
Sun Valley, CA	25,000	Leased	Manufacturing

For another example, Starbucks' 2006 10-K filing writes:

The following table shows properties used by Starbucks in connection with its roasting and distribution operations:

Properties of Starbucks Corporation

Location	Size	Owned or Leased	Purpose
Kent, WA	332,000	Owned	Roasting and distribution
Kent, WA	402,000	Leased	Warehouse
Renton, WA	125,000	Leased	Warehouse
York County, PA	365,000	Owned	Roasting and distribution
York County, PA	297,000	Owned	Warehouse
York County, PA	42,000	Leased	Warehouse
Carson Valley, NV	360,000	Owned	Roasting and distribution
Portland, OR	80,000	Leased	Warehouse
Basildon, United Kingdom	141,000	Leased	Warehouse and distribution
Amsterdam, Netherlands	94,000	Leased	Roasting and distribution

The Company leases approximately 1,000,000 square feet of office space and owns a 200,000 square foot office building in Seattle, Washington for corporate administrative purposes. As of October 1, 2006, Starbucks had more than 7,100 Company-operated retail stores, of which nearly all are located in leased premises. The Company also leases space in approximately 120 additional locations for regional, district and other administrative offices, training facilities and storage, not including certain seasonal retail storage locations.

For a final example, Microsoft's 2006 10-K filing writes: *Our corporate offices consist of approximately 11.0 million square feet of office building space located in King County, Washington: 8.5 million square feet of owned space that is situated on approximately 500 acres of land we own in our corporate campus and approximately 2.5 million square feet of space* *we lease. We own approximately 533,000 square feet of office building space domestically (outside of the Puget Sound corporate campus) and lease many sites domestically totaling approximately 2.7 million square feet of office building space…We own 63 acres of land in Issaquah, Washington, which can accommodate 1.2 million square feet of office space and we have an agreement with the City of Redmond under which we may develop an additional 2.2 million square feet of facilities at our campus in Redmond, Washington.* Microsoft is headquartered in Redmond (King County), WA.

We train assistants to read the 10-K filings and record the location, size, and usage for owned properties in the US; we also record whether the firm owns other properties for which these information are not available. We then match the properties with median property price per square footage in their respective counties using data from Zillow (we first try matching based on county, then city/metro area, and finally state if none of the previous matches were available). We use Zillow price if the property is commercial or retail (office, store, restaurant, hotel, casino). We multiply the Zillow price by 0.85 if the property is a mixture of manufacturing and office (often happens to headquarters of manufacturing firms); by 0.7 if it is manufacturing (facilities, warehouse, distribution center). For firms' owned land, we use state-level land price estimates.

G Borrowing Constraints and Financial Acceleration

This appendix analyzes how financial acceleration dynamics are influenced by the form of firms' borrowing constraints. We consider an environment similar to Kiyotaki and Moore (1997). We study both collateral-based constraints (a firm's borrowing capacity depends on the liquidation value of physical assets) as the original study, and earnings-based constraints (a firm's borrowing capacity depends a multiple of its earnings) analogous to the EBCs we document in Section 2.1. We compare the equilibrium impact of a shock to productive firms' net worth[47] in these two scenarios. The results show that earnings-based constraints lead to much more muted initial response in productive firms' capital and aggregate output, but may lead to slightly more persistence in the model.

G.1 Set-Up

Environment. The environment is similar to the baseline environment studied in Section 2 of Kiyotaki and Moore (1997). We maintain their assumptions about preferences, technologies and markets. The only difference is that we introduce a non-zero depreciation rate of capital.[48] This modification guarantees the existence of steady states in environments with different borrowing constraints; it is not critical to the equilibrium dynamics in response to the shock per se.

[47]This is the same shock considered by Kiyotaki and Moore (1997).

[48]Section 3 of Kiyotaki and Moore (1997) also introduces depreciation.

We consider a discrete-time, infinite-horizon, economy with two goods: a durable asset (land) and a nondurable commodity (fruit). The depreciation rate of land is δ and the total supply of land is $\bar{K}$. The fruit cannot be stored. There is a continuum of infinitely lived agents. Some are farmers and some are gatherers.

Farmers. There is a measure one of infinitely lived, risk neutral farmers. The expected utility of a farmer at date t is

$$E_t\left(\sum_{s=0}^{+\infty}\beta^s x_{t+s}\right),$$

where x_{t+s} is her consumption of fruits at date $t+s$, and $\beta\in(0,1)$ is the farmer's discount rate. Each farmer takes one period to produce fruits from the land she holds, with the following constant returns to scale production function:

$$y_{t+1}=F\left(k_t\right)=\left(a+c\right)k_t,$$

where k_t is the farmer's holding of land at the end of period t, ak_t is the portion of the output that is tradable, while the rest, ck_t, is non-tradable and can only be consumed by the farmer. Similar to Assumption 2 in Kiyotaki and Moore (1997), we assume c is large enough so that, in equilibrium, farmers will not want to consume more than the non-tradable portion of the fruits and invest all their funds in land. Finally, we use K_t to denote the aggregate land holding of farmers.

Gatherers. There is a measure one[49] of infinitely lived, risk neutral gathers. The expected utility of a gather at date t is

$$E_t\left(\sum_{s=0}^{+\infty}\left(\beta^{'}\right)^s x^{'}_{t+s}\right),$$

where $x^{'}_{t+s}$ is his consumption of fruits at date $t+s$ and $\beta^{'}\in(0,1)$ is gathers' discount rate. We assume $\beta^{'}>\beta$ so that in equilibrium farmers always borrow up to the maximum and do not want to postpone production, because they are relatively impatient.

