Internet Appendix: Anatomy of Corporate Borrowing Constraints*

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This Internet Appendix has nine sections.

- Section IA1 provides a detailed explanation of our classification procedures for asset-based lending and cash flow-based lending.
- Section IA2 analyzes the variation in the prevalence of cash flow-based lending across different countries, and the relationship with bankruptcy laws.
- Section IA3 provides more discussions of the earnings-based borrowing constraints (EBCs), including those imposed through financial covenants (earnings-based covenants) and through credit market norms.
- Section IA4 discusses other types of financial covenants.
- Section IA5 provides a simple framework to further illustrate the foundations and implications of cash flow-based lending and EBCs.
- Section IA6 describes variable constructions for firm-level analyses.
- Section IA7 describes the construction of real estate value measures.
- Section IA8 presents additional empirical results.
- Section IA9 analyzes financial acceleration dynamics with different forms of corporate borrowing constraints.

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IA1 Asset-Based Lending and Cash Flow-Based Lending

In this appendix, we explain in detail the categorization of asset-based lending and cash flow-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.[1]

Asset-Based Lending

The main components of asset-based lending are commercial mortgages and business loans backed by specific assets (often referred to as asset-based loans) such as equipment, inventory, accounts receivable, etc. We also include capital leases (explained below).

1. Commercial mortgages

   Commercial mortgages are corporate debt backed by commercial real estate, such as office buildings, 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 specific physical and other separable assets including equipment, inventory, receivable, oil and gas reserves, etc. Asset-based loans typically specify a "borrowing base," calculated according to the estimated liquidation value of the assets pledged to creditors. Creditors monitor the size of the borrowing base on a quarterly (sometimes monthly) basis, and require that the loan size cannot exceed a fraction of the borrowing base. Asset-based loans can be originated by both banks and non-banks (e.g., finance companies that specialize in lending against specific types of assets). We also include receivable factoring in asset-based loans.

3. Capital leases

   In a capital lease, the lessee is likely to have ultimate ownership of the leased asset (e.g., buy the asset at the end of the lease), and therefore assumes the risks associated with ownership (e.g., price fluctuations of the asset) and also enjoys some benefits of ownership (e.g., more control over the asset). In this case, the leased asset shows up on the asset side of the lessee's balance sheet, and the lease shows up on the liability side. Since capital leases are often treated as debt, and the lessee can be the effective owner, we include them in our classification.[2] A well known example of capital lease is

[1] In the categorization, we do not include commercial papers, which are short-term debt for liquidity purposes. In the aggregate, commercial papers account for about 3% of US non-financial corporate debt by value, so the impact of this exclusion is small.

[2] Another type of lease is operating lease (e.g., normal rent), where the lessee is unlikely to have effective ownership of the asset. Because the lessee does not have ownership and is not exposed to the value of the asset, we do not include operating leases as part of debt. In 2019, a new accounting rule (Accounting Standards Update 842) requires firms to also report leased (right-of-use) assets and corresponding operating lease liabilities. Based on this new disclosure, we find that the overall ratio of operating lease to regular debt among Compustat firms is 9% (according to financial statements as of 2019Q3).

used in aircraft financing and studied in Benmelech and Bergman (2011). In this case, a trust (often sponsored by an airline) purchases the aircraft, leases it to the airline (who would take over the aircraft ownership at the end of the lease), and finances the purchase by issuing notes backed by the aircraft. Because the financing of assets in capital leases is generally 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 firms), in the following we merge capital leases with asset-based loans.

Cash Flow-Based Lending

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

1. Corporate bonds

   Corporate bonds in the US are generally backed by borrowers' cash flow value. FISD data shows that in recent periods about 1% of US non-financial corporate bond issuance by value is asset-based (asset-backed bonds, industrial revenue bonds, or other bonds against physical assets such as equipment and real estate). About 10% of bond issuance by value is secured and most secured bonds are cash flow-based (e.g., secured by liens on the corporate entity rather than specific assets).

2. Cash flow-based loans

   Cash flow-based loans comprise of commercial loans that are primarily backed by borrowers' cash flows. They do not use specific assets as collateral, or have borrowing limits tied to the liquidation value of specific assets (in contrast with the borrowing base requirements of asset-based loans). Rather, the collateral (if secured) is typically a lien on the entire corporate entity ("substantially all assets," also referred to as a "blanket lien"), and the collateral value is calculated based on the borrower's going-concern cash flow value. Creditors perform detailed cash flow analyses, and use earnings-based covenants extensively. Term loans in syndicated loans are prototypical cash flow-based loans. Some are unsecured while others are secured with blanket liens. Revolving lines of credit ("revolvers") can belong to cash flow-based lending as well as asset-based lending. Some revolvers are not backed by specific assets (unsecured or secured by blanket liens), which creditors refer to as "cash flow revolvers." Other revolvers are secured by specific assets (most commonly inventory and receivables) with standard borrowing base requirements, which creditors refer to as "asset-based revolvers" (or "ABL revolvers").[3]

[3] However, due to institutional reasons, asset-based revolvers in syndicated loans are often bundled with prototypical cash flow-based loans (e.g., term loans) into a single package, and share the earnings-based covenants.

IA1.1 Aggregate Composition

In the following, we estimate the share of asset-based lending and cash flow-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. We use estimates for the example year of 2015. The results are similar in recent years.

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 mortgages outstanding from the Flow of Funds, which is around $0.6 trillion.

2. Asset-based loans:
   - Share in total non-financial debt outstanding: 13%.
   - Data sources: DealScan, ABL Advisor, Shared National Credit Program (SNC), Small Business Administration (SBA), Flow of Funds, Compustat.
   - Calculation: We first estimate asset-based loans to large firms. For this part, we focus on the portion of large commercial loans (such as syndicated loans) that are asset-based, using data from DealScan, ABL advisor, SNC, and Flow of Funds. We proceed in two steps. We first estimate the share of asset-based loans in large commercial loans, using loan issuance data from DealScan and ABL Advisor. In particular, ABL Advisor reports the volume of issuance in DealScan that can be classified as asset-based loans. We can compare this value to total loan issuance in DealScan. Alternatively, we can also use DealScan data to calculate the share of loan issuance with asset-based debt provisions (i.e., borrowing base requirements), and the results are very similar. The estimated share of asset-based loans is about 5% (annual syndicated loan issuance is $1,500B to $2,000B, of which $60B to $100B is asset-based). We then estimate the amount of syndicated loans outstanding using the SNC report (amount outstanding is not available in DealScan), which is about $2.1 trillion. Taken together, outstanding asset-based loans from syndicated loans are about $0.11 trillion.

     We then estimate asset-based loans to small businesses. For this part, we use outstanding loans to small businesses compiled by the SBA based on Call Reports. These are loans under $1 million, and we categorize all small business lending as asset-based loans to be conservative. Some small business lending can also be cash flow-based loans, but detailed loan-level information is difficult to get and we take a conservative approach. Loans outstanding to small businesses total about \$0.6 trillion.[4]

For asset-based debt originated by finance companies, we use the Flow of Funds data and estimate the outstanding amount to be about \$0.3 trillion.

For capital leases, the total amount in Compustat 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 \$1.1 trillion. There may be some loans to medium-sized firms missing (not covered by SNC/DealScan and finance company loans, but not necessarily small business loans), which could lead to potential under-estimation. At the same time, small business loans can include loans to non-corporate entities (sole proprietorship, partnership) or some mortgages (i.e., overlap with the commercial mortgages category above), leading to potential over-estimation. Nonetheless, in either case the magnitude should be small.

Cash Flow-Based Lending: Around 80% of Debt Outstanding

1. Corporate bonds
   - Share in total non-financial corporate debt outstanding: 57%.
   - Data source: Flow of Funds, Fixed Income Securities Database (FISD), CapitalIQ.
   - Calculation: According to Flow of Funds data, corporate bonds outstanding by US non-financial firms is about \$4.9 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 assets (less than 2% by value). 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: 23%.
   - Data sources: DealScan, ABL Advisor; SNC, Flow of Funds, S&P Leveraged Commentary & Data (LCD).
   - Calculation: We approximate the amount of cash flow-based loans using the cash flow-based portion of large commercial loans. We use the procedure described above: we find that around 5% of large commercial loans are asset-based and 95% are cash flow-based, and then multiply the share with the size of large

[4] See the Small Business Administration report "Small Business Lending in the United States." Data from the Community Reinvestment Act covers new origination of small business loans (not amount outstanding), which total about 0.2 trillion per year.

commercial loans outstanding (roughly \$2.1 trillion). We may miss cash flow-based loans of medium-sized firms due to imperfect data coverage (if they are not covered by SNC/DealScan), which can lead to potential under-estimation.

Table IA1: Summary of Asset-Based Lending and Cash Flow-Based Lending

Debt Type	Category	Amount (\$ Tr)	Share
Commercial mortgages	Asset-based lending	\$0.6	7%
Asset-based loans	Asset-based lending	\$1.1	13%
Corporate bonds	Cash flow-based lending	\$4.9	57%
Cash flow-based loans	Cash flow-based lending	\$2.0	23%

IA1.2 Firm-Level Composition

We now explain the firm-level categorization of asset-based lending and cash flow-based lending, using debt-level data for non-financial firms in CapitalIQ.

We begin with debt-level information from CapitalIQ, available since 2002. For each debt, CapitalIQ provides information about the amount outstanding, together with detailed descriptions of the debt (e.g., 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-year, which facilitates a comprehensive analysis. CapitalIQ assembles these data from various filings. It covers about 80% of Compustat firms and 90% of debt by value in Compustat. The total debt value for each firm matches well based on CapitalIQ data and Compustat data. We supplement information from CapitalIQ with additional information on debt attributes from DealScan, FISD, and SDC Platinum. We examine non-financial firms, which have SIC codes outside of 6000 to 6999.

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 classify a debt as asset-based lending if
   - the debt information contains the following key words (and their variants): asset-based, ABL, borrowing base, mortgage, real estate/building, equipment, machine, fixed asset, inventory, receivable, working capital, automobile/vehicle, aircraft, capital lease, SBA/small business, oil/drill/rig, reserve-based, factoring, industrial revenue bond, finance company, capital lease, construction, project finance;
   - it is a secured revolver (since asset-based revolvers are more common than cash flow-based revolvers with blanket liens).
2. We classify 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 also assign a debt to the miscellaneous/unclassified category if it is
   - borrowing from governments or a pollution control bond;
   - insurance-related borrowing, or borrowing from vendor/seller/supplier/landlord;
   - borrowing from affiliated companies.

4. We classify a debt as cash flow-based lending if it **does not belong to any of the categories above** and
   - it explicitly says "cash flow-based"/"cash flow loan";
   - it is unsecured, is a "debenture", or is secured by "substantially all assets";
   - it contains the following key words and their variants, which are representative of cash flow-based loans: 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 I, we show the median firm-level share of asset-based and cash flow-based lending. In Table II, we show that the amount of asset-based lending a firm has is positively correlated with the amount of physical and other separable assets, while the amount of cash flow-based lending is not (if anything the correlation is generally negative). The results confirm that cash flow-based lending does not depend on the value of specific assets. In Table IA2 below, we present the same regressions, adding firm fixed effects and year fixed effects. The results are very similar.

Table IA2: Properties of Asset-Based Debt and Cash Flow-Based Debt

This table presents panel regressions of a firm's outstanding debt of a given type on the amount of specific assets the firm has. All variables are normalized by book assets. In Panel A, the left hand side variables include all asset-based debt, as well as real estate loans (mortgages) and non-mortgage asset-based debt in particular. In Panel B, the left hand side variables include all cash flow-based debt, as well as cash flow-based loans and secured cash flow-based debt in particular. Liquidation value is estimated liquidation value of plant, property, and equipment (PPE), inventory, and receivable, using industry-average liquidation recovery rates collected from bankruptcy filings. Controls include size (log book assets) and cash holdings. Firm fixed effects and year fixed effects are included (R^2 does not include fixed effects). Sample period is 2002 to 2018, and all Compustat non-financial firms with CapitalIQ debt detail data are included. Standard errors are clustered by firm and time.

