Financial Constraints and Price Rigidities

[VERY preliminary]

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Abstract

I show that binding financial constraints undermine price rigidities both theoretically and empirically. After negative shocks, financially constrained firms have to improve cash flows through internal earnings, hence they move closer to the flexible price path that maximizes internal cash flows despite intertemporal trade-offs due to nominal rigidities. Financially constrained firms also exhibit little strategic complementarities in pricing, as they heavily discount the cost of losing customers to competitors in the future. In aggregate, this "price rigidity" channel creates non-linearity in the Phillips curve. When large cost increases tighten financial constraints by eroding profitability and collateral value, aggregate price rigidities become weaker, leading to a temporarily steeper Phillips curve and amplified inflation dynamics.

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1 Introduction

Since the seminal work by Chevalier and Scharfstein (1996), a vast literature has found evidence that financial constraints affect firms' optimal prices. While *prices* are important macroeconomic phenomena, *price rigidities* are at least equally important because they are the fundamental friction in the New Keynesian framework. Therefore in this paper, I study how financial constraints affect *price rigidities* and what the macroeconomic implications are.

Why should financial constraints affect price rigidities? The intuition is straightforward even in a minimalist model with only nominal rigidities and financial frictions. Financial constraints alter the intertemporal trade-offs between current and future cash flows for financially constrained firms, which weakens the role of nominal rigidities for these firms because nominal

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rigidities effect through the very same intertemporal trade-offs. In the textbook New Keynesian model, a firm attains maximal internal cash flows (equivalent to EBITDA[1] in simple models) in each period along the optimal flexible price path. Since the sticky price path generally differs from the flexible price path, EBITDA along the sticky price path is below the flexible price level in each period. While a firm can raise current EBITDA closer to the flexible-price level by setting current prices closer to flexible prices, the optimality condition means that such an attempt must lower future profits by more. Financial constraints, however, alter this intertemporal optimality. If a firm is pushed towards illiquidity in a recession and external financing is constrained, it will have to raise its current EBITDA to improve cash flows. In this case, the firm will set prices closer to the flexible price path whenever possible at the expense of future profits, resulting in lower observed price rigidities. Therefore, I refer to this channel as the "price rigidity" channel hereafter.

My theoretical model also makes distinct predictions on how financial constraints interact with strategic complementarities, an important form of real rigidities. If a firm's demand elasticity is affected by the contemporaneous prices set by its competitors, financially constrained firms should react more to competitors' prices compared to unconstrained firms. This applies to usual static demand models such as Atkeson and Burstein (2008). The intuition is that, if financially constrained firms prioritize current EBITDA, they will prioritize any factor that affects its current EBITDA including competitors' prices. By contrast, if demand elasticity is affected by competitors' prices but with a lag, financially constrained firms should react less and exhibit lower strategic complementarities. The latter case applies to models where strategic complementarities come from dynamic demand elasticity.[2] For a simple example of the latter, imagine a model where it takes time for customers to switch to other sellers. A financially constrained firm in urgent need of cash flows would therefore choose to raise markups to maximize its short-run EBITDA before customers switch away, even knowing that it will lose customers to its competitors in the long run. By empirically testing the model, one can discriminate between the two ways of modeling strategic complementarities.

My empirical strategy builds on the framework in Amiti et al. (2019), where direct cost pass-through informs the degree of nominal rigidities and the sensitivity to competitors' prices informs the degree of strategic complementarities. Using granular data on input and output prices of manufacturing firms in India, I show that financial constraints have significant and sizable effects on price rigidities. First, consistent with the theory, financially constrained firms attain a pass-through rate of 88% within one year after marginal cost shocks, while financially unconstrained firms pass only 65% of the marginal cost into prices. Pass-through by constrained firms is almost 100% after large cost increases, suggesting high nonlinearity in the interaction between financial constraints and price rigidities. By moving closer to complete pass-through, financially constrained firms also show smaller decreases in profit margins, which further confirms my theory. Importantly, firms show no noticeable difference in their current and future input prices, suggesting that my results are not confounded by heterogeneity on the cost side.

Second, I examine the dynamic aspect of the price rigidity channel. After an initial input

[1] Earnings before interest, taxes, depreciation, and amortization. In the model used in this paper, EBITDA, operating profits, and internal cash flows are all identical, and I use them interchangeably.

[2] To some extent, this is conceptually in line with the external habit model in Ravn et al. (2006) and Gilchrist et al. (2017), except that the latter does not generate strategic complementarities.

price shock, input prices decline by over 30% in one year and 40% in two years. For financially unconstrained firms, price responses are smooth and persistent over time. Their prices remain unchanged after one year and only start to decline after two years. Such a difference in timing is the *prima facie* evidence on price stickiness. By contrast, financially constrained firms substantially revise prices downwards in one year as costs revert, such that the pass-through gap between constrained and unconstrained firms completely closes in one year. This pattern confirms that constrained firms behave more like flexible-price firms and that the difference in initial price responses is not driven by any permanent heterogeneity in their price reactions.

Interestingly, financially constrained firms display no significant strategic complementarities, whereas unconstrained firms respond significantly to competitors' prices with an elasticity of 35%. In other words, financially constrained firms show not only weaker *nominal rigidities* but also weaker *real rigidities*. Through the lens of my theoretical model, this pattern is consistent with a model with dynamic demand elasticity, such that higher relative prices today increase the future but not the current demand elasticity. Note that this is also qualitatively consistent with the intuition in Gilchrist et al. (2017). The latter embeds customer bases and imperfect capital markets in a New Keynesian model, which incentivizes firms to lower markups to invest in their customer bases in normal times. Yet after some shocks such as credit shocks, financially constrained firms have to raise markup to improve cash flows at the expense of future customer bases, resulting in positive markup shocks and higher prices. Strictly speaking, the model in Gilchrist et al. (2017) has no strategic complementarities, yet the intuition is well aligned with my empirical findings.

What are the implications for inflation dynamics and the Phillips curve? To understand the macro consequences, I embed earnings-based borrowing constraints in a textbook New Keynesian model. The model also features a continuum of heterogeneous firms to smooth out the kink induced by occasionally binding constraints at the firm level. I calibrated the benchmark model such that it has similar nonlinearity as in the empirical analysis. After a small cost increase, the benchmark model behaves almost identically to a comparable model with no financial frictions. After a large cost increase, inflation in the benchmark model is 13% higher than inflation in the model with no financial frictions upon impact. Consistent with Bhattarai et al. (2018), higher price flexibility, particularly during large shocks, makes the economy more volatile. Meanwhile, amplified inflation helps smooth markup fluctuations in a more realistic way. In a model with no financial frictions, average markup may even fall below zero after large shocks, and it is highly counterintuitive to think that firms would stay on the demand curve when markup is negative.[3] By contrast, markup changes are smoother in the benchmark model with financial constraints, which avoids the problem of negative markups and is also closer to my empirical findings on profit margins.

Lastly, inflation can feed back to borrowing constraints due to monetary policy reactions to inflation. For example, aggressive monetary policy depresses demand and lowers profits further. Tight monetary policy can also affect credit supply and thus borrowing constraints. If a substantial fraction of firms face tight financial constraints and the shock squeezes profit margins (e.g., a large cost-push shock in a highly leveraged economy), it might be optimal to put more weight on the output gap to avoid further tightening financial constraints.

[3] More broadly, Holden (2024) points out that the problem of negative markups can occur in a simple trend inflation model with Calvo pricing even without large shocks.

Literature. This paper contributes to several strands of the macro literature. The most related is the vast literature on the finance-price nexus (e.g., Chevalier and Scharfstein, 1996, Montero and Urtasun, 2014, Gilchrist et al., 2017, Lenzu et al., 2021, Kim, 2021, Balduzzi et al., 2024, Renkin and Züllig, 2024). Compared to previous work, this paper makes both empirical and theoretical contributions. Empirically, I go beyond the previous focus on prices by estimating the effects on cost pass-through, thanks to the granular data on both prices and balance sheets that are not often available for large samples. The closest paper is perhaps Strasser (2013), who looks at how financial constraints affect exchange rate pass-through. My paper complements Strasser (2013) by examining domestic prices set by primarily non-exporters and analyzing the macroeconomic implications. Theoretically, I show that the interplay between financial constraints and price rigidities, on top of prices, yields important nonlinearity in the New Keynesian framework. Such interactions and nonlinearity are not yet studied in previous macro papers such as Gilchrist et al. (2017). Qualitatively, both Gilchrist et al. (2017) and my model would predict amplified inflation when large cost increases squeeze the profit margin of financially constrained firms. However, the mechanisms are distinct: my price rigidity channel originates from a minimalist model that does not require customer bases, while credit shocks do not steepen the Phillips curve in Gilchrist et al. (2017). In a slightly different setting, Christiano et al. (2015) study how financial shocks raise marginal costs and thus prices through the working capital channel. Conversely, Kim (2021) shows that financially constrained firms may sell off inventories to raise cash flows, leading to depressed output prices. These channels, though out of this paper's scope, are not mutually exclusive from the price rigidity channel in my paper because the latter does not rely on any particular assumption about customer bases, inventories, or working capital.

The paper also contributes to the growing literature on the nonlinearity of the Phillips curve. Several papers, especially after the Covid inflation, emphasize the role of the labor market in the nonlinearity of the output-based Phillips curve (e.g., Forbes et al., 2022, Ball et al., 2022, Benigno and Eggertsson, 2023, Schmitt-Grohé and Uribe, 2022). A different approach is to generate nonlinearity in the marginal cost-based Phillips curve through menu costs (Blanco et al., 2024, Gagliardone et al., 2024) or the shape of the demand curve (Harding et al., 2023). My model differs from these papers by generating nonlinearity through occasionally binding financial constraints.

Third, by incorporating the financial dimension, the paper contributes to the nascent literature on estimating pricing functions using granular input and output data. Amiti et al. (2019) identify direct cost pass-through of 0.6 and strategic complementarities of 0.4 using micro data and emphasize the importance of size heterogeneity. Remarkably, my estimates for financially unconstrained firms are largely in line with Amiti et al. (2019), albeit using a different sample in a very different country. Gagliardone et al. (2023) apply the Amiti et al. (2019) approach to a dynamic setting with Calvo pricing frictions. With high-quality quarterly data, they jointly estimate pricing frictions and strategic complementarities, two key parameters shaping the marginal cost-based Phillips curve. While I do not have high-frequency data in Prowess to estimate structural parameters as in Gagliardone et al. (2023), the availability of balance sheet data allows me to study financial constraints that are unavailable in the previous two studies.

Finally, this paper complements the investment channel in New Keynesian models with financial heterogeneity (e.g., Khan and Thomas, 2013, Ottonello and Winberry, 2020, Caglio et al., 2021). For computational reasons, rich models with financial heterogeneity and investment such as Ottonello and Winberry (2020) often add nominal rigidities only to the retailer sector that faces no financial constraints, therefore mechanically separating finance and pricing. If financially constrained firms can adjust along both pricing and investment margins, the interactions of the two can be useful for future research.

The rest of the paper is organized as follows. In Section 2 I illustrate the price rigidity channel in a minimalist model. In Section 3 I present the empirical evidence. In Section 4 I calibrate a complete New Keynesian model with the price rigidity channel.

2 Intuitions behind the Price Rigidity Channel

In this section, I provide a minimalist model of the intermediate goods sector to show how nominal rigidities interact with financial constraints.

2.1 Model Setup

Production. Each intermediate goods firm i has the following production function, which consists of labor $L_{i,t}$, productivity $A_{i,t}$, and fixed production costs ω:

$$Y_{i,t} = A_{i,t} L_{i,t}^{1-\gamma} - \omega. \tag{2.1}$$

I assume that $A_{i,t}$ is the product of (i) aggregate productivity A_t and (ii) an idiosyncratic component $\tilde{A}_{i,t}$, i.e., $A_{i,t} = A_t \tilde{A}_{i,t}$. $\ln \tilde{A}_{i,t}$ follows an AR(1) process.

$$\tilde{a}_{i,t} = \rho_a \tilde{a}_{i,t-1} + \varepsilon^a_{i,t}, \quad \text{where} \quad \tilde{a}_{i,t} = \ln \tilde{A}_{i,t} \text{ and } \varepsilon^a_{i,t} \sim N(0, \sigma^2_a). \tag{2.2}$$

Note that equation 2.1 has no capital for simplicity. It is a reasonable simplification so long as the investment adjustment costs are larger than price adjustment costs, in which case firms will adjust prices first and then capital expenditure. TO DO: In Appendix X.X I show that introducing investment has little quantitative difference.

EBITDA ($\text{EBITDA}_{i,t}$) equals revenues minus production costs. Let W_t be nominal wages.

$$\text{EBITDA}_{i,t} = P_{i,t} Y_{i,t} - W_t L_{i,t}. \tag{2.3}$$

Nominal rigidities. Firms are subject to a price adjustment cost $\mathscr{C}_{i,t}$ à la Rotemberg (1982). The degree of nominal rigidities is governed by τ_p as defined in equation 2.4. P_t and Y_t are aggregate price and output, respectively. Importantly, $\mathscr{C}_{i,t}$ is a non-monetary cost, i.e., it is not considered an accounting expense. TO DO: I show that this ensures the equivalence between Rotemberg and Calvo in Appendix X.X.

$$\mathscr{C}_{i,t} = \frac{\tau_p}{2} \pi^2_{i,t} P_t Y_t, \quad \text{where } \pi_{i,t} = \ln \frac{P_{i,t}}{P_{i,t-1}}. \tag{2.4}$$

Financial frictions. Debt financing is frictional in this model. At time t, firm i issues one-period debt $D_{i,t}$ subject to an earnings-based borrowing constraint specified in equation 2.5, where ϕ is the maximum debt-to-EBITDA ratio.

$$D_{i,t} \leq \phi \max(\text{EBITDA}_{i,t},\ 0). \tag{2.5}$$

Interest expenses at $t+1$ ($\text{Interest}_{i,t+1}$) equal $D_{i,t}$ multiplied by the nominal borrowing rate $r^b_{i,t+1}$. $r^b_{i,t+1}$ is taken as given and known at t, while the realized real borrowing rate $r^{b,r}_{i,t+1}$ depends on the realized inflation at $t+1$. There is no default for simplicity. Finally, why do firms borrow in this setting? In the absence of capital and investment, I assume that firms borrow for the sole purpose of smoothing cash flows during adverse shocks.

Apart from financing limits, I also assume costly equity issuance. Given that raising equity is equivalent to paying out negative dividends (defined below in equation 2.8) in this model, having costly equity issuance is the same as having a penalty when dividends fall below zero. In other words, the equity financing friction can also be interpreted as a liquidity constraint. In equation 2.6, I assume a non-monetary penalty term that is linear in dividends when dividends are negative:

$$\mathscr{E}_{i,t} = -\tau_e \min(0, \text{Div}_{i,t}). \tag{2.6}$$

Importantly, τ_e captures not only the financial cost of equity issuance but also the opportunity cost of not being able to obtain equity promptly. For a firm that has no access to capital markets, τ_e is effectively infinite. Similarly, if a firm can issue equity at a low cost but issuance takes a prolonged period, one should still assume a high τ_e to account for the unavailability of equity in the short run.[4] Note that equation 2.6 is similar to the per-unit dilution cost for equity issuance assumed in Gilchrist et al. (2017). Nonetheless, unlike in Gilchrist et al. (2017) where the dilution cost is externally calibrated, I will be able to set τ_e such that the model matches pricing behaviors in the empirical analysis in Section 3.

Nominal profits and dividends. Profits are defined as EBITDA minus interest payments. $\mathscr{C}_{i,t}$ and $\mathscr{E}_{i,t}$ are not accounting costs and thus not included.

$$\text{Profit}_{i,t} = \text{EBITDA}_{i,t} - \text{Interest}_{i,t}. \tag{2.7}$$

Dividends are defined as profits plus changes in net borrowing. For instance, firms can save by restricting dividends to lower $D_{i,t}$. Negative $D_{i,t}$ means having a positive cash buffer.

$$\text{Div}_{i,t} = \text{Profit}_{i,t} + (D_{i,t} - D_{i,t-1}). \tag{2.8}$$

Objective. Let $\Lambda_{t,t+h}$ be the stochastic discount factor from t to $t+h$. Each firm i chooses

[4] There are several ways to account for the time dimension more explicitly, though differences are small for our purposes. For example, one can explicitly model the issuance delay by assuming a cost schedule that is decreasing in the time it takes to issue equity. For unanticipated business cycle shocks, the difference is trivial. Alternatively, one can set up the penalty term as a fixed cost plus a linear component. The advantage is that the slope of the linear component is the observed cost of equity conditional on issuance, which is observed in the data. In reality, equity issuance is often procyclical, suggesting that most firms are in the inaction regime.

$\{P_{i,t}, D_{i,t}\}$ to maximize real dividends minus non-monetary costs:

$$\max_{\{P_{i,t},D_{i,t}\}} \mathrm{E}_t \sum_{h=0}^{\infty} \Lambda_{t,t+h} \frac{1}{P_{t+h}} \left[\mathrm{Div}_{i,t+h} - (\mathscr{C}_{i,t+h} + \mathscr{L}_{i,t+h} + \mathscr{E}_{i,t+h})\right], \tag{2.9}$$

subject to

$$\text{Nominal rigidities:} \quad \mathscr{C}_{i,t} = \frac{\tau_p}{2}\pi_{i,t}^2 P_t Y_t; \tag{2.10}$$

$$\text{Borrowing constraint:} \quad \phi \max(\mathrm{EBITDA}_{i,t},\ 0) - D_{i,t} \geq 0; \tag{2.11}$$

$$\text{Equity/liquidity constraint:} \quad \mathscr{E}_{i,t} = -\tau_e \min(0, \mathrm{Div}_{i,t}). \tag{2.12}$$

2.2 Optimal Prices

Demand elasticity. On the demand side, $Y_{i,t}$ is a differentiable function of (i) firm i's current price $P_{i,t}$ and (ii) variables exogenous to firm i, such as aggregate variables and competitors' prices.[5] By including competitors' prices, it nests the class of models with oligopolistic competition (e.g., Amiti et al., 2019, Wang and Werning, 2022). Define firm i's demand elasticity $\epsilon_{i,t}$:

$$\epsilon_{i,t} = -\frac{\partial y_{i,t}}{\partial p_{i,t}}, \quad \text{where } y_{i,t} = \ln Y_{i,t} \text{ and } p_{i,t} = \ln P_{i,t}. \tag{2.13}$$

Optimality conditions. The full derivation is in Appendix B. The first-order condition (FOC) with respect to $P_{i,t}$ is given by:

$$\pi_{i,t} = \big(\underbrace{1 + \xi_{i,t}^{div} + \xi_{i,t}^{ebc}\phi_i}_{\xi_{i,t}}\big) \frac{\epsilon_{i,t} - 1}{\tau_p} \frac{P_{i,t}Y_{i,t}}{P_t Y_t} \left[\mathscr{M}_{i,t} MC_{i,t} \frac{P_t}{P_{i,t}} - 1\right] + \mathrm{E}_t \Lambda_{t,t+1} \frac{Y_{t+1}}{Y_t} \pi_{i,t+1}, \tag{2.14}$$

where (i) $\mathscr{M}_{i,t} = \frac{\epsilon_{i,t}}{\epsilon_{i,t}-1}$, (ii) $MC_{i,t} = \frac{\partial L_{i,t}}{\partial Y_{i,t}} \frac{W_t}{P_t} = \frac{W_t}{P_t} \frac{1}{1-\gamma} \left(\frac{Y_{i,t}+\omega_i}{A_{i,t}}\right)^{\frac{\gamma}{1-\gamma}}$ (real marginal cost), and (iii) $\xi_{i,t}^{div}$ and $\xi_{i,t}^{ebc}$ are the Lagrangian multipliers on the equity financing friction and the borrowing constraint, respectively.[6]

The two Lagrangian multipliers, $\xi_{i,t}^{div}$ and $\xi_{i,t}^{ebc}$, evolve according to the borrowing FOCs:

$$\xi_{i,t}^{ebc} = (1 + \xi_{i,t}^{div}) - \mathrm{E}_t \Lambda_{t,t+1}(1 + r_{i,t+1}^{b,r})(1 + \xi_{i,t+1}^{div}), \tag{2.15}$$

$$\xi_{i,t}^{div} \leq \tau_e. \tag{2.16}$$

[5]One can further generalize the demand function by including past $P_{i,t}$, and then the demand function nests the class of models with habits or customer markets (e.g., Ravn et al., 2006, Gilchrist et al., 2017). Nonetheless, this does not change propositions 1 and 2 below because past $P_{i,t}$ drops out in the limiting case. As such, I do not include past $P_{i,t}$ to keep the derivation concise.

