Hedging Interest Rate Risk: Evidence from U.S. Nonfinancial Firms

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Abstract

This paper shows that interest rate hedging is concentrated among highly leveraged, high cash flow firms, and that for these firms, hedging protects investment when rates increase. Using a large language model, I extract interest rate hedging data from SEC filings for 8,792 U.S. public nonfinancial firms from 2014 to 2024. Hedging is rare and persistent, and leverage and operating cash flow jointly predict hedging. Using an event study around the 2022–2023 hiking cycle, I show that hedging protects firm investment from rate increases. A heterogeneous firm model explains these patterns. Debt raises default risk and therefore the value of hedging, but hedging is costly, and this cost is the main barrier to participation. In the model, full hedging offsets 68% of the aggregate investment decline under no hedging after a 100 basis point rate increase, while only modestly dampening the investment response to rate cuts. These results suggest that the effects of rate changes may fall disproportionately on unhedged firms.

Keywords: interest rate risk, corporate hedging, firm investment, large language model
JEL Codes: G32, G31, E22, E43, D25, C55

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1 Introduction

When interest rates rise, firms with floating rate debt pay more in interest. Higher interest payments drain cash flow, tighten financial constraints, and force firms to cut investment, all of which can weaken investor confidence. Financial contracts called derivatives can directly offset the effects from interest rate fluctuations, allowing firms to avoid these negative outcomes[1]. However, we know very little about which firms hedge and how hedging shapes their decisions over real outcomes.

In this paper, I show that hedging is concentrated among high leverage, high cash flow firms, where it stabilizes investment after changes in interest rates. To do this, I create a new dataset on firm hedging extracted with a large language model (LLM) from U.S. public firms financial filings. The firm-level data reveal how hedging evolves over time. Hedging is extremely persistent, with hedging firms rarely stopping and non-hedging firms rarely starting. High leverage, high cash flow firms are most likely to hedge. Using an even study design, I also find that investment in hedging firms is protected from increasing interest rates.

All together, these facts show clear patterns that I then rationalize in a heterogeneous firm dynamics model. In the model, firms choose investment, debt, and the share of that debt to hedge. Debt raises default risk and therefore the value of hedging, but adjusting a hedge position is costly, so only firms with enough operating cash flow to cover that cost choose to hedge. Taking the model to the data, I find that hedgers offset about two-thirds of the effect of a 100 basis point rate increase, while only modestly dampening the effect of a rate decrease. This is equivalent to the difference between a mild recession and normal business cycle fluctuations.

In the past, researchers struggled to collect the data needed to study hedging. Since 2000, U.S. public companies have been required to disclose their derivatives usage in the notes to their annual and quarterly filings with the Securities and Exchange Commission

[1]Fixed rate debt avoids this risk altogether. However, some firms are more bank-dependent and the majority of bank debt is floating rate, meaning their debt is mostly floating rate. Similarly, firms that can obtain fixed rate debt through bonds may need the short-term flexibility of a bank loan or credit line since issuing a fixed rate bond can take up to a year.

(SEC). For firms that hedge, these notes contain rich information on the volume, purpose, and structure of their positions. However, the information sits in unstructured text and tables that vary widely from firm to firm, so collecting it has meant tedious work by hand, and prior studies have relied on small samples or coarse indicators of whether a firm hedges. Using Claude, an LLM developed by Anthropic, I collect the aggregate insurance value, market value, hedge type, and instruments type for each firm's derivatives from 308,545 filings by 14,258 companies. I validate the accuracy of the extracted variables with a hand-coded sample of filings and find the LLM correctly recorded this information 99.5% of the time.

With the newly constructed data I find several facts about which firms hedge that suggest that persistent differences across firms, rather than temporary conditions, drive the decision to hedge. Firstly, I find that hedging firms differ markedly from non-hedging firms along several dimensions. They are larger, more profitable, more leveraged, and further from default, and they hold fewer liquid assets. Secondly, I find that interest rate hedging is a both uncommon and remarkably stable. In a typical year, only 13.6% of firms hedge, a share that barely moves over time. This stability reflects persistence at the firm level. A firm that hedges in one quarter continues to hedge in the next with 92% probability, while only 1.4% of non-hedgers start hedging in a given quarter.

The third fact is that hedging rises steadily with firm size, but size alone does not determine which firms hedge. Firms across the entire size distribution use interest rate derivatives, and, although small firms hedge far less often, those that do hedge a much larger share of their debt. Among the smallest firms, hedging is rare but intensive; among the largest, it is common but covers only a modest share of debt.

My fourth fact is that leverage and operating cash flow jointly co-vary with hedging. Across firms, both variables are positively associated with hedging, and leverage has the largest correlation after firm size. The two also interact. Within firms over time, and net of sector-specific shocks, higher operating cash flow is associated with more hedging when leverage is high and less hedging when leverage is low. The probability a firm hedges is therefore largest when both leverage and operating cash flow are high.

These facts describe which firms hedge, but not whether hedging matters for how those firms fare after adverse interest rate changes. I show that it does in my fifth and final fact. When interest rates rise, hedging insulates firm investment. I run an event study around the 2022–2023 hiking cycle, comparing firms that hedged before rates began to rise with unhedged firms matched within sector. Before the hikes, investment rates moved together across the two groups. Once rates rose, unhedged firms cut investment sharply, while investment at hedged firms declined only modestly, and the gap persisted through 2024. This suggests that hedging protects a firm's investment from rising rates.

To investigate the mechanism behind my empirical findings, I build a dynamic model in which firms that are ex ante heterogeneous in productivity choose floating rate debt to invest. They choose hedging to minimize the risk of a costly default and exit because of rate changes on their debt. A firm that exits permanently loses its capital and productive capacity, so each firm values reducing the rate volatility that pushes it toward default. The benefit of hedging increases with leverage, since more indebted firms are more exposed to rising rates and closer to the default boundary. However, hedging is costly. Firms pay an adjustment cost to hedge, and only those with sufficient operating cash flow can pay, so firms with low operating cash flow remain exposed even when they would benefit from hedging. Together, these two forces generate the complementarity between leverage and operating cash flow observed in the data.

Lenders amplify this mechanism. Firms borrow from a risk-neutral intermediary that prices debt according to its expectation of their idiosyncratic default risk. Because hedged firms are less likely to exit, they borrow on better terms relative to firms with similar characteristics, which further lowers their default risk. Hedging thus strengthens a firm's financial position both directly, by stabilizing rate payments, and indirectly, by improving its access to credit.

I then take the model to the data to show that hedging protects investment only where there is exposure to protect. I find that after a 100 basis point rate increase in the model, a highly leveraged firm cuts investment by roughly 0.46 percentage points when unhedged but only 0.09 percentage points when fully hedged. Among firms with little

debt, the gap is much smaller, because the repayment a hedge protects scales with the debt burden. Even fully hedged firms cut investment somewhat, since hedging covers only existing debt. New borrowing must be taken on at the higher rate, so firms borrow and invest less.

In the aggregate, hedging offsets 68 percent of the investment decline that follows a rate rise. On impact, a 100 basis point increase reduces the investment rate of an unhedged high leverage firm by roughly 0.5 percentage points, a 10 to 15 percent decline comparable to the quarterly contraction in a mild recession. Hedging brings this down to 0.17 percentage points, closer to normal quarter-to-quarter variation. However, the model is able to show an additional mechanism: investment protection also has an opportunity cost. When rates fall, hedgers remain locked into their prior rates and do not fully benefit from lower debt costs, so hedging dampens the investment increase after a cut. This cost is modest, offsetting only 21 percent of the aggregate response, so the value of interest rate derivatives lies mainly in protection against tightening. Because the model is partial equilibrium, these effects are best read as upper bounds.

Overall, my results have implications for several policy-relevant questions. First, hedging may shape the transmission of monetary policy to the real economy. Changes in the Federal Reserve's target rate pass through to the interest rates firms pay, and hedging dampens this pass through for firms with substantial exposure. Firms who hedge may therefore shape both the strength and the distribution of monetary policy's effects across the macroeconomy. Second, these results inform the pricing of interest rate derivatives. Nonfinancial firms that hedge floating rate debt typically pay fixed and receive floating, so their demand shapes the positions dealers must absorb and, when dealer balance sheets are constrained, swap prices. Finally, these costs point to a role for financial technology in reducing the barrier to hedging for nonfinancial firms. Lowering the cost of hedging or making derivatives easier to access could extend insurance to exposed firms that are currently priced out.

1.1 Literature Review

There is a strong theoretical literature on hedging by nonfinancial firms. In their seminal paper, Modigliani and Miller (1958) demonstrate that firms have no incentive to hedge cash flow risk when there are no financial frictions. Froot, Scharfstein, and Stein (1993) show that hedging becomes valuable when it secures internal funds for attractive investment opportunities, which predicts that more financially constrained firms should hedge more. Yet the opposite holds empirically: firms that hedge tend to be larger and financially unconstrained, while firms that do not hedge tend to be smaller and financially constrained (e.g., Nance, Smith, and Smithson (1993), Campello et al. (2011), Hommel and Piquard (2025)).

Several papers reconcile the theory with the data. Rampini and Viswanathan (2010) model hedging and financing as competing for the limited collateral needed to finance investment, so constrained firms forgo hedging to preserve borrowing capacity. However, Hommel and Piquard (2025) and Chang, Falato, and Zikes (2026) find that collateral posting for derivatives is rare in European and U.S. markets, respectively. Bolton, Wang, and Chen (2011) show that when external finance is costly, liquidity and hedging jointly shape investment. I offer a complementary explanation based on firm heterogeneity. Firms with more debt are more exposed to interest rates and have more to gain from hedging, but only those with sufficient operating cash flow find it worthwhile to pay the cost. Hedging in turn lowers default risk, which improves the debt terms of hedging firms.

My paper also contributes to the growing empirical literature on hedging with derivatives. Much of this work studies currency hedging. Hommel and Piquard (2025) use proprietary data on EU firms' FX derivative contracts to document key facts about FX hedging markets and firms' management of currency risk (see also Du and Huber (2024), Alfaro, Calani, and Varela (2021), Chen (2026)). For interest rate risk, the literature focuses primarily on banks (Kirti (2020), Kim (2024)). Campello et al. (2011), Bartram (2019), and Banerjee et al. (2023) show that nonfinancial firms hedge interest rate risk but offer little detail on which firms do so, while studies focused on nonfinancial firms' interest rate hedging rely on limited samples (Faulkender (2005); Chernenko and Faulkender

(2011); Rampini, Sufi, and Viswanathan (2013)). I contribute a new, population-level dataset of interest rate hedging by U.S. nonfinancial firms and a new set of facts on which firms hedge. The dataset can be used to answer financial and economic questions that have previously been difficult to address.

A few papers model which nonfinancial firms hedge interest rate risk and how hedging affects investment. Closest to my paper, Bretscher, Schmid, and Vedolin (2018) build a dynamic model of investment, financing, and swap hedging in which hedging partially insulates investment from interest rate uncertainty. They study the volatility of rates and find that smaller, constrained firms hedge more intensively because they are more exposed. In contrast, I study rate increases themselves and find that hedging participation is concentrated among large, highly leveraged, high cash flow firms, because the cost of hedging keeps low cash flow firms from hedging even when they are exposed. **?** also build a quantitative model in which default costs motivate swap use, but they focus on the direction of swap positions and find that swaps affect investment only modestly for the typical firm. My results suggest that this average masks large effects among highly levered firms, where hedging protects investment most.

My results also connect to work on how financial frictions and firm heterogeneity shape the effect of interest rate changes on real decisions. Bernanke, Gertler, and Gilchrist (1996) and Gertler and Gilchrist (1994) show that interest rate increases reduce cash flows through pre-existing debt, and Holmstrom and Tirole (1997) introduce collateral constraints and costly monitoring as a further mechanism through which financial frictions curb investment. More recent work finds that interest rate shocks affect financially constrained and unconstrained firms differently (e.g., Caglio, Darst, and Kalemli-Özcan (2024), Ottonello and Winberry (2020), Winberry et al. (2026)). My paper suggests that risk management and real firm outcomes are fundamentally linked: the firms whose investment responds least to interest rate shocks are also the firms that hedge.

Finally, a related literature shows that large firms play an outsized role in aggregate fluctuations (e.g., Gabaix (2011), Galaasen et al. (2025), Gopinath et al. (2019)). My results suggest that risk management shapes how interest rate shocks reach the aggregate

economy. Hedging is more common among large firms, and it insulates the investment of highly levered firms from rate increases. Interest rate shocks may therefore transmit to aggregate investment disproportionately through smaller, unhedged firms.

2 Interest Rate Risk Management in U.S. Firms

Firms can use interest rate derivatives to insure their cash flow against changes in interest rates. In this section, I define interest rate risk, explore the typical derivative used to insure against this risk, and describe firm reporting of derivatives in financial filings. No comprehensive dataset of this information exists in the literature, so I collect it for all U.S. public firms from 2014 to 2024.

2.1 What is Interest Rate Risk?

Many firms borrow at floating rates, meaning the interest rate on their debt resets periodically with a market benchmark.[2] As the benchmark rate moves, so do the firm's interest payments. Each interest payment is both a cash outflow, which reduces the funds available to invest, and an interest expense, which reduces reported earnings. When interest payments change, cash flow, the net flow of money into the company, and earnings, the net profit of the company, both become more volatile. I refer to this exposure as *interest rate risk*.[3]

As an example, say a firm earns \$20 million every quarter has a \$10 million loan from a bank at a rate of 5% plus the value of the market rate in each quarter, $x\%$. Say $x = 2\%$ in quarter one but unexpectedly increases to 3% in quarter two. In quarter one, the firm pays $\$10,000,000 \times (0.05 + 0.02) = \$700,000$ in interest expenses. In quarter two, the firm pays $\$10,000,000 \times (0.05 + 0.03) = \$800,000$, assuming they do not repay any of the principal. Net earnings decreases from $\$20,000,000 - \$700,000 = \$19,300,000$ to

[2]For U.S. bank loans, the most common benchmark was the London Interbank Offered Rate (LIBOR) until its phase-out between 2021 and June 2023, after which loans transitioned to the Secured Overnight Financing Rate (SOFR).

[3]More broadly, interest rate risk includes exposure to rate changes through earnings, capital, and the value of assets and liabilities. This paper focuses on the liability side, through interest payments on debt.

$\$20,000,000 - \$800,000 = \$19,200,000$, a level reduction of $\$100,000$ and an increase in net earnings volatility.[4]

Volatile cash flow and earnings have real consequences for firms. Unstable cash flow makes it harder to fund investment internally and to meet debt obligations. Similarly, volatile earnings erode investor confidence and lower market value, raising the cost of equity and tightening borrowing conditions. Together, these effects make financing more expensive and depress investment and growth. Firms therefore have a strong incentive to stabilize both. This paper focuses on one way they do so, by using interest rate derivatives to hedge floating rate bank debt.[5]

2.2 What is a Derivative?

An interest rate derivative is a contract between two parties whose payments depend on a reference interest rate. In practice, a nonfinancial firm and a counterparty, typically a bank or broker-dealer, agree to exchange interest payments calculated on a *notional amount*. The notional amount is a reference principal, often matched to a loan or bond, used to compute payments but never itself exchanged.

Swaps are by far the most common instrument used by nonfinancial firms to manage interest rate risk. Caps, floors, and collars are also used, though less frequently. Swaptions and forward rate agreements are rare among nonfinancial firms. I discuss these instruments in more detail in appendix B.

The most relevant instrument to this paper is a floating-to-fixed rate swap. In this arrangement, the firm holds floating rate debt, typically from a bank, and wishes to fix its borrowing costs. A swap dealer or other counterparty agrees to pay the floating rate of the loan to the firm. Conversely, the firm pays the counterparty an agreed-upon fixed rate. Thus, the firm recoups the floating interest it paid to its lender and effectively fixes the interest rate on its debt.

Returning to the example in the previous section, suppose that after paying the in-

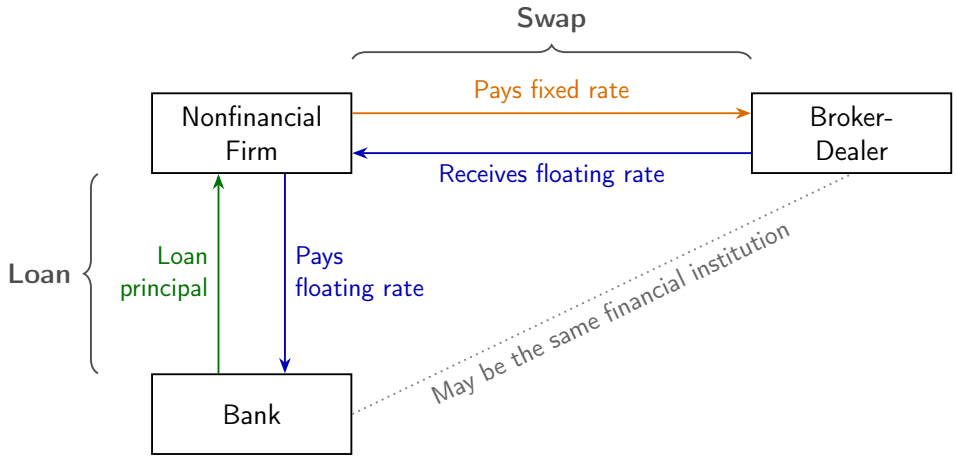
[4] Net earnings and net cash flow are equivalent in this example.

[5] Firms can also offset interest rate risk by holding corresponding assets or borrowing at fixed rates, though banks less commonly offer fixed-rate debt (Kirti (2020)).

terest in quarter one but before quarter two, the firm agrees to a swap with a dealer in the value of \$10 million. The firm agrees to pay a fixed rate of 7% on the \$10 million value to the dealer and the dealer agrees to pay floating rate of 5% plus x\$ to the firm in each quarter. Then, in quarter two, the firm still pays the bank \$800,000 in interest. However, the firm receives \$800,000 from the dealer and pays the dealer \$700,000 for a net outflow of $\$800,000 - \$800,000 - \$700,000 = -\$700,000$. In both quarters, the firm has net earnings of $19,300,000$ and volatility is zero, a much better financial position.

I illustrate this in Figure 1. The firm receives the loan principal of \$10 million from the bank and pays the bank the floating rate on the loan. With a swap, the firm pays a fixed rate on the loan *value* to the swap dealer and the dealer pays the firm the floating rate. The actual loan amount is never exchanged between the firm and the swap dealer. The derivative allows the firm to net out the effect of the volatile market rate on its balance sheet.

Figure 1: Float-to-Fixed Interest Rate Swap, Basic Structure



2.3 Derivatives in SEC Filings

In the United States, all publicly traded companies must file three quarterly financial reports and one annual financial report with the Securities and Exchange Commission (SEC). These filings contain three core accounting statements: the balance sheet, income statement, and cash flow statement. The filings also include explanatory notes to the main statements, a summary of business operations, management's discussion, and any

additional relevant information such as legal proceedings or compliance with regulation.

The notes section contains rich information about the core accounting statements. In this section, firms that use derivatives must include detailed disclosures reporting the objective, context, and strategies behind issuing or holding them. They must also report information sufficient for readers to assess the volume of activity — in practice, the notional value of outstanding derivatives and the number of contracts held. The notional value represents the value of the underlying asset or liability being hedged. Firms typically convey this information through a combination of text and tables.

An example of a derivatives note comes from Deere & Co.'s 10-Q filing for the quarter ending January 30, 2022. Deere & Company is a heavy machinery and equipment manufacturer operating across the construction, agriculture, and forestry industries. In a dedicated note on derivatives and hedging activities, the company states:

> *It is the Company's policy that derivative transactions are executed only to manage exposures arising in the normal course of business and not for the purpose of creating speculative positions or trading.*

This note also contains a dedicated subsection on cash flow hedges, discussing the firm's rationale for hedging and the volume of its hedge positions:

> *Certain interest rate contracts (swaps) were designated as hedges of future cash flows from borrowings. The total notional amounts of the receive-variable/pay-fixed interest rate contracts at January 30, 2022, October 31, 2021, and January 31, 2021 were $2,700 million, $2,700 million, and $2,350 million, respectively.*

No comprehensive tabulation of derivatives and hedging disclosures from the notes section currently exists in the literature. Compustat serves as the primary data source for financial fundamentals among U.S. public companies, drawing from the core accounting statements in SEC filings. It captures the aggregated effect of derivatives on asset and liability values but omits the more granular derivative disclosures that companies report in the notes.

I use a large language model (LLM) to construct a novel dataset on firm hedging covering all SEC 10-Q and 10-K filings from 2014 to 2024. The dataset records the fair value, notional value, instrument type, and hedge type for each position, aggregated by instrument type. I source filings from the Notre Dame Software Repository for Accounting and Finance, which provides clean text versions of the SEC statements that eliminate the need for HTML parsing. The full dataset spans 308,545 filings and 14,258 unique companies. Over 3,000 unique companies report hedging interest rate risk. Per year, the dataset averages 7,588 unique companies, of which approximately 1,436 or 19% of companies report some form of interest rate hedging activity. At roughly 550 GB compressed, the dataset requires a large-memory computing environment to process.

3 Large Language Model Data Extraction

The primary reason the data in the notes sections of 10-K and 10-Q statements has not been tabulated is that, until recently, tools to extract this information have not been widely available. The literature that does use this information manually collects the information available for a small subset of public firms (e.g. Gürkaynak, Karasoy-Can, and Lee (2022), Bretscher, Schmid, and Vedolin (2018)). The amount of time needed to do this stacks up quickly. I estimate that for the universe of filings from 2014-2024, it would take one research assistant around three years of non-stop work to tabulate only two numerical variables and three identifiers.

Large language models have emerged as a powerful tool for constructing datasets that were previously intractable. They easily process large volumes of documents and extract key information in context. When applied carefully, it achieves extraction accuracy that exceeds human coders (Bermejo et al. (2025)). In this paper's application, the LLM extracted the full dataset in under 12 hours.

