Financing from Workers: Can Labor Market Power Mitigate Financial Frictions?*

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Abstract

We show that firms with labor market power can partially offset financial distress by financing through reduced worker compensation. Using Census quarterly employer-employee data, we find that workers in highly leveraged firms experience significantly slower earnings growth following an unexpected disinflation shock that increases the real burden of firms' nominal debt. This response is stronger for firms with greater labor market power. Moreover, we find no evidence that these firms subsequently compensate workers with higher earnings, nor do worker separations increase, suggesting that workers remain despite relatively lower pay. Motivated by these findings, we develop a heterogeneous-firm model featuring both labor market power and default risk. When calibrated to U.S. firm financing patterns and job substitutability, the model shows that labor market power mitigates approximately one-third of the negative effects of financial distress.

Keywords: Inflation, debt disinflation, financial friction, labor market power, business cycles, firm heterogeneity.
JEL Codes: E31, E32, E44, G32, J31, J42.

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1 Introduction

A large literature has established the consequences of firm financial frictions over business cycles, including their effects on firm dynamics, the amplification of recessions, and the need for policy interventions to subsidize distressed firms. Building on this literature, our paper studies an underexplored channel that can potentially mitigate the impact of financial frictions: firms exploit their labor market power to lower worker earnings growth during periods of financial distress. We develop this argument in two steps. First, we provide micro-level empirical evidence supporting the hypothesis. Second, we quantify its aggregate implications by constructing a dynamic general equilibrium model with heterogeneous firms that possess monopsony power in the labor market and face financial frictions.

Using U.S. Census employer-employee matched data, we document new empirical evidence that workers absorb part of firms' negative financial shocks through earnings adjustments. Identifying these effects requires a measure of financial shocks that minimally affects firm productivity. This rules out productivity shocks or monetary policy shocks as ideal instruments. Moreover, the shock must be measurable and occur with sufficient frequency—unlike rare events such as the Lehman Brothers collapse during the Great recession that are commonly used in the literature.

Unexpected disinflation shocks satisfy both criteria. An unexpected disinflation shock occurs when realized inflation falls short of expectations formed when debt contracts were originated. Under the Fisher effect, such shocks increase firms' debt burden, since most debt contracts are denominated in nominal terms and unindexed to inflation. This mechanism works equivalently to financial shocks that tighten firms' financial constraints. Disinflation shocks occur at business-cycle frequency and vary substantially across firms operating in states with different inflation dynamics. Furthermore, these shocks affect firms differentially: firms with higher debt experience larger increases in their real debt burdens from the same disinflation shock.

We find that workers in high-leverage firms experience relatively slower earnings growth following unexpected disinflation shocks that increase firms' real debt burden. Standard implicit contract theory predicts that these workers should subsequently experience higher earning growth to compensate for initial losses. However, we observe no

such compensation, nor do we find increased worker separations. Workers remain with their firms despite relatively lower pay, contradicting predictions from implicit contract theory.

In contrast, firms' monopsony power in the labor market demonstrates significant explanatory power. Following unexpected disinflation shocks, earnings reduction are stronger for firms with greater labor market power, whether measured by a higher Herfindahl-Hirschman Index (HHI), larger firms' employment share in local labor markets, or a lower unionization rate.

These findings reveal a mechanism of *financing from workers*, through which firms cope with financial distress by adjusting wages rather than firing workers. Our empirical analysis further shows that employment at high-leverage firms falls relatively after disinflation shocks, indicating reduced hiring, though not significant separation. Both findings—relatively slower earnings growth and employment declines at higher-leverage firms—are consistent with firms exercising monopsony power in labor markets and facing upward-sloping labor supply curves. These wage adjustments depend on two critical factors: a firm's labor market power and its financial condition.

To quantify the aggregate implications of the financing-from-worker mechanism, we develop a dynamic general equilibrium model with heterogeneous firms. Motivated by our empirical findings, the model features two key elements: jobs are imperfectly substitutable across firms, granting employers labor market power, and firms borrow through state-uncontingent debt contracts with the option to default. In addition, we assume that firms choose employment levels before the realization of their idiosyncratic productivity shocks, making employment a risky investment.

With financial frictions and the assumption that labor is chosen before the productivity shocks, firms' labor choices consider not only the standard tradeoff of marginal cost and the expected marginal product of labor but also the marginal cost of increasing default risk. Large employment is risky since firms may not be able to repay the debt and the labor cost when the future realization of productivity shock is low. Thus, default risk serves as a labor wedge in firms' optimal choices of labor. Firms' labor market power, however, mitigates such risks. By reducing employment levels, they can lower wages across their entire workforce, thereby reducing their liquidity risk. Furthermore, lenders take into consideration such mitigation and offer more lenient bond price schedules when firms

have labor market power, further alleviating potential financial distress.

We calibrate the model to U.S. data on firm financing patterns and job substitutability. The calibrated model successfully reproduces the empirical pattern of worker earnings responses to a disinflation shock that increases firms' real debt burden. In particular, firms with higher leverage reduce their wages by more after such shocks. In the aggregate, firms' labor market power mitigates approximately one-third of the negative impacts of financial distress on output and employment.

Related Literature. Our projects contribute to four strands of literature. First, our work complements the literature on credit within firms (Guiso, Pistaferri, and Schivardi, 2013; Malgieri and Citino, 2024; Michaels, Beau Page, and Whited, 2019; Michelacci and Quadrini, 2009; Wang, 2025). Existing studies primarily analyze cross-sectional patterns and document a "*borrowing*-from-worker" mechanism, in which new employees accept lower initial wages in exchange for steeper future wage growth—an implicit or explicit intertemporal contract akin to a loan from workers to firms. We take a different approach: using quarterly employer-employee matched data, we estimate local projections to trace workers' earnings dynamics at business cycle frequencies. We do not find evidence that firms "repay" workers. Instead, workers in highly leveraged firms experience relative earnings reductions during financial distress, without later compensatory increases. This shows that "*financing*-from-worker" does not necessarily require backloading wages through implicit contracts, and instead can directly operate through the firm's monopsony power.

Second, our model builds on the extensive literature on firm financial frictions (Arellano, Bai, and Kehoe, 2019; Arellano, Bai, and Zhang, 2012; Buera and Shin, 2013; Cooley, Marimon, and Quadrini, 2004; Gilchrist et al., 2017; Gomes, Jermann, and Schmid, 2016; Khan and Thomas, 2013; Midrigan and Xu, 2014; Moll, 2014; Ottonello and Winberry, 2020; Wang, 2022). We incorporate labor market power into a heterogeneous firm model with endogenous default risk. Our contribution to the literature lies in quantifying how labor market power mitigates firms' financial constraints using our empirical findings as a discipline.

Third, our study is motivated by the growing body of research on firms' labor market power (Berger, Herkenhoff, and Mongey, 2022; Bils, Kaymak, and Wu, 2025; Chan, Mat-

tana, Salgado, and Xu, 2023; Manning, 2021; Yeh, Macaluso, and Hershbein, 2022). While this literature mostly uncovers the importance of labor market power using employment and wages data, we highlight the interaction between labor market power and financial frictions and quantify the aggregate macroeconomic implications of this relationship.

Lastly, our theory of financing-from-workers complements a large literature on wage dynamics (Afrouzi, Blanco, Drenik, and Hurst, 2024; Ahn, Hobijn, and Şahin, 2023; Bertheau, Kudlyak, Larsen, and Bennedsen, 2022; Fukui, 2020). Our findings on the heterogeneous impact of firm financial distress on worker earnings reconcile with, rather than contradict, existing evidence on wage rigidity. Furthermore, we provide a new theory where labor market power and firm default risk jointly determine wage dynamics, generating firm-specific wage variation that fluctuates cyclically with financial conditions.

The rest of the paper proceeds as follows. Section 2 documents empirical evidence using U.S. census employer-employee matched data. Section 3 develops a heterogeneous firm model with labor market power and firm default risk. Section 4 quantifies the model to explore aggregate implications of financing from workers. Section 5 concludes.

2 Empirical Analysis

A considerable amount of empirical research has shown that firms provide insurance to workers against shocks to their productivity, largely because firms typically have better access to financial markets. In contrast, this study asks: do workers insure firms during financial distress? Our findings suggest the answer is yes. Using U.S. employer-employee matched data, we find that firms facing adverse financial shocks can finance through workers without increasing separations. This section starts with a simple model to motivate our empirical analysis, followed by a description of the data, the regression specifications, and the empirical evidence.

2.1 Motivating Simple Model

Here, we present a simple static model to illustrate the mechanism and motivate our empirical design. Firms produce output y using labor n according to $y = zn^{\alpha}$, where

$z \in [\underline{z}, \bar{z}]$. Firms choose their labor input before shocks occur. Due to financial frictions, firms cannot borrow new debt or issue equity and are subject to a financial shock ζ, which broadly reduces their profitability. Firms have labor market power, facing an upward-sloping labor supply curve given by $w(n) = n^{\frac{1}{\eta}}\bar{w}$.

We use three cases to illustrate the roles of financial frictions and labor market power: an efficient case without frictions, a case with financial frictions alone, and a case with both financial frictions and labor market power.

Proposition 1 (Efficient Case) *When firms have no labor market power and face complete financial markets, the optimal labor n^* is independent of financial shocks ζ and satisfies*

$$\alpha\,\mathbb{E}(z)(n^*)^{\alpha-1} = \bar{w}. \tag{1}$$

Proof: Appendix A. With competitive labor market, all firms pay the same wage $\bar{w}$. Under the complete markets, firms can use state-contingent debt to ensure non-negative cash flows in every state. As a result, the no-equity-issuance condition never binds. The firm's problem reduces to choosing labor to maximize expected profit before the realization of shocks: $\max_n \mathbb{E}\,(zn^\alpha - \bar{w}n - \zeta)$. This implies that equation (1) holds: the expected marginal product equals its marginal cost. Clearly, financial shocks ζ have no impact on the optimal labor under complete financial markets.

Now suppose labor markets remain competitive, but firms face financial frictions: they can neither borrow nor issue equity. In this case, firms choose labor to maximize expected payoff and must satisfy the non-negative dividend (NND) condition. Namely,

$$\max_n \mathbb{E}\,(zn^\alpha - \bar{w}n - \zeta)\,, \;\; \text{s.t. } \; zn^\alpha - \bar{w}n - \zeta \geq 0, \; \forall z. \tag{2}$$

Proposition 2 (Financial Frictions Only) *With financial frictions but no labor market power, a firm's optimal labor satisfies*

$$\alpha\,\mathbb{E}(z)n^{\alpha-1} = \frac{1+\gamma}{1+(\underline{z}/\mathbb{E}\,z)\gamma}\bar{w}, \tag{3}$$

where $\gamma \geq 0$ is the Lagrangian multiplier associated with the NND condition. Furthermore, larger financial shocks reduce labor.

Proof: Appendix A. The key mechanism is the pre-committed labor choice combined with linearly increasing labor costs: firms that choose larger labor inputs face greater downside risk when productivity z realizes at low values. The efficient labor n^*—which maximizes expected profit—may be too risky for low realizations of z, potentially leading to insolvency (e.g., $\underline{z}(n^*)^\alpha - \bar{w}n^* - \zeta < 0$). Thus, firms consider both marginal profit and insolvency risk when making decisions, yielding the first-order condition in equation (3). The *labor wedge* $\frac{1+\gamma}{1+(\underline{z}/\mathbb{E}\,z)\gamma}$ captures the gap between the firm's marginal product of labor and the wage $\bar{w}$, reflecting the distortion caused by financial frictions. When $\gamma > 0$, the optimal labor is smaller than efficient labor n^* since $\underline{z} < \mathbb{E}\,z$, and firms choose labor to satisfy the NND condition under the lowest z: $\underline{z}n^\alpha - \bar{w}n - \zeta = 0$.

Now, financial shocks ζ directly affect firm labor choices. A larger financial shock tightens the NND condition, increases the multiplier γ, thereby amplifying the labor wedge and reducing employment.

We next consider the case with both labor market power and financial frictions. To make this case comparable with the financial-frictions-only case, we assume that when the NND condition is not binding, the optimal labor equals n^*, as in the complete markets case.[1]

Proposition 3 (Both Financial Frictions and Labor Market Power) *With both frictions, the firm's optimal labor satisifes*

$$\alpha\,\mathbb{E}(z)n^{\alpha-1} = \frac{1+\gamma}{1+(\underline{z}/\mathbb{E}\,z)\gamma}\frac{1+\eta}{\eta}w(n). \tag{4}$$

Larger financial shocks depress both firm-specific wages and labor. Moreover, the response of labor to financial shocks is smaller than under financial frictions alone.

Proof: Appendix A. As before, a larger financial shock tightens the NND condition, raising γ, which amplifies the labor wedge and reduces labor. However, due to the firm's upward-sloping labor supply curve, the reduction of labor lowers the remaining workers' wages $w(n) = n^{\frac{1}{\eta}}\bar{w}$. This mitigates the firm's financial constraint. The term $1/\eta$ captures firms' monopsony power: as $\eta \to \infty$, the model goes back to the competitive labor market case. A higher $1/\eta$ implies a smaller employment cut in response to financial shocks, effectively

[1] Without financial frictions, a hiring subsidy of $\tau = 1/(1+\eta)$ makes firms choose labor the same as the efficient one n^* in general equilibrium.

shielding firms from financial frictions. The reason is that lower wages relax the NND condition, mitigating the distortion caused by financial frictions and partially offsetting the decline in employment. Second, lower wages also helps relax the NND condition when low z is realized. Thus, with labor market power, the NND condition is less likely to be binding, and thus γ is smaller. We refer to this mechanism as *financing from workers*.

2.2 From Model to Data

The three cases in our simple model demonstrate a key feature of the financing-from-worker mechanism: firm-specific wages fall in response to adverse financial shocks. We now turn to the data to test whether this pattern holds and to quantify the magnitude of wage responses to such shocks.

To bridge our theoretical model and the data, we must first identify a suitable measure of financial shock. We use unexpected disinflation as our proxy for the following reason: because debt contracts are signed in advance, unexpected disinflation increases the real debt burden faced by firms (Fisher, 1933; Gomes, Jermann, and Schmid, 2016). Empirical evidence further shows that firms with higher debt levels benefit disproportionally more from inflation (Bhamra et al., 2023; Chen, Liu, and Luo, 2022; Fabiani and Fabio Massimo, 2024), further validating this measure.

We extend the simple model to incorporate nominal debt and disinflation shocks. Suppose firms borrow a nominal amount B_t in period $t-1$ at nominal interest rate $(1+i_{t-1}) = (1+r_{t-1})\pi_t^e$, where $1+r_{t-1}$ is the real interest rate and π_t^e is the expected inflation rate for period t formed in period $t-1$. Firms choose labor after observing realized inflation but before their idiosyncratic productivity shock z_t materializes.[2] Let P_t be the price level at period t. The firm's nominal dividend is $P_t z_t n_t^\alpha - P_t w_t n_t - (1+i_{t-1})B_t$. We define real debt as $b_t = B_t/P_{t-1}$ and inflation $\pi_t = P_t/P_{t-1}$.

