The Financial Channel of Wage Rigidity

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Abstract
Why do firms cut hiring so sharply in recessions? I propose that wage rigidity among incumbent workers forces firms to reduce hiring by squeezing their internal funds. Incumbents' wage rigidity is an irrelevant fixed cost in standard macroeconomic models, which instead rely on wage rigidity among new hires. But much empirical evidence indicates that the wages of new hires, unlike those of incumbents, display little rigidity. I integrate financial constraints and incumbents' wage rigidity – but flexible wages among new hires – into the Diamond-Mortensen-Pissarides matching model. The interaction between these two frictions helps the calibrated model account for more than half of hiring fluctuations in the U.S. data. My empirical analyses support the financial channel of wage rigidity. I present new firm-level evidence that employment responds to cash flow shocks, and that internal funds help firms stabilize employment during recessions. Moreover, I calculate that a slight increase in incumbents' wage procyclicality could smooth aggregate profits and internal funds.

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1 Introduction

In a typical recession, firms cut job openings by almost half from peak. 70 percent of the increase in unemployment is accounted for by this drop in hiring. Standard macroeconomic models rely on wage rigidity among new hires to rationalize why hiring responds so sharply to aggregate shocks. By contrast, those models imply that wage rigidity of incumbent workers is a fixed cost irrelevant for hiring. However, much empirical evidence indicates that new hires’ wages display little rigidity. Most evidence for wage rigidity comes from incumbent workers.

I revisit the role of wage rigidity in recessions with a focus on the financial frictions firms face when investing and hiring. I propose, formalize and quantify a financial channel through which incumbents’ wage rigidity deepens recessions by squeezing firms’ internal funds. I find that this financial channel of wage rigidity can account for more than half of the observed cyclical fluctuations of hiring in the U.S. data.

I first empirically establish the dominant role of wage rigidity in amplifying the empirical fluctuations in firms’ financial conditions. Combining micro-estimates of wage cyclicalities and national accounts, I calculate that a slight increase in wage procyclicality could render aggregate cash flow and profit perfectly smooth with respect to the business cycle. Specifically, incumbents’ real wages would only need to fall by an additional 1.5 percent per percentage point increase in unemployment, from a baseline of 1.25 percent. This counterfactual wage cyclicality would still remain below the measured cyclicality of new hires’ wages. No other drain on aggregate cash flow could realistically stabilize internal funds in recessions. Accordingly, I find at the finely disaggregated industry level that larger labor shares, through which the cash flow effect of rigid wages should loom larger, indeed leads to larger fluctuations in cash flow over the business cycle and in response to industry shocks.

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1 The hiring measure is vacancy postings. See Hall (2005a), Shimer (2012) for the role of fluctuations in hiring, vacancy postings and the job finding rate in aggregate employment fluctuations, and Davis et al. (2006) and Davis et al. (2013) for hiring margin in establishment-level net employment.

2 While at least implicit in all macroeconomic models of wage rigidity, the paradigm is particularly explicit in the search and matching literature (e.g. Shimer (2004), Hall (2005b), Mortensen and Nagypal (2007), Hall and Milgrom (2008), Elsby (2009), Pissarides (2009), Shimer (2010), Michaillat (2012), Christiano et al. (2013)). The paradigm also guides empirical work: Pissarides (2009), Kudlyak (2014), Haefke et al. (2013) Carneiro et al. (2012), Martins et al. (2012) find new hires’ real wages to be substantially more procyclical than incumbents’ wages. Nominal wage rigidity is measured off incumbents (e.g. Card and Hyslop (1997)). Qualitative studies tend to investigate incumbents (Bewley (1999), Galusak et al. (2012)). Most theories rationalize wage rigidity among incumbents. Work tying new hires’ to incumbents’ wage rigidity (Lindbeck and Snower (1989), Gertler and Trigari (2009), Snell and Thomas (2010)) relies on marginal channels. Wage rigidity on both margins would just add the standard marginal channel to the financial one but not attenuate it.

3 Pissarides (2009) conducts a meta-analysis of micro-estimates of wage cyclicalities, and finds that new hires’ (incumbents’) wages move by 3% (1.25%) per unemployment percentage point.

4 For example, dividends and interest (5-10 percent the size of payroll) would need to turn strongly negative.
Similarly, corporate bond rating downgrades and bankruptcies cluster in high labor share industries during recessions.

Would the smoother cash flow from less rigid wages entail cyclical stabilization of employment? I approximate this counterfactual with cross-sectional variation in firms’ excess internal funds before recessions. I find that such liquidity buffers help firms weather recessions with smoother investment and employment. During the financial crisis of 2008/09 for example, firms with above-median liquidity buffers cut employment by only 2 percent vs. 5 percent for the bottom half. In the narrative of this paper, the cash flow provided by small wage adjustments may have enabled the low-liquidity firms to similarly stabilize factor demand. I confirm and quantify the financial mechanism by causally identifying the employment effects of cash flow shocks in a series of micro-empirical strategies. I estimate that a $1 shock to a firm’s cash flow not only affects capital investment but also increases employment, by $0.2–0.6 in payroll terms. At the fine industry level, I confirm that smaller labor shares are associated with smaller fluctuations not only in cash flow but also in investment and employment, as predicted by the financial channel of wage rigidity.

To formally gauge equilibrium effects of the channel and to conduct counterfactuals, I integrate incumbent workers’ wage rigidity and financial constraints into the Diamond-Mortensen-Pissarides (DMP) search and matching model, around which much of the debate on hiring fluctuations and the role of wage rigidity is occurring. Its long-term employment relationships allow me to isolate the financial channel (which works through incumbents’ wages) from standard amplification (through new hires). New hires’ wages are flexible and very procyclical in my model, as I let the worker and the firm freely bargain over the entry wage. But inframarginal wage rigidity (IMWR) constrains the subsequent evolution of the wage in a given match. As a result, incumbents’ wages only partially respond to market conditions. While the paper does not provide new micro-foundations for why the incumbent worker and the firm maintain such wage policies, a variety of theoretical underpinnings would predict the patterns. Financial constraints arise from a borrowing constraint that uncommitted cash flow (net of dividends and interest) partially alleviates. I parameterize

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5Those shocks aim to leave firms’ marginal investment opportunities unchanged, isolating liquidity effects. My employment-cash flow sensitivity mirrors the traditional investment-cash flow sensitivity. In dollar terms, the sensitivity is in the employment range, but in percentage terms around twice as high. Fazzari et al. (1988) started the investment-cash flow sensitivity literature. Sharpe (1994), Benmelech et al. (2012), Bakke and Whited (2012), Greenstone and Mas (2012), Chodorow-Reich (2014) explore employment effects of a variety of financial factors but not the dollar-for-dollar sensitivity to cash flow. Mechanisms other than financial constraints might be agency problems associated with free cash flow and asymmetric information. The financial channel of wage rigidity is robust to any link between inputs and cash flow.

6Wage rigidity is typically directly assumed (Hall (2005b), Shimer (2010), Michaillat (2012), Gertler and Trigari (2009), Christiano et al. (2013), Eliaz and Spiegler (2013)).
the financial frictions in relation to my empirical estimates of the employment-cash flow sensitivity.

I confirm the canonical neutrality of inframarginal wage rigidity (IMWR) in my baseline model, in which financial constraints are slack. Only new hires’ wage rigidity can amplify hiring fluctuations. Incumbents’ wages are an irrelevant fixed cost. Thanks to the perfect financial markets implicit in the model, firms freely take out loans when they hire even in recessions, without an allocative role for internal funds that incumbents’ wages squeeze. This benchmark model echoes the standard DMP notion of the firm as a single job rather than a nexus of employees, capital, and finance.

By contrast, once the firm’s borrowing constraint binds, scarce external finance and internal funds constrain hiring. Hiring depends not only on how profitable new matches are, but also on the cash flow generated by incumbents. Financial constraints break the neutrality of IMWR. I also calibrate the model to quantify the amplification from IMWR under financial constraints. The interaction of IMWR and financial constraints lets the model explain more than half of the puzzling hiring fluctuations in the U.S. data. Without IMWR, firms’ financial conditions do not fluctuate appreciably because both marginal and inframarginal wages absorb the aggregate shocks, leaving financial amplification quantitatively irrelevant. Hiring might thus be much smoother in a counterfactual economy with a realistic increase in the procyclicality of incumbents’ wages.

The financial channel of wage rigidity in labor demand fluctuations appears unexplored in the literature. DMP models with financial shocks (e.g. Petrosky-Nadeau (2009), Petrosky-Nadeau and Wasmer (2013)) examine shocks to external finance without a consideration of internal funds or wage rigidity; Hall (2014) and Kehoe et al. (2014) investigate the effects of discount rate cyclicality on DMP hiring. Asset pricing research explores the stock market implications of wage rigidity but not the internal-funds effects on inputs that would emerge under financial constraints. Corporate finance work investigates leverage as a strategic bargaining device in wage setting. Parallel work by Bils et al. (2014) proposes an alternative...
approach to model distortions in hiring from incumbents’ wage rigidity. In their non-financial mechanism, sticky wages prop up effort in recessions through an efficiency wage mechanism and, under decreasing returns, reduce hiring.

More broadly, this paper contributes to the literature on financial factors in business cycles. Many models of financial amplification from firms’ financial positions inherently require profits to fall in recessions, e.g. for net worth to aggravate agency problems or for asset prices to reduce entrepreneurs’ collateral capacity. I point to wage rigidity’s crucial role in rendering profits and cash flow so procyclical in the first place. Besides contributing to financial amplification, the smoother internal funds from slightly more procyclical wages would also help firms offset shocks to external finance as cyclical driving forces.

Section 2 develops a simple model illustrating the financial channel of wage rigidity. Section 3 presents empirical evidence that wage rigidity amplifies employment fluctuations through cash flow. Section 4 shows how financial constraints break the neutrality of IMWR in the Diamond-Mortensen-Pissarides model. Section 5 calibrates the extended DMP model and assesses its quantitative performance. Section 6 discusses additional implications of the financial channel of wage rigidity, and Section 7 concludes.

2 A Simple Model: Hiring and Wages under Financial Constraints

I convey the key mechanisms of the financial channel of wage rigidity in a simple model, and use it to guide the subsequent empirical investigations in Section 3. The simple model also serves as a building block for the full model in Section 4, to which its intuitions carry over.

The firm chooses employment tomorrow \( n_1 \), which equals hiring \( h_1 \) plus fraction \( s < 1 \) of today’s workforce \( n_0 \): \( n_1 = h_1 + sn_0 \). For simplicity, \( s = 0 \), such that \( n_1 = h_1 \). The firm’s objective function is to set hiring to maximize tomorrow’s cash flow (output \((zh_1, with productivity \( z \)) minus tomorrow’s wage bill \( w_1 h_1 \)), discounted by \( \beta \), minus today’s upfront recruitment expenditure \( c(h_1) \).

\[
\max_{n_1} \{ \beta(zn_1 - w_1n_1) - c(n_1) \} \tag{a}
\]

Recruitment expenditure \( c(n_1) \) is a convex function in the simple model; the full model will endogenize it in equilibrium. While I follow the DMP literature in loosely referring to it as recruitment expenditure, for the financial mechanism it could incorporate a variety of

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12 During the 2008/9 credit crunch for example, Campello et al. (2010) find that constrained firms used up internal funds during the crunch. The employment contractions due to the credit crunch (Greenstone and Mas (2012) and Chodorow-Reich (2014)) may have been weaker if constrained firms had been able to draw from cash stocks. I provide suggestive evidence in line with this interpretation in Section 3.
investment-like costs, e.g. associated capital expenditures or employer-sponsored training.

*Standard hiring* depends on new hires’ wages \( w_1 \) via cash flow tomorrow:

\[
c'(n^*_1) = \beta(z - w_1)
\]

That is, firms hire up until the present value of the cash flow from a new hire equals her upfront cost, or equivalently until her marginal product equals her total marginal (wage plus upfront) cost: \( z = w_1 + c'(n^*_1)/\beta \).

What is the role of wages and their rigidity in hiring fluctuations? Consider a shock to productivity \( z \). Without financial constraints, the cyclicity of hiring depends on how new hires’ wages \( w_1 \) absorb shocks to productivity \( z \):

\[
\frac{\partial \log(n^*_1)}{\partial \log(z)} = \frac{1}{n_1 c''} \cdot \frac{z}{z - w_1} \cdot \left(1 - \frac{\partial w_1}{\partial z}\right)
\]

That is, the response of marginal cash flow \( 1 - \partial w_1/\partial z \) determines the hiring response. If new hires’ wages fully absorb the productivity shock \( (\partial w_1/\partial z = 1) \), the extreme version of what e.g. Pissarides (2009) cautions may hold in the data), hiring is flat in productivity because the return to hiring is flat. *Standard marginal amplification* arises from a rigid wage among new hires, i.e. one that does not absorb the productivity shock \( (\partial w_1/\partial z < 1) \). This intuition essentially underlies the (DMP) paradigm that only new hires’ wages can distort hiring. But the marginal role of wages in labor demand prevails in macroeconomic models featuring wage rigidity more generally.

Implicitly, standard labor demand assumes that the firm faces no frictions in financing upfront costs \( c(n_1) \). Either firms have sufficient internal funds to cover the cost or they can take out a loan priced at interest \( R = 1/\beta \). Motivated by evidence that firms face financial frictions, this paper investigates financially constrained labor demand and the resulting liquidity effect of incumbents’ wages. Consider an extreme case: firms cannot access any external finance but must finance investment entirely out of internal funds – cash flow today:

\[
c(n_1) \leq \underbrace{zn_0 - w_0 n_0}_{\text{Internal Funds}}
\]

Crucially, condition (c) constitutes the credit constraint (it could come from constrained collateral capacity). Constraint (c) conveys that in case the company can comfortably cover costs \( c(n_1) \) out of pocket, it complies with conventional labor demand condition (b).