Each gatherer has an identical production function that exhibits decreasing returns to scale: an input of $k^{'}_t$ land at date t yields $y^{'}_{t+1}$ tradable fruits at date $t+1$, according to

$$y^{'}_{t+1}=G\left(k^{'}_t\right),$$

where $G^{'}>0$, $G^{''}<0$ and $G'(0)>aR>G'\left(\bar{K}\right)$. The last two inequalities are included to ensure that both farmers and gatherers are producing in the neighborhood of a steady-state equilibrium. Finally, we use $K^{'}_t=\bar{K}-K_t$ to denote the aggregate land holding of gatherers.

Markets. At each date t, there is a competitive spot market in which land is exchanged for fruits at price q_t.[50] The only other market is a one-period credit market in which one unit

[49]In Kiyotaki and Moore (1997), there is a measure m of gatherer. For simplicity, we consider the case that $m=1$.

[50]Fruits are the numeraire throughout.

of fruit at date t can be exchanged for a claim to R_t units of fruit at date $t+1$. In equilibrium, as farmers are more impatient, they borrow from gatherers up to their borrowing constraints, and the rate of interest is always determined by gatherers' time preferences: $R_t = \frac{1}{\beta'} = R$.

Each farmer and each gatherer's flow-of-funds constraint in each period t can then be summarized as

$$q_t\left(k_t - (1-\delta)\, k_{t-1}\right) + Rb_{t-1} + x_t - ck_{t-1} = ak_{t-1} + b_t,$$
$$q_t\left(k_t^{'} - (1-\delta)\, k_{t-1}^{'}\right) + Rb_{t-1}^{'} + x_t^{'} = G\left(k_{t-1}^{'}\right) + b_t^{'},$$

where b_t and $b_t^{'}$ are the amount of loan borrowed by the farmer and the gatherer at period t.

Equilibrium concept. Same as Kiyotaki and Moore (1997), we consider perfect-foresight equilibria in which, without unanticipated shocks, the expectations of future variables get realized. We then consider the equilibrium effect of a shock to farmers' net worth in the steady state (characterized later) and its transmission. As in Kiyotaki and Moore (1997), this shock is driven by an unexpected temporary aggregate shock to farmers' productivity.

Capital prices and user costs. As each gatherer is not credit constrained, his demand for land is determined so the present value of the marginal product of land is equal to the opportunity cost, or user cost, of holding land, $u_t = q_t - (1-\delta)\, q_{t+1}/R$:

$$\frac{1}{R}G'\left(k_t^{'}\right) = \frac{1}{R}G'\left(K_t^{'}\right) = u_t,$$

where the symmetric concave production function guarantees that each gatherer holds the same amount of land. Ruling out exploding bubbles in the land price as in Kiyotaki and Moore (1997), one can then express the land price as the present value of user costs,

$$q_t = \sum_{s=0}^{+\infty}\left(\frac{1-\delta}{R}\right)^s u\left(K_{t+s}\right) = u\left(K_t\right) + \frac{(1-\delta)}{R}q_{t+1}, \tag{A3}$$

where $u\left(K_t\right) \triangleq \frac{1}{R}G'\left(\bar{K} - K_t\right) = u_t$ expresses the user cost in each period as an increasing function of *farmers'* aggregate land holding. The user cost is increasing in the farmers' landing holding because, if farmers hold more land, gatherers hold less land and their marginal productivity of the land is higher. From the perspective of *farmers*, the above expression can be viewed as the capital supply curve they face. An increase in q_t or a decreases in q_{t+1} will increase the user cost of land, and increase the amount of land gatherers "supply" to farmers. Log-linearizing around the steady-state, we can express the above supply curve as

$$\hat{q}_t = \frac{1}{\eta}\frac{\frac{1-\delta}{R} - 1}{\frac{1-\delta}{R}}\hat{K}_t + \frac{\frac{1-\delta}{R} - 1}{\left(\frac{1-\delta}{R}\right)^2}\hat{q}_{t+1} = \frac{1}{\eta}\frac{\frac{1-\delta}{R} - 1}{\frac{1-\delta}{R}}\sum_{s=0}^{+\infty}\left(\frac{1-\delta}{R}\right)^{-s}\hat{K}_{t+s}, \tag{A4}$$

where, for any variable X, $\hat{X}$ denotes the log-deviation from the steady and η denotes the elasticity of the residual supply of land to farmers, with respect to the user cost at the steady state.

G.2 Collateral-Based Constraints

In this part, we follow Kiyotaki and Moore (1997) and study the equilibrium impact of an aggregate shock to farmers' net wroth under collateral-based constraints.

Collateral-based constraints. Similar to Kiyotaki and Moore (1997), in period t, if the farmer has land k_t then she can borrow b_t in total, as long as the repayment does not exceed the market value of land (net of depreciation) at $t+1$:

$$Rb_t \leq q_{t+1}(1-\delta)\,k_t. \tag{A5}$$

Their micro-foundation for such constraints is as follows. In Kiyotaki and Moore (1997), farmers' technology is idiosyncratic and they can always withdraw labor. As a result, fruits produced by farmers are not contractible. Creditors protect themselves by collateralizing the farmers' land. The liquidation value of land is then the market value of land (net of depreciation) in the next period, which gives rise to the borrowing constraint in (A5).

Farmers' behavior. As discussed above, farmers borrow up to the maximum amount as they are impatient. They also prefer to invest in land, consuming no more than their current output of non-tradable fruits.[51] This means for each farmer, $x_t = ck_{t-1}$, $b_t = q_{t+1}k_t(1-\delta)/R$ and

$$k_t = \frac{1}{q_t - \frac{1-\delta}{R}q_{t+1}}\left[\left(a + q_t(1-\delta)\right)k_{t-1} - Rb_{t-1}\right],$$

where $n_t = (a + q_t(1-\delta))\,k_{t-1} - Rb_{t-1}$ is the farmer's net worth (defined as the maximum amount of funds available that can be used to acquire new assets and projects) at the beginning of date t, and $q_t - \frac{1-\delta}{R}q_{t+1} = u_t$ is the amount of down payment required to purchase a unit of land. In the case of collateral-based constraints, it coincides with the user cost of land at t.