Firms solve the following problem

$$\max_{n_t} \mathbb{E}\left(z_t n_t^\alpha - w(n_t)n_t - (1+r_{t-1})\frac{b_t}{\pi_t/\pi_t^e}\right), \text{ s.t. } z_t n_t^\alpha - w(n_t)n_t - (1+r_{t-1})\frac{b_t}{\pi_t/\pi_t^e} \geq 0, \ \forall z. \tag{5}$$

[2] In our full dynamic model, firms choose labor before the realization of all shocks, including inflation shocks.

When $\pi_t/\pi_t^e < 1$, the economy experiences disinflation, which increases the real debt burden and acts like a financial shock in our simple model. Suppose an unexpected disinflation shock causes the NND condition to bind. Then n_t solves $\underline{z}n_t^\alpha - w(n_t)n_t - (1+r_{t-1})\frac{b_t}{\pi_t/\pi_t^e} = 0$, which implies $d\ln w = \frac{1}{\eta}\frac{(1+r_{t-1})}{\alpha\underline{z}n_t^\alpha - \frac{1+\eta}{\eta}w(n_t)n_t} b_t \times d\left(\frac{1}{\pi/\pi^e}\right)$. We can prove that under the constrained optimal labor, the marginal profit under $\underline{z}$ is negative, i.e., $\alpha\underline{z}n_t^\alpha - \frac{1+\eta}{\eta}w(n_t)n_t \leq 0$. Thus, the wage growth Δwage has the following property,

$$\Delta\text{wage} = \beta \times \text{ debt} \times \text{disinflation}, \tag{6}$$

where $\beta \leq 0$ captures the markdown and the negative marginal profit. Equation (6) suggests that wages decline more for firms with higher debt in response to unexpected disinflation. As unexpected disinflation increases the real debt burden, the NND condition becomes tighter. Firms respond by reducing labor input, and wages decrease due to the upward-sloping labor supply curve. This effect is stronger for firms with higher debt levels, as they face tighter NND constraints. Equation (6) guides our empirical analysis below.

There are several reasons to use unexpected disinflation shocks. First, β in eq. (6) is a general semi-elasticity of wages to any financial shock ζ that reduces firms' cash on hand, as captured by $\underline{z}n - w(n)n - \zeta = 0$. Second, debt disinflation provides a clear mechanism: the interaction between debt levels and unexpected disinflation effectively captures the Fisher effect and the increase in a firm's real debt burden. This is particularly valuable because empirically measuring firms' conditions is often challenging. Third, debt disinflation represents a type of financial shock that is both measurable and recurrent, unlike rare events such as the Lehman Brothers collapse during the Great Recession. Fourth, debt disinflation likely has minimal impact on the marginal product of labor. Instead, it directly affects wages through firms' financing constraints, making it more suitable for analysis than productivity shocks or monetary policy shocks.

2.3 Data

We use data from three main sources: the US Census Longitudinal Employer-Household Dynamics (LEHD), Compustat, and macro-level data as supplements. This allows us to build a quarterly panel that matches employers and employees, providing detailed

information on individual workers' earnings and job separations, as well as firms' financial conditions and shocks. The sample spans from 1989 to 2017.

We draw a 10% random sample of workers from the LEHD Snapshot 2021, which provides employees' quarterly earnings and firm identifiers.[3] The LEHD is based on UI wage records, recording any job with positive earnings. Unlike datasets that only report total wage bills, the LEHD provides individual workers' wages, enabling us to control for worker heterogeneity in regressions and avoid the compositional effects of heterogeneous employees on firms' wage bills.

Using firm identifiers in the LEHD, we merge worker-firm data from the LEHD with Compustat Quarterly through the Longitudinal Business Database (LBD) and the Compustat-SSEL Bridge (CSB). Compustat Quarterly provides firm-level balance sheet data. Our primary measure of firms' financial condition is leverage, defined as the ratio of total debt to total assets, where total debt is the sum of a firm's short-term and long-term debt.

Next, we construct firm-level unexpected inflation shocks as the difference between actual inflation and expected inflation:

$$\epsilon^{\pi}_{jt} = \sum_{s} \omega^{j}_{st} \pi_{st} - E_{t-4}\pi_{t}, \tag{7}$$

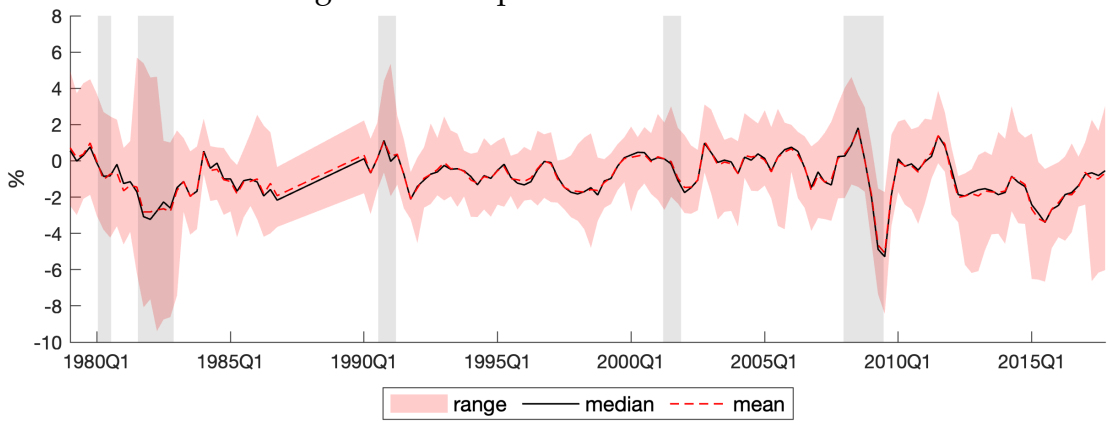
where j indexes firms, s represents states, and t denotes quarter.

The first term, $\sum_s \omega^j_{st}\pi_{st}$, represents firm j's employment-weighted inflation across states. We obtain quarterly state-level CPI inflation, π_{st}, from Hazell et al. (2022), which covers the period from 1978 to 2018. Using Census LEHD data, we then calculate each firm's employment share in each state, ω^j_{st}. The actual inflation faced by firm j is thus the employment-weighted average of state-level inflation rates, $\sum_s \omega^j_{st}\pi_{st}$. This measure assumes that firms set prices based on inflation in the states where they employ workers.

The second term, $E_{t-4}\pi_t$, is the median expected inflation over the next 12 months from the University of Michigan's Survey of Consumers. This measure of national inflation expectations assumes no arbitrage in the financial market within the U.S., so the nominal interest rate and its corresponding expected inflation should be the same across states.

[3] We use a 10% sample rather than the full sample to alleviate the computational burden of high-dimensional fixed-effects regressions.

Figure 1: Unexpected Inflation Shocks



Note: This figure plots the state-level unexpected inflation $\epsilon^{\pi}_{st} = \pi_{st} - E_{t-4}\pi_t$. The solid black line shows the median across states, the dashed red line represents the mean, and the red shaded area depicts the min-max range.

Table 1: Summary Statistics

Variables	Notations	N (observations)	Mean	St. Dev.
Worker earnings growth	$\Delta \ln w_{ijt}$	29,700,000	0.055	0.327
Firm-level unexpected inflation	ϵ^{π}_{jt}	29,700,000	-0.007	0.013
State-level unexpected inflation	ϵ^{π}_{st}	29,700,000	-0.008	0.015
Firm leverage	Leverage_{jt}	29,700,000	0.268	0.181
Worker separation indicator	$\mathbb{1}^{\text{seperation}}_{ijt}$	48,980,000	0.078	0.269

This table shows the summary statistics of the main variables used in the regressions. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 2652. (CBDRB-FY22-P2652-R9856) The numbers are rounded according to the Census Bureau's disclosure avoidance requirements.

To visualize the range of inflation shocks, we compute state-level unexpected inflation as $\epsilon^{\pi}_{st} = \pi_{st} - E_{t-4}\pi_t$. Figure 1 plots its range over time, showing significant variation across states and over time. By construction, firms' employment-weighted unexpected inflation, ϵ^{π}_{jt}, lies within the same range.

Lastly, we obtain state-level unemployment from Hazell et al. (2022) and monetary shocks from Gürkaynak, Karasoy-Can, and Lee (2022) as control variables in our regressions. In the end, the sample starts from 1989 to 2017. Table 1 reports summary statistics for the main variables used in the regressions.

2.4 Local Projections

Our goal is to test whether firms can finance through workers when facing adverse financial shocks. Directly observing pure financial shocks is challenging. Instead, motivated by our simple model, we use the interaction between a firm's leverage and disinflation shocks to capture adverse financial shocks. Intuitively, disinflation increases firms' real debt burden and worsens their financial situations, especially for highly leveraged firms. To alleviate such financial pressure, firms may reduce the growth of wage payments to workers.

Responses of Worker Earnings and Separations. Motivated by eq. (6) in our simple theory, we estimate the following local projection regression to examine the heterogeneous responses of workers' earnings growth to increases in firms' real debt burden:

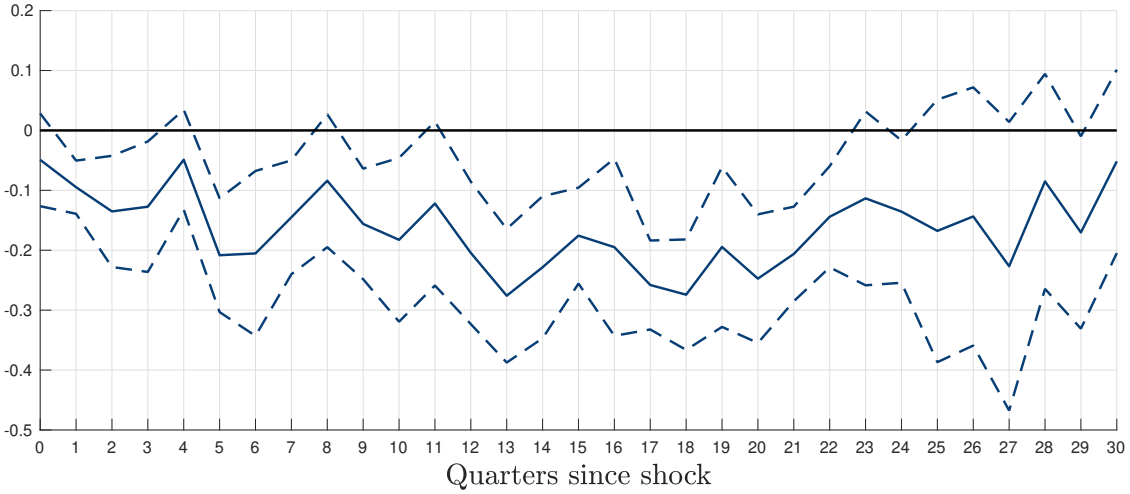
$$\ln w_{ijt+h} - \ln w_{ijt-4} = \beta_h (lev_{jt-5} - \mathbb{E}_j[lev_{jt}])(-\epsilon^{\pi}_{jt-1}) + \Gamma_h' Z_{jt-1} + \alpha_{ih} + \alpha_{jh} + \alpha_{sh} + \alpha_{cth} + e_{ijth}, \; h \geq 0, \tag{8}$$

where $\ln w_{ijt+h} - \ln w_{ijt-4}$ is the earnings growth of worker i in firm j from time $t-4$ to $t+h$, with h denoting the forward-looking horizon. lev_{jt-5} is firm j's leverage in $t-5$, which is lagged to capture ex-ante leverage and avoid overlap with the left-hand side earnings growth. $\mathbb{E}_j[lev_{jt}]$ is the average leverage of firm j, so the demeaned leverage, $lev_{jt-5} - \mathbb{E}_j[lev_{jt}]$, captures within-firm leverage variations, following Ottonello and Winberry (2020). ϵ^{π}_{jt-1} denotes firm j's unexpected inflation shock at quarter $t-1$, with the one-quarter lag mitigating simultaneity between inflation and earnings growth.

The vector of control variables, Z_{jt-1}, includes lagged firm-level unexpected inflation, ϵ^{π}_{jt-1}; the corresponding lagged employment-weighted unemployment rate across states, u_{jt-1}; demeaned leverage, $lev_{jt-5} - \mathbb{E}_j[lev_{jt}]$; lagged total assets; lagged sales growth; lagged current assets as a share of total assets; a fiscal-quarter dummy; the interaction between demeaned leverage and lagged state-level unemployment; and the interaction between demeaned leverage and lagged monetary policy shocks from Gürkaynak, Karasoy-Can, and Lee (2022). These control variables follow Ottonello and Winberry (2020).

The regression also includes worker fixed effects α_{ih}, firm fixed effects α_{jh}, state fixed effects α_{sh}, and sector-by-quarter fixed effects α_{cth}. The error term is denoted by e_{ijth}. Standard errors are two-way clustered by firm and quarter, as in Ottonello and Winberry

Figure 2: Heterogeneous Responses of Worker Earnings Growth



Note: The figure plots the estimated coefficients (β_h) with their corresponding 90% confidence intervals from equation (8), showing the heterogeneous responses of workers' earnings growth to unexpected firm-level disinflation shocks, conditional on firm leverage.

(2020).

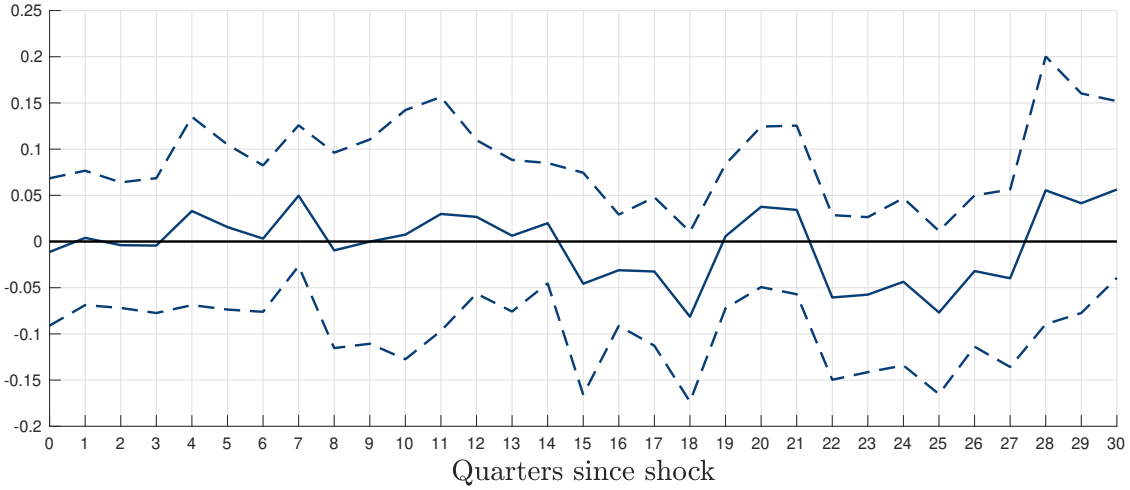
The coefficient of interest is β_h. We make two adjustments to facilitate its interpretation. First, we include a minus sign in front of ϵ^{π}_{jt-1}, so β_h captures the heterogeneous responses to unexpected disinflation rather than inflation. Second, we standardize the demeaned leverage to have a mean of zero and a standard deviation of one.