*Financially constrained hiring*, by contrast, has borrowing constraint (c) bind, marks up upfront costs \( c(n_1) \) with Lagrange multiplier \( \lambda \), and thus depends on incumbents’ wages \( w_0 \).
via internal funds:

$$(1 + \lambda) \cdot c'(n_1^*) = \beta(z - w_1)$$

By squeezing liquidity in borrowing constraint $c$, incumbent workers’ wages distort hiring through total, rather than marginal, cash flow. In fact, since the constraint binds, the extreme financial constraints create a proportionate link between recruitment and incumbents’ wages:

$$c(n_1^*) = n_0(z - w_0)$$

How do financial constraints change the role of wage rigidity in fluctuations? Under financial constraints, the cyclicality of hiring depends on how incumbent workers’ wages $w_0$ absorb shocks to productivity $z$:

$$\frac{\partial \log(n_1^*)}{\partial \log(z)} = \frac{\frac{n_0 c'}{c}}{z - w_0} \cdot \left(1 - \frac{\partial w_0}{\partial z}\right)$$

Financial constraints shift the focus from new hires’ to incumbents’ wages while preserving wage rigidity as the amplification nexus. The response of average (total) cash flow guides hiring cyclicality. If incumbents’ wages absorb the productivity shock ($\partial w_0/\partial z = 1$), hiring is flat in productivity because the firm’s capacity to invest is flat. Financial amplification arises from incumbent workers’ wage rigidity: if $\partial w_0/\partial z < 1$. After all, average profits and internal funds do fluctuate in the data, even if marginal profits are hard to measure. As a result, financially constrained hiring can respond strongly to shocks even if new hires’ wages $w_1$ are perfectly procyclical ($\partial w_1/\partial z = 1$). This property is empirically appealing in light of evidence for substantial procyclicality of new hires’ wages, in contrast to the robust finding of incumbent workers’ wage rigidity (Pissarides (2009)).

3 **Empirical Evidence for the Financial Channel of Wage Rigidity**

**Roadmap.** I provide empirical evidence for the quantitative relevance of the financial channel of wage rigidity in two parts. I first show that a slight increase in incumbents’ wage procyclical could smooth aggregate profits and cash flow with respect to the business cycle. To do the job, incumbents’ wages would move only towards the measured procyclical of new hires’ wages, and a realistic benchmark group. Second, I confirm that cash flow (and employment and capital investment) are smoother in industries with lower labor shares, which mediates the cash flow effect of wage rigidity. In recessions, cash flow declines, credit rating downgrades and bankruptcies are concentrated in industries with high labor shares.
I then present evidence for the second ingredient: the amplified cash flow fluctuations resulting from wage rigidity transmit into hiring, as predicted by financial constraints at the firm level. First, I show that internal funds help firms weather recessions with smoother investment and employment. Second, I support the mechanism with identification designs that link firm-level employment to cash flow shocks.

3.1 Wage Rigidity Amplifies Cash Flow Fluctuations

I present evidence for the first key ingredient: the rigidity of incumbents’ wages is the crucial intermediary factor in firms’ cash flow fluctuations at the aggregate, industry and firm level.

National Accounting. Figure 1 presents a cash flow statement of the U.S. non-financial corporate sector (2006), which I construct from Flow of Funds data. Sectoral value added minus compensation (wage $w$ times employment $n$) roughly equals the flow of internal funds (cash flow): $\Delta IF = Y - wn$. Internal funds plus external finance (equity and debt raised, minus interest and dividends) sum to total liquidity. Out of total liquidity, firms finance investment activities $I$, such as capital expenditure (which I also plot in Figure 1): $I \leq \Delta EF + \Delta IF$. Cash flow is the dominant source of finance at the aggregate level, commonly even exceeding capital investment, and constituting more than 95% of total finance in a given quarter. For fears of financial intermediation being masked in aggregate statistics, I supplement this known aggregate fact with unique firm-level survey micro-data (the CESifo Investment Test, 1990–2000) on the sources of investment finance in Figure 2a. I find that even on the firm level, at least 95% of capital investment appear to be funded internally without any financial intermediation, a pattern that appears similar with proxies in Compustat (Figure 2b).

The Cyclical Behavior of Cash Flow. Cash flow is strongly procyclical. Following the literature on wage rigidity, I take the detrended unemployment rate as the business-cycle indicator, at quarterly frequencies. By this “Okun’s law”, cash flow falls 3 percent per percentage point in unemployment:

$$\frac{d \log(\text{CashFlow})}{d \text{UnempRate}} \approx -3\%$$

Slightly More Procyclical Wages Could Smooth the Fluctuations in Cash Flow. I conduct a simple national accounting exercise to show that it would suffice for incumbent workers’ wages to move as procyclically as new hires’ wages. A robust empirical finding is that incumbent workers’ wage cyclicality is markedly lower than that of new hires. I present the
consensus estimates proposed by Pissarides (2009) in a comprehensive meta study:

\[
\frac{d\log(\text{wage}^{\text{Incumbent}})}{d\text{UnempRate}} \approx -1.25\%
\]

\[
\frac{d\log(\text{wage}^{\text{NewHire}})}{d\text{UnempRate}} \approx -3\%
\]

What additional wage procyclicality is required in order to smooth cash flow with respect to the business cycle? A given percentage change in cash flow can be offset by a percentage change in payroll equal to the ratio of cash flow to payroll, and thus:

\[
\frac{d\log(\text{CashFlow})}{d\text{UnempRate}} \cdot \frac{\text{CashFlow}}{\text{Payroll}} = -1.5\%
\]

A slight increase in incumbents’ wage procyclicality, to the level of $-2.75\%$, would smooth cash flow with respect to the business cycle. Incumbents would only move towards the measured cyclicity of an empirically realistic benchmark: new hires’ wages ($-3\%$).

**Similar Results Hold for Profits.** Alternative financial amplification mechanisms can arise from fluctuations in firms’ profitability, for example through moral hazard (Bernanke and Gertler (1989)) or or collateral values (Shleifer and Vishny (1992)). Pretax profit additionally subtracts the mildly procyclical depreciation from cash flow, resulting in higher procyclicality: \(d\log(\text{Profits})/d\text{UnempRate} \approx -9\%\). Quantitatively, the same smoothing result obtains because of the considerably lower profit-payroll ratio (0.2). To offset a given drop in profits, average wages only need to change by a fifth as much in percentage terms. A 1.8% increase in the procyclicality of average wages would smooth corporate profits with respect to the business cycle. Again, this counterfactual economy with acyclical cash flow would only require incumbents’ wages to inherit the wage cyclicity of new hires.

In summary, because payroll is much larger an item than cash flow and profits, and because average wages are smooth to begin with, a slight increase in the procyclicality of wages has the potential to stabilize profits and cash flow.

**Alternative Sources of Cash Flow Stabilization?** Payroll is unique in that no other drain on corporate resources could realistically stabilize cash flow, as the sectoral cash flow state-

\[13\text{Typically, log wages of individual } i \text{ in job } j \text{ are regressed on detrended unemployment as the cyclical indicator: } \ln(w_{kit}) = \beta_0 + \beta_{UR}R_t + \beta_XX_{it} + \beta_JX_{jt} + [\text{FEs}] + \varepsilon_{ijt}. \text{ Worker- and firm-level controls, and firm-, worker- and even job-fixed effects, reduce cyclical composition bias. The wage cyclical measure is the coefficient on unemployment: } \epsilon_{w,u} = \beta_{UR} = \frac{d\log(w_t)}{dR_t}. \text{ Pissarides (2009)’s meta study puts new hires at } \epsilon_{w,u}^{\text{new}} \approx 3 \text{ vs. at most half for incumbents: } \epsilon_{w,u}^{\text{inc}} \in [1.0, 1.5]. \text{ Pissarides (2009) and Haefke et al. (2013) also explore productivity as cyclical indicators, to which internal-funds/profit results remain robust.} \]
ment in Figure 1 suggests. Take a recession with a 3 percent increase in unemployment. Interest expenditures would need to fall by \(\frac{\text{Payroll}}{\text{Interest Exp.}} \cdot 9\% \approx 300\%\) and thus turn strongly negative to serve as a comparable stabilizer. Rather than a corporate jubilee, lenders would need to inject three times more funds than is owed in interest. Similarly, dividends would need to fall by \(\frac{\text{Payroll}}{\text{Dividends}} \cdot 9\% \approx 170\%\).

**Industry-level Test: the Labor Share Amplifies Cash Flow Fluctuations.** The ideal experiment assigns, all other things equal, different wage cyclicalities to firms or industries. But obtaining clean measures of, let alone suitable variation in, wage rigidity is difficult.\(^{14}\) For one, the realized cyclicality of industry wages is confounded by other cyclical factors such as product demand. I therefore conduct an indirect test exploiting variation in a long-run rather than cyclical industry property: labor share \(\sigma^L\). The cash flow channel of wage rigidity looms larger, the larger the labor share, because \(\text{CF} = z_{n_0} - w_0n_0 = (1 - \sigma^L) \cdot z_{n_0}\) and thus \(\partial \log(\text{CF})/\partial \log(z) = (1 - \sigma^L)^{-1} \cdot (1 - \partial w_0/\partial z)\)\(^{15}\)

The NBER-CES Manufacturing Industry Database provides me with finely disaggregated data, mainly taken from the Census/Annual Survey of Manufacturers establishment micro-data. The annual data is on the 6-digit NAICS level, for 473 industries, spanning 1958 to 2009.\(^{16}\) I compute cash flow as value added minus payroll. Labor share is – the long-run average of – payroll over value added. For both measures, I confirm robustness to value added gross of intermediate input costs, ensuring that the labor share captures payroll as a drain on cash flow rather than intermediate-input intensity. The industry averages of the labor share have a mean of 43%, a standard deviation of 13%; the 5th and 95th percentiles are 19% and 61%.

**Cash Flow Fluctuations over the Aggregate Business Cycle by Labor Share.** Figure 3a plots the cross-sectional relationship between labor shares and cash-flow cyclicalities. The industry cyclicality measure mirrors the aggregate one, obtained from industry-level regressions of detrended log cash flow on detrended unemployment (\(\frac{d \log(\text{CashFlow}_{it})}{d \text{UnempRate}_t}\)). The key finding is that industries with higher labor shares exhibit more procyclical cash

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\(^{14}\)For example, Bils et al. (2014) find industry wage stickiness and real wage rigidity measures to be uncorrelated.

\(^{15}\)The assumption is that wage rigidity (and other cyclically relevant factors) is orthogonal to the labor share. The key concern goes against the hypothesis: higher labor shares should lead to larger costs from the financial channel of wage rigidity, presumably encouraging flexible compensation structures. The labor share should also not be correlated with financial constraints. A priori, it may lower debt capacity through the amount of collateral or agency problems. Matsa (2010), Simintzi et al. (2010), Monacelli et al. (2011), Berk and Walden (2013). Capital expenditures over cash flow (a scaled version of the labor share) is used external finance dependence proxy (Rajan and Zingales (1998)). I find no cross-sectional or panel relationship with leverage in Compustat.

\(^{16}\)Similarly fine industry data are not available for other U.S. sectors. KLEMS or BEA industry statistics contain only 60–70, vastly heterogenous industries for a shorter time period (from 1987 onward). My data contain nine times as many, from 1958 onward, all from one homogeneous sector with consistent variables.
flow, as predicted by the fact that wages do not absorb changes to profitability one to one. I confirm the relationship for cash flow from firm-level accounting data in Figure 3b (U.S. Compustat). Indeed, cash flow is nearly acyclical for low labor shares. If wages were slightly more procyclical, all industries would see their cash flow smoothed.

Further Evidence on Industry-Specific Cash Flow Fluctuations. To rule out confounding factors such as more procyclical product demand, Figures 3c, 3d confirm the relationship between cash flow dynamics and the labor share for industry-specific rather than aggregate shocks. Figure 3c plots the elasticity of cash flow to an industry’s growth in value added; Figures 3d and 3e repeat this exercise with industry-level average labor productivity (value added per worker) as well as for industry-level TFP. Figure 3f conducts the exercise with shocks to industry-specific price indices of intermediate inputs. All elasticities increase in the labor share.

Additional Financial Outcomes: Credit Rating Downgrades and Bankruptcies. I conclude by examining credit market outcomes as measures of firms’ financial condition. First, I use S&P corporate bond credit rating data for manufacturers in the Compustat Ratings module (1985 to 2013) to show that firms in high-labor share industries see their credit ratings drop more steeply during recessions. Figure 4a plots these event studies by labor share tercile. Lastly, I investigate firm bankruptcies. In Figure 4b, I plot the fraction of bankruptcies by labor share by year (1970 to 2010). Firms in higher labor share industries are more likely to declare bankruptcy during recessions.

In summary, wage rigidity appears to play a key role in the cyclicity of firms’ financial conditions. The next section investigates whether an economy with smoother cash flow – such as one with less wage rigidity – would indeed exhibit smoother employment.

3.2 Would the Smoother Cash Flow from Less Rigid Wages Smooth Recessions?

I now present evidence for the second ingredient of the financial channel of wage rigidity: the amplified cash flow fluctuations resulting from wage rigidity transmit into hiring. First, I show that cash buffers help firms stabilize employment during recessions. Second, I estimate the causal effect of internal funds on employment investigating firm-specific cash flow shocks unrelated to investment opportunities.

Firms with Cash Buffers Experience Smoother Recessions. Using U.S. Compustat data around recession episodes, I exploit cross-sectional variation firms’ pre-recession

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17I translate the 20 S&P grades into equally spaced numerical grades (1, 2, 3,...). I match the industry labor-share measures from the NBER-CES data.