Panel A. Asset-Based Debt

	All		Mortgage		Non-Mortgage	
	(1)	(2)	(3)	(4)	(5)	(6)
Plant, property, and equipment	0.116***		0.016***		0.084***	
	(0.013)		(0.003)		(0.011)	
Inventory	0.078***		0.005*		0.074***	
	(0.025)		(0.003)		(0.022)	
Receivable	0.056***		-0.001		0.056***	
	(0.017)		(0.001)		(0.017)	
Liquidation value		0.156***		0.012***		0.133***
		(0.021)		(0.003)		(0.019)
Fixed Effects			Firm, Year			
Obs	57,117	54,305	56,594	53,816	56,849	54,050
R^2	0.03	0.03	0.01	0.00	0.03	0.03

Panel B. Cash Flow-Based Debt

	All		Cash Flow-Based Loans		Secured Cash Flow-Based	
	(1)	(2)	(3)	(4)	(5)	(6)
Plant, property, and equipment	-0.081***		-0.031***		-0.038***	
	(0.024)		(0.008)		(0.009)	
Inventory	-0.155***		-0.054***		-0.050***	
	(0.035)		(0.011)		(0.013)	
Receivable	-0.158***		-0.052***		-0.058***	
	(0.026)		(0.008)		(0.009)	
Liquidation value		-0.251***		-0.080***		-0.094***
		(0.043)		(0.012)		(0.014)
Fixed Effects			Firm, Year			
Obs	57,104	54,295	56,170	53,387	56,364	53,578
R^2	0.01	0.01	0.01	0.01	0.01	0.01

IA2 Legal Institutions and Cash Flow-Based Lending around the World

As discussed in Section 2.3, legal institutions for corporate bankruptcy resolution can be important for the prevalence of asset-based versus cash flow-based lending. In countries where the corporate bankruptcy system emphasizes reorganization instead of liquidation, cash flow-based lending is likely to be more common.

We are able to construct a rough estimate of the amount of asset-based and cash flow-based debt for Compustat non-financial firms in over 50 countries (non-financial firms are those with SIC codes outside of 6000 to 6999). We use debt-level data from CapitalIQ and follow the same categorization algorithm in Appendix IA1.2. We use the same procedure in all countries to maintain consistency and restrict degrees of freedom, although some assumptions in the estimation may ideally change based on the country's institutional setting.[5] For foreign firms, CapitalIQ sometimes has less detailed information, so the estimates can be less precise than our results for the US. The data covers 2002 to 2018.

For legal institutions, we use data on default resolution across 88 countries collected by Djankov, Hart, McLiesh, and Shleifer (2008). Djankov et al. (2008) present a hypothetical bankruptcy case of a hotel called Mirage to legal professionals in each country, and ask them to assess the outcome based on the legal regime around 2006. The case assumes that the firm value is higher if it remains alive as a going concern (i.e., a firm that continues its operations) than if it is liquidated piecemeal. We use a dummy variable which takes value one if legal professionals in a country think Mirage is most likely to be reorganized and remain as a going concern.

For each country-year, we calculate the total share of cash flow-based lending (cash flow-based debt of all firms in the sample divided by their total debt), the median firm-level share of cash flow-based lending, and the median firm-level share among large firms (book assets above Compustat median in each country-year). Table IA3 Panel A shows the average values among countries where the reorganization dummy is one versus countries where it is zero. Panel B shows regression results of the prevalence of cash flow-based lending on the reorganization dummy, controlling for year fixed effects and real log GDP per capita (in US dollars).

We see that in countries with bankruptcy systems that facilitate corporate reorganization, there tends to be a higher prevalence of cash flow-based lending. We note three reasons that can weaken the magnitude of the result. First, large public firms can be less affected by the legal regimes in their home countries. For instance, large firms in other countries often prefer to issue debt under US laws, through US subsidiaries, and utilize Chapter 11 in US courts for default resolution (see a detailed example of the Dutch chemical company LyondellBasell in Gilson (2012)). This would weaken the link between their debt composition and legal institutions in their home countries. Second, we follow the same categorization algorithm in all countries to maintain consistency, but some debt classes that are typically cash flow-based in the US (e.g., bonds) may have different properties in liquidation-focused countries. Third, the data on legal institutions from Djankov et al. (2008) is a one-time snapshot. A number of countries go through bankruptcy law reforms over time, so there can be measurement error in the independent variable. Despite these potential complications that bias against our tests, Table IA3 shows that we still observe a significant relationship

[5]For instance, while in the US we assume corporate bonds are largely cash flow-based, in liquidation-focused countries this may not hold.

between legal institutions and the prevalence of cash flow-based lending.

Table IA3: Legal Environment and Corporate Debt Composition across Countries (Compustat Firms)

The outcome variable is the total share of cash flow-based lending (cash flow-based debt of all firms in a country-year divided by their total debt) in column (1), the median firm-level share of cash flow-based lending (in each country-year), and the median share among large firms (assets above Compustat median in each country-year). The reorganization dummy is equal to one if the firm can reorganize and stay as a going concern in Djankov et al. (2008). Panel A shows the mean of each variable for countries where the reorganization dummy is one ("Yes") and zero ("No"). Panel B shows regression results on the reorganization dummy, controlling for log real GDP per capita in each country-year and time fixed effects. Each observation is a country-year. Standard errors are clustered by country and time. We exclude countries where there are less than 500 firm-level observations. Sample period is 2002 to 2018.

Panel A. Average Share of Cash Flow-Based Debt by Country Group

Reorganization	Total Share (1)	Median Firm-Level Share (2)	Median Firm-Level Share (Large Firms) (3)
Yes	0.66	0.37	0.55
No	0.54	0.21	0.35

Panel B. Share of Cash Flow-Based Debt and Legal Environment

	Total Share (1)	Median Firm-Level Share (2)	Median Firm-Level Share (Large Firms) (3)
Reorganization dummy	0.080***	0.139**	0.181***
	(0.030)	(0.065)	(0.066)
Log GDP per capital	0.065***	0.031	0.023
	(0.016)	(0.025)	(0.027)
Year FE	Yes	Yes	Yes
Obs	816	816	816
R^2	0.22	0.09	0.10

IA3 Earnings-Based Borrowing Constraints

IA3.1 Specifications of Earnings-Based Covenants

Table IA4: Variants of Earnings-Based Covenants

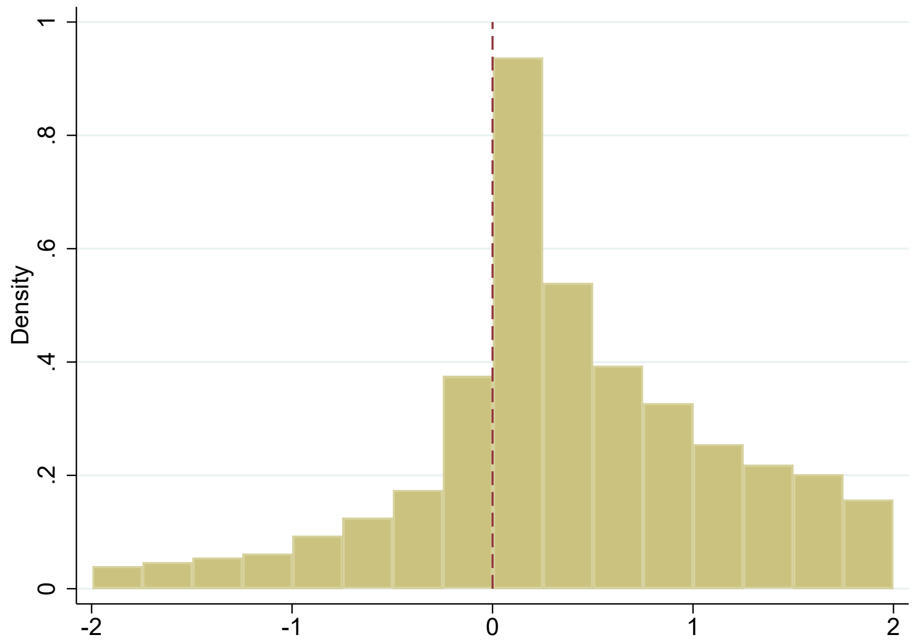
This table lists the main variants of earnings-based covenants and the construction using Compustat variables compiled by Demerjian and Owens (2016). The first column displays the covenant type, which is reported in DealScan data, and the second column describes the form of the covenant. The third column 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 with financial covenants originated between 1997 and 2018 that have each type of earnings-based 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 definition	Compustat implementation	Fraction of loans	Exact match in Demerjian and Owens (2016)
(1)	(2)	(3)	(4)	(5)
Max. Debt to EBITDA	Debt/EBITDA	(DLTT+DLC)/EBITDA	54.4%	91.0%
Max. Senior Debt to EBITDA	Senior Debt/EBITDA	(DLTT+DLC–DS)/EBITDA	9.5%	89.4%
Min. Interest Coverage	EBITDA/Interest Expense	EBITDA/XINT	36.9%	76.3%
Min. Cash Interest Coverage	EBITDA/Interest Paid	EBITDA/INTPN	1.1%	76.8%
Min. Debt Service Coverage	EBITDA /(Interest Expense+ST Debt)	EBITDA/(XINT+L.DLC)	7.5%	37.9%
Min. Fixed Charge Coverage	EBITDA/(Interest Expense+ST Debt+Rent Expense)	EBITDA/(XINT+L.DLC+XRENT)	31.8%	2.7%
Min. EBITDA	EBITDA	EBITDA	9.2%	97.4%

IA3.2 Effect of Earnings-Based Covenants

Figure IA1: Bunching around Earnings-Based Covenant Threshold

This plot shows the histogram of firm-year observations across bins that measure the distance to violating earnings-based loan covenants in DealScan data. As explained in Section 3.2, we first compute the difference between the actual financial ratios and permitted financial ratios. We then normalize this difference using the firm-level standard deviation of the financial ratio. We take the firm-level minimum distance among all earnings-based covenants if the firm has multiple earnings-based covenants. We take the firm-year observations that are within +/- two standard deviations, and group them into twenty equally spaced bins. Firms to the right of zero are in compliance with all earnings-based covenants in DealScan data. Firms to the left of zero are in violation of at least one such covenant.



IA3.3 Other Earnings-Based Constraints

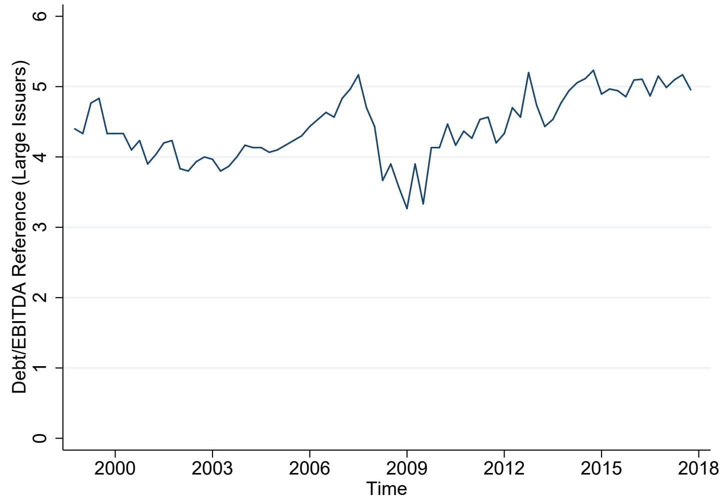
This section provides more information about other forms of earnings-based borrowing constraints discussed in Section 3. When a firm wants to raise debt, it can be difficult to surpass a reference level of debt-to-EBITDA ratio. These credit market norms are most pronounced in the leveraged loan market (commercial loans to non-investment grade borrowers), and are especially relevant for non-investment grade firms.

Figure IA2 below shows a time series of reference debt-to-EBITDA ratio in the leveraged loan market for large firms, using data from S&P Leveraged Commentary & Data (LCD). It is an indicator of the firm-level debt-to-EBITDA ratio lenders are willing to allow on average. Unlike financial covenants, this is primarily a market norm, and not legally binding. Nonetheless, to the extent that firms need to comply with such norms when they borrow, their debt-to-EBITDA ratio may end up being sensitive to the market norm.

Table IA5 shows the sensitivity of firm-level debt to EBITDA to the reference level of debt to EBITDA, based on the regression:

$$\text{Debt/EBITDA}_{it} = \alpha + \theta \text{Ref Debt/EBITDA}_t + X'_{it}\gamma + Z'_t\rho + v_{it}, \tag{A1}$$

Figure IA2: Debt/EBITDA Reference Level for Large Corporate Issuers



where Debt/EBITDA$_{it}$ is firm i's debt to EBITDA at time t, Ref Debt/EBITDA$_t$ is the reference level 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). We show results for firms in different ratings categories: those just below the investment grade cutoff (BB+ and below), and those just above the cut-off (BBB- and above). We also show results separately for firms that primarily use cash flow-based debt (e.g., share of cash flow-based debt greater than 50%) and firms that do not.

Table IA5: 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/assets), cash holdings, accounts receivable, inventory, PPE, size (log book assets) at the end of time $t-1$. Macro controls include term spread (spread between ten-year Treasury and three-month Treasury), credit spreads (spread between BAA bond yield and ten-year Treasury yield, as well as spread between high yield bond yield and ten-year Treasury yield), and real GDP growth in the past twelve months. Observations with negative EBITDA are dropped (because debt/EBITDA is not well-defined in these cases). Standard errors are clustered by both firm and time.