Figure 2 presents the estimated β_h along with the 90% confidence intervals for the regression specification (8). The coefficient β_h is significantly negative for 21 periods. Specifically, a 1% disinflation results in approximately 0.1% lower earnings growth for workers in firms with one standard deviation higher leverage when $h = 1$. It takes about five years for these workers' earnings to fully recover. Cumulatively, workers in firms with one standard deviation higher leverage experience 3.96% lower earnings growth. A back-of-the-envelope calculation suggests that this reduction in payroll offsets roughly 47% of the increase in the real debt burden caused by the disinflation shock.[4]

Importantly, our empirical finding does not suggest that firms *borrow* from workers.

[4] According to the BLS, the average quarterly wage from 1989 to 2023 is \$10,556.8. From Compustat, the average firm employs 8,511 workers and has \$763.65 million in debt. A 1% unexpected disinflation increases the real debt burden by 1%, adding \$7.64 million on average per firm. Meanwhile, the cumulative decrease in workers' earnings is 3.96%, reducing payroll by \$3.56 million on average (\$10,556.8 × 8,511 × 3.96% ÷ 10^6). Thus, the decline in payroll offsets 46.57% (\$3.56 million ÷ \$7.64 million) of the increase in the debt burden.

Figure 3: Heterogeneous Responses of Worker Separations



Note: The figure plots the estimated coefficients (β_h) with their corresponding 90% confidence intervals from equation (8), replacing the dependent variable with the separation indicator $\mathbb{1}^{\text{sep}}_{ijt+h}$. It shows the heterogeneous responses of workers' separation probability to unexpected firm-level disinflation shocks, conditional on firm leverage.

As shown in Figure 2, the estimated β_h remains negative for around 20 quarters before becoming statistically insignificant—and it never turns significantly positive. This pattern indicates that workers in high-leverage firms experience persistently lower earnings growth relative to those in low-leverage firms, without subsequent compensation in the form of higher earnings growth. We interpret this as evidence of firms exercising monopsony power to *finance* from workers, rather than backloading repayment.

We further study the heterogeneous responses of separations. We re-estimate regression (8), replacing the dependent variable with the separation indicator $\mathbb{1}^{\text{sep}}_{ijt}$, which equals one if worker i has positive earnings from firm j in quarter t but no earnings from firm j in $t+1$. Figure 3 presents the results, showing no significant heterogeneous responses of separations to unexpected disinflation. This suggests that while highly leveraged firms pay lower earnings growth in response to unexpected disinflation, workers still remain working in these firms—further supporting the presence of monopsony power.

These empirical results validate our hypothesis that firms can finance through workers by reducing workers' earnings growth when facing financial distress. Note that these findings do not contradict the literature on downward wage rigidity, as our focus is on relative earnings growth across firms with different leverage, so absolute nominal wages

may not necessarily decline.

Roles of Labor Market Power. If our hypothesis is correct, then firms with greater labor market power should exhibit stronger reductions in worker earnings growth following adverse financial shocks. To test this, we extend the benchmark regression (8) by including a triple interaction term—along with the corresponding double interactions—to capture how the response to leverage and disinflation varies with firms' labor market power:

$$\left(lev_{jt-5} - \mathbb{E}_j\left[lev_{jt}\right]\right) \times \left(-\epsilon^{\pi}_{jt-1}\right) \times \text{labor market power}_{ijt-5}.$$

We examine three measures of labor market power: the Herfindahl-Hirschman Index (HHI) of the job's local labor market, employment share of firm j in the job's local labor market, and the unionization rate.

Figure 4: Responses of Earnings Growth Conditional on Firms' Labor Market Power



Note: The figures plot the coefficients of the triple interaction $\left(lev_{jt-5} - \mathbb{E}_j\left[lev_{jt}\right]\right)\left(-\epsilon^{\pi}_{jt-1}\right) \times$ labor market power on an extension of equation (8) with this triple interaction, under three different measures of labor market power. Panel A uses the Herfindahl-Hirschman Index, Panel B uses the employment share in the local labor market, and Panel C uses the unionization rate to approximate a firm's labor market power. Note that the higher HHI, higher employment share, or lower unionization rate implies higher labor market power. Dashed lines are 90% confidence intervals.

A firm's labor market power increases with its Herfindahl–Hirschman Index (HHI) and local employment share, and decreases with the unionization rate. HHIs and employment shares are computed using LEHD data, where a local labor market is defined as the firm's industry within the commuting zone in which the job pair ij is located. Union-

ization rates are obtained from the Current Population Survey (CPS), aggregated to the state–industry level, and merged using firms' industry classifications and job locations. For firms operating in multiple industries, we compute employment-weighted averages.

Figure 4 displays the coefficients on the triple interaction across all three labor market power measures. The results consistently show that workers experience larger earnings growth declines when employed by firms with higher leverage and greater labor market power during disinflation shocks. Estimates using unionization rates have larger standard errors, as the underlying survey data are noisier. These findings further support our hypothesis that firms rely on labor market power to finance through workers.

Responses of Firm Employment. We next analyze the heterogeneous response of firm employment to the disinflation shocks. We consider a firm-level regression as

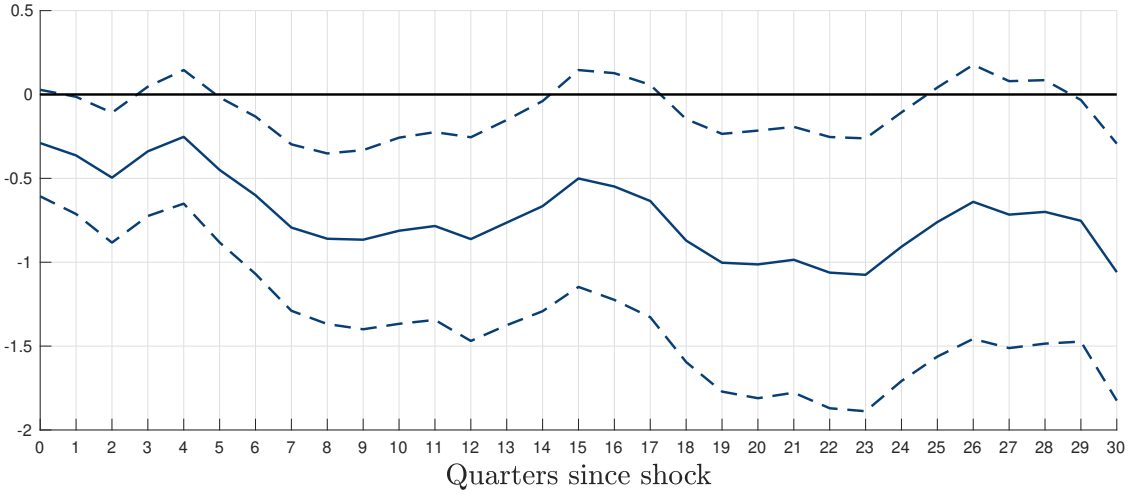
$$\ln n_{jt+h} - \ln n_{jt-4} = \beta_h (lev_{jt-5} - \mathbb{E}_j[lev_{jt}])(-\epsilon^{\pi}_{jt-1}) + \Gamma_h' Z_{jt-1} + \alpha_{jh} + \alpha_{sh} + \alpha_{cth} + e_{jth}, \; h \geq 0, \quad (9)$$

where the dependent variable, $\ln n_{jt+h} - \ln n_{jt-4}$, is the employment growth rate of firm j from period $t-4$ to period $t+h$. The explanatory variables remain the same as in the previous specifications, except for the removal of worker-fixed effects. Figure 5 reveals how employment responds to unexpected disinflation shocks. Highly leveraged firms exhibit significantly lower employment growth, with the decline most pronounced around the 8th quarter after the shock.

Taken together with the earnings decline in Figure 2, the employment response suggests that firms face upward-sloping labor supply curves—earnings fall as employment declines. Motivated by this, our model incorporates an upward-sloping labor supply curve to capture firms' labor market power.

The combination of reduced employment growth and no significant changes in separations (Figure 3) indicates that firms primarily adjust their workforce through reduced hiring rather than increased separations. To test this, we define new hires in the LEHD as workers with positive earnings from the firm in the current period but none in the previous period. We re-estimate the firm-level regression in equation (9), using hiring growth as the dependent variable. Panel A of Figure B.7 in the Appendix confirms that highly leveraged firms reduce hiring growth more than other firms following a disinflation shock.

Figure 5: Heterogeneous Responses of Firms' Employment Growth



Note: The figure plots the estimated coefficients (β_h) with their corresponding 90% confidence intervals from equation (9), showing the heterogeneous responses of firms' employment growth to unexpected firm-level disinflation shocks, conditional on firm leverage.

Robustness and Other Results. Here we present a series of robustness checks and explore alternative shocks and firm-level outcomes. For our baseline regression on worker earnings growth, we (i) replace state-level inflation with aggregate inflation measures; (ii) use inflation in firms' headquarters states instead of the employment-weighted average across states; and (iii) use firms' headquarters-state inflation while restricting the sample to workers employed outside their firms' headquarters states to address potential endogeneity concerns. To test for asymmetries in the debt-deflation channel, we separately examine unexpected inflation and unexpected disinflation shocks. We also investigate heterogeneous responses to monetary policy shocks and disentangle the roles of leverage and debt maturity. In addition, we examine the responses of worker layoffs (involuntary separations), apart from overall separations. Finally, we extend the analysis to study how firms' investment responds to unexpected disinflation shocks.

Alternative Disinflation Measures. Our baseline regression uses firm-level disinflation shocks, which offer several advantages relative to aggregate disinflation. First, inflation and inflation expectations show little variation at the aggregate level, making estimates highly sensitive to model specification and measurement choices (Hazell et al., 2022; Mavroeidis, Plagborg-Møller, and Stock, 2014). Second, since monetary policy targets national inflation, variations at the aggregate level are further dampened (Fitzgerald,

Nicolini et al., 2014; McLeay and Tenreyro, 2020). Third, relying on aggregate inflation increases the risk of omitted variable bias, as numerous factors can simultaneously happen at the aggregate level.

Nevertheless, to acknowledge the possibility that some firms set prices based on national inflation conditions, we conduct a robustness check using aggregate CPI inflation to construct inflation shocks common to all firms. Figure B.1 in the appendix plots the estimated coefficients β_h from equation (8) using aggregate unexpected disinflation. The results are similar to our baseline findings: workers' earnings growth declines in response to unexpected disinflation shocks when they are employed by highly leveraged firms.

Another hypothesis is that firms set product prices based on inflation in the state where their headquarters are located, rather than on inflation in all states in which they employ workers. To accommodate this possibility, we use firms' headquarters-state inflation as our measure of realized inflation and construct unexpected disinflation shocks accordingly. This approach also introduces meaningful cross-state variation in inflation shocks that is less subject to monetary-policy smoothing, thereby strengthening identification. Panel A of Figure B.2 in the appendix reports the regression results, which are similar to our baseline findings: workers employed by highly leveraged firms experience lower wage growth following an unexpected disinflation shock.

Using headquarters-state inflation shocks also allows us to address a concern raised by Hazell et al. (2022), namely that state-level inflation may reflect local demand conditions or other regional shocks that directly affect firm outcomes. To mitigate this concern, we further restrict the sample to workers employed outside their firms' headquarters states. By excluding workers located in the headquarters state, we spatially separate workers' locations from the source of the disinflation shock. Panel B of Figure B.2 presents the baseline regression results for out-of-headquarters-state workers, which remain consistent with our baseline estimates.

Responses to Inflation and Disinflation Shocks. To examine whether workers' earnings growth responds differently to inflation and disinflation shocks, we decompose ϵ^{π}_{jt-1} into unexpected inflation shocks, $\epsilon^{\pi}_{jt-1}\mathbb{1}\{\epsilon^{\pi}_{jt-1} \geq 0\}$, and unexpected disinflation shocks, $\epsilon^{\pi}_{jt-1}\mathbb{1}\{\epsilon^{\pi}_{jt-1} < 0\}$. We then run the regression with leverage interactions for both components. Figure B.3 presents the estimated coefficients for the two interaction terms in Panels A and B, respectively. The results indicate that earnings responses are statistically

significant for both inflation and disinflation shocks; the estimated coefficients for inflation shocks are larger in magnitude but are accompanied by larger standard errors.

Monetary Policy Shocks. The literature has emphasized the role of monetary shock on firm investment in the presence of financial frictions. To account for this channel, our baseline regression includes monetary policy shocks and their interaction with firm leverage as control. Figure B.4 shows that the coefficient on this interaction is insignificant, indicating no heterogeneous response of workers' earnings growth to monetary policy shocks.

Debt Maturity. Following Gomes, Jermann, and Schmid (2016), who emphasize the importance of long-term debt for firms' investment decisions, we test the robustness of our results using a measure of debt maturity—defined as the ratio of long-term debt to total debt. Panel A of Figure B.5 shows that incorporating debt maturity does not materially affect the baseline coefficients on the interaction between leverage and disinflation shocks. Panel B further shows that the interaction between debt maturity and disinflation shocks is statistically insignificant.

Layoffs. Figure 3 shows that the response of worker separations is statistically insignificant. Note that separations include both voluntary and involuntary separations (i.e., layoffs). To assess whether layoffs respond differently, we re-estimate regression (8), replacing the dependent variable with a layoff indicator, $\mathbb{1}_{ijt}^{\text{lay}}$. Although the LEHD data do not directly distinguish layoffs from other separations, we define the layoff indicator to equal one if worker i has positive earnings from firm j in quarter t but has no earnings from firm j in $t+1$ and no earnings from any other firm in the U.S. Hyatt et al. (2014) show that this definition closely matches layoff patterns observed in the Job Openings and Labor Turnover Survey (JOLTS). Figure B.6 shows that the response of layoffs to unexpected disinflation shocks is also statistically insignificant.

Firm-Level Investment. Finally, we examine heterogeneous firm-level investment responses to disinflation shocks. Since investment does not directly involve workers, we estimate the firm-level regression in equation (9), using investment as the dependent variable. Investment is measured as the log change in firms' capital stock from Compustat. Panel B of Figure B.7 presents the estimated coefficients for the interaction between firm leverage and disinflation shocks. We find no statistically significant investment response. Accordingly, we abstract from capital in our model.

