SUPPLY CHAIN HEDGING AND THE COST OF DEBT

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_____ (Signed)

CHAN WAI HO_____ (Name of student)

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Supply Chain Hedging and the Cost of Debt

Abstract:

This paper investigates the relation between the use of purchase obligations (POs) and the cost of debt. I hypothesize POs are hedging tools for risk management, mitigating firms' downside risk by providing price protection and leading to a lower cost of debt. To test this hypothesis, hand-collected data from 10-K reports is used to identify the total amount of POs committed to suppliers. The demonstrate that firms with more POs are associated with a lower cost of debt, and this relation is more pronounced for firms with closer relationships with their suppliers, better information intermediation and smaller market share compared with industry peers. Further, tests using the initiations and suspensions of supply chain hedging as shocks and instrumental variable analyses are conducted to ensure that the findings are robust and account for endogeneity. Additionally, I find that higher PO usage is associated with higher cost stickiness and input price protection. Further analyses show that the price protection channel dominates the cost stickiness channel and resulting in a lower cost of debt. Overall, this paper suggests that the usage of purchase obligations as risk management tools significantly reduces the cost of debt.

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1. Introduction

Purchase obligations (POs) are non-cancelable forward contracts with suppliers that serve to reduce input price volatility and supply chain disruptions (Melnyk et al. 2010; Costello 2013; Almeida et al. 2017). These contracts involve suppliers committing to delivering goods or services at a fixed price in the future, with counterparties required to pay at the time of contract fulfillment. Typically, a PO has to be fulfilled in the next fiscal year, but firms may choose to sign longer-term contracts of two to five years or more (Almeida et al. 2017). POs have become an important tool for supply chain hedging (SCH) worldwide, and an increasing number of researchers are attempting to understand their determinants and consequences.

Considered an important hedging tool to mitigate risks inherent in a firm's current and future cash flows, SEC has required downstream firms to disclose their upstream PO as an off-balance sheet liability since 2003. Prior literature shows that hedging using currency, interest rate, and commodity derivatives reduces the cost of debt (Campello et al. 2011; Chen & King 2014). Despite the fact that 21.5% of non-financial firms use PO to hedge, and only 15.8% use traded commodities derivatives (Almeida et al. 2017), little attention has been given to the impact of PO on financing costs. Almeida et al. (2017) propose that PO is a risk management tool and has a material impact on corporate hedging activity. However, hedging via PO is considered a commitment in which buyers have to fulfill the contract terms and pay the counterparties in the future, while traded commodity derivatives can be resold in the secondary market and may be non-binding to exercise, such as commodity options. Holders of traded commodity derivatives do not have to hold until maturity. Therefore, from creditors' perspectives, the implication of using POs as a risk management tool could differ from that of traditional derivatives. In this paper, the aim is to add to the literature by examining the relation between the usage of PO and its debt financing cost and providing managerial insights into the usage of PO in corporate finance.

The usage of POs can lead to a reduction in financing costs for three primary reasons. First, a firm's use of POs can effectively reduce input price fluctuations and cash flow risk, which makes future input prices more predictable and mitigates the concerns of cash flow uncertainty from creditors' perspectives. This results in a lower cost of debt (Smith & Stulz 1985). Second, supply chain hedging with POs can secure future relationships with suppliers, who are an important source of short-term liquidity. As POs are long-term contracts, suppliers may have already invested in production for the customer at the time the contract is signed. Thus, suppliers may have a stronger incentive to support these customers during bad times by providing more trade credit to mitigate the entire loss of customer-specific investments. Therefore, the use of POs may lower the bankruptcy risk of customer firms and reduce the cost of debt. Third, the mandatory disclosure of PO usage provides additional quantitative information for creditors to assess the information risk, which reduces information asymmetry and results in a lower cost of debt (Sengupta 1998, Derrien et al. 2016).

The above assertion suggests that while the usage of PO may have potential benefits such as reducing cash flow volatility, bankruptcy risk, and information asymmetry, it may also lead to greater cost stickiness and increase the cost of debt. Specifically, PO requires firms to maintain fixed input levels, which may not be optimal when demand declines. Moreover, cost stickiness problems may arise when firms with PO make optimistic projections regarding future demand. As cost stickiness leads to higher credit risk (Homburg et al. 2018), it is plausible that this risk embedded in PO will be priced into the cost of debt. Therefore, the effect of PO usage on the cost of debt financing is unclear and warrants further empirical investigation.

To test the relation between PO usage and the cost of debt, I first manually collect the PO data from the footnote of 10-K reports from 2003 to 2020. Next, I follow prior research and measure the cost of debt as the all-in spread drawn from the Dealscan database. This measure includes all the recurring annual fees paid to lenders and is over the LIBOR. My baseline result

documents a strong negative relation between PO usage and the cost of debt. This relation is economically significant, as the initiation of SCH is associated with a 31.09 base points reduction in loan spread. The finding is robust to a series of tests, including the use of different proxies for the key independent variables, and the inclusion of additional control variables and fixed effects.

Next, I conduct sub-sample tests to further analyse the relation between supply chain hedging and the cost of debt. First, I examine firms that exhibit closer relationships with their suppliers. In these cases, higher usage of POs implies the suppliers are more willing to maintain long-term relationships and are likely to support the borrowers during the bad time, resulting in lower bankruptcy risk and lower debt financing costs. Therefore, the negative relation is expected to be more pronounced when the borrower firms have better prior relationships with their suppliers. Second, when the information asymmetry between lenders and borrowers is higher due to the nature of POs (Lee 2021), lenders may refer to other sources of information such as analyst reports. I anticipate that sell-side analysts play an important role as information intermediaries in processing PO information contained in borrowers' financial statements. Therefore, the negative relation between SCH and the cost of debt is more pronounced for firms with better information intermediation.

This paper contributes to the growing literature on the role of PO in risk management and corporate decision-making (Almeida et al. 2017, Moon & Phillips 2021). Using a unique dataset of POs, I first examine if supply chain hedging affects the cost of debt. To unravel the black box, I examine the input price protection channel based on Arya et al.'s (2015) theory that forwards contracting in input markets can protect buyers against suppliers' upward adjustment of input prices when disclosure reveals high product demand and price protection can, in turn, lower buyers' downside risk and reduce their financing cost. I also consider the association between PO and cost stickiness, which leads to the proposed opposing cost

stickiness channel. This channel is based on the reasoning that POs induce asymmetry cost behaviors by reducing the flexibility to curtail input costs when sales reduce. Our empirical results show that the input price protection effect outweighs the negative impacts of cost stickiness. Second, this paper documents PO usage as a new determinant of debt financing costs. Prior studies have focused on the financing impact of hedging using currency, interest rate, and commodity derivatives (Campello et al. 2011; Chen & King 2014), I add to this literature by showing that hedging using supply chain contracts is a more effective tool in reducing the cost of debt. Third, this project furthers the understanding of additional quantitative financial disclosure used in the debt pricing process.

The rest of this paper is structured as follows. Section 2 is the background and hypothesis development. Section 3 describes the data and regression models used in the analysis. Section 4 reports the baseline and cross-sectional results. Section 5 discusses the mechanisms through which PO usage affects the cost of debt. Section 6 concludes this proposal.

2. Background and Hypothesis Development

Supply chain hedging is an indispensable part of a firm's supply chain planning as it reduces discrepancies between supply and demand-oriented activities, leading to increased operational efficiency and firm value (Braunscheidel & Suresh 2009; Melnyk et al. 2010; Costello 2013; Almeida et al. 2017). To implement SCH, firms use purchase commitments to secure future input prices and quantities. The Securities and Exchange Commission (SEC) defines purchase commitment as an enforceable and legally binding contract that obligates a customer to purchase a fixed or minimum quantity of products or services from a supplier at a fixed, minimum, or variable price. A purchase commitment entails a firm's promise to purchase from a counterparty, which involves an estimated cash outflow within a specified period. Given that there is no economic activity involved at the point of the contract signing, US Generally

Accepted Accounting Principles (GAAP) does not classify purchase commitments as assets or liabilities on company's financial statements. In other words, purchase commitments are off-balance-sheet items.

According to Section 401(a) of the Sarbanes-Oxley (SOX) Act of 2002, publicly traded firms are required to disclose their contractual obligations in the "Management Discussion and Analysis" section. The regulation becomes effective for the U.S. listed firms for fiscal years ending after December 15, 2003. Recent studies have collected PO data from these disclosures to investigate supply chain contractual obligations. Almeida et al. (2017) indicate such contracts serve as a useful risk management tool with a significant impact on a firm's hedging activities. Lee (2018) shows that these contracts are used to help firms achieve their sales targets. Moon and Philips (2021) further argue that firms with SCH are likely to use less leverage to reduce the hold-up problems related to relationship-specific investments. Noh (2022) shows that firms increase (decrease) investment if they have substitutive (complementary) competition strategies after the SEC's mandatory PO disclosure requirement in 2003. However, existing studies have paid little attention to the impacts of PO usage on the cost of debt.