[6]For simplicity, I assume that EBITDA is always positive when deriving equation 2.14. I relax the assumption when numerically solving the model in Section 4, and the intuition remains the same.

Recall that $r^{b,r}_{i,t+1}$ is the real borrowing cost and $\Lambda_{t,t+1}$ is the one-period-ahead discount factor. Meanwhile, financial constraints can be no tighter than $\xi^{div}_{i,t} = \tau_e$ because otherwise firms will resort to equity financing.

2.3 Endogenous Nominal Rigidities

Let $\xi_{i,t} = \xi^{div}_{i,t} + \xi^{ebc}_{i,t}\phi_i$, which summarizes the overall tightness of financial constraints. From equation 2.14, it is straightforward that $\xi_{i,t}$ directly increases the slope of the marginal cost term in the pricing FOC. What does it mean to price rigidities? To answer it, it would be useful to examine the limiting case where (i) $\xi_{i,t} \to \infty$ and (ii) $\forall h, \frac{\xi_{i,t}}{\xi_{i,t+h}} \to \infty$. Economically, the limiting case means that firm i faces an acute need for short-term cash flows.[7]

Let $P^*_{i,t}$ be the optimal *sticky* price, which is the fixed point solution to equation 2.14. In the limiting case where (i) $\xi_{i,t} \to \infty$ and (ii) $\forall h, \frac{\xi_{i,t}}{\xi_{i,t+h}} \to \infty$, equation 2.14 converges to equation 2.17, which is also the optimality condition under *flexible* prices.

$$P_{i,t} = \mathscr{M}_{i,t} MC_{i,t} P_t. \tag{2.17}$$

In other words, the optimal sticky price converges to the optimal flexible price in the limiting case. Denote the optimal flexible price as $P^f_{i,t}$ and summarize the finding in Proposition 1:

Proposition 1 (Nominal Rigidities and Financial Constraints) *In the limiting case where (i) $\xi_{i,t} \to \infty$ and (ii) $\forall h, \frac{\xi_{i,t}}{\xi_{i,t+h}} \to \infty$, the optimal sticky price $P^*_{i,t}$ converges to the optimal flexible price $P^f_{i,t}$ as in equation 2.18. Hence, tight financial constraints weaken nominal rigidities.*

$$\lim_{\xi_{i,t}\to\infty} P^*_{i,t} = P^f_{i,t}, \quad \textit{where } P^f_{i,t} \textit{ satisfies } P_{i,t} = \mathscr{M}_{i,t} MC_{i,t} P_t\,. \tag{2.18}$$

What is the economic intuition behind proposition 1? A sticky-price firm in urgent need of short-term cash flows sets prices like a flexible-price firm to maximize current EBITDA and ignores future costs resulting from nominal rigidities.

From proposition 1, one can derive corollary 1 regarding direct cost pass-through, i.e., pass-through of marginal costs into current prices. The proof is in Appendix D.

Corollary 1 (Complete Cost Pass-through) *Under constant returns to scale (CRS) and constant elasticity of substitution (CES), direct cost pass-through is complete in the limiting case where $\xi_{i,t} \to \infty$ and $\forall h, \frac{\xi_{i,t}}{\xi_{i,t+h}} \to \infty$.*

[7] Since $\xi^{div}_{i,t} \le \tau_e$, in this limiting case we also need $\tau_e \to \infty$, i.e., equity financing is forbidden in the limiting case. The second condition, $\frac{\xi_{i,t}}{\xi_{i,t+h}} \to \infty$, means that financial needs are only acute today and will fade away in the future. Since the paper focuses on the business cycle frequency, firms facing high but permanent financial constraints, perhaps due to the lack of financial development or other structural factors, are beyond the scope of the paper.

2.4 Endogenous Strategic Complementarities

Besides nominal rigidities, equation 2.14 is also suitable for analyzing one particular type of real rigidities, namely the strategic complementarities in price setting. If one substitutes the expectation term through iterating equation 2.14 forward, one can find $\epsilon_{i,t+h}$ in equation 2.14 for all $h \geq 0$. Thus, strategic complementarities can arise in equation 2.14 so long as for some competitors j, their prices $P_{j,t}$ have a positive impact on firm i's demand elasticity $\epsilon_{i,t+h}$ for some $h \geq 0$. Similar to Amiti et al. (2019), I focus on cases where $P_{j,t}$ can be aggregated in the sense that there exists an index of competitor price changes $dp_{-i,t}$ such that for all $h \geq 0$, $\frac{\partial \epsilon_{i,t+h}}{\partial p_{-i,t}}$ is well-defined and is a sufficient statistic for $\frac{\partial \epsilon_{i,t+h}}{\partial p_{j,t}}$. Mathematically, it means that

$$\frac{\partial \epsilon_{i,t+h}}{\partial p_{-i,t}} dp_{-i,t} = \sum_{j \neq i} \frac{\partial \epsilon_{i,t+h}}{\partial p_{j,t}} dp_{j,t}. \tag{2.19}$$

Observe that only $\epsilon_{i,t}$ remains in the limiting case of equation 2.17. Therefore, whether $P_{-i,t}$ changes $\epsilon_{i,t}$ makes a key difference. Proposition 2 discusses two cases: in one case $P_{-i,t}$ only effects through $\epsilon_{i,t}$, while in the other $P_{-i,t}$ only effects through $\epsilon_{i,t+h}$ for some $h \geq 1$. The proof is in Appendix D.

Proposition 2 (Strategic Complementarities and Financial Constraints) *Holding marginal costs constant, in the limiting case where (i) $\xi_{i,t} \to \infty$ and (ii) $\forall h$, $\frac{\xi_{i,t}}{\xi_{i,t+h}} \to \infty$*

- *If $\frac{\partial \epsilon_{i,t}}{\partial p_{-i,t}} > 0$, strategic complementarities strengthen in the limiting case, i.e., tight financial constraints amplify strategic complementarities.*
- *If (i) $\frac{\partial \epsilon_{i,t}}{\partial p_{-i,t}} = 0$ and (ii) $\frac{\partial \epsilon_{i,t+h}}{\partial p_{-i,t}} > 0$ for some $h \geq 1$, strategic complementarities vanish in the limiting case, i.e., tight financial constraints weaken strategic complementarities.*

How to make sense of the second part of proposition 2? Imagine an economy with product market frictions such that it takes time for customers to search for new sellers. If competitors change their prices at t, customers will not switch away until $t+1$, and firm i's demand will not be affected until then. In the limiting case, firm i would like to raise as much internal cash flows as possible no matter how many customers will switch away in the future.

3 Empirical Evidence on the Price Rigidity Channel

Propositions 1 and 2 provide key insights regarding how financial constraints change pricing decisions. In this section, I empirically test the channel using the methodology built on Amiti et al. (2019) (AIK hereafter).

3.1 Data

The main data source is the Prowess database maintained by the Centre for Monitoring the Indian Economy (CMIE) for the period between March 1992 and March 2011, a period during which India experienced large variations in price levels (see Figure A1).[8] Details of the Prowess database are discussed extensively in Goldberg et al. (2010a), Goldberg et al. (2010b), De Loecker et al. (2016). The most unique feature of this database is that it includes both financial data *and* product-level price data for a large annual panel of Indian firms, which is indispensable to studying the price rigidity channel hypothesized in this paper. It also includes granular data on prices and quantities of intermediate inputs, allowing me to implement the empirical strategy in AIK. In Section E.1, I make further comparisons between the Prowess dataset and other datasets in the literature.

Below I explain the main steps to construct the variables, the instrumental variable strategy, and sample restrictions. Detailed procedures to clean and construct the data panel are documented in Section E.2. In terms of notation, products are indexed by p. Consistent with Section 4, firms, time, and 2-digit sectors are indexed by i, t, and s, respectively. In cases where I use s to denote 4-digit industries, I explicitly address it in the text.

3.1.1 Products

Output products. While the model in Section 4 is not explicitly a multi-product/industry model, I follow AIK to aggregate product prices to the firm level and control for firm scope in the regressions.

Prowess provides product names and proprietary product classification codes that are highly consistent over time, even though it does not have unique product identifiers. Thus, I identify a unique product by requiring exactly the same product name, the same classification code, and the same producer.[9] In addition, I determine whether products belong to the same 2-digit sectors, 4-digit industries, or 6-digit narrow industries based on product codes. The industry classification of a firm is based on the product code of its main products.

Manufacturing products are in the following 2-digit sectors: $[27, 57]$ and $[63, 70]$. For a firm to be a manufacturing firm in a given year, (i) it needs to have over 70% of sales from manufacturing products in that year, and (ii) the industry where it operates (based on its main product) should be in the manufacturing sector.

Intermediate goods. Prowess also collects data on intermediate inputs, including prices, quantities, product codes, and names. Prowess uses the same classification system for intermediate goods and output products. I identify a unique intermediate input by requiring exactly the same product name, the same classification code, and the same buyer.

Major intermediate goods. I define major intermediate goods as intermediate goods from major 6-digit industries, and major industries are the top 10% industries ranked by the number of unique buyers in the sample period in Prowess. Major 6-digit industries have 152 or more unique buyers that are included in the Prowess sample.

[8] The legal requirement for data reporting changed after 2011, and product-level price data became less available thereafter.

[9] The drawback of this method is that if the same product is reported under different names over time, it will create more missing observations than what is truly missing.

3.1.2 Price Variables

Output price changes. First, I calculate log price changes, $\Delta p_{i,p,t}$, at the product level for manufacturing products. Following AIK, I drop observations with extreme log changes above $\ln(3)$ or below $-\ln(3)$.[10]

Most firms have more than one manufacturing product. I compute firm-level price changes from $t-1$ to t, $\Delta p_{i,t}$, using the standard Törnqvist index that averages product-level price changes weighted by average sales between $t-1$ and t. Denote the weight (within all products with non-missing $\Delta p_{i,p,t}$) as $s_{i,p,t}^{\text{sales}}$:

$$\Delta p_{i,t} = \sum_p s_{i,p,t}^{\text{sales}} \Delta p_{i,p,t}, \quad \sum_p s_{i,p,t}^{\text{sales}} = 1. \tag{3.1}$$

Similarly, one can define firm-level output changes as below:

$$\Delta y_{i,t} = \sum_p s_{i,p,t}^{\text{sales}} \Delta y_{i,p,t}. \tag{3.2}$$

To reduce measurement errors, I calculate firm-level price and output changes only when the Törnqvist index covers over 50% of manufacturing product sales in a given year for a given firm.

Intermediate price changes. Define $\rho_{i,t}$ as the logged unit price for total material inputs and $x_{i,t}^{\text{input}}$ as the expenditure share of materials in the cost of goods sold (COGS). As in AIK, I assume that changes in $\rho_{i,t}$ equal the average changes in all individual inputs weighted by average expenditure share between $t-1$ and t.

Let $\Delta\rho_{i,t}^{\text{mj}}$ be the average price change of major intermediate goods and $\Delta\rho_{i,t}^{\text{other}}$ be the average price change of other intermediate goods, both weighted by average purchases. Their expenditure shares are $x_{i,t}^{\text{mj}}$ and $x_{i,t}^{\text{other}}$, respectively. Changes in $\rho_{i,t}$ are decomposed as follows:

$$x_{i,t}^{\text{input}} \Delta\rho_{i,t} = x_{i,t}^{\text{mj}} \Delta\rho_{i,t}^{\text{mj}} + x_{i,t}^{\text{other}} \Delta\rho_{i,t}^{\text{other}}, \quad x_{i,t}^{\text{mj}} + x_{i,t}^{\text{other}} = x_{i,t}^{\text{input}}, \tag{3.3}$$

To simplify notation, I use $(x^{\text{mj}}\Delta\rho^{\text{mj}})_{i,t}$ instead of $x_{i,t}^{\text{mj}}\Delta\rho_{i,t}^{\text{mj}}$ hereafter.

Average output price changes of competitors. I compute average price changes of i's competitors, $\Delta p_{-i,t}$, in two steps. First, for each product p, I construct average competitor price changes $\Delta p_{-i,p,t}$ weighted by average sales from $t-1$ to t. Competitors are firms who sell products within the same 6-digit industries, and I only calculate $\Delta p_{-i,p,t}$ when there are at least 5 competitors with non-missing data in 6-digit industries (~10th percentile). Denote the average

[10] Many extreme price changes come from misplacing the decimal point (e.g., 3.11 is written as 31.1 or 311). I correct these errors (explained in Section E.2) before dropping observations.

market share of firm j's product p from $t-1$ to t as $s^{\text{mkt}}_{j,p,t}$.

$$\Delta p_{-i,p,t} = \sum_j \frac{s^{\text{mkt}}_{j,p,t}}{1-s^{\text{mkt}}_{i,p,t}} \Delta p_{j,p,t}, \quad \sum_j s^{\text{mkt}}_{j,p,t} = 1 - s^{\text{mkt}}_{i,p,t}. \tag{3.4}$$

Second, for each firm i, its competitor price change $\Delta p_{-i,t}$ is the average of all its $\Delta p_{-i,p,t}$ weighted by i's average sales of p. Denote the weight as $\widetilde{s^{\text{sales}}_{i,p,t}}$.[11] Again, I calculate $\Delta p_{-i,t}$ only when it covers over 50% of manufacturing sales.

$$\Delta p_{-i,t} = \sum_p \widetilde{s^{\text{sales}}_{i,p,t}} \Delta p_{-i,p,t}, \quad \sum_p \widetilde{s^{\text{sales}}_{i,p,t}} = 1. \tag{3.5}$$

Average intermediate price changes of competitors. Each competitor j has its own $(x^{\text{mj}}\Delta\rho^{\text{mj}})_{j,t}$ and $\Delta\rho^{\text{mj}}_{j,t}$, and I aggregate up the two terms using equations 3.4 and 3.5. For each $z_{j,t} \in \{(x^{\text{mj}}\Delta\rho^{\text{mj}})_{j,t}, \Delta\rho^{\text{mj}}_{j,t}\}$, we define:

$$z_{-i,p,t} = \sum_{j\in Z} \frac{s^{\text{mkt}}_{j,p,t}}{1-s^{\text{mkt}}_{i,p,t}} z_{j,t}, \quad \text{and} \quad z_{-i,t} = \sum_p \widetilde{s^{\text{sales}}_{i,p,t}} z_{-i,p,t}. \tag{3.6}$$

Denote the two resulting cost measures as $(x^{\text{mj}}\Delta\rho^{\text{mj}})_{-i,t}$ and $\Delta\rho^{\text{mj}}_{-i,t}$.

3.1.3 Marginal Costs

As in AIK, I use log changes in average variable costs, i.e., total variable costs divided by output quantity, as a proxy for log changes in nominal marginal costs.

$$\Delta mc^{\text{nom.}}_{i,t} = \Delta \ln \frac{\text{TVC}_{i,t}}{Y_{i,t}}. \tag{3.7}$$

Real output $Y_{i,t}$ is obtained by deflating nominal sales of manufacturing products by the firm-level price we derived above. The total variable cost variable $\text{TVC}_{i,t}$ is measured by the cost of goods sold (COGS) on the income statement. In the case where sales consist of non-manufacturing sales, I allocate COGS proportionally, i.e., $\text{TVC}_{i,t} = \text{COGS}_{i,t} \times \text{Mfg. Sales}_{i,t} \,/\, \text{Sales}_{i,t}$.

3.1.4 Financial and Other Variables

Financial variables. Three commonly used financial ratios are used to gauge the tightness of the financial constraints. The first one is the EBITDA-to-sales ratio, defined as a firm's EBITDA over total income. The second one is the interest coverage ratio (ICR), which is directly available in the Prowess database. The third one is the debt service coverage ratio (DSCR), also available

[11] Note that $\widetilde{s^{\text{sales}}_{i,p,t}}$ (which is within all products with non-missing $\Delta p_{-i,p,t}$) is proportional to but not the same as $s^{\text{sales}}_{i,p,t}$ in equation 3.1 (which does not require non-missing $\Delta p_{-i,p,t}$).

in Prowess. The DSCR is defined as cash profits divided by the current portion of a firm's debt obligations, whereas cash profits are defined as after-tax profits adjusted for non-cash and extraordinary items. Compared to measures such as leverage and the debt-to-EBITDA ratio, the DSCR is more comparable across firms because the denominator has the same maturity (i.e., one year) for all firms, while measures such as leverage conceal potentially huge heterogeneity in maturity structures.[12]

The financial ratios still have considerable heterogeneity that impedes direct comparison across firms. In the top panels in Figure A2, I plot the density functions of all firms in each sector-year used in the regression sample in Section 3.3. The ICR and the DSCR have particularly high heterogeneity given the high dispersion of sector-year densities in the left tail.[13] While it is generally good to have high variation in the data, having excessive heterogeneity prevents me from pooling different sectors together meaningfully in the regression. To reduce heterogeneity, I remove 2-digit sector-year medians from the EBITDA ratios. For the ICR and DSCR, I remove 6-digit sector-year medians. The resulting density functions are plotted in the lower panels of Figure A2, and the heterogeneity in the lower tail is significantly lower for all three measures.

A firm is classified as a low-EBITDA firm at t if its EBITDA ratio (after removing medians) at $t-2$ is below the 25th percentile in the final regression sample. The low-EBITDA dummy has relatively high within-firm variation. 65% are considered low-EBITDA for at least once. 19% of firms are considered low-EBITDA for over 50% of the time, and 7.5% of firms for over 80% of the time. Only 2.7% of firms always have low EBITDA. Finally, low-EBITDA firms account for around 18% of sales in the regression sample. Low-ICR and low-DSCR firms are classified in the same way using the 25th percentile, and the within-firm variation is similar.[14]

Other variables. A firm's market share is defined as the average market share of each product in its 6-digit industry weighted by sales at t. Industry scope is the number of unique 6-digit manufacturing industries where a firm has positive sales in a given year. A firm's exporter status is determined by the share of its export revenues in its total income, as reported directly by Prowess. To determine a firm's relative size at t, I calculate the average log asset size from $t-1$ to t relative to the manufacturing sample average in the same period.

3.2 Specifications and Identification

3.2.1 Baseline Specification

The baseline specification, as in equation 3.8, features double interactions with the pre-determined low-financial dummy to test how financial constraints affect pricing. For robustness, I run the

[12]Unfortunately, Prowess does not have maturity information for my sample period, so it is impossible to use the identification strategy in Almeida (2012).

[13]For the EBITDA, the heterogeneity is much lower. The only exception is the "Fats & oils and derived products" sector, which has noticeably high kurtosis in panel (a); however, the sector only accounts for less than 3% of the regression sample.