To summarize our empirical analyses, using employer–employee matched data and firm-level unexpected disinflation shocks, we find that workers experience slower earnings growth following disinflation shocks when employed by highly leveraged firms, which also exhibit larger declines in employment growth. This heterogeneity in earnings responses is more pronounced for firms with greater labor market power. Our findings are robust across a range of alternative specifications and empirical setups. Taken together, the results reveal a novel mechanism through which firms, during periods of financial distress, obtain financing from workers by exercising monopsony power.

To assess the macroeconomic implications of this mechanism, below we construct a heterogeneous firm model incorporating both labor market power and firm-level default risk. Using this model, we can quantify the aggregate impact of financing from workers and evaluate the extent to which it helps the economy insure against financial distress.

3 Model

This section explores how labor market power interacts with financial frictions. To highlight this interaction, we first consider a parsimonious model that abstracts from other frictions. In the next section, we extend the model with nominal rigidities and monetary policy.

The model has heterogeneous firms with two key elements: firms can issue only state-uncontingent debt with the possibility of default, and workers view jobs across firms as imperfect substitutes, resulting in firm-specific wages that reflect each firm's labor market power. We quantify the impact of labor market power on financial frictions by calibrating the model to firm-level data and comparing the aggregate implications between our benchmark model and a counterfactual scenario where firms lack labor market power.

We consider a small open economy with a representative household and a continuum of measure one of firms. Firms have labor market power due to inelastically substitutable jobs across firms. The world real interest rate is fixed at r. Our analysis focuses on the economy's response to an unexpected disinflation shock, $\pi_t = P_t/P_{t-1} < 1$.

The aggregate labor supply is a CES aggregator over jobs from firms,

$$N_t = \left[\int_0^1 n_{jt}^{\frac{\eta+1}{\eta}} dj \right]^{\frac{\eta}{\eta+1}}, \tag{10}$$

where η is elasticity of substitution and $1/\eta$ reflects firms' labor market power. When $\eta \to \infty$, the labor market becomes perfectly competitive. As discussed in Berger, Herkenhoff, and Mongey (2022), this inelastic substitution across jobs can be micro-founded with worker preference over firms, different amenities offered by firms, or the cost of switching jobs etc.

Firms are competitive and produce with labor with a decreasing return to scale technology, $y = zn^{\alpha}$, where z represents productivity shocks. Prior to shock realization, firms decide on employment and the associated nominal wages W_{jt}. Firms can only borrow nominal state-uncontingent debt but can default. Default triggers immediate firm exit and zeroes out shareholder value. A defaulting firm uses its current output to pay workers. When output is insufficient to cover wage payments, the government steps in to guarantee worker compensation through lump-sum taxation.

The mass of the firms is always at one. Each defaulting firm is replaced by a new entrant firm characterized by productivity z_e and subject to a fixed entry cost $\bar{\omega}$. New entrants can choose their labor size for the next period, and they can finance their entry costs through debt. In equilibrium, the labor market clears in each period.

Household's Problem. The representative household has a per-period utility $u(C, N)$ and discount factor β. The household earns real labor income by supplying labor n_{jt} to each firm j at real wage w_{jt}/π_t. In addition to labor income, the household receives dividend payments Π_t and pays lump-sum taxes T_t. The household can also borrow and lend internationally b_{t+1}^H at the risk-free real interest rate r. The household's flow budget constraint is therefore:

$$C_t + b_{t+1}^H = \int_0^1 \frac{w_{jt} n_{jt}}{\pi_t} dj + (1+r) b_t^H + \Pi_t + T_t.$$

We study the perfect foresight transition path with respect to aggregate states, so the stochastic discount factor of the households is linked to the world interest rate, $\Lambda_{t+1} = \beta u_{ct+1}/u_{ct} = 1/(1+r)$.

The household's optimal labor supply decision for each firm j yields the first-order condition:

$$w_{jt} = \frac{u_{Nt}}{\mathbb{E}_{t-1}[u_{Ct}/\pi_t]} \left(\frac{n_{jt}}{N_t}\right)^{\frac{1}{\eta}}.$$

This optimality condition consists of two key terms. The first term, $\frac{u_{Nt}}{\mathbb{E}_{t-1}[u_{Ct}/\pi_t]}$, represents the standard marginal rate of substitution between leisure and consumption. Since labor contracts are determined before the realization of shocks while consumption decisions are made afterward, this term incorporates the expected marginal utility of consumption and expected inflation. The second term, $\left(\frac{n_{jt}}{N_t}\right)^{\frac{1}{\eta}}$, captures the imperfect substitutability of labor across firms. Let $\bar{W} = \frac{u_N}{\mathbb{E}(u_C/\pi)} N^{-\frac{1}{\eta}}$ summarize the aggregate variables, we can then write a firm's labor supply curve as

$$w(n) = n^{\frac{1}{\eta}} \bar{W}, \tag{11}$$

which increases with the firm's employment n.

Firms' Problem. Firms face two types of shocks: a persistent productivity shock z and an idiosyncratic fixed-cost shock κ, where κ has a cumulative distribution function Φ. Each firm j can issue nominal debt B_{jt+1} with bond price Q_{jt}. The real value of the new debt issuance can be expressed as: $Q_{jt}B_{jt+1}/P_t = Q_{jt}b_{jt+1}$ where $b_{jt+1} = B_{jt+1}/P_t$ denotes the real value of new debt. The real value of existing debt liability is given by $B_{jt}/P_t = b_{jt}/\pi_t$. Thus, an unexpected disinflation (a decrease in π_t) increases the real burden of nominal debt, creating a debt-disinflation channel through which disinflation affects firm balance sheets.

A firm's state variable includes two shocks (z, κ), pre-determined employment level n, and the real value of outstanding debt b/π. Given prices, the firm chooses new employment n' and debt b' for the next period. Due to default risk, bond prices are firm-specific and incorporate the expected losses to lenders in the event of default. Specifically, the bond price $Q_{jt} = Q(z, n', b')$ depends on (n', b') since these decisions affect the probability of default. The model incorporates two additional financial frictions: an equity issuance constraint that prevents firms from raising new equity and a limited liability condition that requires non-negative dividends.

The firm's dividend payment is given by

$$div = zn^{\alpha} - \frac{w(n)n}{\pi} - \frac{b}{\pi} - \kappa + Q(z, n', b')b' \geq 0. \tag{12}$$

Since the value of default is zero, a firm will choose to continue operating as long as it can borrow sufficiently to satisfy the non-negative dividend constraint. Therefore, defaults in this model arise from liquidity constraints rather than strategic considerations. When the idiosyncratic shock κ is small, the firm can use its sales and new borrowings to cover wage bills and current debt obligations. However, there exists a threshold value $\kappa^*(z, n, b)$ above which default becomes inevitable. This default threshold is characterized by:

$$\kappa^*(z, n, b) = zn^{\alpha} - \frac{w(n)n}{\pi} - \frac{b}{\pi} + \max_{n', b'}\{Q(z, n', b')b'\}.$$

A firm defaults if and only if its realized fixed cost exceeds this threshold, $\kappa > \kappa^*(z, n, b)$.

Conditional on repaying, the firm chooses labor n' and debt b' to solve the following problem,

$$\boldsymbol{V}(z, \kappa, n, b; \pi) = \max_{div, n', b'} div + \beta \mathbb{E}\left[\int^{\kappa^*(z', n', b')} \boldsymbol{V}(z', \kappa', n', b'; \pi') d\Phi(\kappa)\right] \tag{13}$$

subject to the upward labor supply curve (11) and the non-negative dividend condition (12).

The optimal labor choice is characterized by the following first-order condition (FOC), where γ is the Lagrange multiplier on the non-negative dividend condition (12).

$$-(1+\gamma)\frac{\partial Q}{\partial n'}b' = \beta \mathbb{E}\left\{\left(\alpha z'(n')^{\alpha-1} - \frac{1+\eta}{\eta}\frac{w(n')}{\pi'}\right)\left[(1+\gamma')\Phi(\kappa'^*) + V'^*\phi\left(k'^*\right)\right]\right\}.$$

This optimality condition balances two key effects. The left-hand side captures the marginal impact of labor on the bond prices. A reduction in future labor n' decreases the wage bill and potentially reduces default risk during low productivity, thereby improving bond prices.

The right-hand side reflects the marginal impact of n' for future profits and default risk. It works through two channels. First, the marginal profit in each future state is

$\alpha z'(n')^{\alpha-1} - \frac{1+\eta}{\eta}\frac{w(n)}{\pi'}$. Note that the firm charges a constant markdown $(\eta+1)/\eta$ to wages and faces a firm-specific wage $w(n)$ due to its labor market power. Second, labor choice influences future financial conditions through two mechanisms: it affects the likelihood of binding dividend constraints (captured by γ') and matters for default risk. In the event of default, the firm loses future value V', as reflected in the last term of the first order condition. The optimal labor decision thus embodies the interaction between financial frictions and labor market power.

Bond Price Schedule. Lenders are competitive and charge bond prices to exactly compensate for their losses during firm default. The bond price schedule is given by

$$Q(z, n', b') = \frac{1}{1+r}\,\mathbb{E}\left[\Phi(\kappa^*(z', n', b'))\frac{1}{\pi'}\right], \tag{14}$$

where $\Phi(\kappa^*(z', n', b'))$ is the repayment probability.

4 Quantitative Analysis

Our analysis proceeds in three steps to evaluate how much labor market power can alleviate financial distress. We begin by calibrating our model using micro-level data on firm financing patterns. We then validate the model by demonstrating that it reproduces the differential earnings responses observed in our empirical analysis. Finally, we consider a reference model that preserves financial frictions but removes firm labor market power. By comparing aggregate responses to disinflation shock between our baseline and the reference model, we quantify the degree to which firms' labor market power serves as a buffer against financial distress.

4.1 Parameters and Moments

Functional Forms. We assume firms' productivity follows a log AR(1) process with a persistence ρ_z and standard deviation of innovation σ_z:

$$\log z_{jt+1} = \rho_z \log z_{jt} + \sigma_z \epsilon^z_{jt}, \epsilon^z_{jt} \sim \mathcal{N}(0,1). \tag{15}$$

Assigned Parameters. We externally assign four parameters to parameterize the model. First, we set the decreasing returns to scale coefficient α to 0.66, corresponding to the average labor share in the United States. Second, we target a 4% annual interest rate by setting the risk-free rate $r = 0.01$ (quarterly). Third, following Bloom et al. (2018), we calibrate the productivity persistence parameter $\rho_z = 0.95$. Lastly, we follow Berger, Herkenhoff, and Mongey (2022) and adopt their estimated job substitutability elasticity $\eta = 10.85$, which is a relatively conservative number for firms' labor market power in the literature. This parameterization implies that a 1% reduction in employment size enables firms to lower wages by approximately 0.1% for its all remaining workers.

Fitted Parameters. We jointly calibrate the remaining parameters by matching the most relavent empirical moments. Table 2 reports these endogenously determined parameters and their matched moments.

Our calibration targets four empirical moments: (1) the interquartile range (IQR) of firm sales growth rates, (2) median firm leverage, (3) the distribution of credit spreads, and (4) the relative productivity of entrants versus incumbents. We define leverage as the ratio of debt to annual sales: leverage $= \frac{b/\pi}{4zn^{\alpha}}$ if $b > 0$, and leverage is zero if $b \leq 0$. The annualized spread is defined as the difference from the risk-free rate: $4 \times [1/Q(z, n', b') - (1 + r)]$. The IQR of sales growth rates is obtained from Bloom et al. (2018), while the remaining data moments are from Arellano, Bai, and Zhang (2012).

Table 2 shows the model's strong fit to the empirical moments. The calibrated quarterly discount factor of $\beta = 0.81$, while seemingly low, is consistent with incomplete markets models featuring uninsurable risks. This value reflects the need to incentivize external borrowing to match observed firm leverage. An alternative approach would be to explicitly model agency frictions, as in Arellano, Bai, and Kehoe (2019), which would yield a higher calibrated value of β while achieving similar leverage moments.

4.2 Model Validation: Heterogeneous Wage Responses

To validate our model and quantify the importance of the financing-from-workers mechanism, we conduct a model-simulated local projection regression that is comparable with our empirical analysis.

Table 2: Moment Matching: Parameters and Moments

Parameters	**Notations**	**Benchmark**	**No Labor Maker Power**
SD of productivity	σ_z	0.084	0.068
Discount rate	β	0.81	0.803
Mean of operating costs	$\bar{\kappa}$	0.001	0.001
SD of operating costs	σ_κ	0.095	0.087
Entrants' relative productivity	$z_e/\bar{z}$	0.76	0.76
Moments (%)	**Data**	**Benchmark**	**No Labor Market Power**
IQR of firm sale growth	19	19	19
Median leverage	26	26	26
25th-percentile credit spread	1.0	1.5	1.4
Median credit spread	1.5	2.0	2.0
75th-percentile credit spread	2.8	2.1	2.1
Entrants' relative productivity	0.75	0.75	0.76

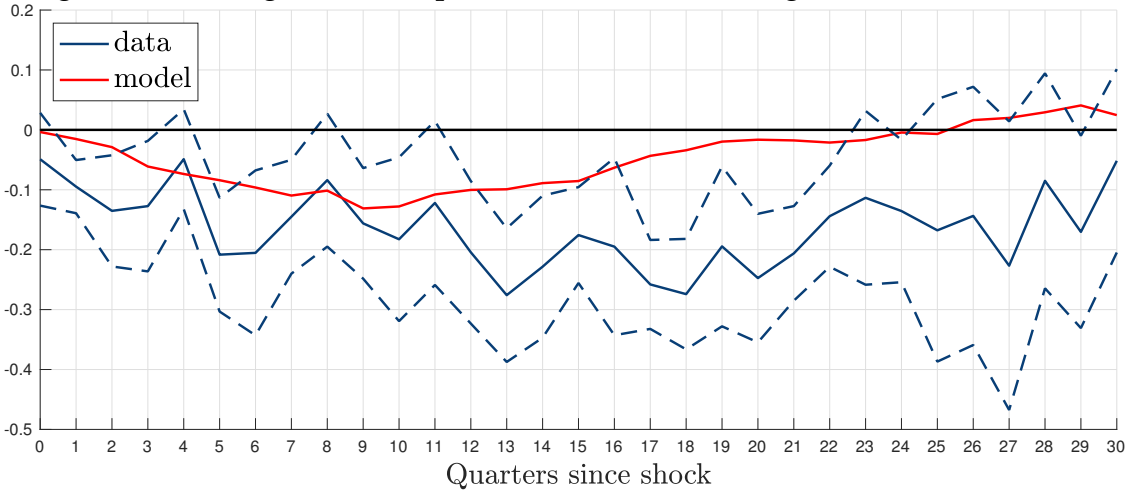
Note: This table reports the endogenously calibrated parameters and matched moments for both the benchmark model (with labor market power) and the counterfactual model without firms' labor market power. Data sources: Bloom et al. (2018) and Arellano, Bai, and Kehoe (2019).