PO is an important hedging tool that is widely used to reduce future cash flow uncertainty and could affect financing costs. Almeida et al (2017) find that 21.5% of nonfinancial firms use PO as a hedging tool. Prior literature documents that hedging is associated with higher firm values (Carter et al. 2006), lower stock return volatility (Bartram et al. 2011), lower idiosyncratic risk, and systematic risk (Bartram et al. 2011). Intuitively, supply chain hedging can protect firms against future input price increases and help them to meet obligations (Campbell & Kracaw 1990, Bessembinder 1991). However, the usage of PO fixes future input prices and purchase amounts, reducing firms' flexibility to curtail production when future demand is unexpectedly low and increasing the cost stickiness. Given that supply chain

hedging plays contrasting roles, it is unknown how the PO usage affects the risk pricing in loan contacts, as reflected in loan spreads and contractual restrictions, ex-ante.

Drawing on accounting theory (Arya et al. 2015), I first posit that supply chain hedging can lower the cost of debt through the input price fixing channel. PO usage can mitigate the impact of operational uncertainty and input price volatility for customer firms. Firms without POs may face difficulty purchasing raw materials at higher prices to meet their customers' demands when suppliers raise prices. POs, therefore, provide insurance against input price hikes. In addition, firms that rely more on POs have more agreements on future purchasing prices and quantities (Almeida et al. 2017). The predictable future input prices and demand communicated by POs can reduce cash flow uncertainty and lower creditors' concerns, thus resulting in a lower cost of debt (Smith & Stulz 1985).

Second, increased PO usage indicates that suppliers are more committed to maintaining long-term relationships, thereby reducing the firm's bankruptcy risk. When suppliers invest in relationship-specific assets after signing the contract, they are vulnerable to financial losses if the borrower firms go bankrupt, as these assets have limited value outside the supply chain (Crawford 1990). The interest alignment motivates suppliers to help the borrower firms during the bad time and results in lower bankruptcy risk. For example, suppliers can provide more trade credit that allowing customer firms repay at a later scheduled date if they believe it is a short-term cash flow shock. Moreover, prior studies show that suppliers have a better information advantage than other financial intermediaries (Petersen & Rajan 1997). As more PO usage implies that even well-informed suppliers are willing to sustain long-term business relationships with borrowers, lenders may perceive firms with more supply chain hedging as having lower default risk, thereby reducing the cost of debt.

Third, mandatory disclosure of PO usage on financial reports provides quantitative information for creditors to assess borrowers' performances, reducing the level of information

asymmetry and leading to a lower cost of debt (Duffie & Lando 2001). Prior studies show that managers are better informed about firm performance than investors, and information asymmetry arises when costs of disclosure are high and managers have a private incentive to distort the information. Easley and O'Hara (2004) show that investors require higher returns when firms own more private information while DaDalt et al. (2002) suggest that hedging using derivatives could alleviate this problem by reducing noise related to exogenous factors and information asymmetry. Since the usage of PO provides additional information for creditors and reduces the future cash flow noise, it can reduce information asymmetry between creditors and borrowers and result in a lower cost of debt.

Fourth, POs offer the advantage of pre-determined amounts and dates of cash outflow. This enables managers to seek a debt-financing scheme that aligns with the cash needs at different dates. By matching the financing with specific cash outflows, firms can achieve more efficient debt-financed operations. Hence, it can lead to a reduction in the overall cost of debt. The ability to synchronize debt financing with cash requirements enhances financial planning and optimization, ultimately contributing to lower borrowing costs for the organization.

Although the above arguments suggest that PO can decrease cash flow volatility, information asymmetry, and bankruptcy risk, and improve debt-financing plan, they can also lead to higher financing costs due to cost stickiness. When firms use POs, they are committed to maintaining a fixed input quantity and cash outflow, even if future demand drops. Furthermore, there are significant costs associated with breaching a PO contract, including compensation, loss of supplier relationship, and reputational damage (Golden, Mashruwala, & Pevzner 2020). Additionally, firms may invest in hiring new employees and increasing capacity after securing raw material sources through POs, reducing their flexibility to cut costs in the future. Cost stickiness is particularly problematic when future demand projections are too optimistic at the time of signing the PO. Prior literature shows that cost stickiness is associated

with higher earnings volatility and less accurate analyst forecast which leads to higher credit risk (Weiss 2010, Homburg et al. 2018). As a result, the risk embedded in PO could be priced in loan spread, potentially resulting in a higher cost of debt.

Overall, I predict that the beneficial effects of PO on reducing borrowers' cash flow uncertainty, information asymmetry, and bankruptcy risk would outweigh its adverse effects of worsening cost stickiness on debt financing costs. Thus, I form the following hypothesis in an alternative form:

H1 Supply chain hedging is negatively associated with the cost of debt.

Next, I investigate if prior relationships with suppliers moderate the association between supply chain hedging and debt financing cost. First, a closer relationship with suppliers implies a positive outlook. Petersen and Rajan (1997) document that suppliers have better information about customers' financial conditions than other financial intermediaries because they pay close attention to their order size and frequency. Goto et al. (2015) show that suppliers provide trade credit to loss-making customers promising future sales potential, which signals the prospects of the customer firms and alleviates information asymmetry between lenders and borrowers. Building on the above discussion, higher-value PO contracts agreed upon by a firm's long-term suppliers may serve as a signal of the firm's financial health and prospects to creditors.

Second, closeness in supply chain networks represses opportunism, enhances coordination, and facilitates information sharing, ultimately enhancing the effectiveness of supply chain contracts. Customers and suppliers are typically bounded by incomplete contracts (Williamson 1996). Either of them usually has incentives to extract quasi-rent due to differences in bargaining power and ability of redeploying production capacity (Handley & Benton 2012). For example, according to the incomplete contract, suppliers can force their

customers to purchase products or services even if there is a sudden decrease in demand. However, a closer relationship, such as common institutional ownership, can help to mitigate this risk and promote collaboration between parties, maximizing their joint benefits (Cheung et al. 2020). Therefore, the usage of PO with a closer supplier tends to have less quasi-rent extraction from suppliers and counterpart risk, resulting in lower operations risk.

Third, when borrowers have a closer relationship with their suppliers, creditors may expect the suppliers to provide support during tough times, thereby reducing the borrower's bankruptcy risk. This expectation is driven by the fact that suppliers may have invested in relationship-specific assets immediately after signing the contract with the borrower. As these assets are typically less valuable outside the supply chain (Crawford 1990), suppliers may suffer significant losses if the borrower firms go bankrupt. Thus, the alignment of interests between suppliers and borrowers can motivate suppliers to assist the borrower firms during difficult times, resulting in lower bankruptcy risk.

Hence, I propose the second hypothesis as follows:

H2 The negative relation between supply chain hedging and the cost of debt is more pronounced when the firms have closer relationships with suppliers.

I then predict that the benefit of PO usage varies with information environments. Sell-side analysts are information intermediatory by collecting, processing, and distributing information about firms to investors (Kirk et al. 2014). Banks rely on the information contained in borrowers' financial statements when making lending decisions. However, when financial statements are difficult to interpret, lenders may rely on information intermediaries to decode the information. For example, Mansi et al. (2011) document that firms with more analyst following and better analyst forecast quality are associated with a lower cost of debt.

Analysts provide new information for investors to assess the firm's performance and

operating risks. When a borrower firm discloses PO usage information, creditors may not be able to access its impact on borrowing risk because PO usage could increase the cost stickiness and decrease future input price fluctuations simultaneously. Moreover, POs can be interpreted as managers' forecasts of future performance which cannot be verified by investors (Lee 2021). Hence, more usage of PO is associated with higher information asymmetry between investors and managers. As the amount of POs communicates future raw material supply and the input level of production, this information is an important piece of the "mosaic" for financial analysts to make better forecasts. Thus, reports produced by sophisticated analysts who routinely track firms and their related counterparties (such as suppliers and peers) can help creditors gain more insight into the firm's future prospects. Meanwhile, the mandatory disclosures of POs in 10-K reports are an alternative source of information combined with analysts' reports for creditors to access firms' credit risks. Thus, I state the following hypothesis:

H3 The negative relation between PO usage and the cost of debt is more pronounced when the firm has better information intermediation.

The primary objective of forward purchase contracts is to reduce input price fluctuations and maintain stability in the supply chain procurement (Almeida et al. 2017). The effectiveness of these contracts is expected to be more significant for firms with weaker bargaining power in the market. In contrast, powerful customer firms with larger market shares possess the ability to negotiate favourable prices with suppliers. As a result, these firms prefer higher flexibility in determining input prices, making the role of PO contracts in price fixation less important. Consequently, the impact of PO contracts is expected to be less pronounced for firms that have a larger market share compared to their industry peers. Conversely, firms with smaller market shares face limitations in bargaining power when it comes to securing favourable prices after demand is realized. Therefore, it is anticipated that firms with lower

bargaining power rely more on PO contracts to mitigate price volatility and minimize disruptions in the supply chain.

H4 The negative relation between PO usage and the cost of debt is more pronounced when the firm has a smaller market share compared with industry peers.