[14]For the low-ICR dummy, the statistics are 73%, 14%, 3.6%, 0.5% (of firms), and 18% (of sales). For the low-DSCR dummy: 71%, 14%, 4.6%, 1.3% (of firms), and 20% (of sales).

same regression using the EBITDA dummy, the ICR dummy, and the DSCR dummy separately.

$$\Delta p_{i,t} = \underbrace{\beta_0 \Delta mc_{i,t} + \beta_1 \mathbb{1}_{i,t}^{\text{Tight}} \Delta mc_{i,t}}_{\text{Direct cost pass-through}} + \underbrace{\gamma_0 \Delta p_{-i,t} + \gamma_1 \mathbb{1}_{i,t}^{\text{Tight}} \Delta p_{-i,t}}_{\text{Strategic complementarity}}$$
$$+ \zeta \, \mathbb{1}_{i,t}^{\text{Tight}} + \text{Fixed Effects} + \varepsilon_{i,t}. \tag{3.8}$$

Main regressors. The EBITDA dummy defined in Section 3.1.4 serves as a proxy for having tight financial constraints and high $\xi_{i,t}$. As shown in the illustrative model in Section 2, firms with low EBITDA have lower internal cash flows and face greater liquidity and/or solvency risks when negative shocks hit. The same rationale applies to the ICR dummy and the DSCR dummy as well.

Economically, β_0 captures the direct cost pass-through by financially unconstrained firms. β_1 is the difference between constrained and unconstrained firms, i.e., the effects of financial constraints on pass-through. Their sum, $\beta_0 + \beta_1$, is the pass-through by financially constrained firms. Similarly, γ_0 tells the strength of strategic complementarities of unconstrained firms, while γ_1 is the effect of financial constraints on strategic complementarities. Finally, I do not need to include lagged $\Delta p_{i,t}$ on the right-hand side because $\Delta p_{i,t}$ exhibits a very weak serial correlation of only -0.11 at the annual frequency. In unreported tests, I also control for lagged IVs (defined below) as well as the lags of $\Delta mc_{i,t}$, $\Delta p_{-i,t}$, and interaction terms. Estimates are virtually unchanged.

Identification and instrumental variables. Both $\Delta mc_{i,t}$ and $\Delta p_{-i,t}$ are endogenous. For $\Delta mc_{i,t}$, the main confounder is demand shocks. Had we lived in the textbook macro model where buyers are measure-zero price takers, demand shocks would not affect input prices at all, and any input price change could be a valid instrument in firm-level regressions. In reality, firms are not always price takers, in which case demand shocks simultaneously affect both output and input prices. This creates an omitted variable bias problem for β_0. The existence of financial constraints worsens the problem because financially constrained firms might bargain harder for lower input prices compared to unconstrained firms, which biases estimates of not only β_0 but also β_1. For $\Delta p_{-i,t}$, the main confounder is common input price shocks that affect $\Delta mc_{i,t}$ and $\Delta p_{-i,t}$ simultaneously. In AIK, the assumption is that firms often source inputs from different countries, which generates sufficient idiosyncratic variation in the foreign marginal cost component of competing firms. Unfortunately, unlike in AIK, imported goods only account for a negligible share for the majority of firms in Prowess. The median share of imported goods in all intermediate goods is only 1.5%. Therefore, I cannot use import price shocks as exogenous variation.

Alternatively, I exploit the fact that domestic *major input markets* defined in Section 3.1.1 are analogous to foreign markets in AIK in the following sense. First, while firms are unlikely price takers in all input markets, they should be reasonably close to price takers in domestic major input markets because there are a large number of buyers. More importantly, even if firms might not be pure price takers in major input markets, the question is to what extent it biases β_1. As I verify in Section 3.5, financial constraints are not significantly correlated with lower input prices, which alleviates the concern that β_1 may be biased if constrained firms can negotiate lower prices.

Second, is there enough idiosyncratic variation in price changes in major input markets among competitors to instrument both $\Delta mc_{i,t}$ and $\Delta p_{-i,t}$? Prowess does not contain the identity of sellers of intermediate goods, so there is no direct answer. Following AIK, who face the same problem, I check the correlation between $(x^{\mathrm{mj}}\Delta\rho^{\mathrm{mj}})_{i,t}$ and $(x^{\mathrm{mj}}\Delta\rho^{\mathrm{mj}})_{-i,t}$, which are analogous to $\Delta mc^{*}_{i,t}$ and $\Delta mc^{*}_{-i,t}$ in their paper. They find a low correlation of 0.27, whereas I find a higher correlation of 0.57 in my sample. The higher correlation is not surprising, given that firms still source in the same domestic market no matter how different their suppliers are. Given that all my results below strongly reject the underidentification test (Kleibergen-Paap rk LM statistic ≈ 40), $(x^{\mathrm{mj}}\Delta\rho^{\mathrm{mj}})_{-i,t}$ still seems to have enough idiosyncratic variation to identify γ's despite the moderately higher correlation.

Given the identifying assumptions, my first two instruments are $(x^{\mathrm{mj}}\Delta\rho^{\mathrm{mj}})_{i,t}$ and $(x^{\mathrm{mj}}\Delta\rho^{\mathrm{mj}})_{-i,t}$. The former is the direct contribution to firm i's marginal costs by major intermediate goods, and the latter to the competitors'. Second, I include $\Delta\rho^{\mathrm{mj}}_{i,t}$ and $\Delta\rho^{\mathrm{mj}}_{-i,t}$ as IVs in case price changes can be correlated among major and other inputs and that the observed cost share underestimates the loading of $\Delta\rho^{\mathrm{mj}}$. Third, given the double interactions with the financial dummy in specification 3.8, the four IVs ($(x^{\mathrm{mj}}\Delta\rho^{\mathrm{mj}})_{i,t}$, $\Delta\rho^{\mathrm{mj}}_{i,t}$, $(x^{\mathrm{mj}}\Delta\rho^{\mathrm{mj}})_{-i,t}$, and $\Delta\rho^{\mathrm{mj}}_{-i,t}$) are all interacted with the financial dummy. Finally, I only include observations where major intermediate goods with price information account for 10-110% of total variable costs.[15]

For robustness, I include an alternative specification in Section 3.2.2 that only exploits the idiosyncratic component in marginal cost to identify β_0 and β_1, while dropping the strategic complementarity terms altogether. The trade-offs are discussed in Section 3.2.2.

Sample restrictions. Specification 3.8 has several potential other confounding factors. Crouzet and Mehrotra (2020) show that very large firms (top 1%) are less cyclical than the rest likely due to their industry scope. This can bias β_1 depending on the correlations between profit margins, size, and scope. Second, under the standard nested-CES demand system, the residual elasticity is a function of market share, and thus one would expect firms with very high market share to have much lower cost pass-through. Third, large exporters likely face a different set of competitors not included in Prowess data. Therefore, I exclude firms with very large market share (top 5%), firms with very large industry scope (top 5%), firms with either very large or very small asset size (top and bottom 5%), as well as very large exporters (top 5%). All exclusions are based on average values from $t-2$ to $t-1$.

Fixed effects, clusters, and weights. I include a battery of fixed effects as shown in Table 1. The tightest fixed effects are sector/industry-year fixed effects, which absorb any unobserved common factors such as trend inflation or inflation expectations at the sector/industry level. In principle, these fixed effects would not fit multi-sector/industry firms, but 75% of firms in the sample are single-sector and 59% are single-industry, which alleviates the concern. Importantly, I require each sector-year pair (or each industry-year pair if I use industry fixed effects) to have at least 6 firms with at least 8 years of observations in the regression sample. As a re-

[15]The lower bound is to ensure its relevance. I allow the upper bound to exceed 100% for two reasons. First, when input prices rise sharply, COGS tends to underestimate total variable cost under either the FIFO method (first in, first out) or the average cost method. Second, data on intermediate goods have high quality in Prowess while COGS is only a rough measure of total variable cost. Using the latter to censor the former may create more noise.

sult, the median (mean) number of firms in each sector-year is 44 (55.6) and 13 (24.0) in each industry-year.

Standard errors are clustered by firm and sector-year (industry-year) when fixed effects are based on sectors (industries). In particular, firm clusters address the concern that the financial dummy is sticky at the firm level. Given that I only have 20 years, 9 sectors, and 25 industries in the sample, I do not cluster standard errors by year *and* sector/industry. Finally, regressions are weighted by average PPI-deflated sales of goods between $t-2$ and $t-1$.

Pre-determined variable assumption. Reverse causality between financial variables and prices happens when firms anticipate cost increases and adjust prices in advance. If a cost increase at t is anticipated at $t-2$, financially unconstrained firms will raise prices in advance at $t-2$, leading to (i) lower margins and worse financial ratios at $t-2$ but also (ii) smaller price changes t. Therefore, anticipated input price changes, even if exist, only bias $\hat{\beta}_1$ downwards and attenuate the estimated effects of financial constraints.

3.2.2 Idiosyncratic Cost Shocks

The identifying assumptions above are reasonable but not perfect. In particular, one might worry that the IVs above may be contaminated by aggregate demand shocks. When aggregate demand shocks hit, demand for all intermediate inputs rises, driving up input prices. Even though input prices are still exogenous to firms' decisions, they are correlated with firms' demand now.

Hence in the second specification, I only use the idiosyncratic variation in input prices, which is obtained by removing 4-digit industry-year fixed effects from the IVs. The main advantage is that residualization cleanses common demand shocks in 4-digit industries. The main disadvantage is that it also cleanses common supply shocks, which are particularly important to macroeconomic dynamics. Another disadvantage is that residualization absorbs over 80% of variation of $(x^{\mathrm{mj}}\Delta\rho^{\mathrm{mj}})_{-i,t}$ and $\Delta\rho^{\mathrm{mj}}_{-i,t}$, making it impossible to estimate γ^T and γ^{NT}. To avoid weak instruments, I exclude strategic complementarity terms from the new specification in equation 3.9. As before, β_1 measures the effects of financial constraints.

$$\Delta p_{i,t} = \beta_0 \Delta mc_{i,t} + \beta_1 \mathbb{1}^{\mathrm{Tight}}_{i,t} \Delta mc_{i,t} + \zeta\, \mathbb{1}^{\mathrm{Tight}}_{i,t} + \text{Fixed Effects} + \varepsilon_{i,t}. \tag{3.9}$$

Instrumental variables. For $(x^{\mathrm{mj}}\Delta\rho^{\mathrm{mj}})_{i,t}$ and $\Delta\rho^{\mathrm{mj}}_{i,t}$, I regress each on 4-digit industry-year fixed effects to obtain the residuals, $(x^{\mathrm{mj}}\Delta\rho^{\mathrm{mj}})^{\mathrm{resi}}_{i,t}$ and $(\Delta\rho^{\mathrm{mj}})^{\mathrm{resi}}_{i,t}$, respectively. The residualized IVs are then interacted with the financial dummy.

3.3 Effects of the Price Rigidity Channel on Prices

3.3.1 Effects on Current Prices

In Table 1, I report empirical results using the specifications above and find significant support for the theoretical prediction in Section 2. All instruments are strong as the Cragg-Donald Wald F statistics are much higher than 10.

When input prices change, financially unconstrained firms have a pass-through rate of 0.64 ($\hat{\beta}_0$) in the same year. For financially constrained firms, measured by the EBITDA ratio, the cost pass-through is higher by around 0.2 percentage points ($\hat{\beta}_1$) and significant at the 1% level. In other words, financially constrained firms have a pass-through rate of 0.87 ($\hat{\beta}_0 + \hat{\beta}_1$), which is around 35% steeper than the pass-through of unconstrained firms. $\hat{\beta}_0$ and $\hat{\beta}_1$ from specification B, which uses residualized IVs, show similar patterns, albeit with marginally smaller $\hat{\beta}_1$. When I use the ICR and DSCR instead of the EBITDA ratio in Tables A1 and A2, $\hat{\beta}_0$ and $\hat{\beta}_1$ are highly similar. Three different measures all give supporting evidence for corollary 1.

Interestingly, strategic complementarities show opposite patterns in Table 1: financially constrained firms have much weaker strategic complementarities compared to unconstrained firms. Financially unconstrained firms have $\hat{\gamma}_0$ around 0.35, slightly lower than but roughly in line with the 0.5 estimated by Amiti et al. (2019). For financially unconstrained firms, however, their strategic complementarities ($\hat{\gamma}_0 + \hat{\gamma}_1$) are indistinguishable from zero. The same result also shows up in Tables A1 and A2 when I use alternative financial measures. This empirical pattern is consistent with the second case discussed in proposition 2 where competitors affect demand elasticity only with a time lag.

3.3.2 Effects on Future Prices

In addition to the effects on current prices, I examine the effects on future prices. Financially unconstrained firms, given price adjustment costs, should opt for a smoother path of price adjustments compared to their financially constrained peers. Thus, the difference in pricing should be the strongest up on the shock and fade away over time. If differences are persistent, then the price rigidity channel should be rejected.

In Table A5 I show the cumulative effects on prices after one year ($\sum_{h=0}^{1} \Delta p_{i,t+h}$) and two years ($\sum_{h=0}^{2} \Delta p_{i,t+h}$) using all three financial measures. $\hat{\beta}_0$ for financially unconstrained firms remain unchanged from $t = 0$ to $t = 1$ and decline mildly at $t = 2$, consistent with the price smoothing prediction. Furthermore, cumulative differences between constrained and unconstrained firms ($\hat{\beta}_1$ and $\hat{\gamma}_1$) lose both significance and magnitude after one year across all specifications. After two years, $\hat{\beta}_1$ even turns negative, albeit insignificantly, in some specifications. Given that $\hat{\beta}_1$ is significantly positive at $t = 0$, it means that financially constrained firms not only stop raising prices at $t = 1$ but even partially reverse their price increases, which is the opposite of what a sticky price firm would normally do.

The results also alleviate the concern that annual data might not be frequent enough to test sticky price models. If price rigidities are so low that the price rigidity channel is effective only in the first few quarters and largely dissipates within one year, the significant differences observed in Section 3.3.1 should reflect something more fundamental. Then it will be difficult to explain the partial reversal at $t = 1$.

Finally, $\hat{\gamma}_0$ becomes significantly positive at $t = 2$, meaning that both financially constrained and unconstrained firms respond to competitor prices with a lag. This also appears consistent with the second case discussed in proposition 2, and future research is needed to provide more empirical evidence.

Dep. variable: $\Delta p_{i,t}$	(1)	(2) Spec A	(3)	(4)	(5) Spec B	(6)
$\Delta mc_{i,t}$ ($\hat{\beta}_0$)	0.64***	0.64***	0.63***	0.62***	0.69***	0.67***
	(0.05)	(0.06)	(0.05)	(0.05)	(0.04)	(0.04)
Tight × $\Delta mc_{i,t}$ ($\hat{\beta}_1$)	0.23***	0.20**	0.24***	0.27***	0.20***	0.16***
	(0.08)	(0.09)	(0.08)	(0.08)	(0.05)	(0.05)
$\Delta p_{-i,t}$ ($\hat{\gamma}_0$)	0.35***	0.35***	0.29***	0.36***		
	(0.08)	(0.09)	(0.09)	(0.13)		
Tight × $\Delta p_{-i,t}$ ($\hat{\gamma}_1$)	-0.26**	-0.24**	-0.26**	-0.29***		
	(0.10)	(0.11)	(0.10)	(0.11)		
Tight	0.02***	0.02***	0.02***	0.02***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y				
Sector FE	Y					
Industry FE		Y				
Sector-Year FE			Y		Y	
Industry-Year FE				Y		Y
R^2	0.729	0.732	0.688	0.671	0.689	0.680
N	9,738	9,065	9,738	9,065	9,738	9,065
Firms	826	797	826	797	826	797
Two-digit Sectors	9		9		9	
Four-digit Industries		25		25		25
Weak IV F-test						
Cragg-Donald	64.65	59.32	65.63	58.30	244.00	222.98
Kleibergen-Paap	15.05	14.11	15.09	10.00	27.36	25.71
Hansen J-test χ^2	2.896	2.447	5.409	2.993	5.051	1.730
p value	0.575	0.654	0.248	0.559	0.080	0.421
Financial Amplification						
$\hat{\beta}_0 + \hat{\beta}_1$	0.88***	0.85***	0.87***	0.88***	0.89***	0.82***
$\hat{\gamma}_0 + \hat{\gamma}_1$	0.09	0.11	0.03	0.07		

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: "Low EBITDA" ("High EBITDA") refers to the bottom 25th (top 75th) percentile in the regression sample. All regressions are weighted by average PPI-deflated sales of goods between $t-2$ and $t-1$. The median (mean) number of years per firm is 11 (11.8). The median (mean) number of firms in each sector-year is 44 (55.6) and 13 (24.0) in each industry-year. First-stage results are in Table xxx. Standard errors are clustered by firm and sector-year in columns 1, 3, 5, and by firm and industry-year in columns 2, 4, 6.

Table 1: Effects of Financial Constraints on Current Prices

3.3.3 Non-binary Interactions

The binary dummy used above is easy to interpret but inevitably coarse. In particular, when financial constraints are one-sided as in many models, their effects should also be one-sided, i.e., financially unconstrained firms should have the same cost pass-through no matter how unconstrained they are. To test this hypothesis, I split the financial variable into four quartiles, of which the lowest coincides with the $\mathbb{1}^{\text{Tight}}_{i,t}$ dummy in specifications 3.8 and 3.9. Then I set the lowest quartile as the reference group and interact the other three quartiles with $\Delta mc_{i,t}$ and $\Delta p_{-i,t}$, as shown in specification 3.10. β_1, β_2, and β_3 are the difference between the reference group (financially constrained firms) and the second, third, and fourth quartiles, respectively. If the effects of financial constraints are indeed one-sided, β_1, β_2, and β_3 should be negative but not monotone.

$$\begin{aligned}\Delta p_{i,t} = &\beta_0 \Delta mc_{i,t} + \beta_1 \mathbb{1}_{i,t}^{(25^{\text{th}},50^{\text{th}}]} \Delta mc_{i,t} + \beta_2 \mathbb{1}_{i,t}^{(50^{\text{th}},75^{\text{th}}]} \Delta mc_{i,t} + \beta_3 \mathbb{1}_{i,t}^{\geq 75^{\text{th}}} \Delta mc_{i,t} \\ &+ \gamma_0 \Delta p_{-i,t} + \gamma_1 \mathbb{1}_{i,t}^{(25^{\text{th}},50^{\text{th}}]} \Delta p_{-i,t} + \gamma_2 \mathbb{1}_{i,t}^{(50^{\text{th}},75^{\text{th}}]} \Delta p_{-i,t} + \gamma_3 \mathbb{1}_{i,t}^{\geq 75^{\text{th}}} \Delta p_{-i,t} \\ &+ \zeta_1 \mathbb{1}_{i,t}^{(25^{\text{th}},50^{\text{th}}]} + \zeta_2 \mathbb{1}_{i,t}^{(50^{\text{th}},75^{\text{th}}]} + \zeta_3 \mathbb{1}_{i,t}^{\geq 75^{\text{th}}} + \text{Fixed Effects} + \varepsilon_{i,t}. \end{aligned} \tag{3.10}$$

Table A3 shows the results for all three financial variables. In none of the 12 regressions does cost pass-through exhibit monotonicity. When I use the EBITDA ratio in columns (1)-(4), $\hat{\beta}_2$ and $\hat{\beta}_3$ (the two least constrained groups) are almost identical. $\hat{\gamma}_3$ is larger than $\hat{\gamma}_2$ but the difference is not statistically significant. When I use the ICR and the DSCR in columns (5)-(12), $\hat{\beta}_1$ is roughly the same as $\hat{\beta}_2$, while $\hat{\beta}_3$ is very noisy and insignificant. One potential reason for the insignificant $\hat{\beta}_3$ is that the highest ICR/DSCR quartile may include some highly constrained firms that borrow only very little. If a firm has little access to credit, the denominator in the ICR and the DSCR will be close to zero, leading to spuriously high ratios.[16] Overall, results in Table A3 suggest that the price rigidity channel is one-sided as expected, and the use of the binary dummy does not conceal any important heterogeneity in the unconstrained group.