3.1 LLM Prompts

In this paper, I use Anthropic's Claude model (Claude Haiku 4.5, `claude-haiku-4-5-20251001`) to extract data from SEC filings. I provide Claude with the text filings and two prompts, the system prompt and the user prompt, to guide the data extraction task.

The system prompt instructs the model to treat extraction as its sole task and to draw exclusively from the provided text, without imputing or omitting information. It narrows the model's focus and reduces the risk of irrelevant or fabricated output. The system prompt used in this paper reads as follows:

> *You are a financial analyst that is an expert at creating datasets from public companies' financial reporting documents. Your task is to create a dataset of companies' interest rate risk hedging behavior from the text and tables of cleaned SEC statements. Pay close attention to whether the derivative instruments used are expired before the reporting period of the document or are current derivatives. Also pay attention to interest rate risk derivatives only. Only transcribe information from the document itself. Do not add or fill in any missing information.*

The user prompt follows the system prompt and provides granular extraction instructions. The prompt is longer and more detailed than the system prompt, so I provide the full text in Appendix A. It directs the model to locate filing metadata, identify interest rate risk hedging instruments, and extract each instrument's notional and fair value, aggregated by type. It also instructs the model to flag instruments that expired prior to the reporting period and to identify offsetting derivative positions for financial firms. The prompt reiterates that derivatives hedging risks other than interest rate risk should be excluded. Each response returns a JSON object containing the requested variables alongside a field documenting the model's reasoning for each reported value.

3.2 Validation Exercises

I carefully validate the model's accuracy against a hand-coded sample. I randomly select 100 filings from each year of the sample, for a total of 1,100 filings, and hand-code the same information the model extracts. The model and my hand coding initially disagree on 15% of filings. On review, several disagreements stemmed from an error in the hand coded sample, either information missed in tables, footnotes, or other sections of the filing.

An example of this discrepancy comes from the November 2, 2023 10-Q filing for Alaska Air Group, Inc. The hand coded sample noted that there were fair values for interest rate derivatives but no notional value. The LLM-coded entry contained a notional value of $216 million. When I compared the LLM entry and the hand-coded entry, I realized the hand-coded sample had only looked in the section "Note 4: Fair Value Measurements" of the filing but the notional amount of the interest rate swaps in this filing was reported in the secton "Note 5: Long-Term Debt", where the company reported:

> *Approximately $216 million of the Company's total variable-rate notes payable are effectively fixed via interest rate swaps at September 30, 2023...*

The LLM was able to gather in context that the notional value of the interest rate swaps was approximately $216 million. The hand coded sample missed this key detail because it was in a separate section.

After removing these discrepancies, I compute error rates against the reconciled sample. The false negative rate, the share of filings where the model misses an attribute of an interest rate derivative, is 1.5%. The false positive rate, the share of filings where the model reports an interest rate derivative that does not exist, is 0%.

I also find that 57% of the LLM errors are financial firms rather than non-financial firms. Once I drop financial firms, the false negative rate drops to 0.5%. The majority of the financial firm errors were units errors. In other words, this means that the LLM reported $160,000 in notional value when in the filing, the true value is $160 million. I find these errors are concentrated in financial firms that have multiple types of derivatives and

use derivatives across the business structure – these filings are much more complicated to read and assess. Units are often changed throughout those filings.

Table 1 summarizes the results from the validation exercises. From these exercises, I assess that the LLM did a very good job extracting the hedging information and proceed to documenting facts in the data.

Table 1: Validation Error Rates by Stage

Stage	**Measure**	**Rate**
Initial comparison	Disagreement with hand coding	15%
After reconciliation	False negative rate	1.5%
	False positive rate	0.0%
Excluding financial firms	False negative rate	0.5%

Notes: The validation sample contains 1,100 filings, 100 drawn at random from each year of the sample. The reconciled sample corrects errors in the hand-coded sample identified on review. The false negative rate is the share of filings where the model misses an attribute of an interest rate derivative; the false positive rate is the share of filings where the model reports an interest rate derivative that does not exist.

3.3 Summary of Extracted Variables

The final dataset contains information on the notional value and fair value of the derivatives a firm holds. It also contains information on hedge type, instrument type used to hedge, whether the contract is expired, whether there is an offsetting position, and firm-filing metadata. Table 2 summarizes the variables extracted from the SEC statements.

I merge Compustat quarterly fundamentals from 2014-2024 with my new hedging dataset extracted from the SEC statements. The final dataset contains the population of publicly-traded non-financial firms in the United States. I drop any financial and utilities firms. I also drop amendment filings. The sample is quarterly from 2014 to 2024. There are 8,792 unique firms and 1,486 or 16.9% of these hedge interest rate risk at some point in time. A full list of the dataset variables is in Appendix A.

Table 2: Variables extracted by Claude from 10-K and 10-Q filings

	Data Field	Description
Metadata	Company ID	Unique company identifier (CIK)
	Company Name	Registered company name
	Filing Date	Date the filing was submitted to the SEC
	Report Date	End date of the reporting period
	IRS Number	Company's IRS Employer ID Number
	Form Type	Filing type (10-K, 10-Q)
New data	Instrument Group	Interest rate swap, cap, floor, collar, forward, etc.
	Hedge Type	Cash flow hedge, fair value hedge, or investment hedge
	Fair Value	Aggregated fair value of instruments within the group
	Notional Value	Total notional amount of the instrument group
	Expired	Contract expired before the reporting period
	Offsetting Position	Position is offset with a third party

Notes: "Metadata" identifies extracted information used to merge with Compustat data, and "New Data" describes the new extracted variables on firm interest rate derivatives.

4 New Facts about Hedging Firms

In this section, I document new facts about interest rate hedging among U.S. public nonfinancial firms. Hedging is uncommon and persistent. Hedgers are larger, more leveraged, and more profitable than non-hedgers, and they hold less cash. Size matters, but it does not determine which firms hedge. Firms across the size distribution hedge, and small hedgers cover a larger share of their liabilities than large hedgers. Leverage is the strongest predictor of hedging after size, and operating cash flow is associated with more hedging as leverage rises but less hedging among firms with little debt. This complementarity between leverage and operating cash flow motivates the model in Section 5.

4.1 The Hedging Firm Distribution

Table 3 reports summary statistics for the data sample. Size is the log of deflated total assets. Liquid assets are cash and cash equivalents scaled by total assets. Leverage is total liabilities divided by total assets. Profitability is operating income before depreciation divided by total assets. The market-to-book ratio is the market value of equity plus total debt, scaled by total assets. The short-term debt share is short-term debt divided by total debt, and net worth is total assets less total liabilities, scaled by total assets. Following

Ottonello and Winberry (2020), I also construct distance to default, which measures how many standard deviations a firm's asset value must fall before it defaults. Appendix A describes the construction of all variables.

Table 3: Summary Statistics by Hedging Status

Variable	All Firms	Hedging	Not Hedging	Difference
Size (logs)	5.637	8.134	5.255	2.879***
	(3.066)	(1.675)	(3.051)	
Liquid Assets	0.268	0.090	0.296	-0.205***
	(0.283)	(0.096)	(0.293)	
Leverage	0.259	0.398	0.237	0.161***
	(0.243)	(0.195)	(0.243)	
Distance to Default	5.880	6.850	5.658	1.192***
	(4.783)	(4.579)	(4.801)	
Profitability	-0.071	0.030	-0.087	0.116***
	(0.323)	(0.027)	(0.346)	
Market-to-Book	2.180	1.632	2.275	-0.643***
	(2.184)	(1.190)	(2.299)	
Short-Term Debt Share	0.291	0.105	0.325	-0.220***
	(0.335)	(0.150)	(0.348)	
Net Worth	0.055	0.332	0.012	0.320***
	(2.654)	(0.244)	(2.850)	
Observations	206,264	27,332	178,932	

Notes: Means with standard deviations in parentheses. Difference in means tested with Welch's t-test; *** $p < 0.01$. All variables have been winsorized at the 1st/99th percentiles except the market-to-book ratio, which is winsorized at the 1st/95th percentiles, leverage, which is winsorized at the 5th/95th percentiles, and log assets, where all negative values were dropped. The values do not add up because some variable observations were not in Compustat.

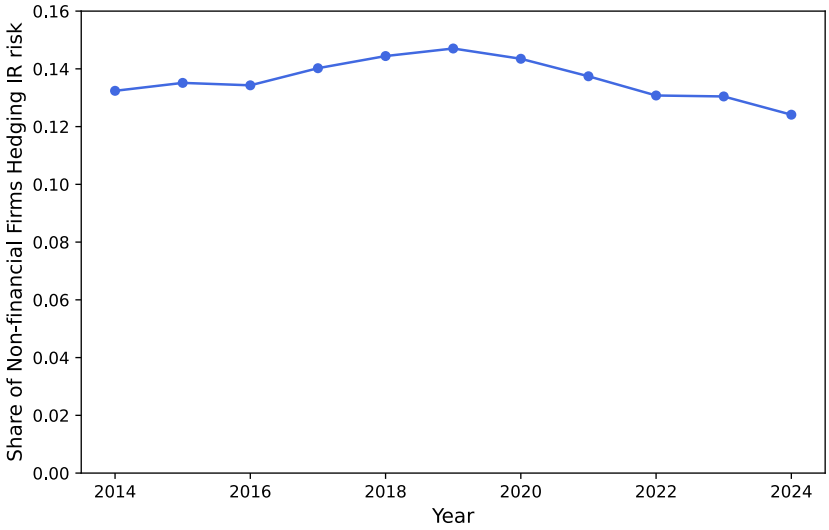
The estimates are in line with prior work (e.g., Gürkaynak, Karasoy-Can, and Lee (2022)) but cover the universe of U.S. public nonfinancial firms. Hedgers differ systematically from non-hedgers. They are larger, more profitable, and more leveraged, with lower market-to-book ratios, more long-term debt, and less cash. They are also further from default. Every difference in means is statistically significant, indicating that hedgers are a distinct group of firms.

4.2 Hedging Behavior is Uncommon but Persistent

Hedging is uncommon and remarkably stable. In a typical year, 13.6% of firms hedge interest rate risk, and as Figure 2 shows, this share barely changes over the sample period. The stability reflects persistence at the firm level.

Table 4 reports quarterly transition probabilities between hedging and not hedging. A firm that hedges in one quarter continues to hedge in the next with 92.05% probability, while only 1.43% of non-hedgers begin hedging in a given quarter.

Figure 2: The share of non-financial firms hedging interest rate risk per year.



This persistence suggests that selection into hedging is driven mainly by firm characteristics rather than by fluctuations in market conditions. Once a firm begins hedging, it rarely stops, consistent with either a fixed threshold that firms must overcome to begin hedging or a stable capital structure whose risks hedging continues to offset.

Table 4: Quarterly Transitions

	Status at t	
Status at $t-1$	Non-hedger	Hedger
Non-hedger	98.57%	1.43%
Hedger	7.95%	92.05%

Notes: Rows correspond to status at $t-1$ and columns to status at t. Each row sums to 100%.

4.3 Hedging Rises Steadily with Size

If firm characteristics drive selection into hedging, the natural first candidate is size. The literature consistently finds that larger firms are more likely to hedge. My data confirm this, with an important caveat. Larger firms hedge more often, but smaller hedgers hedge a greater proportion of their total debt. Table 5 reports both margins by asset quintile.

Panel A shows that participation rises steadily with size, from 2.5% of firm-quarters in the bottom quintile to 30% in the top. Hedging is nonetheless common among smaller firms, as 30.3% of hedging firm-quarters come from the bottom three quintiles. Panel B measures hedging intensity as the notional value of interest rate derivatives divided by total liabilities. Hedgers in the bottom three quintiles cover about 26% of their liabilities, compared with 9.6% in the top quintile. This measure has one limitation. The largest firms rely less on bank debt, so a lower share of total liabilities may still cover a large share of their floating rate debt. Size therefore shapes hedging, but it cannot fully explain which firms hedge. The next section examines additional characteristics that predict hedging.

Table 5: Hedging Participation and Intensity by Asset Quintile

	Q1	Q2	Q3	Q4	Q5
Panel A: Extensive margin (all firm-quarters)					
% hedging	2.5	9.4	18.4	25.7	30.0
N (total)	22,240	22,240	22,239	22,240	22,240
Panel B: Intensive margin (hedging firm-quarters only)					
Mean hedge intensity (%)	25.6	26.3	25.5	19.1	9.6
Std. dev.	17.9	18.8	17.1	14.7	10.2
N (hedgers)	548	2,077	4,094	5,701	6,670

Asset quintiles based on the unconditional distribution of real assets. % hedging is the share of all firm-quarters in the quintile that report at least one IR derivative position. Hedge intensity = total IR derivative notional value divided by total liabilities, winsorized at the 1st and 99th percentiles.

4.4 Leverage and Operating Cash Flow Jointly Predict Hedging

The previous section shows that size does not explain to satisfaction which firms hedge. In this section, I show that two characteristics do: leverage, which determines a firm's exposure to interest rates, and operating cash flow, which governs the net benefit of

hedging. Jointly, they increase the probability of hedging by around 30 percentage points.

Table 6: Leverage, Operating Cash Flow, and Hedging

	(1) Baseline	(2) Standardized	(3) Firm FE	(4) Interaction
Operating cash flow	0.0707***	0.0050***	0.0158	-0.0661***
	(0.0226)	(0.0016)	(0.0132)	(0.0207)
Leverage	0.2100***	0.0401***	0.0974***	0.1014***
	(0.0349)	(0.0067)	(0.0288)	(0.0291)
Operating cash flow × Leverage				0.2708***
				(0.0635)
N	105,929	105,929	105,929	105,929
R^2	0.128	0.128	0.687	0.687
Sector + time FE	Yes	Yes	No	No
Firm FE	No	No	Yes	Yes
Time × sector FE	No	No	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Linear probability model. The dependent variable equals one if the firm reports an interest rate derivative position in the quarter. Firm-clustered standard errors in parentheses. In column (2), continuous regressors are standardized, so coefficients give the change in hedging probability per one standard deviation increase. Operating cash flow = (oibdpq − dpq − Δppentq)/atq. Controls: log real assets, short-term debt share, net worth, cash holdings, and market-to-book. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

To see why, consider a firm that borrows at a floating rate. Its cash flow in period t can be expressed

$$\text{Cash flow}_t = \underbrace{\text{Operating Income}_t - \text{Investment}_t}_{\text{Operating cash flow}} - \underbrace{r_t \cdot \text{Debt}_t}_{\text{Debt service}}$$

where r_t is the prevailing interest rate. A change in r_t passes through to cash flow in proportion to the firm's debt, and a hedge removes this exposure by replacing r_t with a fixed rate $\bar{r}$. This framing points to two empirical objects. The first is leverage, which governs exposure. The more debt a firm carries, the more a given rate change moves its cash flow, and a firm with no debt has no exposure through this channel.

The second object is operating cash flow, which is operating income net of investment expenditure. Investment and hedging are both uses of the same pool of operating income. Investment drives productive capacity, while hedging manages the cost of existing debt. A firm that commits most of its operating income to reinvestment has little margin left

to run an active interest rate management program. This is visible in the data. I show in the appendix that higher investment negatively predicts hedging. Operating cash flow is the margin from which active interest rate management becomes feasible.

These two characteristics are complements. A highly levered firm with little operating cash flow faces rate exposure it cannot afford to manage without cutting investment. A cash-rich firm with negligible debt has the capacity but nothing to hedge against, suggesting a conditional effect.

I test the qualitative importance of this relationship cross-sectionally with the following baseline specification:

$$\text{hedge}_{ijt} = \alpha_j + \gamma_t + \beta \cdot \text{operating cash flow}_{ijt} + \delta \cdot \text{leverage}_{ijt} + \Gamma Z_{ijt} + \varepsilon_{ijt} \qquad (1)$$

where hedge_{ijt} is a dummy variable for whether firm i in sector j hedges interest rate risk in quarter t, $\text{operating cash flow}_{ijt}$ is operating income net of investment scaled by total assets, and leverage_{ijt} is the liabilities-to-assets ratio. In the baseline specification, I add sector α_j and time γ_t fixed effects. Z_{ijt} is a vector of firm-level controls including liquid assets, log real assets, the short-term liabilities share of total liabilities scaled by total assets, and net worth scaled by total assets.

Table 6 displays the results. In the baseline regression in Column 1, both operating cash flow and leverage are positively and significantly associated with hedging. Firms that generate more income from their core operations after investment are more likely to hedge, as are firms with more debt and therefore greater exposure to rate changes.

Column 2 standardizes the regressors to compare their relative importance. After log assets, which is not shown in the table, leverage is the strongest predictor. A one standard deviation increase in leverage is associated with a 4.0 percentage point higher probability of hedging, compared with 0.5 percentage points for operating cash flow. This is not surprising, since a firm with more debt is more exposed to interest rate changes.

Adding firm fixed effects and time by sector fixed effects absorbs all time-invariant firm characteristics and time-by-sector variation. I show these results in Column 3. The leverage result survives within firms, but operating cash flow loses its significance. Column 4

shows why. Adding the interaction of operating cash flow and leverage, the interaction is positive and highly significant. Operating cash flow is associated with less hedging for firms with little leverage and more hedging with high leverage, so the average effect in Column 3 masks opposite effects on either side of this threshold. This is exactly what the discussion above suggested. Because Column 4 includes firm fixed effects, this complementarity between leverage and operating cash flow holds within firms over time.

The appendix presents two robustness checks. First, the results are not driven by collinearity among the three main regressors. Second, the signs and significance are consistent on a balanced panel of firms, though the estimates are less precise because the balanced sample is smaller and skews toward older, larger firms.

Together, these results motivate the core mechanism of the model in Section 5. Firms that carry more debt have greater exposure to interest rate changes, which raises the value of hedging. But hedging is costly, so only firms generating sufficient operating cash flow find it worthwhile. The model's endogenous hedge ratio quantitatively matches the sign and relative magnitude of these empirical patterns.

4.5 Hedging Insulates Firm Investment

The previous section shows which firms hedge. This section asks whether hedging changes how those firms' investment decisions fare when interest rates rise. When rates rise, firms with unhedged floating rate debt pay more in interest, which drains cash flow and tightens financial constraints. A firm that has locked in a fixed rate avoids this pass-through on the hedged portion of its debt and should be better able to sustain capital investment.

I test this mechanism with a matched-sample event study around the 2022–2023 Federal Reserve tightening cycle. After a long period of near-zero rates, the Federal Reserve raised its target rate rapidly and by a large amount, creating a sharp increase in borrowing costs across firms.

To show the effects of hedging on investment responses over this period, I match firms that held interest rate derivatives in the final quarter of 2021 (*treated*) with similar firms that did not (*control*). Measuring hedging status in 2021Q4, one quarter before the first

rate hike in March 2022, ensures that treatment status does not reflect hedging decisions made in response to the hikes themselves. I restrict the sample to firms with at least $10 million in total outstanding debt in 2021Q4, so that every firm carries meaningful exposure to rate changes.

To construct the matched sample, I match each hedger to an unhedged firm in the same 2-digit NAICS sector using nearest-neighbor propensity score matching, estimating the propensity score on log real assets, book leverage, short-term debt share, cash to assets, operating cash flow to assets, and the firm's average investment ratio over the pre-period from 2020Q1–2021Q4. Including the pre-period investment average ensures that matched pairs are on comparable investment trajectories before the hiking cycle begins. Matching within sector ensures that treated and control firms face the same industry environment. The propensity score removes remaining differences in financial structure. The matched sample contains 818 firms, or 409 hedged–unhedged pairs. I measure investment as the four-quarter rolling average of capital expenditure to capital stock (I/K), winsorized at the 5th and 95th percentiles within each quarter, normalized to zero at 2022Q1.

Hedged firms sustained investment through the hiking cycle. The left panel of Figure 3 plots the investment rate for matched hedged and unhedged firms. Before the first rate hike, the two series track each other closely. Once the hikes begin, investment at unhedged firms falls persistently while hedged firms maintain their investment rate through the end of 2024.

The right panel formalizes this comparison with a matched-pair event study, regressing within-pair investment differences on quarter indicators with pair fixed effects. For each matched pair p and quarter t, let $d_{p,t}$ denote the within-pair difference in I/K (hedged minus unhedged). I estimate

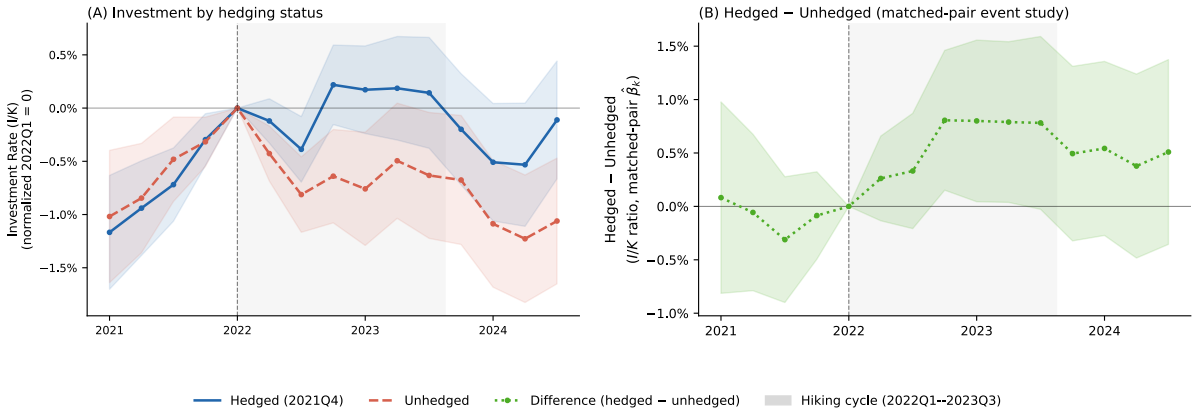
$$d_{p,t} = \alpha_p + \sum_{k \neq 2021\text{Q4}} \beta_k \mathbb{1}[t = k] + \varepsilon_{p,t} \tag{2}$$

where α_p is a pair fixed effect that absorbs any time-invariant investment-rate gap within

each matched pair, and the β_k trace the evolution of the hedged-minus-unhedged gap relative to the base period 2021Q4. Standard errors are clustered at the pair level.