3. Methodology

3.1 Data

The supply chain hedging data is manually collected from the 10-K financial reports. First, I identify the keywords related to SCH such as purchase obligation, purchase commitment, and order commitment, and use the computer program to extract the PO amount in the corresponding table where the keywords are located. Given that the format of reporting PO varies across firms and time, I manually check whether the number correctly captures PO and excludes other obligations such as capital obligations. The final extraction includes the total purchase obligation, and PO that needed to be fulfilled in 1 year, 2-3 years, 4-5 years, and over 5 years. Bank loan information is extracted from the Dealscan database which includes loan spread, nonprice terms, loan size, and maturity information. Following prior literature, the cost of debt is proxied by the all-in spread drawn (in bps) which is borrower's payout including recurring annual fees beyond the London Interbank Offered Rate (LIBOR). Other accounting data is collected from the Compustat database. Customer-supplier linkage is collected from the Compustat Segment database. Analyst forecast data is extracted from the IBES database. The sample period is from 2003 to 2016 because the listed firms are required to report their PO since 2003. All the continuous variables are winsorized at 1% and 99%.

3.2 Regression Specifications

The main analysis relies on loan-year-level panel regression as follows:

$$Cost\ of\ Debt_{ijt} = \beta_0 + \beta_1 supply\ chain\ hedging_{it} + \beta_k\ (Firm\ Characteristics_{it} + Loan\ Charateristics_{ijt} + Macro.\ \ Variables_t) + Fixed\ Effects \quad (1)$$

where *cost of debt* is the natural logarithm of loan spread and nonprice terms dummies of loan *j* of firm *i* in year *t*; supply chain hedging is the total purchase obligation to total asset ratio of firm *i* in year *t*. Firm characteristics are included in the regression as control variables such as size (control for the ability to access external financing and information asymmetry), Tobin's Q (control for firm growth opportunities), book leverage (control for existing leverage), profitability, tangibility and Modified Altman's Z-score (control for default risk), cash-flow volatility (control for earnings risk) and hedging using commodity derivatives (Campello et al. 2011; Chen & King 2014). For the loan-level control variables, I control for (1) loan maturity since longer maturity is associated with higher credit quality, (2) loan size as it is related to economies of scale and (3) performance-pricing indicators because such loans could have different structures that affect the loan spread. I also control for credit spread which is the difference in yields between BAA and AAA; and term spread which is the difference in yields between 10-year and 2-year Treasury bonds. The loan-type fixed effect, loan-purpose fixed effect, firms fixed effect, and year fixed effect are included in the model.

Based on the prediction of *H1*, I expect that the coefficient on *supply chain hedging* (β_1) is negative and significant, i.e., firms that use more PO as a supply chain hedging tool tend to have lower costs of debt.

4. Results

4.1 Supply Chain Hedging and the Cost of Debt

Table 1A reports the summary statistics of the variables used in our data analysis. The final sample includes 19,196 firm-year observations during the period between 2003 and 2016. The mean loan spread is 227.11 basis points (bps) with a standard deviation of 153.29 bps. The mean value of the key independent variable – aggregate purchase obligation to the average total asset (*PO/asset*) is 0.05. It implies that the amount of supply chain hedging accounts for around 5% of the total asset on average. Table 1B shows that the percentage of firms that reported non-zero purchase obligations increase from 22.68% in 2003 to 56.09% in 2016. Among the firms that reported non-zero purchase obligation, the mean of *PO/asset* is 12.72% and consistently above 10% over the sample period except 2016. Panel C reports the differences in firm characteristics between the report and non-report firms. It shows that if a firm engages in supply chain hedging, it has a lower (higher) loan spread, and cash flow uncertainty (firm size, profitability, Z-score, number of analysts following, maturity, loan size, performance price, and term spread). Overall, hedging using supply chain contracts become more important over time and it accounts for a significant amount of the total asset.

Table 2 is the correlation matrix, which reports the relation between the proxy of supply chain hedging (*PO/asset*) and the cost of debt (*ln_loan_spread*). In particular, *PO/asset* is negatively and significantly correlated with the logarithm of loan spread (-0.044, $p<0.01$). It indicates that firms that engage in more supply chain hedging tend to have lower costs of debt. The univariate analysis is consistent with *H1*.

Table 3 reports the empirical findings on the relation between supply chain hedging and the cost of debt. Columns (1) and (2) show the results of equation (1) excluding and including the control variables respectively. The coefficient on *PO/asset* is negative and significant (β_1 = -0.106, $p < 0.01$ and β_1 = -0.085, $p < 0.05$). Given that the mean of *ln(loan spread)* is 5.18,

it implies a one standard deviation increase in supply chain hedging, the loan spread is reduced by 2.55 basis points[1].

The coefficients on the control variables are generally consistent with prior literature. The coefficients on *ln_size* are significant and negative indicating that larger firms tend to have a lower cost of debt. *profitability* and *tobins_q* are also significantly negative, implying that profitable and high-growth-opportunity firms are more likely to have a lower borrowing cost. *book_leverage*, *cf_volatility*, and *Z_score* are positively significant which indicates that higher liquidity risk, cash flow uncertainty, and bankruptcy risk are associated with the higher cost of debt. Consistent with Mansi et al. (2010), I show that the coefficients on *analyst_fol* are significantly negative, suggesting that a firm's information environment is negatively associated with its cost of debt. For the loan-level characteristics, the results indicate that loans with a shorter maturity, larger loan size, performance pricing requirements, and previous borrowing records tend to have a lower spread. Overall, the results are consistent with *H1* which suggests that supply chain hedging is negatively associated with the cost of debt.

I next use alternative proxies for measuring POs and restrict the sample to ensure the robustness of the main results. Given the number of borrowings reduced during the financial crisis (2008 and 2009), column 3 reports the results of equation (1) excluding that period and the results still hold. Columns 4 and 5 report the results of equation (1) using alternative proxies for supply chain hedging. In particular, they are purchase obligations of the next 5 years and total purchase obligations to cost of goods sold ratio[2]. The results coefficients remain negative and significant. I also measure the present values of POs using 8% as the discount rate. The results in columns (6) and (7) are still significantly negative. Column (8) shows that the

[1] Although the economic impact of PO on the cost of debt is quite small here, the magnitude becomes larger in the following subsample tests. The potential reason for small magnitude in the main test is that lenders may consider both price fixation and cost stickiness effects. The detailed discussion can be found in the path analyses in Section (7).

[2] I exclude the service and financial industry in the analysis of Column 5 as inventory costs of firms in these industries are not important component.

coefficient is -0.094 with a significant level at 1%. It suggests that the results are not driven by financial industry firms in the sample. Overall, the results from columns (3) – (8) suggest that the baseline results are robust to alternative measures of SCH and alternative regression specifications.

4.2 Cross-Sectional Analyses

4.2.1 Supplier Closeness

I conduct cross-section tests to examine whether the negative relation between SCH and the cost of debt is more pronounced for firms with closer relationships with their suppliers. In *H2*, I expect that supply chain hedging with PO secures the future relationship with suppliers who are an important source of short-term liquidity. Suppliers may have a stronger incentive to support the customers with more PO under the bad state to ensure their short-term survival by providing more trade credit to mitigate the entire loss of customer-specific investments. Hence, the use of PO may lower the bankruptcy risk of customer firms and reduces the cost of debt. To test *H2*, I divide the sample into two groups based on the proxies of the closeness with suppliers. The first proxy is the average duration of customer-supplier links from the Compustat Customer Segment database[3]. A firm with a longer supply chain relationship with a specific supplier implies that they are dependent on each other and likely have a closer relationship[4]. I use average duration since a customer can have multiple suppliers. Another proxy is the common institutional investor (CII) of a supply chain that contains one supplier and one customer. Following Cheng et al. (2018), I collect the CII data from the Thomson Reuters Institutional (13F) Holdings database and measure the percentage of CII as follows:

[3] Listed firms are required to disclose the major customers that account for more than 10% of current sales. I employ a reverse engineer to identify the suppliers by using the links reported by the supplier firms.
[4] Dasgupta et al. (2021) find that social connections such as school ties and third-party employment connections are positively associated with the duration of supply chain relationship

$$CIICO_{it} = \sum_{j=1}^{J} CIICO_{itj} \times Customer\ ownership_{itj}$$

where j denotes the common institutional investor of a supply chain i where include one customer and one supplier. $CIICO_{it}$ is the percentage of CII j's shareholding in supply chain i, whichever is lower, in year t. Specifically, $CIICO_{itj}$ represents the ownership percentage of institution j that is lower between the customer and the supplier. [5] $Customer\ ownership_{itj}$ is the customer's ownership percentage of institution j.