18I use a bankruptcy indicator from Alanis and Chava (2012), which covers all filings in the Wall Street Journal Index, the SDC database, SEC filings and the CCH Capital Changes Reporter. I merge the data with CRSP, and take annual fraction of firms in bankruptcy per industry.
excess cash buffers to approximate the experiment of smoother cash flow from lower wages.\textsuperscript{19} I find patterns suggesting that firms that happen to enter recessions with such excess internal funds, stabilize their employment and investment by burning through these buffers.\textsuperscript{20}

The Excess Liquidity Measure is the residual of liquid assets over total assets regressed on firm size dummies (deciles), industry dummies (2-digit SIC) and their interactions in cross-sectional regressions for each pre-recession reference year.\textsuperscript{21}

Liquidity Helps Firms Stabilize Employment and Investment During Recessions. While I investigate financial amplification in general and confirm the following patterns to extend to the “garden variety” of recessions (see Figures 6b, 6a and 5b for the early 70s, 80s, and 2000s recessions), the 2008/09 financial crisis (Figure 5a) makes for the most opportune narrative. The onset of the recession was accompanied by not only a crunch in cash flow but also in credit, which internal liquidity buffers might have attenuated. Indeed, Figure 5a shows that firms with high excess liquidity cut employment only by 2% instead of 5% for the bottom half, similarly for capital investment. Indeed, the Figure confirms that high-liquidity firms burn through more than 20% of their liquid assets, whereas their low-liquidity peers’ cash draw-down is almost zero.\textsuperscript{22} These patterns suggest that the cash flow freed up by lower wages would have enabled the low-liquidity firms to stabilize employment much like the high-liquidity firms. It is encouraging for this interpretation that the liquidity groups exhibit parallel trends before and after each recession examined.\textsuperscript{23}

Firm-Level Employment Effects of Cash Flow Shocks. I next support and quan-

\textsuperscript{19}In a slight extension, firms in the simple model now hold assets $A$ and can smooth negative shocks (which increase the shadow value of liquidity $\lambda$) by dissaving, following dissaving policy $f(\lambda, A)$, with $f_\lambda(\lambda, A) > 0$ and $f_{\lambda A}(\lambda, A) > 0; \partial\log(n_1^*)/\partial\log(z) = 1/n_1^* \cdot z/z - w_0 \cdot (1 - \partial w_0/\partial z + f_\lambda(\lambda, A) \cdot \partial \lambda/\partial z)$, from which follows that $\partial \left( \frac{\partial \log(n_1^*)}{\partial \log(z)} \right) / \partial A < 0$. That is, the more liquid assets the firm holds to compensate for cash flow drops, the less the firm will be forced to cut hiring.

\textsuperscript{20}Duchin et al. (2010), Campello et al. (2010), Campello et al. (2011) and Almeida et al. (2012) investigate the role of liquidity in the 2008/09 recession only, and with a focus on investment.

\textsuperscript{21}Variants of the measure yield similar results. Opler et al. (1999) and Dittmar and Mahrt-Smith (2007) compute similar excess liquidity measures; Duchin et al. (2010) and Zwick and Mahon (2014) employ them as proxies of financial constraints.

\textsuperscript{22}The patterns are in line with firm-level survey evidence of Campello et al. (2010), who document that (self-declared) financially constrained firms used up their cash reserves during the credit crunch.

\textsuperscript{23}Other indicative patterns are the following. First, if pre-recession excess liquidity represented investment opportunities, one may expect to see higher than average investment and cash among high liquidity firms, but those firms reduce their liquid assets by more. Similarly, if liquid assets denoted random delay of discrete investment episodes, factor growth would diverge in the pre-recession reference year and converge during the recession; but the groups share pre- and post-trends and only diverge during the recession. Third, I confirm that high-liquidity firms indeed run down their cash reserves in recessions, whereas the low-liquidity group does not. Fourth, in liquidity management models (Froot et al. (1993), Rampini and Viswanathan (2010), Almeida et al. (2013)), firms holding more liquidity have more severe/procyclical financial constraints. (For example, Harford et al. (2014) document precautionary cash holdings among firms with higher refinancing risk.) This last concern would have predicted excess liquidity to entail larger, rather than smaller, factor declines.
tify the liquidity channel in a series of empirical designs using firm-level shocks to cash flow. Those shocks leave marginal investment opportunities unchanged, isolating the cash flow channel that is active under financial constraints. Indeed, the quantitative relevance of the financial channel of wages can be estimated off any such shock to liquidity that leaves marginal hiring and investment incentives constant. I follow the regression specification of the conventional capital investment cash flow sensitivity. Mirroring the standard capital expenditure outcome, the dependent variable is the net employment change (dollar-denominated by an imputed payroll contribution of a marginal worker) over assets:

\[
\frac{\bar{w}_t \cdot dEmp_t}{Assets_{t-1}} = \beta^q \cdot q + \sigma^E \cdot \frac{Liquidity_t}{Assets_{t-1}} + \beta_X X_{t-1,i} + \alpha_t + \alpha_i + \varepsilon_{it}
\]  

(1)

The interpretation of coefficient \(\sigma^E\) is: Into how many dollars of employment does one dollar of liquidity translate? I describe the data and the employment measure in the Appendix alongside Table

Estimates of the Firm-Level Employment Effects of Cash Flow Shocks. Table summarizes my estimates of the employment-cash flow sensitivity from each design. I propose as an empirically plausible range [0.2, 0.6]. That is, 20 to 60 cents on the cash flow dollar transmit into net employment changes. In dollar terms, the sensitivity falls within the range of the estimates of the conventional capital investment sensitivity, which I also include for each design. But in percentage terms, capital expenditure responds twice as strongly, in line with its greater investment character.

Whence the Sensitivity of Labor to Cash Flow? In the model, I rationalize the relationship between cash flow and employment with labor (hiring) as an investment good in its own right, as it is explicitly in DMP models. This approach allows me to restrict the analysis to only one explicit factor in the model. But the investment-like features of labor include additional

24 Sharpe (1994), Beamelech et al. (2012), Bakke and Whited (2012), Greenstone and Mas (2012), Chodorow-Reich (2014) explore employment effects of a variety of financial factors but not the dollar-for-dollar sensitivity to cash flow.

25 Typically, investment over assets is regressed on firm-specific proxies of investment opportunities (proxy: Tobin’s \(q\), with market/book asset value ratios) and cash flow over assets. Under the frictionless benchmark, cash flow should not affect investment decisions. Early “structural” regressions interpret significance on cash flow as evidence for financial constraints. Second-generation work has sought exogenous cash flow shocks. The studies find 10 to 60 cents on the cash flow dollar to transmit into capital expenditure in the average firm. I circumvent the debate about heterogeneity by firm-level financial constraint proxies (e.g. Kaplan and Zingales 1997, Farre-Mensa and Ljungqvist 2013), by focusing on the average firm for my aggregate purpose.

26 For labor rather than capital, the frictionless benchmark can be rationalized with adjustment costs similarly to the capital investment specification. Adjustment costs in labor demand can generate a \(q\) theory of labor (Yashiv (2000) and Merz and Yashiv (2007)) akin to the investment one. My empirical work differs from related antecedents (Bennmelech et al. 2012, McLean and Zhao 2014) investigating employment effects in that I seek to quantify a dollar-for-dollar sensitivity and focus on exogenous variation in cash flow.
aspects such as firm-sponsored training. Other links are pragmatic approaches such as the working capital set-up that assumes that the firm takes out a loan to pre-finance the wage bill, as production revenues arrive with a delay. As a result, labor is marked up by the interest rate or, in a possible extension, liquidity terms. Finally, labor might be perfectly variable factor without investment character, yet sensitive to financial shocks through its complementarity with capital investment.

**The Industry-level Labor Share is not only Associated with Amplified Cash Flow Fluctuations but also Investment and Employment Fluctuations.** I now return to the industry level to support the link from rigid labor costs onto factor demand via cash flow: manufacturing industries in which rigid wages appear to amplify cash flow fluctuations through higher labor shares should also exhibit more volatility in employment and investment as predicted by the financial constraints I found in the firm-level design.

First, I take a nonparametric look at the five post-war recessions sufficiently long enough for the annual data: do drops in employment vary by labor share? They do, as I show in Figure 7a. Grouping industries again by labor share, I plot their respective percentage employment declines. Figures 7b and 7c confirm that cash flow and capital expenditure declines also exhibit the labor-share dependence during recessions.

Second, to more quantitatively gauge the labor-share gradient of this amplification, I construct an employment cyclicity measure for each industry. As with the cash flow cyclicity measures, I detrend log employment by industry and run industry-level regressions on a business cycle indicator (again detrended unemployment). Figure 7d plots these industry cyclicalities against the labor share. Employment in the lowest labor share group is nearly acyclical, while the highest labor share group’s employment falls by 4% for each percentage point increase in unemployment. The cyclicity gradient implies that moving along the labor share distribution by 0.1 lowers an industry’s employment cyclicity by 1 percentage point.

Third, Figure 7d shows that industry-level cyclicity measures for investment analogous mirror the patterns for employment and cash flow with respect to the labor share.

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27 Christiano et al. (2005) and Jermann and Quadrini (2012) are examples resorting to working capital.

28 The labor share should also not be correlated with financial constraints. A priori, it may lower debt capacity through the amount of collateral or agency problems (Matsa (2010), Simintzi et al. (2010), Monacelli et al. (2011), Berk and Walden (2013)). Capital expenditures over cash flow is used external finance dependence proxy (Rajan and Zingales (1998). I find no cross-sectional or panel relationship with leverage in Compustat.

29 I confirm robustness to monthly employment data (Quarterly Census of Employment and Wages, 1975+).
Synthesis. I provide empirical evidence for the quantitative relevance of the financial channel of wage rigidity from the firm, industry and aggregate level:

- **Aggregate Fact:** Wage rigidity renders aggregate cash flow and profits so procyclical. A slight increase in incumbents’ wage procyclicality (toward that of new hires) could perfectly smooth profits and cash flow with respect to the business cycle.

- **Industry-Level Support:** High labor share industries, in which wage rigidity appear to amplify cash flow fluctuations, also exhibit more procyclical employment and investment. Bankruptcies and credit rating downgrades cluster in those industries in recessions.

- **Firm-Level Test:** Internal funds help firms weather recessions with smoother investment and employment. Cash flow shocks transmit not only into investment but also into employment.

4 A Search and Matching Model of the Aggregate Labor Market with Inframarginal Wage Rigidity and Financial Constraints

To assess the financial channel of wage rigidity in an equilibrium context and to conduct counterfactuals, I integrate the channel into the workhorse macro-labor model, the Diamond-Mortensen-Pissarides (DMP) search and matching model. Much of the recent literature on wage rigidity, hiring and unemployment fluctuations has centered around versions of the DMP model. An active and central debate concerns the empirical volatility of firms’ recruitment over the business cycle in the face of comparatively smooth labor productivity (the DMP driving force), which Figure 9 plots for the U.S. data between 1958 and 2013. Recruitment drops typically by 40-50% from peak in a typical recession; productivity does by an order of magnitude less. Following Shimer (2005), the degree to which new hires’ wages absorb productivity shocks has been recognized as the nexus of amplification in the standard model. Cash flow from new hires determines firms’ recruitment intensity. Follow-up papers have achieved realistic amplification by making new hires’ wages rigid by force or by micro-foundation. However, in the data, the pronounced procyclicality of new hires’ wages might call into question this source of amplification (Pissarides (2009)). The mechanism explored in this paper avoids this potential empirical tension by generating amplification from incumbents’ wage rigidity alone.

I integrate the financial channel of wage rigidity into an otherwise standard DMP model by combining two ingredients: incumbent workers’ wage rigidity and financial constraints.

---

My notion of incumbents’ wage rigidity is purely “inframarginal”, occurring over the course of a given match. Initial base wages – and thus the expected present value of labor costs in a new match – are set flexibly and with rational expectations. In the standard model, such wage rigidity is irrelevant: ex post a mere fixed cost, ex ante bargained away. I break this canonical neutrality with financial constraints. Quantitatively in Section 5 I find that the financial channel of wage rigidity enables a calibrated version of the model to account for more than half of the hiring fluctuations in the U.S. data. While I examine hiring, the financial channel of wage rigidity would at least as plausibly apply to aggregate capital investment, which Figure 9 shows tracks vacancies over the business cycle.

4.1 The Labor Market Structure of the DMP Class of Models

DMP Search and Matching Frictions. The DMP class of aggregate labor market models deviates from the centralized labor market primarily in terms of aggregate matching function $\mathcal{M}(u,v)$, which embodies the search and matching frictions. Matching function $\mathcal{M}(u,v)$ denotes the (gross) inflow of employment matches newly formed in a given period between stocks of vacancies posted $v$ and unemployed job seekers $u$. Homogeneity of degree one leads the literature to focus on labor market tightness $\theta = v/u$ as the key labor market variable: $\theta$ determines the vacancy filling rate $q(\theta) = \mathcal{M}(u,v)/v = \mathcal{M}(1/\theta, 1)$ and the unemployed job seeker’s job finding rate $f(\theta) = \mathcal{M}(u,v)/u = \mathcal{M}(1, \theta) = \theta q(\theta)$.

Unemployment and Hiring Fluctuations. Since hiring fluctuations account for around 70% of the fluctuations in unemployment in the U.S. data (Hall (2005b), Shimer (2012)), the standard model de-emphasizes the separation margin by featuring a constant match separation rate $\delta$. In the model, an increase in vacancy posting $v$ leads to tight labor markets $\theta = v/u$. A higher $\theta$ raises job finding rate $f(\theta)$. When having separated exogenously into unemployment at rate $\delta$, job seekers $u$ find a new match faster. Unemployment decreases. That is, unemployment evolves as the inflow into unemployment from employment, $\delta n^-$, minus the outflow from unemployment into employment, $f(\theta^-)u^-$:

$$\Delta u = \delta(1 - u^-) - f(\theta^-)u^-$$

(2)

with steady-state unemployment: $u^{ss} = \delta/(\delta + f(\theta^{ss}))$.

Vacancy Costs. Firms incur flow cost $k$ to maintain a vacancy, and thus pay hiring cost $k/q(\theta)$, as a given vacancy fills at rate $q(\theta)$.

The Long-Term Employment Relationships of the DMP model let me distinguish new and incumbent workers. Upon being matched, the firm and the worker form a long-term employment relationship separating at rate $\delta$ and yielding cash flow (productivity minus wages $z - w$). By generating a range of wages for which each bargaining party prefers the
match to her outside option (new search), search frictions provide a theoretically appealing setting for wage rigidity (Hall (2005b)).

4.2 Inframarginal Wage Rigidity

I introduce inframarginal wage rigidity (IMWR) in a specification that is, first, tractable. Second, it allows me to isolate incumbents’ wage rigidity from new hires’ wage flexibility. Third, it can be directly calibrated to micro-estimates of wage cyclicality, reflecting the differentials between new and incumbent workers. Like most work investigating the consequences of wage rigidity, this paper does not micro-found its version (IMWR).