Our validation exercise proceeds as follows: Our empirical sample has access to 24 states. Accordingly, we simulate 24 economies, each experiencing a one-time unexpected inflation shock at period $t = 5$. These shocks are drawn from a normal distribution whose parameters are estimated from the historical distribution shown in Figure 1. Each simulated economy contains 1,000 firms, with all simulations initialized from the steady state. We discard the first quarter of each simulation to eliminate initialization effects.

We pool data from all 24 simulated economies and estimate the local projection regression using the specification in equation (8). In the model-simulated regression, we define leverage as the debt-to-capital ratio (with capital normalized to 1). Unlike the empirical analysis, our model is not subject to seasonal fluctuations, allowing us to directly use contemporaneously lagged variables (w_{jt-1} and lev_{jt-2}) rather than the longer lags (w_{jt-4} and lev_{jt-5}) required in the empirical estimation.

Figure 6 compares these model-simulated results (red line) with our baseline empirical estimates (blue lines) from Figure B.2. The model successfully reproduces the key empirical pattern—the differential decline in workers' earnings growth conditional on the firm's leverage—though the simulated response exhibits less persistence than observed in the data.

Figure 6: Heterogeneous Responses of Worker Earnings: Model versus Data



Note: This figure compares our baseline empirical estimates (blue lines) from Figure B.2 with the model-simulated results (red line). The solid lines plot the estimated coefficients (β_h) from equation (8), with the blue dashed lines representing empirical 90% confidence intervals. The solid red line shows the corresponding model-predicted responses. They demonstrate the heterogeneous responses of workers' earnings growth to unexpected firm-level disinflation shocks.

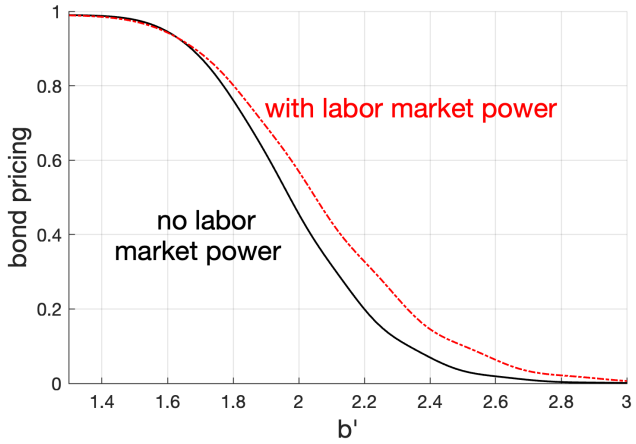
4.3 Quantification of Financing from Workers

In our model, labor market power is the key to enabling financing from workers, distinguishing it from typical firm financial friction models. To isolate this mechanism's quantitative importance, we recalibrate a reference model that maintains financial frictions but eliminates labor market power. As shown in Table 2, this reference model achieves comparable moment matching to our benchmark model. Next, we compare bond price schedules, firm-level decisions, and aggregate impulse responses across the two models to quantify the role of financing from workers.

Bond Price Schedules. Figure 7 plots the bond price schedules $Q(z, n', b')$—as defined in equation (14)—for the average-productivity firm, as a function of next-period debt b'. The solid black line depicts the model with labor market power, while the dash-dot red line corresponds to the baseline model without labor market power.

The bond price schedule $Q(z, n', b')$ is the amount a firm can borrow today per dollar of promised repayment in the next period. In both models, bond prices decline with higher borrowing levels, as the probability of default increases with debt. Lenders respond to

Figure 7: Bond Price Schedules



Note: This figure plots the bond price schedules $Q(z, n', b')$ for the average-productivity firm as a function of borrowing b'. The solid black line represents the model with labor market power, while the dash-dot red line corresponds to the baseline model without labor market power.

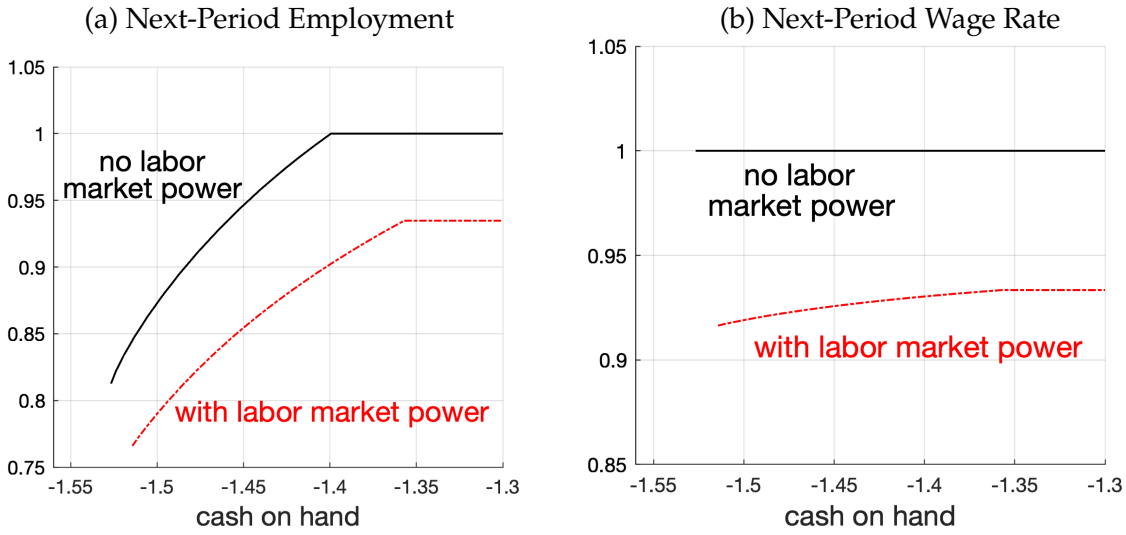
this elevated risk by demanding a higher return, thereby reducing the bond price.

Notably, the price schedule $Q(z, n', b')$ is higher in the model with labor market power, implying lower borrowing costs for firms in that setting. When firms possess monopsony power, lenders anticipate a lower probability of default, given firms' ability to reduce wages during downturns. Consequently, lenders require lower repayment per dollar borrowed, endogenously lowering the cost of external financing. This channel operates alongside the direct wage suppression effect and highlights an additional financing advantage associated with firms' labor market power.

Firm Decision Rules. Figure 8 shows the optimal policies of the average-productivity firm as a function of cash on hand. The left panel plots next-period employment n', and the right panel shows the corresponding wage rate. To facilitate interpretation, both panels are normalized such that the maximum value in the no-labor-market-power model is set to one.

We begin by examining the model without labor market power (solid black lines), which features only financial frictions. As shown in the left panel, the firm's employment decision depends on its cash on hand. When cash on hand is sufficiently high, the non-negative dividend constraint (12) is slack, so employment remains constant regardless of cash levels. As cash on hand falls, the constraint becomes binding, and the firm must borrow to meet

Figure 8: Average Firm Decisions



Note: This figure displays the optimal policies of the average-productivity firm as a function of cash on hand. The left panel plots next-period employment n', and the right panel shows the corresponding wage rate. The solid black line represents the model with labor market power, while the dash-dot red line corresponds to the baseline model without labor market power. To facilitate interpretation, both panels are normalized such that the maximum value in the no-labor-market-power model is set to one.

its obligations. Increased borrowing raises default risk, making employment riskier, so the firm shrinks its workforce.

The decision rules as a function of cash on hand help illustrate how firms respond to an unexpected disinflation shock. Such a shock—characterized by a decline in π and a corresponding increase in $\frac{b}{\pi}$—increases the firm's real debt burden and reduces its cash on hand. When the non-negative dividend constraint (12) binds, this decline forces the firm to reduce employment in order to meet its financial obligations. Additionally, the employment decision is concave, so an unexpected disinflation is more contractionary if the firm has higher ex-ante leverage and lower cash on hand, consistent with our empirical findings.

The dash-dot red line in the left panel shows the average firm's employment decision under labor market power. First, firms optimally choose lower employment levels due to monopsony power, leading them to operate at a smaller size. Second, similar to the reference model without labor market power, employment declines as cash on hand decreases. However, the decline is more gradual.

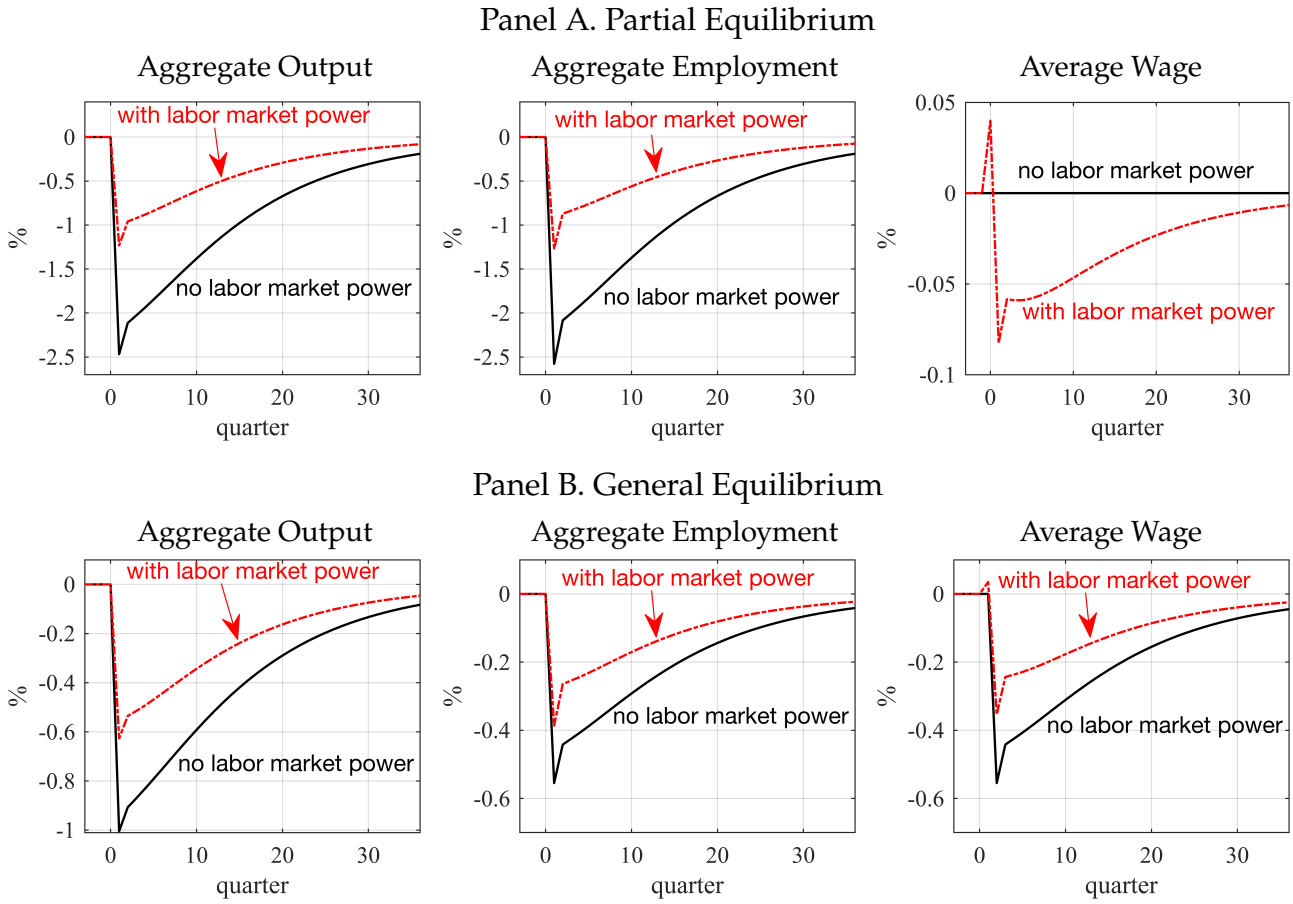
This mitigated decline arises from an additional margin of adjustment: the wage rate. As shown in the right panel, in the absence of labor market power, the labor market is perfectly competitive, so the wage rate is the same across firms—regardless of their cash on hand. In contrast, when firms have monopsony power, they face an upward-sloping labor supply curve. As firms demand less labor, their remaining workers' wage rate also declines. This response of wages helps firms to finance from workers: lower wages relieve the firm's financial burden of payroll and mitigate the impact of adverse shocks on employment. Therfore, labor market power enhances firms' resilience to financial distress.

Aggregate Impact: Mitigation from Labor Market Power. To evaluate the aggregate implications of labor market power, we compare the responses of the two economies to an unexpected decrease in firms' cash on hand in Figure 9. The shock is common across firms and proportional to firms' debt levels. The shock size is chosen so that aggregate output declines by 1% on impact in the model without labor market power under general equilibrium. Both models are (re)calibrated to match the same set of data moments and thus start from comparable firm distributions.

Panel A shows the impulse responses under partial equilibrium, where the wage index $\bar{W}$ is held constant at the level before the unexpected fall in cash on hand. In response to such shock, firms face tighter financial constraints and reduce their employment for the subsequent period, leading to contractions in aggregate employment and output. The decline in output is larger than that in employment due to a fall in aggregate labor productivity. This occurs because some firms exit following the shock, and new entrants tend to be less productive, lowering overall productivity.

The model with labor market power (dash-dot red lines) predicts smaller declines in both employment and output than the model without labor market power (solid black lines). The rightmost panel on the wage response illustrates the stabilizing mechanism: firms with monopsony power can pay lower wages following a decline in their own labor demand, despite the constant aggregate wage index. This wage adjustment helps cushion the impact of debt disinflation on firms' balance sheets. Moreover, lenders internalize this mechanism—recognizing its mitigating effect on default risk—and respond by offering more favorable bond prices. Together, these two channels—wage adjustment and improved credit terms—allow firms to maintain more stable employment and output levels after the adverse shock.

Figure 9: Impulse Response Functions to an Unexpected Decrease in Cash on Hand



Note: This figure displays the aggregate impulse responses to an unexpected decrease in firms' cash on hand, simulated as a common shock proportional to firms' debt levels. The shock size is chosen so that aggregate output declines by 1% on impact in the model without labor market power under general equilibrium. Panel A shows the partial-equilibrium results where the wage index $\bar{W}$ is held constant, while Panel B shows the general-equilibrium results where the labor market clears. Each panel plots the responses of aggregate output, aggregate employment, and the average wage rate. The solid black line represents the model without labor market power, while the dash-dot red line represents the benchmark model with labor market power. All models are (re)calibrated.