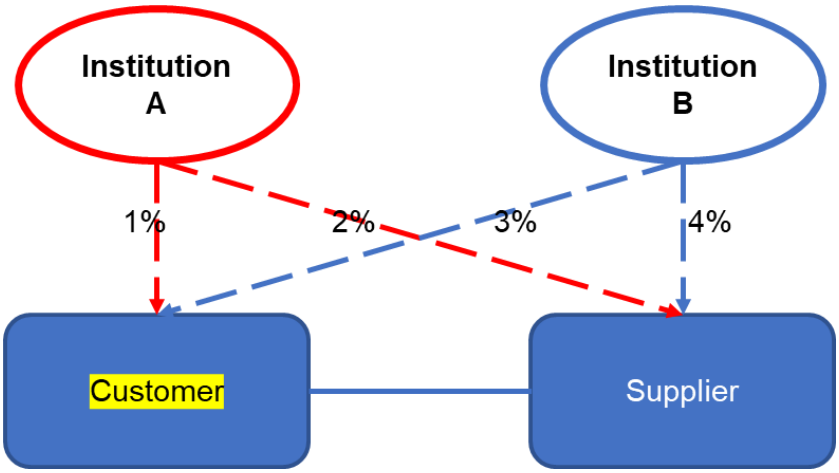

Figure 1 Illustration of the measurement for $CIICO_{it}$

To aggregate the observations from the relationship level to the customer level, I calculate the percentage of purchases made from each supplier. Since a customer may have multiple suppliers, this approach enables me to capture the overall relationship between the customer and its suppliers. A higher value of *CIICO* implies that the customer has a higher percentage of CII with its supplier.

Table 5 reports the results of the cross-sectional tests for the supplier relationship channel. In columns (1) and (2), the coefficients on *PO/asset* are -0.380 for *High* and 0.176 for *Low* average duration of supplier chain relationship, respectively. The coefficients on *PO/asset*

[5] For example, in a supply chain with one customer and one supplier, institution A has 1% of customer's ownership and 2% of supplier's ownership and institution B has 3% of customer's ownership and 4% of supplier's ownership. CIICO is min(1%, 2%) × 1% + min(3%, 4%) × 3% = 0.1%. Figure 1 illustrates the supply chain and institution relationship of this example.

for *High* duration firms are significant at the 1% level while the coefficients for *Low* duration firms are not significant. Moreover, the difference between the coefficients for the *High* and *Low* group is statistically significant at the 1% level. Columns (3) - (4) exhibit a similar pattern for common ownership in the supply chain. Overall, the results in Table 5 are consistent with the prediction of *H2* that the negative relation between supply chain hedge and the cost of debt is stronger when a firm has closer relationships with suppliers.

4.2.2 Information Environment

Next, I conduct cross-section analyses to test the moderating effect of the information environment. *H3* predicts the negative relation between SCH and the cost of debt is more pronounced when the firms have a better information environment. Panel A of Table 6 shows that the coefficient on *PO_report* is negative in column (1) for firms with high analysts following and it is positive (β_1=0.054, p<0.05) in column (2) for firms with low analyst following. The difference between the coefficients in the *High* and *Low* column are statistically significant. The results imply that the main results are concentrated on firms with a better information environment and the creditors may not be able to interpret the borrowing risk associated with SCH under a poor information environment. Hence, when a firm reports POs and has fewer analyst following, the uncertainty is priced in the loan spread and result in a higher cost of debt.

In Panel B, I replace the PO dummy (i.e., *PO_report*) with *PO/asset*. The results show that the negative relation between SCH and the cost of debt is stronger for firms with lower analyst forecast errors (β_1=-0.286, p<0.01) and lower forecast dispersion (β_1=-0.176, p<0.01). Also, the coefficient on *PO/asset* is significantly negative (β_1=-0.142, p<0.1) when the firm is in the high analyst following group. Overall, the results are consistent with the prediction of *H3* that the negative relation between PO usage and the cost of debt is more pronounced when

the firm has better information environments. Add to prior literature, I document that financial analysts play an important role in processing and transmitting the PO information to creditors.

4.2.3 Bargaining Power

Subsequently, I perform cross-sectional analyses to examine the moderating effect of the bargaining power of the focal customer firms. *H4* predicts the negative relation between SCH and the cost of debt becomes more prominent when the firms possess limited bargaining power. To test the hypothesis, I divide the sample into two groups based on the proxy of bargain power which is the firm's market share. It is defined as the proportion of a firm's sales relative to the total sales within the same industry for a given year.

Table 7 reports the empirical results in which the coefficient on *PO_report* is insignificant in column (1) for the subsample with high market share while it is negative and significant in column (2) for firms with low market share. The difference between the coefficients in the *High* and *Low* subsample are statistically significant with a p-value less than 0.01. The results indicate that the findings are concentrated on firms with a low bargaining power as they need the PO contracts to secure the future input price fluctuations. Meanwhile, customer firms with larger market shares wield significant bargaining power, enabling them to negotiate favourable prices with suppliers. These firms prioritize flexibility in determining input prices and the role of PO contracts in input price fixing become less important. Overall, the results are consistent with the prediction that the impact of market share on the main findings is more pronounced for firms with lower market shares in comparison to their industry counterparts.

4.3 Robustness Tests

4.3.1 Initiations and Suspensions of Supply Chain Hedging and the Cost of Debt

To examine the effects of SCH on the cost of debt and address the endogeneity concerns, I employ the setting that firms initiate and suspend SCH during the sample period. After removing the observations that do not have the necessary information to construct the main and control variables, I find 190 firms initiate SCH and 65 firms suspended SCH in the sample period. The initiation firm is defined as those who do not exhibit SCH from the beginning of the sample period in 2003, and initiate SCH during the sample period. The suspension firm is defined as those exhibiting SCH during the sample period but suspending it before the end of the sample period in 2016. After identifying the initiation and suspension firms, I employ the propensity score matching (PSM) technique to match them with the non-SCH firms. Specifically, I conduct one-to-one matching based on firm characteristics including size, growth opportunities, leverage, profitability, tangibility, operating risk, default risk, and the number of analysts following. The final sample includes 190 (65) SCH initiation (suspension) firms and 190 (65) control firms.

To test whether SCH initiations and suspensions affect loan spread, I use the change-based regression specification. In particular, I regress the change in loan spread on initiations or suspensions dummy and other control variables. The firm and loan-level variables are replaced by their change from year *t-1* to year *t* where year *t* is the year of initiation or suspension[6]. I include industry fixed effects instead of firm fixed effects because the later will absorb all the variation of control variables[7]. The initiations and suspensions dummies equal one if the firm initiates or suspends SCH in year t, and zero otherwise. The results in Table 4, Panel A show that the coefficient on initiations is negative and significant (-31.09) and the of

[6] The analysis in this section is based on firm-year-level observations. If a firm has multiple loans in the same year, I only include the one with the largest size and/ or longest maturity.
[7] Industry is defined base on 2-digit SIC.

suspension is positive and significant (69.09) at a 1% level. The results indicate that, on average, the loan spread is reduced (increased) by 31.09 (69.09) base points after SCH initiation (suspension) compared to the control firms. The findings support the argument that SCH benefits in reducing the cost of debt.

4.3.2 Hedging using Supply Chain Contract and Financial Derivative

To mitigate the omitted correlated concerns, I include financial hedging as an additional control variable. Prior literature has documented a negative relation between hedging using financial derivatives and the cost of debt (Campello et al. 2011; Chen & King 2014). Although the use of derivatives is also required to state on the financial reports[8], creditors may not be able to distinguish between hedging and speculating purposes as the derivatives can be re-sold in the secondary market. Given that supply chain contracts cannot be sold to other firms, it is more likely that PO plays as a hedging tool instead of a speculative instrument. Thus, it is expected that the impact of hedging using POs on the cost of debt remains significant after controlling for the usage of financial hedging.

Table 4 Panel B reports the results of equation (1) including the financial hedging as a control variable. Specifically, I use the one plus the number of financial hedging keywords in 10-K reports (*fxhedge*) as the proxy of financial hedging. This data is compiled by Hoberg and Moon (2017). Column (1) shows that the coefficient on *fxhedge* is negatively significant (β_1=-0.086, p<0.01) without including the SCH and other controls. The result is consistent with prior literature the financial hedging is associated with a lower cost of debt. Column (2) show that the coefficient on *PO/asset* remains consistent with the baseline inference after controlling for financial hedging.

[8] Financial Accounting Standards Statement No. 133, "Accounting for Derivative Instruments and Hedging Activities"

4.3.3 Instrumental Variable Analyses

Next, I conduct instrumental variable (IV) analysis to mitigate the endogeneity concerns on the relation between SCH and the cost of debt. A valid instrumental variable should satisfy the inclusion and exclusion restrictions. I thus use import penetration and distance to the nearest entry port as instrumental variables (Hombert & Matray 2018, and Moon & Phillips 2021). Following Moon & Phillips (2021) and Chen et al. (2023), import penetration is measured by the industry-level total import value and divided by the summation of GDP and total import. Then, I transform it to indicator variable if the value exceeds one percent. For the exclusion restriction, it is unlikely that loan contract terms are directly affected by firms' involvement in industries with high import penetration. For the inclusion restriction, Moon & Phillips (2021) show that higher import penetration is associated with higher PO usage. In particular, outsourcing companies typically participate in offshore procurements especially when the firms have few fixed assets before the import penetration shock (Moon & Phillips 2021). Import penetration often leads to increased competition from foreign suppliers offering lower-cost products. In response, firms choose to use PO contracts with these suppliers to take advantage of the cost savings and access to specialized expertise they offer.