Since the optimal k_t and b_t are linear in k_{t-1} and b_{t-1}, we can aggregate across farmers to find the equations of the dynamics of aggregate land demand and borrowing of farmers, K_t and B_t:

$$K_t = \frac{1}{q_t - \frac{1-\delta}{R}q_{t+1}}\left[\left(a + q_t(1-\delta)\right)K_{t-1} - RB_{t-1}\right], \tag{A6}$$

$$B_t = \frac{1-\delta}{R}q_{t+1}K_t. \tag{A7}$$

Steady state. Based on conditions (A3), (A6) and (A7), one can characterize the unique

[51] This is because of a high enough c (non-tradable fruits), which guarantees the value of investing in land is high enough. Around the steady state, it suffices that $c < \frac{1-\beta}{\beta}a$, which is not restrictive when β is close to 1.

steady state, where

$$\left(1 - \frac{1}{R}(1-\delta)\right) q^* = u^* = a,$$

$$\frac{1}{R} G' \left[\left(\bar{K} - K^*\right)\right] = u^*,$$

$$\frac{B^*}{K*} = \frac{(1-\delta)\, a}{R\left(1 - \frac{1}{R}(1-\delta)\right)}.$$

Shock and transmission. As in Kiyotaki and Moore (1997), we consider the equilibrium response to an unexpected aggregate shock to farmers' net worth at $t = 0$. Specifically, suppose at date -1 the economy is in the steady state: $K_{-1} = K^*$ and $B_{-1} = B^*$. There is an unexpected and temporary shock to all farmers' productivity at period 0, which increases the fruits they harvest to $1 + \Delta$ times the expected level, at the start of date 0.[52] Such a shock will then increase farmers' net worth by $\Delta a K^*$. The production technologies then return to the pre-shock level thereafter. (For exposition, we use a positive shock $\Delta > 0$. The analysis of a negative shock $\Delta < 0$ is identical under log-linearization.)

Using conditions (A6) and (A7), one can then characterize farmers' land demand curve at $t = 0$ and $t \geq 1$. For period $t = 0$, farmers' land demand curves without and with log-linearization are:[53]

$$u(K_0)\, K_0 = \left(q_0 - \frac{1-\delta}{R} q_1\right) K_0 = \left(a + \Delta a + (q_0 - q^*)(1-\delta)\right) K^*, \quad \text{(A8)}$$

$$\left(1 + \frac{1}{\eta}\right) \hat{K}_0 = \frac{1}{1 - \frac{1}{R}(1-\delta)} \hat{q}_0 - \frac{\frac{1}{R}(1-\delta)}{1 - \frac{1}{R}(1-\delta)} \hat{q}_1 + \hat{K}_0 = \Delta + \frac{1-\delta}{1 - \frac{1}{R}(1-\delta)} \hat{q}_0, \quad \text{(A9)}$$

For a given down payment per unit of capital (in this case equal to the user cost, $u(K_0) = q_0 - \frac{1-\delta}{R} q_1$), an increase of land price q_0 increases farmers' net worth, $\left(a + \Delta a + (q_0 - q^*)(1-\delta)\right) K^*$, and thus increases their land demand. Moreover, the net worth increases more than proportionately with q_0 because of the leverage effect of outstanding debt. Even though the down payment also increases with q_0, this is largely dampened as the down payment decreases with next period land price q_1. As a result, the total impact of land prices on farmers' land demand is highly positive (when $R \approx 1$ and $\delta \approx 0$, the coefficient on $\hat{q}_0$ in condition A9 could be very large).

For period $t \geq 1$, farmers' land demand curves without and with log-linearization are

[52] Following Kiyotaki and Moore (1997), we take Δ to be small, so we can log-linearize around the steady state and find closed-form expressions for the new equilibrium path.

[53] In condition (A9), $\frac{1}{1-\frac{1}{R}(1-\delta)} = \frac{q^*}{u^*}$ is the ratio between land price and down payment in the steady state and $\frac{1-\delta}{1-\frac{1}{R}(1-\delta)} = \frac{(1-\delta) q^* K^*}{a K^*}$ is the ratio between farmers' land holding collateral value and their net worth in the steady state.

$$u(K_t)K_t = \left(q_t - \frac{1-\delta}{R}q_{t+1}\right)K_t = aK_{t-1}, \tag{A10}$$

$$\left(1+\frac{1}{\eta}\right)\hat{K}_t = \frac{1}{1-\frac{1}{R}(1-\delta)}\hat{q}_t - \frac{\frac{1}{R}(1-\delta)}{1-\frac{1}{R}(1-\delta)}\hat{q}_{t+1} + \hat{K}_t = \hat{K}_{t-1}. \tag{A11}$$

An increase in farmers' land holding in period $t-1$ increases their net worth in period $t-1$, aK_{t-1}, and in turn translates to an increase in farmers' land holding in period t.[54] Through the forward looking land pricing equation in condition (A3), the persistent increase in farmers' land holding then increases land price in period 0, far more than what is driven by the increase in user cost in that particular period. The increase in land price then further increases farmers' net worth and capital demand in period 0 through condition (A9), which in turn increases farmers' net worth and land holding in all periods and further pushes up the land price. This asset price feedback loop is the core of the financial acceleration mechanism in Kiyotaki and Moore (1997).