3.3.4 Pass-through of Large Cost Increases

Next, I check whether the effects of financial constraints differ during large cost increases. When cost increases are large, financially constrained firms face even greater pressure on their margins, therefore they should move even closer to complete cost pass-through. The new specification for testing this hypothesis includes a new dummy, $\mathbb{1}_{i,t}^{\text{Large}}$, for large cost increases on top of the double interactions in equation 3.8.[17] To calculate the dummy, I first remove industry medians from $(x^{\text{mj}}\Delta\rho^{\text{mj}})_{i,t}$ to obtain $(x^{\text{mj}}\Delta\rho^{\text{mj}})^*_{i,t}$. Next, I assume that a firm faces large cost increases ($\mathbb{1}_{i,t}^{\text{Large}} = 1$) when $(x^{\text{mj}}\Delta\rho^{\text{mj}})^*_{i,t}$ exceeds the 70th percentile (3.5%) in the regression sample. During large cost increases, financially constrained firms account for around 32% of observations across specifications.

The two dummy variables create four groups of firms: financially constrained (unconstrained) firms with large cost increases (normal cost changes). To make it easier to read regression results, I create a dummy for each of the four firm groups and estimate β and γ for each group using specification 3.11. For instance, $\beta^{\text{T,L}}$ and $\gamma^{\text{T,L}}$ characterize the pricing behavior of finan-

[16] In Figure A3, I plot the distribution of leverage (after removing time-industry medians). In each panel, I partition the regression sample evenly into 16 groups by their EBITDA, ICR, or DSCR and show the box plot for each group. In panel (a), leverage appears stable among high-EBITDA groups. By contrast, firms with the highest ICR or DSCR in panels (b) and (c) have much lower leverage, consistent with the hypothesis that some firms in this group are indeed constrained and have little access to credit.

[17] Notice that equation 3.9 is not suitable for studying nonlinear effects of large cost increases because residualization already assumes linearity.

cially constrained firms during large cost increases.[18]

$$
\begin{aligned}
\Delta p_{i,t} = \beta^{\text{T,L}}\, \mathbb{1}_{i,t}^{\text{Tight, Large}} \Delta mc_{i,t} \quad & + \beta^{\text{NT,L}}\, \mathbb{1}_{i,t}^{\text{Not Tight, Large}} \Delta mc_{i,t} \\
+ \beta^{\text{T,NL}}\, \mathbb{1}_{i,t}^{\text{Tight, Not Large}} \Delta mc_{i,t} \quad & + \beta^{\text{NT,NL}}\, \mathbb{1}_{i,t}^{\text{Not Tight, Not Large}} \Delta mc_{i,t} \\
+ \gamma^{\text{T,L}}\, \mathbb{1}_{i,t}^{\text{Tight, Large}} \Delta p_{-i,t} \quad & + \gamma^{\text{NT,L}}\, \mathbb{1}_{i,t}^{\text{Not Tight, Large}} \Delta p_{-i,t} \\
+ \gamma^{\text{T,NL}}\, \mathbb{1}_{i,t}^{\text{Tight, Not Large}} \Delta p_{-i,t} \quad & + \gamma^{\text{NT,NL}}\, \mathbb{1}_{i,t}^{\text{Not Tight, Not Large}} \Delta p_{-i,t} \\
+ \zeta_1\, \mathbb{1}_{i,t}^{\text{Tight}} + \zeta_2\, \mathbb{1}_{i,t}^{\text{Large}} + \zeta_3\, \mathbb{1}_{i,t}^{\text{Tight}} \mathbb{1}_{i,t}^{\text{Large}} & + \text{Fixed Effects} + \varepsilon_{i,t}.
\end{aligned} \tag{3.11}
$$

Table A4 presents the results. The Cragg-Donald F statistics are around 15, albeit weaker than the F statistics in Table 1. Nonetheless, estimates in Table A4, particularly for financially unconstrained firms, are largely in line with estimates in Table 1, which alleviates concerns about weak instruments.

For financially unconstrained firms, direct cost pass-through is virtually unchanged regardless of the magnitude of the cost increase. Strategic complementarities are also similar across specifications, ranging from 0.3 to 0.4, although point estimates are mildly larger and more significant during large cost increases.

Financially constrained firms exhibit the highest cost pass-through during large cost increases — most point estimates of $\hat{\beta}^{\text{T,L}}$ fall between 0.95 and 1 across specifications, which are around 0.3 percentage points higher (or 50% steeper) than $\hat{\beta}^{\text{NT,L}}$. The difference is significant at the 1% level for all specifications using the EBITDA ratio and between the 1% and 5% levels for those using the ICR. The significance deteriorates when I switch to the DSCR: only two out of four regressions report significant differences, although point estimates are still similar.

During normal cost changes, cost pass-through ($\hat{\beta}^{\text{T,NL}}$) is only significantly higher for constrained firms in columns (3) and (4) when I use the EBITDA ratio. When I use the ICR and DSCR, $\hat{\beta}^{\text{T,NL}}$ is no different from $\hat{\beta}^{\text{NT,NL}}$, meaning that there is little difference in pass-through during normal times. However, one needs to interpret the results with a grain of salt because $(\hat{\beta}^{\text{T, L}} - \hat{\beta}^{\text{NT, L}}) - (\hat{\beta}^{\text{T, NL}} - \hat{\beta}^{\text{NT, NL}})$, the difference in pass-through differentials, is only significant when I use the ICR in columns (6)-(8). Finally, financially constrained firms show no significant strategic complementarities regardless of the shock size, though point estimates appear closer to zero during large cost increases.

[18] Specification 3.11 is econometrically identical to the usual triple interaction specification in the following form. For instance, $\beta^{\text{T,L}}$ in specification 3.11 is the same as $(\beta_0 + \beta_1 + \beta_2 + \beta_3)$, $(\beta^{\text{T,L}} - \beta^{\text{NT,L}}) = \beta_1 + \beta_3$, and $\beta_3 = (\beta^{\text{T,L}} - \beta^{\text{NT,L}}) - (\beta^{\text{T,NL}} - \beta^{\text{NT,NL}})$. Nonetheless, specification 3.11 is more convenient in this case.

$$
\begin{aligned}
\Delta p_{i,t} = {} & \beta_0 \Delta mc_{i,t} + \beta_1 \mathbb{1}_{i,t}^{\text{Tight}} \Delta mc_{i,t} + \beta_2 \mathbb{1}_{i,t}^{\text{Large}} \Delta mc_{i,t} + \beta_3 \mathbb{1}_{i,t}^{\text{Tight}} \mathbb{1}_{i,t}^{\text{Large}} \Delta mc_{i,t} \\
& + \gamma_0 \Delta p_{-i,t} + \gamma_1 \mathbb{1}_{i,t}^{\text{Tight}} \Delta p_{-i,t} + \gamma_2 \mathbb{1}_{i,t}^{\text{Large}} \Delta p_{-i,t} + \gamma_3 \mathbb{1}_{i,t}^{\text{Tight}} \mathbb{1}_{i,t}^{\text{Large}} \Delta p_{-i,t} \\
& + \zeta_1\, \mathbb{1}_{i,t}^{\text{Tight}} + \zeta_2\, \mathbb{1}_{i,t}^{\text{Large}} + \zeta_3\, \mathbb{1}_{i,t}^{\text{Tight}} \mathbb{1}_{i,t}^{\text{Large}} + \text{Fixed Effects} + \varepsilon_{i,t}.
\end{aligned}
$$

3.4 Effects of the Price Rigidity Channel on Non-price Variables

Having shown the effects on prices, now I show the effects on important non-price variables to validate my theoretical model.

Profit margins. First and foremost, I examine the effects on profit marginals, which play a pivotal role in the theoretical model. The theory predicts that financially constrained firms should be able to mitigate the negative impact on their profit margins through raising current prices.

First, I check the COGS margin. The COGS margin, calculated as sales over COGS, is the most primitive measure of profitability.[19] In the empirical analysis, I use log changes in the COGS margin, i.e., $\Delta \ln \frac{\text{Sales}_{i,t}}{\text{COGS}_{i,t}}$, as the dependent variable and show the results in Panel (a) of Table A6. Both constrained and unconstrained firms see significantly lower COGS margins when costs rise, but the impact on constrained firms is significantly smaller. After a 1% increase in marginal costs, the COGS margin of unconstrained firms drops by around 0.35 percentage points ($\hat{\beta}_0$), while the COGS margin of constrained firms drops by less than 0.2 percentage points ($\hat{\beta}_0 + \hat{\beta}_1$). The difference is significant at the 1% level when I use the EBITDA dummy, the 5% level when I use the ICR dummy, and 10% when I use the DSCR dummy.

Next, I check the EBITDA margin, a more comprehensive measure of profitability than the COGS margin. Similar to the COGS margin, the EBITDA margin is defined as sales over sales minus EBITDA, which avoids the problem of taking the log of negative EBITDA. Panel (b) of Table A6 shows the results using $\Delta \ln \frac{\text{Sales}_{i,t}}{\text{Sales}_{i,t} - \text{EBITDA}_{i,t}}$. After a 1% increase in marginal costs, the EBITDA margin of unconstrained firms drops by 0.2 percentage points, while for constrained firms I find $\hat{\beta}_0 + \hat{\beta}_1 \approx 0$ across all specifications, meaning that they manage to keep their EBITDA margin unaffected despite the cost increase. However, the difference ($\hat{\beta}_1$) is less significant than in Panel (a). $\hat{\beta}_1$ is still significant at the 1% to 5% level when I use the ICR dummy and the DSCR dummy, but it sometimes turns insignificant when I use the EBITDA dummy. The weakened significance is potentially because the EBITDA margin consists of more items not directly related to production.

Overall, results in Table A6 confirm the theoretical prediction that financially constrained firms increase their cost pass-through to improve short-term profitability and internal cash flows.

Output. As financially constrained firms pass through more costs into output prices, they should see lower output quantity. To test the dynamic effects on output, I use specifications A and B and replace the dependent variable with cumulative output changes up to two years. Output is defined in equation 3.2.

[19] Note that sales-to-COGS is identical to manufacturing sales-to-TVC by the definition of TVC in Section 3.1.3. Following equation 3.7 and the assumptions behind it, one can also equalize log changes in the COGS margin and log changes in markup:

$$\Delta \ln \frac{\text{Sales}_{i,t}}{\text{COGS}_{i,t}} = \Delta \ln \frac{\text{Mfg. Sales}_{i,t}}{\text{TVC}_{i,t}} = \Delta \ln \frac{P_{i,t} Y_{i,t}}{\text{TVC}_{i,t}} = \Delta \left(p_{i,t} - mc_{i,t}^{\text{nom.}} \right).$$

For this reason, I write the COGS margin as $\frac{\text{Sales}}{\text{COGS}}$ instead of $\frac{\text{Sales}-\text{COGS}}{\text{Sales}}$.

Table A7 reports the empirical results. When marginal costs rise by 1%, financially unconstrained firms lose output by 0.3% ($\hat{\beta}_0 \approx -0.3$) at $t = 0$, and estimates are significant at the 1% level. The loss of output remains largely unchanged at $t = 1$ and starts to fade away at $t = 2$. For financially unconstrained firms, estimates of $\hat{\beta}_0$ across time horizons are highly consistent under different specifications and fixed effects.

Financially constrained firms do not seem to lose more output... TO ADD

Leverage. Finally, I examine how leverage evolves after cost increases. Intuitively, credit demand should increase as firms want to borrow to smooth cash flows. If firms are financially unconstrained, higher credit demand should lead to higher leverage either through borrowing more or through repaying less. Constrained firms, on the contrary, should prefer raising internal cash flows over increasing leverage.

Table A8 shows the effects on leverage.[20] Since the debt-to-assets ratio is often skewed, I use the log transformation $\ln\left(1 + \text{Debt} / \text{Assets}\right)_{i,t}$ instead. As expected, unconstrained firms increase leverage after cost increases, and estimates become significant at the 10% level after one year. By contrast, constrained firms have no significant changes in leverage, and point estimates are small. The empirical results, of course, are suggestive and should be taken with a grain of salt because the differences are not statistically significant.

3.5 Robustness

Input costs. Price changes result from changes either in the pass-through rate or in input prices, so it is necessary to check whether my instrumental variables indeed predict the same input price changes for constrained and unconstrained firms. In particular, firms respond to not only current but also future input prices with nominal rigidities. To test if price changes are driven by input price differentials, I put cumulative changes in intermediate prices multiplied by expenditure share up to two years, $\sum_{h=0}^{k\in\{0,1,2\}} (s^{\text{input}} \Delta\rho)_{i,t+h}$, on the left-hand side and examine their correlations with the right-hand side conditional on firm types. I keep the same regression specification as before for consistency, though there are surely other specifications one can use. The interpretation is that, to generate a 1% increase in marginal cost, how large the contemporaneous increase in input prices should be, and how persistent the increase is in two years.

Results for cumulative input price changes in two years ($k = 2$) are reported in Table 2. Contemporaneous and one-year cumulative changes are reported in Table A9. $\hat{\beta}_1$ is insignificant in all columns in both tables, suggesting no significant difference between the two firm types across specifications. If anything, point estimates show that after price increases in major intermediate markets, financially constrained firms exhibit slightly smaller (but insignificant) increases in input prices, likely reflecting their greater efforts to cut costs in non-major intermediate markets. Therefore, results in Table 1 are not driven by differential changes in average input prices.

$\hat{\beta}_0$ declines substantially from around 2.0 at $t = 0$ to 1.4 at $t + 1$ and eventually to 1.2 at

[20] Debt is measured by the "Borrowing" variable in Prowess, which includes all borrowings from banks, bonds, other companies, etc. Unfortunately, it does not distinguish the current and non-current portions of borrowings for data before 2011, and I cannot test the effects on debt by maturity.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dep.: $\Sigma_{h=0}^{2}(\text{lnSH}^{\rho}\Delta\rho)_{i,t+h}$		x = EBITDA				x = ICR				x = DSCR		
$\Delta mc_{i,t}$ ($\hat{\beta}_0$)	1.27***	1.19***	1.23***	1.17***	1.24***	1.20***	1.21***	1.18***	1.23***	1.17***	1.20***	1.16***
	(0.18)	(0.16)	(0.16)	(0.14)	(0.17)	(0.14)	(0.15)	(0.13)	(0.17)	(0.14)	(0.15)	(0.13)
Tight × $\Delta mc_{i,t}$ ($\hat{\beta}_1$)	-0.09	-0.07	-0.08	-0.04	0.03	-0.14	-0.03	-0.16	0.10	0.03	0.04	-0.05
	(0.32)	(0.29)	(0.24)	(0.22)	(0.26)	(0.23)	(0.21)	(0.20)	(0.27)	(0.24)	(0.20)	(0.18)
$\Delta p_{-i,t}$ ($\hat{\gamma}_0$)	-0.66***	-0.22			-0.64***	-0.24			-0.63***	-0.22		
	(0.22)	(0.35)			(0.21)	(0.32)			(0.21)	(0.32)		
Tight × $\Delta p_{-i,t}$ ($\hat{\gamma}_1$)	0.10	0.06			0.01	0.15			-0.12	-0.14		
	(0.37)	(0.33)			(0.29)	(0.25)			(0.32)	(0.28)		
Tight	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.01	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Year FE	Y		Y		Y		Y		Y		Y	
Industry-Year FE		Y		Y		Y		Y		Y		Y
R^2	-1.358	-1.405	-1.239	-1.351	-1.332	-1.397	-1.214	-1.341	-1.345	-1.389	-1.217	-1.326
N	8,193	7,610	8,193	7,610	8,193	7,610	8,193	7,610	8,193	7,610	8,193	7,610
Firms	826	792	826	792	826	792	826	792	826	792	826	792
Two-digit Sectors	9		9		9		9		9		9	
Four-digit Industries		25		25		25		25		25		25
Weak IV F-test												
Cragg-Donald	55.83	53.07	197.45	205.35	62.21	56.88	193.94	181.45	61.94	56.67	194.20	198.64
Kleibergen-Paap	11.67	5.81	22.53	29.21	7.33	7.39	11.83	10.56	14.92	6.48	24.89	31.87
Hansen J-test χ^2	0.608	2.304	0.749	0.306	3.022	3.135	4.814	3.046	2.424	3.958	3.219	4.235
p value	0.962	0.680	0.688	0.858	0.554	0.535	0.090	0.218	0.658	0.412	0.200	0.120
Financial Amplification												
$\hat{\beta}_0 + \hat{\beta}_1$	1.18***	1.12***	1.14***	1.13***	1.27***	1.06***	1.17***	1.02***	1.32***	1.20***	1.24***	1.11***
$\hat{\gamma}_0 + \hat{\gamma}_1$	-0.56	-0.16			-0.63**	-0.09			-0.75**	-0.37		

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: xxx

Table 2: Correlation with Input Prices

$t+2$, suggesting moderate persistence of input price shocks. Given that input prices decline substantially while financially unconstrained firms barely change prices after one year, it is the *prima facie* evidence that price stickiness exists in the data.

$\hat{\gamma}_0$ looks spurious, though dropping it does not affect $\hat{\beta}$'s... TO ADD WHY

Firm size. While I use the EBITDA dummy as a proxy for financial constraints, in practice EBITDA is often strongly correlated with firm size. Yet it is less clear how the correlation with size would affect my results. On the one hand, size is often used as a proxy for financial constraints in the literature, which indeed helps identify financially constrained firms. On the other hand, large firms have lower residual elasticity in usual variable markup models, higher steady-state markups, and thus higher steady-state EBITDA ratios. Lower residual elasticity also leads to a flatter FOC slope per equation 2.14. Therefore, even without financial frictions, one might still observe that low-EBITDA firms have higher cost pass-through.

To formally examine to what extent the size factor affects my results, I re-run regressions in Table 1 but with size controls. Table A10 reports estimates of β's and γ's after controlling for possible non-linear effects of size. In particular, I include dummies for the 10th, 25th, 75th, and 90th in the size distribution... TO ADD

4 The Price Rigidity Channel in A New Keynesian Model

Empirical results lend strong support to the theoretical prediction that tight financial constraints amplify direct cost pass-through with high nonlinearity. During large shocks, direct cost pass-through can be over 50% higher for 25% of firms that are classified as "low-EBITDA," suggesting quantitatively important aggregate implications. In this section, I embed the price rigidity channel into a textbook New Keynesian model to analyze its general equilibrium implications.

4.1 Baseline Model

The intermediate goods sector is described in Section 2. Here I describe other sectors to close the model.

4.1.1 Households

A representative household chooses consumption C_t, labor supply N_t, and bond holdings B_t to maximize her lifetime utility, $\sum_{h=0}^{\infty}\beta^h\left(\frac{C_t^{1-\sigma}}{1-\sigma}-\frac{N_t^{1+\psi}}{1+\psi}\right)$, subject to a budget constraint $P_tC_t+Q_tB_t=B_{t-1}+W_t^hN_t+T_t$. B_t is risk-free bonds, of which the price is Q_t. W_t^h is the nominal wage received by households. T_t is the profits from firms net of any government transfers. Consumption C_t is defined by a standard CES aggregator: $C_t=\left(\int_0^1 C_{i,t}^{\frac{\epsilon-1}{\epsilon}}di\right)^{\frac{\epsilon}{\epsilon-1}}$.

Since all adjustment costs are non-monetary costs, in equilibrium $C_t=Y_t$. On top of the household's Euler equation, I introduce a generic demand shock ν_t in the IS curve in equation 4.1. ν_t can come from a variety of sources, such as shocks to the discount factor β, shocks to interest rates, or shocks to households' inflation expectations.

$$Y_t^{-\frac{1}{\sigma}}=\mathrm{E}_t\,\beta e^{(i_{t+1}-\pi_{t+1}+\nu_t)}Y_{t+1}^{-\frac{1}{\sigma}}, \tag{4.1}$$

Notice that i_{t+1} is the risk-free rate at t, and $i_{t+1}=-\ln Q_t$ in equilibrium. Both i_{t+1} and π_t are defined in log changes instead of in percentage changes.