The second IV is the minimum distance between the firm's operating location and the nearest entry port. Port of entry includes airports, border crossings and seaports in the U.S. Airport data is collected from the Passenger Boarding and All-Cargo Data from the Federal Aviation Administration website[9]. Mexican border crossings and Canadian border crossings with truck traffic information are extracted from the US transborder website[10]. The seaport data is collected from the Port Import Export Reporting Service from the Maritime Administration's website[11]. Firm's historical headquarters are collected from 10-K fillings. After calculating the

[9] https://www.faa.gov/airports/
I only consider airports with cargo services in the information.
[10] http://transborder.bts.gov/
[11] The sources http://www.marad.dot.gov/

distance to the nearest port, I then construct an indicator variable that equals one if the distance is in the lowest tercile of the sample (Moon & Philips 2021). For the inclusion restriction, Moon & Phillips (2021) find that firm with closer distance to the port of entry tend to use more PO contracts. Being geographically closer to the port of entry provides firms with easier access to a wider range of suppliers and resources. Moreover, closer to the port reduces transportation costs and time, allowing firms to receive imported goods more quickly and efficiently. For the exclusion condition, it is unlikely that the loan contract terms are determined by the location of port of entry and firm's headquarters.

Table 4 Panel C reports the results of the IV analyses. Column (1) shows the first-stage of the IV test. The coefficient on import penetration (*dimport_pen*) and close to port of entry (*close port*) indicators are positive and significantly associated with *PO/Asset* which implies that firms in the industry with higher import penetration and closer to any port of entry tend to use more POs. The LM statistic is for the test of null hypotheses of underidentification in the instrument. The test demonstrates statistical significance at the 5% level which suggests that the model is not underidentified, as the statistic significantly differs from zero. Hence, import penetration and close the port indicators likely satisfy the inclusion restriction as a valid IV. Column (2) reports the result of second-stage regression. The coefficient on instrumented *PO/asset* is significant and negative at the 5% level. Overall, the results are consistent with the hypothesis that SCH can reduce firms' borrowing costs.

4.3.4 Tests for Alternative Explanation

This section aims to address the concern of the potential alternative explanation that firms with low demand variability tend to engage in more hedging activities. Meanwhile, these firms have lower costs of debt when the demand uncertainty is low. Hypothesis 1 proposes a

I only consider the seaport have an import value greater than 500 Twenty-Foot Equivalent Units (TEUs).

negative association between SCH and the cost of debt when the cost of signing PO contracts being sufficiently low and the associated benefits being sufficiently high. In other words, customer firms opt for SCH when the expected volatility in demand is lower than the volatility in input prices, and when they can benefit from increased protection against input price fluctuations. Hence, lower in the cost of debt could be the result of lower demand variability instead of the hedging activities.

To disentangle the effects of demand volatility on the cost of debt, I first test whether firms with higher demand volatility tend to use more SCH. Specifically, I regress *PO/asset* on the proxy of demand volatility which is defined as the standard deviation of sales to the mean of sales in a five-year rolling window. Column (1) of Table 4 Panel D shows that demand volatility is not significantly associated with SCH during the sample period. It implies that firms' hedging decisions are not likely determined by demand uncertainty after considering other factors. Next, I employ propensity score matching (PSM) to match the firms with and without SCH. Specifically, the treatment and control groups are matched using firms' characteristics including demand volatility and other firm-level control variables in equation (1). Column (2) demonstrates that the coefficient of *PO/asset* remains negative and significant. Overall, the results in this section suggest that the main findings are unlikely to be driven by fundamental characteristics, such as demand volatility, of the hedging firms.

5. Mechanisms Through which PO Usage Affects the Cost of Debt

It is possible that PO exerts both a positive and negative effect on the debt financing cost through fixation on future input prices. To unravel the underlying mechanisms, I use path analysis to assess whether more PO usage resulted in changes in two intermediary variables: price protection and cost stickiness.

Regarding price protection, I predict that more PO usage leads to better price protection

because PO can protect the focal firm against suppliers by fixing future input prices. Suppliers cannot exploit the buyer by increasing the input prices when the buyer reveals a high product demand (Arya 2015). As prior studies (Almeida et al. 2017) show that better price protection facilitates firms to reduce operational and cash flow uncertainty, I predict the mediating effect of PO on the cost of debt through the price protection channel to be negative.

Turning to cost stickiness, I expect a positive indirect effect of PO usage on debt financing costs as managers cannot curtail the costs even if the realized demand is lower than expected after signing future purchasing contracts. One stream in operations management emphasizes operational flexibility, which is arising from the use of overcapacity and stochastic recourse (Huchzermeier 1991). Specifically, firms can postpone logistics decisions, change production and procurement strategies in response to demand and exchange rate uncertainties, restructure the supply chain network, retain the excess capacity, and delay the final obligations of capacity investments to reduce exposures in the long run and downside risks (Ding & Kouvelis 2001, Cohen & Huchzermeier 1999, and Huchzermeier & Cohen 1996). However, PO usage reduces the above operational flexibilities by fixing the future procurements price and amount from a specific supplier. Specifically, PO contracts include exchange of raw materials and services. If the realized demand is lower than the expectation at the time the contract is signed, the customer firm still needs to pay the service providers such as utility or transportation expenses. Although the unsold raw materials or products can be recorded as assets and carried forward to next fiscal periods, the associated holding and spoilage costs have to be included in the current fiscal period. These expenses are directly arise from PO contracts and cannot be curtailed even when the demand is lower than expectation. Hence, PO usage can induce higher cost stickiness and credit risk and thus, increase the cost of debt (Homburg 2018).

Overall, I predict a net positive effect of PO usage on debt financing if the negative mediating effects via the price protection channel outweigh the positive indirect effect of cost

stickiness, considering debtholders mainly focus on downside risks. Following prior literature (e.g, DeFond et al. 2016), I examine the following framework:

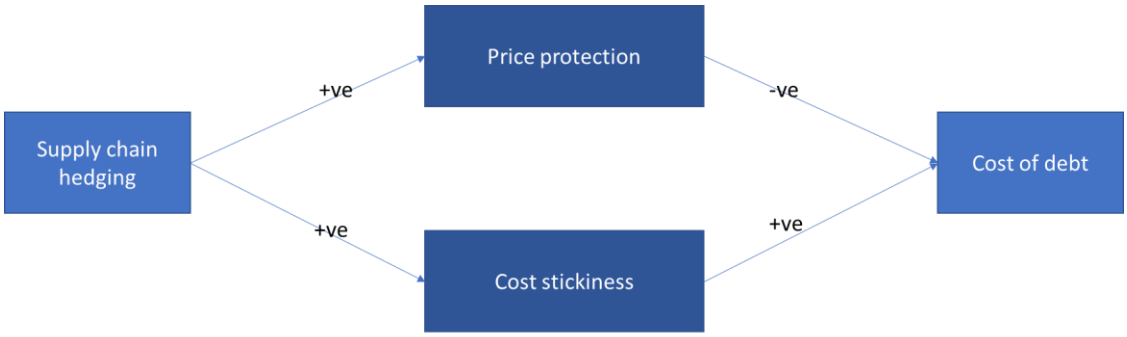

Figure 2 Path analysis

To test the mediating effects, I conduct path analysis using the following regressions:

$$sticky_{it} = \beta_0 + \beta_1 Supply\ chain\ hedging_{it} + \beta_k\ (Firm\ Characteristics_{it} + Loan\ Charateristics_{ijt} + Macro.\ \ Variables_t) + Fixed\ Effects \quad (2)$$

$$price\_protection_{it} = \beta_0 + \beta_1 Supply\ chain\ hedging_{it} + \beta_k\ (Firm\ Characteristics_{it} + Loan\ Charateristics_{ijt} + Macro.\ \ Variables_t) + Fixed\ Effects \quad (3)$$

where $price\_protection_{it}$ is proxied by the minus one time the number of financial hedging-related keywords in 10-K reports (Hoberg & Moon 2017). Almeida et al. (2017) show that financial hedging tools are a substitute for POs. Because not all firms can hedge using financial derivatives, firms have more financial hedging indicating that they require lower price protections through POs.

$sticky_{it}$ is the measure of cost stickiness following Weiss (2010). It is measured using quarterly data as follows:

$$sticky_{i,q} = -(\ln\left(\frac{\Delta cost}{\Delta sale}\right)_{i,\underline{\tau}} - \ln\left(\frac{\Delta cost}{\Delta sale}\right)_{i,\overline{\tau}}\ \underline{\tau}, \overline{\tau} \in \{q, \dots, q-3\})$$

where $\underline{\tau}$ denotes the latest quarter with a drop in sales and $\overline{\tau}$ denotes the latest quarter with an

increase in sales [12], $\Delta sale_{iq} = sales_{iq} - sales_{i,q-1}$, $\Delta cost_{iq} = (sales_{iq} - ib_{iq}) - (sales_{i,q-1} - ib_{i,q-1})$, and ib_{iq} is income before extraordinary items. I then aggregate the quarterly measure into annual data. $sticky$ measures the difference in cost-sale relation between the most recent quarters with sales decrease and the one with sales increase. Hence one quarter has a sales increase while one has a sales decrease. The proposed metric has a negative value if the cost is sticky, that is if the cost increases more when activity increases than when activity decreases by a corresponding amount. To make it consistent with the underlying construct, I multiply the measure with minus one so that a higher value of $sticky$ implies higher cost stickiness. I also include the relevant control variables and fixed effects as described in the previous sections.