**Individual Wages.** Period-\(t\) wage of an incumbent hired in period \(s\) is the geometric mean of two components, the (cyclical) indexation to the going wage and the (rigid) cohort effect, weighted by IMWR parameter \(\rho\):

\[
\frac{w_{t,s}}{w_{t,t}} = \left(1 - \frac{\log(w_{t,s})}{\log(w_{t,t})}\right) \cdot \frac{w_{s,s}^\rho}{w_{s,s}^{\rho}}
\]  

The parameter controlling IMWR, \(\rho \in [0,1]\), shields the incumbent’s wage from cyclical market wage \(w_{t,t}\) by putting weight on the rigid “cohort effect” \(w_{s,s}^\rho\) that persists throughout the match. The cohort effect is the base wage that is flexibly bargained over with rational expectations at match formation. Market wage \(w_{t,t}\) is the going wage among new hires, i.e. the wage the incumbent worker would obtain if she fully rebargained the wage. IMWR \(\rho\) guides the *relative* wage cyclicality of incumbents vis-à-vis new hires. For small changes in \(w_{t,t}\), it maps directly into the wage cyclicality estimates I review in Section 3.1:

\[
\rho = 1 - \frac{\log(w_{t,s})}{\log(w_{t,t})} = 1 - \frac{\log(w_{t}^{inc})}{\log(w_{t}^{new})} = 1 - \frac{e_{inc}^{w,u}}{e_{new}^{w,u}}
\]  

**Total Payroll.** The role financial frictions create for total payroll and average wages requires me to keep track of the hiring history: each worker cohort hired in period \(s \leq t\), of whom \(n_{t,s} = (1 - \delta)^{t-s} n_{s,s}\) remain at time \(t\), with cohort-specific wage \(w_{t,s}\). Payroll \(\Phi\) sums all cohorts’ wage bills \(\Phi_t = \sum_{s \leq t} w_{t,s} n_{t,s}\). My specification of IMWR renders the law of motion

17
for payroll $\Phi$ recursive and tractable under the conventional constant separation rate $\delta$:

$$\Phi = wh + (1 - \delta) \left( \frac{w}{w^-} \right)^{1-\rho} \Phi^-$$  

(5)

Average wage $w^{avg} = \Phi/n$ evolves recursively as the turnover-weighted average of its lag and new hires’ going wage $w$:

$$w^{avg} = w\frac{h}{n} + (1 - \delta) \frac{n^-}{n} \left( \frac{w}{w^-} \right)^{1-\rho} w^{avg^-}$$  

(6)

which approximates to $\delta w + (1-\delta) \left( \frac{w}{w^-} \right)^{1-\rho} w^{avg^-}$ around steady-state hiring rate $h^{ss}/n^{ss} = \delta$.

**Inftramarginal Wage Rigidity Generates a Rigid Average Wage while Leaving New Hires’ Wages Flexible.** By divorcing average from marginal wages, IMWR lets me isolate the financial channel of (incumbents’) wage rigidity from the standard amplification arising from marginal (new hires’) wages.

**Wage Dynamics under IMWR.** The degree of IMWR, $\rho$, directly reduces the responsiveness of incumbents’ and thus average wages to market conditions. Figure 10 illustrates this wage smoothing for a given path of new hires’, incumbents’ and average wages, for three levels of IMWR $\rho \in \{0, 0.5, 1\}$. The impulse is a one-standard-deviation shock to productivity ($\sim 2\%$) in the standard DMP model without financial constraints. Column I presents “wage biographies” of a given worker cohort hired in a particular period conditional on that match prevailing. Trivially, for $\rho = 0$ (Panel A), all cohorts’ wages perfectly track new hires’ wages, and so remuneration is homogeneous. Once hired, workers remain fully exposed to aggregate conditions (“on the market”). Standard models implicitly examine this special case. In contrast for $\rho = 1$ (Panel B), incumbent workers’ wages remain fixed at their entry wage (cohort effect), completely unresponsive to business cycle conditions. As law of motion (6) predicts for $\rho = 1$, adjustments in the average wage are sluggish and exclusively through turnover. Calibration Section 5 appeals to micro-empirical estimates of wage cyclicalities of new and incumbent workers to calibrate IMWR $\rho$ to lie between 0.5 and 0.8. In Panel C, I plot the resulting wage dynamics, which now mirror the cohort effects and the relative wage rigidity of incumbents found in the micro data.

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31 I refrain from cohort-specific separation rates for two reasons. First, the net effect of wage differentials on separations (quits plus layoffs) is ambiguous: the firm’s incentive to lay off overpaid workers (for evidence on this mechanism, see Schmieder and von Wachter (2010) and Mueller (2012)) vs. quit incentives of high-rent workers (Katz and Summers (1989)). Second, fluctuations in total separations (quits plus lay-offs) play the secondary role in U.S. unemployment fluctuations (Hall (2005b), Shimer (2012)). I discuss new cyclical implications of turnover generated by the financial channel of wage rigidity in Section 6.

32 *Ex-ante*, IMWR also smooths going wages, as the bargaining parties rationally expect the cohort wage to partially persist over the course of a given new match. I discuss this effect along with wage determination.
4.3 Firm and Worker Optimization

When firms do not face financial frictions, inframarginal wage rigidity (IMWR) is perfectly neutral ex post, and ex ante bargained away. But once financial constraints bind, cash flow – revenue minus payroll – affects recruitment, and so IMWR intermediates the cash flow effect of productivity shocks. I first consider the firm’s problem and the household’s problem, to then examine wage determination and the equilibria for the unconstrained and the constrained economy.

**Firms** maximize the expected present value of dividends (I describe their policy and frictions next) by posting vacancies \( v \) to recruit tomorrow’s new hires \( h^+ \) at vacancy filling rate \( q(\theta) \):

\[
V(s; n^-, \Phi^-, h, B^-) = \max_{v,B} \left\{ d + \mathbb{E}\beta V(s^+; n, \Phi, h^+, B) \right\}
\]

subject to:

\[
\Phi = hw + (1 - \delta) \left( \frac{w}{w^-} \right)^{1-\rho} \Phi^- \tag{8}
\]

\[
n = (1 - \delta)n^- + h \tag{9}
\]

\[
h^+ = vq(\theta) \tag{10}
\]

\[
vk \leq \zeta - d + (\Delta B - RB^-) \tag{11}
\]

\[
B \leq \bar{B} \tag{12}
\]

where \( \beta \) is the discount factor of the managers (and of the firm-owning households). Recruitment expenditure is subject to borrowing constraint (11, 12), which may or may not bind.

**Financial Frictions.** The financial block consists of three steps. First, a collateral constraint precludes the firm from scaling up profitably by taking out more loans. Second, a similar friction leaves stockholders unwilling to provide funds (by reducing dividends temporarily) to let the firm produce at the first-best scale. Third, the retention rate of cash flow shocks is the crucial statistic for the cash flow channel. I introduce it in a parsimonious dividend-friction specification.

**Liquidity.** The firm uses internal funds and potentially external finance to cover recruitment expenditure \( vk \). Liquidity \( L \) is a function of cash flow \( \zeta \) plus new net borrowing \( \Delta B \), minus interest expenditure \( RB^- \) minus dividends:

\[
L = \zeta - RB^- - d + \Delta B \tag{13}
\]

Cash flow \( \zeta = zn - \Phi \) is revenue minus payroll. Retained earnings available for reinvestment
are residual (uncommitted) cash flow $\zeta^{\text{resid}} = \zeta - RB^-$ minus dividends $d$.

**Borrowing Limit** $\bar{B}$ may or may not bind. It needs to bind for inframarginal cash flow to matter. But why would credit markets not provide funds to firms with profitable investment opportunities? I appeal to a collateral constraint. Enforcement friction $\xi^B \in [0, 1]$ marks down the value of the firm’s collateralizable assets $A$ to creditors, generating borrowing limit $\bar{B} = (1 - \xi^B)A$. The firm’s assets are its employment relationships, which have positive values in equilibrium due to financial constraints. To isolate the cash flow channel from a collateral one, I grant firms access to external finance written on the (steady-state) book value of assets: $\bar{B} = (1 - \xi^B)V^{ss} \cdot n^{ss}$.

**Dividend Policy.** Stockholders enjoy the residual claim on cash flow after interest payments $\zeta^{\text{resid}} = \zeta - RB^-$, which financial constraints render positive in equilibrium. Enforcement friction $\xi^D$, akin to that on collateral, leads the stockholders to demand payout of inefficiently high dividends that leave the firm financially constrained and with profitable investment opportunities.\(^\text{34}\)

When financial constraints are slack, any dividend policy with the same present value is optimal, as debt can perfectly substitute for equity. When the borrowing constraint binds, the firm’s dividend policy mediates how cash flow shocks transmit into inputs. The sensitivity of liquidity to cash flow then depends on the firm’s propensity to retain cash flow $\alpha = \partial L/\partial \zeta = 1 - \partial d/\partial \zeta$. For the purposes of calibration and tractability in the subsequent exposition, I consider a constant retention rule $\alpha$ arising from external-finance frictions such

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\(^{33}\)Enforcement frictions commonly rationalize collateral constraints (e.g. Jermann and Quadrini (2012)).  

\(^{34}\)Consider one simple story: Managers divert fraction $\xi^D$ of funds into projects that yield private non-monetary benefits but no or only unseizable cash flow. Shareholders therefore demand dividends $d$ such that their (Euler) condition is $1 = E(1 - \xi^D)V^{ss}$. Cash value $V_\zeta$ then exceeds the first-best $V_\zeta(\xi^D = 0)$. Despite enforcement friction $\xi^D$, a linear incentive scheme lets the managers take optimal marginal actions to maximize the present value of dividends with discount factor $\beta$, which preserves the standard formulation of the objective function. For example, managers might contribute effort $e$ to productivity $z = e \cdot a$, at convex cost $c'(e)$ under a linear performance contract: $c'(e) = \mu \partial \pi / \partial e$. Given $e^*(\mu)$, the shareholders set $\mu$ to $\max e(1 - \mu)^\pi e(\mu)$, thus $\mu^* = 1/\{[(\pi'(e)/\pi)(\partial e/\partial \mu)] - 1 \in [0, 1]$. Under the linear incentive scheme the manager takes efficient actions at the margin subject to the liquidity constraint. $e$ and $\mu$ are fixed in advance and thus acyclical. I suppress $\mu$ in the firm’s (the manager’s) problem because it scales linearly.
as dividend adjustment costs or free-cash-flow agency problems:

\[ d = d^{ss}(\xi_D) + (1 - \alpha) \cdot (\zeta_{\text{resid}} - \zeta^{ss}_{\text{resid}}) \]

\[ (14) \]

**Fraction \( \alpha \) of Cash-Flow Fluctuations Transmits into Liquidity.** Total liquidity consists of uncommitted external funds available for reinvestment plus changes in net debt:

\[ L = (\zeta - R\bar{B} - d) + \Delta B = (\zeta^{ss}_{\text{resid}} - d^{ss}) + \alpha \cdot (\zeta - \zeta^{ss}) + \Delta B. \]

The tractability of this approach allows for analytical steady-state elasticities. Moreover, I can directly parameterize retention rate \( 0 \leq \alpha \leq 1 \) to let the model match the employment-cash flow sensitivity that I estimate empirically in Section 3.2, through which incumbents’ wage rigidity affects hiring. When \( \alpha = 0 \), dividends fully absorb shocks to cash flow, leaving the internal-funds component of liquidity perfectly smooth. When \( \alpha = 1 \), dividends follow a fixed policy, and cash flow movements fully pass through into liquidity and thus hiring.

**Alternative Amplification from Collateral Channels.** Financial amplification arises from inframarginal cash flow only (rather than from collateral value fluctuations), because book-value collateralization renders the debt-capacity component acyclical. Cash flow shocks such as those arising from wage rigidity likely also affect asset market-values, in the same direction, and so the two channels are hard to disentangle in theory and also in the data. This paper’s key mechanism is in principle agnostic to the particular link from cash flow onto inputs, to which I calibrate the model’s dividend policy \( \alpha \). But either way, my empirical calculation in Section 3.1 found that not only cash flow but also aggregate profit fluctuations – and thus any asset prices movements they trigger – would turn acyclical under a slight increase in wage procyclicality. Both cash flow and profit-related collateral amplification channels would be shut off.

**Hiring.** Under financial constraints, productivity increases hiring not by making vacancy

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35 See Lintner (1956) for dividend smoothing. More recently Jermann and Quadrini (2012) use dividend smoothing frictions; as in their model, the “dividend” in mine is to capture the marginal source of external finance more broadly. See Jensen and Meckling (1976) and related models for free cash flow agency problems. Here, consider a story that would generate this dividend rule, idiosyncratic cash flow shocks (which wash out in the aggregate) of two types: type 1 affects marginal investment opportunities, and type 2 is purely inframarginal. Asymmetric information leaves owners unable to distinguish the shocks, and contracts can only be written on cash flow, linearly so. The owners would like to perfectly lean against (accommodate) inframarginal (marginal) cash flow shocks by adjusting the dividend one to one (leaving dividends fixed). There exist cash flow shock distributions such that any \( \alpha \) can be rationalized given \( \xi_D \).

36 Chaney et al. (2012) find evidence that real estate collateral values affect debt capacity.

37 By side-stepping the collateral channel, the calibration strategy may underestimate the financial channel of wage rigidity as the cash flow effects of wage rigidity are accompanied by longer-lasting drops in cash flow, and thus larger associated asset value drops, than the ideal one-time cash flow shocks in the empirical designs.