	Non IG		IG		Share of Cash Flow-Based Debt	
	All BB	BB+	BBB-	All BBB	$> 50\%$	$< 50\%$
θ	0.515**	0.615**	0.360**	0.247**	0.206**	0.062
	(0.254)	(0.276)	(0.146)	(0.119)	(0.099)	(0.141)

IA4 Other Types of Financial Covenants

Corporate debt contracts can have many types of covenants, which are legally binding contractual restrictions on the borrower. There are financial covenants, which specify restrictions on the borrower' financial conditions, as well as non-financial covenants, which require or restrict other actions by the borrower (e.g., require audited financial statements, restrict mergers and acquisitions, dividend payment, or investment activity).

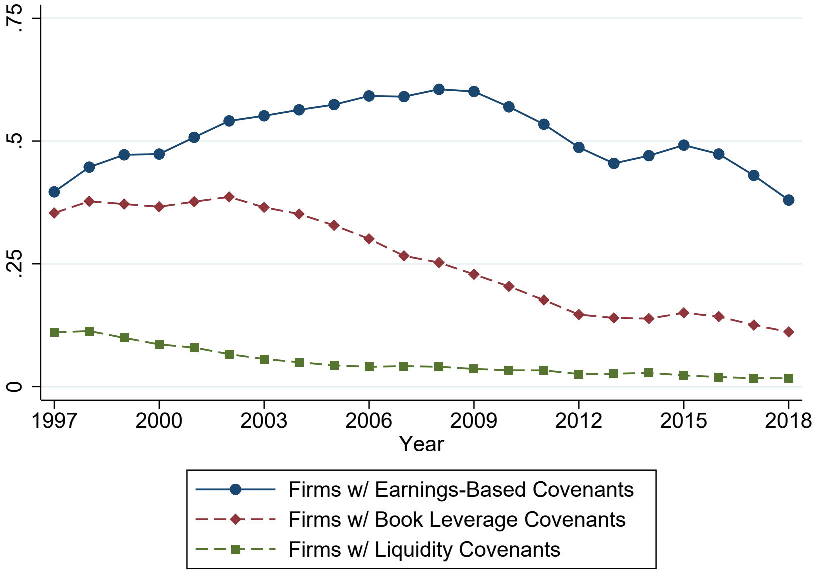
In this paper, we focus on earnings-based covenant, a common form of financial covenants, as a way to implement the earnings-based borrowing constraints. As mentioned in Section 3, other financial covenants mainly take two forms, which we discuss here. One type specifies an upper bound on book leverage, or analogously a lower bound on book equity (book net worth). The popularity of this type of covenant has declined in the past twenty years for several reasons. Demerjian (2011) postulates the decline is affected by shifts in accounting standards that gave firms more discretion in estimating the value of assets and liabilities on their balance sheets. In addition, institutional investors (e.g., hedge funds, mutual funds) have become increasingly more important in corporate loans, who place less emphasis on balance sheet-based metrics and more emphasis on earnings-based metrics. Currently the prevalence of covenants on book equity or book leverage is less than a third of the prevalence of earnings-based covenants, and violations are uncommon. The other type of financial covenant focuses on liquidity conditions, and specifies limits on the ratio of current assets to current liabilities. The prevalence of this type of financial covenant is relatively low.

Figure IA3 shows the firm-level prevalence of different types of financial covenants. It plots the fraction of large firms with earnings-based covenants, book leverage (or book equity) covenants, and liquidity covenants in their outstanding debt, based on covenant information from DealScan loans. While about a half of these firms have earnings-based covenants, in recent years less than a quarter have book leverage covenants and less than 5% have liquidity covenants. Similar patterns hold at the debt issuance level. For instance, among DealScan loan issues with financial covenants, about 85% have earnings-based covenants, while only 25% and 5% have book leverage (or book equity) covenants and liquidity covenants respectively.

Overall, restrictions based on earnings are the most common among financial covenants of corporate debt contracts for US non-financial firms.

Figure IA3: Firms with Different Types of Financial Covenants

This figure shows the prevalence of different types of financial covenants among large US non-financial firms (assets above Compustat median). The solid line with circles shows the fraction of firms with earnings-based covenants. The dashed line with diamonds shows the fraction of firms with book leverage covenants. The dashed line with squares shows the fraction of firms with liquidity covenants (limits on current assets relative to current liabilities). The covenants data are based on DealScan loans.



IA5 A Simple Framework

In this appendix, we provide a simple framework to further illustrate the foundations and implications of different forms of corporate borrowing constraints. Specifically, the framework addresses three questions.

First, it illustrates how institutional environments (e.g., legal infrastructure, cash flow verifiability) shape the prevalent form of corporate borrowing (asset-based lending versus cash flow-based lending). High verifiable cash flows, together with high asset specificity of most non-financial firms (limited liquidation values of physical assets), make cash flow-based lending especially relevant.

Second, it discusses why, in the context of cash flow-based lending, borrowing constraints take the form of earnings-based borrowing constraints (EBCs), with a central focus on operating earnings in the past twelve months. The key issue is constraints on contractibility. To be able to enforce constraints on a regular basis, creditors need a metric that can be measured and verified frequently, which makes current earnings an appealing choice.

Third, it lays out specific predictions of how asset-based lending versus cash-flow based lending affects the way financial variables influence firm outcomes on the margin and the applicability of classic macro-finance mechanisms. This follows from understanding whether the firm's total debt capacity is driven by the liquidation value of physical assets or by the value of the firm's cash flows (in the form of operating earnings).

IA5.1 Economic Foundations of Lending Practices and Borrowing Constraints

We start with the first question: how the institutional environment shapes the prevalent form of corporate borrowing (asset-based lending versus cash flow-based lending).

In many classic macro-finance models, the environment for debt enforcement assumes that creditors can seize physical assets, while cash flows are not verifiable. In this case, in default creditors recover based on the liquidation value of physical assets. Correspondingly, firms' ex ante debt capacity is driven by the liquidation value of physical assets that creditors can seize (the traditional collateral constraints).

On the other hand, our work focuses on the US institutional environment, where creditors may not be able to seize physical assets (given the automatic stay in bankruptcy), while cash flows can be verifiable. As explained in Section 2.1, in the US, total payments to creditors in default (Chapter 11) are given by the value of cash flows from firms' continuing operations, which makes cash flow-based debt fairly natural. If they choose to, creditors can also tie the value of their debt claims to the liquidation value of specific assets pledged to them (asset-based debt), which would be estimated when the firm is not actually liquidated. Correspondingly, firms' ex ante total debt capacity derives from the value of cash flows from firms' continuing operations (while the traditional collateral constraints only apply to the asset-based subset of debt where creditors choose to tie their claims to the liquidation value of specific assets).

We provide a simplified formalization below. We use ϕ^{ABL} to capture the enforceability of asset-based lending given the institutional environment (i.e., the value lenders of asset-based debt can recover in default relative to the liquidation value of assets pledged to them), and qk to capture the liquidation value of physical assets the firm owns. The maximum payoff for asset-based debt in bankruptcy is then given by $\phi^{ABL}qk$, which shapes the firm's ex ante debt capacity for asset-based debt (through creditors' optimality or incentive compatibility conditions). The value $\phi^{ABL}qk$ tends to be high when it is easy to seize assets (high ϕ^{ABL}), and the firm has a large amount of highly redeployable assets (high qk).

Similarly, we use ϕ^{CFL} to capture the enforceability of cash flow-based lending given the institutional environment (i.e., the value lenders can recover relative to the firm's cash flows from operations), and π to capture the value of cash flows from the firm's operations. The maximum payoff for cash flow-based debt in bankruptcy (e.g., Chapter 11 restructuring) is then $\phi^{CFL}\pi$, which shapes the firm's ex ante debt capacity for cash flow-based debt (through creditors' optimality or incentive compatibility conditions). The value $\phi^{CFL}\pi$ tends to be high when cash flow verifiability and contractibility are high (ϕ^{CFL} is high) and firms produce high cash flows (π is high).

Given the size of $\phi^{CFL}\pi$ and $\phi^{ABL}qk$, the institutional environment along with the nature of firms' assets and cash flows then shapes whether cash flows or the liquidation value of physical assets drives the debt capacity of the firm. One stylized formulation is as follows.

For the case where $\phi^{CFL}\pi > \phi^{ABL}qk$: This tends to happen when $\phi^{CFL}\pi$ is high (e.g., reliable accounting, Chapter 11 type bankruptcy system, and firm generating positive earnings), and/or $\phi^{ABL}qk$ is low (e.g., firms' assets are specialized and illiquid). In such settings, the firm's cash flows (e.g., operating earnings) determine its maximum debt capacity.

For the case where $\phi^{ABL}qk > \phi^{CFL}\pi$: This tends to happen when $\phi^{CFL}\pi$ is low (e.g., cash flows not verifiable or contractible, or firms having low/negative earnings), and/or $\phi^{ABL}qk$ is high (e.g., assets highly standardized and transferrable). In this case, the liquidation value of physical assets determines the maximum debt capacity.

While it is not easy to directly measure ϕ^{ABL} and ϕ^{CFL} in practice, the analyses in Sections 2 and 3 suggest that large US non-financial firms in most industries could be represented by the former case, and small firms, airlines, and firms in other countries with different legal environments (e.g., Japan and countries where bankruptcy systems focus on liquidation) could be represented by the latter case. For simplicity, in this illustration we just specify the determinant of maximum debt capacity. We further discuss how to pin down debt composition in Section IA5.3 below.

From Cash Flow-Based Lending to Earnings-Based Borrowing Constraints (EBCs)

We now turn to the second question: why, in the context of cash flow-based lending, borrowing constraints commonly take the form of EBCs, with a central focus on operating earnings in the past twelve months.

For default resolution in Chapter 11, the cash flow value π is typically an estimate of the going-concern value of the firm (the present value of future earnings from the continuing operation of the restructured firm). This value, however, may not be easily verifiable on a regular basis, and may not be easy to contract on. To facilitate enforcement of borrowing constraints on a regular basis, one needs a measure that is readily observable and verifiable, and borrowers and lenders do not dispute its value. This can be viewed as an additional dimension of cash flow verifiability, especially relevant for enforcing borrowing constraints on a regular basis. Given these contractibility constraints, credit markets in practice use the firm's EBITDA in the past twelve months as a focal metric. This measure strikes a balance between being informative about the cash flow value of the firm, and being easily observable and verifiable on a frequent basis (generally quarterly, based on firms' financial statements). In comparison, projections or estimates of future cash flows can be costly to verify and easily disputable. Other metrics such as stock prices can fluctuate due to non-fundamental reasons, and there is the risk that investors may deliberately influence stock prices to trigger or avoid violations. Accordingly, earnings-based borrowing constraints arise as the prevalent norm in the context of cash flow-based lending.

In addition, in practice, firms in the US may have multiple types of creditors (e.g., some asset-based lenders and some cash flow-based lenders). As described in Section 3.1, EBCs generally restrict a firm's *total debt* as a function of its total current operating earnings (instead of specifying restrictions for the size of cash flow-based debt). The reason is that in Chapter 11, the total payments to creditors are pinned down by the going-concern cash flow value of the restructured firm. The payoffs of cash flow-based debt are then determined by this value, minus the estimated liquidation value of specific assets pledged to asset-based debt, if there are multiple types of debt. Therefore, it is easier to specify ex ante limits of total borrowing as a function of the firm's operating earnings (so cash flow-based lenders do not have to continuously estimate the liquidation value of specific assets pledged to asset-based debt, which is generally not their specialty).

As a result, for subsequent analyses in Section IA5.2, we transition to the specification of the commonly-used earnings-based constraint $b \leq \phi^{EBC}\pi$, where b is the firm's total borrowing, π is the firm's current operating earnings, and ϕ^{EBC} is the tightness of the constraint.

Potential Inefficiencies

Finally, we summarize the potential sources of inefficiencies in the setting of cash flow-based lending and EBCs. First, corporate restructuring (e.g., Chapter 11) or cash flow verifiability may not be perfect, and firms generally cannot borrow the full amount of the present value of future cash flows (as in the frictionless first-best scenario). Second, given limits of verifiability and contractibility, borrowing constraints in this setting have a primary focus on operating earnings in the past twelve months, which can induce further deviations from the first-best. For instance, small or young firms that may have high cash flows in the future (and high present value of future cash flows), but do not have positive operating earnings in the near term, would find it difficult to obtain credit this way.

IA5.2 Lending Practices and Corporate Borrowing Sensitivity on the Margin

We now turn to the third question: how asset-based lending versus cash-flow based lending provides specific predictions for the way financial variables influence firm outcomes on the margin, and the relevance of macro-finance mechanisms.

Consider a firm that makes investment 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. External borrowing can take the form of both asset-based debt b_{ABL} and cash flow-based debt b_{CFL}.