Table 8 reports the results of the path analysis. Columns (1) and (2) show that the coefficients on *PO/asset* are positive and significant which indicates that the firm with more SCH is associated with higher cost stickiness (β_1 = 0.008, p < 0.05) and price protection (β_1 = 0.008, p < 0.01). The economic magnitudes for both relations are significant but higher for the price protection model. Given the standard deviation of *sticky* is 0.15 and the mean of *PO/asset* is 0.051, one standard deviation increase in SCH is associated with a 2.4% increase in cost stickiness. Similarly, given the standard deviation of *price_protection* is 1.096, one standard deviation increase in *PO/asset* is associated with a 17.54% increase in the proxy of price protection. Column (3) reports the result of equation (1) with additional independent variables (*sticky* and *price_protection*). Although the coefficient on *PO/asset* is negative, its statistical significance becomes weaker (β_1 = 0.09, p < 0.1). The results show a positive but insignificant coefficient on *sticky* ($\beta = 0.002, p > 0.1$), while the coefficient on *price_protection* is negatively significant. It implies that the price protection channel is one of the important

[12] If there is no increase or drop in sales in the last 4 quarters, $sticky_{i,q}$ is considered as a missing value for that quarter.

mediating factors for the negative relation between SCH and the cost of debt. Overall, the results are consistent with the prediction that the effect of PO usage on debt financing via the price protection channel dominates the indirect effect of cost stickiness.

6. Conclusion

This study tests the relation between supply chain hedging and the cost of debt. I use purchase obligation, which is hand collected from the 10-K report, as a proxy for supply chain hedging. I find a negative relation between SCH and the cost of debt. The results are consistent with the hypothesis that SCH using PO can effectively reduce input price fluctuations which leads to lower credit risk. Moreover, the negative association is more pronounced when the firms have closer relationships with suppliers, better information intermediation and limited bargaining power. Further, the robustness of the results is ensured by accounting for endogeneity through various approaches, including tests for the initiation and suspension of supply chain hedging, instrumental analysis, and controlling for financial hedging. The results in the path analysis indicate that the price protection channel dominates the cost stickiness channel and resulting in a lower cost of debt. Overall, this paper suggests that the usage of POs as risk management tools significantly affects borrowing costs.

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Appendix A

Table 1 Distribution of the sample

Panel A *Summary statistics*

	Observations	mean	sd	p25	median	p75
loan spread (bps)	19163	227.11	153.29	125.00	200.00	300.00
ln_loan_spread	19163	5.18	0.76	4.83	5.30	5.70
PO/asset	19163	0.05	0.14	0.00	0.00	0.02
PO_report	19163	0.38	0.49	0.00	0.00	1.00
Total Asset (m)	19163	12244.56	46019.75	668.88	2116.51	7544.77
tobins_q	19163	1.81	1.01	1.18	1.52	2.07
book_leverage	19163	0.36	0.24	0.18	0.33	0.50
profitability	19163	0.13	0.09	0.08	0.12	0.17
tangibility	19163	0.32	0.28	0.09	0.23	0.51
cf_volatility	19163	0.04	0.04	0.02	0.03	0.06
Z_score	19163	1.40	1.37	0.48	1.32	2.25
analyst_following	19163	1.83	1.16	0.69	2.20	2.77
maturity (month)	19163	50.93	20.71	36.00	60.00	60.00
loan size	19163	896.54	1496.52	150.00	400.00	1000.00
performance_price	19163	0.39	0.49	0.00	0.00	1.00
credit_spread	19163	101.64	39.05	81.00	92.00	110.00
term_spread	19163	142.14	89.37	77.00	150.00	225.00

Panel B *Year distribution*

Fiscal Year	% of firms reported non-zero PO	N	mean of PO/asset (PO firms)	N
2003	22.68%	1,887	13.80%	428
2004	27.56%	1,952	17.42%	538
2005	32.90%	1,839	14.61%	605
2006	33.67%	1,797	12.07%	605
2007	33.83%	1,342	15.96%	454
2008	29.38%	793	12.39%	233
2009	34.41%	863	11.05%	297
2010	42.17%	1,297	15.24%	547
2011	47.40%	1,384	14.18%	656
2012	43.97%	1,319	11.35%	580
2013	47.09%	1,306	10.69%	615
2014	50.15%	1,316	10.46%	660
2015	52.43%	1,173	10.72%	615
2016	56.09%	895	8.24%	502
Total	38.28%	19,163	12.72%	7,335

Panel C Differences in loan spread and other control variables between the report and non-report firms

					(Ha: diff=0)
variable	non-report	report PO	diff		p-value
loan spread [bps]	233.189	220.884	12.305	***	0.00
size	11712.696	17476.814	-5764.118	***	0.00
tobins_q	1.819	1.820	-0.001		0.95
leverage	0.356	0.361	-0.005		0.16
profitability	0.125	0.129	-0.004	***	0.00
tangibility	0.322	0.321	0.001		0.77
cf_volatility	0.048	0.040	0.008	***	0.00
Z_score	1.351	1.458	-0.107	***	0.00
analyst_following	1.678	2.079	-0.401	***	0.00
maturity	49.889	52.743	-2.854	***	0.00
loan_size	848.141	1034.125	-185.984	***	0.00
performance_price	0.380	0.397	-0.017	**	0.02
credit_spread	101.968	101.100	0.868		0.13
term_spread	140.650	144.536	-3.886	***	0.00

Panel A shows summary statistics using all firms, presenting the mean, standard deviation, 25th percentile, median, and 75th percentile.

Panel B shows the percentage of firms that reported non-zero purchase obligations and the means of purchase obligation to total asset ratio.

Panel C reports the mean values and the differences in loan spread and other control variables between the report and non-report firms. The last column reports the p-value of the differences, and the second last column reports the significance of the differences. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively.

Table 2 Correlation Table

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]
[1]	ln_loan_spread	1														
[2]	PO/asset	-0.0440***	1													
[3]	ln_size	-0.340***	0.0797***	1												
[4]	Tobins_q	-0.125***	-0.0252***	-0.161***	1											
[5]	book_leverage	0.240***	-0.00863	0.0792***	-0.00109	1										
[6]	profitability	-0.195***	0.0174**	-0.0515***	0.424***	0.0281***	1									
[7]	tangibility	-0.0148**	0.0905***	0.0647***	-0.0771***	0.188***	0.0726***	1								
[8]	cf_volatility	0.168***	-0.00858	-0.365***	0.206***	-0.0516***	-0.0137*	-0.0687***	1							
[9]	Z_score	-0.222***	0.0627***	-0.0704***	0.160***	-0.305***	0.493***	-0.150***	-0.0407***	1						
[10]	analyst_following	-0.257***	0.0203***	0.415***	0.153***	-0.132***	0.147***	-0.0580***	-0.141***	0.126***	1					
[11]	ln_maturity	0.159***	0.00701	-0.0540***	0.0103	0.0915***	0.0940***	-0.0108	-0.0610***	0.0831***	0.0148**	1				
[12]	ln_loan_size	-0.236***	0.0530***	0.663***	-0.0273***	0.191***	0.0927***	0.0558***	-0.276***	0.0187***	0.319***	0.157***	1			
[13]	performance_price	-0.207***	0.0213***	-0.0324***	0.0504***	-0.111***	0.104***	0.0137*	-0.0216***	0.133***	0.0623***	0.0532***	0.0709***	1		
[14]	credit_spread	0.0901***	-0.00225	-0.00176	-0.102***	-0.0459***	-0.0607***	0.0182**	0.0345***	-0.0298***	0.0128*	-0.134***	-0.0692***	0.0267***	1	
[15]	term_spread	0.254***	0.00942	0.00201	-0.0802***	-0.0232***	-0.0557***	0.0123*	0.00436	-0.0220***	0.0512***	-0.0970***	-0.0113	-0.0509***	0.139***	1

Table 2 reports the correlation matrix. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively.