38 Of course, some driving forces (discount rate (Hall (2014)), uncertainty shocks (Bloom et al. (2012))) may lead to collateral value movements unrelated to profits.
posting more attractive, but by making more vacancy posting feasible. In the standard DMP model, firms post vacancies until the value from adding a vacancy is zero, that is, until the present value of cash flow from another employment match equals its upfront recruitment cost. To finance recruitment and possibly associated capital expenditures, the standard model implicitly lets the firm freely take out loans in perfect capital markets even during recessions. First consider this unconstrained case in which borrowing constraint (11) is slack. Inframarginal wage rigidity (IMWR) augments the standard DMP "zero-profit condition" with a term that takes into account the degree to which the going wage at match formation will persist over the course of the match:

$$\mathbb{E} \frac{\partial V}{\partial v} = \mathbb{E} \sum_{s>t}^{\infty} \beta^{s-t}(1-\delta)^{s-t}(z_s - w_{s,t+1}) - \frac{k}{q(\theta^*)} = 0$$

Given a wage rule, the condition pins down equilibrium market tightness $\theta$. For $\rho = 0$, this condition collapses to the standard DMP zero profit condition. \[39\]

When financial constraints on recruitment expenditure (11) bind, the condition features Lagrange multiplier $\tau$ and stochastic cash flow valuations through $V_{F\Phi}^{++}$ (the expected present value of a dollar in payroll commitment taken on today, anticipating the wage frictions, productivity movements and state-contingent cash valuations):

$$\tau \frac{k}{q(\theta^*)} = \mathbb{E} \left[ \beta(z^+ - w^+) \right] + (1-\delta)\mathbb{E} \left[ \beta \frac{k}{q(\theta^*)} \right] + (1-\delta)\mathbb{E} \left[ \beta V_{h}^{++}(w^+) \right]$$

$$- \mathbb{E} \left[ (1-\delta)\beta \frac{k}{1-\beta(1-\delta)} \mathbb{E} \left[ (w^{+\rho} - w^{++\rho})w^{++1-\rho} \right] \right]$$

$$V_{h}^{++}(w^+) - V_{h}^{++}(w^+)$$

(15)

Households take dividends and, as in most DMP variants, employment as given. \[40\] With linear consumption utility, they maximize the present value of income plus payroll $\Phi$ plus

\[39\] The standard DMP zero profit condition is: $k/q(\theta^*) = \mathbb{E}\beta(z^+ - w^+) + (1-\delta)\mathbb{E}\beta k/q(\theta^*)$.

\[40\] Division into many small, identical households (or separate worker and capitalist households) prevents the worker from internalizing the effect of her wage bargain on dividends. Relying on labor demand vs. labor supply mechanisms to generate the employment fluctuations in the data avoids empirically contentious supply elasticities.

\[41\] Household risk aversion would amplify employment fluctuations by smoothing wages more, because the higher marginal utility during recessions would prop up bargained wages.
dividends $d$ plus interest $RB^-$ minus new lending $\Delta B$, minus labor disutility $\gamma$:

$$V(s; n^-, \Phi^-, h, B^-) = \Phi + d - \gamma n + RB^- - \Delta B + \mathbb{E}\beta V(s; n, \Phi, h^+, B)$$

subject to:

$$\Phi = hw + (1 - \delta) \left( \frac{w}{w^-} \right)^{1-\rho} \Phi^-$$

$$n = h + n^- (1 - \delta)$$

$$h^+ = f(\theta)(1 - n)$$

### 4.4 Wage Determination: Nash Bargaining

The DMP wage rule – Nash bargaining – closes the model. It splits the match surplus under rational expectations, incl. about IMWR and financial constraints. There is full commitment within contracts with respect to the rigid base wage; the indexation to the going wage is external. Upon a match, the Nash bargain has the parties set wage $\tilde{w}$ to maximize the geometric average of each party’s value from employment of one incremental worker at wage $\tilde{w}$ ($V^H_h(\tilde{w})$) for the household\textsuperscript{42} $V^F_h(\tilde{w})$ for the firm\textsuperscript{43} weighted by household bargaining power $\phi$:

$$\max_w \{ V^H_h(w)^{\phi} V^F_h(w)^{1-\phi} \}$$

**The Nash Wage under Financial Constraints and IMWR** is defined by $\phi \cdot \frac{V^H}{V^H} = (1 - \phi) \cdot \frac{V^F}{V^F}$ and solves into:

$$\tilde{w}^* = (1 - \tilde{\phi}) \gamma + \tilde{\phi} \left( z + \frac{\tau}{1 + \alpha(\tau - 1)} k\theta \right) +$$

$$\mathbb{E}(1 - \delta) \beta \left[ \tilde{w}^\rho - w^+ \rho \right] w^{+1-\rho} \cdot \left[ \tilde{\phi} V^F + (1 - \tilde{\phi}) V^{+H} \right] + \Gamma$$

where:

$$\tilde{\phi} = \frac{\phi\psi}{\phi\psi + (1 - \phi)} \geq \phi \quad \psi = \frac{V^H}{V^H} \quad \tilde{V}^{+H} = \frac{V^F}{1 + \alpha(\tau - 1)}$$

$$\Gamma = \tilde{\phi}(1 - \delta + f(\theta)) \cdot \mathbb{E} \left[ \frac{V^F}{1 + \alpha(\tau - 1)} \left( 1 - \frac{\psi}{\psi} \right) \right]$$

\textsuperscript{42}Household: $V^H_h(\tilde{w}) = (\tilde{w} - \gamma) + (1 - \delta - f(\theta))\beta V^H_h(\tilde{w}') + (1 - \delta)\beta \mathbb{E} \left[ (\tilde{w}^\rho - w^+ \rho)w^{+1-\rho} \cdot V^{+H} \right]$

\textsuperscript{43}The firm’s incremental match value is cash flow (valued at $1 + \alpha(\tau - 1)$) plus continuation value adjusted for the $\rho$-weighted match-specific wage path: $V^F_h(\tilde{w}) = (1 + \alpha(\tau - 1)) \cdot (z - \tilde{w}) + (1 - \delta) \cdot \beta \mathbb{E} \left[ \frac{\tau + k}{\eta(\theta)} \right] + (1 - \delta) \cdot \beta \mathbb{E} \left[ (\tilde{w}^\rho - w^+ \rho)w^{+1-\rho} \cdot V^{+F} \right]$
When financial constraints are slack \((B < \bar{B})\) and the firm thus values retained cash flow and dividend payout equally \((\tau = 1)\), wage bargain \(22\) nests a variety of previously analyzed DMP wage bargains. \(\psi = V_h^H(w)/V_h^F(w)\) represents the relative marginal value from a dollar in wages settled on today. When financial constraints are slack and discount rates are symmetric (as implicitly true in the standard model), \(\psi\) constantly equals one.

But when financial constraints bind \((B = \bar{B})\), the firm values cash more than the worker \((\tau > 1, \text{ which enters } V_h^F(\tilde{w}))\). The firm’s financial condition \((V_h^F(\tilde{w}))\) then enters the wage bargain through \(\psi = V_h^H(w)/V_h^F(w)\), effectively entailing liquidity-dependent bargaining weights \(\tilde{\phi}\). As a result, the steady-state Nash wage features a small wage concession.

Over the business cycle moreover, the Nash wage falls even more in recessions, to partially alleviate the countercyclical liquidity squeeze. But is the Nash wage sufficiently flexible for the firm to countercyclically borrow from (new) workers to relax tight cash flow in a recession? No, for lack of state- and period-contingent compensation contracts. Even “flexible” DMP bargaining \((\rho = 0, \text{ period by period})\), would therefore not fully offset a recessionary liquidity squeeze. Worse, IMWR institutionalizes recessionary wage concessions in form of the rigid cohort effect. In anticipation of this persistence, the worker is even less willing to lower wages when liquidity tightens temporarily. This dynamic consideration is captured by the IMWR-amortization term \(\mathbb{E}(1 - \delta)\beta [\tilde{w}^{\rho} - w^{+\theta}] w^{1-\rho}\) (featuring a difference between today’s and tomorrow’s expected going wage). This term is multiplied by the weighted average of the relative cash valuations of the bargaining parties, \(\left[\tilde{\phi}V^{+HF} - (1 - \tilde{\phi})V^{+HF}\right]\), which would equal one without financial constraints. \(45\) \(\Gamma\) merely adjusts for the evolution of \(\psi\). \(46\) In Section 6, I present empirical evidence from a unique micro-data set (Canadian collective bargaining agreements) that wage contracts appear to insufficiently backload wages in recessions.

### 4.5 Equilibrium under IMWR: With and Without Financial Constraints

The hiring condition and Nash wage define the equilibrium of the extended DMP model, analogously to the standard DMP one:

**Definition.** DMP search equilibrium with inframarginal wage rigidity and financial constraints is a pair of labor market tightness \(\theta\) and Nash wage \(w(\theta, w)\) that

\[w_{\text{DMP}} = \tilde{w}_{\rho=0} = \phi(z + \theta k) + (1 - \phi)\gamma + \text{amortization term}\]

\[w_{\rho=0} = w_{\rho=0} + \frac{(1 - \beta)(1 - \delta)}{\beta(1 - \delta)} \mathbb{E}_\theta (w^{+\theta} - \tilde{w}^{\rho})w^{1-\rho}.\]

For \(\rho = 0\), this expression collapses to the standard DMP Nash wage of perfect period-by-period rebargaining: \(w_{\rho=0} = \tilde{w}_{\text{DMP}}.\) \(\rho = 1\) nests the special case of (neutral) perfectly rigid inframarginal wages considered in Shimer (2004).

\(45\) This term captures the expected present value differential between the current match persisting tomorrow and a freshly priced match tomorrow as a benchmark. This value differential is split by \(\tilde{\phi}\); payroll is valued at \(V_h^F\) and \(V_h^H\). \(46\) \(\Gamma\) is an artifact of my following the DMP literature in using the value of a new match tomorrow (at tomorrow’s going wage) as reference for the continuation value, which complicates things if \(\psi\) and \(\psi'\) diverge.
solves the firm’s vacancy posting condition (16) and Nash wage (22).

In the absence of financial constraints, the wage-smoothing effect of IMWR $\rho$ turns out to be perfectly neutral with respect to all DMP quantity variables:

Proposition 1. (Quantity Neutrality of IMWR when Financial Constraints are Slack) IMWR affects the responsiveness of flow wages to productivity shocks but not of their expected present value, which drives vacancy posting $v$ and thus labor market tightness $\theta$.

1a. **Ex-ante neutrality (in new matches):** The Nash wage perfectly offsets IMWR in new matches in present-value terms.

1b. **Ex-post neutrality (in ongoing matches):** IMWR among incumbent workers does not distort hiring, for which firms take out loans.

The intuitions are simple. (Short proofs in the Appendix.) Ex post, say in a recession, the fact that incumbent workers’ wages are too high does not distort hiring because they are an inframarginal fixed cost. This ex-post neutrality is implicit in a wide class of macroeconomic models without financial constraints. In contrast, when internal funds finance investments, incumbents’ payroll squeezes liquidity otherwise available for hiring.

More subtly, hiring is also not distorted ex ante by the fact that IMWR endogenously props up new hires bargain entry wages in recessions. This neutrality arises from Nash bargaining over the first-period “base wage”, through which the bargaining parties offset IMWR by amortizing the present-value productivity change through smoother entry wages. The ex-ante consideration is particular to wage determination within long-term employment relationships such as in the DMP model.47 This present-value neutrality underlies the macro-labor paradigm that only new hires’ wage rigidity can matter for hiring, which guides both the theory and empirics of wage rigidity, e.g. Shimer (2004), Hall (2005b), Mortensen and Nagypal (2007), Hall and Milgrom (2008), Elsby (2009), Pissarides (2009), Shimer (2010), Michaillat (2012), Christiano et al. (2013).

Financial constraints on the firm side break the canonical neutrality of IMWR:

Proposition 2. (Quantity Non-Neutrality of IMWR with Financial Constraints) IMWR $\rho$ amplifies the response of vacancy posting and labor market tightness to productivity shocks, by amplifying fluctuations in cash flow.

47 This property extends to other protocols such as Hall and Milgrom (2008) credible bargaining (see Christiano et al. (2013)) or that in Michaillat (2012). See also Mortensen and Nagypal (2007) and Pissarides (2009). Alternatives to IMWR are Calvo-like set-ups with stochastic albeit full wage reset. The key wage results (rigid average and inframarginal wages, EPV neutrality) go through (see e.g. Pissarides (2009) or Mortensen and Nagypal (2007)).
Standard Marginal vs. Financial Amplification. Financial and standard (marginal) amplification from wage rigidity share wage contracts as the key nexus of amplification, yet at different margins: standard amplification works through new hires’ wage rigidity whereas financial amplification works through incumbents’ (average) wage rigidity. Analytical expressions (out of the non-stochastic steady state) can be derived that mirror the structure and the intuitions in the simple model of Section 2.

Crucially, financial amplification can still occur even if new hires’ wages are very procyclical (i.e. absorb shocks to productivity), for which case the standard model predicts weak hiring fluctuations. The key for the financial model is relative rigidity of incumbents’ wages \( \rho > 0 \). Then, firms’ recruitment becomes responsive to productivity shocks through their effect on inframarginal cash flow. But for \( \rho = 0 \), the financial model also would generate weak fluctuations: marginal as well as inframarginal wages would then absorb productivity shocks, leaving cash flow smooth and thus limiting financial amplification.

5 Quantitative Evaluation: How Much Does Incumbents’ Wage Rigidity Amplify Hiring Fluctuations under Financial Constraints?

To investigate the dynamic effects of the financial channel of wage rigidity in hiring fluctuations and to conduct counterfactuals, I calibrate and simulate log-linear versions of the model, perturbed with shocks to productivity \( z \). I translate the weekly simulated data into quarterly frequencies. To highlight the role of inframarginal wage rigidity \( \rho \) under financial

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\[ \frac{\partial \log(\theta)}{\partial \log(z)} \bigg|_{B < \bar{B}} = \chi_{\text{DMP}} \cdot \left( 1 - \frac{dw_{\text{new}}}{dz} \right) \frac{d\text{CashFlow}_{\text{new}}}{dz} \]

How new hires’ wages respond, mediates how productivity shocks change marginal cash flow, namely the firms’ incentives to hire. Financial amplification – i.e. if financial constraints bind \( (B < \bar{B}) \) – occurs through the average wage:

\[ \frac{\partial \log(\theta)}{\partial \log(z)} \bigg|_{B = \bar{B}} = \chi_{\text{financial}} \cdot \alpha \cdot (1 - [\delta + (1 - \delta)(1 - \rho)] \frac{dw_{\text{new}}}{dz} ) \frac{d\text{CashFlow}_{\text{avg}}}{dz} \]

How the average wage responds, mediates how productivity shocks affect total cash flow, which in turn affects hiring through financial constraints. I relegate uninteresting terms into \( \chi_{\text{DMP}} \) and \( \chi_{\text{financial}} \), which are just functions of parameters: \( \chi_{\text{DMP}} = \frac{\partial \theta}{\partial c} \frac{dc_{\text{marg}}}{dz} \frac{d\text{CashFlow}_{\text{marg}}}{dz} = \left( \frac{1}{\eta_z} \right) \left( 1 - \frac{dw_{\text{new}}}{dz} \right) \) and \( \chi_{\text{financial}} = \frac{\partial \theta}{\partial c} \frac{dc_{\text{avg}}}{dz} \frac{d\text{CashFlow}_{\text{avg}}}{dz} = \left( \frac{1}{\eta_z} \right) \left( 1 - \frac{dw_{\text{avg}}}{dz} \right) \) where \( \kappa = \eta u \) and \( \kappa = \eta(1 - u) \) represent the attenuating effects of \( v \) on \( \theta \) through \( u \), of \( \theta \) on \( \zeta \) respectively.
In this section, I use the HP filter with \( \lambda = 10^5 \) common in the DMP literature. All insights hold with the more standard smoothing parameter \( \lambda = 1600 \). I apply the same filters to the simulated data.