We now specify the determinants of borrowing constraints following the discussion above. The amount of asset-based debt b_{ABL} is subject to the constraint $b_{ABL} \leq \phi^{ABL}qk$, where qk is the liquidation value of physical assets pledged to creditors, and ϕ^{ABL} captures the tightness of this constraint. If the firm borrows cash flow-based debt (i.e., $b_{CFL} > 0$), then following the empirical evidence we document, the total amount of external borrowing $b = b_{ABL} + b_{CFL}$ is subject to an earnings-based constraint $b = b_{ABL} + b_{CFL} \leq \phi^{EBC}\pi$ following credit market conventions, where π now denotes specifically the firm's current operating earnings (treated as given for the current decision, consistent with EBCs focusing on earnings in the past twelve months discussed in Section 3.1). The parameter ϕ^{EBC}

captures the tightness of the earnings-based constraint. For simplicity, here the interest rate on all external borrowing is fixed to be 1.

The firm's optimization problem is:

$$(I^*, b^*, b^*_{ABL}, b^*_{CFL}) = \arg \max_{I,b,b_{ABL},b_{CFL} \geq 0} F(I) - b \tag{A2}$$

$$s.t.\ I = w + b = w$$

$$b_{ABL} \leq \phi^{ABL} qk \tag{A3}$$

$$b = b_{ABL} + b_{CFL} \leq \phi^{EBC} \pi, \text{ if } b_{CFL} > 0. \tag{A4}$$

The following proposition summarizes how the prevalent form of corporate borrowing practices influences the way financial variables affect firm outcomes on the margin. In the proposition, we use I^{FB} to denote the first-best investment, which solves $F'\left(I^{FB}\right) = 1$.

Proposition A1. ***Cash Flow-Based Lending Region:*** *When $\phi^{EBC}\pi > \phi^{ABL}qk$, the firm's total borrowing and investment are increasing in the firm's current earnings π, but are not sensitive to the liquidation value of physical assets qk:*

$$\frac{\partial b^*}{\partial \pi} \geq 0, \ \frac{\partial I^*}{\partial \pi} \geq 0, \ \frac{\partial b^*}{\partial (qk)} = 0 \ \text{and} \ \frac{\partial I^*}{\partial (qk)} = 0,$$

and the two inequalities are strict if the firm is constrained, that is, $I^{FB} > w + \phi^{EBC}\pi$.

Asset-Based Lending Region: *When $\phi^{ABL}qk > \phi^{EBC}\pi$, the firm's total borrowing and investment are increasing in the liquidation value of physical assets qk, but are not sensitive to the firm's current earnings π:*

$$\frac{\partial b^*}{\partial \pi} = 0, \ \frac{\partial I^*}{\partial \pi} = 0, \ \frac{\partial b^*}{\partial (qk)} \geq 0 \ \text{and} \ \frac{\partial I^*}{\partial (qk)} \geq 0,$$

and the two inequalities are strict if the firm is constrained, that is, $I^{FB} > w + \phi^{ABL}qk$.

The proposition can be understood in two steps. The first step is that institutional environments and the nature of firms' assets determine whether cash flows or the liquidation value of physical asset drives the firm's debt capacity, as discussed in Section IA5.1.

The second step then shows whether the firm is in the asset-based lending region or the cash flow-based lending region then shapes how financial variables influence firm outcomes on the margin. Specifically, in the cash flow-based lending region, corporate borrowing and investment are increasing in the firm's operating earnings π (given the common form of earnings-based borrowing constraints), but are not sensitive to the liquidation value of physical assets qk. On the other hand, in the asset-based lending region, corporate borrowing and investment are increasing in the liquidation value of physical assets qk, but are not sensitive to the firm's operating earnings π. Those predictions are consistent with our empirical evidence in the paper. Classic fire sale amplification may not apply to the firm's borrowing and investment on the margin in the former case, but could be more relevant in the latter case.

IA5.3 Debt Composition

The simplified formulation above focuses on the determinants of the firm's maximum debt capacity. If we assume that asset-based lending and cash flow-based lending have the same interest rates, then debt composition is indeterminate in this case. In other words, the model specifies the firm's total borrowing b^* (whether it is driven by cash flows in the form of operating earnings $\phi^{EBC}\pi$ or by liquidation value of physical assets $\phi^{ABL}qk$), but not debt composition (i.e. b^*_{ABL} and b^*_{CFL}).

In the following, we illustrate an extension of the environment above, where the debt composition is also determined. The key is to let the interest rates of asset-based lending and cash flow-based lending vary with the amount of borrowing. Specifically, the firm solves the following problem:

$$\begin{aligned}(I^*, b^*, b^*_{ABL}, b^*_{CFL}) = \arg \max_{I,b,b_{ABL},b_{CFL}\geq 0} \; & F(I) - r_{ABL}\left(b_{ABL};\phi^{ABL}qk\right) b_{ABL} \\ & - r_{CFL}\left(b_{ABL}+b_{CFL};\phi^{EBC}\pi\right) b_{CFL} \\ & s.t.\; I = w + b = w,\end{aligned}$$

where the interest rate on asset-based debt $r_{ABL}\left(b_{ABL};\phi^{ABL}qk\right)$ is an increasing function of b_{ABL} and a decreasing function of $\phi^{ABL}qk$, and the interest rate on cash flow-based debt $r_{CFL}\left(b_{ABL}+b_{CFL};\phi^{EBC}\pi\right)$ is an increasing function of $b_{ABL}+b_{CFL}$ and a decreasing function of $\phi^{EBC}\pi$. Note that the interest rate on cash flow-based debt is a function of total debt $b_{ABL}+b_{CFL}$ (instead of cash flow-based debt b_{CFL} only), to be consistent with the fact that EBCs are based on the firm's total debt.

To illustrate how the firm's debt composition can be determined, we impose the following assumption to achieve a closed form solution:

$$\begin{aligned} r_{ABL}\left(b_{ABL};\phi^{ABL}qk\right) &= 1 + \epsilon^{-1}_{ABL}\left(\phi^{ABL}qk\right) b_{ABL} \\ r_{CFL}\left(b_{ABL}+b_{CFL};\phi^{EBC}\pi\right) &= 1 + \epsilon^{-1}_{CFL}\left(\phi^{EBC}\pi\right)\left(b_{ABL}+b_{CFL}\right), \end{aligned} \tag{A5}$$

where $\epsilon_{ABL}\left(\phi^{ABL}qk\right)$ is an increasing function that captures the inverse of the sensitivity of asset-based debt interest rate to the amount of asset-based debt, and $\epsilon_{CFL}\left(\phi^{EBC}\pi\right)$ is an increasing function that captures the inverse of the sensitivity of cash flow-based debt interest rate to total borrowing.

Proposition A2. *The share of asset-based debt in the firm's total debt is given by*

$$\frac{b^*_{ABL}}{b^*_{ABL}+b^*_{CFL}} = \frac{\epsilon_{ABL}\left(\phi^{ABL}qk\right)}{2\epsilon_{CFL}\left(\phi^{EBC}\pi\right)},$$

which increases with $\phi^{ABL}qk$ and decreases with $\phi^{EBC}\pi$.

In other words, the share of cash flow-based debt is high when the firm has high verifiable cash flows (operating earnings), given the legal infrastructure (e.g., reliable accounting, Chapter 11 type bankruptcy system) and a profitable business. It is also high when the liquidation value of specific assets is low (e.g., the firm does not have much physical or separable assets, or assets are specialized and illiquid). These features are consistent with the findings in Section 2.

IA5.4 Proofs

Proof of Proposition A1. We have two cases:

- Case 1: **Cash Flow-Based Lending Region.** When $\phi^{EBC}\pi > \phi^{ABL}qk$, we have $b^* = \max\left\{\phi^{EBC}\pi, I^{FB} - w\right\}$, and $I^* = b^* + w$. The first case of Proposition A1 then follows.

- Case 2: **Asset-Based Lending Region.** When $\phi^{ABL}qk > \phi^{EBC}\pi$, we have $b^* = \max\left\{\phi^{ABL}qk, I^{FB} - w\right\}$, and $I^* = b^* + w$. The second case of Proposition A1 then follows.

Proof of Proposition A2. Firm's optimality implies:

$$\begin{aligned} F'\left(w + b^*_{ABL} + b^*_{CFL}\right) &= r_{ABL}\left(b^*_{ABL}\right) + r^{'}_{ABL}\left(b^*_{ABL}\right) b_{ABL} + r^{'}_{CFL}\left(b^*_{ABL} + b^*_{CFL}\right) b^*_{CFL} \\ &= r^{'}_{CFL}\left(b^*_{ABL} + b^*_{CFL}\right) b^*_{CFL} + r_{CFL}\left(b^*_{ABL} + b^*_{CFL}\right). \end{aligned}$$

Together this means:

$$r_{ABL}\left(b^*_{ABL}\right) + r^{'}_{ABL}\left(b^*_{ABL}\right) b^*_{ABL} = r_{CFL}\left(b^*_{ABL} + b^*_{CFL}\right).$$

Based on (A5), The firm's ratio of asset-based lending is given by

$$\frac{b^*_{ABL}}{b^*_{ABL} + b^*_{CFL}} = \frac{\epsilon_{ABL}\left(\phi^{ABL}qk\right)}{2\epsilon_{CFL}\left(\phi^{EBC}\pi\right)}.$$

IA6 Definition of Main Firm-Level Variables

Variable	Construction	Source
Net debt issuance	(DLTIS-DLTR)/l.AT	Compustat
ΔLT book debt	(DLTT-l.DLTT)/l.AT	Compustat
ΔTotal book debt	(DLTT+DLC-l.DLTT-l.DLC)/l.AT	Compustat
Capital expenditure	CAPX/l.AT	Compustat
R&D spending	XRD/l.AT	Compustat
Operating earnings EBITDA	EBITDA/l.AT	Compustat
Net cash receipts OCF	(OANCF+XINT)/l.AT	Compustat
Q	(DLTT+DLC+PRC*SHROUT)/AT	CRSP, Compustat
Stock returns	RET	CRSP
Cash holding	CHE/AT	Compustat
Book leverage	(DLTT+DLC)/AT	Compustat
PPE	PPENT/AT	Compustat
Inventory	INVT/AT	Compustat
Receivable	RECT/AT	Compustat
Depreciation	DP/l.AT	Compustat
Margin	EBITDA/SALE	Compustat
Size (log book assets)	Log(AT)	Compustat
Option compensation expense	XINTOPT/l.AT (available before fiscal year 2006)	Compustat
Firm age	# of years since min(incorporation year, IPO year), see Cloyne, Ferreira, Froemel, and Surico (2019)	Datastream (DATEOFINCORPORATION), Compustat (IPODATE)
W/ earnings-based covenants	With at least one earnings-based covenant from loans or bonds outstanding	Compustat, DealScan, FISD

Non-financial firms in Compustat are defined as firms with SIC codes outside of 6000 to 6999. US firms are those with country code (incorporation), namely Compustat variable FIC, being "USA." Japan firms are those with FIC being "JPN."

IA7 Estimates of Market Value of Firm Real Estate

Because accounting data only reports the value of firm properties at historical costs, not market values, we need to estimate or collect additional data to know the market value of firm real estate. We use two methods described in detail below.

IA7.1 Method 1: Traditional Estimates

The first method we use builds on Chaney, Sraer, and Thesmar (2012), which has the following steps:

1. We estimate the market value of firm real estate in 1993. This method requires firms to exist in Compustat since 1993, which is the last year when the net book value and accumulated depreciation of real estate assets are 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) in 1993. 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 the accumulated depreciation and the 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, using 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 $\text{RE}_{i,t} \times P_{it+1}/P_{it} \times 97.5\%$ (changes in the value of existing holdings) plus changes in the gross book value of real estate (net acquisitions), where P_{it} is the property price index in firm i's headquarters CBSA 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 headquarters location, this method assumes that most of the real estate owned by a firm is near its headquarters. The premise of this assumption is that corporate offices or properties near the headquarters are the most common types of owned real estate. Chaney, Sraer, and Thesmar (2012) verify that this is not an unreasonable assumption.

IA7.2 Method 2: Property Information from Firm Annual Reports

In US non-financial firms' annual reports, 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 annual report provides the following table of properties in the US (AVX is a large international manufacturer of electronic connectors with 10,000 employees, headquartered in Myrtle Beach, SC):

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 annual report writes:

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

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 annual report 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.

We train assistants to read annual reports and record the location, size, and usage for owned properties in the US. 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 prices if the property is commercial or retail (e.g., offices, stores, restaurants, hotels, casinos). We multiply Zillow prices by 0.85 if the property is a mixture of manufacturing and office (often happens to headquarters of manufacturing firms), and by 0.7 if it is manufacturing (e.g., facilities, warehouses, distribution centers). For firms' owned land, we use state-level land price estimates.