Table 3 Relation between supply chain hedging and cost of debt

	baseline	with control	non-financial crisis	PO_15_at	PO/cogs	PV(PO/asset)	PV(PO/cogs)	non-finance
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PO/asset	-0.106***	-0.085**	-0.065*					-0.094***
	-3.35	-2.88	-2.11					-3.14
PO_15_at				-0.110***				
				-3.38				
PO/cogs					-0.036**			
					-2.19			
PV(PO/asset)						-0.095**		
						-2.22		
PV(PO/cogs)							-0.047*	
							-2.16	
ln_size		-0.053***	-0.053***	-0.053***	-0.034*	-0.033*	-0.034*	-0.053***
		-3.61	-3.58	-3.63	-1.8	-1.79	-1.8	-3.13
tobins_q		-0.030***	-0.030**	-0.030***	-0.032**	-0.033**	-0.033**	-0.026**
		-3.08	-3.06	-3.06	-2.81	-2.79	-2.82	-2.84
book_leverage		0.386***	0.385***	0.386***	0.376***	0.370***	0.377***	0.412***
		10.3	10.11	10.25	7.54	7.46	7.54	10.3
profitability		-0.613***	-0.732***	-0.614***	-0.561***	-0.573***	-0.561***	-0.653***
		-3.95	-4.82	-3.95	-3.94	-4.01	-3.93	-4.55
tangibility		-0.047	-0.039	-0.048	-0.055	-0.061	-0.055	-0.051
		-0.6	-0.48	-0.62	-0.57	-0.62	-0.58	-0.6
cf_volatility		1.175***	1.275***	1.172***	1.426***	1.404***	1.426***	1.197***
		6.27	5.58	6.26	4.88	4.7	4.89	5.39
Z_score		-0.043***	-0.041***	-0.043***	-0.042***	-0.039***	-0.042***	-0.044***
		-4.83	-3.55	-4.8	-3.65	-3.23	-3.65	-4.44
analyst_following		-0.044***	-0.041**	-0.044***	-0.054***	-0.055***	-0.054***	-0.045***
		-3.6	-2.8	-3.58	-4.08	-4.15	-4.07	-3.61
ln_maturity		0.026	0.040*	0.026	0.021	0.022	0.021	0.032
		1.3	1.93	1.31	0.87	0.9	0.87	1.57
ln_loan_size		-0.111***	-0.118***	-0.111***	-0.103***	-0.103***	-0.103***	-0.107***
		-12.43	-12.77	-12.42	-9.93	-9.9	-9.92	-13.47
performance_price		-0.070***	-0.076***	-0.070***	-0.073***	-0.072***	-0.073***	-0.072***

	baseline	with control	non-financial crisis	PO_15_at	PO/cogs	PV(PO/asset)	PV(PO/cogs)	non-finance
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		-5.18	-5.65	-5.18	-4.46	-4.49	-4.47	-4.96
credit_spread		0.001***	0.001	0.001***	0.001***	0.001***	0.001***	0.001***
		4.22	1.63	4.21	3.98	4.04	3.98	3.87
term_spread		0.001**	0	0.001**	0.001*	0.001*	0.001*	0.001*
		2.23	1.57	2.23	2.08	2.05	2.08	2.14
previous_loan		-0.026**	-0.022	-0.026**	-0.031**	-0.031**	-0.031**	-0.026**
		-2.26	-1.69	-2.25	-2.49	-2.46	-2.48	-2.31
high_PO_at		0.007	-0.003	0.008	0.025*	0.025*	0.025*	0.013
		0.59	-0.26	0.6	1.87	1.88	1.89	1.03
hhi		-0.061	-0.095	-0.06	-0.036	-0.045	-0.036	-0.024
		-1.02	-1.47	-1	-0.6	-0.8	-0.6	-0.4
constant	5.187***	6.059***	6.067***	6.061***	5.870***	5.874***	5.870***	6.034***
	3207.58	33.68	29.77	33.75	27.96	27.93	27.97	30.12
No. of obs.	19163	19163	17507	19163	13861	13883	13861	17407
Adjusted R2	0.698	0.728	0.741	0.728	0.724	0.724	0.724	0.721
Loan_Type_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan_Purpose_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The table presents the results of multivariate analyses between 2003 and 2016. All regression results include loan type fixed effects, loan purpose fixed effects, firms fixed effects, and year fixed effects. Columns 1 and 2 report the results with and without control variables. Column 3 excludes the observations in the financial crisis period. Column 4 uses within 5 years purchase obligations to total asset ratio (*PO_15_at*). Column 5 uses purchase obligations to the cost of goods sold ratio (*PO_cogs*) but is limited to the inventory-intensive industries only (i.e., non-financial, services, public admin companies, and non-construction industry). Columns 6 and 7 report the results using alternative measures of supply chain hedging. Column 8 reports the results excluding financial firms. t -statistics are presented in parentheses and are calculated from robust standard errors clustered by year. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively.

Table 4 Addressing endogeneity issues

Panel A *Initiations and suspensions of supply chain hedging and the cost of debt*

	Δ(Loan spread [bps])	
	initiations	suspensions
	(1)	(2)
initiations	-31.087**	
	-2.48	
suspension		69.090**
		2.23
ch_tobins_q	3.456	-7.79
	0.31	-0.42
ch_leverage	91.039	135.146
	1.61	0.88
ch_profitability	139.314	150.857**
	0.77	2.22
ch_tangibility	58.282	-88.843
	0.41	-0.57
ch_cf_volatility	-72.642	-246.996
	-0.09	-0.39
ch_Z_score	-39.345	-61.995*
	-1.74	-2.05
ch_analyst_fol	-13.017	-79.525
	-0.70	-1.44
ch_at	0.003**	0.00
	2.50	0.00
ch_ln_maturity	17.876*	31.408
	1.84	1.4
ch_ln_loan_size	-14.157	-26.463*
	-1.49	-2.01
ch_performance_price	-52.681***	-21.898
	-5.08	-1.13
ch_credit_spread	0.407	1.292***
	0.86	3.66
ch_term_spread	-0.236	-0.099
	-1.08	-0.29
previous_loan	4.915	-26.15
	0.21	-0.65
high_PO_at	-13.284	-26.919
	-0.72	-0.67
hhi	-4.994	17.11
	-0.15	0.2
constant	-1.232	-29.066
	-0.11	-0.67
No. of obs.	380	130
Adjusted R2	0.124	0.277
Industry_FE	Yes	Yes
Year_FE	Yes	Yes

Panel B Inclusion of financial hedging as a control variable

	ln(Loan spread)	
	(1)	(2)
PO/asset		-0.100***
		-3.02
fxhedge	-0.086***	0.033***
	-8.8	3.21
No. of obs.	18005	18005
Adjusted R2	0.415	0.729
Controls	Yes	Yes
Loan_Type_FE	Yes	Yes
Loan_Purpose_FE	Yes	Yes
Firm_FE	No	Yes
Year_FE	Yes	Yes

Panel C Instrumental variable

	PO/Asset	ln(Loan spread)
	First stage	IV
	(1)	(2)
dimport_pen	0.016***	
	3.88	
close port	0.007*	
	1.77	
PO/Asset		-2.018**
		-2.32
No. of obs.	17821	17821
Adjusted R2	0.034	0.025
LM test statistic		8.293
p-value of underidentification		0.016
F statistic for weak identification		7.539
Loan_Type_FE	Yes	Yes
Loan_Purpose_FE	Yes	Yes
Year_FE	Yes	Yes

Panel D Test for alternative explanation

		PSM
	PO/asset	ln(Loan spread)
	(1)	(2)
demand_volatility	0.000	
	0.01	
PO/asset		-0.088**
		-2.53
cf_volatility	0.012	1.095***
	0.24	3.97
N	19133	
N: Treat		7335
N: Control		7335
Adjusted R2	0.625	0.733
Loan_Type_FE	Yes	Yes
Loan_Purpose_FE	Yes	Yes
Firm_FE	Yes	Yes
Year_FE	Yes	Yes

Panel A presents the results of the impact of initiations or suspensions of SCH on the change in loan spread. The initiation firm is defined as those who do not exhibit SCH from the beginning of the sample period in 2003, and initiate SCH during the sample period. The suspension firm is defined as those exhibiting SCH during the sample period but suspending it before the end of the sample period in 2016. The change in loan spread, other firm-level, and loan-level control variables are calculated as the change from year t-1 to year t. Industry fixed effects and year-fixed effects are included in the regression.
Panel B reports the results of equation (1) with financial hedging as a control variable. Financial hedging is measured as one plus the number of financial hedging keywords in 10-K reports (Hoberg & Moon 2017).
Panel C presents the results of the instrumental variable analysis. Column (1) reports the first-stage result of regressing the PO/asset on import penetration dummy (*dimport_pen*), dummy for the distance to the nearest port (*close port*) and other control variables. *dimport_pen* is defined as the dummy that equals one if a firm is in the industries that have a positive import penetration index which is calculated as the total import to the summation of GPD and total import at three-digit NAICS level. *close port* dummy equals one if a firm's distance between the nearest port and the headquarter is at the bottom tercile. Column (2) reports the relation between the instrumented *PO/asset* and *ln(Loan spread).*
Panel D column (1) reports the result of the OLS regression for the relation between firm-level demand volatility and PO. Column (2) reexamine equation (1) with propensity score matched sample. Specifically, we match the hedge firm and non-hedge firms with similar demand volatility and other firm characteristics.
t -statistics are presented in parentheses and are calculated from robust standard errors clustered by year. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively.