From conditions (A4), (A9), and (A11), we can solve the the full equilibrium dynamics with collateral-based constraints:

$$\hat{K}_t = \left(1+\frac{1}{\eta}\right)^{-t-1}\frac{\eta}{\eta+\frac{\delta}{1-\frac{1-\delta}{R}}}\left(1+\frac{\frac{R}{1-\delta}}{\frac{R}{1-\delta}-1}\frac{1}{\eta}\right)\Delta, \tag{A12}$$

$$\hat{q}_t = \left(1+\frac{1}{\eta}\right)^{-t}\frac{1}{\eta+\frac{\delta}{1-\frac{1-\delta}{R}}}\Delta.$$

When $R \approx 1$ and $\delta \approx 0$, the multiplier $1+\frac{\frac{R}{1-\delta}}{\frac{R}{1-\delta}-1}\frac{1}{\eta}$ in farmers' land holding could be very large, summarizing financial acceleration driven by asset price feedback in Kiyotaki and Moore (1997).

G.3 Earnings-Based Constraints

In this part, we then consider the case of earnings-based constraints studied in this paper.

Earnings-based constraints. The constraint is specified as follows. If at period t, a farmer has land k_t, then she can borrow b_t in total, as long as the repayment does not exceed a multiple of her (tradable) earnings at $t+1$:

$$Rb_t \leq \theta a k_t. \tag{A13}$$

Such a constraint could arise if the bankruptcy court is able to and prefers to enforce the

[54] However, farmers' period t net worth, aK_{t-1}, no longer depends on land price in t. This is because, for all $t \geq 1$, an increase in period t land price will be anticipated in period $t-1$, and allow farmers to borrow more. As a result, land price's impact on farmers' period t net worth is offset by the increase in debt payment in period t.

continuation of operation when the farmer fails to pay her debt.[55]

Farmers' behavior. Similar to the analysis in the previous subsection following Kiyotaki and Moore (1997), farmers prefer to borrow up to the maximum as they are impatient; they also prefer to invest in land, consuming no more than their current output of non-tradable fruits.[56] This means for each farmer, $x_t = ck_{t-1}$, $b_t = \theta a k_t / R$ and

$$k_t = \frac{1}{q_t - \frac{\theta a}{R}} \left[\left(a + q_t \left(1 - \delta \right) \right) k_{t-1} - R b_{t-1} \right],$$

where $q_t - \frac{\theta a}{R}$ is how much down payment is required to purchase a unit of land. In the case of earnings-based constraints, it does not depend on the land price in the next period q_{t+1} and does not coincide with the user cost u_t. This is because q_{t+1} does not directly enter the farmer's borrowing constraint (A13) in the case of EBCs. As we elaborate later, this missing link from asset prices to farmers' borrowing capacity is key to dampening asset price feedback under EBCs.

Since the optimal k_t and b_t are linear in k_{t-1} and b_{t-1}, we can aggregate across farmers to characterize the dynamics of aggregate land demand and borrowing of farmers, K_t and B_t:

$$K_t = \frac{1}{q_t - \frac{\theta a}{R}} \left[\left(a + q_t \left(1 - \delta \right) \right) K_{t-1} - R B_{t-1} \right], \tag{A14}$$

$$B_t = \frac{1}{R} \theta a K_t. \tag{A15}$$

Steady state. We set $\theta = \frac{1-\delta}{1-\frac{1}{R}(1-\delta)}$. This guarantees that the economy under earnings-based constraints shares the same steady states as the economy under collateral-based constraints. This ensures that the difference in the two economies' responses to the shock we consider is driven by the form of borrowing constraints, instead of the steady state leverage ratio.

Shock and transmission. Similar to Kiyotaki and Moore (1997) and the analysis in the previous part, we consider the equilibrium response to an unexpected aggregate shock to farmers' net worth at $t = 0$. Specifically, suppose at date $t = -1$ the economy is in the steady state: $K_{-1} = K^*$ and $B_{-1} = B^*$. There is an unexpected and temporary shock to all farmers' productivity at period $t = 0$, which increases the fruits they harvest to $1 + \Delta$ times the expected level, at the start of date $t = 0$.[57]. Such a shock increases farmers' net worth

[55] It must be that $\theta \leq \bar{\theta} \triangleq \frac{1}{1 - \frac{(1-\delta)}{R}} = 1 + \frac{1-\delta}{R} + \left(\frac{1-\delta}{R}\right)^2 + \cdots$, which is the present value of tradable fruits generated by one unit of land held by the farmer. The ratio $\frac{\theta}{\bar{\theta}}$ could be thought of as the proportion of tradable fruits that can be produced with court involvement and continuing operations.

[56] This could be guaranteed with a high enough c (non-tradable fruits). Note that the farmer's utility from investing a dollar in land today is at least $\beta \frac{(a+c+(1-\delta)q_{t+1})}{q_t - \frac{\theta a}{R}}$, the utility of investing in land in this period and consuming fully in the next period. It is always bigger than one with a large c, as q_t is bounded above (gatherers' marginal product is bounded above).

[57] Following Kiyotaki and Moore (1997), we take Δ to be small, so we can log-linearize around the steady state and find closed-form expressions for the new equilibrium path.

by $\Delta a K^*$. The production technologies between 0 and 1 (and thereafter) then return to the pre-shock level.