4.1.2 Flexible Wages

On the labor side, wages are assumed flexible as in the textbook three-equation model. I further introduce a wedge, μ_t^w, between the nominal wage paid by companies W_t and the one received by households W_t^h. Lower case variables denote variables in the log.

$$\mu_t^w=w_t-w_t^h. \tag{4.2}$$

μ_t^w can be interpreted as either a hiring cost shock or a general cost-push shock.

4.1.3 Others

The model has a fully competitive retail sector. The central bank sets the policy rate i_{t+1}, which is the risk-free rate at t, according to a Taylor rule:

$$i_{t+1}=\phi_\pi\pi_t+\phi_y\hat{y}_t+\ln\beta. \tag{4.3}$$

$\hat{y}_t$ is the deviation of y_t from the steady state value. There is no fiscal policy. Markets clear when $C_t = Y_t$ and $N_t = L_t$.

4.1.4 Aggregation

Aggregate prices. Individual prices $P_{i,t}$ are given by equation B.6 in Section 2.1. Prices are then aggregated according to $P_t = \left(\int_0^1 P_{i,t}^{1-\epsilon} di\right)^{\frac{1}{1-\epsilon}}$. Define $\tilde{P}_{i,t} = \frac{P_{i,t}}{P_t}$ as the deviation from the aggregate price.

Labor demand. Define aggregate $A_t = \left(\int_0^1 A_{i,t}^{\epsilon-1} di\right)^{\frac{1}{\epsilon-1}}$, $\tilde{A}_{i,t} = \frac{A_{i,t}}{A_t}$, and $\omega = \left(\int_0^1 \omega_i^{\epsilon-1} di\right)^{\frac{1}{\epsilon-1}}$. Aggregate labor demand is given by:

$$L_t = \left(\frac{Y_t + \omega}{A_t}\right)^{\frac{1}{1-\gamma}} \int_0^1 \left[\frac{\tilde{A}_{i,t}^{-1}}{Y_t + \omega}\left(\tilde{P}_{i,t}^{-\epsilon} Y_t + \omega_i\right)\right]^{\frac{1}{1-\gamma}} di. \tag{4.4}$$

Let $\Delta_t = \int_0^1 \left[\frac{\tilde{A}_{i,t}^{-1}}{Y_t+\omega_i}\left(\tilde{P}_{i,t}^{-\epsilon} Y_t + \omega\right)\right]^{\frac{1}{1-\gamma}} di$, which measures the effect of price dispersion on labor usage.

4.1.5 Calibration

Table 3 summarizes the calibration of all parameters. For all parameters that do not directly affect financial constraints (i.e., all except ω, ϕ, and τ_e), I use standard values in the literature for their calibration. The slope of the margin cost Phillips curve for unconstrained firms, $\frac{\epsilon_{i,t}-1}{\tau_p}$, equals 0.02.

For the earnings-based borrowing constraint, I set ϕ at 4. In the DealScan-Compustat sample, the medium debt-to-EBITDA ratio is 16 for quarterly EBITDA (or 4 for annual EBITDA), and the medium slack is 3.8 (or 0.96 for annual EBITDA). Since I have neither investment nor term loans in the model, the debt-to-EBITDA ratio is not directly comparable, and slack is a more appropriate metric.

For the benchmark model, I calibrate ω to be 0.25 and τ_e to be 5. Simple as it is, the benchmark calibration can generate moments similar to estimates in Section 3.3.1.[21] After an idiosyncratic productivity decrease of one standard deviation, a flexible-price firm will increase its price by 16.0 percentage points at the end of the fourth quarter ($t+4$). For firms whose leverage is above the 75% quartile (analogous to the dummy variable in the regressions), their average price increases by 14.1 percentage points, which is 88% of 16.0 percentage points. For the remaining firms, their average price increases by 8.1 percentage points, which is 51% of 16.0 percentage points. The pass-through rates in the model are similar to my empirical estimates.

[21] Note that this is only a back-of-the-envelope calculation based on the commonly used AR(1) process. A rigorous moment-matching exercise would first need to address the empirical distribution of idiosyncratic shocks in my data given the critique by Jaimovich et al. (2023), which is beyond the scope of this paper.

Parameter		Value
Discount factor	β	0.98
IES	σ	1
Labor supply elasticity	ψ	5
Demand elasticity	ϵ	6
Return to scales	γ	0.25
Rotemberg adj. cost	τ_p	250
Idio. shock variance	σ_a	0.05
Idio. shock persistence	ρ_a	0.7
Fixed cost	ω	0.25
Borrowing constraint	ϕ	4
Taylor rule for π_t	ϕ_π	1.5
Taylor rule for $\hat{y}_t$	ϕ_y	0.125
Equity issuance cost	τ_e	5

Notes: xx

Table 3: Calibration

I solve the nonlinear transitional dynamics in the sequence space using the quasi-Newton method described in Section 6 of Auclert et al. (2021). Details are in Appendix C.

4.2 Price Responses in Partial Equilibrium

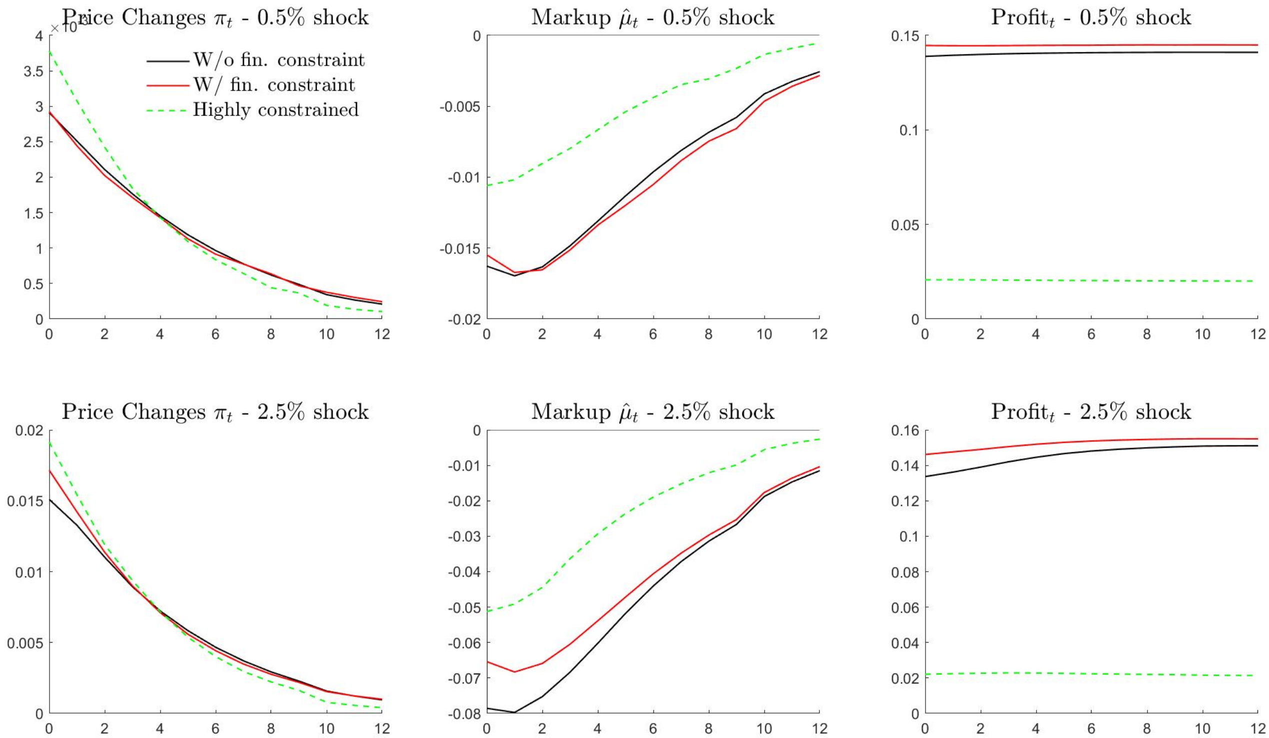
To verify the mechanisms, I first show how prices respond to shocks in partial equilibrium, and I consider three types of firms as in Panel (b) of Table 3: firms with no financial frictions at all, benchmark firms with moderate financial constraints, and firms with tight financial constraints.

In Figure 1, I simulate the average responses of the heterogeneous firm block after an unexpected inflation shock. Inflation shocks are a convenient way of modeling general cost increases because the flexible-price response should be just the same as the shock itself, making it easier to compare responses under flexible prices and sticky prices. The inflation shock follows an AR(1) process with a moderate degree of persistence of 0.7.

In the upper panel, I impose a small inflation shock of 0.5% (or 2% annualized) at $t = 0$. Without financial constraints (black line), firms would raise prices by 0.29% (or 1.2% annualized) upon impact. The inability to stay on the flexible price path leads to a drop in average markup by over 1.6% at $t = 0$. Profits fall marginally by 0.0021, equivalent to 0.64% of sales. For firms with tight financial constraints (dotted green line), price adjustments are much quicker upfront. The average price jumps by 0.38% upon impact, while the average markup falls by only 1%. Accounting profits are calibrated to be much lower for financially constrained firms in the steady state, but they are barely affected by the shock as firms adjust prices more aggressively to keep themselves afloat.[22] Finally, the benchmark firms with moderate financial constraints (red line) are almost identical to firms with no financial friction after such a small shock.

In the lower panel, I impose a large inflation shock of 2.5% (or 10% annualized) upon impact.

[22]Unlike accounting profits, the objective function of financially constrained firms does decrease significantly due to higher Rotemberg adjustment costs.



Notes: ...

Figure 1: Partial Equilibrium Responses

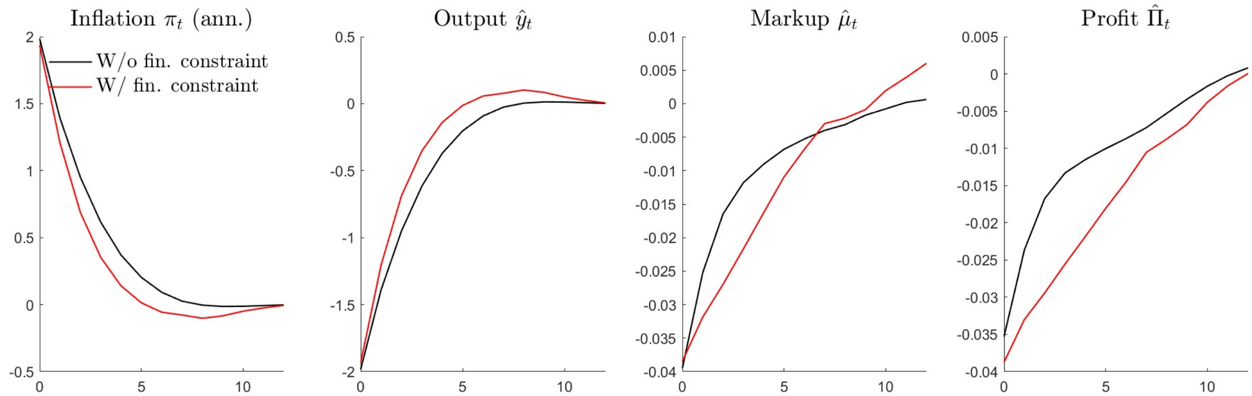
For both firms with no financial frictions and firms already with tight financial constraints, their responses increase virtually proportionally to the shock. Such strong linearity at the aggregate level, despite the nonlinearity at the individual level, is not entirely surprising. For instance, in the HANK literature, researchers often find that aggregate dynamics remain highly linear despite the strong nonlinearity at the micro level (e.g., Auclert et al., 2021).

Nonetheless, nonlinearity arises after a large shock for firms with moderate financial constraints, which are the firms we care most about. The average pass-through becomes larger as more firms face tighter financial constraints after a large shock. Prices increase by 1.7% (6.8% annualized) at $t = 0$, right between the 1.5% (6.0% annualized) by firms without financial frictions and the 1.9% (7.6% annualized) by heavily constrained firms. Consequently, the average markup falls by 6.5% compared to the 8% drop for firms without financial frictions.

4.3 Inflation in General Equilibrium (TO BE ADDED)

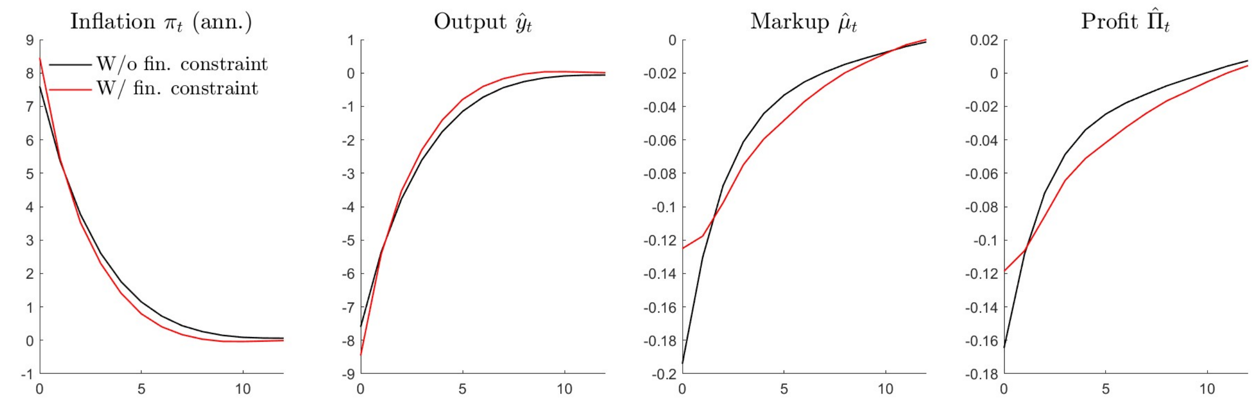
In Figures 2 and 3, I show the impulse response functions after a small and a large production decrease. A flexible-wage model with no financial constraint ($\tau_e = 0$) is added for comparison.

... TO BE ADDED.



Notes: Flexible wage model. Some lines are jagged due to numerical accuracy issues.

Figure 2: Impulse Response Functions After Large Productivity Shocks



Notes: Flexible wage model. Some lines are jagged due to numerical accuracy issues.

Figure 3: Impulse Response Functions After Large Productivity Shocks

4.4 The Role of Monetary Policy

TO BE ADDED.

5 Robustness to Alternative Pricing Models

5.1 Calvo Pricing

TO BE ADDED.

5.2 Menu Cost Models

TO BE ADDED. Use calibration in Gagliardone et al. (2024).

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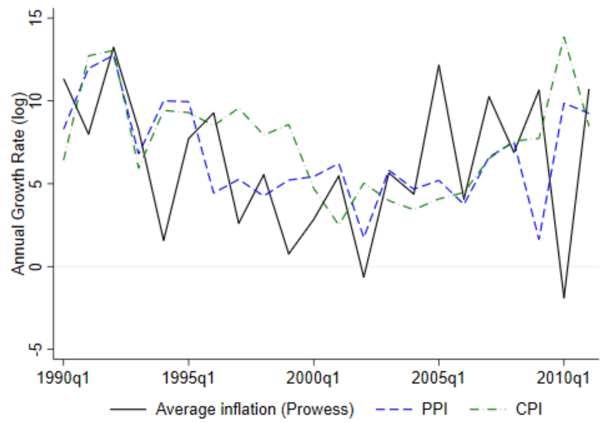
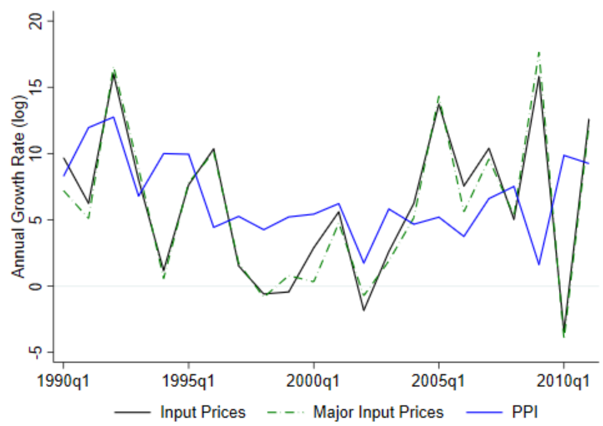
Appendix

A Additional Tables and Figures



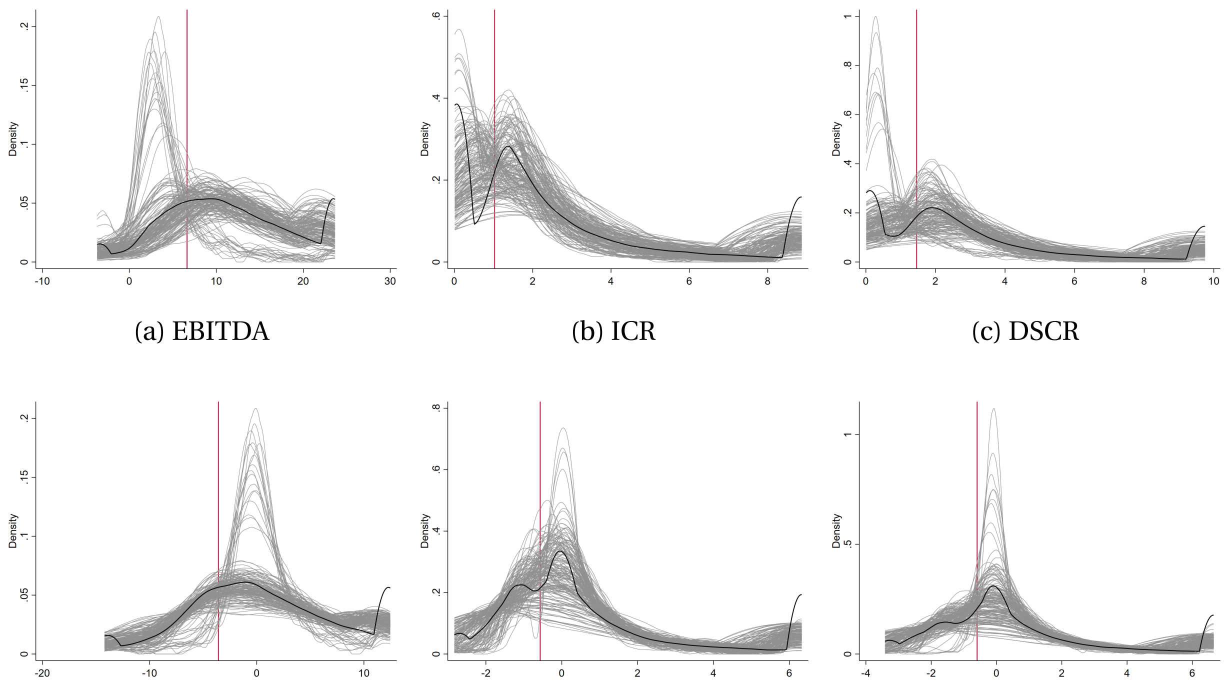
(a) Output Prices



(b) Input Prices

Notes: Average inflation in Prowess is defined as the average price changes weighted by sales among manufacturing firms. PPI includes all industries (FRED series: INDWPIATT01GPM). CPI includes all items (FRED series: INDCPIALLMINMEI). Growth rates are from March to March, corresponding to the timing in Prowess.