Table 5 Sources of supply chain hedging benefit: relationship with suppliers

Supplier relation	average #of supply chain year		Common Ownership	
	High	Low	High	Low
	(1)	(2)	(3)	(4)
PO/asset	-0.380***	0.176	-0.369**	0.251
	-4.12	1.01	-2.32	1.22
ln_size	-0.066	-0.004	-0.041	0.091
	-1.68	-0.07	-0.4	1.24
tobins_q	-0.048	-0.05	-0.006	-0.114**
	-1.34	-1.67	-0.16	-3
book_leverage	0.354**	0.302	0.577**	0.012
	2.35	1.13	2.32	0.09
profitability	-0.595	-0.133	-0.756	0.034
	-1.62	-0.38	-1.11	0.06
tangibility	-0.375*	0.054	-0.663	0.144
	-2.04	0.35	-1.58	0.4
cf_volatility	0.516	1.532*	0.173	1.1
	0.76	1.87	0.15	0.96
Z_score	-0.005	-0.065	0.006	-0.068
	-0.12	-1.11	0.06	-1.11
analyst_following	0.015	0.022	-0.139	-0.108
	0.28	0.45	-1.15	-1.39
ln_maturity	0.131***	0.017	0.165***	0.081
	3.9	0.37	3.22	1.52
ln_loan_size	-0.153***	-0.155***	-0.202***	-0.183***
	-10.27	-6.83	-5.75	-5.63
performance_price	-0.024	-0.03	-0.042	-0.029
	-0.9	-1.1	-0.97	-0.67
credit_spread	0.001	0.002*	0.002**	0.002*
	1.00	2.15	2.24	2.11
term_spread	0.001	0.001***	0	0.001*
	1.47	3.18	0.26	1.98
previous_loan	-0.043	0.004	0.009	-0.049
	-1.67	0.12	0.29	-1.43
high_PO_at	-0.011	0.044	-0.078	-0.065
	-0.25	0.85	-1.32	-1.72
hhi	0.385	-0.624	0.174	-0.92
	1.29	-1.44	0.63	-1.41
constant	6.018***	5.607***	6.384***	5.228***
	16.48	10.14	6.64	7.62
p-value of tests of the difference between the coefficients for the Low and High groups	0.00		0.00	
No. of obs.	2614	2544	1551	1550
Adjusted R2	0.797	0.779	0.768	0.816
Loan_Type_FE	Yes	Yes	Yes	Yes
Loan_Purpose_FE	Yes	Yes	Yes	Yes
Firm_FE	Yes	Yes	Yes	Yes
Year_FE	Yes	Yes	Yes	Yes

The table presents cross-sectional evidence between 2003 and 2018. All regression results include loan type fixed effects, loan purpose fixed effects, firms fixed effects, and year fixed effects. A *High* (*Low*) supplier relation indicates that the proxies exceed (is below) the sample median. *supplier relation* is

proxied by the average number of years of supplier relationship and the percentage of common institutional investors with both supplier and customer (Cheung et al. 2020). t -statistics are presented in parentheses and are calculated from robust standard errors clustered by year. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively.

Table 6 Information intermediation role by analysts on the relation between SCH and the cost of debt

Panel A	ln(Loan spread)	
Information intermediation	Analyst following	
	High	Low
	(1)	(2)
PO_report	-0.018	0.054**
	-0.65	2.92
p-value of tests of the difference between the coefficients for the Low and High groups	0.00	
No. of obs.	9665	9498
Adjusted R2	0.75	0.70
Controls	Yes	Yes
Loan_Type_FE	Yes	Yes
Loan_Purpose_FE	Yes	Yes
Firm_FE	Yes	Yes
Year_FE	Yes	Yes

Panel B	ln(Loan spread)					
	AFE		Dispersion		Analyst following	
	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
PO/asset	0.005	-0.286***	-0.041	-0.176***	-0.142*	-0.029
	0.09	-5.83	-0.4	-3.06	-2.02	-0.46
p-value of tests of the difference between the coefficients for the Low and High groups	0.00		0.01		0.05	
No. of obs.	7093	7093	6822	6822	9941	9222
Adjusted R2	0.732	0.768	0.747	0.756	0.753	0.695
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Loan_Type_FE	Yes	Yes	Yes	Yes	Yes	Yes
Loan_Purpose_FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm_FE	Yes	Yes	Yes	Yes	Yes	Yes
Year_FE	Yes	Yes	Yes	Yes	Yes	Yes

The table presents cross-sectional evidence between 2003 and 2018. All regression results include loan type fixed effects, loan purpose fixed effects, firms fixed effects, and year fixed effects. A *High* (*Low*) analyst following, analyst forecast errors (*AFE*), dispersion indicates that the variable exceeds (is below) the sample median. t -statistics are presented in parentheses and are calculated from robust standard errors clustered by year. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively.

Table 7 Moderating effect of bargaining power on the relation between supply chain hedging and cost of debt

Bargaining Power	ln(Loan spread)	
	Market Share	
	High	Low
	(1)	(2)
PO/asset	-0.004	-0.163**
	-0.07	-2.32
p-value of tests of the difference between the coefficients for the Low and High groups	0.00	
No. of obs.	9583	9580
Adjusted R2	0.747	0.715
Control	Yes	Yes
Loan_Type_FE	Yes	Yes
Loan_Purpose_FE	Yes	Yes
Firm_FE	Yes	Yes
Year_FE	Yes	Yes

The table presents cross-sectional evidence between 2003 and 2018. All regression results include loan type fixed effects, loan purpose fixed effects, firms fixed effects, and year fixed effects. A *High* (*Low*) *Market Share* indicates that the variable exceeds (is below) the sample median. Market Share is defined as sales of individual firm to the total sales in the same 4-SIC industry classification. t -statistics are presented in parentheses and are calculated from robust standard errors clustered by year. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively.

Table 8 Path analysis

	sticky (1)	price_protection (2)	ln(Loan spread) (3)
PO/asset	0.008**	0.008***	-0.090*
	2.27	4.54	-2.1
sticky			0.002
			0.4
price_protection			-0.038***
			-3.03
ln_size	0.05	-0.172***	-0.066***
	0.72	-5.99	-3.35
tobins_q	-0.025	0.028	-0.055***
	-0.64	1.53	-4.2
book_leverage	-0.033	-0.043	0.471***
	-0.17	-0.76	8.16
profitability	-0.346	0.154	-0.640***
	-0.55	1.07	-3.49
tangibility	-0.06	0.247**	-0.234**
	-0.17	2.31	-2.94
cf_volatility	-0.553	-0.042	0.934***
	-0.68	-0.14	3.91
Z_score	0.03	-0.014	-0.024*
	0.76	-0.88	-2.00
analyst_fol	0.073	0.027	-0.047***
	1.28	0.96	-5.54
ln_maturity	0.052	0.019	0.033
	1.00	1.2	1.29
ln_loan_size	0.027	-0.004	-0.112***
	1.70	-0.43	-16.64
performance_price	0.005	-0.032**	-0.066***
	0.16	-2.54	-3.89
credit_spread	0.001	0.00	0.002***
	1.25	-0.39	3.81
term_spread	-0.001	0.00	0.001**
	-0.94	-0.69	2.32
previous_loan	-0.047	-0.012	-0.025
	-1.27	-0.71	-1.76
high_PO_at	-0.122*	-0.043*	0.011
	-1.8	-2.06	0.66
hhi	-0.047	-0.213**	-0.059
	-0.19	-2.52	-0.99
constant	-0.627	0.155	6.099***
	-1.22	0.93	29
No. of obs.	13854	13854	13854
Adjusted R2	0.293	0.833	0.735
Loan_Type_FE	Yes	Yes	Yes
Loan_Purpose_FE	Yes	Yes	Yes
Firm_FE	Yes	Yes	Yes
Year_FE	Yes	Yes	Yes

The table presents the results for the mechanisms through which PO usage affects the cost of debt. All regression results include loan type fixed effects, loan purpose fixed effects, firms fixed effects, and year fixed effects. The outcome variable in columns (1) and (2) are the proxies of cost stickiness and input price protection. Column (3) reports the result of the analysis that includes the two proxies as independent variables in equation (1). t -statistics are presented in parentheses and are calculated from robust standard errors clustered by year. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively.

Appendix B Variable definitions

Variables	Definition
ln_loan_spread	The natural logarithm of the all-in spread drawn that includes any recurring annual fees paid to lenders, reported in the DealScan database
PO/asset	The total amount of POs scaled by average total assets
PO/cogs	The total amount of POs scaled by the cost of goods sold
PO_report	The indicator equals one if the firm reports PO in that fiscal year.
ln_size	The natural logarithm of total asset
Tobins_q	The market-to-book ratio
book_leverage	Total debts to average total assets
profitability	Operating income before depreciation to average total assets
tangibility	Plat, property, and equipment to average total assets
cf_volatility	The standard deviation of operating cash flow over the past 5 years
Z_score	Altman's Z Score for bankruptcy risk
analyst_following	The natural logarithm of 1 plus the number of analysts following
high_PO_at	The indicator equals one if the industry mean of *PO/asset* is higher than the median of the industry means of *PO/asset* of all other industries, and zero otherwise
hhi	Herfindahl-Hirschman Index
ln_maturity	The natural logarithm of 1 plus maturity
ln_loan_size	The natural logarithm of the total loan amount
performance_price	An indicator equals 1 if the loan contract includes performance pricing requirement and 0 otherwise
credit_spread	The difference between the yields of BAA corporate bonds and AAA corporate bonds.
term_spread	The difference between the yields of 10-year Treasury bonds and 1-year Treasury bonds.
sticky	The measure of cost stickiness following Weiss (2010)
price_protection	Natural logarithm of 1 plus the occurrence of financial hedging-related keywords in 10-K reports following Hoberg and Moon (2017).