Using conditions (A14) and (A15), one can then characterize farmers' land demand curve at period $t = 0$ and $t \geq 1$. For period 0, farmers' land demand curves without and with log linearization are:[58]

$$\left(q_0 - \frac{\theta a}{R}\right) K_0 = \left(\left(1-\theta\right) a + \Delta a + q_0 \left(1-\delta\right)\right) K^*, \tag{A16}$$

$$\hat{q}_0 \left(\frac{1}{1-\frac{1}{R}\left(1-\delta\right)}\right) + \hat{K}_0 = \Delta + \frac{1-\delta}{1-\frac{1}{R}\left(1-\delta\right)}\hat{q}_0, \tag{A17}$$
$$\iff \hat{K}_0 = \Delta - \frac{\delta}{1-\frac{1}{R}\left(1-\delta\right)}\hat{q}_0.$$

For a given down payment per unit of capital $(q_0 - \frac{\theta a}{R})$, an increase of land price q_0 still increases farmers' net worth, $(1-\theta)\,a + \Delta a + q_0\,(1-\delta)$. However, the down payment per unit of capital also increases with land price q_0. Different from the case under collateral-based constraints, as farmers' borrowing capacity under EBCs do not depend on the land price in the next period q_1, an increase of q_1 will not relax their borrowing constraints and decrease the down payment per unit of capital. As a result, the total impact of land prices on farmers' land demand is negative, as shown by the last expression above. This is in stark contrast with the case under collateral-based constraints. The asset price movement now dampens the financial shock's impact on farmers' land holding, instead of generating financial amplification.

For period $t \geq 1$, farmers' land demand curve is:

$$\left(q_t - \frac{\theta a}{R}\right) K_t = \left[\left(1-\theta\right) a + \left(1-\delta\right) q_t\right] K_{t-1}, \tag{A18}$$

$$\hat{q}_t \left(\frac{1}{1-\frac{1}{R}\left(1-\delta\right)}\right) + \hat{K}_t = \frac{1-\delta}{1-\frac{1}{R}\left(1-\delta\right)}\hat{q}_t + \hat{K}_{t-1}, \tag{A19}$$
$$\iff \hat{K}_t = -\frac{\delta}{1-\frac{1}{R}\left(1-\delta\right)}\hat{q}_t + \hat{K}_{t-1}.$$

Compared to the case under collateral-based constraints, condition (A19), there are two differences. First, as discussed above, the down payment under EBCs does not depend on next period land price, q_{t+1}, as q_{t+1} does not relax farmers' borrowing constraints. Second, current period net worth, $(1-\theta)\,a + (1-\delta)\,q_t$, now increases with land prices in period t. Specifically, in the case with EBCs, as an increase of land prices in period t does not allow farmers to borrow more in $t-1$, q_t's impact on farmers' period t net worth will *not* be offset

[58] In condition (A9), $\frac{1}{1-\frac{1}{R}(1-\delta)} = \frac{q^*}{q^*-\frac{\theta a}{R}}$ is the ratio between land price and down payment in the steady state and $\frac{1-\delta}{1-\frac{1}{R}(1-\delta)} = \frac{(1-\delta)q^*K^*}{(1-\theta)a+(1-\delta)q^*K^*}$ is the ratio between collateral value of farmers' land holding and net worth in the steady state.

by the increase in debt payment in period t. As we discuss more below, this may lead to a more persistent impact of the shock's impact on farmers' net worth, even though the initial impact is much more muted with EBCs.[59]

From conditions (A4) and (A19), we can then characterize the equilibrium dynamics under earning-based constraints:

$$\begin{pmatrix} \hat{q}_t \\ \hat{K}_t \end{pmatrix} = \begin{pmatrix} \frac{R}{1-\delta} & -\frac{1}{\eta}\left(\frac{R}{1-\delta}-1\right) \\ -\delta\frac{\frac{R}{1-\delta}}{1-\frac{1-\delta}{R}} & 1+\frac{\delta}{\eta}\frac{R}{1-\delta} \end{pmatrix} \begin{pmatrix} \hat{q}_{t-1} \\ \hat{K}_{t-1} \end{pmatrix} \quad \forall t \geq 1. \tag{A20}$$

The matrix $\begin{pmatrix} \frac{R}{1-\delta} & -\frac{1}{\eta}\left(\frac{R}{1-\delta}-1\right) \\ -\delta\frac{\frac{R}{1-\delta}}{1-\frac{1-\delta}{R}} & 1+\frac{\delta}{\eta}\frac{R}{1-\delta} \end{pmatrix}$ has only one eigenvalue $\lambda \in (0,1)$ within the unique circle.[60] Let (q_λ, k_λ) be the corresponding eigenvector and $\alpha = \frac{q_\lambda}{k_\lambda} > 0$. Together with the initial condition (A17), we have

$$\hat{K}_t = \frac{1}{1+\frac{\delta}{1-\frac{1}{R}(1-\delta)}\alpha}\lambda^t\Delta \quad \text{and} \quad \hat{q}_t = \frac{\alpha}{1+\frac{\delta}{1-\frac{1}{R}(1-\delta)}\alpha}\lambda^t\Delta. \tag{A21}$$

G.4 Financial Acceleration: A Comparison

Now we can compare the equilibrium impact of the aggregate shock to farmers' net worth under these two forms of borrowing constraints. As mentioned above, since land price increases have a negative impact on farmers' land demand in the case of EBCs, financial acceleration due to asset price feedback is dampened. Indeed, one can prove analytically that the shock's initial impact on farmers' capital holding and aggregate output is stronger with collateral-based constraints.