IA8 Additional Results

IA8.1 Response of Debt Issuance and Investment to EBITDA

Table IA6: Debt Issuance and Investment Activities: Interactions

This table presents firm-level annual regressions of debt issuance and investment activities:

$$Y_{it} = \alpha_i + \eta_t + \beta \text{EBITDA}_{it} + \phi \text{EBITDA}_{it} \times 1\{\text{Large w/ EBCs}\} + \lambda 1\{\text{Large w/ EBCs}\} + X'_{it}\gamma + \epsilon_{it}.$$

The outcome variable Y_{it} are the same as those in Table IV. The dummy variable 1{Large w/ EBCs} takes value one for large firms (assets greater than Compustat median in a given year) with earnings-based covenants. The control variables are the same as those in Table IV. Firm fixed effects and year fixed effects are included (R^2 does not include fixed effects). Sample period is 1997 to 2018. Standard errors are clustered by firm and time.

	Net Debt Iss (1)	ΔLT Book Debt (2)	CAPX (3)	R&D (4)
EBITDA	-0.004	0.005	-0.001	-0.273***
	(0.012)	(0.012)	(0.003)	(0.032)
EBITDA × 1{Large w/ EBCs}	0.304***	0.382***	0.105***	0.162***
	(0.039)	(0.053)	(0.010)	(0.018)
Controls		Yes		
Fixed Effects		Firm, Year		
Obs	57,653	60,767	60,847	38,148
R^2	0.05	0.08	0.08	0.36

Table IA7: Debt Issuance by Type

This table presents firm-level annual regressions of debt issuance:

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

In columns (1) and (2), Y_{it} is the change in cash flow-based debt outstanding in year t (normalized by assets at the beginning of year t). In columns (3) to (4), Y_{it} is the change in asset-based debt. In columns (5) to (6), Y_{it} is the change in unsecured debt. In columns (7) to (8), Y_{it} is the change in secured debt. Control variables are the same as those in Table IV. Firm fixed effects and year fixed effects are included (R^2 does not include fixed effects). Sample period is 2002 to 2018 (when we have detailed data for firm-level debt classification). The sample includes large US non-financial firms that have earnings-based covenants in year t. Standard errors are clustered by firm and time.

	ΔCash Flow-Based		ΔAsset-Based		ΔUnsecured		ΔSecured	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EBITDA	0.383***	0.336***	0.070**	0.092***	0.293***	0.265***	0.210***	0.189***
	(0.058)	(0.068)	(0.029)	(0.025)	(0.046)	(0.055)	(0.043)	(0.042)
OCF		0.096		-0.044		0.058		0.044
		(0.063)		(0.030)		(0.051)		(0.053)
Q	0.020***	0.019***	0.003	0.003	0.013**	0.013**	0.008**	0.008**
	(0.006)	(0.006)	(0.002)	(0.002)	(0.006)	(0.006)	(0.003)	(0.003)
Past 12m stock ret	-0.011***	-0.011***	0.001	0.001	-0.006*	-0.006*	-0.010***	-0.010***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
L.Cash holding	-0.030	-0.025	0.048*	0.046*	-0.092***	-0.089***	0.100***	0.103***
	(0.032)	(0.033)	(0.025)	(0.026)	(0.017)	(0.018)	(0.036)	(0.037)
Controls				Yes				
Fixed Effects				Firm, Year				
Obs	14,980	14,975	14,935	14,930	14,984	14,979	14,971	14,966
R^2	0.07	0.07	0.02	0.02	0.06	0.06	0.05	0.05

Table IA8: Firms w/ Low Prevalence of EBCs

This table presents firm-level annual panel regressions of borrowing sensitivity to EBITDA among firm groups not bound by EBCs. The regression specifications are the same as those in Table IV, Panel A, and the outcome variable is net debt issuance. "Large w/o EBCs" is large firms without earnings-based covenants, which use cash flow-based lending but are generally far from the earnings-based constraints. "Small," "Low Margin," and "Airlines etc" are small firms, low profit margin firms, and airlines and utilities which have low prevalence of cash flow-based lending and EBCs. Firm fixed effects and year fixed effects are included (R^2 does not include fixed effects). Sample period is 1997 to 2018. Standard errors are clustered by firm and time.

	Large w/o EBCs		Small		Low Margin		Airlines etc	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EBITDA	-0.006	0.041	-0.032***	-0.016	-0.045***	-0.024	-0.071	-0.052
	(0.028)	(0.031)	(0.010)	(0.012)	(0.012)	(0.016)	(0.081)	(0.113)
OCF		-0.072**		-0.031**		-0.027*		-0.034
		(0.029)		(0.013)		(0.016)		(0.115)
Q	0.005**	0.005**	0.007***	0.007***	0.007***	0.007***	0.061***	0.063***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.018)	(0.018)
Past 12m stock ret	0.001	0.001	0.003*	0.003*	0.007***	0.006**	-0.001	-0.001
	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.009)	(0.009)
L.Cash holding	-0.053***	-0.056***	-0.022***	-0.027***	-0.045***	-0.047***	-0.034	-0.044
	(0.019)	(0.019)	(0.009)	(0.009)	(0.012)	(0.013)	(0.071)	(0.079)
Controls	Yes							
Fixed Effects	Firm, Year							
Obs	10,849	10,847	25,262	25,225	27,628	27,602	3,040	3,039
R^2	0.07	0.07	0.02	0.03	0.04	0.04	0.08	0.08

Table IA9: Debt Issuance and Investment Activities: Industry-Year Fixed Effects

This table presents firm-level annual regressions of debt issuance and investment activities:

$$Y_{it} = \alpha_i + \eta_{kt} + \beta \text{EBITDA}_{it} + X'_{it}\gamma + \epsilon_{it}.$$

The outcome variable Y_{it} and the independent variables are the same as those in Table IV. Firm fixed effects (α_i) and industry-year fixed effects (η_{kt}, using two-digit SICs) are included (R^2 does not include fixed effects). Sample period is 1997 to 2018. The sample includes large US non-financial firms that have earnings-based covenants in year t. Standard errors are clustered by firm and time.

	Net Debt Issuance		ΔLT Book Debt		CAPX		R&D	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EBITDA	0.319***	0.324***	0.437***	0.413***	0.107***	0.079***	0.037***	0.031**
	(0.045)	(0.043)	(0.056)	(0.049)	(0.010)	(0.012)	(0.012)	(0.014)
OCF		-0.010		0.047		0.051***		0.009
		(0.042)		(0.044)		(0.010)		(0.013)
Q	0.011**	0.011**	0.005	0.004	0.008***	0.008***	0.004***	0.004***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.001)	(0.001)	(0.001)	(0.001)
Past 12m stock ret	-0.002	-0.002	-0.003	-0.003	0.004**	0.004**	-0.002***	-0.002***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.002)	(0.002)	(0.001)	(0.001)
L.Cash holding	0.018	0.018	0.063**	0.065**	-0.002	0.001	0.015	0.015
	(0.027)	(0.027)	(0.029)	(0.030)	(0.008)	(0.008)	(0.009)	(0.010)
Controls	Yes							
Fixed Effects	Firm, Year							
Obs	20,675	20,675	22,072	22,059	22,107	22,107	11,308	11,306
R^2	0.11	0.11	0.12	0.12	0.12	0.13	0.11	0.11

Table IA10: Debt Issuance and Investment Activities:
Lagged Dependent Variable Specification

This table presents firm-level annual regressions of debt issuance and investment activities:

$$Y_{it} = \eta_t + \beta \text{EBITDA}_{it} + X_{it}'\gamma + \xi Y_{it-1} + \epsilon_{it}.$$

The outcome variable Y_{it} and the independent variables are the same as those in Table IV. The lagged dependent variable (LDV) Y_{it-1} is also included, while firm fixed effects are not. Sample period is 1997 to 2018. The sample includes large US non-financial firms that have earnings-based covenants in year t. Standard errors are clustered by firm and time.

	Net Debt Issuance		ΔLT Book Debt		CAPX		R&D	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EBITDA	0.189***	0.186***	0.316***	0.292***	0.133***	0.088***	0.057***	0.043***
	(0.051)	(0.052)	(0.055)	(0.054)	(0.014)	(0.016)	(0.016)	(0.015)
OCF		0.005		0.049		0.086***		0.020
		(0.043)		(0.046)		(0.015)		(0.012)
Q	0.010***	0.010***	0.003	0.003	0.001	0.000	0.004***	0.004***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)
Past 12m stock ret	0.013***	0.013***	0.018***	0.019***	0.012***	0.013***	-0.003***	-0.003***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.002)	(0.002)	(0.001)	(0.001)
L.Cash holding	-0.012	-0.012	0.007	0.007	0.014***	0.014***	0.050***	0.050***
	(0.015)	(0.015)	(0.018)	(0.018)	(0.005)	(0.005)	(0.010)	(0.010)
ldv	0.035***	0.035***	0.027*	0.028*	0.542***	0.539***	0.604***	0.604***
	(0.013)	(0.013)	(0.015)	(0.016)	(0.032)	(0.032)	(0.072)	(0.072)
Controls	Yes							
Fixed Effects	Firm, Year							
Obs	20,321	20,321	22,453	22,440	22,507	22,507	11,426	11,424
R^2	0.03	0.03	0.04	0.04	0.63	0.64	0.66	0.66

Table IA11: Debt Issuance and Investment Activities:
Controlling for Real Estate Value

This table presents firm-level annual regressions of debt issuance and investment activities:

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

The outcome variable Y_{it} is net debt issuance. The independent variables are the same as those in Table IV. The additional control is market value of firm real estate in year t (estimated using two different methods described in Section 4.2). Firm fixed effects and year fixed effects are included (R^2 does not include fixed effects). Sample period is 2002 to 2018. The sample includes large US non-financial firms that have earnings-based covenants in year t and real estate value estimates. Standard errors are clustered by firm and time.

	Net Debt Issuance			
	(1)	(2)	(3)	(4)
EBITDA	0.534***	0.543***	0.342***	0.338***
	(0.172)	(0.173)	(0.072)	(0.073)
OCF	-0.113*	-0.111*	-0.118	-0.115
	(0.060)	(0.061)	(0.143)	(0.142)
Q	0.020**	0.020**	0.016*	0.016*
	(0.010)	(0.010)	(0.009)	(0.009)
Past 12m stock ret	-0.011	-0.012	-0.019***	-0.019***
	(0.008)	(0.008)	(0.007)	(0.007)
L.Cash holding	-0.070	-0.072	-0.035	-0.033
	(0.055)	(0.055)	(0.069)	(0.068)
RE (Method 1)		0.053***		
		(0.017)		
RE (Method 2)				0.031
				(0.078)
Controls	Yes			
Fixed Effects	Firm, Year			
Obs	3,560	3,560	2,865	2,865
R^2	0.13	0.13	0.09	0.09

Table IA12: Firm Outcomes and EBITDA: US vs. Japan

This table shows a comparison of the sensitivity of firm outcomes to EBITDA in US and Japan. Panel A presents summary statistics of the US and Japan samples. The samples cover all large non-financial firms in US and Japan (book assets above Compustat median in the respective country). Panel B presents firm-level annual regressions of debt issuance and investment activities on EBITDA:

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

The independent variables are the same as those in Table IV. The outcome variable Y_{it} is the change in long-term book debt in year t (normalized by assets at the beginning of year t). Here we do not use net 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 1997 to 2018. 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	6.28	7.16	8.29	7.38	34,628	6.35	6.96	7.87	7.28	22,217
Log market cap	6.05	7.07	8.21	7.16	34,628	5.29	6.15	7.27	6.37	22,217
EBITDA	56.61	165.81	537.62	883.60	34,628	0.05	0.08	0.12	0.09	22,217
EBITDA/l.assets	0.08	0.13	0.19	0.13	34,628	0.05	0.08	0.12	0.09	22,217
EBITDA/sales	0.08	0.14	0.22	0.08	34,510	0.05	0.08	0.12	0.09	22,084
Debt/EBITDA	0.54	1.86	3.59	2.35	34,136	0.65	2.27	4.90	3.79	22,004
Debt/assets	0.11	0.26	0.40	0.28	34,628	0.06	0.19	0.33	0.21	22,217
Q	0.81	1.14	1.74	1.50	34,628	0.50	0.66	0.87	0.76	22,217
MTB	1.23	2.00	3.30	2.74	34,072	0.67	0.98	1.47	1.22	22,134
OCF/l.assets	0.07	0.11	0.16	0.12	34,628	0.04	0.06	0.09	0.07	22,217
Cash/assets	0.02	0.07	0.19	0.13	34,628	0.07	0.13	0.20	0.15	22,217
PPE/assets	0.11	0.23	0.46	0.30	34,628	0.20	0.29	0.40	0.31	22,217
Inventory/assets	0.01	0.07	0.16	0.11	34,628	0.06	0.11	0.15	0.12	22,217
Receivable/assets	0.06	0.12	0.19	0.14	34,539	0.14	0.21	0.29	0.22	21,968
Depreciation/l.assets	0.03	0.04	0.06	0.05	34,628	0.02	0.03	0.05	0.04	22,217
ΔBook debt/l.assets	-0.02	0.00	0.05	0.03	34,621	-0.02	-0.00	0.02	-0.00	22,154
ΔLT book debt/l.assets	-0.02	0.00	0.04	0.03	34,628	-0.01	0.00	0.01	0.00	22,217

Panel B. Results

	ΔLT Book Debt			
	US Large NF		Japan Large NF	
EBITDA	0.243***	0.269***	-0.063***	-0.000
	(0.033)	(0.029)	(0.015)	(0.014)
OCF		-0.035		-0.099***
		(0.025)		(0.010)
Q	0.002	0.002	0.004***	0.004***
	(0.002)	(0.002)	(0.002)	(0.001)
Past 12m stock ret	0.001	0.000	-0.002	-0.002*
	(0.003)	(0.003)	(0.001)	(0.001)
L.Cash holding	0.006	0.005	-0.035***	-0.044***
	(0.012)	(0.012)	(0.006)	(0.006)
Controls	Yes			
Fixed Effects	Firm, Year			
Obs	33,878	33,861	22,167	22,095
R^2	0.09	0.09	0.02	0.03

IA8.2 Informativeness of EBITDA and Q

This section presents checks about the informativeness of EBITDA and Q across firm groups. We would like to test whether among large firms with earnings-based covenants, EBITDA is more informative or Q is more mismeasured (less informative) relative to the comparison groups. If so, their EBITDA coefficient could have a larger upward bias in the baseline regressions of Tables IV and IA8. In other words, one may worry that their high sensitivity of borrowing and investment to EBITDA might come from being more exposed to Q mismeasurement problems. We perform two sets of tests below, and we do not find evidence for such concerns.