50 The relative financial results go through with other \( \gamma \)'s used in the literature.
in the upcoming Figures.

The Financial Friction Parameters are two blocks: those guiding baseline (steady-state) liquidity \( \bar{L} \) (borrowing limit \( B(\xi^B) \), steady-state dividend \( d^{ss}(\xi^D) \)), and those guiding the effects of cash flow changes on liquidity (retention parameter \( \alpha \)).

Baseline Liquidity \( \bar{L} \) depends on borrowing limit \( B(\xi^B) \) and on dividend target \( d^{ss}(\xi^D) \) (via cash flow available for reinvestment). Arbitrary combinations generate the same baseline liquidity \( \bar{L} \) and thus production scale. I set it to have the steady-state financial model’s labor market tightness to “almost” (90%) match the unconstrained one’s level, for financial constraints to bind and internal funds to affect input decisions. Sensitivity analyses of \( \bar{L} \) yield negligible effects on the cyclical behavior of the simulated DMP model.

Retention Rate \( \alpha \) guides the firm’s propensity to retain cash flow deviations, and thereby the force of the financial channel of wage rigidity. I calibrate \( \alpha \) to have the representative firm’s employment sensitivity to a transitory cash flow shock match the lower values of the empirical sensitivity I estimate and summarize in Table 1: around 0.25 for \( \alpha = 0.2 \). That is, in the calibrated model, I pick \( \alpha \) such that experiments with exogenous shocks to cash flow translate into employment changes corresponding to $0.25 in payroll per $1 in cash flow (measured at the peak employment response of the transitory shock).\(^{51}\) This calibration strategy invests the degree of the relevant financial friction parameters with quantitative and empirical tangibility.

5.1 Simulated Moments: Slack Financial Constraints (Benchmark Model)

Figure 11 plots the quarterly volatilities of the simulated data against IMWR \( \rho \in [0, 1] \) with slack financial constraints. First consider the standard DMP model, which the model nests with IMWR \( \rho = 0 \). In this model, all (new hires’ and incumbents’) wages are volatile, absorbing much of the productivity shocks. Two consequences of the wage volatility emerge. First, marginal recruitment incentives are smooth, which leaves labor market tightness \( \theta \) and unemployment \( u \) smooth, exactly the Shimer (2005) puzzle. Second, the procyclicity of average wages leads total cash flow to be similarly – counterfactually – smooth.

Now consider the empirical range of IMWR \( \rho \in [0.5, 0.8] \). Incumbents’ wages become smoother by construction. New hires’ entry wages become smoother endogenously, as the prospect of IMWR leads to frontload compensation during recessions.

\(^{51}\) Note that this simulated effect is an aggregate, equilibrium effect. The estimates to which I relate the effect are taken from firm-level, partial equilibrium empirical designs. A priori, it is unclear whether the bias is upward or downward. Various financial amplification models in fact have the mechanism go through equilibrium effects, and would predict firm-level cash flow shocks to have smaller effects than aggregate cash flow movements (e.g. Bernanke et al. (1999)). I assess the bias in ongoing empirical work (Schoefer (2015)). Lastly, note that the core framework of the DMP model is poorly suited for firm-level experiments, absent extended features such as monopolistic competition.
Figure 11 illustrates the present-value neutrality of IMWR in the benchmark model: the volatility of labor market tightness remains perfectly flat in $\rho$. But cash flow gains volatility, because average flow wages are smoother. Yet, this volatility is of mere accounting interest since the benchmark model abstracts from financial constraints.

5.2 Simulated Moments: Binding Financial Constraints

Figure 12 presents the results for the model with binding financial constraints. Fluctuations in inframarginal cash flow from IMWR now translate into the firm’s capacity to invest in hiring.

But for $\rho = 0$, the financially constrained economy again exhibits negligible fluctuations, as did the unconstrained economy. When productivity changes, both new hires’ and incumbent workers’ wages absorb much of the shock, leaving liquidity smooth, in line with the aggregate and industry-level findings in Section 3. The higher $\rho$, the less incumbent workers absorb productivity shocks, and the more cash flow responds. As a result, hiring becomes more and more responsive to productivity. Indeed, for the empirical range of IMWR $\rho \in [0.5, 0.8]$, labor market tightness fluctuations reach the empirical target of $SD(\theta) = 0.35$ already with the moderate financial constraints considered here.

Interpreted in counterfactual terms, the calibrations suggest that reducing inframarginal wage rigidity $\rho$ towards $\rho = 0$ would greatly smooth aggregate hiring fluctuations by smoothing cash flow. Encouragingly, in Section 3.1 the empirical counterpart of the model’s theoretical notion of flexibility ($\rho = 0$) also found that if incumbents’ wages were as procyclical as new hires’ wages appear in the data, aggregate cash flow would be stabilized.

Even with weaker financial frictions and with the lower bound of IMWR $\rho = 0.5$, the model can generate fluctuations that match half of the observed fluctuations of labor market tightness in the U.S. data, which are puzzling to the standard DMP model without further frictions such as new hires’ wage rigidity.

Through cash flow and financial constraints, incumbent workers’ wage rigidity, which is empirically well documented but deemed neutral in the standard models, appears to help the DMP model to account for more than half of the fluctuations of hiring in the U.S. data.

6 Further Implications of the Financial Channel of Wage Rigidity

I. The Labor Share and Employment Cyclicality. In Section 3, I use between-industry variation in the labor share to test for the financial channel of wage rigidity. The amplification of an industry’s employment cyclicality from its labor share might enrich the understanding of industry dynamics. But the financial channel of wage rigidity also generates the prediction that shifts in the labor share, all other things equal, should affect the cyclical properties of an industry, or an economy. The U.S. economy as well as the global economy have seen
a dramatic secular decline in the labor share. This drop is particularly pronounced in the manufacturing sector, which the time series in Figure 13a (1958 to 2009) documents: from 0.6 in 1970 to less than 0.35 in 2009. Among 473 finely disaggregated manufacturing industries, I find evidence for the prediction of the financial channel of wage rigidity that larger industry-specific labor-share declines are indeed associated with larger industry-specific declines in employment cyclicality. Concretely, I regress an industry’s detrended log employment on the interaction between its trend labor share and the unemployment rate – and the interaction between the industry fixed effect and that cyclical indicator. The coefficient on the interaction is identified off changes in the trend labor share. Figure 13b is a binned scatter plot of the residualized dependent variable against this residualized interaction effect, for all industries. The strong negative relationship confirms that those industries whose labor share has dropped by more have seen bigger declines in employment procyclical.

All other things equal, shifting income from wages to (possibly more flexible) forms such as capital income might thus attenuate the role of financial factors in business cycles.

II. Turnover (Separation Rate \( \delta \)) Affects Cash Flow Dynamics. The financial channel of wage rigidity generates a new cyclical role for turnover. In standard DMP models, the (constant) separation rate \( \delta \) has no quantitatively relevant cyclical consequences. It merely scales the present value of a given match through its expected duration. But with IMWR, the separation rate governs the “extensive” margin of average-wage rigidity: the rate at which legacy cohorts enjoying pre-recession wage premia are replaced with new hires commanding lower market wages. Law of motion for the average wage \( \begin{bmatrix} \delta w + (1 - \delta) \left( \frac{w}{w^*} \right)^{1-\rho} w^{avg-} \end{bmatrix} \) illustrated this in the approximation around the steady-state hiring rate: \( w^{avg} = \delta w + (1 - \delta) \left( \frac{w}{w^*} \right)^{1-\rho} w^{avg-} \).

If a firm’s workforce fully turns over each period (\( \delta = 1 \)), IMWR is mute. In contrast, wage flexibility \( (1 - \rho) \) represents the “intensive” margin; for \( \rho = 0 \) stayers’ wages adjust fully. Stay around the steady-state hiring rate and consider how cash flow depends on wages mediated by turnover \( \delta \) and \( (1 - \rho) \):

\[
\text{CashFlow} = n \cdot \left( z - \left[ \delta w + \left[ \frac{(1 - \delta)}{w/w^*} \right] \cdot \left( 1 - \rho \cdot w^{avg-} \right) \right] \right)
\]

\( w^{avg} \) Average wage

52 The decline in the aggregate U.S. labor share is discussed in Elsby et al. (2013); for the global labor share see Karabarbounis and Neiman (2013).

53 The panel regression of industry \( i \) in year \( t \) is: \( \text{cyc}_t \cdot \text{ln}(\text{Emp}_it) = \beta_1 \cdot \text{cyc}_t \cdot \text{URate}_t + \beta_2 \cdot \text{cyc}_t \cdot \text{URate}_t \cdot \text{IndustryFE}_it + \beta_3 \cdot \text{trend} \cdot \text{LaborShare}_it + \beta_4 \cdot \text{IndustryFE}_it + \beta_5 \cdot \text{cyc}_t \cdot \text{URate}_t + \epsilon_{it} \)

54 The panel effect is quantitatively in line with the cross-sectional results. This relationship is robust to production workers instead of total employment, alleviating composition concerns about offshoring or outsourcing of labor-intensive production steps.
Financial amplification from wage rigidity depends on how long legacy cohorts hold on to their jobs. Figure 14 quantifies those dynamics in the financial and the standard model: it plots the volatility of labor market tightness against a range of quarterly separation rates $\delta \leq 0.1$ (the quarterly value used in the typical DMP calibrations). While the slope on turnover is negligible in the standard model, binding financial constraints render quite sensitive the volatility of hiring to lowering the separation rate. Firm-level survey evidence supports the role of turnover in wage adjustment: in Figure 15a, I document that firms, possibly unsurprisingly, consider the replacement of incumbent workers with cheaper new hires a cost reduction strategy, using firm-level survey micro-data from the Wage Dynamics Network.

**Cyclical Implications of Labor Market Sclerosis.** The role of turnover suggests new cyclical consequences of labor market sclerosis, labor adjustment costs and firing regulations. Common macroeconomic analyses of those factors investigate steady-state effects such as cross-country variation in unemployment, rather than cyclical implications. For example, two secular changes in the U.S. economy might have affected the extensive and intensive margin of average-wage cyclicality. First, the secular decline in the U.S. separation rate has lowered the extensive margin of wage adjustment. Estimating the separation rate from the BLS unemployment stock data, I find that the trend of monthly separation rate fell from 4% in 1980 to 2% in 2013 (Figure 15b). The financial channel of wage rigidity would predict the U.S. secular decline in turnover to entail deeper and longer recessions as a consequence of sharper and longer cash flow crunches. A testable prediction would relate industry variation of turnover levels and heterogenous trend changes therein to the speed of an industry’s employment recovery (and secular changes therein). Second, the secular decline in the inflation rate may have effectively lowered $(1 - \rho)$ (the intensive margin of flexibility of the incumbents’ real wages) under nominal wage rigidity. The financial channel of wage rigidity might thus link both frictions in the adjustment of incumbents’ wages with the contemporaneous emergence of “jobless recoveries”, which manifests itself in Figure 15b as sluggish recoveries of hiring via the job-finding rate.

**Duration-Dependent vs. Homogeneous Separation Rates.** The DMP literature imposes a counterfactually homogeneous separation rate of $\delta \approx 10\%$ per quarter during a job. This simplification masks the substantial duration dependence of separations found in the data,
which I highlight in Figure 15c. After six months, only 40% of job entrants remain on the job, in comparison to 80% as predicted by the constant separation hazard. Under IMWR, this empirical tension is innocuous as long as financial constraints are slack. But when financial constraints bind, a cohort-specific separation hazard would slow down the extensive margin of average-wage adjustment because churn largely occurs among the same, marginal workers. The core incumbent workers – who drive the sluggish average wage – remain on the job throughout the recession, squeezing cash flow for longer. Incorporating the realistic (but in the DMP literature irrelevant and thus ignored) feature of duration dependence in turnover would amplify the financial channel of wage rigidity, in an economically interesting way.

Tenure Effects vs. Homogeneous Wages. The empirical wage-tenure profiles imply that the typical incumbent worker’s earnings exceed those of marginal workers, because of human capital growth, incentive purposes or match quality. Using Quarterly Wage Indicator data for 1996–2013, I calculate that a typical new hire earns only two thirds of incumbents’ salary within an industry. The current model side-steps such tenure effects on wages and might therefore underestimate the financial burden that incumbent workers exert, particularly in combination with the similarly side-stepped tenure dependence of the separation rate. In contrast, in standard models without financial constraints such tenure effects would be neutral and bargained away similarly to IMWR.