Figure A1: Aggregate Prices in India

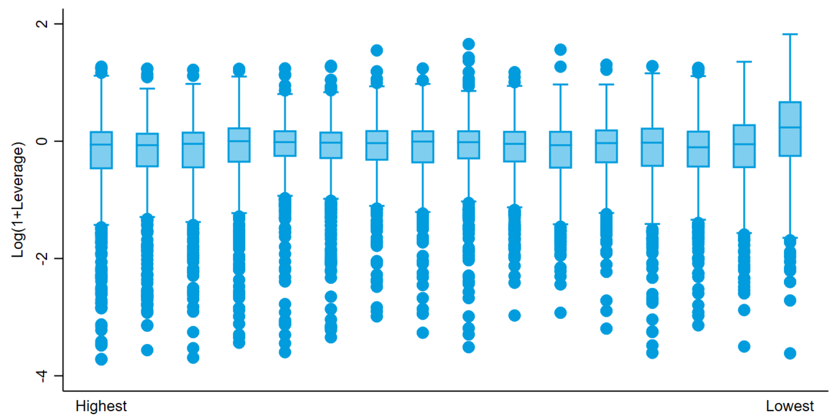


(a) EBITDA (b) ICR (c) DSCR

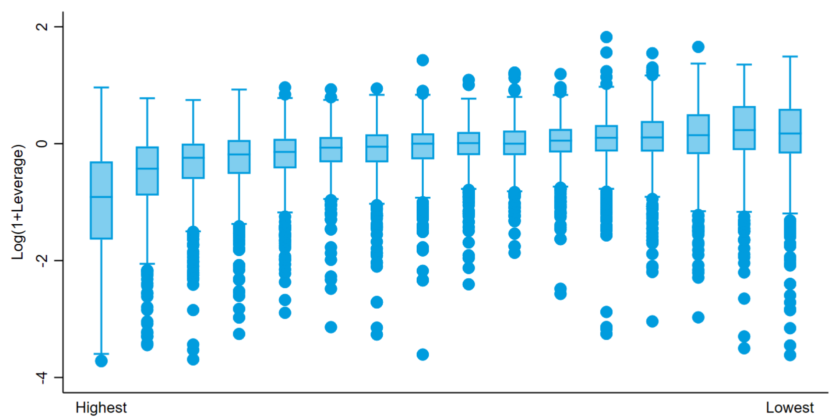
(d) EBITDA (adj.) (e) ICR (adj.) (f) DSCR (adj.)

Notes: The upper three panels show the kernal density functions of the EBITDA, ICR, and DSCR, each winsorized at the 2.5th and 90th percentiles. The black lines are the density functions of all firms in the 2-digit sector-year pairs that ever appear in the regression sample from column (1) of Table 1. The gray lines are density functions estimated for each 2-digit sector in each year. The vertical lines show the 25th percentile within the regression sample from column (1) of Table 1. In the lower three panels, I remove the sector-year medians from the variables.

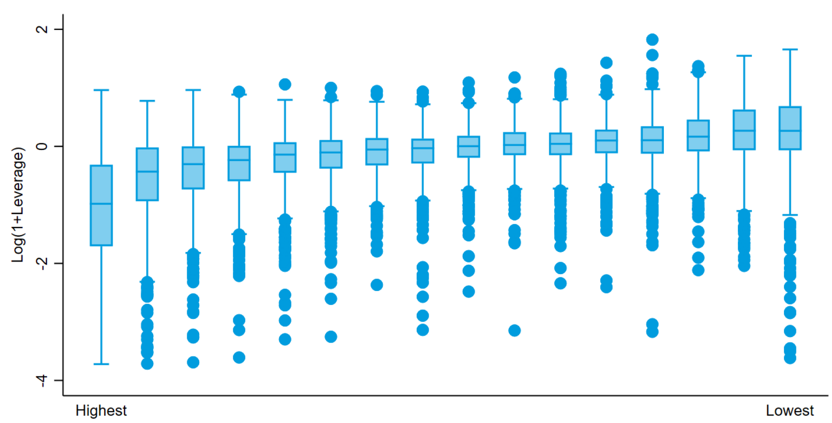
Figure A2: Distributions of Financial Variables



(a) EBITDA



(b) ICR



(c) DSCR

Notes: xxx

Figure A3: Leverage Distribution

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable: $\Delta p_{i,t}$			Spec A			Spec B
$\Delta mc_{i,t}$ ($\hat{\beta}_0$)	0.64***	0.64***	0.64***	0.63***	0.70***	0.68***
	(0.05)	(0.06)	(0.05)	(0.05)	(0.04)	(0.04)
Tight × $\Delta mc_{i,t}$ ($\hat{\beta}_1$)	0.23***	0.21**	0.19**	0.21**	0.12**	0.14**
	(0.08)	(0.09)	(0.08)	(0.08)	(0.06)	(0.06)
$\Delta p_{-i,t}$ ($\hat{\gamma}_0$)	0.35***	0.35***	0.27***	0.33**		
	(0.08)	(0.08)	(0.08)	(0.13)		
Tight × $\Delta p_{-i,t}$ ($\hat{\gamma}_1$)	-0.27***	-0.26**	-0.23**	-0.25**		
	(0.10)	(0.11)	(0.10)	(0.10)		
Tight	0.02***	0.02***	0.01***	0.01***	0.01*	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y				
Sector FE	Y					
Industry FE		Y				
Sector-Year FE			Y		Y	
Industry-Year FE				Y		Y
R^2	0.724	0.726	0.686	0.669	0.688	0.677
N	9,738	9,065	9,738	9,065	9,738	9,065
Firms	826	797	826	797	826	797
Two-digit Sectors	9		9		9	
Four-digit Industries		25		25		25
Weak IV F-test						
Cragg-Donald	64.65	59.32	65.63	58.30	244.00	222.98
Kleibergen-Paap	7.85	6.46	7.00	7.70	9.89	11.35
Hansen J-test χ^2	0.731	1.957	2.139	2.755	0.930	0.446
p value	0.947	0.744	0.710	0.600	0.628	0.800
Financial Amplification						
$\hat{\beta}_0 + \hat{\beta}_1$	0.87***	0.85***	0.83***	0.84***	0.82***	0.81***
$\hat{\gamma}_0 + \hat{\gamma}_1$	0.09	0.09	0.04	0.08		

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table replicates Table 1 but replaces the dummy variable with the low-ICR dummy. The low-ICR dummy is defined using the 25th percentile of the regression sample.

Table A1: Effects of Financial Constraints on Current Prices - ICR

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable: $\Delta p_{i,t}$			Spec A			Spec B
$\Delta mc_{i,t}$ ($\hat{\beta}_0$)	0.64***	0.64***	0.64***	0.62***	0.70***	0.67***
	(0.06)	(0.06)	(0.05)	(0.05)	(0.04)	(0.04)
Tight × $\Delta mc_{i,t}$ ($\hat{\beta}_1$)	0.19**	0.18*	0.17**	0.22**	0.11*	0.13**
	(0.09)	(0.09)	(0.09)	(0.09)	(0.06)	(0.06)
$\Delta p_{-i,t}$ ($\hat{\gamma}_0$)	0.35***	0.35***	0.27***	0.34***		
	(0.08)	(0.08)	(0.08)	(0.13)		
Tight × $\Delta p_{-i,t}$ ($\hat{\gamma}_1$)	-0.23**	-0.23**	-0.22**	-0.28***		
	(0.10)	(0.11)	(0.10)	(0.11)		
Tight	0.02***	0.02***	0.02***	0.01***	0.01**	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y				
Sector FE	Y					
Industry FE		Y				
Sector-Year FE			Y		Y	
Industry-Year FE				Y		Y
R^2	0.724	0.725	0.685	0.665	0.687	0.675
N	9,738	9,065	9,738	9,065	9,738	9,065
Firms	826	797	826	797	826	797
Two-digit Sectors	9		9		9	
Four-digit Industries		25		25		25
Weak IV F-test						
Cragg-Donald	64.65	59.32	65.63	58.30	244.00	222.98
Kleibergen-Paap	11.02	13.91	13.38	9.74	24.37	27.45
Hansen J-test χ^2	1.823	2.346	2.530	3.590	0.937	0.619
p value	0.768	0.672	0.639	0.464	0.626	0.734
Financial Amplification						
$\hat{\beta}_0 + \hat{\beta}_1$	0.83***	0.82***	0.81***	0.84***	0.81***	0.80***
$\hat{\gamma}_0 + \hat{\gamma}_1$	0.12	0.13	0.05	0.06		

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table replicates Table 1 but replaces the dummy variable with the low-DSCR dummy. The low-DSCR dummy is defined using the 25th percentile of the regression sample.

Table A2: Effects of Financial Constraints on Current Prices - DSCR

Dep. variable: $\Delta p_{i,t}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	x = EBITDA				x = ICR				x = DSCR			
Direct Pass-through												
$\Delta mc_{i,t}$ ($\hat{\beta}_0$)	0.86^{***}	0.89^{***}	0.88^{***}	0.83^{***}	0.84^{***}	0.86^{***}	0.83^{***}	0.83^{***}	0.81^{***}	0.85^{***}	0.81^{***}	0.81^{***}
	(0.07)	(0.07)	(0.05)	(0.05)	(0.07)	(0.07)	(0.06)	(0.06)	(0.07)	(0.08)	(0.06)	(0.06)
$x \in (25^{\text{th}}, 50^{\text{th}}] \times \Delta mc_{i,t}$ ($\hat{\beta}_1$)	-0.13	-0.19^{**}	-0.09	-0.05	-0.27^{**}	-0.28^{**}	-0.20^{**}	-0.20^{**}	-0.31^{**}	-0.30^{**}	-0.19^{**}	-0.18^{*}
	(0.09)	(0.09)	(0.06)	(0.05)	(0.11)	(0.11)	(0.09)	(0.08)	(0.14)	(0.13)	(0.10)	(0.09)
$x \in (50^{\text{th}}, 75^{\text{th}}] \times \Delta mc_{i,t}$ ($\hat{\beta}_2$)	-0.24^{**}	-0.28^{***}	-0.22^{***}	-0.19^{***}	-0.23^{**}	-0.27^{***}	-0.14^{*}	-0.18^{**}	-0.19^{**}	-0.25^{**}	-0.13^{**}	-0.15^{**}
	(0.10)	(0.11)	(0.06)	(0.06)	(0.10)	(0.10)	(0.08)	(0.08)	(0.09)	(0.10)	(0.07)	(0.07)
Highest x ($\geq 75^{\text{th}}$) $\times \Delta mc_{i,t}$ ($\hat{\beta}_3$)	-0.25^{**}	-0.33^{***}	-0.20^{***}	-0.18^{***}	-0.10	-0.14	-0.08	-0.12^{*}	-0.06	-0.14	-0.06	-0.10
	(0.10)	(0.11)	(0.07)	(0.07)	(0.10)	(0.11)	(0.07)	(0.07)	(0.11)	(0.12)	(0.08)	(0.08)
Strategic Complementarity												
$\Delta p_{-i,t}$ ($\hat{\gamma}_0$)	0.04	0.08			0.03	0.03			0.04	0.06		
	(0.08)	(0.12)			(0.09)	(0.13)			(0.09)	(0.13)		
$x \in (25^{\text{th}}, 50^{\text{th}}] \times \Delta p_{-i,t}$ ($\hat{\gamma}_1$)	0.15	0.21^{**}			0.29^{**}	0.31^{**}			0.39^{**}	0.39^{***}		
	(0.11)	(0.10)			(0.12)	(0.13)			(0.16)	(0.15)		
$x \in (50^{\text{th}}, 75^{\text{th}}] \times \Delta p_{-i,t}$ ($\hat{\gamma}_2$)	0.23^{*}	0.27^{*}			0.30^{**}	0.36^{***}			0.23^{*}	0.33^{**}		
	(0.14)	(0.14)			(0.12)	(0.13)			(0.12)	(0.13)		
Highest x ($\geq 75^{\text{th}}$) $\times \Delta p_{-i,t}$ ($\hat{\gamma}_3$)	0.32^{**}	0.42^{***}			0.11	0.17			0.08	0.18		
	(0.15)	(0.15)			(0.15)	(0.16)			(0.16)	(0.15)		
Others												
$x \in (25^{\text{th}}, 50^{\text{th}}]$	-0.01^{***}	-0.01^{***}	-0.01^{**}	-0.01^{***}	-0.01^{***}	-0.01^{**}	-0.00	0.00	-0.01^{**}	-0.01^{*}	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
$x \in (50^{\text{th}}, 75^{\text{th}}]$	-0.02^{***}	-0.02^{***}	-0.01^{***}	-0.01^{***}	-0.02^{***}	-0.02^{***}	-0.01	-0.01	-0.02^{***}	-0.02^{***}	-0.01^{*}	-0.01^{*}
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Highest x ($\geq 75^{\text{th}}$)	-0.03^{***}	-0.04^{***}	-0.03^{***}	-0.03^{***}	-0.02^{***}	-0.02^{***}	-0.02^{***}	-0.02^{***}	-0.02^{***}	-0.02^{***}	-0.02^{***}	-0.02^{***}
	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Year FE	Y		Y		Y		Y		Y		Y	
Industry-Year FE		Y		Y		Y		Y		Y		Y
R^2	0.693	0.672	0.694	0.684	0.684	0.668	0.687	0.676	0.677	0.660	0.684	0.674
N	9,738	9,065	9,738	9,065	9,738	9,065	9,738	9,065	9,738	9,065	9,738	9,065
Firms	826	797	826	797	826	797	826	797	826	797	826	797
Two-digit Sectors	9		9		9		9		9		9	
Four-digit Industries		25		25		25		25		25		25
Weak IV F-test												
Cragg-Donald	23.92	27.28	98.23	96.07	27.92	28.91	84.41	89.85	18.53	23.13	64.89	73.77
Kleibergen-Paap	3.63	4.73	7.29	7.15	1.70	6.88	4.09	5.62	2.33	1.66	3.24	3.13
Hansen J-test χ^2	14.425	11.669	11.321	5.724	8.577	13.052	1.739	2.614	6.069	5.884	0.874	1.354
p value	0.071	0.167	0.023	0.221	0.379	0.110	0.784	0.624	0.640	0.660	0.928	0.852
Between Less Constrained Firms												
$\hat{\beta}_3 - \hat{\beta}_2$	-0.00	-0.05	0.02	0.01	0.13	0.13	0.06	0.06	0.14	0.11	0.08	0.05
$\hat{\gamma}_3 - \hat{\gamma}_2$	0.09	0.15			-0.19	-0.19			-0.15	-0.15		

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The specifications are extended from columns (3)-(6) in Table 1. All elements except for the categorical variable are unchanged.

Table A3: Results Using Non-binary Interactions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dep. variable: $\Delta p_{i,t}$	x = EBITDA				x = ICR				x = DSCR			
Tight × Large Increase × $\Delta mc_{i,t}$ ($\hat{\beta}^{\text{T, L}}$)	0.96***	1.03***	0.96***	1.06***	0.95***	1.01***	0.96***	1.05***	0.88***	0.90***	0.91***	1.00***
	(0.09)	(0.15)	(0.10)	(0.13)	(0.15)	(0.15)	(0.15)	(0.17)	(0.14)	(0.14)	(0.15)	(0.17)
Not Tight × Large Increase × $\Delta mc_{i,t}$ ($\hat{\beta}^{\text{NT, L}}$)	0.68***	0.63***	0.67***	0.63***	0.66***	0.61***	0.66***	0.63***	0.67***	0.62***	0.66***	0.62***
	(0.09)	(0.10)	(0.08)	(0.09)	(0.09)	(0.10)	(0.09)	(0.09)	(0.09)	(0.10)	(0.09)	(0.09)
Tight × Not Large × $\Delta mc_{i,t}$ ($\hat{\beta}^{\text{T, NL}}$)	0.81***	0.79***	0.81***	0.79***	0.68***	0.67***	0.56***	0.56***	0.71***	0.71***	0.64***	0.67***
	(0.09)	(0.10)	(0.08)	(0.10)	(0.14)	(0.15)	(0.13)	(0.14)	(0.13)	(0.14)	(0.12)	(0.12)
Not Tight × Not Large × $\Delta mc_{i,t}$ ($\hat{\beta}^{\text{NT, NL}}$)	0.59***	0.61***	0.55***	0.51***	0.64***	0.65***	0.63***	0.59***	0.62***	0.63***	0.61***	0.56***
	(0.10)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.10)	(0.10)	(0.10)	(0.10)
Tight × Large Increase × $\Delta p_{-i,t}$ ($\hat{\gamma}^{\text{T, L}}$)	0.06	-0.03	-0.01	-0.03	0.06	0.01	0.01	-0.04	0.15	0.15	0.07	0.00
	(0.12)	(0.17)	(0.12)	(0.17)	(0.15)	(0.15)	(0.15)	(0.17)	(0.13)	(0.14)	(0.13)	(0.18)
Not Tight × Large Increase × $\Delta p_{-i,t}$ ($\hat{\gamma}^{\text{NT, L}}$)	0.36***	0.42***	0.32***	0.42**	0.39***	0.45***	0.32***	0.40***	0.38***	0.44***	0.32***	0.40***
	(0.11)	(0.12)	(0.11)	(0.16)	(0.11)	(0.12)	(0.11)	(0.15)	(0.12)	(0.12)	(0.11)	(0.14)
Tight × Not Large × $\Delta p_{-i,t}$ ($\hat{\gamma}^{\text{T, NL}}$)	0.13	0.14	0.07	0.09	0.20	0.20	0.22	0.24	0.15	0.13	0.11	0.10
	(0.10)	(0.10)	(0.09)	(0.14)	(0.13)	(0.14)	(0.13)	(0.18)	(0.13)	(0.14)	(0.13)	(0.16)
Not Tight × Not Large × $\Delta p_{-i,t}$ ($\hat{\gamma}^{\text{NT, NL}}$)	0.34***	0.31***	0.30**	0.36**	0.30**	0.28**	0.22*	0.26*	0.32***	0.31***	0.23**	0.29*
	(0.12)	(0.11)	(0.12)	(0.15)	(0.12)	(0.11)	(0.11)	(0.14)	(0.12)	(0.11)	(0.12)	(0.15)
Tight	0.02***	0.02***	0.02***	0.02***	0.01***	0.02***	0.01**	0.01***	0.01***	0.02***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Large Increase	-0.00	-0.00	-0.01	-0.01	-0.01	-0.00	-0.01	-0.01	-0.01	-0.00	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Tight × Large Increase	-0.00	-0.01	-0.00	-0.01	0.00	-0.01	0.00	-0.01	-0.00	-0.01	-0.00	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y			Y	Y			Y	Y		
Sector FE	Y				Y				Y			
Industry FE		Y				Y				Y		
Sector-Year FE			Y				Y				Y	
Industry-Year FE				Y				Y				Y
R^2	0.724	0.725	0.672	0.643	0.725	0.721	0.678	0.649	0.724	0.722	0.680	0.646
Weak IV F-test												
Cragg-Donald	13.61	14.32	15.12	17.37	15.12	15.06	17.69	18.06	15.82	16.00	17.70	18.76
Kleibergen-Paap	3.16	4.63	3.91	5.03	1.47	1.76	2.01	2.31	4.32	4.80	4.60	5.15
Hansen J-test χ^2	8.183	9.566	11.746	10.872	8.656	10.380	11.109	12.032	7.982	10.980	9.546	12.126
p value	0.416	0.297	0.163	0.209	0.372	0.239	0.196	0.150	0.435	0.203	0.298	0.146
Financial Amplification												
$\hat{\beta}^{\text{T, L}} - \hat{\beta}^{\text{NT, L}}$	0.27***	0.40***	0.29***	0.43***	0.29*	0.40**	0.30*	0.42**	0.21	0.28*	0.24	0.38**
$\hat{\beta}^{\text{T, NL}} - \hat{\beta}^{\text{NT, NL}}$	0.22	0.17	0.26*	0.27**	0.04	0.02	-0.07	-0.03	0.09	0.09	0.04	0.11
$(\hat{\beta}^{\text{T, L}} - \hat{\beta}^{\text{NT, L}}) - (\hat{\beta}^{\text{T, NL}} - \hat{\beta}^{\text{NT, NL}})$	0.05	0.23	0.03	0.15	0.25	0.38*	0.37*	0.45**	0.12	0.19	0.21	0.26
$\hat{\gamma}^{\text{T, L}} - \hat{\gamma}^{\text{NT, L}}$	-0.30***	-0.45**	-0.33***	-0.45***	-0.33*	-0.44**	-0.32*	-0.43**	-0.23	-0.29*	-0.25	-0.40**
$\hat{\gamma}^{\text{T, NL}} - \hat{\gamma}^{\text{NT, NL}}$	-0.22	-0.17	-0.23	-0.27*	-0.10	-0.08	-0.00	-0.02	-0.17	-0.18	-0.12	-0.19
$(\hat{\gamma}^{\text{T, L}} - \hat{\gamma}^{\text{NT, L}}) - (\hat{\gamma}^{\text{T, NL}} - \hat{\gamma}^{\text{NT, NL}})$	-0.08	-0.28	-0.09	-0.19	-0.23	-0.35*	-0.32	-0.41*	-0.06	-0.11	-0.13	-0.21

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Large cost increases refer to firm-years where $(x^{\text{mj}} \Delta\rho^{\text{mj}})_{i,t}$ exceeds its 70th percentile (or 5.3% in nominal terms). The specifications are extended from columns (1)-(4) in Table 1. All elements except for the large cost dummy are unchanged.