Lemma 1. *When the shock to farmers' net worth hits, the impact on farmers' land holding and aggregate output is stronger with collateral-based constraints.*

To numerically illustrate the difference, we consider a standard parametrization. Specially, we let $R = 1.01$, $\delta = 0.025$ and $\eta = 1$. Figure A2 shows the impulse response of farmers' land holding to the shock Δ. We find that the initial impact on farmers' land holding under collateral-based constraints is ten times as large as the one under earnings-based constraints. With EBCs, the dampening of financial acceleration driven by asset price feedback is quantitatively very important. As aggregate output $\hat{Y}$ is just a multiple of $\hat{K}$ (proved below), the initial impact on *aggregate output* under collateral-based constraints is also ten times as large as the one under earnings-based constraints. Nonetheless, the impact of the

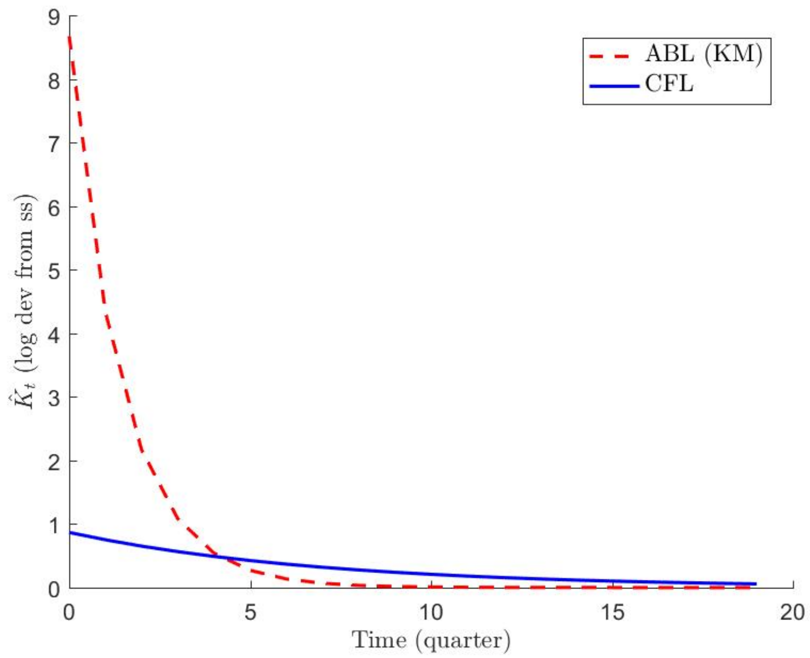
[59]As shown above, in farmers' land demand condition (A19), the appearance of the term $\frac{1-\delta}{1-\frac{1}{R}(1-\delta)}\hat{q}_t$ increases the persistence of the shock. The disappearance of term $-\frac{\frac{1}{R}(1-\delta)}{1-\frac{1}{R}(1-\delta)}\hat{q}_{t+1}$ on the left hand side, meanwhile, decreases the persistence of the shock. However, as $\hat{q}_t - \frac{1}{R}\hat{q}_{t+1} > 0$ in the equilibrium (from condition (A21)), the first effect nominates.

[60]Note that the land price is bounded as the gatherer's marginal product is bounded. As a result, explosive equilibrium can be ruled out. One can also prove the equilibrium uniqueness without the help of log-linearization.

shock in the economy with EBCs can be more persistent. This is because, with EBCs, for each period $t \geq 1$, as borrowing in the previous period does not depend on current period asset prices, higher land value increases farmers' net worth and is not offset by higher debt payment.

Figure A2: Impulse Response of Farmers' Land Holdings

This plot shows farmers' land holdings (log deviations from steady state) after a small positive unexpected shock to their net worth (one log point).



Section 3 of Kiyotaki and Moore (1997) also considers a case in which the elasticity of land supply is low, $\eta = 0.1$ (shown in Figure A3). Based on this parameter value, it is still the case that the initial impact on farmers' land holding and aggregate output under collateral-based constraints is way larger than that under earnings-based constraints, corroborating the robustness of the above finding.

H Proofs

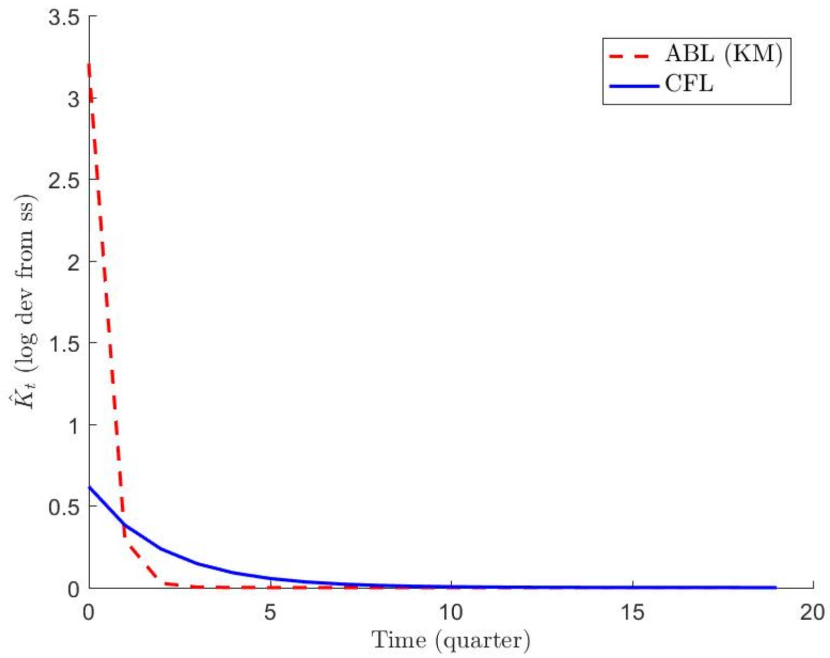
Proof of Proposition 1. In an internal solution, the optimal external borrowing must satisfy the following first order condition with respect to b:

$$F'(w + b^*) = C_b(b^*, \pi). \tag{A22}$$

(i) We can then use the inverse function theorem to derive how optimal external borrowing b^* responds to π, for a given w: $\frac{\partial b^*}{\partial \pi} |_w = \frac{C_{b\pi}(b^*,\pi)}{-C_{bb}(b^*,\pi)+F''(w+b^*)}$. As $C_{b\pi} \leq 0$, $C_{bb} > 0$ and $F''(x) \leq 0$, for a given amount of internal funds w, optimal borrowing is weakly increasing in EBITDA $\frac{\partial b^*}{\partial \pi} |_w \geq 0$. For optimal investment, using $I^* = b^* + w$ we have $\frac{\partial I^*}{\partial \pi} |_w = \frac{\partial b^*}{\partial \pi} |_w$, and optimal investment is weakly increasing in EBITDA $\frac{\partial I^*}{\partial \pi} |_w \geq 0$.