III. Leverage From Wage Rigidity. Several parallels emerge between wages and interest expenditure. The latter has received more attention as a drain on corporate resources in low-cash-flow states. First, labor, along with taxes, generally enjoys the most senior claim on cash flow, even before creditors. Rigid wage contracts are debt-like in terms of their lacking responsiveness to the firm’s financial condition, and in fact some theoretical underpinnings of wage rigidity echo the asymmetric information theories of debt. Like debt, wages are renegotiated in extreme financial distress. Second, the accounting concept of operating leverage is related to this paper’s cash flow effect of wage rigidity, although it typically refers to the fixity of quantities rather than prices. Wage rigidity might be the

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59 The particular representation in Figure 15c computed from CPS tenure data and taken from Hall (2014).
60 See Solon et al. (1994) for the composition bias is the cyclicity of the simple average wage.
61 The data do not distinguish hires from job-to-job transitions and those out of unemployment.
62 Hall and Lazear (1984) and Kennan (2010) feature information wage rigidity mechanisms that implicitly parallel mechanisms related to informational foundations of debt contracts (Townsend (1979)).
63 Benmelech et al. (2012) documents airlines renegotiating wage contracts during financial distress.
64 Operating leverage denotes the amplification of profit responses to sales caused by fixed-quantity costs, with a focus on individual firms. The financial channel I explore differs in two ways. First, operating leverage is generally not connected to real effects emerging under financial constraints. Second, operating leverage refers to cost rigidity arising from fixed input quantities rather than rigid input prices. Operating leverage might focus on quantities because the individual firm is considered a price taker, although the profit/quantity...
key source of operating leverage in aggregate terms, as payroll exceeds the often examined fixed commitment of interest expenditure as a drain on cash flow by a factor of 10–20, as the cash flow statement of the U.S. nonfinancial corporate sector in Figure 1 illustrates. Third, Fisher (1933) debt deflation worries about the real burden of firms’ debt under disinflation. But wage contracts share the key properties (nominally sticky and long-term) that Jermann et al. (2014) highlight as crucial for the debt mechanism. The financial channel of (nominal) wage rigidity implies that similar, if not much larger, effects might arise from wages under disinflation.

IV. Compensation vs. Wages. The financial channel of wage rigidity applies to all components of compensation rather than to wages only. Non-wage/-salary compensation (employer’s contributions to health insurance, pensions,...) now makes up around 20% of aggregate labor costs, up from less than 10% in 1960, as I summarize in Figure 15d. Moreover, with firm-level survey micro-data from the Wage Dynamics Network in Figure 15a, I document that firms consider cutting incumbents’ non-wage compensation (bonus and benefits, promotions) a crucial tool of labor cost reductions.

A priori, those components may be more rigid than wage rates, on which empirical studies tend to focus. Indeed, anecdotal and survey evidence indicates that employers do worry about the countercyclicality of the financial burden from rigid inframarginal, non-wage labor costs, for example their countercyclical contribution requirements to retirees’ and incumbents’ defined-benefit pensions. Employers call for procyclical requirements to alleviate the financial burden during recessions: “These extraordinary pension funding requirements... could derail the [2009] economic recovery by forcing these employers to either severely curtail their capital investments or make further reductions in their workforces.” (American Benefits Council (2009)) By contrast, standard frameworks deem the rigidity of DB funding requirements irrelevant: “Retiree pension obligations are fixed costs... Thus, basic economic theory predicts they should have no effect on firms decisions.” (Aaronson et al. (2004) 65) This paper’s framework predicts cyclical consequences from moving to more cyclically flexible compensation structures such as defined-contribution plans, performance pay or profit sharing through the financial mechanism.

V. Countercyclical Compensation Backloading Appears Limited. Could the wage bargaining parties attenuate the liquidity squeeze in recessions by backloading wages? The wage bargain in the model (22) limits such borrowing from workers by precluding state-nexus is second-order by Shepard’s lemma. In the aggregate and even the firm level (through profit sharing, bargaining etc.), much of operating leverage may come from the response of prices (wages) to shocks.  

Rauh (2006) exploits cash-flow shocks from pension refunding but does not treat the broader liquidity channel of compensation.
and period-contingent wage contracts, with a variety of potential underlying frictions. Is this assumption empirically justified? Unfortunately, empirical evidence on the dynamic structure of wage contracts, let alone its cyclical variation, is scarce. Guiso et al. (2013) document that tenure wage profiles differ by local financial development, and Michelacci and Quadrini (2005) investigate how firms’ degree of financial constraints affects growth and wage paths. The financial channel of wage rigidity suggests a liquidity aspect to the cyclical variation in compensation backloading, for which existing studies of spot-wage cyclicality provide little empirical guidance.

I document new empirical evidence for limited cyclical compensation backloading, using unique wage contract micro data: the universe of Canadian collective bargaining agreements from 1975 to 2013. Most importantly, my data set differs from conventional (flow) wage data in that it reveals the wage path as contracted at settlement, along with realized wages. Moreover, institutionalized collective (vs. decentralized) bargaining might facilitate backloading arrangements in practice – and thus detecting it in the data.

To operationalize the analysis, I propose an intertemporal Gini coefficient approach to quantifying the degree of compensation backloading over the course of long-term wage contracts. The thought experiment concerns a patient worker continuously employed over the contract duration. The intertemporal Lorenz curve asks: by which fraction of contract duration has which fraction of compensation been paid out? The Gini coefficient of compensation backloading integrates the difference between the Lorenz curve of a given contract and the constant-payout benchmark. It ranges from −1 (perfect frontloading) over 0 (constant-payout) to 1 (perfect backloading). Intuitively, for small deviations from the constant-payout benchmark, positive Gini values correspond to the fraction of compensation backloaded from the first period to the subsequent ones; negative units denote the fraction frontloaded.

The mean Gini coefficient (real wages) is 3 · 10⁻⁴. That is, the average contract neither front- nor back-loads compensation appreciably. Moreover, the dispersion is tiny: the 25th

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66 Berk and Walden (2013) discuss human capital risk as a constraint on dynamic wage contracts. Additional concerns should mirror the objections to the “bonding critique” of efficiency wages and severance payments (Katz 1986, Akerlof and Katz 1986, Lazear 1990). Regarding cyclical variation in backloading, a richer model moreover would likely make ambiguous predictions, for example when households are risk averse and liquidity-constrained too.

67 Such intertemporal patterns of compensation are typically rationalized as incentive schemes or human capital dynamics.

68 Incl. settlement data, previous wage, and the wage changes over the course of the contract scheduled ex ante or occurring due to COLA clauses. The data cover all contracts with employment greater than 100 for the federal and 500 for the provincial level. The 18,000 contracts include 8,000 private sector ones. I focus on the private sector. A shorter subsample of this data was used as the “Labour Canada Wage Tape” by Abowd (1989), Card (1990), Abowd and Lemieux (1993) and Christofides and Oswald (1992). The data set was constructed for this project with the Workplace Information and Research Division, Labour Program, Employment and Social Development Canada, to whose research staff the author is grateful.
(1st) and 75th (99th) percentiles are -0.004 (-0.019) and 0.005 (0.017). But how much cyclical variation is there in backloading? Figures plots detrended quarterly averages of Gini coefficients for real and nominal wages, along with recession dates. First, the cyclical variation of the Gini coefficient is again tiny. Second, contracts do not start backloading real compensation until late in the recession. Third, Figure plots the Gini coefficient against detrended log GDP. Real compensation appears to exhibit mildly procyclical backloading. I conclude that at least collective wage bargaining appears to leave little room for cyclical compensation backloading, supporting the amplification capacity of wage rigidity as well as the restrictions on wage contracts assumed in the model.

VI. Insider-Outsider Effects Through Liquidity. In establishing a link between incumbent workers’ wages and outsiders’ employment opportunities, this paper’s amplification mechanism is broadly related to the Lindbeck and Snower (1989) insider-outsider model. The key difference is the mechanism: the Lindbeck-Snower model features standard labor demand with homogeneous wages. The firm hires until the marginal product of a worker equals the firm-level wage. Incumbent insiders inadvertently discourage hiring by propping up the price of unemployed outsiders along with their own wage. In contrast, in this paper’s financial channel, insiders squeeze financial resources that would otherwise be available for hiring. A key distinction of the financial mechanism is its ability to rationalize the coexistence of high unemployment among youth and other outsiders (with comparatively flexible wages) in two-tier labor markets such as Italy, Spain or Portugal, where incumbent insiders enjoy wage and job security. Indeed, some of the best evidence for the wage cyclicality differential between new and incumbent workers comes from Portugal. The standard view would prescribe cutting wages among new hires even further, while the financial channel of wages suggests that labor cost reductions among incumbents might stimulate hiring.

VII. Payroll Tax Cuts Among Incumbent Workers. Do policy remedies to incumbents’ wage rigidity necessarily expose households to more labor income risk? Lower wages in recessions may trigger adverse aggregate demand or welfare effects if households too face liquidity constraints. However, in practice, structuring employer-borne payroll taxes in a procyclical way may offset the rigidity in firms’ labor costs without lowering post-tax labor income. Given the role of incumbents, such payroll tax cuts would target all workers. In contrast, policy prescriptions based on the standard model recommend implementing hiring subsidies for new hires only, and deem any transfers to incumbents ineffective.

69 See Martins et al. (2012) and Carneiro et al. (2012) for Portugal.
70 Kehoe et al. (2014) investigate the effects of worker debt constraints under external finance shocks, integrating the Mian and Sufi (2012) aggregate-demand channel from deleveraging into the macro-labor context. Empirical work finds that unemployed workers appear liquidity constrained (Gruber (1997), Chetty (2008)), yet this paper’s channel refers to incumbent workers, with likely smaller consumption responses.
in terms of stimulating hiring.\footnote{For example, “subsidizing the jobs of incumbent workers in firms that recruit has no employment effects: all it does is to create windfalls for firms.” (Cahuc et al. (2014)) More broadly, fiscal policy through payroll taxes in e.g. Farhi et al. (2013) and Correia et al. (2013) also works through standard marginal-cost rather than liquidity channels (but would replicate the flexible-price/-wage allocation even with liquidity effects).} Evidence for such marginal wage subsidies to stimulate hiring is mixed.\footnote{See Katz (1996) or Egebark and Kaunitz (2014). Cahuc et al. (2014) find moderate hiring effects.} Singapore uses such procyclical payroll taxes on all workers for purposes of macroeconomic stabilization.\footnote{Singapore for example cut payroll taxes from 20% to 10% in the 1999 and 2003 downturns and restored rates in between. Ongoing follow-up work evaluates these procyclical payroll taxes at the fine industry level.} Ongoing work (Schoefer and Seim (2015)) investigates how such policies might stimulate hiring and investment by stabilizing cash flow rather than by changing factor prices at the margin. We evaluate an age-specific, 10–18 percent cut of employer-borne payroll taxes in Sweden. The empirical design brings also an additional micro-empirical test of this paper’s mechanism, and tests whether cash flow effects from wages may drive a share of the wage elasticity of labor demand in general.

7 Conclusion

I revisit the role of wage rigidity in recessions with a focus on the financial frictions firms face when investing and hiring. Under such frictions, I show that wages also affect labor demand through cash flow, not only as a factor price at the margin. Payroll is by far the dominant drain on corporate cash flow. By squeezing cash flow in recessions, rigid wages curb investment and hiring. I empirically establish this financial channel of wage rigidity with a set of aggregate, industry-level and firm-level evidence. The financial burden from rigid wages appears to cause bankruptcies and declines in credit worthiness, as well as in profit and in cash flow, which I find transmit into employment and investment. Conversely, I calculate that a slight increase in wage procyclicality could perfectly smooth profits and cash flow over the business cycle, attenuating those financial factors in aggregate fluctuations.

I quantify the equilibrium effect of the financial channel of wage rigidity by integrating it into a calibrated macro-labor model. The channel helps the model account for the volatility of hiring in the U.S. data. It applies to capital investment too. The financial channel of wage rigidity also generates new cyclical roles for compensation backloading, the labor share and turnover, which condition its amplification. Finally, in recessions, cuts to employer-borne payroll taxes, for all workers rather than for new hires only, might be a practicable policy tool to stimulate hiring while preserving household labor income.

This paper’s financial channel of wage rigidity contrasts with standard amplification of hiring fluctuations from wage rigidity, which works through making the marginal cost of labor rigid. In those models, incumbent workers’ wage rigidity is just a fixed cost, canonically irrelevant for hiring. I shift focus onto inframarginal incumbent workers, those neither looking...
for a job nor at risk of layoff, who make up the vast majority of the workforce. Their wages are an empirically appealing source of amplification as they actually appear rigid in the data, whereas the evidence for new hires’ wage rigidity remains mixed and elusive.

I conclude by pointing out that the financial channel of wages might play a role in labor demand more generally. A corporate finance economist may see cash flow shocks where labor economists see exogenous wage changes. I propose as a conceptual decomposition a “Slutsky identity” of liquidity-constrained labor demand. Besides the standard marginal (substitution and scale) effects, it features the new liquidity effect of wages in factor demand (akin to the income effect in standard consumer theory):

\[
\varepsilon_{n,w}^{\text{Marshallian}} = \varepsilon_{n,w}^{\text{Hicksian}} \bigg|_{\text{Liquidity}} - \frac{\bar{w}d\text{Employment}}{d\text{CashFlow}}
\]

Having estimated this employment-cash flow sensitivity to lie between 0.2 and 0.6, I speculate that a share of the short-run effect of wages on employment might actually be driven by the financial channel of wages. A testable prediction is that financially constrained firms’ labor demand elasticities are higher due to the cash flow effect.
References


Simintzi, E., V. Vig, and P. Volpin (2010). Labor and capital: Is debt a bargaining tool?


Derivations and Proofs

The Neutrality of IMWR When Financial Constraints Do Not Bind

Proof 1. Ex-post neutrality of IMWR without financial constraints.

1.1 \(\frac{dw}{dz} = (1 - \rho)\frac{dw}{dz} n\): IMWR \(\rho\) attenuates incumbent worker’s wages response productivity shocks vis-à-vis new hires’ wages.

1.2 \(\frac{d\theta}{d\rho} = d\theta/d\phi^- = 0\): labor market tightness is not affected by incumbents’ payroll.

Proof 2. Ex-ante neutrality of IMWR without financial constraints.