Table A4: Large Cost Increases

(a) **Effects on $t+1$ Prices**

Dep. variable: $\sum_{h=0}^{1} \Delta p_{i,t+h}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		x = EBITDA				x = ICR				x = DSCR		
$\Delta mc_{i,t}$ $(\hat{\beta}_0)$	0.66***	0.55***	0.69***	0.61***	0.64***	0.54***	0.69***	0.60***	0.65***	0.54***	0.69***	0.59***
	(0.10)	(0.11)	(0.08)	(0.09)	(0.10)	(0.10)	(0.08)	(0.08)	(0.11)	(0.10)	(0.09)	(0.08)
Tight × $\Delta mc_{i,t}$ $(\hat{\beta}_1)$	0.08	0.09	0.13	0.05	0.14	0.18	0.09	0.11	0.05	0.11	0.08	0.12
	(0.18)	(0.18)	(0.14)	(0.12)	(0.16)	(0.18)	(0.12)	(0.14)	(0.20)	(0.21)	(0.15)	(0.16)
$\Delta p_{-i,t}$ $(\hat{\gamma}_0)$	0.26	0.50*			0.30*	0.48			0.30*	0.50*		
	(0.17)	(0.30)			(0.16)	(0.29)			(0.16)	(0.29)		
Tight × $\Delta p_{-i,t}$ $(\hat{\gamma}_1)$	-0.02	-0.12			-0.23	-0.30			-0.17	-0.26		
	(0.23)	(0.22)			(0.21)	(0.22)			(0.22)	(0.23)		
Tight	0.02**	0.02***	0.02**	0.02**	0.02***	0.02**	0.02*	0.01	0.03***	0.02***	0.02*	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Year FE	Y		Y		Y		Y		Y		Y	
Industry-Year FE		Y		Y		Y		Y		Y		Y
R^2	0.294	0.259	0.285	0.261	0.291	0.255	0.284	0.258	0.293	0.257	0.284	0.259
N	9,118	8,478	9,118	8,478	9,118	8,478	9,118	8,478	9,118	8,478	9,118	8,478
Firms	826	796	826	796	826	796	826	796	826	796	826	796
Two-digit Sectors	9		9		9		9		9		9	
Four-digit Industries		25		25		25		25		25		25
Weak IV F-test												
Kleibergen-Paap	15.25	7.42	28.61	28.73	6.97	8.31	9.15	10.53	11.93	7.12	25.99	34.51
Hansen J-test χ^2	7.027	3.034	4.609	2.932	7.472	6.210	4.026	1.799	6.045	4.016	4.057	1.950
p value	0.134	0.552	0.100	0.231	0.113	0.184	0.134	0.407	0.196	0.404	0.132	0.377
Financial Amplification												
$\hat{\beta}_0 + \hat{\beta}_1$	0.74***	0.64***	0.82***	0.66***	0.77***	0.72***	0.77***	0.71***	0.69***	0.65***	0.77***	0.71***
$\hat{\gamma}_0 + \hat{\gamma}_1$	0.25	0.39			0.07	0.17			0.13	0.24		

(b) **Effects on $t+2$ Prices**

Dep. variable: $\sum_{h=0}^{2} \Delta p_{i,t+h}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		x = EBITDA				x = ICR				x = DSCR		
$\Delta mc_{i,t}$ $(\hat{\beta}_0)$	0.44***	0.34***	0.51***	0.45***	0.44***	0.36***	0.55***	0.46***	0.43***	0.34***	0.54***	0.44***
	(0.11)	(0.11)	(0.09)	(0.10)	(0.11)	(0.10)	(0.08)	(0.09)	(0.11)	(0.10)	(0.08)	(0.09)
Tight × $\Delta mc_{i,t}$ $(\hat{\beta}_1)$	-0.07	0.02	0.11	-0.03	-0.13	-0.18	-0.13	-0.19	-0.06	-0.03	0.00	0.00
	(0.29)	(0.21)	(0.21)	(0.16)	(0.20)	(0.20)	(0.17)	(0.15)	(0.19)	(0.19)	(0.15)	(0.14)
$\Delta p_{-i,t}$ $(\hat{\gamma}_0)$	0.42*	1.13***			0.51**	1.07***			0.53**	1.12***		
	(0.22)	(0.41)			(0.23)	(0.38)			(0.23)	(0.38)		
Tight × $\Delta p_{-i,t}$ $(\hat{\gamma}_1)$	0.29	-0.10			-0.03	0.00			-0.08	-0.13		
	(0.38)	(0.27)			(0.24)	(0.25)			(0.23)	(0.23)		
Tight	0.02	0.03*	0.02	0.03**	0.04***	0.04***	0.04***	0.04***	0.03***	0.02*	0.03**	0.02
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Year FE	Y		Y		Y		Y		Y		Y	
Industry-Year FE		Y		Y		Y		Y		Y		Y
R^2	0.152	0.101	0.159	0.141	0.151	0.103	0.157	0.138	0.151	0.100	0.158	0.139
N	8,435	7,828	8,435	7,828	8,435	7,828	8,435	7,828	8,435	7,828	8,435	7,828
Firms	826	793	826	793	826	793	826	793	826	793	826	793
Two-digit Sectors	9		9		9		9		9		9	
Four-digit Industries		25		25		25		25		25		25
Weak IV F-test												
Kleibergen-Paap	11.26	7.10	25.81	33.19	6.28	7.36	9.85	9.98	15.98	7.30	26.57	35.18
Hansen J-test χ^2	5.131	1.727	2.475	1.383	6.152	4.061	2.383	1.780	4.899	3.506	2.226	1.255
p value	0.274	0.786	0.290	0.501	0.188	0.398	0.304	0.411	0.298	0.477	0.329	0.534
Financial Amplification												
$\hat{\beta}_0 + \hat{\beta}_1$	0.37	0.36**	0.63***	0.42***	0.31	0.18	0.41**	0.27**	0.37**	0.31*	0.54***	0.44***
$\hat{\gamma}_0 + \hat{\gamma}_1$	0.71*	1.03***			0.48*	1.07***			0.45*	0.99**		

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: xxx

Table A5: Effects of Financial Constraints on Future Prices

(a) **Effects on the COGS Margin**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	x = EBITDA				x = ICR				x = DSCR			
$\Delta mc_{i,t}$ ($\hat{\beta}_0$)	-0.37***	-0.38***	-0.31***	-0.33***	-0.36***	-0.36***	-0.30***	-0.32***	-0.36***	-0.37***	-0.31***	-0.33***
	(0.05)	(0.05)	(0.04)	(0.04)	(0.05)	(0.05)	(0.04)	(0.04)	(0.05)	(0.05)	(0.04)	(0.04)
Tight × $\Delta mc_{i,t}$ ($\hat{\beta}_1$)	0.22***	0.24***	0.18***	0.14***	0.19**	0.19**	0.11**	0.12**	0.16*	0.20**	0.11*	0.12*
	(0.07)	(0.08)	(0.05)	(0.05)	(0.08)	(0.08)	(0.05)	(0.06)	(0.08)	(0.09)	(0.06)	(0.06)
$\Delta p_{-i,t}$ ($\hat{\gamma}_0$)	0.29***	0.35***			0.28***	0.33***			0.27***	0.34***		
	(0.09)	(0.13)			(0.08)	(0.12)			(0.08)	(0.12)		
Tight × $\Delta p_{-i,t}$ ($\hat{\gamma}_1$)	-0.24**	-0.25**			-0.22**	-0.22**			-0.21**	-0.25**		
	(0.10)	(0.10)			(0.10)	(0.10)			(0.10)	(0.11)		
Tight	0.02***	0.02***	0.01***	0.01***	0.01***	0.02***	0.01**	0.01*	0.01***	0.01***	0.01**	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Year FE	Y		Y		Y		Y		Y		Y	
Industry-Year FE		Y		Y		Y		Y		Y		Y
R^2	0.089	0.064	0.100	0.090	0.080	0.059	0.096	0.084	0.076	0.045	0.090	0.075
N	9,703	9,033	9,703	9,033	9,703	9,033	9,703	9,033	9,703	9,033	9,703	9,033
Firms	826	797	826	797	826	797	826	797	826	797	826	797
Two-digit Sectors	9		9		9		9		9		9	
Four-digit Industries		25		25		25		25		25		25
Weak IV F-test												
Kleibergen-Paap	14.71	9.94	27.17	25.93	6.77	7.42	9.86	11.45	13.35	9.70	24.26	27.43
Hansen J-test χ^2	5.701	2.727	5.526	1.741	2.375	2.376	0.692	0.397	2.837	2.889	0.594	0.378
p value	0.223	0.605	0.063	0.419	0.667	0.667	0.708	0.820	0.585	0.577	0.743	0.828
Financial Amplification												
$\hat{\beta}_0 + \hat{\beta}_1$	-0.149**	-0.138**	-0.134***	-0.185***	-0.178**	-0.177**	-0.195***	-0.203***	-0.202***	-0.176**	-0.196***	-0.204***
$\hat{\gamma}_0 + \hat{\gamma}_1$	0.051	0.095			0.057	0.101			0.069	0.088		

(b) **Effects on the EBITDA Margin**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	x = EBITDA				x = ICR				x = DSCR			
$\Delta mc_{i,t}$ ($\hat{\beta}_0$)	-0.20***	-0.20***	-0.18***	-0.18***	-0.22***	-0.21***	-0.19***	-0.20***	-0.22***	-0.23***	-0.19***	-0.21***
	(0.05)	(0.05)	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)
Tight × $\Delta mc_{i,t}$ ($\hat{\beta}_1$)	0.14	0.17	0.16*	0.14*	0.28*	0.28*	0.21*	0.24*	0.23*	0.27**	0.19*	0.21**
	(0.14)	(0.13)	(0.09)	(0.08)	(0.16)	(0.15)	(0.12)	(0.12)	(0.12)	(0.12)	(0.10)	(0.10)
$\Delta p_{-i,t}$ ($\hat{\gamma}_0$)	0.20**	0.13			0.22***	0.09			0.22**	0.13		
	(0.09)	(0.12)			(0.08)	(0.11)			(0.09)	(0.11)		
Tight × $\Delta p_{-i,t}$ ($\hat{\gamma}_1$)	-0.13	-0.19			-0.28	-0.28			-0.25*	-0.30**		
	(0.18)	(0.16)			(0.20)	(0.19)			(0.14)	(0.13)		
Tight	0.01***	0.01***	0.01	0.01	0.01**	0.01***	0.00	0.00	0.01**	0.01**	0.00	-0.00
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Year FE	Y		Y		Y		Y		Y		Y	
Industry-Year FE		Y		Y		Y		Y		Y		Y
R^2	0.021	0.017	0.013	0.018	-0.017	-0.015	-0.004	-0.003	-0.017	-0.024	-0.009	-0.009
N	9,702	9,030	9,702	9,030	9,702	9,030	9,702	9,030	9,702	9,030	9,702	9,030
Firms	826	797	826	797	826	797	826	797	826	797	826	797
Two-digit Sectors	9		9		9		9		9		9	
Four-digit Industries		25		25		25		25		25		25
Weak IV F-test												
Cragg-Donald	64.03	59.01	235.50	233.91	60.82	60.96	217.71	211.84	68.12	62.80	230.87	233.38
Kleibergen-Paap	15.15	10.05	27.35	25.67	6.78	7.56	9.86	11.33	13.31	9.83	24.37	27.45
Hansen J-test χ^2	5.683	5.600	3.388	2.270	5.838	6.250	1.103	1.154	5.024	3.795	2.038	2.349
p value	0.224	0.231	0.184	0.321	0.212	0.181	0.576	0.562	0.285	0.434	0.361	0.309
Financial Amplification												
$\hat{\beta}_0 + \hat{\beta}_1$	-0.06	-0.03	-0.02	-0.05	0.06	0.07	0.03	0.04	0.01	0.04	-0.01	0.00
$\hat{\gamma}_0 + \hat{\gamma}_1$	0.07	-0.06			-0.06	-0.18			-0.03	-0.16		

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: xxx

Table A6: Effects of Financial Constraints on Profit Margins

(a) **Effects on $t+0$ Output**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	x = EBITDA				x = ICR				x = DSCR			
$\Delta mc_{i,t}$ ($\hat{\beta}_0$)	-0.44***	-0.37***	-0.34***	-0.30***	-0.37***	-0.33***	-0.30***	-0.27***	-0.34**	-0.29**	-0.28***	-0.24**
	(0.11)	(0.12)	(0.09)	(0.10)	(0.11)	(0.11)	(0.09)	(0.09)	(0.13)	(0.13)	(0.10)	(0.10)
Tight × $\Delta mc_{i,t}$ ($\hat{\beta}_1$)	0.56	0.31	0.16	0.00	0.35	0.32	-0.08	-0.09	0.10	0.04	-0.17	-0.23
	(0.36)	(0.34)	(0.23)	(0.19)	(0.35)	(0.33)	(0.24)	(0.22)	(0.27)	(0.27)	(0.20)	(0.19)
$\Delta p_{-i,t}$ ($\hat{\gamma}_0$)	0.21	0.16			0.04	0.01			-0.02	-0.04		
	(0.24)	(0.36)			(0.23)	(0.34)			(0.28)	(0.37)		
Tight × $\Delta p_{-i,t}$ ($\hat{\gamma}_1$)	-0.98**	-0.65			-0.79*	-0.76*			-0.41	-0.36		
	(0.46)	(0.42)			(0.47)	(0.44)			(0.30)	(0.31)		
Tight	-0.01	-0.02*	-0.03**	-0.03**	0.01	-0.00	-0.01	-0.01	-0.00	-0.00	-0.01	-0.01
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Year FE	Y		Y		Y		Y		Y		Y	
Industry-Year FE		Y		Y		Y		Y		Y		Y
R^2	0.042	0.053	0.061	0.064	0.051	0.046	0.068	0.062	0.064	0.059	0.070	0.063
N	9,738	9,065	9,738	9,065	9,738	9,065	9,738	9,065	9,738	9,065	9,738	9,065
Firms	826	797	826	797	826	797	826	797	826	797	826	797
Two-digit Sectors	9		9		9		9		9		9	
Four-digit Industries		25		25		25		25		25		25
Weak IV F-test	15.09	10.00	27.36	25.71	7.00	7.70	9.89	11.35	13.38	9.74	24.37	27.45
Hansen J-test χ^2	1.520	4.096	0.850	2.028	1.516	1.508	0.971	1.142	1.602	2.015	1.331	1.081
p value	0.823	0.393	0.654	0.363	0.824	0.825	0.615	0.565	0.808	0.733	0.514	0.583
Financial Amplification												
$\hat{\beta}_0 + \hat{\beta}_1$	0.11	-0.06	-0.18	-0.30	-0.02	-0.01	-0.37	-0.36	-0.23	-0.25	-0.44**	-0.47***
$\hat{\gamma}_0 + \hat{\gamma}_1$	-0.77	-0.49			-0.75	-0.75			-0.43	-0.40		

(b) **Effects on $t+1$ Output**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	x = EBITDA				x = ICR				x = DSCR			
$\Delta mc_{i,t}$ ($\hat{\beta}_0$)	-0.58***	-0.48***	-0.39***	-0.37***	-0.52***	-0.44***	-0.31***	-0.33***	-0.46***	-0.39***	-0.26**	-0.27**
	(0.14)	(0.13)	(0.11)	(0.11)	(0.14)	(0.13)	(0.11)	(0.11)	(0.16)	(0.15)	(0.12)	(0.12)
Tight × $\Delta mc_{i,t}$ ($\hat{\beta}_1$)	-0.08	-0.34	0.16	-0.19	-0.36	-0.49	-0.38	-0.43	-0.49	-0.59	-0.52*	-0.62**
	(0.52)	(0.48)	(0.29)	(0.30)	(0.48)	(0.46)	(0.31)	(0.31)	(0.36)	(0.37)	(0.28)	(0.28)
$\Delta p_{-i,t}$ ($\hat{\gamma}_0$)	0.72**	1.15**			0.62*	1.12**			0.53	1.06*		
	(0.33)	(0.58)			(0.34)	(0.55)			(0.38)	(0.55)		
Tight × $\Delta p_{-i,t}$ ($\hat{\gamma}_1$)	-0.08	0.25			0.34	0.52			0.67	0.81		
	(0.71)	(0.64)			(0.70)	(0.66)			(0.49)	(0.50)		
Tight	-0.03	-0.04**	-0.03*	-0.03*	-0.03*	-0.03	-0.02	-0.01	-0.05***	-0.05***	-0.02	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Year FE	Y		Y		Y		Y		Y		Y	
Industry-Year FE		Y		Y		Y		Y		Y		Y
R^2	0.015	0.007	0.025	0.027	0.017	0.009	0.029	0.025	0.020	0.010	0.026	0.020
N	8,883	8,264	8,883	8,264	8,883	8,264	8,883	8,264	8,883	8,264	8,883	8,264
Firms	826	795	826	795	826	795	826	795	826	795	826	795
Two-digit Sectors	9		9		9		9		9		9	
Four-digit Industries		25		25		25		25		25		25
Weak IV F-test	13.79	7.05	27.43	27.72	12.56	7.98	9.47	10.98	10.92	7.01	24.37	31.67
Hansen J-test χ^2	5.235	3.253	2.831	2.672	2.359	0.923	0.740	0.747	4.047	1.580	0.779	0.458
p value	0.264	0.516	0.243	0.263	0.670	0.921	0.691	0.688	0.400	0.812	0.678	0.795
Financial Amplification												
$\hat{\beta}_0 + \hat{\beta}_1$	-0.66	-0.82*	-0.23	-0.56*	-0.88*	-0.92**	-0.70**	-0.75**	-0.96***	-0.99***	-0.79***	-0.89***
$\hat{\gamma}_0 + \hat{\gamma}_1$	0.64	1.40*			0.96	1.64**			1.20**	1.87***		