First, Table IA13 shows several metrics for accounting quality, which can be relevant for the informativeness of EBITDA.

- Net operating assets is calculated following Hirshleifer, Hou, Teoh, and Zhang (2004), which reflect accumulated accruals. High net operating assets indicate potentially high cumulative earnings management and low earnings quality.

- Operating cycle and trade cycle are calculated following Dechow and Dichev (2002). Longer operating cycles and trade cycles are potentially associated with greater difficulty and less precision in earnings estimates, and correspondingly lower earnings quality.

- Larger variability of EBITDA, accruals, and residual accruals (calculated following Dechow and Dichev (2002), which capture accruals not explained by net cash receipts from year $t-1$ to year $t+1$) also reflects potential difficulty in earnings estimates, and therefore lower earnings quality.

- Loss avoidance is calculated following Bhattacharya, Daouk, and Welker (2003), using the difference between the probability of small positive net income and that of small negative net income. More loss avoidance indicates more earnings manipulation and lower earnings quality.

Across all these measures, it does not appear that large firms with earnings-based covenants have different properties of earnings than the comparison groups.

Second, Figure IA4 and Table IA14 show results of predicting future EBITDA and net cash receipts (OCF) in year $t+1$ and $t+2$. These tests examine the informativeness of EBITDA and Q in predicting future earnings and cash flows. The results show that relative to comparison groups, EBITDA of large firms with earnings-based covenants is *not more informative*, and their Q is *not more mismeasured*. Overall, it does not appear that Q mismeasurement may lead to an upward bias in the EBITDA coefficient among large firms with earnings-based covenants relative to other firms.

Table IA13: Accounting Quality Statistics

This table shows firm characteristics by group. Net operating assets is operating assets minus operating liabilities following Hirshleifer et al. (2004) (normalized by total assets), which captures the accumulated accruals. Operating cycles, trade cycles, and residual accruals are calculated following Dechow and Dichev (2002). Small positive net income is net income (normalized by lagged assets) between zero and 0.01; small negative net income is net income (normalized by lagged assets) between zero and -0.01. "Large w/ EBCs" is large non-financial firms with earnings-based covenants. "Large w/o EBCs" is large non-financial firms without earnings-based covenants, which are generally firms that use cash flow-based lending but are far from earnings-based constraints. "Small," "Low Margin," and "Airlines etc" are small firms, low profit margin firms, and airlines and utilities which have low prevalence of cash flow-based lending and EBCs.

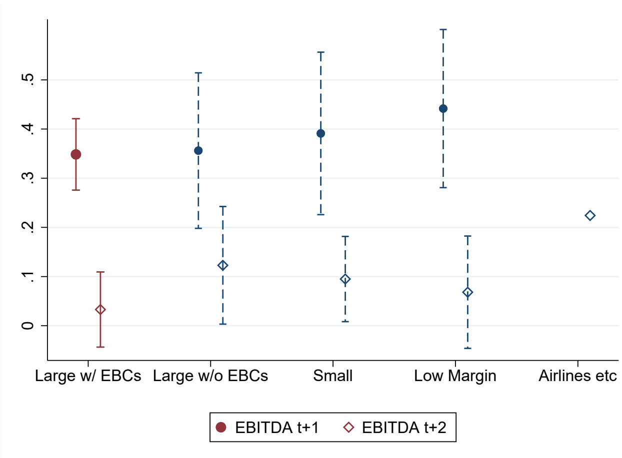
	Large w/ EBCs	Large w/o EBCs	Small	Low Margin	Airlines etc
	Group-Level Medians				
Net operating assets	0.648	0.543	0.503	0.551	0.652
Operating cycles (days)	93.8	102.9	114.9	101.9	69.9
Trade cycles (days)	54.5	58.7	68.1	56.5	27.2
EBITDA SD	0.043	0.043	0.090	0.054	0.029
Accrual SD	0.034	0.032	0.070	0.057	0.022
Residual accrual SD	0.034	0.031	0.068	0.056	0.022
	Group-Level Means				
P(small pos NI)-P(small neg NI)	0.014	0.016	0.012	0.021	0.031

Figure IA4: Informativeness of EBITDA and Q by Firm Group

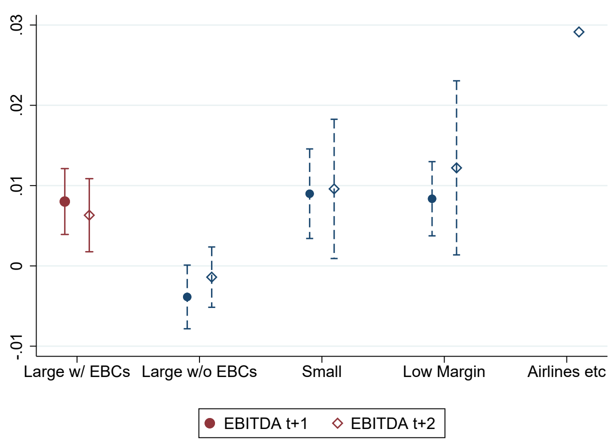
This figure shows the coefficient β on EBITDA, and the coefficient ϕ on beginning-of-year Q, from regressions predicting future EBITDA in year $t+1$ and $t+2$:

$$Y_{i,t+k} = \alpha_i + \eta_t + \beta \text{EBITDA}_{it} + \phi Q_{it} + X_{it}'\gamma + \epsilon_{it}.$$

The outcome variable $Y_{i,t+k}$ is EBITDA in year $t+1$ and $t+2$ (normalized by lagged assets). The circles represent coefficients when $Y_{i,t+k}$ uses $k = 1$; the diamonds represent coefficients when $Y_{i,t+k}$ uses $k = 2$. The right hand side variables are the same as the main specification in Tables IV and IA8. "Large w/ EBCs" is large non-financial firms with earnings-based covenants. "Large w/o EBCs" is large non-financial firms without earnings-based covenants, which are generally firms that use cash flow-based lending but are far from earnings-based constraints. "Small," "Low Margin," and "Airlines etc" are small firms, low profit margin firms, and airlines and utilities which have low prevalence of cash flow-based lending and EBCs.



(a) Coefficients on Current EBITDA



(b) Coefficients on Q

Table IA14: Predicting Future EBITDA and Net Cash Receipts

This table presents firm-level annual regressions of predicting future EBITDA and net cash receipts (OCF):

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

The outcome variable Y_{it+k} is future EBITDA in Panel A, and future net cash receipts (OCF) in Panel B. The independent variables are the same as those in Table IV. Firm groups are the same as those in Table IV and Table IA8, Figure IV, and Figure IA4. Firm fixed effects and year fixed effects are included (R^2 does not include fixed effects). Sample period is 1997 to 2018. Standard errors are clustered by firm and time.

Panel A. Predicting Future EBITDA

	Large w/ EBCs		Large w/o EBCs		Small		Low Margin		Airlines etc	
$t+k=$	$t+1$	$t+2$	$t+1$	$t+2$	$t+1$	$t+2$	$t+1$	$t+2$	$t+1$	$t+2$
EBITDA	0.348***	0.033	0.356***	0.123**	0.391***	0.095**	0.442***	0.068	1.372***	0.224
	(0.037)	(0.039)	(0.081)	(0.061)	(0.084)	(0.044)	(0.082)	(0.058)	(0.427)	(.)
OCF	0.077***	0.067***	0.188*	0.065**	0.057	0.135***	0.058	0.116**	0.130	0.023
	(0.023)	(0.025)	(0.107)	(0.029)	(0.065)	(0.052)	(0.058)	(0.051)	(0.362)	(0.119)
Q	0.008***	0.006***	-0.004*	-0.001	0.009***	0.010**	0.008***	0.012**	-0.064	0.029
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)	(0.006)	(0.039)	(0.037)
Controls	Yes									
Fixed Effects	Firm, Year									
Obs	18,793	17,012	9,844	8,996	21,878	18,961	23,948	20,776	2,777	2,557
R^2	0.23	0.07	0.12	0.02	0.12	0.02	0.13	0.02	0.24	0.01

Panel B. Predicting Future Cash Receipts (OCF)

	Large w/ EBCs		Large w/o EBCs		Small		Low Margin		Airlines etc	
$t+k=$	$t+1$	$t+2$	$t+1$	$t+2$	$t+1$	$t+2$	$t+1$	$t+2$	$t+1$	$t+2$
EBITDA	0.251***	0.055**	0.255***	0.183***	0.287***	0.131***	0.314***	0.121***	0.890***	0.115
	(0.026)	(0.026)	(0.068)	(0.042)	(0.039)	(0.029)	(0.044)	(0.032)	(0.272)	(.)
OCF	0.005	0.001	0.144	-0.026	0.003	0.015	0.020	0.013	0.198	0.054
	(0.031)	(0.030)	(0.115)	(0.039)	(0.035)	(0.033)	(0.032)	(0.040)	(0.414)	(0.130)
Q	0.008***	0.008***	-0.001	-0.001	0.005*	0.005	0.006**	0.008**	-0.040	0.035
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)	(0.004)	(0.034)	(0.026)
Controls	Yes									
Fixed Effects	Firm, Year									
Obs	18,801	17,019	9,861	9,018	21,882	18,978	23,952	20,768	2,778	2,559
R^2	0.13	0.05	0.07	0.02	0.11	0.02	0.10	0.02	0.14	0.01

IA8.3 Accounting Natural Experiment: Placebo Tests

Table IA15 below presents results of placebo tests using alternative timing. In Table V, outcome variables are measured in 2006, while EBITDA in 2006 is instrumented using average option compensation expenses in 2002 to 2004. In Table IA15 we shift the same timing backwards. For instance, in column (1) option compensation expenses are measured from 1998 to 2000, while outcome variables are measured in 2002.

Table IA15: Placebo Tests

This table presents cross-sectional placebo regressions, for years t from 2002 to 2006, which are parallel to Table V in the paper. Panel A shows the reduced form results, and Panel B shows the IV results, if the same regressions are run in different years.