Panel B shows the general-equilibrium results where the labor market clears. Weaker labor demand lowers the equilibrium wage in both models, partially offsetting the downturn. In the reference model without labor market power, the cash-on-hand shock leads to a 1% decline in aggregate output—by construction—accompanied by a 0.55% decline in both aggregate employment and the average wage rate. In contrast, the model with labor market power displays a substantially smaller downturn, with only a 0.63% decline in output, a 0.39% decline in employment, and a 0.35% decline in the average wage. That is,

labor market power mitigates 38% of the output decline, 30% of the employment decline, and 36% of the wage decline.

In the end, the average wage decrease turns out to be smaller in the model with labor market power because firms can use monopsony power to make idiosyncratic wage adjustments based on their financial conditions. This mechanism is much more effective in stabilizing aggregate labor demand than a uniform, economy-wide wage decline, resulting in a smaller aggregate wage decrease in the model with labor market power.

5 Conclusion

Using Census employer-employee data, we find that workers in high-leverage firms experience significantly slower earnings growth following an unexpected disinflation shock that increases the real burden of firms' nominal debt. Thus, with labor market power, firms can finance from workers through reduced compensation to partially mitigate financial distress. To explore this mechanism, we develop a heterogeneous firm model incorporating both labor market power and default risk. When calibrated to US firm financing patterns and labor market elasticities, our model shows that labor market power significantly mitigates the negative impacts of financial distress on firms.

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Appendix to "Financing from Workers: Can Labor Market Power Mitigate Financial Frictions?"

by Yan Bai and Yajie Wang

A Proofs

Proof of Proposition 2 With only financial frictions, a firm solves the following problem

$$\max_n \mathbb{E}\left(zn^\alpha - \bar{w}n - \zeta\right), \text{ s.t. } zn^\alpha - \bar{w}n - \zeta \geq 0, \ \forall z,$$

which is equivalent to solving

$$\max_n \mathbb{E}\left(zn^\alpha - \bar{w}n - \zeta\right), \text{ s.t. } \underline{z}n^\alpha - \bar{w}n - \zeta \geq 0.$$

Let γ be the multiplier on the NND condition. The first order condition over n is given by

$$\alpha\, \mathbb{E}\, z n^{\alpha-1} - \bar{w} + \gamma(\underline{z}\alpha n^{\alpha-1} - \bar{w}) = 0.$$

After combining terms, we obtain

$$\alpha\, \mathbb{E}\, z n^{\alpha-1} = \frac{1+\gamma}{1+(\underline{z}/\mathbb{E}\, z)\gamma}\bar{w}.$$

We now prove that labor falls with a larger financial shock ζ.

When the NND condition is not binding, $\gamma = 0$, and the labor $n = n^*$ is efficient and solves $\alpha\, \mathbb{E}\, z n^{\alpha-1} = \bar{w}$. When ζ is large enough, NND condition under $\underline{z}$ binds at n^*. In this case, labor has to fall to satisfy the NND condition. Now labor and multiplier (n, λ) solves

$$\underline{z}n^\alpha - \bar{w}n - \zeta = 0,$$
$$\alpha\, \mathbb{E}\, z n^{\alpha-1} = \frac{1+\gamma}{1+(\underline{z}/\mathbb{E}\, z)\gamma}\bar{w}.$$

Taking derivatives over ζ, we have

$$\frac{dn}{d\zeta} = \frac{1}{\underline{z}\alpha n^{\alpha-1} - \bar{w}} \leq 0.$$

The inequality holds because for any $n > \underline{n}$, the marginal return is smaller than the

marginal cost. Thus, labor falls with financial shock.

Proof of Proposition 3 With both financial frictions and labor market power, the firm solves

$$\max_n \mathbb{E}\left(zn^\alpha - w(n)n - \zeta\right), \text{ s.t. } \underline{z}n^\alpha - w(n)n - \zeta \geq 0.$$

The first order condition over labor is given by

$$\alpha\, \mathbb{E}\, z n^{\alpha-1} = \frac{1+\gamma}{1+(\underline{z}/\mathbb{E}\, z)\gamma}\frac{1+\eta}{\eta} n^{\frac{1}{\eta}} \bar{w}.$$

We now prove that labor market power mitigates the adverse impact of financial shock on labor. To make this case comparable with that with only financial frictions, assuming that when the NND condition is not binding, the optimal labor is the same as the complete market case $n = n^*$. When the NND condition binds, optimal labor satisfies

$$\underline{z}n^\alpha - w(n)n - \zeta = 0.$$

Let $\hat{x}$ denote the percentage deviation of variable x from some initial level x_0: $\hat{x} = (x - x_0)/x_0$. Let $\xi^* = \bar{z}(n^*)^\alpha - w(n^*)n^*$. When $\zeta > \zeta^*$, firms have to reduce labor. Using the binding NND condition,

$$\zeta = \underline{z}n^\alpha - w(n)n.$$

We can derive the response of labor to financial shocks:

$$\hat{n}^L = -\frac{\zeta^*}{\frac{\eta+1}{\eta}w(n^*)n^* - \alpha\hat{z}(n^*)^\alpha}\hat{\zeta} \leq 0.$$

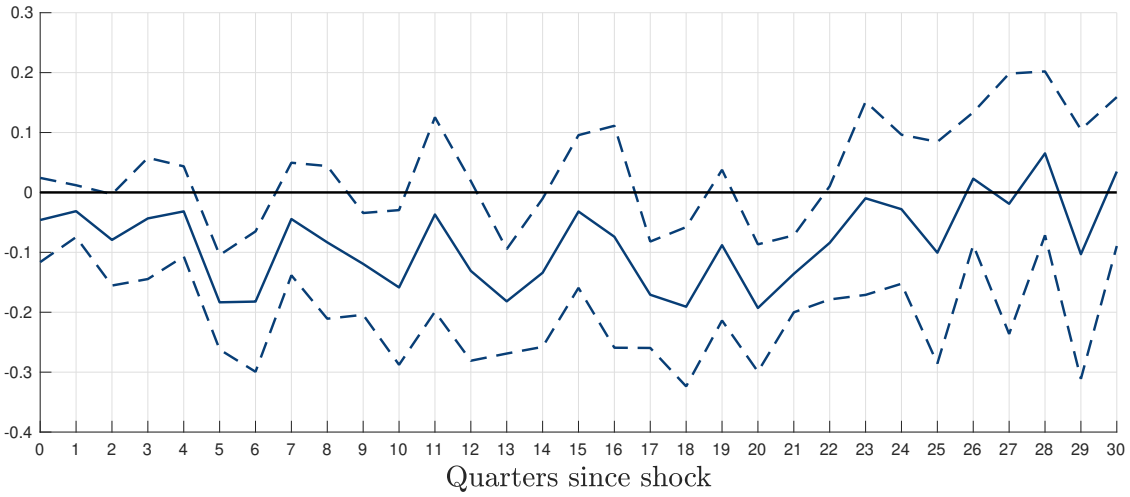
For comparison, in the case without labor market power:

$$\hat{n}^{noL} = -\frac{\zeta^*}{\bar{w}n^* - \alpha\hat{z}(n^*)^\alpha}\hat{\zeta} \leq 0.$$

When the labor supply curve is upward sloping, the markdown factor $(\eta+1)/\eta$ appears in the denominator, which mitigates the response of labor to a financial shock. As a result, $\hat{n}^L < \hat{n}^{noL}$.

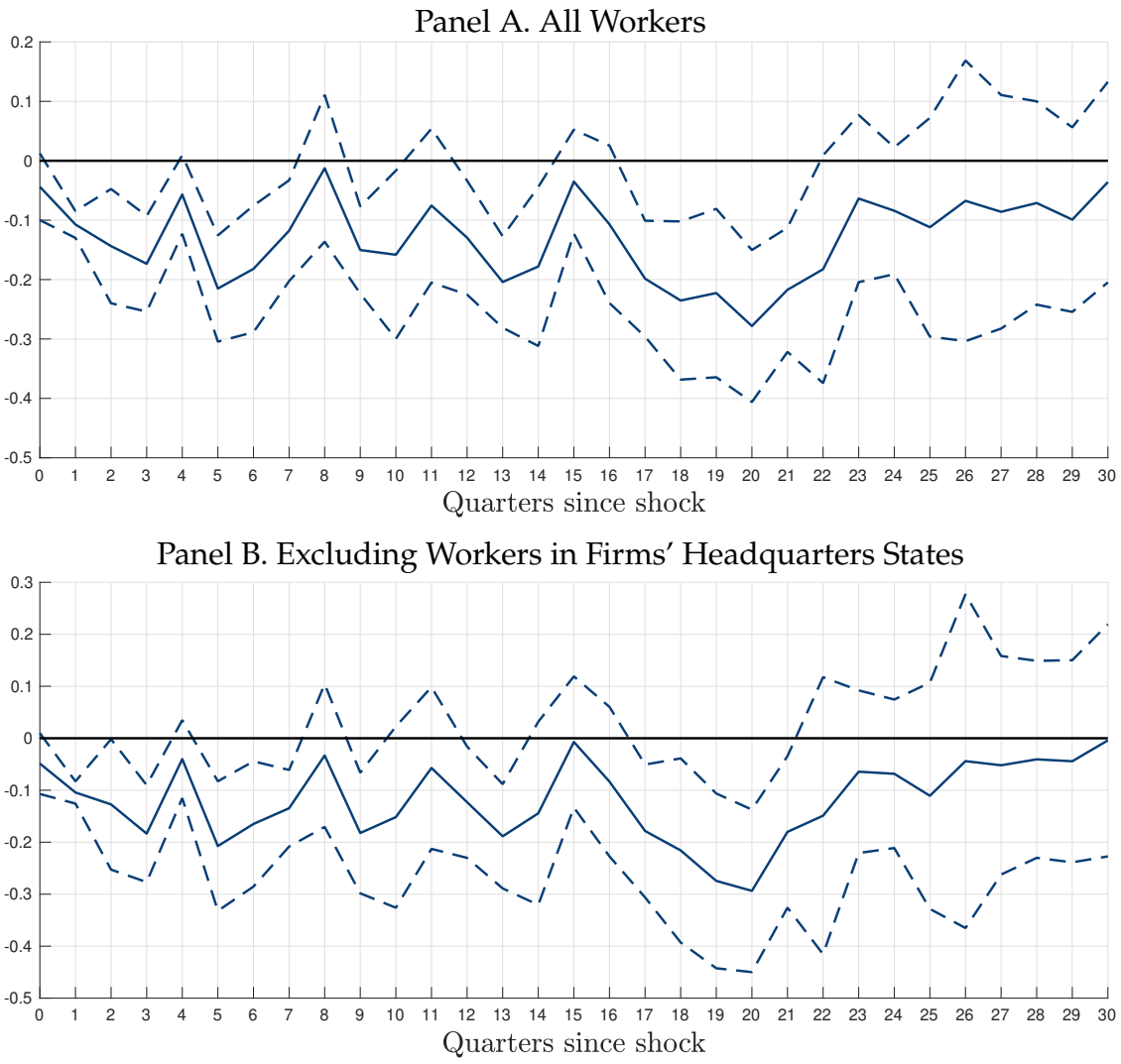
B Empirical Robustness

Figure B.1: Heterogeneous Responses of Worker Earnings to Aggregate Disinflation



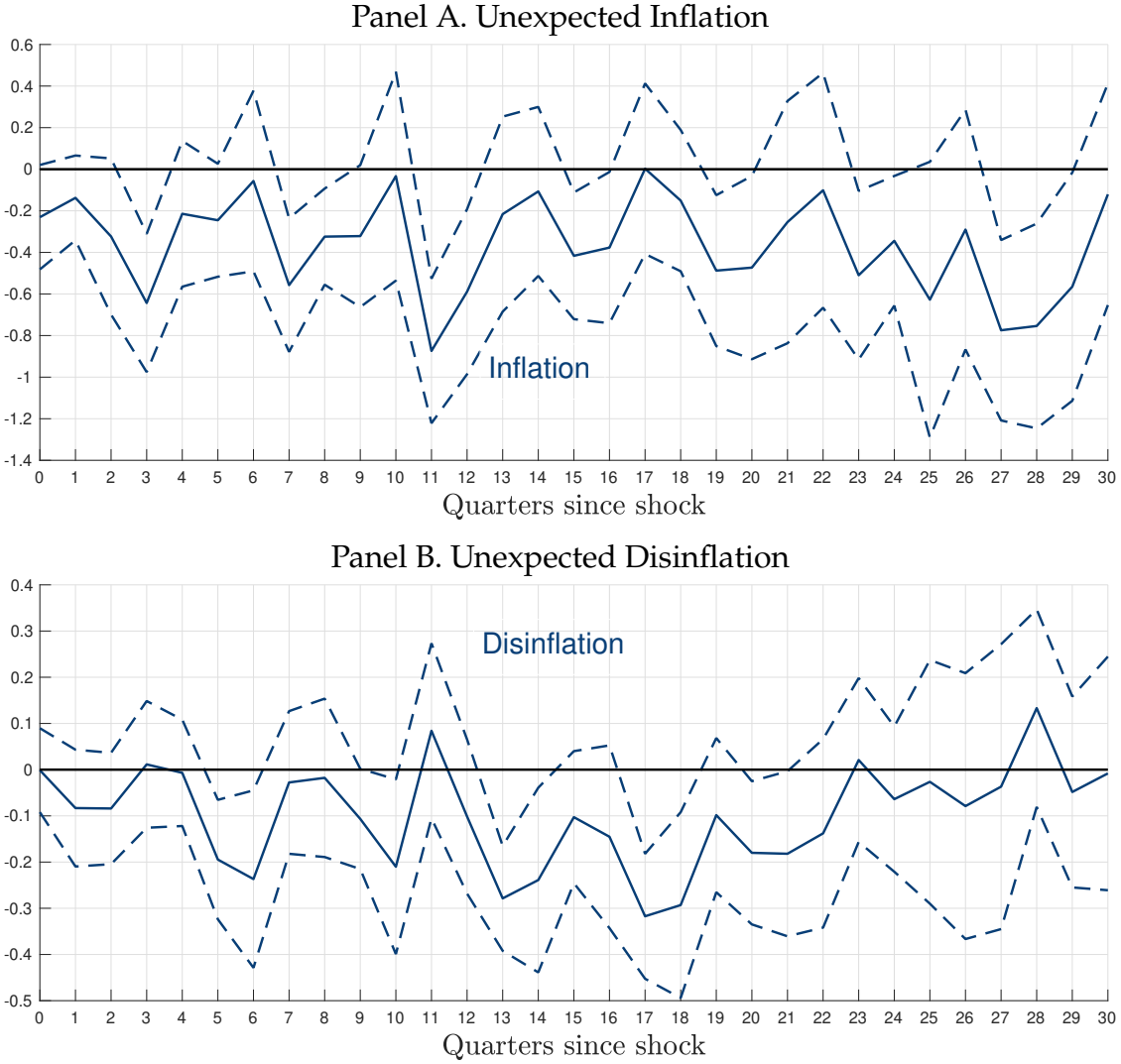
Note: The figure plots the estimated coefficients (β_h) with their corresponding 90% confidence intervals from equation (8), using nationwide CPI-based unexpected disinflation. It illustrates the heterogeneous responses of workers' earnings growth to aggregate disinflation shocks, conditional on firm leverage.