Before 2022Q1 the estimated gap is small and flat, satisfying the parallel trends condition. After the hiking cycle begins, the gap widens steadily: by late 2022, hedged firms invest approximately 0.8 percentage points more than their matched unhedged counterparts, a difference that is statistically significant in 2022Q4 and marginally significant through mid-2023. Averaged over the full post-hike period, the investment gap is 0.6 percentage points. I report additional regression estimates under alternative specifications in Appendix B.6.

Figure 3: Investment Changes During the 2022–2023 Hiking Cycle



Notes: Left panel: quarterly group means of the I/K ratio for hedged (solid blue) and matched unhedged (dashed red) firms; shaded bands are 90% confidence intervals. Right panel: matched-pair event study coefficients $\hat{\beta}_k$ with 90% confidence intervals, estimated from within-pair differences in I/K regressed on quarter indicators with pair fixed effects; base period 2022Q1. Sample: 409 hedged–unhedged pairs matched one-to-one by propensity score within two-digit NAICS sector on log total assets, book leverage, short-term debt share, cash to assets, operating cash flow to assets, and average I/K over 2020Q1–2021Q4; firms with $\geq$ \$10 million in total debt in 2021Q4. I/K is winsorized at the 5th and 95th percentiles within each quarter, normalized to zero at 2022Q1. Gray shaded region: hiking cycle (2022Q1–2023Q3).

4.5.1 Robustness

Appendix B.6 reports regression estimates of the average post-hike investment gap under three specifications: unweighted OLS on the propensity-score matched sample, a doubly robust estimator that augments the matching with inverse propensity weights, and the doubly robust estimator applied to a stayers subsample. The first two estimates are nearly identical (0.53 and 0.58 percentage points, respectively), providing confidence against

misspecification in either the outcome regression or the propensity score. The doubly robust event study is also shown in the appendix.

One concern is that some firms switch hedging status during the sample period. Firms classified as treated in 2021Q4 may stop hedging during the hiking cycle, and some control firms may start, both of which would attenuate the estimated effect. To address this, I re-estimate on a stayers subsample in which treated firms hedged in 2021Q4 *and* in every subsequent observed quarter, and control firms never hedged in any quarter of the full sample window (2019Q1–2024Q3). Re-running the within-sector matching on this subsample yields 268 pairs. The point estimate remains positive and of similar direction, though less precisely estimated given the smaller and more restrictive sample.

4.6 Connecting to the Literature

My results raise a natural question. If the largest firms hedge most often, do they actually have floating rate debt to hedge? Large firms can issue fixed-rate bonds, so it is possible their derivatives insure something other than floating rate exposure. I do not observe the terms of firms' debt directly, but recent work using supervisory data suggests that floating rate bank debt is an important part of capital structure even for large public firms. Bank debt offers flexibility that bonds do not. Issuing a bond requires underwriting, regulatory review, and finding investors, while a firm with an established bank relationship can draw on a loan or credit line almost immediately.

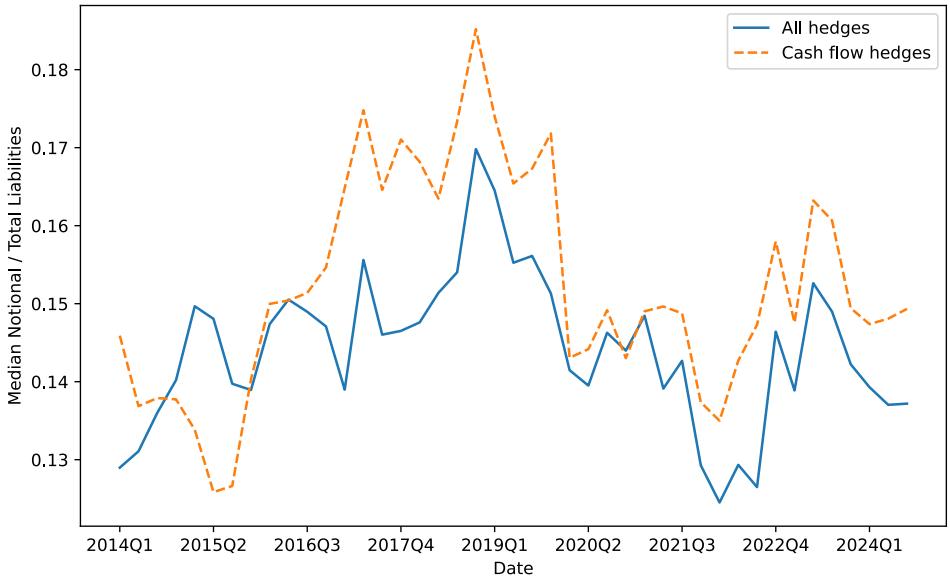
Much of this evidence comes from the Federal Reserve's FR Y-14Q data, which cover the loan and derivative portfolios of the largest U.S. bank holding companies.[6] Using these data, Caglio, Darst, and Kalemli-Özcan (2024) show that bank debt makes up roughly 20 to 30% of the debt of public and large private firms, and that about 70% of these loans are floating rate. Together, these imply that floating rate bank loans account for roughly 14 to 21% of public firms' total debt. They also find that the average interest

[6]The FR Y-14Q is a quarterly report collected as part of the Federal Reserve's Comprehensive Capital Analysis and Review (CCAR) for large bank holding companies and U.S. intermediate holding companies of foreign banking organizations. Schedule H.1 reports loan-level information on corporate borrowers, including term loans and credit lines. Schedule L contains counterparty-level information on derivatives, and the reporting banks account for most U.S. derivatives activity.

rate on bank loans falls monotonically with firm size, so small and medium-sized firms pay more to borrow from banks than large ones. Amiti et al. (2026) find that 89% of bank loans are floating rate and that about 93% have a maturity of five years or less, consistent with the maturities of the derivatives in my data. Higher-rated firms also pay lower spreads on bank debt.

Although I do not directly observe firms' floating rate exposure, hedges that firms report as "cash flow hedges" offer a proxy, since by their accounting definition, they are hedges of variable-rate debt. Figure 4 shows that the median cash flow hedge equals about 15% of total liabilities, compared with 14% for all hedges. Given that floating rate bank debt makes up roughly 14 to 21% of public firms' debt, hedgers appear to cover a substantial share of their floating rate exposure.

Figure 4: Notional Value Relative to Total Liabilities: Cash Flow Hedges and All Hedges



Notes: The figure plots the median ratio of hedge notional to total liabilities for all hedges and for cash flow hedges. Cash flow hedges typically hedge variable-rate debt. The median notional to total liabilities of cash flow hedges is higher than the median of all hedges.

5 A Heterogeneous-Firm Dynamics Model of Hedging

The empirical analysis in the previous two sections point to a clear pattern. Hedging is concentrated among firms with high leverage and high operating cash flow and hedging

is highly persistent. To rationalize these facts, I build a dynamic model in which heterogeneous firms choose investment, debt, and hedging to maximize firm value. Firms differ in productivity and in their exposure to interest rates. Hedging is valuable because it pushes firms away from a costly default. Firms with more debt are more exposed to rate changes and closer to default, so both the marginal value of hedging and the optimal hedge share rise with leverage. Hedging is also costly. Firms pay an adjustment cost to hedge, and firms with low productivity and capital, and therefore low operating cash flow, do not generate enough to make hedging worthwhile. Together, these forces produce the complementarity between leverage and operating cash flow documented in the previous section. Hedging is most valuable for highly levered firms, but only those with sufficient operating cash flow choose to hedge.

5.1 Environment

I adapt the model in Salomao and Varela (2022) to the interest rate hedging problem. Time is discrete and infinite and indexed by time t. There is a fixed mass μ of heterogeneous firms with idiosyncratic, time-varying productivity. All firms choose production, financing, and hedging to maximize their current and future expected cash flows. There is a representative financial intermediary that lends to firms and is the counterparty on firms' hedges. Firms are heterogeneous in four dimensions: productivity, capital, debt, and hedging.

There are two exogenous processes in the model that both evolve according to a standard AR(1) process. Market interest rates evolve exogenously:

$$r_{t+1} = (1 - \rho_r)\bar{r} + \rho_r r_t + \sigma_r \varepsilon^r_{t+1} \tag{3}$$

where $\bar{r}$ is the long run interest rate mean and $\varepsilon^r_{t+1} \sim N(0, 1)$. Similarly, firms' idiosyncratic productivity is stochastic and follows

$$\log a_{t+1} = \rho_a \log a_t + \sigma_a \varepsilon^a_{t+1} \tag{4}$$

with $\varepsilon^a_{t+1} \sim N(0,1)$. The two shocks are independent.

5.2 Firms

In each period t, firms maximize their value by choosing the maximum of the value of default V^D and the value of repayment and producing V^R. I normalize the value of default to zero.

$$V = \max\{V^R, V^D\} \tag{5}$$

If a firm decides to repay, it chooses capital k_{t+1}, new debt b_{t+1}, and the proportion of the new debt to hedge λ_{t+1} to maximize current and future expected streams of cash flow w_t:

$$V^R(b_t, k_t, \lambda_t; a_t, r_t, r_{t-1}) = \max_{b_{t+1}, k_{t+1}, \lambda_{t+1}} [w_t + \beta E_t[V(b_{t+1}, k_{t+1}, \lambda_{t+1}; a_{t+1}, r_{t+1}, r_t)]] \tag{6}$$

I separate cash flow into two distinct blocks: the operating block, which contains net cash flow from production, and the financing block, which contains new debt, repayments of old debt, and hedging.

5.2.1 Operating Block

The first block of firm cash flow is the operating block. Firms produce according to a decreasing returns to scale production function $y_t = a_t k_t^\alpha$, where k_t is capital and a_t is a time-variant technology parameter. Capital depreciates at a rate δ. Firms also pay capital adjustment costs $\phi(k_t, k_{t+1})$ and have a fixed operating cost c_F in each period. So, operating cash flow can be expressed as

$$\pi_t = y_t - (k_{t+1} - (1-\delta)k_t) - \phi(k_t, k_{t+1}) - c_F$$

5.2.2 Financing Block

The second block of cash flow contains the financing side of the firm. Each firm has access to two types of financing supplied by a risk-neutral financial intermediary: hedged or unhedged one-period loans. These loans are lent at time-varying discounts q_t^H and q_t^U.

In time t, firms choose total new debt b_{t+1} and the proportion of new debt that is hedged $\lambda_{t+1} \in [0, 1]$. In the following period, $t + 1$, they will repay this debt with a total repayment c_{t+1}. Hedged debt has an interest rate that is fixed at the current period's market interest rate, r_t. Unhedged debt is subject to interest rate changes and will pay the market interest rate realized in the next period, r_{t+1}. So, the total repayment the firm pays in $t + 1$ is

$$c_{t+1} = (1 - \lambda_{t+1})b_{t+1}(1 + r_{t+1}) + \lambda_{t+1}b_{t+1}(1 + r_t) \tag{7}$$

Firms also must pay a convex hedging adjustment cost $\psi(\lambda_t b_t, \lambda_{t+1}b_{t+1})$ which represents the cost of maintaining a risk management team, financial relationships, legal filings for derivatives, accounting frictions, and other costs firms acquire in risk management. Because ψ is convex, the cost of adjusting the hedged position rises more than proportionally with the size of the adjustment.

5.2.3 Cash Flow

Putting all of these elements together, I build the expression of firms' current cash flow

$$\begin{aligned} w_t = \pi_t &+ b_{t+1}[q_t^U(1 - \lambda_{t+1}) + q_t^H\lambda_{t+1}] \\ &- b_t[(1 - \lambda_t)(1 + r_t) + \lambda_t(1 + r_{t-1})] \\ &- \psi(\lambda_t b_t, \lambda_{t+1}b_{t+1}) \end{aligned} \tag{8}$$

Firms cannot issue equity, so cash flow must be nonnegative, $w_t \geq 0$.

To summarize, the operating block is $\pi_t = a_t k_t^\alpha - (k_{t+1} - (1 - \delta)k_t) - \phi(k_t, k_{t+1}) - c_F$ as described above and is composed of operating revenues and expenses. The financing block is composed of the remaining terms and includes new unhedged and hedged debt

b_{t+1}, repayments of old unhedged debt with interest $b_t(1-\lambda_t)(1+r_t)$, repayments of old hedged debt with interest $b_t\lambda_t(1+r_{t-1})$, and the convex adjustment cost of hedging $\psi(\lambda_t b_t, \lambda_{t+1}b_{t+1})$.

5.3 Financial Intermediary and Pricing Functions

Both hedged and unhedged loans are supplied by the financial intermediary who is risk-neutral and follows zero-profit competitive pricing. The intermediary discounts repayments at the realized rate r_{t+1} and recovers nothing when a firm defaults. Hedged loans are lent at a firm-specific discount q_t^H which is set by the intermediary. Similarly, unhedged loans are lent at the firm-specific discount q_t^U.

Thus, the pricing functions become

$$q_t^U(b_{t+1}, k_{t+1}, \lambda_{t+1}; a_t, r_t) = E_t[\mathbb{1}\{V^R(b_{t+1}, k_{t+1}, \lambda_{t+1}; a_{t+1}, r_{t+1}, r_t) > 0\}] \tag{9}$$

and

$$q_t^H(b_{t+1}, k_{t+1}, \lambda_{t+1}; a_t, r_t) = E_t\left[\frac{1+r_t}{1+r_{t+1}}\mathbb{1}\{V^R(b_{t+1}, k_{t+1}, \lambda_{t+1}; a_{t+1}, r_{t+1}, r_t) > 0\}\right] \tag{10}$$

The discounts depend directly on the firm's default risk. A firm with a higher probability of repaying in the next period will have a smaller discount on borrowing today and will be able to borrow relatively more. By contrast, a high default risk firm will have a larger discount and will be able to borrow less.

5.4 Entry

Each period, a constant mass of potential entrants receive a signal $x \sim Q(x)$ over their next period productivity which determines the expected value of entry:

$$V^e(x) = \max_{k_{t+1}} \left[-k_{t+1} + \beta E_t\left[V(k_{t+1}; a_{t+1}, r_{t+1}, r_t) \mid x\right]\right]$$

The entering firm will only enter if

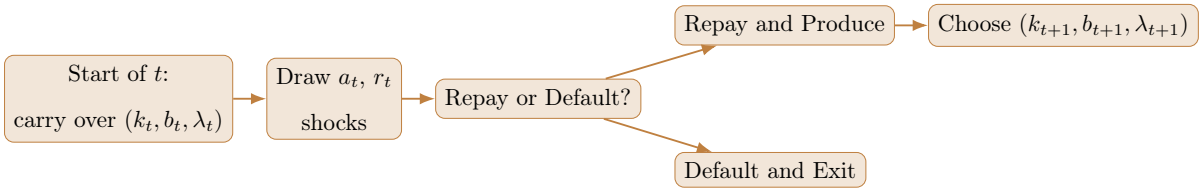
$$V^e(x) \geq c_e$$

where c_e is a sunk cost of entry. Firms enter the market when the value of entry and production is greater than the value of no entry.

5.5 Timeline

The timeline of each period is as follows. Firms carry over capital, debt, and hedge proportion from the previous period. Upon observing productivity and interest rate shocks, they decide whether to repay and produce or default and exit. Repayment occurs when V^R is positive and cash flow is non-negative (i.e., the firm is liquid). Active firms receive revenues net of fixed costs, investment and adjustment costs, and debt repayments. They then observe the new discounts set by the financial intermediary and choose capital, debt, and hedging for the next period.

Figure 5: Timeline of Decisions and Information at Period t



5.6 Equilibrium

For states

$$s = (b_t, k_t, \lambda_t, a_t, r_t, r_{t-1}),$$

a recursive equilibrium is defined as policies $\{b_{t+1}(s), k_{t+1}(s), \lambda_{t+1}(s)\}$, financial intermediary pricing functions $\{q_t^U, q_t^H\}$, a stationary measure of firms $\mu(s)$, and exogenous processes $\{a_t\}$ and $\{r_t\}$ such that

1. Firms solve their value function maximization problem.

2. The financial intermediary prices loans according to the zero-profit pricing functions.

3. Default probabilities in pricing are equal to those implied by the firm's optimal policies.

4. Exit occurs when $V^R(s) \leq 0$.

5. Entry occurs when $V^e(x) \geq c_e$.

6. The stationary distribution $\mu(s)$ is time-invariant.

5.7 Model Solution Method

I solve the model numerically by value function iteration (VFI) over a six-dimensional state space consisting of the firm's current capital stock, debt level, hedge ratio, productivity, the current interest rate, and the lagged interest rate. The two exogenous AR(1) processes — productivity and the risk-free rate — are discretized.

Each iteration of the VFI proceeds in three stages. First, the continuation value is computed by integrating next period's value function over the joint transition probabilities of productivity and the interest rate. Second, loan discounts are updated endogenously. Third, the firm's value function is updated by solving for the optimal choices of next-period capital, debt, and hedge ratio at every point in the state space, subject to a non-negativity constraint on cash flow. Firms exit whenever their value falls to or below zero.

Once the value function and policy functions have converged, the stationary distribution of firms across the state space is computed by iterating the distribution forward over the converged policy functions. This process is repeated until the cross-sectional distribution converges, yielding the steady-state joint distribution used to compute moments. Appendix E contains additional detailed information about the solution method.

5.8 Mechanism

This section describes the model's mechanism in equilibrium. Appendix D contains all derivations. Firms in the model are risk-neutral, and heterogeneous in productivity. Firms fund investment with internal funds and costly external debt, investing until the marginal product of capital equals the marginal cost of financing it. External financing exposes firms to exogenous interest rate changes that can push them toward a costly, permanent default where they lose their capital and the value of their future productivity. No one recovers these losses, and because the intermediary prices default risk into its loans, the firm bears the expected loss through worse borrowing terms. For a firm with a lot of external floating rate debt, a high interest rate realization can reduce its investment capacity by constraining cash flow and, in the worst case, push it into default. By locking in today's rate, hedging maintains the investment capacity of the firm and lowers the probability of default in exactly these states.

The firm's hedging choice is governed by the first-order condition for λ_{t+1}. Differentiating the firm's problem, applying the envelope theorem, and dividing by b_{t+1} yields

$$\begin{aligned} &\overbrace{(q_t^H - q_t^U)}^{\text{Price Effect}} + \underbrace{\overbrace{\left[(1-\lambda_{t+1})q_{t,\lambda}^U + \lambda_{t+1}q_{t,\lambda}^H\right]}^{\text{Price Feedback Effect}}}_{\text{Financing Benefit of Hedging}} - \underbrace{\psi_2(\lambda_t b_t, \lambda_{t+1}b_{t+1})}_{\text{Adjustment Cost}} \\ &+ \underbrace{\beta E_t\Big[\mathbb{1}\{V^R(s_{t+1}) > 0\}\Big((r_{t+1} - r_t) - \psi_1(\lambda_{t+1}b_{t+1}, \lambda_{t+2}b_{t+2})\Big)\Big]}_{\text{Repayment Effect}} \leq 0 \end{aligned} \tag{11}$$

where $q_{t,\lambda}^U$ and $q_{t,\lambda}^H$ are the partial derivatives of the pricing functions with respect to λ_{t+1}, and ψ_1 and ψ_2 are the partial derivatives of the adjustment cost with respect to its first and second arguments. The condition holds with equality when the firm chooses an interior hedge ratio, $0 < \lambda_{t+1} < 1$. When the left-hand side is negative at $\lambda_{t+1} = 0$, the marginal benefit of even the first unit of hedging falls short of its marginal cost, and the firm does not hedge.

This condition balances three different marginal effects. The first is the financing benefit of hedging, which operates through the price the firm receives for its debt today.

The second is the repayment effect, which captures how hedging changes what the firm owes tomorrow in the states where it survives. The third is the cost of adjusting the hedged position, both today and in the future. I discuss each in turn.

The financing benefit has two parts. The first is the price effect, $q_t^H - q_t^U$, which is the direct financing advantage of shifting a marginal unit of debt from unhedged to hedged. The firm's proceeds from new debt are $b_{t+1}[(1-\lambda_{t+1})q_t^U + \lambda_{t+1}q_t^H]$, so holding debt fixed, raising λ_{t+1} changes proceeds by $b_{t+1}(q_t^H - q_t^U)$. From the pricing functions,

$$q_t^H - q_t^U = E_t\left[\frac{r_t - r_{t+1}}{1+r_{t+1}}\mathbb{1}\{V^R(s_{t+1}) > 0\}\right]$$

The sign depends on the rate environment. When current rates are high relative to expected future rates, the fixed repayment is valuable to the lender, $q_t^H > q_t^U$, and the price effect favors hedging. When rates are expected to rise, the firm commits to a below-market repayment, raises less capital per unit of face value, and the price effect works against hedging.

The second part of the financing benefit is the price feedback effect, $(1-\lambda_{t+1})q_{t,\lambda}^U + \lambda_{t+1}q_{t,\lambda}^H$, which captures how hedging changes the marginal price of the firm's debt. Raising λ_{t+1} reduces the probability of default risk in high-rate states and the intermediary passes this through as higher prices on all of the firm's debt, including unhedged debt. Leverage amplifies this channel. Because the repayment change from a unit increase in λ_{t+1} equals $b_{t+1}(r_t - r_{t+1})$, a more indebted firm's default probability is more sensitive to the value of λ_{t+1}. The intermediary prices in this sensitivity, so the marginal effects of a unit increase in λ_{t+1} on debt prices, q_λ^U and q_λ^H, are larger for higher-debt firms.

The second part of equation 11, the repayment effect, captures tomorrow's benefit or cost of hedging today. Conditional on repayment and production, locking in r_t today saves the firm $r_{t+1} - r_t$ next period, a benefit when rates rise and a cost when they fall. Because the intermediary prices loans competitively, this saving is nearly the opposite of the price effect. The firm is compensated today for the expected repayment it gives up tomorrow. In high rate states, the firm benefits from the repayment effect when it survives, and the marginal value of having hedged is zero in states where it defaults.