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: xxx

Table A7: Effects of Financial Constraints on Output

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		x = EBITDA				x = ICR				x = DSCR		
$\Delta mc_{i,t}$ ($\hat{\beta}_0$)	-0.00	0.00	-0.00	-0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tight × $\Delta mc_{i,t}$ ($\hat{\beta}_1$)	-0.03	-0.02	-0.02*	-0.02	-0.05***	-0.05***	-0.03**	-0.03**	-0.03*	-0.03*	-0.02**	-0.03**
	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
$\Delta p_{-i,t}$ ($\hat{\gamma}_0$)	0.01	-0.02			0.00	-0.02			0.00	-0.02		
	(0.01)	(0.02)			(0.01)	(0.03)			(0.01)	(0.03)		
Tight × $\Delta p_{-i,t}$ ($\hat{\gamma}_1$)	0.02	0.02			0.05**	0.06**			0.03	0.03		
	(0.02)	(0.02)			(0.02)	(0.02)			(0.02)	(0.02)		
Tight	0.00**	0.00***	0.00***	0.00***	0.00	0.00	0.00***	0.00**	0.00**	0.00**	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Year FE	Y		Y		Y		Y		Y		Y	
Industry-Year FE		Y		Y		Y		Y		Y		Y
R^2	-0.025	-0.017	-0.015	-0.011	-0.055	-0.065	-0.024	-0.036	-0.024	-0.025	-0.017	-0.022
N	9,738	9,065	9,738	9,065	9,738	9,065	9,738	9,065	9,738	9,065	9,738	9,065
Firms	826	797	826	797	826	797	826	797	826	797	826	797
Two-digit Sectors	9		9		9		9		9		9	
Four-digit Industries		25		25		25		25		25		25
Weak IV F-test	15.09	10.00	27.36	25.71	7.00	7.70	9.89	11.35	13.38	9.74	24.37	27.45
Hansen J-test χ^2	3.819	4.378	1.653	4.592	4.611	4.316	1.517	3.155	3.998	4.545	2.640	4.305
p value	0.431	0.357	0.438	0.101	0.330	0.365	0.468	0.207	0.406	0.337	0.267	0.116
Financial Amplification												
$\hat{\beta}_0 + \hat{\beta}_1$	-0.03	-0.02	-0.02**	-0.02*	-0.05***	-0.05***	-0.03***	-0.03**	-0.03*	-0.03*	-0.02**	-0.03**
$\hat{\gamma}_0 + \hat{\gamma}_1$	0.03	0.00			0.05**	0.04			0.03	0.01		

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: xxx

Table A8: Effects of Financial Constraints on Leverage

(a) **Effects on $t = 0$ Input Prices**

Dep. variable: $(\text{lnSH}^{\rho}\Delta\rho)_{i,t}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	x = EBITDA				x = ICR				x = DSCR			
$\Delta mc_{i,t}$ $(\hat{\beta}_0)$	2.21***	2.22***	2.04***	2.05***	2.13***	2.13***	1.96***	1.98***	2.21***	2.21***	2.02***	2.03***
	(0.24)	(0.24)	(0.19)	(0.19)	(0.22)	(0.21)	(0.17)	(0.17)	(0.24)	(0.24)	(0.19)	(0.19)
Tight × $\Delta mc_{i,t}$ $(\hat{\beta}_1)$	-0.42	-0.45	-0.38	-0.35	-0.05	0.01	-0.07	-0.08	-0.42	-0.46	-0.36*	-0.38*
	(0.37)	(0.37)	(0.25)	(0.25)	(0.35)	(0.33)	(0.22)	(0.21)	(0.29)	(0.31)	(0.20)	(0.20)
$\Delta p_{-i,t}$ $(\hat{\gamma}_0)$	-1.41***	-1.62***			-1.31***	-1.48***			-1.40***	-1.55***		
	(0.29)	(0.49)			(0.27)	(0.43)			(0.28)	(0.45)		
Tight × $\Delta p_{-i,t}$ $(\hat{\gamma}_1)$	0.47	0.61			0.00	-0.01			0.44	0.54		
	(0.42)	(0.44)			(0.41)	(0.38)			(0.34)	(0.35)		
Tight	0.01	-0.00	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.03*	0.03**
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Year FE	Y		Y		Y		Y		Y		Y	
Industry-Year FE		Y		Y		Y		Y		Y		Y
R^2	-7.204	-8.544	-5.894	-6.925	-7.133	-8.415	-5.732	-6.763	-7.203	-8.374	-5.767	-6.758
N	9,730	9,058	9,730	9,058	9,730	9,058	9,730	9,058	9,730	9,058	9,730	9,058
Firms	826	797	826	797	826	797	826	797	826	797	826	797
Two-digit Sectors	9		9		9		9		9		9	
Four-digit Industries		25		25		25		25		25		25
Weak IV F-test												
Kleibergen-Paap	15.09	10.03	27.32	25.67	7.02	7.67	9.89	11.35	13.35	9.74	24.35	27.38
Hansen J-test χ^2	2.658	3.224	1.391	2.432	1.265	1.887	1.860	2.002	1.910	3.431	2.661	3.883
p value	0.617	0.521	0.499	0.296	0.867	0.757	0.395	0.368	0.752	0.488	0.264	0.143
Financial Amplification												
$\hat{\beta}_0 + \hat{\beta}_1$	1.79***	1.77***	1.66***	1.69***	2.08***	2.14***	1.89***	1.90***	1.79***	1.75***	1.66***	1.65***
$\hat{\gamma}_0 + \hat{\gamma}_1$	-0.94***	-1.02**			-1.31***	-1.49***			-0.95***	-1.00**		

(b) **Effects on $t + 1$ Input Prices**

Dep. variable: $\Sigma_{h=0}^{1}(\text{lnSH}^{\rho}\Delta\rho)_{i,t+h}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	x = EBITDA				x = ICR				x = DSCR			
$\Delta mc_{i,t}$ $(\hat{\beta}_0)$	1.52***	1.47***	1.42***	1.39***	1.47***	1.42***	1.38***	1.37***	1.52***	1.45***	1.42***	1.38***
	(0.16)	(0.17)	(0.13)	(0.13)	(0.16)	(0.15)	(0.13)	(0.13)	(0.17)	(0.16)	(0.14)	(0.13)
Tight × $\Delta mc_{i,t}$ $(\hat{\beta}_1)$	-0.02	-0.09	0.01	0.00	0.21	0.18	0.14	0.09	-0.03	-0.01	-0.03	-0.03
	(0.29)	(0.29)	(0.20)	(0.19)	(0.28)	(0.28)	(0.20)	(0.20)	(0.26)	(0.26)	(0.19)	(0.18)
$\Delta p_{-i,t}$ $(\hat{\gamma}_0)$	-0.73***	-0.65			-0.68***	-0.57			-0.73***	-0.62		
	(0.23)	(0.42)			(0.22)	(0.39)			(0.23)	(0.39)		
Tight × $\Delta p_{-i,t}$ $(\hat{\gamma}_1)$	0.05	0.15			-0.21	-0.23			0.05	0.01		
	(0.35)	(0.35)			(0.32)	(0.32)			(0.31)	(0.30)		
Tight	0.01	0.00	0.00	0.00	0.01	-0.00	-0.00	-0.01	0.02*	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector-Year FE	Y		Y		Y		Y		Y		Y	
Industry-Year FE		Y		Y		Y		Y		Y		Y
R^2	-2.089	-2.411	-1.741	-2.106	-2.086	-2.410	-1.713	-2.112	-2.084	-2.377	-1.710	-2.073
N	8,979	8,351	8,979	8,351	8,979	8,351	8,979	8,351	8,979	8,351	8,979	8,351
Firms	826	796	826	796	826	796	826	796	826	796	826	796
Two-digit Sectors	9		9		9		9		9		9	
Four-digit Industries		25		25		25		25		25		25
Weak IV F-test												
Kleibergen-Paap	10.36	5.96	23.76	21.70	11.02	6.34	9.06	10.28	10.18	6.49	23.03	25.85
Hansen J-test χ^2	0.768	0.644	0.093	0.425	1.342	0.388	1.806	0.413	0.664	1.071	1.183	1.342
p value	0.943	0.958	0.955	0.809	0.854	0.983	0.405	0.813	0.956	0.899	0.553	0.511
Financial Amplification												
$\hat{\beta}_0 + \hat{\beta}_1$	1.50***	1.38***	1.43***	1.39***	1.69***	1.60***	1.52***	1.46***	1.49***	1.44***	1.38***	1.36***
$\hat{\gamma}_0 + \hat{\gamma}_1$	-0.68*	-0.51			-0.90***	-0.80*			-0.68**	-0.61		

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: xxx

Table A9: Correlation with Input Prices

Notes: xxx

Table A10: Effects of Financial Constraints with Size Controls

B Baseline Model

B.1 Households

Market clearing. Assume that neither Rotemberg adjustment costs nor the leverage adjustment costs are physical costs. In equilibrium,

$$C_{i,t} = Y_{i,t}. \tag{B.1}$$

Goods demand. Household demand is standard:

$$\frac{P_{i,t}}{P_t} = C_{i,t}^{-\frac{1}{\epsilon}} C_t^{\frac{1}{\epsilon}}. \tag{B.2}$$

In equilibrium,

$$p_{i,t} - p_t = -\frac{1}{\epsilon} y_{i,t} + \frac{1}{\epsilon} y_t. \tag{B.3}$$

Optimality conditions. As in Galí (2015), the household's problem yields the usual FOCs (at the first order):

$$w_t - p_t = \sigma y_t + \psi l_t + \mu_t^w, \tag{B.4}$$

$$y_t = \mathrm{E}_t \left[y_{t+1} - \frac{1}{\sigma}(i_{t+1} - \pi_{t+1} - \rho) \right]. \tag{B.5}$$

where i_{t+1} is the nominal risk free rate (i.e., the monetary policy rate) set by the central bank at time t.

B.2 Intermediate Goods Producers

Objective.

$$\max_{\{P_{i,t}, D_{i,t}\}} \mathrm{E}_t \sum_{h=0}^{\infty} \Lambda_{t,t+h} \frac{1}{P_{t+h}} \left[\mathrm{Div}_{i,t+h} - (\mathscr{C}_{i,t+h} + \mathscr{E}_{i,t+h}) \right], \tag{B.6}$$

subject to

$$\text{Nominal rigidities:} \quad \mathscr{C}_{i,t} = \frac{\tau_p}{2} \pi_{i,t}^2 P_t Y_t; \tag{B.7}$$

$$\text{Borrowing constraint:} \quad \phi_i \max(\mathrm{EBITDA}_{i,t},\ 0) - D_{i,t} \geq 0; \tag{B.8}$$

$$\text{Equity/liquidity constraint:} \quad \mathscr{E}_{i,t} = -\tau_e \min(0, \mathrm{Div}_{i,t}). \tag{B.9}$$

Borrowing FOC. Let the three Lagrangian multipliers (in real terms) be $\xi_{i,t}^{ebc}$ and $\xi_{i,t}^{div}$. Differentiate w.r.t. $D_{i,t}$:

$$\xi^{ebc}_{i,t} = (1+\xi^{div}_{i,t}) - \mathrm{E}_t\,\Lambda_{t,t+1}(1+r^{b,r}_{i,t+1})(1+\xi^{div}_{i,t+1}) \tag{B.10}$$

where $r^{b,r}_{i,t+1}$ is the real borrowing cost.

Pricing FOC. Standard FOC w.r.t. $P_{i,t}$:

$$\frac{\partial \mathrm{EBITDA}_{i,t}}{\partial P_{i,t}} = Y_{i,t} + P_{i,t}\frac{\partial Y_{i,t}}{\partial P_{i,t}} - W_t\frac{\partial L_{i,t}}{\partial Y_{i,t}}\frac{\partial Y_{i,t}}{\partial P_{i,t}} = Y_{i,t} - Y_{i,t}\epsilon_{i,t} + W_t\frac{Y_{i,t}}{P_{i,t}}\epsilon_{i,t}\frac{\partial L_{i,t}}{\partial Y_{i,t}} \tag{B.11}$$

$$= Y_{i,t}(\epsilon_{i,t}-1)\left[\frac{\epsilon_{i,t}}{\epsilon_{i,t}-1}\frac{\partial L_{i,t}}{\partial Y_{i,t}}\frac{W_t}{P_{i,t}} - 1\right] \tag{B.12}$$

Next,

$$\frac{(1+\xi^{div}_{i,t}+\xi^{ebc}_{i,t}\phi_i)}{P_t}\frac{\partial \mathrm{Div}_{i,t}}{\partial P_{i,t}} - \frac{1}{P_{i,t}}Y_t\tau_p\pi_{i,t} + \frac{1}{P_{i,t}}\mathrm{E}_t\,\Lambda_{t,t+1}\tau_p\pi_{i,t+1}Y_{t+1} = 0 \tag{B.13}$$

and because $\frac{\partial \mathrm{EBITDA}_{i,t}}{\partial P_{i,t}} = \frac{\partial \mathrm{Div}_{i,t}}{\partial P_{i,t}}$,

$$\pi_{i,t} = (1+\xi^{div}_{i,t}+\xi^{ebc}_{i,t}\phi_i)\frac{\epsilon_{i,t}-1}{\tau_p}\frac{P_{i,t}Y_{i,t}}{P_tY_t}\left[\mathscr{M}_{i,t}\frac{\partial L_{i,t}}{\partial Y_{i,t}}\frac{W_t}{P_{i,t}} - 1\right] + \mathrm{E}_t\,\Lambda_{t,t+1}\pi_{i,t+1} \tag{B.14}$$

Define $\kappa_{i,t} = \frac{\epsilon_{i,t}-1}{\tau_p}\frac{P_{i,t}Y_{i,t}}{P_tY_t}$,

$$\pi_{i,t} = (1+\xi^{div}_{i,t}+\xi^{ebc}_{i,t}\phi_i)\kappa_{i,t}\left[\mathscr{M}_{i,t}\frac{\partial L_{i,t}}{\partial Y_{i,t}}\frac{W_t}{P_{i,t}} - 1\right] + \mathrm{E}_t\,\Lambda_{t,t+1}\pi_{i,t+1} \tag{B.15}$$

Marginal costs. Define the nominal marginal cost $MC^n_{i,t}$ and the real marginal cost $MC^r_{i,t}$:

$$MC^n_{i,t} = \frac{\partial L_{i,t}}{\partial Y_{i,t}}W_t \tag{B.16}$$

$$MC^r_{i,t} = \frac{\partial L_{i,t}}{\partial Y_{i,t}}\frac{W_t}{P_t} \tag{B.17}$$

Note that

$$L_{i,t} = \left(\frac{Y_{i,t}+\omega_i}{A_{i,t}}\right)^{\frac{1}{1-\gamma}} \tag{B.18}$$

$$\frac{Y_{i,t}}{L_{i,t}}\frac{\partial L_{i,t}}{\partial Y_{i,t}} = \frac{1}{1-\gamma}\frac{Y_{i,t}}{Y_{i,t}+\omega_i} \tag{B.19}$$

$$\frac{\partial L_{i,t}}{\partial Y_{i,t}} = \frac{1}{1-\gamma}\frac{L_{i,t}}{Y_{i,t}+\omega_i} = \frac{1}{1-\gamma}(Y_{i,t}+\omega_i)^{\frac{\gamma}{1-\gamma}} A_{i,t}^{-\frac{1}{1-\gamma}} \tag{B.20}$$

$$mc^n_{i,t} = \ln\frac{1}{1-\gamma} + \frac{\gamma}{1-\gamma}\ln(Y_{i,t}+\omega_i) - \frac{1}{1-\gamma}a_{i,t} + W_t \tag{B.21}$$

where $Y_{i,t} = P_{i,t}^{-\epsilon}P_t^{\epsilon}Y_t$. Also have $\frac{\partial mc^n_{i,t}}{\partial y_{i,t}} = \frac{\gamma}{1-\gamma}\frac{Y_{i,t}}{Y_{i,t}+\omega_i}$.

B.3 Equilibrium

Goods. Denote $\tilde{x}_{i,t} = x_{i,t} - x_t$, which is the gap between firm-level x and aggregate x.

When all firms have equal weights:

$$\tilde{y}_{i,t} = y_{i,t} - y_t = -\epsilon\tilde{p}_{i,t}, \tag{B.22}$$

where

$$Y_t = \left(\int_0^1 Y_{i,t}^{\frac{\epsilon-1}{\epsilon}}di\right)^{\frac{\epsilon}{\epsilon-1}}, \qquad P_t = \left(\int_0^1 P_{i,t}^{1-\epsilon}di\right)^{\frac{1}{1-\epsilon}}. \tag{B.23}$$

At the first order around the symmetric equilibrium,

$$0 = \int_0^1 \tilde{y}_{i,t}di, \qquad 0 = \int_0^1 \tilde{p}_{i,t}di, \qquad \pi_t = \int_0^1 \pi_{i,t}di. \tag{B.24}$$

Labor.

Assume some aggregate A_t and ω:

$$L_t = \int L_{i,t} di = \int \left(\frac{Y_{i,t} + \omega_i}{A_{i,t}} \right)^{\frac{1}{1-\gamma}} di = \int \left(\frac{P_t^{\epsilon}}{A_{i,t} P_{i,t}^{\epsilon}} Y_t + \frac{\omega_i}{A_{i,t}} \right)^{\frac{1}{1-\gamma}} di \tag{B.25}$$

$$= \left(\frac{Y_t + \omega}{A_t} \right)^{\frac{1}{1-\gamma}} \int \left[\frac{A_t}{A_{i,t}} \left[\left(\frac{P_{i,t}}{P_t} \right)^{-\epsilon} \frac{Y_t}{Y_t + \omega} + \frac{\omega_i}{Y_t + \omega} \right] \right]^{\frac{1}{1-\gamma}} di \tag{B.26}$$

$$= \left(\frac{Y_t + \omega}{A_t} \right)^{\frac{1}{1-\gamma}} \underbrace{\int \left[\frac{\tilde{A}_{i,t}^{-1}}{Y_t + \omega} \left(\tilde{P}_{i,t}^{-\epsilon} Y_t + \omega_i \right) \right]^{\frac{1}{1-\gamma}} di}_{\text{Misallocation}} \tag{B.27}$$

Define $\Delta_t = \int \left[\frac{\tilde{A}_{i,t}^{-1}}{Y_t+\omega} \left(\tilde{P}_{i,t}^{-\epsilon} Y_t + \omega_i \right) \right]^{\frac{1}{1-\gamma}} di$, which can be solved numerically fairly easily. Second-order approximation of Δ_t can be cumbersome, yet the intuition behind Δ_t is straightforward. Holding $A_{i,t}$ constant, when price dispersion is large, Δ_t increases. The increase in Δ_t is increasing in ϵ and γ and decreasing in ω.

C Numerical Method

See Capelle and Liu (2023).

D Proofs

E Data Appendix

E.1 Data Description

Comparison with other datasets. First of all, as mentioned in Section 3.1, India experienced high inflation in both the mid-1990s and the late 2000s, but it also enjoyed stable inflation from the late 1990s to 2005. This is ideal for studying large price changes. By contrast, most advanced countries, such as Belgium studied by AIK and GGLT, and the U.S. studied by Gilchrist et al. (2017) (GSSZ) and Kim (2021), saw great moderation in inflation in the past two decades until Covid. Second, the Belgian data used by AIK and GGLT do not contain financial information, even though they have many more observations than Prowess has. Lenzu et al. (2021) merge credit registry records to the same dataset and assemble an annual panel of 9,667 observations from 2006 to 2016, the scope of the data is essentially the same as the data I use. Papers that amend price data to U.S. firm-level data, such as GSSZ and Kim (2021), have much more restricted samples. These advantages should suffice to outweigh the fact that Prowess only has annual data on prices.

E.2 Data Cleaning

Negative values. Firms should also report non-negative sales, costs, and assets.

Correcting errors. Decimal points are sometimes misplaced. Not a huge issue per se but they force us to drop many observations. We bring back some obvious ones under strict conditions. And they, if anything, attenuate the true estimates so no need to worry.

Observe that nominal sale values look right while unit counts look very erroneous. So I correct the unit price when the unit price and the number of units *both* appear misrecorded.

Data interpolation. Given that the right hand side of my regressions include up to two lags, one missing data point can cost up to three observations in the regression sample. This may further interact with the fact that I require at least 8 years for each firm and 6 firms in each sector-year pair, costing more observations. For this reason, a little bit interpolation may improve the sample size disproportionally.

In the first stage of IV regressions (for both $\Delta mc_{i,t}^{\text{nom.}}$ and $\Delta p_{-i,t}$), I interpolate all variables up to 1 period. That is, if both x_{t-1} and x_{t+1} are available, I linearly interpolate x_t. In no other case do I interpolate any data.

Interpolated data only account for about 1% in the regression sample, but the inclusion of them increases the sample by more than 3%.