Figure B.2: Heterogeneous Responses of Worker Earnings Growth to Firm-Headquarters State Disinflation



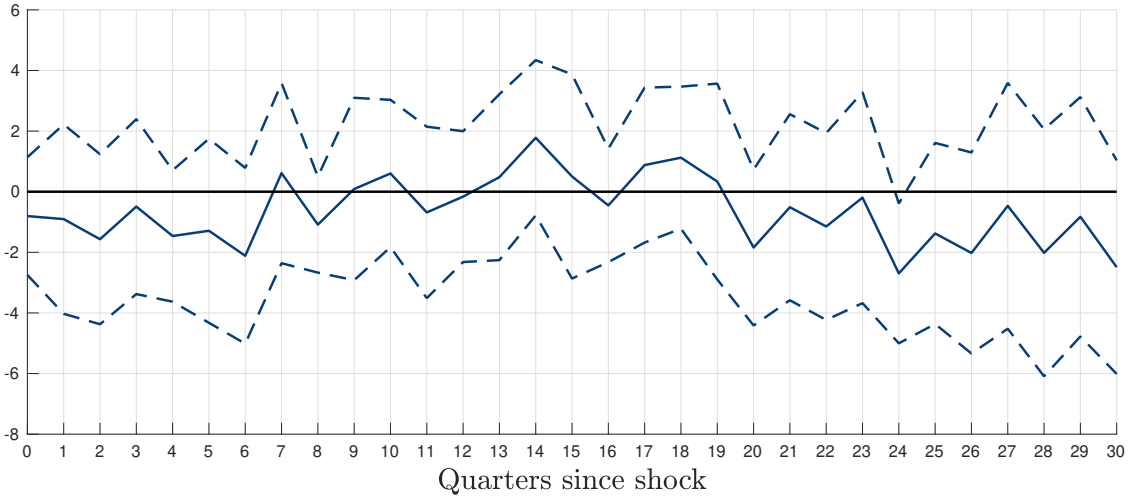
Note: The figure plots the estimated coefficients (β_h) with their corresponding 90% confidence intervals from equation (8), showing the heterogeneous responses of workers' earnings growth to unexpected state-level disinflation shocks in firms' headquarters states, conditional on firm leverage. Panel A includes all employees, while Panel B excludes workers located in their firms' headquarters states.

Figure B.3: Heterogeneous Responses of Worker Earnings to Inflation and Disinflation



Note: The figure plots the estimated coefficients with their corresponding 90% confidence intervals from equation (8), allowing asymmetric responses to unexpected inflation and disinflation shocks: $lev_{jt-5} \cdot (-\epsilon^{\pi}_{jt-1}) \cdot (\beta^1_h \mathbb{1}\{\epsilon^{\pi}_{jt-1} \geq 0\} + \beta^2_h \mathbb{1}\{\epsilon^{\pi}_{jt-1} < 0\})$. Panel A shows the heterogeneous responses of workers' earnings growth to unexpected firm-level inflation shocks (β^1_h), and Panel B shows the resposnes to disinflation shocks (β^2_h), conditional on firm leverage.

Figure B.4: Heterogeneous Responses of Worker Earnings to Monetary Policy Shocks



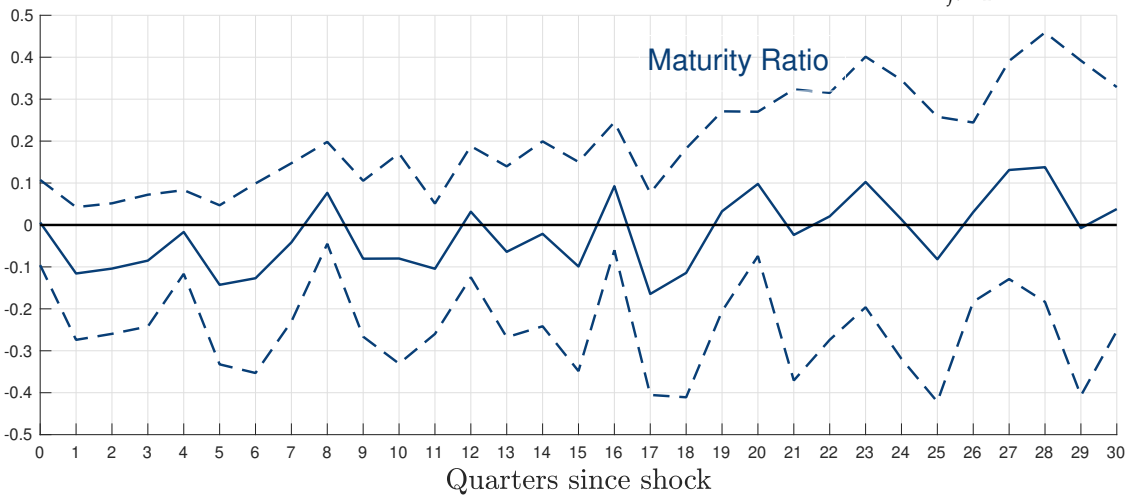
Note: The figure plots the estimated coefficients and 90% confidence intervals of the interaction between lagged leverage and lagged monetary policy shocks from equation (8), showing the heterogeneous responses of workers' earnings growth to monetary policy shocks, conditional on firm leverage.

Figure B.5: Heterogeneous Responses of Worker Earnings to Unexpected Disinflation Conditional on Debt Maturity

Panel A. Estimated Coefficients of $(lev_{jt-5} - \mathbb{E}_j[lev_{jt}])(-\epsilon^{\pi}_{jt-1})$

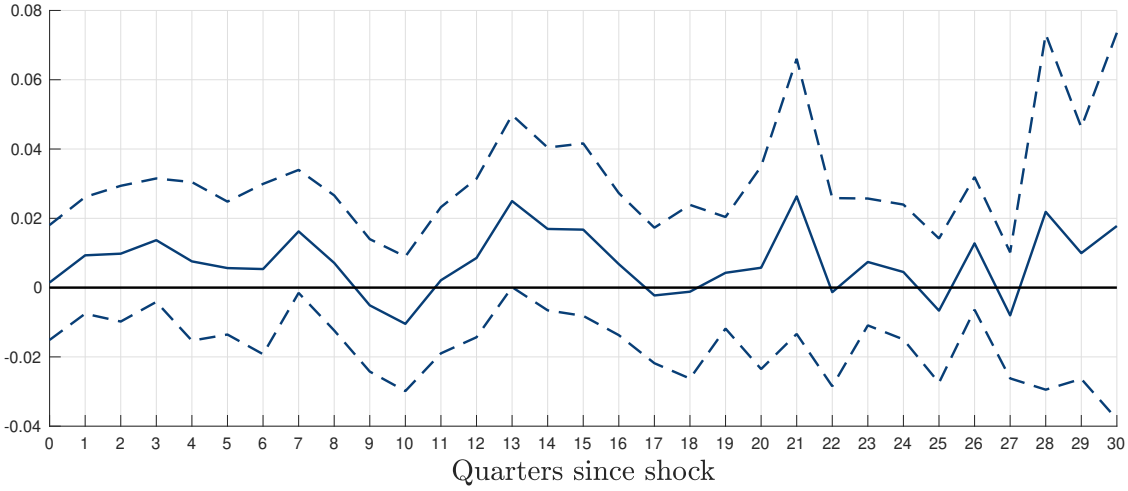


Panel B. Estimated Coefficients of $(mty_{jt-5} - \mathbb{E}_j[mty_{jt}])(-\epsilon^{\pi}_{jt-1})$



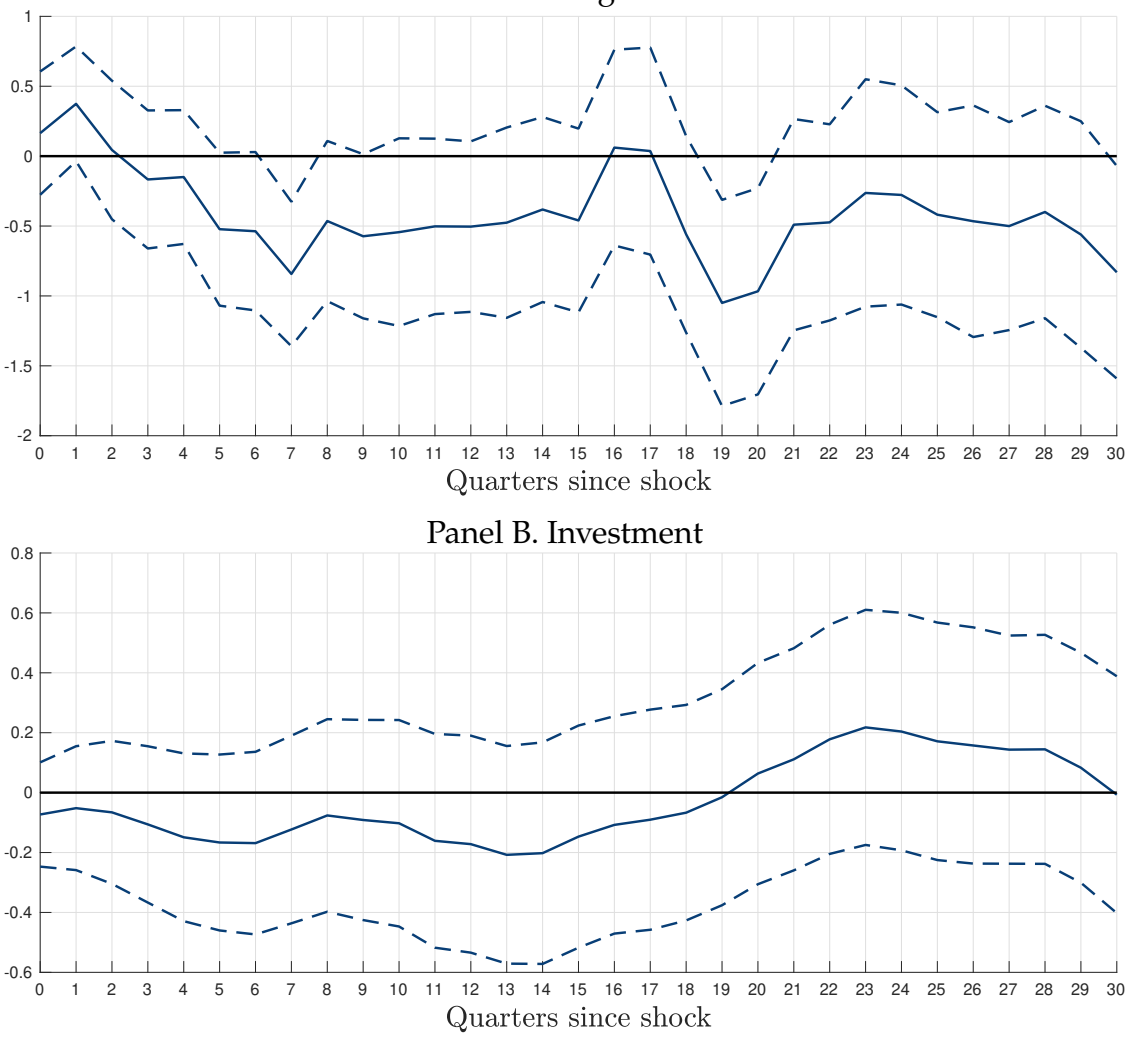
Note: The blue lines plot the estimated coefficients (β_h) and their corresponding 90% confidence intervals from equation (8), illustrating the heterogeneous responses of workers' earnings growth to unexpected firm-level disinflation shocks, conditional on firm leverage and debt maturity. Panel A reports the estimated coefficients for the interaction between lagged, demeaned leverage and unexpected disinflation shocks. Panel B reports the estimated coefficients for the interaction between the lagged, demeaned maturity ratio and unexpected disinflation shocks. The maturity ratio, mty, is defined as long-term debt ($dlttq$) divided by total debt ($dlcq + dlttq$).

Figure B.6: Heterogeneous Responses of Worker Layoffs



Note: The figure plots the estimated coefficients (β_h) with their corresponding 90% confidence intervals from equation (8), replacing the dependent variable with the layoff indicator $\mathbb{1}^{\text{lay}}_{ijt+h}$. It shows the heterogeneous responses of workers' layoff probability to unexpected firm-level disinflation shocks, conditional on firm leverage.

Figure B.7: Heterogeneous Responses of Firms to Unexpected Disinflation



Note: The figure plots the estimated coefficients (β_h) with their corresponding 90% confidence intervals from equation (9), using hiring growth as the dependent variable in Panel A and capital growth in Panel B. Panel A shows the heterogeneous responses of firms' hiring growth to unexpected firm-level disinflation shocks, conditional on firm leverage. Panel B shows the heterogeneous responses of firms' investment.