Figure A3: Impulse Response of Farmers' Land Holdings, $\eta = 0.1$

This plot sets $\eta = 0.1$, rather than $\eta = 1$ in Figure A2.



(ii) Similarly, we can also use the inverse function theorem to derive how optimal borrowing b^* responds to w, for a given π: $\frac{\partial b^*}{\partial w} |_\pi = \frac{-F''(w+b^*)}{-C_{bb}(b^*,\pi)+F''(w+b^*)}$. As $C_{bb} > 0$ and $F''(x) \leq 0$, for a given amount of EBITDA π, borrowing is weakly decreasing in internal funds $\frac{\partial b^*}{\partial w} |_\pi \leq 0$. Moreover, when F is strictly concave, $\frac{\partial b^*}{\partial w} |_\pi < 0$. For optimal investment, using $I^* = b^* + w$, we have $\frac{\partial I^*}{\partial w} |_\pi = 1 + \frac{\partial b^*}{\partial w} |_\pi = 1 + \frac{-F''(w+b^*)}{-C_{bb}(b^*,\pi)+F''(w+b^*)} = \frac{-C_{bb}(b^*,\pi)}{-C_{bb}(b^*,\pi)+F''(w+b^*)} > 0$, and optimal investment is strictly increasing in internal funds.

Proofs for Appendix G

Characterization of the equilibrium dynamics under collateral-based constraints. From conditions (A4) and (A11), we have, for all t,

$$\hat{q}_t = \frac{1}{\eta} \frac{\left(\frac{R}{1-\delta}\right) - 1}{\left(\frac{R}{1-\delta}\right)} \frac{1}{1 - \left(1 + \frac{1}{\eta}\right)^{-1} \left(\frac{R}{1-\delta}\right)^{-1}} \hat{K}_t = \frac{\left(1 + \frac{1}{\eta}\right) \left[\frac{R}{1-\delta} - 1\right]}{\eta \left[\left(1 + \frac{1}{\eta}\right) \left(\frac{R}{1-\delta}\right) - 1\right]} \hat{K}_t,$$

Substitute in period 0 farmers' land demand curve (condition (A9)), we have

$$\left(1 + \frac{1}{\eta}\right) \hat{K}_0 = \Delta + \frac{1-\delta}{1 - \frac{1}{R}(1-\delta)} \left(\frac{\left(1 + \frac{1}{\eta}\right) \left[\frac{R}{1-\delta} - 1\right]}{\eta \left[\left(1 + \frac{1}{\eta}\right) \left(\frac{R}{1-\delta}\right) - 1\right]} \hat{K}_0 \right),$$

$$\hat{K}_0 = \frac{1}{1 + \frac{1}{\eta}} \left(1 + \frac{\frac{R}{1-\delta}}{\frac{R}{1-\delta} - 1} \frac{1}{\eta}\right) \frac{\eta}{\eta + \frac{\delta}{1 - \frac{1-\delta}{R}}} \Delta,$$

$$\hat{q}_0 = \frac{1}{\eta + \frac{\delta}{1 - \frac{1-\delta}{R}}} \Delta.$$

Using conditions (A11), we then have

$$\hat{K}_t = \left(1+\frac{1}{\eta}\right)^{-t} \hat{K}_0 \quad \text{and} \quad \hat{q}_t = \left(1+\frac{1}{\eta}\right)^{-t} \hat{q}_0.$$

Characterization of the steady state under earnings-based constraints. From conditions (A14) and (A15), the steady state can be characterized by

$$q^*\delta K^* + RB^* = aK^* + B^*,$$
$$RB^* = \theta a K^*,$$
$$q^* = u(K^*)$$

As a result,

$$q^* = a\frac{\left(1+\frac{\theta}{R}-\theta\right)}{\delta} \quad , \frac{B^*}{K^*} = \frac{\theta a}{R} \quad \text{and} \quad K^* = u^{-1}\left(a\frac{\left(1+\frac{\theta}{R}-\theta\right)}{\delta}\right).$$

When $\theta = \frac{1-\delta}{1-\frac{1}{R}(1-\delta)}$, the steady state will then be the same as the one under collateral-based constraints.

Characterization of the equilibrium under earnings-based constraints. $\lambda = \frac{\left(\frac{R}{1-\delta}\left(1+\frac{\delta}{\eta}\right)+1\right)-\sqrt{\left(\frac{R}{1-\delta}\left(1+\frac{\delta}{\eta}\right)+1\right)-4\frac{R}{1-\delta}}}{2} \in (0,1)$ is the only eigenvalue of $\begin{pmatrix} \frac{R}{1-\delta} & -\frac{1}{\eta}\left(\frac{R}{1-\delta}-1\right) \\ -\delta\frac{\frac{R}{1-\delta}}{1-\frac{1-\delta}{R}} & 1+\frac{\delta}{\eta}\frac{R}{1-\delta} \end{pmatrix}$ that is within the unit circle. Together with the fact that $\hat{q}_t$ is bounded, we have $\hat{q}_0 = \alpha\hat{K}_0$, $\hat{q}_t = \lambda^t\hat{q}_0$ and $\hat{K}_t = \lambda^t\hat{K}_0$, where $\alpha = \frac{q_\lambda}{k_\lambda} = \frac{\frac{1}{\eta}\left(\frac{R}{1-\delta}-1\right)}{\frac{R}{1-\delta}-\lambda} > 0$ and (q_λ, k_λ) is the eigenvector corresponding to λ. Using the farmers' capital holding at 0 in condition (A17), we arrive at condition (A21).