Because an unhedged firm's default risk is concentrated in high-rate states, hedging shifts survival toward exactly the states where the repayment saving is largest. This asymmetry makes the expected benefit of hedging largest for firms near the default threshold.

The final effect is the cost of adjusting the hedged position. The term $\psi_2(\lambda_t b_t, \lambda_{t+1} b_{t+1})$ is the marginal cost today of expanding the hedged position. The term

$$-\psi_1(\lambda_{t+1} b_{t+1}, \lambda_{t+2} b_{t+2})$$

inside the expectation captures how today's position affects next period's adjustment cost. A firm that plans to maintain or expand its hedge saves on future adjustment costs by hedging more today, while a firm that plans to unwind its hedge faces higher future costs. Adjustment costs also interact with current cash flow. Because they reduce current cash flow, a firm with little operating cash flow may be unable to cover them along with its investment and debt service, and for firms near this threshold, the cost of hedging can tip the firm from survival to default.

Together, these effects divide firms into three groups. Low-leverage firms do not hedge, regardless of their cash flow. With little debt, they are far from the default threshold, so hedging barely changes their default risk. Highly levered firms with low operating cash flow also do not hedge, despite having the most exposure. Low cash flow places them near the default threshold across many rate states. Adjustment costs compete with productive investment and debt service for scarce cash flow. Only highly levered firms with sufficient operating cash flow hedge. They have enough exposure for hedging to meaningfully reduce their default risk and enough cash flow to bear its cost.

This is the complementarity between leverage and operating cash flow documented in the data in the previous section. Exposure to interest rates drives hedging demand, but it is not sufficient to allow a firm to hedge, even if it wants to. Adjustment costs keep firms with low operating cash flow out of the hedging market even when they are highly exposed to interest rate changes.

5.9 Calibration

This section describes the calibration of the model. The model is quarterly, and I calibrate eleven parameters in total. I set three externally from the literature, estimate five directly from data, and calibrate the remaining three via the Simulated Method of Moments (SMM).

5.9.1 Externally Calibrated and Estimated Parameters

I assign three parameters standard values from the literature. The quarterly discount factor $\beta = 0.998$ corresponds to an annual real interest rate of approximately 0.8%. The quarterly capital depreciation rate $\delta = 0.025$ implies an annual rate of 10%, consistent with the postwar U.S. average for equipment and structures. I set the capital share in production to $\alpha = 0.25$.

To estimate the productivity process, I calculate productivity for each firm following Gopinath et al. (2019):

$$\hat{a}_{ijt} = \left(\frac{(P_{jt}Y_{jt})^{-\frac{1}{\eta-1}}}{P_{jt}} \right) \left(\frac{(p_{ijt}y_{ijt})^{\frac{\eta}{\eta-1}}}{k_{ijt}^{\omega} l_{ijt}^{1-\omega}} \right) \tag{12}$$

where $p_{ijt}y_{ijt}$ is the nominal value added of firm i in sector j at time t, measured in the data as sales minus cost of goods sold. $P_{jt}Y_{jt} = \sum_i p_{ijt}y_{ijt}$ is nominal value added by 3-digit NAICS sector, and P_{jt} is the price deflator by 2- or 3-digit NAICS sector from the Bureau of Economic Analysis (BEA). In this calculation, I set the capital share to $\omega = 0.35$ for all sectors, which corresponds to the average capital share in advanced economies like the U.S. This differs from the model's α, which governs returns to scale in production rather than the capital share of value added. k_{ijt} is the book value of fixed assets, measured by net property, plant, and equipment in Compustat. l_{ijt} is the firm's wage bill, measured by `xlr` in Compustat or, when `xlr` is missing, by the industry average wage bill from the QCEW. I set the elasticity of substitution to $\eta = 3$, following Hsieh and Klenow (2009).[7]

[7]The appendix contains a figure of the resulting data series, showing that hedging firms are substantially more productive than non-hedging firms. Productivity trends slightly upward over the sample

I estimate the AR(1) parameters for firm-level log productivity, (ρ_a, σ_a), directly from the productivity measure above using

$$\log a_{it} = \rho_a \log a_{i,t-1} + \xi_i + \nu_{jt} + u_{it}, \tag{13}$$

which absorbs firm fixed effects ξ_i and two-digit NAICS sector $\times$ quarter fixed effects ν_{jt}, with standard errors clustered by firm. This yields $\hat{\rho}_a = 0.530$ (s.e. $= 0.009$) and an innovation standard deviation of $\hat{\sigma}_a = 0.720$.

I calibrate the interest rate process to the Moody's BAA corporate bond yield from FRED over 2014–2024. This yields a long-run mean of $\bar{r} = 0.0565$, a persistence of $\hat{\rho}_r = 0.9657$, and an innovation standard deviation of $\hat{\sigma}_r = 0.0035$, with the rate expressed in annual terms. Within firms' problems, the model converts this rate to a quarterly rate by dividing by four. Table 7 summarizes these parameters.

Table 7: Externally Calibrated and Estimated Parameters

Parameter	Value	Description	Source
β	0.998	Quarterly discount factor	0.8% real rate
δ	0.025	Quarterly depreciation rate	10% annual
α	0.250	Capital share in production	U.S. firms
ρ_a	0.530	Persistence of log TFP	Compustat
σ_a	0.720	SD of log TFP innovations	Compustat
$\bar{r}$	0.0565	Mean interest rate (annual)	BAA yield
ρ_r	0.9657	Persistence of interest rate	BAA yield
σ_r	0.0035	SD of interest rate innovations (annual)	BAA yield

5.9.2 Simulated Method of Moments

I calibrate three parameters jointly using SMM: the fixed operating cost c_F, the capital adjustment cost parameter ϕ_K, and the hedging adjustment cost parameter c_H, which scales the adjustment cost function ψ. ϕ and ψ are quadratic. Let $\theta = (c_F, \phi_K, c_H)$ denote the parameter vector, $m(\theta) \in \mathbb{R}^3$ the vector of simulated model moments, and

period for both groups, with a steeper trend for hedging firms.

$\hat{m} \in \mathbb{R}^3$ the corresponding data moments. The SMM estimator solves

$$\hat{\theta} = \arg\min_{\theta} \big(\hat{m} - m(\theta)\big)^{\top} \Omega \big(\hat{m} - m(\theta)\big), \tag{14}$$

where $\Omega = \operatorname{diag}\big(\hat{m}_1^{-2},\, \hat{m}_2^{-2},\, \hat{m}_3^{-2}\big)$ is a diagonal weighting matrix that scales each deviation by the inverse square of its data target, so the objective penalizes equal percentage deviations equally across moments.

I match c_F to the quarterly firm death rate of 1.95%, computed from the Business Dynamics Statistics from the U.S. Census Bureau over 2014–2023. A higher fixed operating cost raises the mass of firms whose value of repaying falls below zero, increasing the equilibrium exit rate.

I match ϕ_K to the cross-sectional standard deviation of the investment rate, $I_{it}/K_{i,t-1}$, in my sample of firms which is equal to 34.46%. Gross investment is constructed from Compustat as $I_{it} = \Delta \text{ppentq}_{it} + \text{dpq}_{it}$, the change in net property, plant, and equipment plus reported depreciation. A higher capital adjustment cost discourages lumpy investment and compresses the dispersion of the investment rate.

I match c_H to the mean ratio of interest rate derivative notional value to total liabilities across all firms, unconditional on hedging, which equals 2.20% in my data. Because debt is the only liability in the model, this ratio corresponds to the average hedge share λ across all firms. Table 8 reports the calibrated parameters.

Table 8: SMM-Calibrated Parameters

Parameter	Value	Description	Target
c_F	0.9882	Fixed operating cost	Exit rate: 1.95%
ϕ_K	0.2673	Capital adjustment cost	SD of investment rate: 34.46%
c_H	0.00492	Hedging adjustment cost	Notional to total liabilities: 2.20%

5.9.3 Model Fit

Panel A of Table 9 shows that the model matches all three targeted moments closely. The exit rate and the standard deviation of investment are slightly higher in the model than in the data, and the mean hedge rate is exactly on target at 2.20%.

Table 9: Calibration Fit

Moment	Model	Data
Panel A: Targeted		
Quarterly exit rate	2.01%	1.95%
SD of I/K	36.55%	34.46%
Mean hedge rate (unconditional)	2.20%	2.20%
Panel B: Untargeted		
Hedging margins		
Share of firms hedging	8.82%	13.3%
Mean hedge rate among hedgers ($E[\lambda \mid \lambda > 0]$)	24.92%	16.6%
Quarterly transition probabilities		
Non-hedger $\rightarrow$ Non-hedger	97.84%	98.90%
Non-hedger $\rightarrow$ Hedger	2.16%	1.10%
Hedger $\rightarrow$ Hedger	77.91%	92.49%
Hedger $\rightarrow$ Non-hedger	22.09%	7.51%

Panel B reports untargeted moments. The first two describe the extensive and intensive margins of hedging. Because the targeted moment is the unconditional mean hedge rate, which equals the share of firms hedging times the mean hedge rate among hedgers, the model matches their product by construction. How the model splits this product between the two margins is therefore a test of the mechanism. The model produces fewer hedgers than the data (8.82% vs. 13.3%), each hedging a larger share of its debt (24.9% vs. 16.6%). The higher intensity reflects the model's simplified capital structure. All debt in the model is short-term and floating rate, so a hedge covers a larger share of total liabilities than in the data, where firms hold a mix of fixed- and floating rate obligations at different maturities.

Another test of the mechanism is whether the model generates realistic rates at which firms begin and stop hedging as reported in section 4. The model closely matches the persistence of non-hedging. Non-hedgers remain non-hedgers with probability 97.84% in the model and 98.90% in the data. The implied rate at which non-hedgers begin hedging is somewhat higher in the model (2.16% vs. 1.10%), but both are small. The remaining gap is modest given that the model abstracts from other frictions that would further slow the start of hedging, such as search and contracting costs, counterparty relationships, and covenant restrictions. The model understates the persistence of hedging, with hedgers

continuing to hedge with probability 77.91% in the model compared with 92.49% in the data. This gap reflects the model's one-period debt structure, since firms must reset their hedge each period as their debt rolls over, rather than a failure of the hedging mechanism. Even so, hedging status is highly persistent in the model.

Together, these results show that the model reproduces the key features of hedging dynamics. Few firms begin hedging, and those that do tend to continue. This is consistent with the model's mechanism, in which only firms with sufficient operating cash flow find it worthwhile to pay the cost of hedging.

6 Counterfactual: Hedged Firms Respond Less to Rate Shocks

Having validated the model, I use it to conduct a counterfactual exercise around rate shocks. I measure the role of hedging in post-shock investment decisions, both at the firm level and in the aggregate. I find that hedging firms reduce investment by less than nonhedgers after an interest rate increase. Conversely, hedging firms increase investment by less than non-hedging firms after a rate decrease. The effect is stronger for highly leveraged firms than for low leverage firms.

To examine how investment sensitivity to interest rates differs between hedging and non-hedging firms in equilibrium, I compare the investment responses of the two groups directly from the baseline model's stationary distribution after a 100 basis point (1 percentage point) rate shock. Let μ^* denote the stationary distribution over states $(k_t, b_t, \lambda_t, a_t, r_t, r_{t-1})$. I partition levered firms ($b_t > 0.01$) into hedgers ($\lambda_t > 0$) and non-hedgers ($\lambda_t = 0$) according to their equilibrium hedge ratio. For each group $g \in \{\text{hedgers}, \text{non-hedgers}\}$, I compute the capital-weighted investment response to a one-time interest rate shock:

$$\Delta I/K_g = \frac{\sum_{s \in g} \mu(s_t) \cdot \left[k_{t+1}(s_t, \hat{r}_t) - k_{t+1}(s_t, r_t)\right]}{\sum_{s \in g} \mu(s_t) \cdot k(s_t)}$$

where $\hat{r}$ denotes the shocked rate and r the baseline, and the policy function $k_{t+1}(s_t)$

is evaluated at each firm's equilibrium λ_t. In this exercise, firms' hedging choices are endogenous, so hedgers and non-hedgers differ along dimensions beyond λ_t. In particular, hedgers are disproportionately large, high-leverage firms. The comparison therefore reflects both the direct effect of hedging on investment and the compositional differences between the two groups.

To separate out these compositional effects, I run an additional counterfactual. I introduce the same 100 basis point (1 percentage point) shock to the interest rate in the stationary distribution. but hold each firm's state (k_t, b_t, a_t) fixed. Rather than comparing firms that endogenously choose to hedge against those that do not, I evaluate the investment policy function at two counterfactual hedge choices for every firm: full hedging ($\lambda = 1$) and no hedging ($\lambda = 0$). The investment protection provided by hedging at some fixed state (k_t, b_t, a_t) is then

$$\Delta \frac{I_t}{k_t}\bigg|_{\lambda=1} - \Delta \frac{I_t}{k_t}\bigg|_{\lambda=0}, \qquad \text{where } \frac{I_t}{k_t} = \frac{k_{t+1} - (1-\delta)k_t}{k_t}. \tag{15}$$

I then calculate the weighted average of this over the stationary distribution. I restrict the analysis to levered firms ($b > 0$). Including all firms reduces these estimates by only a few percentage points since unlevered firms are not exposed to rate risk.

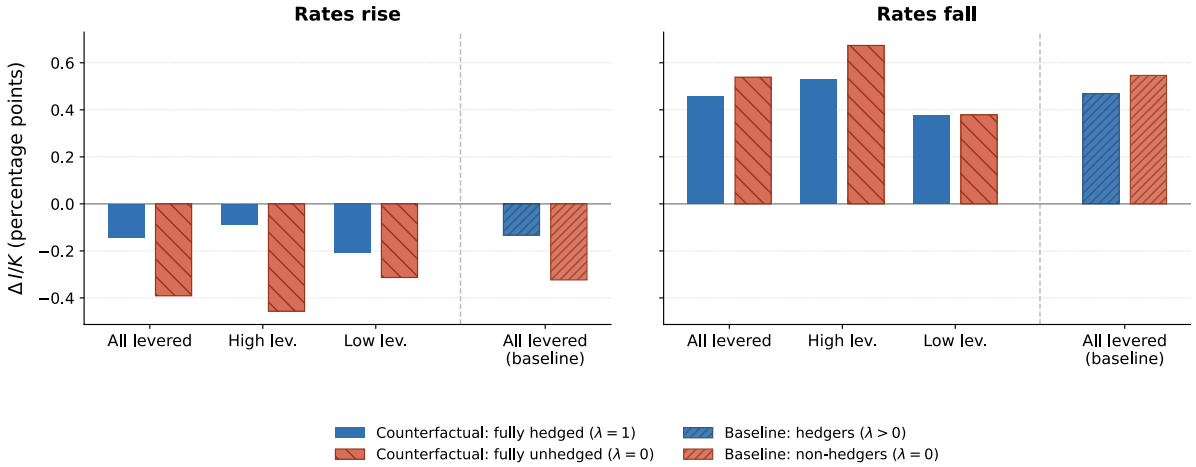
Figure 6 shows these results split at the median leverage b/k. The left graph shows the effect of a 100 basis point *increase* on investment. Fully hedged firms cut investment by much less than nonhedged firms as shown in the leftmost set of columns. The next set of columns shows that the investment discrepancy is concentrated among high leverage firms. Following a rate rise, a fully hedged high leverage firm cuts investment by roughly 0.09 percentage points, while the same firm under no hedging cuts investment by roughly 0.46 percentage points. The fully hedged firm still reduces investment because hedging protects only the repayment on existing debt. New borrowing is reduced since firms in this exercise must lock in today's rate which is high. Because firms are borrowing less, they have less funds to invest and investment is reduced. In the final column group in the rates rise panel are the results for low leverage firms. For these firms the investment discrepancy is substantially smaller. The repayment a hedge protects is $\lambda_t b_t (r_t - r_{t-1})$,

so protection of investment spending scales with the debt burden.

The rightmost column group in the "Rates rise" panel shows the same exercise for all levered firms using the equilibrium λ_t distribution rather than forcing λ_t to its extremes. Hedgers in the baseline model cut investment by less than non-hedgers following a rate rise (-0.13 versus -0.32 percentage points). When rates fall, hedgers and non-hedgers respond similarly, with non-hedgers investing slightly more (0.55 versus 0.47 percentage points).

When rates fall, as shown in the panel labeled "Rates fall", the pattern reverses in sign but narrows considerably. Hedging modestly dampens the investment increase, since hedging firms have locked-in rates and do not fully benefit from lower debt costs. This asymmetry between rate rises and falls suggests that for hedged firms, the benefits of hedging such as more stable investment and lower financing costs outweigh the costs they face when rates decrease.

Figure 6: Investment response to a one-time rate shock



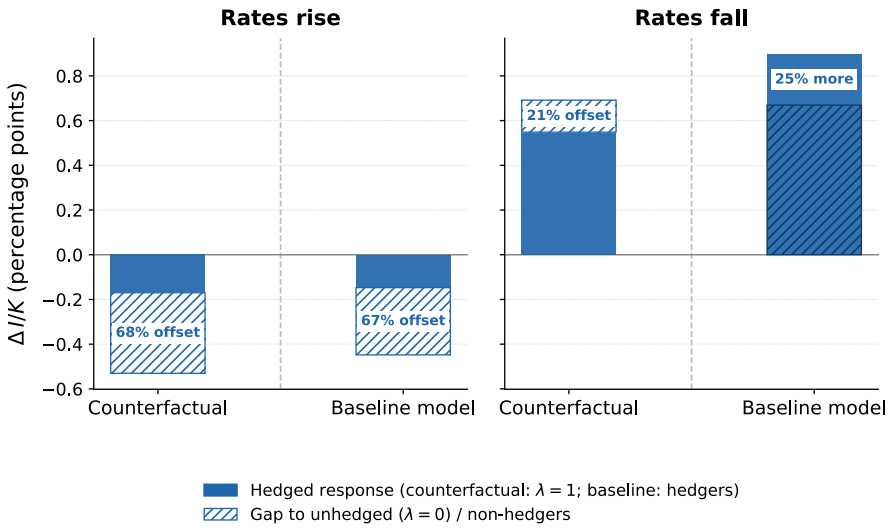
Notes: Sample is levered firms ($b > 0.01$), mass-weighted. High- and low-leverage groups are split at the mass-weighted median leverage ratio (b/k). The counterfactual forces all firms within each group to $\lambda = 1$ or $\lambda = 0$ at their actual state; the baseline "All levered" column uses the equilibrium λ distribution.

To find the aggregate effect of the rate shock on investment, I find the capital-weighted average of the investment rate response. This means that larger firms are weighted in proportion to their investment contribution to the economy. Figure 7 shows that hedging offsets 68 percent of the average investment decline following a rate rise, and 21 percent of the average investment increase following a rate fall. This asymmetry reflects that

interest rate derivatives cap borrowing costs when rates rise but do not prevent firms from benefiting when rates fall. However, firms may still take advantage of low rates to take out new debt for investment.

The baseline columns tell a consistent story for rate rises: equilibrium hedgers cut investment by −0.15 percentage points on average, compared with −0.45 percentage points for non-hedgers—a 67 percent gap that closely mirrors the counterfactual. For rate falls, the capital-weighted baseline shows hedgers investing more than non-hedgers (0.90 versus 0.67 percentage points), a reversal driven by selection. Equilibrium hedgers are disproportionately large, capital-intensive firms that invest more regardless of their hedging status.

Figure 7: Average capital-weighted change in investment



Notes: Sample is levered firms ($b > 0.01$), capital-weighted. The counterfactual forces all firms to $\lambda = 1$ (fully hedged) or $\lambda = 0$ (fully unhedged) at their actual state (k, b, a, z); the baseline uses the equilibrium λ distribution, comparing firms with $\lambda > 0$ to those with $\lambda = 0$. The "% offset" figure equals $|\Delta I/K_{\text{hedged}} - \Delta I/K_{\text{unhedged}}|/|\Delta I/K_{\text{unhedged}}| \times 100$ for the counterfactual, and analogously for the baseline.

To put these responses in perspective, a 100 basis point shock reduces the investment rate of a fully unhedged levered firm by roughly 0.5 percentage points on impact. This is approximately a 10–15 percent decline relative to the steady-state investment rate, comparable in scale to the quarterly investment contraction observed during a mild recession. Hedging absorbs 68 percent of this aggregate decline, reducing the impact to 0.17 percentage points, a contraction closer to normal quarter-to-quarter variation. These effects

are for a one-time shock with no persistence so a sustained tightening cycle of the kind observed in 2022–23 would compound across periods and produce substantially larger cumulative effects. The asymmetry between rate rises and falls suggests that the primary economic value of interest rate derivatives lies in protection from downside risk. Hedging smooths investment during tightening cycles but does not amplify the response to easing.

Because the model is a partial equilibrium model, the measures of investment protection should be interpreted as an upper bound. In general equilibrium, a rate rise that depresses unhedged investment would also reduce the price of capital, partially offsetting each firm's investment reduction. The true effect of hedging is therefore smaller. A full quantification would require extending the model to a general equilibrium framework with a capital-production sector.

7 Conclusion

This paper shows that interest rate hedging is concentrated among highly leveraged, high cash flow firms, where it protects investment from changes in interest rates. Using a new dataset on interest rate hedging by U.S. public nonfinancial firms, collected with a large language model, I document that hedging is uncommon and highly persistent, that leverage and operating cash flow are complements in the decision to hedge, and hedging protects investment after rate shocks. A heterogeneous firm model explains these facts. To invest, firms borrow costly external debt that exposes them to interest rate changes. Debt raises the risk of default in adverse rate states and therefore the value of hedging. However, hedging is costly, so only firms with sufficient operating cash flow find it worthwhile. In the model, as in the data, hedging protects investment only where there is exposure to protect.