Panel A. Reduced Form

Year t =	2002 (1)	2003 (2)	2004 (3)	2005 (4)	**2006** (5)
Avg opt comp expense 02-04	-0.410	-0.685	0.038	-1.175	-0.777**
	(0.326)	(0.419)	(0.262)	(1.199)	(0.364)
Obs	514	532	653	654	668

Panel B. IV

Year t =	2002 (1)	2003 (2)	2004 (3)	2005 (4)	**2006** (5)
$\widehat{EBITDA}_i^{06}$	0.134	7.856	0.097	0.690	0.964**
	(0.214)	(22.028)	(0.674)	(0.852)	(0.398)
1st-stage F	6.80	0.15	2.84	3.45	19.74
Obs	511	531	653	653	668

IA8.4 Impact of Real Estate Value

Table IA16: Summary Statistics: Firm Real Estate Value

This table presents summary statistics of firms in the samples with market value of real estate measures. The statistics are sample medians (other than the fraction of large firms and firms with earnings-based covenants). The column labeled "Method 1" refers to the sample where market value of real estate estimates are available using Method 1 described in Section 4.2 and Appendix IA7, which follows the traditional procedure (Chaney, Sraer, and Thesmar, 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 4.2 and Appendix IA7, which uses hand-collected information from annual reports. 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 2018 (sample period in Table VI), for which we have firm-level measures of asset-based and cash flow-based lending. Panel B displays additional statistics for the Great Recession period of 2007 to 2009. $\Delta RE_{06}^{07-09}/assets_{06}$ is the gain/loss on 2006 real estate holdings during the crisis, normalized by assets in 2006. $\Delta P^{07-09}(HQ)$ is the percentage change in property price index in headquarters CBSA from 2007 to 2009. The remaining statistics are changes in EBITDA, net 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—2018		
Real estate/assets	0.20	0.12	.
Real estate/market cap	0.21	0.11	.
PPE/assets	0.25	0.20	0.20
EBITDA/l.assets	0.13	0.12	0.12
Q	1.16	1.18	1.21
Debt/assets	0.22	0.17	0.22
Log book assets	6.64	6.15	6.17
Asset-based lending/debt	0.14	0.28	0.25
Cash flow-based lending/debt	0.82	0.64	0.66
Asset-based lending/assets	0.02	0.02	0.03
Cash flow-based lending/assets	0.15	0.08	0.11
Net debt issuance/l.assets	-0.00	0.00	0.00
CAPX/l.assets	0.04	0.03	0.03
Fraction of large firms	0.69	0.59	0.58
Fraction w/ earnings-based covenants	0.58	0.51	0.48
	Panel B. 2007—2009		
ΔRE_{06}^{07-09}/assets	-0.01	-0.01	.
ΔP^{07-09}(HQ)	-0.05	-0.07	-0.06
$\Delta EBITDA_{06}^{07-09}/assets_{06}$	-0.02	-0.01	-0.01
ΔNet debt $issuance_{06}^{07-09}/assets_{06}$	0.00	0.00	0.00
$\Delta CAPX_{06}^{07-09}/assets_{06}$	-0.01	-0.01	-0.01

Table IA17: Firm Outcomes and Changes in Real Estate Value in the Great Recession

This table presents 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 debt issuance, in Panel B Y_i^{07-09} is the change in CAPX, 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 4.2 and Appendix IA7. Controls include changes in EBITDA and OCF from 2007 to 2009 (normalized by assets by the end of 2006), Q, past year stock returns cash holdings, book leverage, PPE (plant, property, and equipment), inventory, depreciation, EBITDA, and size (log book assets) by the end of 2006. Industry 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 Debt Issuance

	Method 1		Method 2	
ΔNet Debt Issuance$^{07-09}$	OLS	LAD	OLS	LAD
$\Delta \text{RE}_{06}^{07-09}$	-0.024	-0.033	0.105	0.021
	(0.177)	(0.093)	(0.203)	(0.049)
RE_{06}	0.006	0.019	-0.016	-0.002
	(0.025)	(0.012)	(0.043)	(0.004)
ΔP^{07-09}	0.071	0.017	-0.049	-0.002
	(0.052)	(0.037)	(0.071)	(0.018)
Controls	Yes			
Fixed Effects	Industry			
Obs	435	435	537	537
R^2	0.02		0.07	

Panel B. Capital Expenditures

	Method 1		Method 2	
ΔCAPX$^{07-09}$	OLS	LAD	OLS	LAD
$\Delta \text{RE}_{06}^{07-09}$	-0.071	0.040	0.015	0.018
	(0.086)	(0.081)	(0.054)	(0.046)
RE_{06}	0.019	0.011	0.014	0.012*
	(0.012)	(0.010)	(0.011)	(0.006)
ΔP^{07-09}	0.085***	0.018	0.018	0.013
	(0.028)	(0.014)	(0.022)	(0.008)
Controls	Yes			
Fixed Effects	Industry			
Obs	486	486	583	583
R^2	0.15		0.09	

Table IA18: 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 the two methods described in Section 4.2 and Appendix IA7. Controls X_i include cash flows (contemporaneous with the investment variable), as well as Q, cash holdings and book leverage (measured prior to the outcome variable). The regression also follows Gan (2007) and includes 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 (Method 1)	-	0.005	0.007*	0.000	0.009*	-0.005	0.003
	-	(0.009)	(0.004)	(0.009)	(0.005)	(0.009)	(0.006)
RE 2006 (Method 2)	-	0.009	0.001	0.011	0.004	-0.002	-0.002
	-	(0.007)	(0.006)	(0.008)	(0.006)	(0.005)	(0.004)

IA9 Borrowing Constraints and Financial Acceleration

This appendix analyzes how the form of firms' borrowing constraints can affect financial acceleration dynamics. We consider an environment similar to Kiyotaki and Moore (1997). We examine both traditional collateral constraints (a firm's borrowing capacity depends on the liquidation value of physical assets) as in the original study, and earnings-based constraints (a firm's borrowing capacity depends on a multiple of its earnings) analogous to the EBCs we document in Section 3. We compare the equilibrium impact of a shock to productive firms' internal funds (i.e., net worth), which is the same shock studied by Kiyotaki and Moore (1997), in these two settings. The results show that EBCs lead to a more muted initial response of productive firms' capital and aggregate output in general equilibrium, due to less fire sale amplification.

To illustrate further, we also consider the case where some firms face traditional collateral constraints while others face EBCs. We calibrate the proportion of each based on our empirical evidence. Since the vast majority of US non-financial corporate debt by value is not subject to traditional collateral constraints, the general equilibrium response of productive firms' capital and aggregate output in this mixed case is close to that in the baseline EBC-only case.

We finally study what drives the muted equilibrium response of aggregate output in the case of EBCs. The absence of a direct link between the liquidation value of physical assets and firms' borrowing constraints plays a key role for dampening fire sale amplification.

IA9.1 Setup

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.[6] 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.

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

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

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

where x_{t+s} is her consumption of fruits at date $t+s$, and $\beta \in (0,1)$ is her discount rate. Each farmer takes one period to produce fruits from the land she holds, with the following constant returns to scale production function:

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

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 of infinitely lived, risk neutral gathers.[7] The expected utility of a gatherer 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 his 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.[8] The only other market is a one-period credit market in which one unit of fruit at date t can be exchanged for a claim to R_t units of fruits 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

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

[8] Fruits are the numeraire throughout.

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 borrowing 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 the 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,

$$q_t=\sum_{s=0}^{+\infty}\left(\frac{1-\delta}{R}\right)^s u\left(K_{t+s}\right)=u\left(K_t\right)+\frac{(1-\delta)}{R}q_{t+1}, \tag{A6}$$

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 farmers' land holding because if farmers hold more land, gatherers hold less land and farmers' marginal productivity of 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 decrease 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

$$\hat{q}_t=\frac{1}{\eta}\frac{\frac{1-\delta}{R}-1}{\frac{1-\delta}{R}}\hat{K}_t+\frac{\frac{1-\delta}{R}-1}{\left(\frac{1-\delta}{R}\right)^2}\hat{q}_{t+1}=\frac{1}{\eta}\frac{\frac{1-\delta}{R}-1}{\frac{1-\delta}{R}}\sum_{s=0}^{+\infty}\left(\frac{1-\delta}{R}\right)^{-s}\hat{K}_{t+s}, \tag{A7}$$

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

IA9.2 Traditional Collateral Constraints

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

Traditional Collateral 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 $t+1$:

$$Rb_t \leq q_{t+1}(1-\delta)k_t. \tag{A8}$$

The 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 (A8).

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.[9] This means for each farmer, $x_t = ck_{t-1}$, $b_t = q_{t+1}k_t(1-\delta)/R$ and

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

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 traditional collateral 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 holding and borrowing of farmers, K_t and B_t:

$$K_t = \frac{1}{q_t - \frac{1-\delta}{R}q_{t+1}}\left[(a + q_t(1-\delta))K_{t-1} - RB_{t-1}\right], \tag{A9}$$

$$B_t = \frac{1-\delta}{R}q_{t+1}K_t. \tag{A10}$$

Steady State. Based on conditions (A6), (A9) and (A10), one can characterize the

[9] 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.

unique 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.[10] Such a shock will then increase farmers' net worth by ΔaK^{*}. 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 (A9) and (A10), one can then characterize farmers' land demand curves at $t=0$ and $t\geq 1$. For period $t=0$, farmers' land demand curves without and with log-linearization are:

$$u\left(K_{0}\right)K_{0}=\left(q_{0}-\frac{1-\delta}{R}q_{1}\right)K_{0}=\left(a+\Delta a+\left(q_{0}-q^{*}\right)(1-\delta)\right)K^{*},\tag{A11}$$

$$\left(1+\frac{1}{\eta}\right)\hat{K}_{0}=\frac{1}{1-\frac{1}{R}(1-\delta)}\hat{q}_{0}-\frac{\frac{1}{R}(1-\delta)}{1-\frac{1}{R}(1-\delta)}\hat{q}_{1}+\hat{K}_{0}=\Delta+\frac{1-\delta}{1-\frac{1}{R}(1-\delta)}\hat{q}_{0}.\tag{A12}$$

An increase of land price q_0 increases farmers' net worth, $\left(a+\Delta a+\left(q_{0}-q^{*}\right)(1-\delta)\right)K^{*}$, and increases their land demand, for a given down payment per unit of capital (in this case the same as the user cost $u\left(K_{0}\right)=q_{0}-\frac{1-\delta}{R}q_{1}$).

Moreover, 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 (A12) could be very large).

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

$$u\left(K_{t}\right)K_{t}=\left(q_{t}-\frac{1-\delta}{R}q_{t+1}\right)K_{t}=aK_{t-1},\tag{A13}$$

$$\left(1+\frac{1}{\eta}\right)\hat{K}_{t}=\frac{1}{1-\frac{1}{R}(1-\delta)}\hat{q}_{t}-\frac{\frac{1}{R}(1-\delta)}{1-\frac{1}{R}(1-\delta)}\hat{q}_{t+1}+\hat{K}_{t}=\hat{K}_{t-1}.\tag{A14}$$

[10] 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.

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 into an increase in farmers' land holding in period t.[11] Through the forward-looking land pricing equation in condition (A6), the persistent increase in farmers' land holding then increases land prices in period 0, far more than what is driven by the increase in user cost in that particular period. The increase in land prices then further increases farmers' net worth and capital demand in period 0 through condition (A12), 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 (A7), (A12), and (A14), we can solve the full equilibrium dynamics with traditional collateral constraints:

$$\hat{K}_t = \left(1 + \frac{1}{\eta}\right)^{-t-1} \frac{\eta}{\eta + \frac{\delta}{1-\frac{1-\delta}{R}}} \left(1 + \frac{\frac{R}{1-\delta}}{\frac{R}{1-\delta} - 1} \frac{1}{\eta}\right) \Delta, \tag{A15}$$

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

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, which demonstrates financial acceleration driven by asset price feedback in Kiyotaki and Moore (1997).

IA9.3 Earnings-Based Constraints

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 $t+1$:[12]

$$Rb_t \leq \theta a k_t. \tag{A16}$$

Such a constraint could arise if the bankruptcy court is able to and prefers to enforce the continuation of operation when the farmer fails to pay her debt.[13]

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

[12] Here we tie the farmer's borrowing capacity to her earnings at $t+1$, generated by current period land holding k_t. One could also tie the farmer's borrowing capacity to her earnings at t, generated by the past period land holding k_{t-1}. Such backward-looking borrowing capacity will not change the key lesson about the attenuation of asset price feedback. However, it would open the door for more deviations from the Kiyotaki-Moore benchmark, such as path dependence of firms' outcomes beyond their dependence on current net worth level.

[13] 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

Farmers' Behavior. Similar to the analysis above 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.[14] 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 (A16) 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:

$$K_t = \frac{1}{q_t - \frac{\theta a}{R}} \left[\left(a + q_t \left(1 - \delta\right) \right) K_{t-1} - R B_{t-1} \right], \tag{A17}$$

$$B_t = \frac{1}{R} \theta a K_t. \tag{A18}$$

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 traditional collateral 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 $t = 0$.[15]. Such a shock increases farmers' net worth by $\Delta a K^*$. The production technologies between 0 and 1 (and thereafter) then return to the pre-shock level.

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.

[14] This could be guaranteed by 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).

[15] 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.