Proof of Lemma 1. From conditions (A12) and (A21), for the part of the Lemma about farmers' land holding ($\frac{d\hat{K}_0}{d\Delta}|_{KM} > \frac{d\hat{K}_0}{d\Delta}|_{EBC}$), we only need to prove that

$$\frac{1}{1+\frac{1}{\eta}}\left(1+\frac{\frac{R}{1-\delta}}{\frac{R}{1-\delta}-1}\frac{1}{\eta}\right)\frac{\eta}{\eta+\frac{\delta}{1-\frac{1-\delta}{R}}} > \frac{1}{1+\frac{\delta}{1-\frac{1}{R}(1-\delta)}\alpha}. \tag{A23}$$

Let us first prove that

$$\frac{1}{1+\frac{1}{\eta}}\left(1+\frac{\frac{R}{1-\delta}}{\frac{R}{1-\delta}-1}\frac{1}{\eta}\right)\frac{\eta}{\eta+\frac{\delta}{1-\frac{1-\delta}{R}}} > \frac{1}{1+\frac{\delta}{\eta}}. \tag{A24}$$

This is equivalent to proving that

$$\frac{\frac{\frac{R}{1-\delta}-1}{\frac{R}{1-\delta}}+\frac{1}{\eta}}{\frac{\frac{R}{1-\delta}-1}{\frac{R}{1-\delta}}+\frac{\delta}{\eta}} = \left(1+\frac{\frac{R}{1-\delta}}{\frac{R}{1-\delta}-1}\frac{1}{\eta}\right)\frac{\eta}{\eta+\frac{\delta}{1-\frac{1-\delta}{R}}} > \frac{1+\frac{1}{\eta}}{1+\frac{\delta}{\eta}},$$

which is true as $\frac{\frac{R}{1-\delta}-1}{\frac{R}{1-\delta}} > 1$ and $\delta < 1$.

We then prove that

$$\frac{1}{1+\frac{\delta}{1-\frac{1}{R}(1-\delta)}\alpha} < \frac{1}{1+\frac{\delta}{\eta}}. \tag{A25}$$

Note that from the formula of λ above, we have

$$\lambda = \frac{\left(\frac{R}{1-\delta}\left(1+\frac{\delta}{\eta}\right)+1\right) - \sqrt{\left(\frac{R}{1-\delta}\left(1+\frac{\delta}{\eta}\right)+1\right) - 4\frac{R}{1-\delta}}}{2}$$

$$= \frac{2\frac{R}{1-\delta}}{\frac{R}{1-\delta}\left(1+\frac{\delta}{\eta}\right)+1+\sqrt{\left(\frac{R}{1-\delta}\left(1+\frac{\delta}{\eta}\right)+1\right) - 4\frac{R}{1-\delta}}} > \frac{\frac{R}{1-\delta}}{\frac{R}{1-\delta}\left(1+\frac{\delta}{\eta}\right)+1}$$

$$\alpha = \frac{\frac{1}{\eta}\left(\frac{R}{1-\delta}-1\right)}{\frac{R}{1-\delta}-\lambda} > \frac{\frac{1}{\eta}\left(\frac{R}{1-\delta}-1\right)}{\frac{R}{1-\delta}-\frac{\frac{R}{1-\delta}}{\frac{R}{1-\delta}\left(1+\frac{\delta}{\eta}\right)+1}} = \frac{\frac{1}{\eta}\left(\frac{R}{1-\delta}-1\right)}{\left(\frac{R}{1-\delta}\right)^2\frac{\left(1+\frac{\delta}{\eta}\right)}{\frac{R}{1-\delta}\left(1+\frac{\delta}{\eta}\right)+1}}.$$

We then have

$$\frac{1}{1+\frac{\delta}{1-\frac{1}{R}(1-\delta)}\alpha} < \frac{1}{1+\frac{\delta}{1-\frac{1}{R}(1-\delta)}\frac{\frac{1}{\eta}\left(\frac{R}{1-\delta}-1\right)}{\left(\frac{R}{1-\delta}\right)^2\frac{\left(1+\frac{\delta}{\eta}\right)}{\frac{R}{1-\delta}\left(1+\frac{\delta}{\eta}\right)+1}}} = \frac{1}{1+\frac{\frac{1}{\eta}\delta}{\frac{\frac{R}{1-\delta}\left(1+\frac{\delta}{\eta}\right)}{\frac{R}{1-\delta}\left(1+\frac{\delta}{\eta}\right)+1}}} < \frac{1}{1+\frac{\delta}{\eta}}.$$

Together, we prove condition (A23). Finally, note that the aggregate output from period t land holding (which gets produced in period $t+1$) is

$$\hat{Y}_t = \frac{a+c-Ra}{a+c}\frac{(a+c)\,K^*}{Y^*}\hat{K}_t,$$

where $\frac{a+c-Ra}{a+c}$ reflects the difference between the farmers' productivity (equal to $a+c$) and the gatherers' productivity (equal to Ra in the steady state) and the ratio $\frac{(a+c)K^*}{Y^*}$ is the share of farmers' output. In other words, $\hat{Y}_t$ is just a multiple $\hat{K}_t$. The above result about $\frac{d\hat{K}_0}{d\Delta}$ then also applies to $\frac{d\hat{Y}_0}{d\Delta}$.