Hedging costs shape which firms hedge far more than they shape aggregate investment, but they create a divide between firms that can afford to insure their interest rate exposure and firms that are priced out. This divide has implications for the transmission of monetary policy. Changes in the Federal Reserve's target rate pass through to the

interest rates firms pay, and hedging dampens this pass-through for firms with substantial exposure. Because most firms do not hedge, and non-hedgers are especially common among smaller firms, the investment response to monetary policy may be concentrated among unhedged firms. Quantifying this mechanism is a natural direction for future work.

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A Data Collection and Details

This section documents additional information about the data collection with the Large Language Model (LLM) that are not present in the main text.

A.1 Example of a Table in the Notes Sections

An example of a table in a derivatives and hedging notes section is following table of derivative fair values from J.M. Smucker, Co.'s 10-Q filing for the quarter ending January 31, 2019.

	January 31, 2019			
	Other Current Assets	Other Current Liabilities	Other Noncurrent Assets	Other Noncurrent Liabilities
Derivatives designated as hedging instruments:				
Interest rate contracts	$ —	$ —	$ —	$ 37.6
Total derivatives designated as hedging instruments	$ —	$ —	$ —	$ 37.6
Derivatives not designated as hedging instruments:				
Commodity contracts	$ 13.2	$ 15.7	$ —	$ —
Foreign currency exchange contracts	1.0	0.4	—	—
Total derivatives not designated as hedging instruments	$ 14.2	$ 16.1	$ —	$ —
Total derivative instruments	$ 14.2	$ 16.1	$ —	$ 37.6

Figure 8: Example table of derivative fair values in millions.

As seen in this table, the company has split out their derivative instruments by "derivatives designated as hedging instruments" and "derivatives not designated as hedging instruments". This designation is referring to an accounting designation of hedging and not the common understanding of hedging. So, while commodity contracts and foreign currency exchange contracts are listed as "not designated as hedging instruments", that does not mean they are not hedges. The company explains further in the text of the notes. Listed by location of the fair value reporting on the balance sheet are the fair values. So, the company reported $37.6 million in interest rate contract fair values in noncurrent liabilities. Again, the company provides additional information on the type of contract and the notional value of these contracts in the notes.

A.2 Full Text Prompt for LLM

The system prompt is presented in the main text. Here, I present the full user prompt. The prompt is as follows:

> You are given a text document of a cleaned SEC statement such as a 10-Q or a 10-K.
>
> Here is the document content: <document> {txt_content} </document>
>
> Your task is to tabulate a set of specific data on hedging and derivatives usage for interest rate risk. All of this information can be found in the text or tables of each filing. The result will be a json-format output with 14 columns total for each interest rate instrument group in the filing. There can be zero, one, or multiple instrument groups in each individual filing.
>
> Most of the information on interest rate derivatives can usually be found in one of two notes in the notes section: either the note about "hedging" or "derivatives" or the note about "fair value measurements". This is not always the case but it is usually the case.
>
> Follow these specific guidelines:
>
> ** What to include **
> 1. The first set of data points that you need to gather is metadata about the company and filing. You want to put the CIK code (Central Index Key) in the first column, the Company Name in the second column, the Filing Date in the third column, the Report Date in the fourth column, the IRS number in the fifth column, and the Form Type (i.e., 10-Q, 10-K, etc.) in the sixth column. You should be able to gather all this information from the beginning of the document. Report this metadata in a json format even if there is no interest rate risk or hedging in the company.
>
> 2. The second set of data points that you need to gather is information on the interest rate risk hedging and derivatives used for this purpose. There could

be several types of derivatives used to hedge interest rate risk and you need to find information on each current (not expired) derivative as of the reporting date. The information you need to find for each interest rate derivative is the following:

2.1 In the seventh column you tabulate the Instrument Group, which is the type of instrument used to hedge against interest rate risk. The possible types of instruments are interest rate swap, interest rate cap, interest rate floor, interest rate collar, interest rate future, interest rate forward, and interest rate lock. Sometimes the type of interest rate derivative used is not identified in the document. In this case, you can report whatever the contract is called in the filing (i.e., interest rate contract, interest rate derivative, etc.) in the Instrument Group column.

2.2 You will tabulate the 8th column with a description of the Hedge Type. There are a few different possibilities for this column:

2.2.1 If the company has any contracts that are designated as hedges for hedge accounting, they will state this somewhere in the text of the notes section. If any of the interest rate derivative instruments are designated for this purpose, they will also report what type of hedge it is. The possible types are "cash flow hedge", "fair value hedge", or "investment hedge". You will put the relevant hedge type into the Hedge Type column.

2.2.2 The company may have contracts that are not designated as hedges for hedge accounting. In this case, there are two possibilities.

2.2.2.a The company may be offering interest rate contracts to their customers. If the instrument group in question is this type, you will input the hedge type of the derivative instrument as "customer IR risk". Additionally, if the company is offering interest rate contracts to their customers, look out any indications in the text or tables that the company has an offsetting derivative position with a third party. If so, in the 13th column "Offsetting Position",

put an "X" to indicate that that position is offset. It may not be very obvious so be careful to find this as it is probably there in this case.

2.2.2.b The second possibility is that the derivative is simply hedging interest rate risk and is just not designated as a hedge for hedge accounting. These types of instruments are NOT offered to customers but hedge the company's own interest rate risk. In this case, you will put "interest rate risk" as the Hedge Type for that instrument group.

2.3 You will record the Fair Value of the instrument in the 9th column. This information will be in the notes section of the document, not in the balance sheet or comprehensive income statement. It could be found in a table or in the text. You will record the fair value of the instrument as a negative if it is a liability and a positive if it is an asset. If both an asset and a liability are record, report the aggregated value. For example, if the fair value asset is 50 and the fair value liability is -10, report 50 + (-10) = 40. Be sure that you are recording the fair value and not the gain or loss to fair value as both measures may be recorded. It would be inaccurate to record changes in the fair value. You want to record the fair value level.

2.4 You will record the Notional Value of the instrument group in the 10th column. This value will most likely be reported in the text of the notes section or in a table in a note about hedging and derivatives. You understand that the notional value may not always be directly referred to as the notional value in the text but sometimes follows phrases like "in the amount of" in the discussion of derivative instruments the company has entered into to mitigate interest rate risk. This is the most important number in the dataset, so be careful recording it. It will always be much larger in value than the fair value since it refers to the underlying amount that payments will be made on.

2.5 You will report the units of the fair value (e.g., billions, millions, thousands, etc.) in the 11th column. You will find this either in the table you find the value in or in the header of the page or at the beginning of the notes

section. If you cannot find a unit, leave it blank.

2.6 You will report the units of the notional value (e.g., billions, millions, thousands, etc.) in the 12th column. You will find this either in the table you find the value in or in the text where the value is found.

2.7 The 14th column is an indicator for whether the instrument group is Expired and will be empty for most of the instrument groups since we are looking for current interest rate risk derivative instruments. However, if you realize that the instrument group has expired before the reporting date or in a different year to the filing date, put an "X" in this column.

** Non-negotiable Guidelines **

- You report all individual instruments at the level of the instrument group. Aggregate the fair values and notional values by summing the individual values. So, for example, if there are three interest rate swaps, one with a fair value of -1300, one with a fair value of 300 and one with a fair value of -400, report one aggregate fair value of -1400 in the Fair Value column for the instrument group "interest rate swaps".
- If for any reason you cannot find any of the information for the columns, leave that space blank. Do not fill with any characters.
- Companies hedge other risks. Do not record instruments related to risks that are not interest rate risk. You are not interested in this information.
- If no interest rate risk hedging information is found, return the metadata from task 1 above and leave the other columns blank.

A.3 Compilation

I compile my dataset in several steps. To comply with token and rate limits, I split the dataset into 247 batches. I then submit each batch as an API call from a Python script. Each call passes a JSON object containing a system prompt, a user prompt, and the

model specification (Claude Haiku 4.5, `claude-haiku-4-5-20251001`).[8]

B Additional Empirical Details and Results

I find a few more results about hedging firms that are relevant for the exposition in the paper and discuss them in this appendix.

B.1 Data Description and Construction

Table 10 describes all data variables and their sources. Variable construction for distance to default and other variables are in their own sections.

Table 10: Dataset Variable List

Variable	Description	Source
Identifiers & Administrative		
`gvkey`	Compustat firm identifier	Compustat
`cik`	SEC Central Index Key	Compustat / SEC
`cusip`	CUSIP security identifier	Compustat
`ein`	Employer identification number	Compustat
`tic`	Ticker symbol	Compustat
`conm`	Company name	Compustat
`datadate`	Date of financial data (YYYYMMDD)	Compustat
`datacqtr`	Calendar quarter (YYYYQQ)	Compustat
`datafqtr`	Fiscal quarter	Compustat
`ipodate`	IPO date	Compustat
`sic`	SIC industry code	Compustat

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[8] Haiku is Anthropic's fastest and lowest-cost model tier, which makes it well suited to high-volume extraction. The validation exercise in Section 3.2 confirms that its accuracy is sufficient for this task.

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Variable	Description	Source
naics	NAICS industry code	Compustat
Balance Sheet (quarterly)		
atq	Total assets	Compustat
ltq	Total liabilities	Compustat
seqq	Stockholders' equity	Compustat
dlcq	Short-term debt (debt in current liabilities)	Compustat
dlttq	Long-term debt total	Compustat
lctq	Current liabilities total	Compustat
lltq	Long-term liabilities total	Compustat
actq	Current assets total	Compustat
ancq	Non-current assets total	Compustat
cheq	Cash and short-term investments	Compustat
chq	Cash	Compustat
invtq	Inventories	Compustat
intanq	Intangible assets	Compustat
apq	Accounts payable	Compustat
req	Retained earnings	Compustat
ppentq	Property, plant & equipment (net)	Compustat
Income Statement (quarterly)		
saleq	Net sales	Compustat
oibdpq	Operating income before depreciation (EBITDA)	Compustat
oiadpq	Operating income after depreciation	Compustat
cogsq	Cost of goods sold	Compustat

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Variable	Description	Source
dpq	Depreciation & amortization	Compustat
xintq	Interest expense	Compustat
xrdq	R&D expense	Compustat
xsgaq	Selling, general & administrative expense	Compustat
dvpq	Dividends paid – preferred	Compustat
xlr	Labor expenses (annual, divided by 4 quarterly; imputed from QCEW when missing)	Compustat / BLS QCEW
Market Data (quarterly)		
cshoq	Common shares outstanding	Compustat
prccq	Closing stock price	Compustat
mkvaltq	Total market value	Compustat
dvpspq	Dividends per share	Compustat
SEC Derivatives Filing Data		
Company_Name	Company name from SEC filing	SEC EDGAR
Filing_Date	SEC filing date	SEC EDGAR
IRS_Number	IRS number from SEC filing	SEC EDGAR
Form_Type	Filing type (10-K or 10-Q)	SEC EDGAR
Instrument_Group	Derivative instrument type	SEC EDGAR
Hedge_Type	Hedge designation	SEC EDGAR
Fair_Value	Fair value of derivative position	SEC EDGAR
Notional_Value	Notional value (raw)	SEC EDGAR
Offsetting Position	Offsetting position flag	SEC EDGAR
Expired	Expired instrument flag	SEC EDGAR

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Variable	Description	Source
hedges	= 1 if firm reports any derivative position this quarter	Constructed
Constructed Financial Ratios		
cpi	CPI price level	BLS
atq_deflated	log(atq/(cpi/100))	Constructed
profitability	oibdpq/atq	Constructed
leverage	(dlcq + dlttq)/atq	Constructed
market_to_book	(prccq × cshoq + dlcq + dlttq)/atq	Constructed
short_term_debt_to_total_debt	dlcq/(dlcq + dlttq)	Constructed
net_worth	(atq − ltq)/atq	Constructed
cash_holdings	cheq/atq	Constructed
distance_to_default	Distance to default, construction described below	Constructed
TFP / Productivity		
price_idx	Chain-type price index for gross output, matched by NAICS sector	BEA
nom_value_added	Nominal value added (saleq − cogsq)	Constructed
k_ijt	Real capital input (ppentq deflated by price index)	Constructed
sector_VA	Sector-level aggregate value added	BEA
avg_wage_bill	Average wage bill per firm in sector-quarter	BLS QCEW
productivity	TFP (Solow residual, sector-corrected)	Constructed
log_productivity	log(productivity)	Constructed

B.2 Distance to Default Construction

I adapt the construction of distance to default from Ottonello and Winberry (2020) and Gilchrist and Zakrajšek (2012). I calculate distance to default for each firm-quarter. Gilchrist and Zakrajšek (2012) extensively documents the theoretical background for this variable, so I go into less detail here. However, I highlight the main points.

B.2.1 The Black-Scholes-Merton Formula

Let V_{it} be the total value of firm i on day t and assume that V_{it} follows a geometric Brownian motion with instantaneous draft μ_{it}^V and volatility σ_{it}^V. Also assume that the firm defaults if its value V_{it} is below and accounting-liability based measure D_{it}. The firm's equity value E_{it} can be viewed as a call-option on the underlying value of the firm's value V_{it} with a strike price equal to the face value of the firm's debt and time to maturity T.

Then, according to the Black-Scholes-Merton option pricing formula, the value of the firm's equity satsifies

$$E_{it} = V_{it}\Phi(\delta_{1it}) - e^{-rT}D_{it}\Phi(\delta_{2it})$$

where

$$\delta_{1it} = \frac{\log(V_{it}/D_{it}) + (r_t + 0.5(\sigma_{it}^V)^2)T}{(\sigma_{it}^V)^2\sqrt{T}}$$

and

$$\delta_{2it} = \delta_{1it} - \sigma_{it}^V\sqrt{T}$$

and r_t denotes the daily one-year constant maturity Treasury yield and Φ is the cumulative

standard normal distribution.

B.2.2 Distance to Default

Distance to default is defined as:

$$\text{dd}_{it} = \frac{\log(V_{it}/D_{it}) + \mu_{it}^V - 0.5(\sigma_{it}^V)^2}{\sigma_{it}^V}$$

where I follow the literature and assume $T = 1$. μ_{it}^V is the annual expected return on V_{it} and σ_{it}^V is the annual expected volatility of V_{it}. I interpret D_{it} as the firm's debt, defined as the sum of the firm's short-term debt (dlcq in Compustat) plus one half of the long-term debt (dlttq in Compustat). To estimate $\mathbf{dd}_{it}$, I use standard numerical methods with the Black-Scholes-Merton formula presented above.

B.2.3 The Algorithm

I use the following algorithm to estimate distance to default (dd_{it}):

- Calculate D_{it} as $\text{dlcq} + 0.5 * \text{dlttq}$.
- Use an iteration method to compute the value of the firm, V_{it}:
    1. Set an initial value for the firm value equal to the sum of firm debt and equity, that is: $V_{it} = E_{it} + D_{it}$, where E_{it} is the firm stock price times the number of shares outstanding from CRSP.
    2. Estimate the mean and variance of the return on firm value $(\mu_{it}^V, \sigma_{it}^V)$ over a 250-day moving window. Note that the return on firm value is measured as the daily implied log return on assets – $\Delta \log(V)$.
    3. Compute the following objects (note, must do this for every day of the 250-day moving window):
        - $\delta_{1it} = \frac{1}{\sigma_{it}^V \sqrt{T}}(\log(V_{it}/D_{it}) + (r + 0.5(\sigma_{it}^V)^2)T)$
        - $\delta_{2it} = \delta_{1it} - \sigma_{it}^V \sqrt{T}$
        - $N_{1it} = \Phi(\delta_{1it})$

- $N_{2it} = \Phi(\delta_{2it})$
- $V'_{it} = \frac{E_{it}+D_{it}e^{-rT}N_{2it}}{N_{1it}}$

4. Iterate on Steps 2. and 3. until convergence.
5. Calculate distance to default as $\text{dd}_t = \frac{\log(V_{it}/D_{it})+\mu^V_{it}-0.5(\sigma^V_{it})^2}{\sigma^V_{it}}$.

B.2.4 Notes on Data

Use the following data for the estimation:

- For firm-level variables, I use the Compustat dataset described in the text.
- For stock returns, I use daily returns from CRSP.
- For r_t, I use the daily one-year constant maturity Treasury yield (DSG1 from FRED).

B.2.5 Summary Statistics: Distance to Default

The summary statistics and correlation with assets within asset quintile are in the following tables.

Table 11: Summary Statistics and Correlation: Distance to Default vs. Book Leverage

	Distance to default	Book leverage
Mean	6.286	0.320
Std. dev.	5.162	0.274
Min	−2.072	0.000
p25	2.586	0.128
Median	5.357	0.281
p75	8.970	0.443
Max	24.294	8.660
Correlation	−0.345	
N	111,199	

Common sample of firm-quarters with non-missing values for both variables. DD winsorised at the 1st and 99th percentiles.

Table 11 presents summary statistics for distance to default. Distance to default has a mean value of 6.286 standard deviations from default, which is in line with estimates by Ottonello and Winberry (2020) and Gilchrist and Zakrajšek (2012). I also provide summary statistics for book leverage and calculate the correlation between distance to default and leverage which is negative at -0.345. This indicates that leverage and distance to default are strongly correlated but not perfectly. High leverage does not necessarily mean that the firm has high default risk.

Table 12: Distance to Default and Hedging by Asset Quintile

	Q1	Q2	Q3	Q4	Q5
Mean DD	4.047	5.750	6.462	7.025	8.146
Std. dev.	4.318	4.939	5.071	5.190	5.313
Corr(DD, assets)	0.234	0.046	0.023	0.033	0.187
% hedging	0.025	0.094	0.184	0.257	0.300

Each quintile contains 22,240 firm-quarter observations. Asset quintiles based on the unconditional distribution of real assets. DD winsorised at the 1st and 99th percentiles. Corr(DD, assets) is the correlation between distance to default and real assets within each quintile. % hedging is the share of firm-quarters that report at least one IR derivative position.

Table 12 presents the mean and standard deviation of distance to default by asset quintile. It also shows the correlation split by asset default and the percent of firms in each asset category that hedge. Interestingly, the correlation between assets and distance to default is U-shaped. It is very positive at the tails of the distribution – the smallest and largest firms – and positive but small in the middle of the distribution. Distance to default is increasing across the size distribution – it's smallest in the mean with the smallest firms and largest in mean for the largest firms. Standard deviation stays relatively consistent across the size distribution.

B.3 Additional Empirical Results

B.3.1 Swaps are the Most Common Instrument

Firms that choose to hedge their interest rate risk have access to a broad array of instruments. Interest rate swaps are by far the most common type of instrument on firm balance sheets. Options or option-like instruments like caps, floors, and collars are also common. Forwards and futures are also a common instrument. All of these are shown in figure 9.

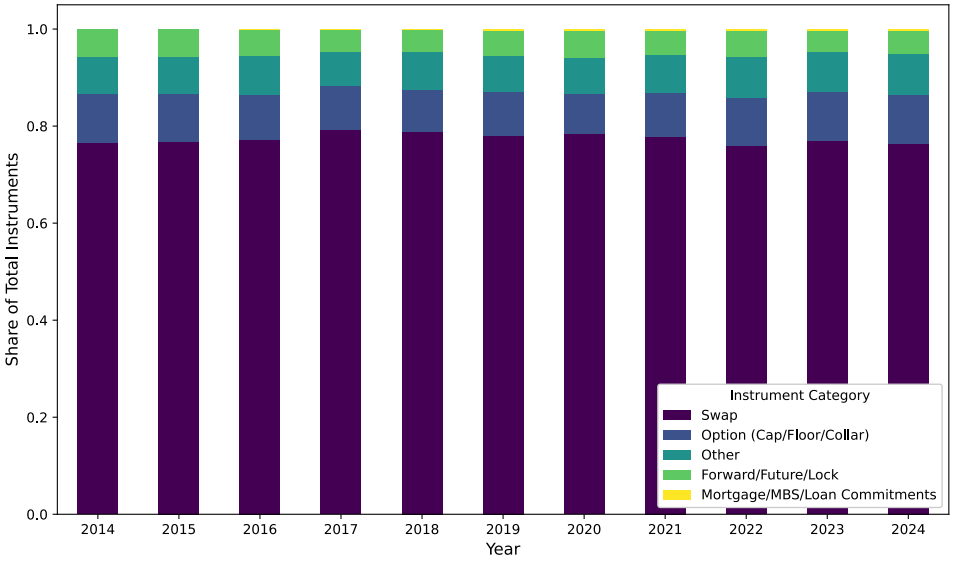


Figure 9: Share of each type of derivative instrument for all hedges.

Firms use different types of derivatives for different objectives. A basic float-to-fixed interest rate swap, which accounts for around 60-70% of derivatives in my sample, is often used for fixing floating rate debt. Caps are used the same way but are less restrictive and easier to understand. In contrast, forward-starting swaps and rate locks are used for a very short period of time before a large bond issuance to lock in a fixed rate ahead of time if there are concerns about rates rising over the bond-planning period. Because the majority of derivatives are float-to-fixed swaps, I design my model with this type of derivative in mind.

B.3.2 Liquid Assets are Negatively Correlated with Hedging

Rampini and Viswanathan (2010) suggest that collateral constraints in the form of liquid assets drive the selection of large, well-capitalized firms into hedging. The finding that larger firms are more likely to hedge but smaller firms hedge more of their debt does not rule out the possibility that this result is driven by collateral constraints. Small and medium firms may be subject to binding collateral constraints, forcing them to elect out of hedging. In this section, however, I show that collateral constraints are an unlikely driver for this split.

Some insights into the derivatives market in the U.S. are inconsistent with this theory.

First, under the Dodd-Frank Act, which was enacted in 2010 following the 2008 Financial Crisis, nonfinancial firms were exempt from required margin posting. Consistent with this, Chang, Falato, and Zikes (2026) find in proprietary data that the vast majority of interest rate derivatives used by nonfinancial corporations in the U.S. are uncollateralized. The collateral theory is also inconsistent with some understandings of risk management activities: liquid assets and derivatives can be used as substitutes since both can act as insurance for cash flow fluctuations due to interest rate shocks. Trade-offs between cash and other risk strategies exist throughout risk management activities (e.g., Acharya, Almeida, and Campello (2013)).