Using conditions (A17) and (A18), one can then characterize farmers' land demand curves at period $t = 0$ and $t \geq 1$. For period 0, farmers' land demand curves without and with log linearization are:[16]

$$\left(q_0 - \frac{\theta a}{R}\right) K_0 = \left(\left(1-\theta\right) a + \Delta a + q_0 \left(1-\delta\right)\right) K^*, \tag{A19}$$

$$\hat{q}_0 \left(\frac{1}{1 - \frac{1}{R}\left(1-\delta\right)}\right) + \hat{K}_0 = \Delta + \frac{1-\delta}{1 - \frac{1}{R}\left(1-\delta\right)} \hat{q}_0, \tag{A20}$$

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

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 traditional collateral constraints, as farmers' borrowing capacity under EBCs does 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 contrast with the case under traditional collateral 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:

$$\left(q_t - \frac{\theta a}{R}\right) K_t = \left[\left(1-\theta\right) a + \left(1-\delta\right) q_t\right] K_{t-1}, \tag{A21}$$

$$\hat{q}_t \left(\frac{1}{1 - \frac{1}{R}\left(1-\delta\right)}\right) + \hat{K}_t = \frac{1-\delta}{1 - \frac{1}{R}\left(1-\delta\right)} \hat{q}_t + \hat{K}_{t-1}, \tag{A22}$$

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

Compared to the case under traditional collateral constraints, condition (A22), 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 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

[16] In condition (A12), $\frac{1}{1-\frac{1}{R}(1-\delta)} = \frac{q^*}{q^* - \frac{\theta a}{R}}$ 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.

though the initial impact is much more muted with EBCs.[17]

From conditions (A7) and (A22), we can then characterize the equilibrium dynamics under earning-based constraints:

$$\begin{pmatrix} \hat{q}_t \\ \hat{K}_t \end{pmatrix} = \begin{pmatrix} \frac{R}{1-\delta} & -\frac{1}{\eta}\left(\frac{R}{1-\delta}-1\right) \\ -\delta\frac{\frac{R}{1-\delta}}{1-\frac{1-\delta}{R}} & 1+\frac{\delta}{\eta}\frac{R}{1-\delta} \end{pmatrix} \begin{pmatrix} \hat{q}_{t-1} \\ \hat{K}_{t-1} \end{pmatrix} \quad \forall t \geq 1. \tag{A23}$$

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.[18] Let (q_λ, k_λ) be the corresponding eigenvector and $\alpha = \frac{q_\lambda}{k_\lambda} > 0$. Together with the initial condition (A20), we have

$$\hat{K}_t = \frac{1}{1+\frac{\delta}{1-\frac{1}{R}(1-\delta)}\alpha}\lambda^t\Delta \quad \text{and} \quad \hat{q}_t = \frac{\alpha}{1+\frac{\delta}{1-\frac{1}{R}(1-\delta)}\alpha}\lambda^t\Delta. \tag{A24}$$

IA9.4 Financial Acceleration: A Comparison

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

Lemma A1. *When the shock to farmers' net worth hits, the impact on farmers' land holding and aggregate output is stronger with traditional collateral constraints.*

To numerically illustrate the difference, we consider a standard parametrization. Specially, we set $R = 1.01$, $\delta = 0.025$ and $\eta = 1$. Figure IA5 shows the impulse response of farmers' land holding to the shock Δ. We find that the initial impact on farmers' land holding under traditional collateral constraints (solid blue line in Figure IA5) is ten times as large as the one under earnings-based constraints (dashed red line in Figure IA5). With EBCs, the dampening of financial acceleration through asset price feedback can be quantitatively important. Since aggregate output $\hat{Y}$ is just a multiple of $\hat{K}$, the initial impact on aggregate output under traditional collateral constraints is also ten times as large as that under earnings-based constraints. Nonetheless, the impact of the shock in the economy with

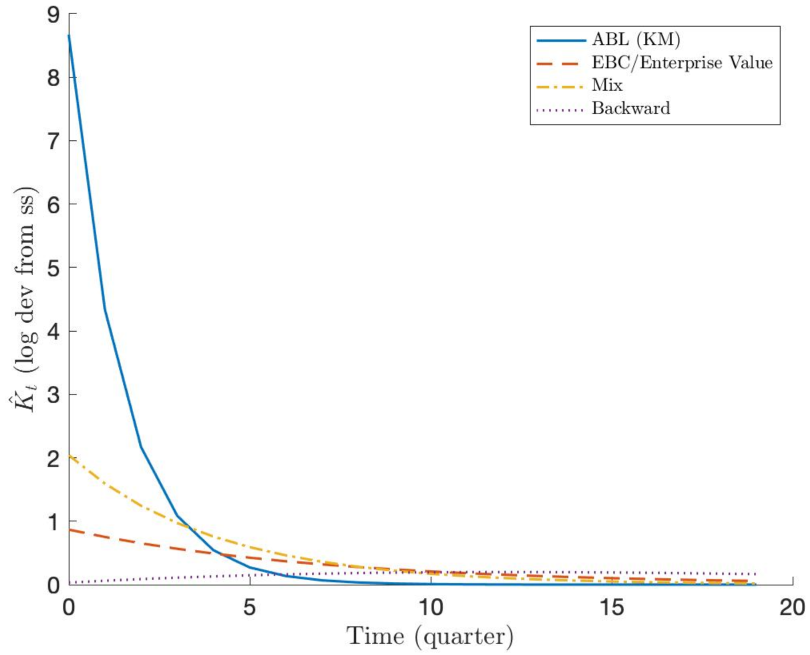
[17] As shown above, in farmers' land demand condition (A22), the appearance of the term $\frac{1-\delta}{1-\frac{1}{R}(1-\delta)}\hat{q}_t$ increases the persistence of the impact of the shock. The disappearance of term $-\frac{\frac{1}{R}(1-\delta)}{1-\frac{1}{R}(1-\delta)}\hat{q}_{t+1}$ on the left hand side, meanwhile, decreases the persistence of the impact of the shock. However, as $\hat{q}_t - \frac{1}{R}\hat{q}_{t+1} > 0$ in the equilibrium (from condition (A24)), the first effect dominates.

[18] 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.

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

Figure IA5: 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).



To illustrate further, we also study the case where some productive firms (farmers) face traditional collateral constraints in (A8) while others face earnings-based constraints in (A16). We calibrate the proportion of the former based on our empirical evidence. Specifically, we find that 20% of US non-financial corporate debt by value is asset-based debt, which can have traditional collateral constraints. We therefore specify $\phi = 20\%$.[19]

We use K_t^{EBC} and B_t^{EBC} to denote the average land holding and borrowing of farmers with EBCs, and K_t^{ABL} and B_t^{ABL} to denote those of farmers with traditional collateral constraints. Similar to (A6), (A9), (A10), (A17), and (A18), the equilibrium evolution of land holding, debt level, and land price can be summarized as follows:

[19]In practice, some asset-based debt also comes from firms that primarily use cash flow-based debt and have earnings-based borrowing constraints marginally binding for total debt limits. Accordingly, $\phi = 20\%$ could be an upper bound for this calibration.

Table IA19: Initial Response of Productive Capital (Land) $\hat{K}_0$

	KM	EBC	Mixed	Backward-Looking
$\hat{K}_0$	8.67	0.87	2.04	0.03

$$
\begin{aligned}
K_t^{EBC} &= \frac{1}{q_t - \frac{\theta a}{R}} \left[\left(a + (1-\delta) q_t\right) K_{t-1}^{EBC} - R B_{t-1}^{EBC} \right] \quad \forall t \geq 1 \\
B_t^{EBC} &= \frac{\theta a K_t^{EBC}}{R} \quad \forall t \geq 0 \\
K_t^{ABL} &= \frac{1}{q_t - \frac{1}{R}(1-\delta) q_{t+1}} \left[\left(a + q_t (1-\delta)\right) K_{t-1}^{ABL} - R B_{t-1}^{ABL} \right] \quad \forall t \geq 1 \\
B_t^{ABL} &= \frac{(1-\delta)}{R} q_{t+1} K_t^{ABL} \quad \forall t \geq 0 \\
q_t - \frac{1}{R} q_{t+1} &= \frac{1}{R} G' \left(\bar{K} - K_t\right) \quad \forall t \geq 0 \\
K_t &= \phi K_t^{ABL} + (1-\phi) K_t^{EBC} \quad \forall t \geq 0,
\end{aligned}
$$

where θ is still given by $\frac{1-\delta}{1-\frac{1}{R}(1-\delta)}$, so all farmers share the same steady state leverage. We then study the equilibrium response to the same shock as before, which is an unexpected aggregate shock to all farmers' net worth at $t = 0$. That is, at $t = 0$, we have:

$$
\begin{aligned}
\left(q_0 - \frac{1-\delta}{R} q_1\right) K_0^{ABL} &= \left(a + \Delta a + (q_0 - q^*)(1-\delta)\right) K^* \\
\left(q_0 - \frac{\theta a}{R}\right) K_0^{EBC} &= \left((1-\theta) a + \Delta a + q_0 (1-\delta)\right) K^*,
\end{aligned}
$$

where q^* and K^* are the steady state land price and land holding as in the baseline analysis.

The yellow dash-dot line in Figure IA5 plots the equilibrium impact on farmers' land holding in this mixed case. Since the majority of US non-financial corporate debt by value is not subject to the collateral constraints in (A8), the equilibrium response of farmers' land holding in this mixed case is close to that in the baseline EBC-only case. Specifically, the initial impact on farmers' land holding under traditional collateral constraints is still 4.25 times as large as that in the mixed case. This analysis helps clarify that, although there are many small firms which may primarily resort to asset-based debt, since cash flow-based debt and EBCs dominate among the largest firms in the economy, the behavior of aggregate outcomes is closer to that obtained in models with a representative firm facing EBCs.

IA9.5 What Drives the Degree of Financial Acceleration

Finally, we study what features of borrowing constraints drive the muted financial acceleration through fire sale amplification. We show that the absence of a direct link between the liquidation value of physical assets and the firm's borrowing constraints is the key.

To clarify this issue, in the baseline environment introduced above, we consider four different determinations of farmers' borrowing constraints:

(i) The liquidation value of land, i.e., the one studied in (A8).

(ii) The farmer's earnings, i.e., the one studied in (A16).

(iii) The farmer's forward-looking enterprise value, i.e., the value of the discounted earnings generated by her own land holding:

$$b_t \leq \theta^E \sum_{k=1}^{+\infty} \frac{a}{R^k (1-\delta)^{k-1}} k_t. \tag{A25}$$

Note that the borrowing constraint here depends on the value of the land based on the farmer's own production, instead of the liqudiation value of land, which is driven by the valuation of the second-best use of the gatherers.

(iv) The backward-looking book value of the farmer's land holding:

$$Rb_t \leq \theta^B k_{t-1}. \tag{A26}$$

Similar to the main analysis above, we set θ^E and θ^B such that the steady state leverage ratio of farmers across different cases is the same. This ensures that the differences in responses to the shock are driven by the form of borrowing constraints. We then study the equilibrium response to the same unexpected aggregate shock to all farmers' net worth at $t = 0$ as analyzed above.

Cases (i) and (ii) have been studied above. For case (iii) (constraints based on forward-looking enterprise value), since the environment here uses a linear production function, case (iii) and case (ii) have the same equilibrium response of the farmer's land holding and total output. This is because, in both cases, the farmer's borrowing constraints are linear in the farmer's land holding k_t. After controlling for the steady state leverage, the two cases effectively share the same borrowing constraints. Accordingly, the initial impact of the shock on productive capital and aggregate output in case (iii) is also one tenth of that under traditional collateral constraints in case (i).

Given that farmers' borrowing constraints in both case (i) and case (iii) are driven by forward-looking valuations of farmer's landing holding, one may wonder why case (iii) has less financial acceleration. In case (iii), there is some financial acceleration: for instance, a negative net worth shock leads the farmer to sell some of her land, which is captured by an initial decline of $\hat{K}_0$, which further tightens the farmer's constraint. However, for the remaining land owned by the farmer, borrowing constraints are calculated based on the discounted earnings generated by her own operations (first-best use). This differs from case (i), where the remaining land is valued based on the liquidation value (q). Since q declines further when farmers sell land to gatherers, this decline of the liquidation value of land further tightens the farmer's borrowing constraints and drive the substantial amount of fire sale amplification in case (i).

For case (iv) with backward-looking constraints, the initial response of the farmer's land and total output is also small, as shown by the purple dotted line in Figure IA5. This is because, even though the negative net worth shock leads the farmer to sell some of her land (a decline of $\hat{K}_0$), it does not influence her backward-looking borrowing constraint initially.

In sum, the four cases above illustrate that the direct link between the liquidation value of physical asset and the firm' borrowing constraints is the key driving force of financial acceleration through asset price feedback.

Finally, in Section 2.1 we discuss several reasons why the liquidation value of physical assets (as in case (i)) can differ substantially from the cash flow value the firm generates from its own operations (as in case (iii)). In environments like Kiyotaki and Moore (1997), such as our analysis above, this difference arises because the liquidation value is determined by the second-best users of capital (gatherers). In environments like Bernanke, Gertler, and Gilchrist (1999), the difference arises because of adjustment costs of capital. Despite these different micro-foundations, as long as deleveraging increases the wedge between the liquidation value and the cash flow value from the firm's own operations, financial acceleration through asset price feedback can happen if borrowing constraints are determined by the liquidation value.

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