C Computation Algorithm

C.1 Financial Friction + Labor Market Power + Inflation

Firm's problem (treat π' as parameter):

$$V(S,z,x) = \max_{l',b'} x + q(S,z,l',b')b' + \beta \sum_{z'} \pi(z'|z) \Big[\int^{\kappa'^*(S',z',l',b')} V(S',z',x')\phi(\kappa')d\kappa' \Big] \quad (16)$$

$$\text{s.t. } x + q(S,z,l',b')b' \geq 0 \quad (17)$$

$$x' = z' l'^{\alpha} - \frac{w'(l')}{\pi'} l' - \frac{b'}{\pi'} - \kappa' \quad (18)$$

$$w'(l') = l'^{\frac{1}{\eta}} \bar{w}' \quad (19)$$

$$\kappa'^*(S',z',l',b') = z' l'^{\alpha} - \frac{w'(l')}{\pi'} l' - \frac{b'}{\pi'} + M(S',z') \quad (20)$$

$$q(S,z,l',b') = \frac{1}{1+r} \sum_{z'} \pi(z'|z) \Phi(\kappa'^*) \frac{1}{\pi'} \quad (21)$$

First-order conditions:

Let $\gamma(S,z,x)$ and $\eta(S,z,x)$ denote the multipliers on the non-negative equity payout constraint and the borrowing constraint. Define $G(S,z,l',b') = \sum_{z'} \pi(z'|z) \int^{\kappa'^*} V(S',z',x')\phi(\kappa')d\kappa'$. Then the first-order conditions are:

$$[1 + \gamma(S,z,x) + \eta(S,z,x)] \frac{\partial [q(S,z,l',b')b']}{\partial l'} + \beta \frac{\partial G(S,z,l',b')}{\partial l'} = 0, \quad (22)$$

$$[1 + \gamma(S,z,x) + \eta(S,z,x)] \frac{\partial [q(S,z,l',b')b']}{\partial b'} + \beta \frac{\partial G(S,z,l',b')}{\partial b'} = 0, \quad (23)$$

where

$$\frac{\partial [q(S,z,l',b')b']}{\partial l'} = \frac{1}{1+r} b' \sum_{z'} \pi(z'|z) \Big[\phi(k'^*(S',z',l',b'))(\alpha z' l'^{\alpha-1} - \frac{\eta+1}{\eta} \frac{w'(l')}{\pi'}) \Big] \frac{1}{\pi'} \quad (24)$$

$$\frac{\partial[q(S,z,l',b')b']}{\partial b'} = q(S,z,l',b') - \frac{1}{1+r}b' \sum_{z'} \pi(z'|z)\Big[\phi(k'^*(S',z',l',b'))\Big]\frac{1}{\pi'^2} \tag{25}$$

$$\frac{\partial G(S,z,l',b')}{\partial l'} = \sum_{z'} \pi(z'|z)(\alpha z' l'^{\alpha-1} - \frac{\eta+1}{\eta}\frac{w'(l')}{\pi'})\Big[\int^{\kappa'^*} (1+\gamma'(S',z',x'))\phi(\kappa')d\kappa' + V(S',z',x'^*(\kappa'^*))\phi(k'^*)$$

(26)

$$\frac{\partial G(S,z,l',b')}{\partial b'} = -\frac{1}{\pi'}\sum_{z'} \pi(z'|z)\Big[\int^{\kappa'^*} (1+\gamma'(S',z',x'))\phi(\kappa')d\kappa' + V(S',z',x'^*(\kappa'^*))\phi(k'^*)\Big] \tag{27}$$

Algorithm:

1. Setup grids for z using Tauchen method.
2. Set up the grids for l' and b'.
3. Iterate to find the borrowing limit and bond price schedule.
   (a) Make an initial guess of the maximum borrowing $M^{\{0\}}(S,z)$.
   (b) Update new bond price
   $$q^{\{n\}}(S,z,l',b') = \frac{1}{1+r}\sum_{z'} \pi_z(z'|z)\Phi(\kappa'^*)\frac{1}{\pi'}, \tag{28}$$
   where $\kappa'^* = z'l'^{\alpha} - \frac{w'(l')}{\pi'}l' - \frac{b'}{\pi'} + M^{\{n\}}(S',z')$.
   (c) Update the maximum borrowing
   $$M^{\{n+1\}}(S,z) = \max_{l',b'} q^{\{n\}}(S,z,l',b')b'$$
   (d) Continue (b)-(d) until the maximum borrowing and the bond price converge.
4. Guess the grids for cash on hand, the multiplier on the non-negative equity payout constraint $\gamma^{\{0\}}(S,z,x)$, and the value function $V^{\{0\}}(S,z,x)$.
5. Solve the relaxed problem without the two inequality constraints:
   $$\hat{V}(S,z) = \max_{l',b'} q(S,z,l',b')b' + \beta G^{\{n\}}(S,z,l',b').$$

We solve the following first-order conditions to find the optimal policies to the relaxed problem $\{\hat{l}'(S,z), \hat{b}'(S,z)\}$:

$$\frac{\partial[q(S,z,l',b')b']}{\partial l'} + \beta \frac{\partial G^{\{n\}}(S,z,l',b')}{\partial l'} = 0. \tag{29}$$

$$\frac{\partial[q(S,z,l',b')b']}{\partial b'} + \beta \frac{\partial G^{\{n\}}(S,z,l',b')}{\partial b'} = 0. \tag{30}$$

6. If $\hat{b}'(S,z)$ does not satisfy the borrowing constraint, replace the solutions with $\hat{b}'(S,z) = 0$ and solve $\hat{l}'(S,z)$ using the following condition:

$$\frac{\partial[q(S,z,l',b')b']}{\partial l'} \frac{\partial G^{\{n\}}(S,z,l',b')}{\partial b'} - \frac{\partial[q(S,z,l',b')b']}{\partial b'} \frac{\partial G^{\{n\}}(S,z,l',b')}{\partial l'} = 0, \tag{31}$$

where $b' = 0$.

7. Update cash-on-hand grids $x \in [x_{min}^{\{n+1\}}(S,z), x_{max}^{\{n+1\}}(S,z)]$:

$$x_{min}^{\{n+1\}}(S,z) = -M(S,z),$$

$$x_{max}^{\{n+1\}}(S,z) = \hat{x}(z) \equiv -q(S,z,\hat{l}'(S,z),\hat{b}'(S,z))\hat{b}'(S,z).$$

When $x \leq \hat{x}(z)$, the non-negative equity payout condition binds, and the borrowing constraint automatically holds. For any $x \geq \hat{x}(z)$, the optimal policies are $\hat{l}'(S,z)$ and $\hat{b}'(S,z)$, independent of x.

8. Solve the constrained problem for $x \in [x_{min}^{\{n+1\}}(S,z), x_{max}^{\{n+1\}}(S,z)]$:

$$x + q(S,z,l',b')b' = 0,$$

$$\frac{\partial[q(S,z,l',b')b']}{\partial l'} \frac{\partial G^{\{n\}}(S,z,l',b')}{\partial b'} - \frac{\partial[q(S,z,l',b')b']}{\partial b'} \frac{\partial G^{\{n\}}(S,z,l',b')}{\partial l'} = 0,$$

9. We use the optimal polices are $l'(S,z,x)$ and $b'(S,z,x)$ to update the multiplier:

$$\gamma^{\{n+1\}} = -\beta \frac{\frac{\partial G^{\{n\}}(S,z,l',b')}{\partial b'}}{\frac{\partial[q(S,z,l',b')b']}{\partial b'}} - 1. \tag{32}$$

Also update the value function:

$$V^{\{n+1\}}(S,z,x) = x + q(S,z,l'b')b' + \beta \sum_{z'} \pi(z'|z) \int^{\kappa'^*(S',z',l',b')} V^{\{n\}}(S',z',x')\phi(\kappa')d\kappa' \tag{33}$$

10. Iterate 5-9 until γ and V converge.

Households problem

Assume households have GHH preference and can borrow internationally with international risk-free rate r.

$$u(C,N) = \frac{\left(C - \chi \frac{N^{1+1/\nu}}{1+1/\nu}\right)^{1-\sigma}}{1-\sigma}$$

subject to

$$C_t + b^H_{t+1} = \int w_{jt}\ell_{jt}dj + (1+r)b^H_t$$

$$N_t = \left[\int_0^1 \ell_{jt}^{\frac{\eta+1}{\eta}} dj\right]^{\frac{\eta}{\eta+1}}$$

FOC

$$w_{jt} = \chi N_t^{\frac{1}{\nu}} N_t^{1/\eta} \ell_{it}^{-1/\eta}$$

Thus $w(\ell) = \ell^{-\frac{1}{\eta}}[\chi N^{\frac{1}{\nu}+\frac{1}{\eta}}] = \ell^{-\frac{1}{\eta}}\bar{W}$. We can then calibrate χ such that $\chi = \bar{W}N^{-\frac{1}{\nu}+\frac{1}{\eta}}$.

C.2 Only Financial Friction + Inflation

Firm's problem (treat π' as parameter):

$$V(S,z,x) = \max_{l',b'} x + q(S,z,l',b')b' + \beta \sum_{z'} \pi(z'|z)\Big[\int^{\kappa'^*(S',z',l',b')} V(S',z',x')\phi(\kappa')d\kappa'\Big] \tag{34}$$

$$\text{s.t. } x + q(S,z,l',b')b' \geq 0 \tag{35}$$

$$x' = z'l'^{\alpha} - \frac{w'}{\pi'}l' - \frac{b'}{\pi'} - \kappa' \tag{36}$$

$$\kappa'^*(S',z',l',b') = z'l'^{\alpha} - \frac{w'}{\pi'}l' - \frac{b'}{\pi'} + M(S',z') \tag{37}$$

$$q(S,z,l',b') = \frac{1}{1+r}\sum_{z'}\pi(z'|z)\Phi(\kappa'^{*})\frac{1}{\pi'} \tag{38}$$

First-order conditions:

Let $\gamma(S,z,x)$ and $\eta(S,z,x)$ denote the multipliers on the non-negative equity payout constraint and the borrowing constraint. Define $G(S,z,l',b') = \sum_{z'}\pi(z'|z)\int^{\kappa'^{*}} V(S',z',x')\phi(\kappa')d\kappa'$. Then the first-order conditions are:

$$[1+\gamma(S,z,x)+\eta(S,z,x)]\frac{\partial[q(S,z,l',b')b']}{\partial l'} + \beta\frac{\partial G(S,z,l',b')}{\partial l'} = 0, \tag{39}$$

$$[1+\gamma(S,z,x)+\eta(S,z,x)]\frac{\partial[q(S,z,l',b')b']}{\partial b'} + \beta\frac{\partial G(S,z,l',b')}{\partial b'} = 0, \tag{40}$$

where

$$\frac{\partial[q(S,z,l',b')b']}{\partial l'} = \frac{1}{1+r}b'\sum_{z'}\pi(z'|z)\Big[\phi(k'^{*}(S',z',l',b'))(\alpha z' l'^{\alpha-1} - \frac{w'}{\pi'})\Big]\frac{1}{\pi'} \tag{41}$$

$$\frac{\partial[q(S,z,l',b')b']}{\partial b'} = q(S,z,l',b') - \frac{1}{1+r}b'\sum_{z'}\pi(z'|z)\Big[\phi(k'^{*}(S',z',l',b'))\Big]\frac{1}{\pi'^{2}} \tag{42}$$

$$\frac{\partial G(S,z,l',b')}{\partial l'} = \sum_{z'}\pi(z'|z)(\alpha z' l'^{\alpha-1} - \frac{w'}{\pi'})\Big[\int^{\kappa'^{*}}(1+\gamma'(S',z',x'))\phi(\kappa')d\kappa' + V(S',z',x'^{*}(\kappa'^{*}))\phi(k'^{*})\Big] \tag{43}$$

$$\frac{\partial G(S,z,l',b')}{\partial b'} = -\frac{1}{\pi'}\sum_{z'}\pi(z'|z)\Big[\int^{\kappa'^{*}}(1+\gamma'(S',z',x'))\phi(\kappa')d\kappa' + V(S',z',x'^{*}(\kappa'^{*}))\phi(k'^{*})\Big] \tag{44}$$

Algorithm:

1. Setup grids for z using Tauchen method.
2. Set up the grids for l' and b'.
3. Iterate to find the borrowing limit and bond price schedule.
   (a) Make an initial guess of the maximum borrowing $M^{\{0\}}(S,z)$.

(b) Update new bond price

$$q^{\{n\}}(S,z,l',b') = \frac{1}{1+r}\sum_{z'}\pi_z(z'|z)\Phi(\kappa'^*)\frac{1}{\pi'}, \tag{45}$$

where $\kappa'^* = z'l'^{\alpha} - \frac{w'}{\pi'}l' - \frac{b'}{\pi'} + M^{\{n\}}(S',z')$.

(c) Update the maximum borrowing

$$M^{\{n+1\}}(S,z) = \max_{l',b'} q^{\{n\}}(S,z,l',b')b'$$

(d) Continue (b)-(d) until the maximum borrowing and the bond price converge.

4. Guess the grids for cash on hand, the multiplier on the non-negative equity payout constraint $\gamma^{\{0\}}(S,z,x)$, and the value function $V^{\{0\}}(S,z,x)$.

5. Solve the relaxed problem without the two inequality constraints:

$$\hat{V}(S,z) = \max_{l',b'} q(S,z,l',b')b' + \beta G^{\{n\}}(S,z,l',b').$$

We solve the following first-order conditions to find the optimal policies to the relaxed problem $\{\hat{l}'(S,z), \hat{b}'(S,z)\}$:

$$\frac{\partial[q(S,z,l',b')b']}{\partial l'} + \beta\frac{\partial G^{\{n\}}(S,z,l',b')}{\partial l'} = 0. \tag{46}$$

$$\frac{\partial[q(S,z,l',b')b']}{\partial b'} + \beta\frac{\partial G^{\{n\}}(S,z,l',b')}{\partial b'} = 0. \tag{47}$$

6. If $\hat{b}'(S,z)$ does not satisfy the borrowing constraint, replace the solutions with $\hat{b}'(S,z) = 0$ and solve $\hat{l}'(S,z)$ using the following condition:

$$\frac{\partial[q(S,z,l',b')b']}{\partial l'}\frac{\partial G^{\{n\}}(S,z,l',b')}{\partial b'} - \frac{\partial[q(S,z,l',b')b']}{\partial b'}\frac{\partial G^{\{n\}}(S,z,l',b')}{\partial l'} = 0, \tag{48}$$

where $b' = 0$.

7. Update cash-on-hand grids $x \in [x_{min}^{\{n+1\}}(S,z), x_{max}^{\{n+1\}}(S,z)]$:

$$x_{min}^{\{n+1\}}(S,z) = -M(S,z),$$

$$x_{max}^{\{n+1\}}(S,z) = \hat{x}(z) \equiv -q(S,z,\hat{l}'(S,z),\hat{b}'(S,z))\hat{b}'(S,z).$$

When $x \leq \hat{x}(z)$, the non-negative equity payout condition binds, and the borrowing constraint automatically holds. For any $x \geq \hat{x}(z)$, the optimal policies are $\hat{l}'(S,z)$ and $\hat{b}'(S,z)$, independent of x.

8. Solve the constrained problem for $x \in [x_{min}^{\{n+1\}}(S,z), x_{max}^{\{n+1\}}(S,z)]$:

$$x + q(S,z,l',b')b' = 0,$$

$$\frac{\partial[q(S,z,l',b')b']}{\partial l'}\frac{\partial G^{\{n\}}(S,z,l',b')}{\partial b'} - \frac{\partial[q(S,z,l',b')b']}{\partial b'}\frac{\partial G^{\{n\}}(S,z,l',b')}{\partial l'} = 0,$$

9. We use the optimal polices are $l'(S,z,x)$ and $b'(S,z,x)$ to update the multiplier:

$$\gamma^{\{n+1\}} = -\beta \frac{\frac{\partial G^{\{n\}}(S,z,l',b')}{\partial b'}}{\frac{\partial[q(S,z,l',b')b']}{\partial b'}} - 1. \tag{49}$$

Also update the value function:

$$V^{\{n+1\}}(S,z,x) = x + q(S,z,l'b')b' + \beta \sum_{z'} \pi(z'|z) \int^{\kappa'^*(S',z',l',b')} V^{\{n\}}(S',z',x')\phi(\kappa')d\kappa' \tag{50}$$

10. Iterate 5-9 until γ and V converge.

Outside, we update w until it converges $w = \chi N^{1/\nu}$ using Broyden method.