To test the role of liquid assets in derivative decisions, I regress an indicator for whether a firm is hedging in a specific quarter on their cash holdings in that quarter. Since the majority of collateral posting by public firms is cash-based, regardless of size, cash holdings is a good proxy for the liquid assets used in both collateral posting and risk management (Caglio, Darst, and Kalemli-Özcan (2024), Amiti et al. (2026)). If cash is a constraint to using derivatives, I would expect to see a positive relationship between derivative usage and cash. If cash and derivatives are substitutes in risk management, I should see a negative relationship between the two.

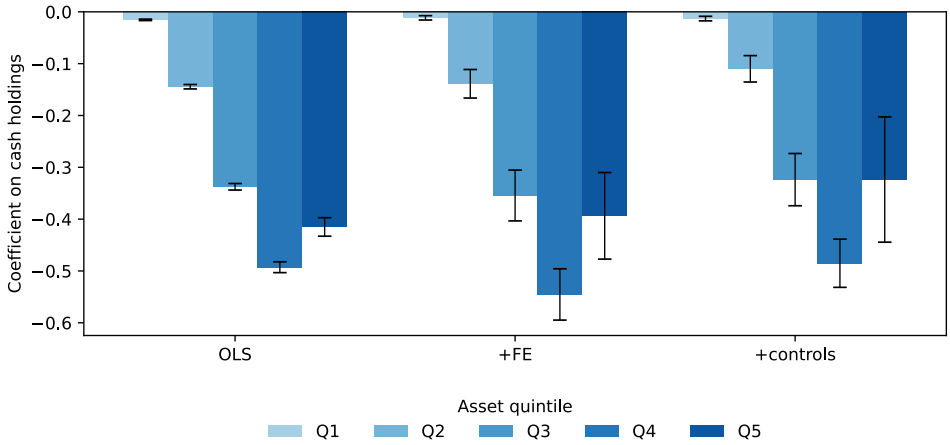
Figure 10 shows a series of regressions of the hedge indicator on cash holdings by asset quintile. One immediate concern is that derivative choices may be driven by different mechanisms because of size heterogeneity. Large, unconstrained firms may not have to post collateral for derivatives but may internally decide between different cash flow risk management strategies. Small and medium sized firms are more constrained and may still face collateral constraints for derivatives. To mitigate this issue, I regress a hedge indicator on cash holdings separately for the five asset quintiles described above.

Across all asset quintiles, I find a strong and significant negative relationship between cash holdings and derivative usage. Regardless of size, a firm that holds more cash is far less likely to be hedging. The effect is less negative for firms in the bottom two quartiles, but this is most likely a result of the sample – less small firms hedge so the effect is weaker. I absorb aggregate and sector-level risks with time and sector fixed effects, but my results

remain the same. Finally, I control for several firm characteristics that may confound these results. I control for book leverage, since is it the main predictor of hedging – more risky firms may hold more cash as well. I also control for individual firm assets, profitability, net worth, and market-to-book. The results remain stable, significant, and negative.

My results indicate that cash is more likely to be a substitute for hedging rather than collateral for hedging. Holding more cash allows a firm to be liquid in case of shocks to cash flow. Derivatives are geared for the same purpose. This result holds across the size distribution, indicating that small and medium sized public firms also trade-off risk management strategies as substitutes rather than as complements.

Figure 10: Regressions of the hedge indicator on cash holdings by asset quintile



Notes: Fixed effects are sector and time fixed effects. Controls include firm-level assets, profitability, leverage, net worth, and market-to-book ratio. For the OLS regression, standard errors are heteroskedasticity-robust (HC1). For the fixed effects and controls regressions, standard errors are firm-clustered.

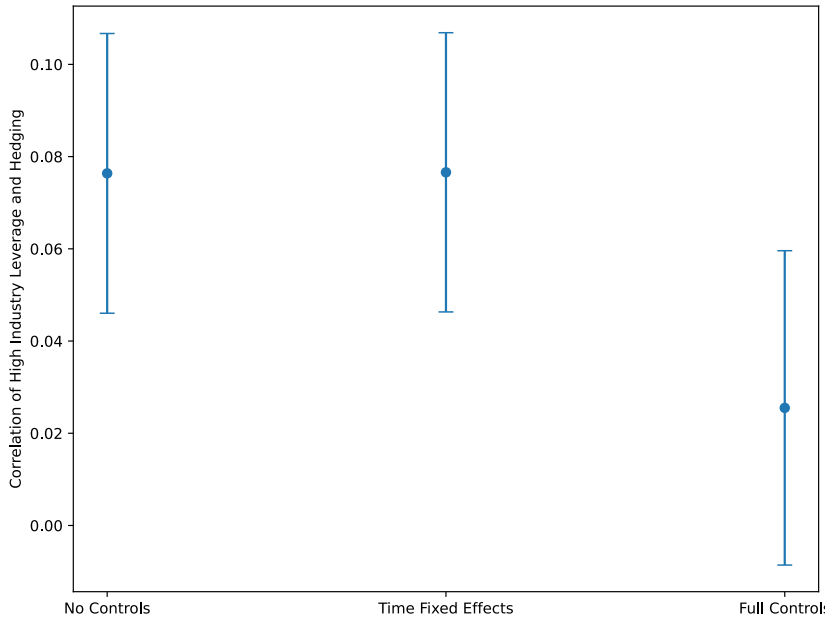
B.3.3 Sector-Level Evidence

I investigate whether there are any trends in hedging between 2-digit sectors in the North American Industrial Classification System (NAICS). Figure **??** shows that the majority of notional derivative amounts are concentrated in the electronics product manufacturing, mechanical, physical, and chemical manufacturing, and information sectors.

One concern is that sectors that have high leverage because of the capital-intensive

nature of their business like manufacturing, may hedge more than firms outside of these sectors. I argue that the effect of leverage is not due to sector-specific attributes since I control for these with fixed effects. I also check robustness with estimates of the correlation between high leverage industries and hedging. The correlation is significant but tiny, with a correlation estimate of 0.06. The estimates lose significance once I control for other firm attributes. The relationship between leverage and hedging therefore reflects differences across firms rather than across sectors. Figure 11 shows the results.

Figure 11: Association between above-median sector leverage for two-digit NAICS sectors and hedging probability, with 95% CIs, across three control sets



Notes: The three specifications progressively add time fixed effects and the full set of firm-level controls (log real assets, book leverage, cash holdings, short-term debt share, net worth, market-to-book). Firm-clustered SEs.

B.3.4 Robustness for Operating Cash Flow and Leverage Regressions

In Table 13, I show that investment expenditure is negatively related to hedging, as discussed in Section 4.

Table 13: Investment Intensity and Hedging

	(1) Baseline	(2) Standardized	(3) Firm FE
Investment intensity (capex/assets)	-0.3701***	-0.0143***	-0.0989***
	(0.0426)	(0.0016)	(0.0236)
Book leverage	0.2316***	0.0438***	0.1106***
	(0.0374)	(0.0071)	(0.0324)
Cash holdings	-0.2239***	-0.0409***	-0.0705***
	(0.0199)	(0.0036)	(0.0211)
N	93,258	93,258	93,258
R^2	0.130	0.130	0.692
Industry + Time FE	Yes	Yes	No
Firm FE	No	No	Yes
Time × Sector FE	No	No	Yes
Full controls	Yes	Yes	Yes

LPM (OLS). Firm-clustered SEs in parentheses. Col (2): all continuous RHS variables standardized to z-scores; coefficients are pp change per 1 SD increase. Investment intensity = $(\Delta\text{ppentq} + \text{dpq})/\text{atq}$ (capex/assets). Controls: log real assets, ST debt share, net worth, M/B. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

In Table 14, I present the robustness checks for the joint operating cash flow and leverage regressions presented in Section 4.

Table 14: Robustness

	(1) Orth. regressors	(2) Balanced panel
Operating cash flow	0.0633***	−0.2609**
	(0.0224)	(0.1207)
Book leverage	0.2114***	0.2314***
	(0.0350)	(0.0803)
Cash holdings	−0.2656***	−0.1372***
	(0.0214)	(0.0381)
Leverage × Op. cash flow	0.5225***	0.8729*
	(0.1004)	(0.4545)
N	105,929	20,152
R^2	0.129	0.108
Industry + Time FE	Yes	Yes
Firm FE	No	No
Additional controls	Yes	Yes

Col (1): each main regressor residualized against the other two via OLS before estimation; coefficients reflect variation unique to each variable, independent of the others. Col (2): optimal balanced panel, window 2019Q2–2024Q3 (22 quarters, 916 firms); sample skews toward older, larger firms. Linear probability model (OLS). Firm-clustered SEs in parentheses. Additional controls: log real assets, ST debt share, net worth, M/B. UFCF = (oibdpq − capex)/atq; capex = Δppentq + dpq. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

B.4 Time Series Facts about Hedgers

This section presents time series plots of the median and interquartile ranges for firm characteristics for hedging and non-hedging firms. Hedging firms are larger. The distribution is almost constant over the sample period, as seen in figure 12. Size is defined at the log of total assets.

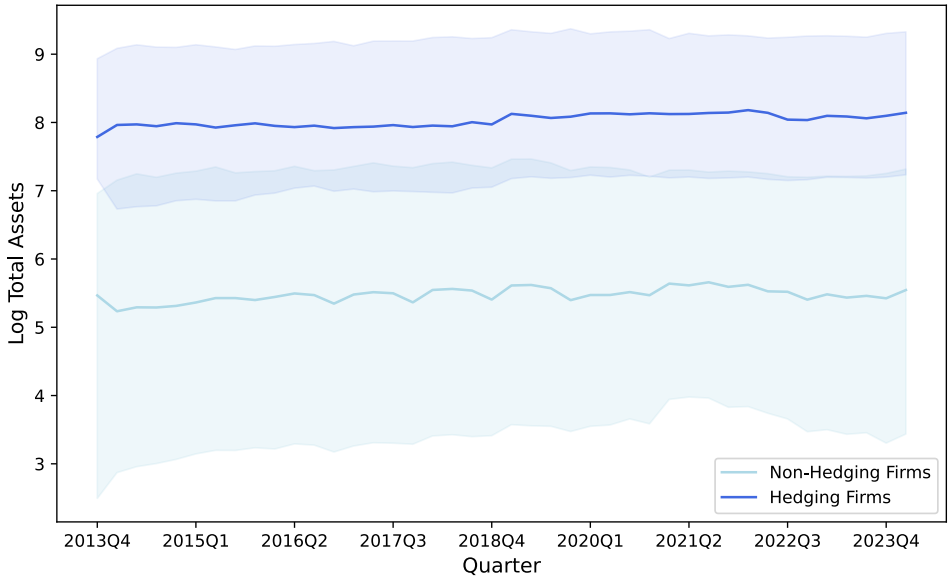


Figure 12: Interquartile ranges by hedging and non-hedging firms. The median is the darker line.

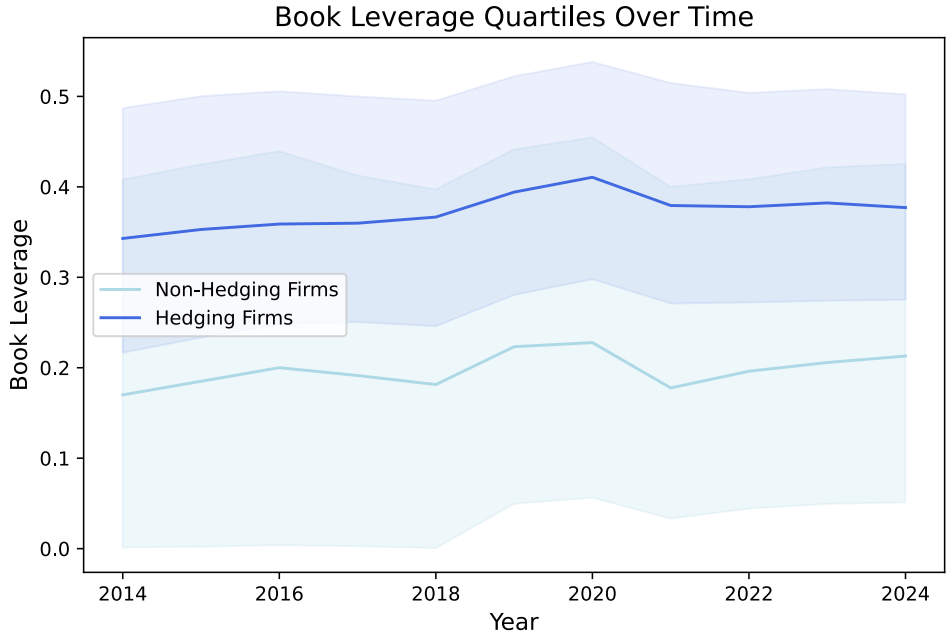


Figure 13: Interquartile ranges by hedging and non-hedging firms. Median is the dark line.

Hedging firms are more profitable as shown in figure 14. The dispersion is tiny relative to non-hedging firms and hover around 0.03 every year. Profitability is earnings before interest and taxes (EBIT) scaled by total assets.

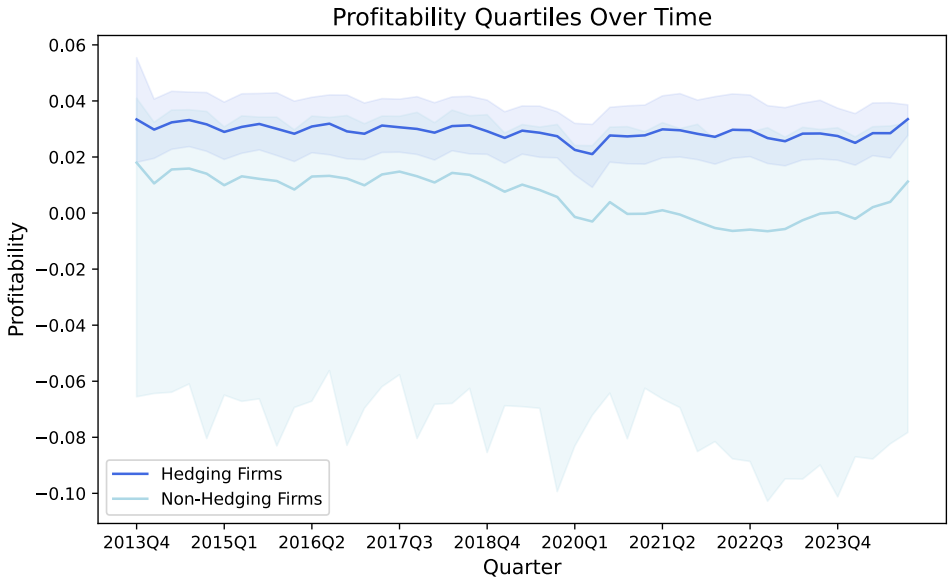


Figure 14: Interquartile ranges by hedging and non-hedging firms. Median is the dark line.

Hedging firms have lower market-to-book ratios than non-hedging firms. The market-to-book ratio is the market capitalization scaled by the book value of equity. Figure 15 presents the interquartile range over time.

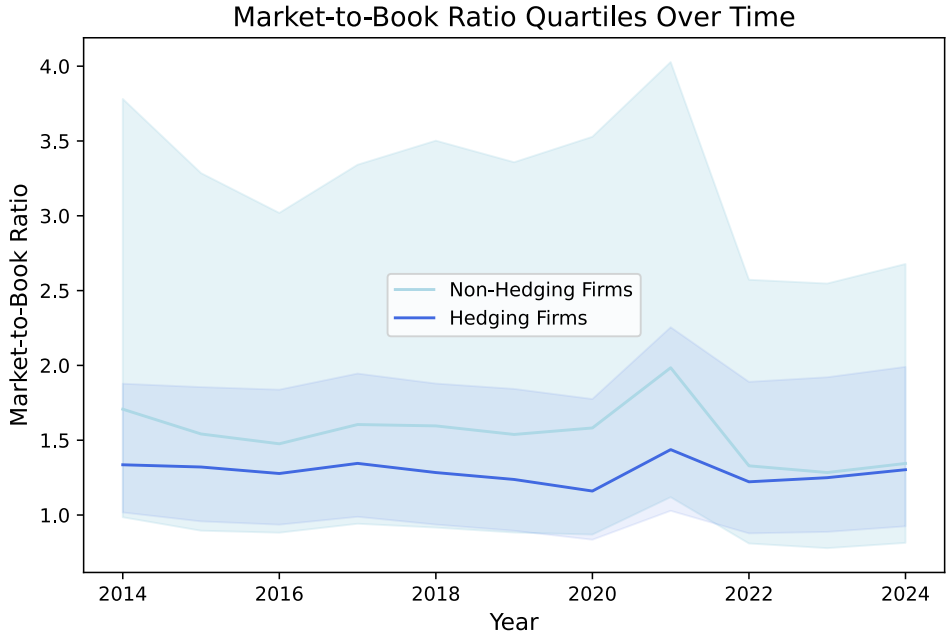


Figure 15: Interquartile ranges for market-to-book ratio for hedging and non-hedging firms. The dark line is the median.

Hedging firms hold less cash than non-hedging firms. Cash holdings is defined as cash

and cash equivalents scaled by total assets. Figure 16 demonstrates.

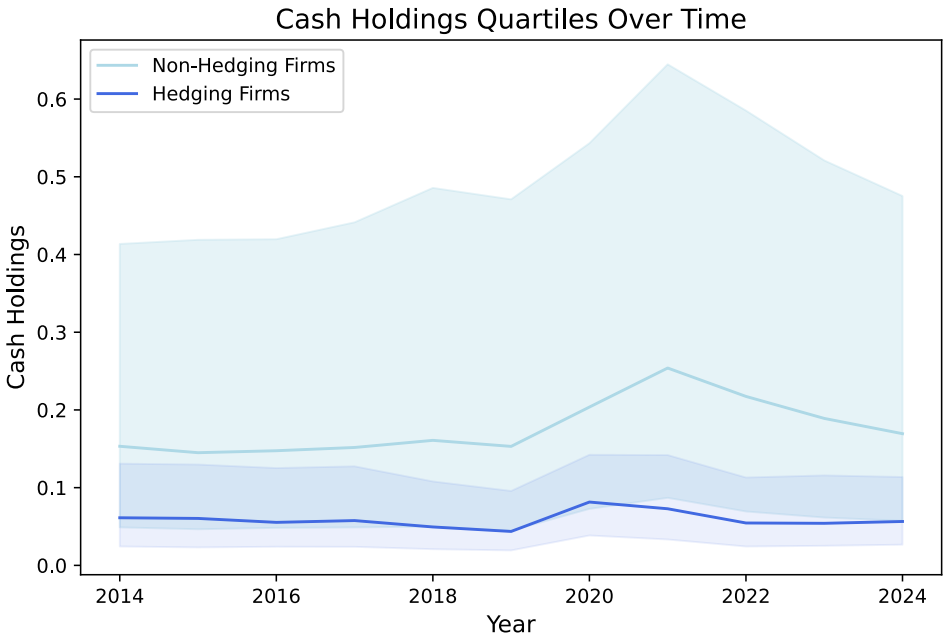


Figure 16: Interquartile ranges for hedging and non-hedging firms' cash holdings. The darker line is the median.

Hedging firms are more likely to be older. I define an "old" firm as a firm who has had its initial public offering (IPO) more than 5 years prior. "Young" firms are firms whose IPO was less than 5 years prior. Figure 17 shows the share of old and young firms that hedge. It is interesting that the share of young firms hedging drops off around the Covid-19 pandemic. However, the share of old firms trends upward.

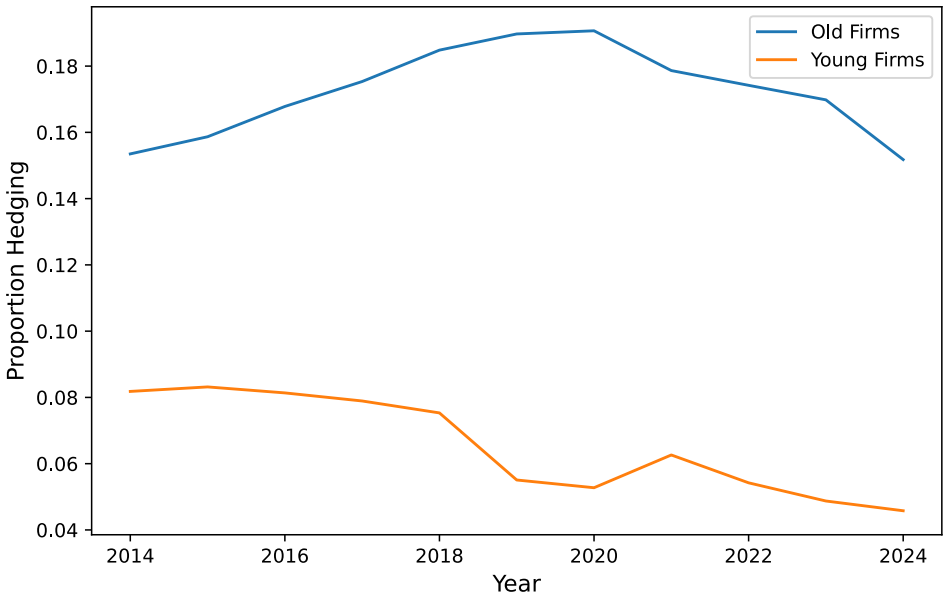


Figure 17: Given a firm is old or young, this plot shows the proportion of firms hedging interest rate risk.

I also plot the total notional amount over time in Figure 18.

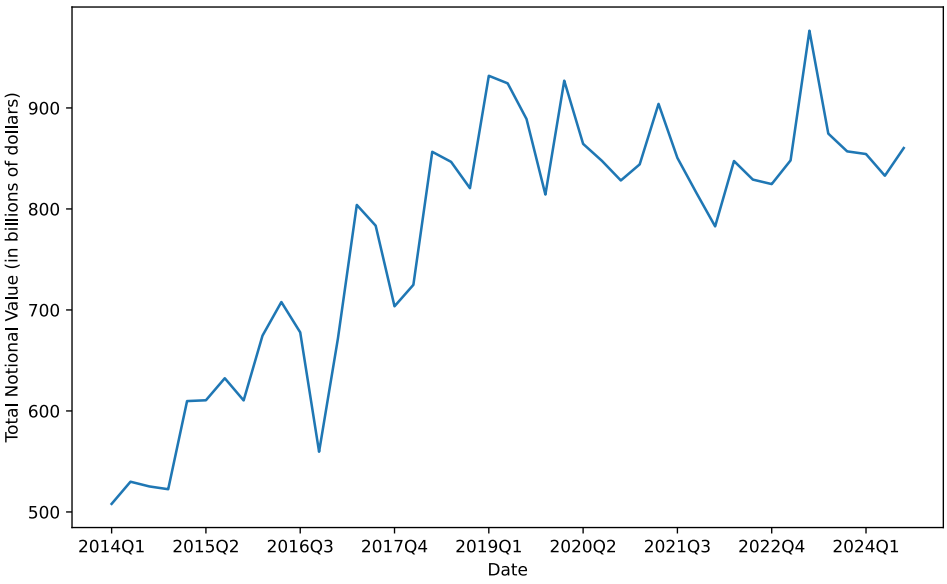


Figure 18: Total Notional Outstanding over time (some seasonality?)

B.5 Firm value is increased when electing into hedging

B.5.1 CRSP data

I download CRSP-Compustat merged (CCM) data. CRSP contains stock return data that can be merged easily with Compustat to get a stock price view of firm value.

I specifically download the monthly securities information with returns data (variable *trt1m*).

I keep only primary common stock and drop any duplicate share classes. I compound the returns to the quarterly frequency over the 3 months of each calendar quarter for the firm. This is the geometrically compounded total return, not a simple sum. I also drop partial quarters ($n < 3$), since this reflects delisting or acquisition periods.

B.5.2 Regression Details

To test whether selection into hedging increases the value of the firm that begins hedging, I run a two-way FE panel regression. I regress the change in the stock return in the quarter the firm elected into hedging on the change of whether the firm selects into or out of hedging in the quarter. So,

$$\Delta\text{stock return}_{it} = \alpha_t + \gamma_i + \beta\Delta\text{hedge}_{it} + \varepsilon_{it} \tag{16}$$

for firm i in quarter t. Δstock return$_{it}$ is the first-difference in the stock return from quarter $t-1$ to quarter t. The variable Δhedge_{it} is the first-difference of the hedge dummy. So it measures the selection into or out of hedging. The first differences absorb persistent level differences in returns across firms (i.e., risk premia). I also add controls in an additional specification, all of which are lagged by one period to reduce reverse causality. I also winsorize the controls at the 1st and 99th percentiles. The controls are log assets, book leverage, profitability, market-to-book, short term debt to total debt, net worth, and cash holdings. Standard errors in all specifications are clustered at the firm level to account for serial correlation in returns within the same firm over time.

Table 15: Stock Returns and Interest Rate Hedging: First-Differences Specification

	Δ Quarterly Stock Return		
	(1)	(2)	(3)
Δ Hedge dummy	0.0180**	0.0191***	0.0147**
	(0.0072)	(0.0071)	(0.0068)
N	109,521	109,521	109,521
R^2	0.0000	0.0000	0.0390
Firm FE	No	Yes	Yes
Time FE	No	Yes	Yes
Controls	No	No	Yes

OLS with two-way fixed effects (firm and quarter) in columns (2)–(3). Firm-clustered standard errors in parentheses.

Dep. var. is the first difference in quarterly CRSP stock return (Δq_{it}).

Col. (1): pooled OLS, R^2 is overall. Cols. (2)–(3): within R^2.

Controls are lagged one period and winsorized at the 1st/99th percentile.

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

B.5.3 Results

Table 15 presents the results. Column (1) contains the results for the baseline regression without controls or fixed effects. A change in the hedge status is positively correlated with the stock return in the quarter the firm elects into hedging. That is, if a firm starts to hedge, this correlates to a 1.8% increase in the stock return for that quarter. By contrast, if the firm stops hedging, this leads to a 1.8% decrease in the market return of the firm for that quarter. The estimate is highly significant at the 1% level.

Column (2) adds firm and time fixed effects. The firm fixed effects control for any firm-specific time-invariant characteristics that may impact the fundamental value of the firm via its stock return. The time fixed effects remove any macroeconomic shocks in

a quarter that equally effect all firms in the sample (e.g., the COVID-19 pandemic). Adding this fixed effects does not change the estimate by much, in fact, the estimate rises to 1.91%.

Finally, column (3) adds the firm-level controls described above. The estimate does not change much in value or significance, but the R^2 jumps to 0.039. As a result, the third column is my preferred specification.

B.6 Robustness for the Hiking Cycle Analysis

B.6.1 Scalar Post-Period Estimates

Table 16 collapses the matched-pair event study (Figure 3) to a single post-period average treatment effect under three specifications. Column (1) is unweighted OLS on the propensity-score matched sample. Column (2) is a doubly robust estimator that re-weights control firms by $\hat{p}/(1-\hat{p})$, normalized to mean one, combining regression adjustment with inverse propensity weighting to reduce sensitivity to misspecification of the propensity score. Column (3) applies the doubly robust estimator to the stayers subsample described below. The baseline and doubly robust estimates are nearly identical (0.72 and 0.79 percentage points, respectively), providing confidence that the finding is not driven by the choice of estimator.

Table 16: Investment Insulation During the 2022–2023 Hiking Cycle: I/K Ratio

	(1) Baseline	(2) Doubly Robust	(3) Stayers
Treated	0.0058*	0.0053*	0.0052
	(0.0031)	(0.0032)	(0.0040)
N (firms)	809	809	534
Sample	Post-hike	Post-hike	Post-hike
Controls	Yes	Yes	Yes
IPW weights	No	Yes	Yes

Dependent variable: I/K ratio (gross capex / capital stock, 4-quarter rolling average), normalized to zero at 2022Q1. Sample: 2022Q1–2024Q3 (post-hiking-cycle period only). Treated = hedged in 2021Q4. Each column collapses the time dimension of the matched-pair event study (Figure 3) to a single post-period average treatment effect. Col (1): unweighted OLS on 1:1 PSM matched sample (within 2-digit NAICS, caliper 0.10). Col (2): IPW-weighted WLS; control weights = $\hat{p}/(1-\hat{p})$ normalized to mean 1. Col (3): stayers subsample — treated firms hedged in every post-2021Q4 quarter; controls never hedged (2019Q1–2024Q3); IPW-weighted. Firm-clustered SEs in parentheses. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Figure 19 replicates the matched-pair event study under both the baseline and doubly robust specifications side by side. The post-2022 widening of the investment gap is present under both, and the estimates are close in magnitude throughout.

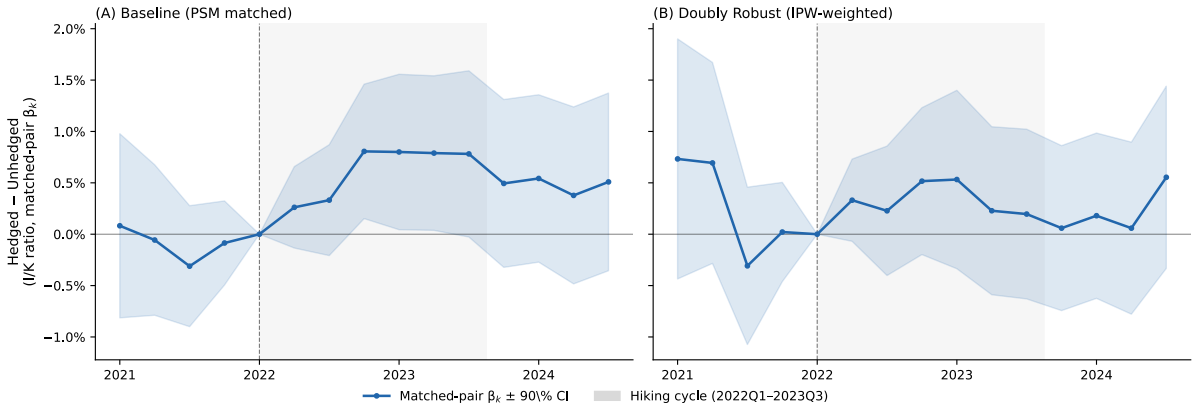


Figure 19: Matched-pair event study for the I/K ratio under two specifications. Panel (A): unweighted OLS on the PSM matched sample. Panel (B): IPW-weighted WLS (doubly robust). Each panel plots $\hat{\beta}_k$ from estimating equation (2) with pair fixed effects; base period 2022Q1. Shaded bands are 90% confidence intervals with pair-clustered standard errors. Gray shaded region: hiking cycle (2022Q1–2023Q3). Sample: 409 hedged–unhedged pairs.

Figure 20 replicates the matched-sample level trajectories under the doubly robust inverse propensity weights. The patterns are qualitatively unchanged relative to the unweighted matched-sample figure in the main text.

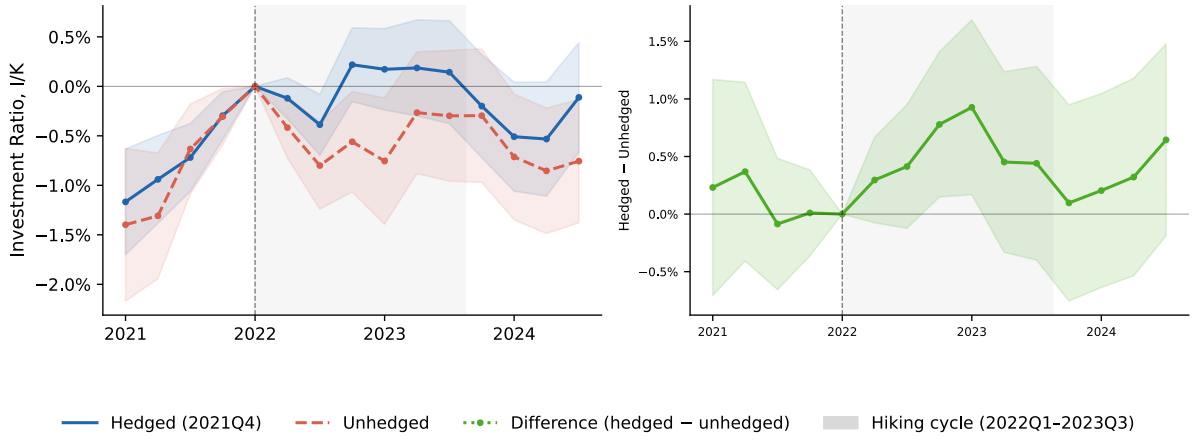


Figure 20: IPW-weighted matched-sample comparison of the I/K ratio for hedged (solid blue) and unhedged (dashed red) firms around the 2022–2023 hiking cycle. Control firms are re-weighted by $\hat{p}/(1-\hat{p})$, normalized to mean one. Sample: 409 matched pairs. All series normalized to zero at 2022Q1. The right panel shows the IPW-weighted hedged-minus-unhedged difference with 90% confidence intervals. Gray shaded region: hiking cycle (2022Q1–2023Q3).

B.6.2 Stayers

Column (3) of Table 16 reports the doubly robust estimate on the stayers subsample: treated firms hedged in 2021Q4 *and* in every subsequent observed quarter; control firms never hedged in any quarter of the full sample window (2019Q1–2024Q3). Re-running the within-sector PSM on this subsample yields 268 matched pairs (536 firms). The point estimate is positive (0.52 percentage points) and in the same direction as the main results, though it does not reach conventional significance levels given the smaller and more restrictive sample.

Figure 21 plots the investment trajectories for the stayers sample. The visual pattern remains: unhedged firms' I/K ratio falls below that of always-hedged firms once the hiking cycle begins, with the gap persisting into 2024.

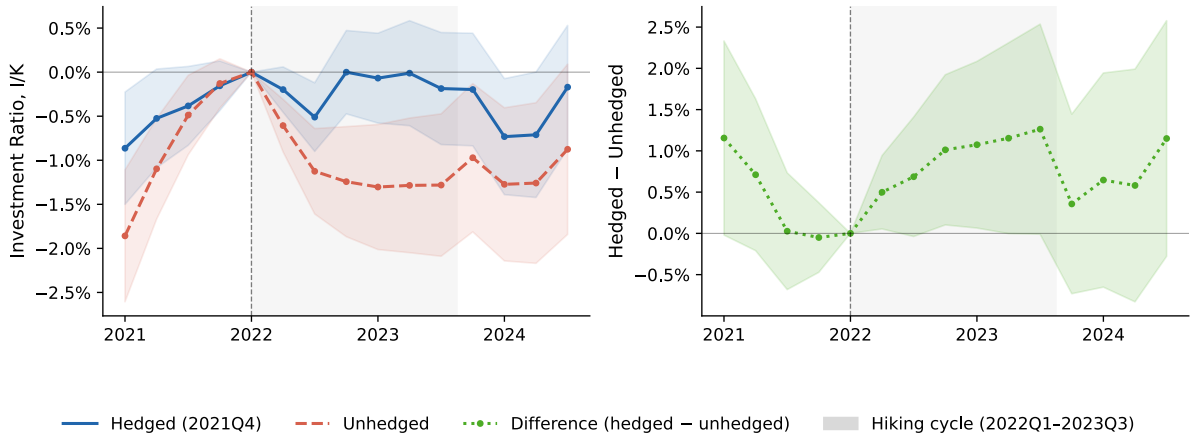


Figure 21: Matched-sample comparison of the I/K ratio for always-hedged (solid blue) and never-hedged (dashed red) firms around the 2022–2023 hiking cycle. Stayers sample: 268 firms that held interest rate derivatives in every post-2021Q4 quarter versus 268 firms that never hedged in any quarter of the sample window (2019Q1–2024Q3), matched one-to-one by propensity score within two-digit NAICS sector. All series normalized to zero at 2022Q1. The right panel shows the within-matched-pair difference with 90% confidence intervals. Gray shaded region: hiking cycle (2022Q1–2023Q3).

C Hedge Accounting Details

C.1 Cash Flow Hedges Dominate Interest Rate Derivatives

Firms that hedge also have an accounting choice. They can choose to match and report the changes in the fair value of the derivative at the same time as the gains or losses from the underlying hedged item, called "hedge accounting". Conversely, they can choose to report changes in the fair value of the hedge instrument directly into earnings when the hedge's gains or losses are realized but not the underlying, which is the default accounting choice. The benefit of pursuing hedge accounting is that earnings are not artificially volatile. Since the gains or losses in the hedge and the underlying item are mismatched, earnings and income can exhibit swings that are actually offset in the underlying. However, hedge accounting is more expensive and has more complex documentation (e.g., KPMG (2024)).

If firms elect into hedge accounting, they must report the type of hedge. Figure 22 breaks down derivatives in hedging firms by hedge type. Most common are cash flow hedges, hedges of the exposure to variability in the future cash flows, typically variable-rate debt. Fair value hedges are hedges of the exposure to changes in the fair value of an asset or liability, typically fixed-rate financial instruments. Net investment hedges are hedges of the exposure to foreign currency risk in a foreign operation. In context of an interest rate derivatives, this is hedging risk from interest rates on foreign debt. In the figure, the category denoted "interest rate risk" are the derivatives that are not recorded with hedge accounting. As seen from the figure, non-hedge accounted derivatives are around 20% of all derivatives. Derivatives that are denoted "customer IR risk" or customer interest rate risk are derivatives that a firm has sold to their customers.[9] Since cash flow hedges are most likely to be hedges on variable rate debt, I focus on these in the empirical analysis below.

[9] In the data, this is a tiny subset of construction and home-building firms. They offer mortgage rate locks to home buyers which are interest rate "hedges" but are not directly related to borrowing. I drop these instruments in my analysis.

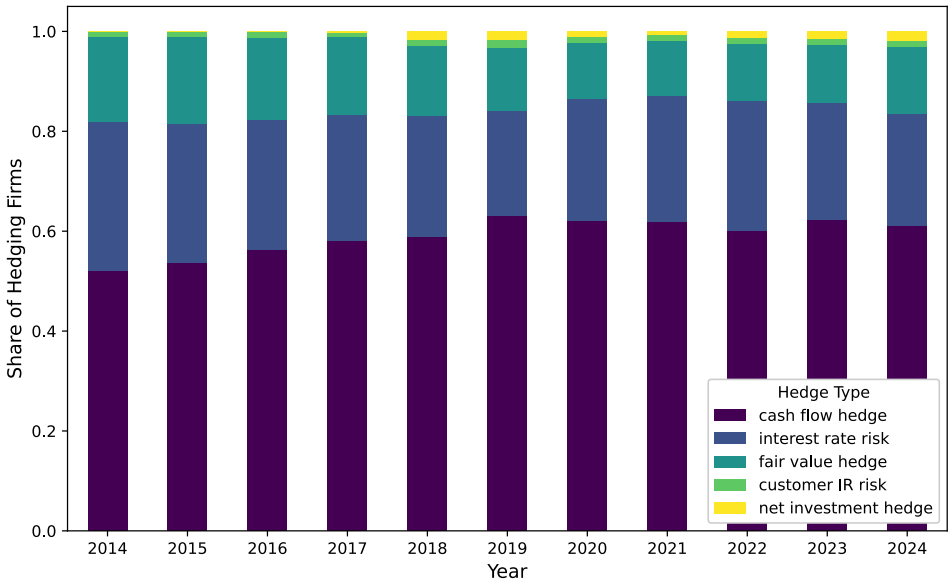


Figure 22: Type of hedge if firms elect to do hedge accounting. "Interest Rate Risk" is a category that includes firms that do not elect to do hedge accounting. These are most likely to be for interest rate risk in cash flow.

C.2 Hedge Accounting: Additional Information

This section summarizes the accounting treatment of derivatives under U.S. GAAP. All information comes from the KPMG Derivatives and Hedging Handbook, which is freely available online for every year it has been issued.

Derivative instruments are recorded on the balance sheet as assets or liabilities at fair value. How changes in that fair value are reported depends on whether the derivative is designated as a hedge. For nonhedging derivatives, changes in fair value are reported directly in earnings. For hedging instruments, the treatment depends on the type of hedge and the risk being hedged, but under every type of hedge, gains and losses on the derivative are generally recognized at the same time as the offsetting gains and losses on the hedged item or forecasted transaction.

Hedge accounting allows an entity to hedge risks inherent in certain transactions using derivative instruments. It is **elective**, and it is permitted only if the hedging relationship meets all applicable qualifying criteria. When it does, the accounting depends on which of three types of hedge the relationship is:

1. *Fair value hedge*: a hedge of the exposure to changes in the fair value of a recognized

asset or liability, or of an unrecognized firm commitment, that is attributable to a particular risk.

2. *Cash flow hedge*: a hedge of the exposure to variability in the future cash flows of a recognized asset or liability, or of a forecasted transaction, that is attributable to a particular risk.

3. *Net investment hedge*: a hedge of the exposure to foreign currency risk of a net investment in a foreign operation.

Five general criteria apply to fair value and cash flow hedges, and some of them also apply to net investment hedges: the hedged item or transaction must be eligible, the hedged risk must be eligible, the hedging instrument must be eligible, the hedge must be highly effective, and the relationship must be formally documented. The first two criteria differ between fair value and cash flow hedges, as described below.

Fair value hedges. Only recognized assets or liabilities, or unrecognized firm commitments, can be designated as the hedged item in a fair value hedge. Eligible risks are:

- *Interest rate risk*: changes in the benchmark interest rate for recognized fixed-rate financial instruments.

- *Credit risk*: changes in the obligor's creditworthiness and in the credit spread over the benchmark interest rate.

- *Foreign currency risk*: changes in the related foreign currency exchange rates.

- *Price risk*: the total change in fair value.

Fair value hedge accounting addresses a measurement mismatch. The hedged item is measured under other applicable U.S. GAAP (for example, at amortized cost), while the hedging instrument is measured at fair value, with changes in fair value reported in earnings. Fair value hedge accounting allows the entity to remeasure the hedged item for changes in fair value attributable to the hedged risk, so that the two sides offset.

Cash flow hedges. Cash flows from existing recognized assets or liabilities, or from forecasted transactions, can be designated as the hedged transaction in a cash flow hedge. Eligible risks are:

- *Interest rate risk*: changes in a contractually specified interest rate for variable-rate financial instruments or for forecasted issuances or purchases of variable-rate financial instruments, or changes in the benchmark interest rate for forecasted issuances or purchases of fixed-rate financial instruments.
- *Credit risk*: the risk of default, changes in the obligor's creditworthiness, and changes in the credit spread over the contractually specified or benchmark interest rate.
- *Foreign currency risk*: changes in the related foreign currency exchange rates.
- *Price risk*: the total change in the cash flows related to the asset or liability (for example, all changes in the purchase or sale price).

Because the hedged transactions are often probable future transactions not yet recognized on the balance sheet or in earnings, cash flow hedge accounting defers recognition of the derivative's gains and losses rather than recognizing the forecasted transaction early. The derivative is recorded at fair value on the balance sheet, and changes in its fair value that are included in the assessment of hedge effectiveness are reported in other comprehensive income (OCI). The amounts accumulated in AOCI are reclassified into earnings, in the same income statement line item as the hedged transaction, when the hedged transaction affects earnings.

Hedge effectiveness. Hedge accounting is permitted only if the hedging relationship is highly effective at managing the hedged risk. Effectiveness must be assessed prospectively at hedge inception, and then both prospectively and retrospectively at least quarterly.

C.3 Timeline of Regulations and Requirements for Derivatives

Source: Evolution of U.S. Regulation and the Standard-Setting Process for Financial Reporting: 1930s to the Present (Stephen A. Zeff, 2021).

- 1934: SEC founded with the Securities Exchange Act of 1934 post-Great Depression. Granted the authority to set accounting practices and standards.
- 1939: SEC delegated to the private sector, Committee on Accounting Procedure (CAP)
- 1959: CAP replaced by Accounting Principles Board (APB)
- 1973: APB replaced by the Financial Accounting Standards Board (FASB), which even today is responsible for setting accounting standards and policies.
- Mid-20th century: GAAP accounting principles
- June 1998: Approval of SFAS No. 133 "Accounting for Derivative Instruments and Hedging Activities", applying after 2000.
- Dodd-Frank Act of 2010: pushed derivatives more toward exchanges and away from OTC markets

D Theoretical Results and Derivations

D.1 Derivation of Pricing Functions

The financial intermediary's pricing functions are derived from a standard zero-profit condition. The financial intermediary is risk neutral and prices the loan so that the price it pays today equals the expected discounted payoff it receives tomorrow. This means there is no expected profit and no expected loss. The intermediary does not recover any positive return R from a firm's default on a loan, so I set recovery $R = 0$. So, the

expression for the discount factor q_t is

$$q_t = E_t \left[\frac{\text{repayment}_{t+1}}{\text{discount factor}} \mathbb{1}\{V^R > 0\} \right]$$

The pricing functions q_t^U and q_t^H are the price the financial intermediary pays today for promised repayment of $1 + r_{t+1}$ and $1 + r_t$, respectively. The discount factor is the lender's opportunity cost of funds over the period t to $t + 1$ and is thus the market rate that prevails over that window, $1 + r_{t+1}$. So then, the pricing functions are

$$q_t^U = E_t \left[\frac{1 + r_{t+1}}{1 + r_{t+1}} \mathbb{1}\{V^R > 0\} \right] = E_t[\mathbb{1}\{V^R > 0\}] \tag{17}$$

and

$$q_t^H = E_t \left[\frac{1 + r_t}{1 + r_{t+1}} \mathbb{1}\{V^R > 0\} \right] \tag{18}$$

D.2 Euler Equations

Using the Envelope condition, I find the following:

$$\frac{\partial V^R(s_{t+1})}{\partial k_{t+1}} = \alpha a_{t+1} k_{t+1}^{\alpha-1} + (1 - \delta) - \phi_1(k_{t+1}, k_{t+2}) \tag{19}$$

$$\frac{\partial V^R(s_{t+1})}{\partial b_{t+1}} = -[(1 - \lambda_{t+1})(1 + r_{t+1}) + \lambda_{t+1}(1 + r_t)] - \lambda_{t+1}\psi_1(\lambda_{t+1}b_{t+1}, \lambda_{t+2}b_{t+2}) \tag{20}$$

$$\frac{\partial V^R(s_{t+1})}{\partial \lambda_{t+1}} = b_{t+1}(r_{t+1} - r_t) - b_{t+1}\psi_1(\lambda_{t+1}b_{t+1}, \lambda_{t+2}b_{t+2}) \tag{21}$$

where s_{t+1} is the set of state variables in $t + 1$.

Taking first order conditions of the firm's problem, I get the following expressions:

$$k_{t+1}: \quad \underbrace{b_{t+1}\left[(1-\lambda_{t+1})\frac{\partial q_t^U}{\partial k_{t+1}} + \lambda_{t+1}\frac{\partial q_t^H}{\partial k_{t+1}}\right]}_{\text{Price-Feedback Benefit}} + \underbrace{\beta E_{a_{t+1}}\left[\mathbb{1}\{\cdot\}\frac{\partial V^R(s_{t+1})}{\partial k_{t+1}}\right]}_{\text{Continuation Benefit}} \tag{22}$$
$$\text{Marginal Benefit of Investment}$$
$$= \underbrace{\overbrace{1}^{\text{Purchase Cost}} + \overbrace{\phi_2(k_t, k_{t+1})}^{\text{Adjustment Cost}}}_{\text{Marginal Cost of Investment}}$$

$$b_{t+1}: \quad \underbrace{\overbrace{(1-\lambda_{t+1})q_t^U + \lambda_{t+1}q_t^H}^{\text{Direct Benefit}} + \overbrace{(1-\lambda_{t+1})b_{t+1}\frac{\partial q_t^U}{\partial b_{t+1}} + \lambda_{t+1}b_{t+1}\frac{\partial q_t^H}{\partial b_{t+1}}}^{\text{Feedback Benefit}}}_{\text{Marginal Benefit of Debt}} \tag{23}$$
$$= \underbrace{\overbrace{\lambda_{t+1}\psi_2(\lambda_t b_t, \lambda_{t+1}b_{t+1})}^{\text{Adjustment Cost}} \overbrace{-\beta E_{a_{t+1}}\left[\mathbb{1}\{\cdot\}\frac{\partial V^R(s_{t+1})}{\partial b_{t+1}}\right]}^{\text{Continuation Cost}}}_{\text{Marginal Cost of Debt}}$$

$$\lambda_{t+1}: \quad \underbrace{\overbrace{b_{t+1}(q_t^H - q_t^U)}^{\text{Direct Benefit}} + \overbrace{b_{t+1}(1-\lambda_{t+1})\frac{\partial q_t^U}{\partial \lambda_{t+1}} + \lambda_{t+1}b_{t+1}\frac{\partial q_t^H}{\partial \lambda_{t+1}}}^{\text{Indirect Feedback Benefit}}}_{\text{Marginal Benefit of Hedging}} \tag{24}$$
$$= \underbrace{\overbrace{b_{t+1}\psi_2(\lambda_t b_t, \lambda_{t+1}b_{t+1})}^{\text{Adjustment Cost}} \overbrace{-\beta E_{a_{t+1}}\left[\mathbb{1}\{\cdot\}\frac{\partial V^R(s_{t+1})}{\partial \lambda_{t+1}}\right]}^{\text{Continuation Cost}}}_{\text{Marginal Cost of Hedging}}$$

Equation (22) equalizes the cost of an additional marginal unit of investment to the expected marginal benefit to the firm value from this additional expense. The total cost is equal to the direct cost of investment and the cost due to the indirect price-feedback effect through the loan discounts the firm is offered on borrowing. A firm's next period capital affects its future repayment likelihood, current investment affects the firm's current cost of funds and, as a result, the overall cost of this investment.

Equations (23) and (24) show the first order conditions for debt and the hedged proportion of the debt. Equation (23) shows that if the total benefit of borrowing from the financial intermediary is lower than the cost of this debt, firms will not borrow at all. A firm that chooses to borrow from the financial intermediary borrows until the total

benefit of debt, both hedged and unhedged debt, is equal to its expected cost. The benefit of debt depends directly on the current discounts offered on the debt and indirectly on the endogenous effect of an additional unit of debt on the firm's offered discounts. Firm default probability increases when they borrow more debt from the financial intermediary, which is then internalized by the financial intermediary and affects the loan discounts and thus the total benefit of borrowing more debt. Notice that default probability effects both hedged and unhedged debt, so any decision to borrow, whether unhedged or hedged debt changes the discount offered to the firm on the other type of debt as well.

I then substitute (19), (20), and (21) into the first order conditions to obtain the following expressions:

$$\begin{aligned} k_{t+1}: \quad & -1-\phi_2(k_t,k_{t+1})+b_{t+1}\left[(1-\lambda_{t+1})q^U_{t,k}+\lambda_{t+1}q^H_{t,k}\right] \\ & =-\beta E_t\Big[\mathbb{1}\{V^R(s_{t+1})>0\}\Big(\alpha a_{t+1}k_{t+1}^{\alpha-1}+(1-\delta)-\phi_1(k_{t+1},k_{t+2})\Big)\Big] \end{aligned} \tag{25}$$

$$\begin{aligned} b_{t+1}: \quad & (1-\lambda_{t+1})q^U_t+\lambda_{t+1}q^H_t+b_{t+1}\left[(1-\lambda_{t+1})q^U_{t,b}+\lambda_{t+1}q^H_{t,b}\right]-\lambda_{t+1}\psi_2(\lambda_t b_t,\lambda_{t+1}b_{t+1}) \\ & =-\beta E_t\Big[\mathbb{1}\{V^R(s_{t+1})>0\}\Big(-\left[(1-\lambda_{t+1})(1+r_{t+1})+\lambda_{t+1}(1+r_t)\right] \\ & \quad -\lambda_{t+1},\psi_1(\lambda_{t+1}b_{t+1},\lambda_{t+2}b_{t+2})\Big)\Big] \end{aligned} \tag{26}$$

$$\begin{aligned} \lambda_{t+1}: \quad & b_{t+1}(q^H_t-q^U_t)+b_{t+1}\left[(1-\lambda_{t+1})q^U_{t,\lambda}+\lambda_{t+1}q^H_{t,\lambda}\right]-b_{t+1}\psi_2(\lambda_t b_t,\lambda_{t+1}b_{t+1}) \\ & =-\beta E_t\Big[\mathbb{1}\{V^R(s_{t+1})>0\}\Big(b_{t+1}(r_{t+1}-r_t)-b_{t+1}\psi_1(\lambda_{t+1}b_{t+1},\lambda_{t+2}b_{t+2})\Big)\Big] \end{aligned} \tag{27}$$

Equation (25) demonstrates that at the optimum choice of capital, the total cost of one additional unit of capital is equal to its expected benefit. The expected benefit is the marginal product of capital plus its non-depreciated value minus marginal adjustment costs in states of repayment (i.e., when $V^R > 0$).

Equation (26) shows that firms optimally choose to borrow debt until the revenue

received from funds equals its expected cost. The cost is equal to the repayments on unhedged debt, repayments on hedged debt, and adjustment costs in states of repayment (non-exit).

Equation (27) shows that firms optimally choose their hedged debt proportion up until the expected benefit of an addition unit of hedged debt relative to unhedged debt equals its expected cost. The expected cost, depends on the expected insurance value of hedged debt to unhedged debt $r_{t+1} - r_t$ net of adjustment costs. This means that unhedged debt has an additional source of risk from interest rate changes whereas hedged debt is immune to this risk.

D.2.1 Why do Firms Choose to Hedge?

There is one derivation that characterizes the main mechanism in this model. Taking equation (27), I divide through by b_{t+1} to show the marginal benefit of an additional unit of hedged debt relative to unhedged debt. This gives the following equation:

$$(q_t^H - q_t^U) + [(1+\lambda_{t+1})q_{t,\lambda}^U + \lambda_{t+1}q_{t,\lambda}^H] - \psi_2(\lambda_t b_t, \lambda_{t+1}b_{t+1}) \tag{28}$$

$$+ \beta E_t\Big[\mathbb{1}\{V^R(s_{t+1}) > 0\}\Big((r_{t+1} - r_t) - \psi_1(\lambda_{t+1}b_{t+1}, \lambda_{t+2}b_{t+2})\Big)\Big] \geq 0 \tag{29}$$

Notice that the continuation value can be rewritten like so, using the identity $E[XY] = E[X]E[Y] + Cov(X,Y)$:

$$E_t[\mathbb{1}\{V^R(s_{t+1}) > 0\}][E_t[r_{t+1} - r_t] - E_t[\psi_1]] \tag{30}$$

$$= E_t[\mathbb{1}\{V^R(s_{t+1}) > 0\}](E_t[r_{t+1}] - r_t) + Cov(\mathbb{1}\{V^R(s_{t+1}) > 0\}, r_{t+1}) \tag{31}$$

$$- E_t[\mathbb{1}\{V^R(s_{t+1}) > 0\}\psi_1(\cdot)] \tag{32}$$

So, the first order condition can be rewritten as

$$
\begin{aligned}
&(q_t^H - q_t^U) + \left[(1-\lambda_{t+1})q_{t,\lambda}^U + \lambda_{t+1}q_{t,\lambda}^H\right] - \psi_2(\lambda_t b_t, \lambda_{t+1}b_{t+1}) \\
&+ \beta\Big[\underbrace{E_t[\mathbb{1}\{V^R(s_{t+1})>0\}]\big(E_t[r_{t+1}] - r_t\big)}_{\text{Expected Repricing Gap}} + \underbrace{Cov_t\big(\mathbb{1}\{V^R(s_{t+1})>0\},\, r_{t+1}\big)}_{\text{Default–Rate Covariance}} \\
&- E_t\Big[\mathbb{1}\{V^R(s_{t+1})>0\}\,\psi_1(\lambda_{t+1}b_{t+1}, \lambda_{t+2}b_{t+2})\Big]\Big] \leq 0
\end{aligned}
\tag{33}
$$

This is an equation I discuss in depth in the main text.

The equation can be split into several parts to explain a firm's decision to hedge. The first part is

$$
q_t^H - q_t^U \tag{34}
$$

which is the direct relative marginal benefit an additional unit of hedged debt has to an additional unit of unhedged debt. In the text, I call this the financing-cost effect.

The second part of the equation is $\left[(1-\lambda_{t+1})q_{t,\lambda}^U + \lambda_{t+1}q_{t,\lambda}^H\right]$. This is called the price-feedback effect in the text and composes the second part of the financing benefit of hedging. This describes the indirect marginal benefit that an additional unit of hedged debt has over an additional unit of unhedged debt through the discounts offered on both types of debt. The sign of this part is conditional on r_{t+1}. In states where $r_{t+1} > r_t$, raising λ_{t+1} also increases the survival probability $V^R(s_{t+1}) > 0$. In states where $r_{t+1} < r_t$, raising λ_{t+1} decreases the survival probability. Whether hedging on net lowers the default threshold (which raises $q_{t,\lambda}^U$ and $q_{t,\lambda}^H$) depends on much probability mass sits above versus below r_t. If $r_t < \bar{r}$, since rates are mean-reverting, the interest rate is expected to rise, and the mass of r_{t+1} skews above r_t. This means hedging is net risk-reducing and $q_{t,\lambda}^U > 0$ and $q_{t,\lambda}^H > 0$. Conversely, if r_t is sufficiently above $\bar{r}$, the interest rate is expected to fall and the mass skews below r_t. This means that hedging becomes net risk-increasing and the derivatives are negative.

I show this more concretely in several steps. There is some threshold value $\tilde{a}(r_{t+1})$

that solves $V^R(\tilde{a}, r_{t+1}; k_{t+1}, b_{t+1}, \lambda_{t+1} = 0$. The discount q_t^U can be rewritten as

$$q_t^U = \int_r \int_{\tilde{a}}^{\infty} f_a(a_{t+1}|a_t) f_r(r_{t+1}|r_t) da_{t+1} dr_{t+1} \tag{35}$$

Using the Leibniz rule to differentiate this expression with respect to λ_{t+1}, I get the following expression:

$$q_{t,\lambda}^U = -\int_r f_a(\tilde{a}(r_{t+1})|a) f_r(r_{t+1}|r_t) \frac{\partial \tilde{a}(r_{t+1})}{\partial \lambda_{t+1}} dr_{t+1} \tag{36}$$

Note that changing λ_{t+1} does not effect the density of either interest rates or productivity, but it does shift the threshold where the cutoff productivity sits.

Since V^R is increasing in productivity, implicitly differentiating $V^R(\tilde{a}(r_{t+1}), r_{t+1}) = 0$ gives

$$\frac{\partial \tilde{a}(r_{t+1})}{\partial \lambda_{t+1}} = -\frac{\partial V^R(s_{t+1})/\partial \lambda_{t+1}}{\partial V^R(s_{t+1})/\partial a_{t+1}} = -\frac{b_{t+1}(r_{t+1} - r_t) - b_{t+1}\psi_1(\cdot)}{\partial V^R/\partial a_{t+1}} \tag{37}$$

using the envelope theorem. Note that $\partial V^R/\partial a_{t+1} > 0$ so the sign of the numerator of this expression determines the sign of the overall expression. Ignoring ψ_1, if $r_{t+1} > r_t$, the threshold decreases, hedging decreases default risk so less productivity is needed to survive. The converse is true under $r_{t+1} < r_t$.

Substituting (37) into (36), the integral can be split into two for the "positive" and "negative" interest rate difference:

$$q_{t,\lambda}^U = \int_{r_{t+1} > r_t} f_a(\tilde{a}|a) f_r(r_{t+1}|r_t) \frac{r_{t+1} - r_t}{\partial V^R/\partial a_{t+1}} dr_{t+1} - \int_{r_{t+1} < r_t} f_a(\tilde{a}|a) f_r(r_{t+1}|r_t) \frac{r_{t+1} - r_t}{\partial V^R/\partial a_{t+1}} dr_{t+1} \tag{38}$$

Notice that since the conditional distribution of r_{t+1} is centered at $(E[r_{t+1}] = 1 - \rho_r)\bar{r} + \rho_r r_t$, when $r_t < \bar{r}$, mean reversion pulls $E[r_{t+1}]$ above r_t, which means more than half of the default probability mass sits in the positive region, so the positive region dominates and $q_{t,\lambda}^U > 0$. When $r_t > \bar{r}$, the negative region dominates and $q_{t,\lambda}^U < 0$.

The fourth part of the expression is the expected repricing gap, $E_t[\mathbb{1}\{V^R(s_{t+1}) >$

$0\}]\big(E_t[r_{t+1}] - r_t\big)$. This expression describes the expected insurance benefit from an additional unit of hedged debt in repayment states. If $E[r_{t+1}] > r_t$, then locking in today's interest rate is a bargain in expectation. Else, this part of the expression is negative and hedging has an opportunity cost.

The fifth part of the expression is the covariance of the default probability and the interest rate. The covariance is negative – the probability of default goes up when rates go up. Rate spikes coincide with lower survival probability. This makes sense since unhedged coupons rise exactly when cash-strapped firms are closest to default – then hedging is insuring precisely the states that matter most: the firm is disproportionately likely to still be producing and repaying in the states where being unhedged would have hurt most. This term is weakly negative. If $\lambda_{t+1} < 1$, it is strictly negative since the repayment burden of unhedged debt $(1 - \lambda_{t+1})(1 + r_{t+1})b_{t+1}$ is strictly increasing in r_{t+1}. If $\lambda_{t+1} = 0$, the covariance is equal to zero since the firm has no interest rate exposure.

I skipped the third part to handle it jointly with the sixth part since they both deal with adjustment costs. The third part of the equation is the marginal adjustment cost of hedged debt, $\psi_2(\lambda_t b_t, \lambda_{t+1} b_{t+1})$.The sixth and final part of the expression is the expectation of the marginal adjustment cost in the future, weighted by the expected default probability. These grow closer to zero the closer the previous period's decision over debt and hedging are similar to the current period's decision over debt and hedging. So the firm has an incentive to smooth their borrowing and hedging over time.

Finally, the price-effect effect and the adjustment costs are the most important part of this expression. The financing-cost effect is nearly offset by the expected repricing gap and the default-rate covariance terms. To see this, notice that

$$q_t^H - q_t^U = E_t\Big[\frac{r_t - r_{t+1}}{1 + r_{t+1}} \mathbb{1}\{\cdot\}\Big] \tag{39}$$

$$\approx -(1 - \rho_r)\mathbb{1}\{V^R > 0\}(\bar{r} - r_t) - Cov_t(\mathbb{1}\{V^R > 0\}, r_{t+1}) \tag{40}$$

where the final line is a first-order linear approximation. Then,

$$q_t^H - q_t^U + \beta\Big[E_t[\mathbb{1}\{V^R(s_{t+1}) > 0\}]\big(E_t[r_{t+1}] - r_t\big) + Cov_t\big(\mathbb{1}\{V^R(s_{t+1}) > 0\},\, r_{t+1}\big)\Big] \quad (41)$$

$$= (\beta - 1)\Big[E_t[\mathbb{1}\{V^R(s_{t+1}) > 0\}]\big(E_t[r_{t+1}] - r_t\big) + Cov_t\big(\mathbb{1}\{V^R(s_{t+1}) > 0\},\, r_{t+1}\big)\Big] \quad (42)$$

If $\beta < 1$, the difference is quite small and they effectively cancel. To the first order, the price a firm pays today for hedged debt already reflects the market's rational expectation movements and default correlation. So, the "cheap to hedge now" and the "expensive to have hedged later" signals roughly cancel.

This means that the most important terms for whether or not a firm decides to hedge are the price-feedback effect, which says that a firm hedges more when r_t is below trend and hedging is risk-reducing and less or not at all when r_t is well above trend, and the present and future expected adjustment costs which push the firm towards a smooth decision over hedging.

E Model Solution Methods

E.1 Value Function Iteration

The model is solved on a discrete state space with $N_K = 25$ capital grid points (log-spaced from 0.5 to 150), $N_B = 25$ debt grid points (uniformly spaced from 0 to 20), $N_\Lambda = 10$ hedge ratio grid points (uniformly spaced from 0 to 1), $N_A = 7$ productivity nodes, and $N_R = 5$ interest rate nodes. Both continuous AR(1) processes are discretized via Tauchen's method with $m = 3$ standard deviations. The choice $N_A = 7$ is important for identification of the exit rate: with $N_A = 5$, the lowest productivity state has an unrealistically high self-transition probability ($\approx$22% vs. the continuous-time value of $\approx$14%), which causes the optimizer to converge to the wrong c_F.

The value function is solved by value function iteration with Howard improvement. Bond prices (q^U, q^H) are updated only at full argmax iterations and never inside the Howard step, since within-Howard price feedback generates an exit spiral in which falling

prices raise exit, which further lowers prices. The stationary distribution is computed by forward simulation of 50,000 firms over 300 burn-in quarters followed by 500 collection quarters.

Optimization uses the Nelder-Mead simplex algorithm, initialized at $(c_F, \phi_K, c_H) = (1.001, 0.270, 0.0082)$. The starting point is constructed from a sequence of diagnostic sweeps. A coarse grid over c_F revealed a phase transition between $c_F = 1.0$ and $c_F = 2.0$, above which the model collapses to mass exit and zero hedging; the calibrated solution lies below this threshold. A two-dimensional sweep over (c_F, ϕ_K) located the exit-crossing ridge near $c_F \approx 1.0$, $\phi_K \approx 0.27$. A dedicated sweep over c_H with (c_F, ϕ_K) held fixed at those values located the hedge-rate crossing near $c_H \approx 0.0082$. The five initial simplex vertices span this neighborhood in all three dimensions. The optimizer converges in 65 function evaluations.