2.1 \(d\frac{dw}{dw} < 0\): IMWR \(\rho\) smooths new hires’ base wages in response to productivity shocks \(dq\) (e.g. here with law of motion \(z = (1 - r\bar{z} + rz^- + dz)\):

\[
\frac{dw}{dz} |_{\rho = 0} = \frac{1}{1 + \rho \beta(1 - \delta) \frac{(1 - r\bar{z})}{1 - \beta(1 - \delta)}} \leq \frac{dw}{dz} |_{\rho = 0}
\]

2.2 \(dE_{PV}(w)/d\rho = d\frac{dE_{PV}(w)}{dz} / d\rho = 0\): the present value of wages in new matches (which determines hiring) and its cyclicality are independent of IMWR \(\rho\):

\[
\frac{d\Phi}{dz} / d\rho = d\frac{d\Phi}{d\rho} = 0
\]

2.3 \(d\theta/d\rho = d\frac{d\theta}{d\rho} = 0\): for wage rule \(w_{\rho} > 0\), all quantity variables as well as their cyclicality are unresponsive to IMWR \(\rho\), as \(\rho\) does not affect hiring:

\[
\frac{k}{q(\theta^+)} = \frac{1 - \delta}{1 - \beta(1 - \delta)} E[(w^+ - w^+ + \rho)w^{++1 - \rho}] + (1 - \delta)\beta E \frac{k}{q(\theta^+)}
\]

\[
= \frac{1}{q(\theta^+)} = \frac{1}{q(\theta^+)} + (1 - \delta)\beta \frac{k}{q(\theta^+)} = \frac{k}{q(\theta^+)}
\]
I follow the investment-cash flow sensitivity literature in analyzing U.S. publicly traded companies using Compustat data. I moreover impose the same sample restrictions as the original designs. I construct $w_{marg}$ as a scaled leave-out-mean per-employee salary measure to isolate quantity-driven employment changes and to increase the sample size. Standard firm-level data like Compustat requires me to construct such a work-around to measure $d\text{Payroll}_{i}^{marginal} = w_{marg} \cdot d\text{Emp}_{i}$, because of two challenges: first, one should avoid ascribing all changes in total payroll to marginal changes in net employment. Payroll of incumbents likely moves with cash flow (pension funding, profit sharing, bonuses, stock options,...), in response to an idiosyncratic cash flow shock. See Christofides and Oswald (1992), Bertrand (2004), Budd et al. (2005), Card et al. (2013) for evidence on rent sharing. I filter out changes in the number of employees on payroll from intensive compensation responses. The second concern is practical: even economic concerns aside, while most Compustat firms report employment, payroll reporting is scarcer, which would lead me to substantially reduce the samples vis-à-vis the original designs (the empirical design in Lamont (1997) uses 26 firms). As a solution I use the leave-out-mean salary times the firm’s actual net employment change: $\hat{d}\text{Payroll}_{i}^{marginal} = \hat{w}_{marg} \cdot d\text{Emp}_{i}$. I use a straightforward procedure to back out the marginal wage from the average wage via the elasticity of payroll to employment changes, which is around 0.45–0.5 in Compustat: $\frac{w_{marg}}{w_{avg}} = \frac{1}{n} \frac{d\text{Payroll}_{i}}{d\text{log}(n_{i})} \approx 0.475$, since $\frac{d\text{log}(\text{Payroll}_{i})}{d\text{log}(n_{i})} = \frac{n}{nw_{avg}} \frac{d\text{Payroll}_{i}}{d\text{Emp}_{i}} = \frac{w_{marg}}{w_{avg}}$, as $\frac{d\text{Payroll}_{i}}{d\text{Emp}_{i}} = w_{marg}$. This number matches other (individual-level-based) data sources I check, with little industry dispersion. For example, using the Quarterly Workforce Indicators I find that the average new hire makes around two thirds of the average worker’s earnings, even excluding separations. I go with the above strategy, which might yield a conservative employment-cash flow sensitivity with its lower number.
Table 1: My Estimates of the Employment Sensitivity to Cash Flow Shocks. Six Identification Designs.

<table>
<thead>
<tr>
<th>Design</th>
<th>Identification (Liquidity Shock)</th>
<th>Data</th>
<th>Cash Flow Sensitivity: $\beta$ (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Tobin’s $q$/ALP &amp; cash flow</td>
<td>Aggregate analysis</td>
<td>Flow of Funds (1950-2013)</td>
</tr>
<tr>
<td>II</td>
<td>Tobin’s $q$ &amp; cash flow</td>
<td>“Structural” approach: the empirical designs augment the frictionless model with cash flow.</td>
<td>Compustat (1950-2012)</td>
</tr>
<tr>
<td></td>
<td>Fazzari et al. (1988)</td>
<td>Kaplan and Zingales (1997)</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>Benmelech et al. (2012)</td>
<td>McLean and Zhao (2014)</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Oil price shocks &amp; conglomerates</td>
<td>How do internal capital markets in conglomerates transmit an exogenous cash flow shock from oil-related to -unrelated segments?</td>
<td>Compustat (segments) (1985-86)</td>
</tr>
<tr>
<td>IV</td>
<td>Stock option redemption</td>
<td>Cash flow shock from discontinuous redemption of employee stock options once in the money [0.72 (inv.) &amp; 0.61 (emp.) if I deviate from org. spec. by applying reg. kink design]</td>
<td>Compustat, Risk Metrics (1999-2005)</td>
</tr>
<tr>
<td></td>
<td>Babenko et al. (2011)</td>
<td>Babenko et al. (2011)</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>DB pension refunding</td>
<td>Mandatory DB pension refunding shocks triggered by asset/liability ratios generate cash flow shocks.</td>
<td>Compustat, IRS F. 5500 (1990-1998)</td>
</tr>
<tr>
<td>VI</td>
<td>Real estate collateral</td>
<td>Between-firm variation in real-estate holdings and real-estate price changes trigger changes in firms’ collateral capacity [IV effect from realized long-term debt response, increases (up to 2x) w/ alt. debt cap. measures]</td>
<td>Compustat 1993-2007</td>
</tr>
<tr>
<td></td>
<td>Chaney et al. (2012)</td>
<td>Chaney et al. (2012)</td>
<td></td>
</tr>
</tbody>
</table>

Notes: My estimates of the employment-cash flow sensitivity & my replication of the conventional capital investment for each design. Full version in ongoing companion paper. I thank various authors of investment designs for facilitating the implementation.
Table 2: Parameterization in Calibrated Model; Quarterly Frequency.

<table>
<thead>
<tr>
<th>Param’r</th>
<th>Value</th>
<th>Description</th>
<th>Target</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma_z$</td>
<td>0.02</td>
<td>Standard deviation of $z$</td>
<td>BLS average</td>
<td></td>
</tr>
<tr>
<td>$\rho_z$</td>
<td>0.95</td>
<td>Autocorrelation of $z$</td>
<td>labor productivity</td>
<td></td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.1</td>
<td>Separation rate</td>
<td>Current Pop. Survey</td>
<td></td>
</tr>
<tr>
<td>$\beta^H$</td>
<td>0.953</td>
<td>Household discount factor</td>
<td>Annual rate of 4%</td>
<td>Shimer (2005)</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0.6</td>
<td>Labor disutility</td>
<td>Opportunity cost of empl.</td>
<td></td>
</tr>
<tr>
<td>$\mu$</td>
<td>1.355</td>
<td>Matching efficiency</td>
<td>Beveridge curve</td>
<td></td>
</tr>
<tr>
<td>$\varphi$</td>
<td>{0.5, 0.72}</td>
<td>Vacancy matching elasticity</td>
<td>Beveridge curve</td>
<td></td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.72</td>
<td>Worker bargaining power</td>
<td>Hosios (1990) condition</td>
<td></td>
</tr>
<tr>
<td>$k$</td>
<td>0.213</td>
<td>Vacancy flow cost</td>
<td>6% S.s. unemp. rate</td>
<td></td>
</tr>
<tr>
<td>$\alpha$</td>
<td>[0, 0.5]</td>
<td>Cash flow-liquidity</td>
<td>Match employment-cash flow sensitivity estimates</td>
<td>Own estimates (Section 3.2)</td>
</tr>
<tr>
<td>$L^{ss}$</td>
<td>0.012</td>
<td>Baseline liquidity</td>
<td>Close to s.s. vacancy cost w/o FCs</td>
<td>Internally calibrated</td>
</tr>
<tr>
<td>$\bar{\beta}(\xi^B)$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$d^{ss}(\xi^D)$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\rho$</td>
<td>{0.05, 0.8, 1}</td>
<td>Inframarginal wage rigidity</td>
<td>Cyclicalit of wages in new vs. old matches</td>
<td>Pissarides (2009)</td>
</tr>
</tbody>
</table>
Figures

Figure 1: Cash Flow Statement of the U.S. Nonfinancial Corporate Sector, 2006.

Notes: Levels of value added, payroll, internal funds (cash flow), interest, dividends, debt and equity raised, and capital expenditure. Drains on corporate resources (e.g. payroll) are negative, inflows (e.g. debt raised) are positive. Source: Federal Reserve Flow of Funds.

Figure 2: Internal Funds and Investment.

(a) Total investment, and amount directly financed by internal vs. external sources; German manufacturing firms. Level values (y-axis) pending disclosure view. Source: author’s calculation using restricted-access micro-data (ifo Investment Survey).

(b) Two measures of internal funding: \(\frac{\text{agg. CashFlow}}{\text{agg. CapX}}\) (“internally financed”), and the sum of firm-level cash flow capped at firm-level capital expenditure, over total capital expenditure (“internally financed without financial intermediation”). Source: Compustat, non-financial firms.
Figure 3: Industry Cash Flow Dynamics and the Labor Share.

(a) Industry-level cash flow cyclicality (comovement w/ unemployment; more negative numbers represent stronger procyclicality).

(b) Firm-level cash flow cyclicality (Compustat; comovement w/ unemployment; more negative numbers represent stronger procyclicality).

(c) Cash flow elasticity to industry value added.

(d) CF elast. to industry avg. labor productivity.

(e) Cash flow elasticity to industry TFP.

(f) CF elast. to ind. input price index shock.

Notes: Binned scatter plots; each data point represents 23 industries. Long-run average labor share (payroll over value added), all other variables in logs and detrended on the industry level (HP filter, $\lambda = 6.25$). Elasticities are the coefficients from industry-level regressions of cash flow (value added minus payroll) on shocks. Results are robust to value of shipments instead of value added. Annual data, 1958-2009; 473 6-digit NAICS manufacturing industries. Source: NBER-CES Manufacturing Industry Database & Compustat.
Figure 4: The Labor Share and Firms’ Financial Conditions over the Business Cycle.

(a) Bond Rating Changes by Labor Share

(b) Bankruptcies by Industry’s Labor Share

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Notes: Firms are cut above/below median of excess liquidity in pre-recession reference year (vertical line). Excess liquidity: residual of liquid over total assets regressed on size (total asset deciles) & 2-digit SIC industry and interactions. Annual, weighted by pre-recession levels. Source: Compustat.
Figure 6: Internal Funds & Recessions (continued). See Figure 5 for documentation.

(a) 1982 Recession

(b) 1970 Recession
Figure 7: Industry-level Cyclicalities by Labor Share: Cash Flow, Employment, Investment.

(a) Recession event studies: Employment declines by labor share.

(b) Recession event studies: Cash flow declines by labor share.

(c) Recession event studies: Capital expenditure declines by labor share.

(d) Industry cyclicalities: cash flow, employment, capital expenditure.

Figure 8: See main text for construction of cyclicality measures (coefficient on detrended unemployment from industry-level regressions). Source: NBER-CES Manufacturing Industry Data Base, annual data, 1958-2009.
Figure 9: The Cyclical Behavior of Hiring, Labor Market Tightness, Labor Productivity, and Investment.

Notes: Hiring: vacancy proxy from Conference Board Help-Wanted Index (composite version by Barnichon (2010)); labor market tightness: ratio of vacancies over (BLS) unemployment rate; (real) capital expenditure: Flow of Funds; average labor productivity: real output over civilian employment. Quarterly data points, 1954-2013, all in logs, detrended (HP-filter, $\lambda = 10^5$ commonly used in the DMP literature).
Figure 10: Wage Dynamics Under Three Levels of Infrahmarginal Wage Rigidity.

Panel A: No IMWR ($\rho = 0$)

Panel B: Perfect IMWR ($\rho = 1$)

Panel C: Intermediate IMWR ($\rho = 0.5$)

Notes: Wage Dynamics under IMWR $\rho \in \{0, 0.5, 1\}$ in Panels A, B and C. The impulse response of the going wage is to a 1 SD ($\sim 2\%$) shock to productivity. Column I shows wage biographies: the workers’ wages by their hiring cohort, along with the going wage. Column II shows impulse responses of new hires’ and average wages.
Figure 11: Simulated Standard Deviations in Benchmark Model without Financial Constraints, for Inframarginal Wage Rigidity $0 \leq \rho \leq 1$.

Notes: Inframarginal wage rigidity parameter $\rho \in [0, 1]$, where $\rho = 1$ denotes perfect cohort wage effects and where $\rho = 0$ denotes perfect period-by-period (re-)bargaining of the wage. The driving force are productivity shocks. The simulated data are quarters, seasonally adjusted and HP-filtered with smoothing parameter $\lambda = 10^5$. Table 2 lists the calibrated parameters.
Figure 12: Simulated volatilities (standard deviations) of key labor market variables in model with medium financial constraints ($\alpha = 0.2$), for inframarginal wage rigidity $0 \leq \rho \leq 1$.

Notes: Inframarginal wage rigidity parameter $\rho = 1$ denotes perfect cohort wage effects and where $\rho = 0$ denotes perfect period-by-period (re-)bargaining of the wage. $\alpha = 0.2$ corresponds to an employment-cash flow sensitivity of 0.25. The driving force are productivity shocks. The simulated data are quarters, seasonally adjusted and HP-filtered with smoothing parameter $\lambda = 10^5$. Table 2 lists the calibrated parameters.
Figure 13: Changes in Employment Cyclicality vs. Labor-Share Changes.


(b) Changes in employment cyclicality by long-run changes in labor share. Binned scatterplot of annual data points (1958–2009) and 473 industries. The panel regression of industry $i$ in year $t$ is: $cyc_{ln}(Emp_{it}) = \beta_1 \cdot cyc_{URate_t} \cdot trend_{LaborShare_{it}} + \beta_2 \cdot cyc_{URate_t} \cdot IndustryFE_i + \beta_3 \cdot trend_{LaborShare_{it}} + \beta_4 \cdot IndustryFE_i + \beta_2 \cdot cyc_{URate_t} + \epsilon_{it}$. The graph plots the residualized dependent variable and the residualized boxed interaction effect. Source: NBER-CES Manufacturing Industry Data Base, annual data, 1958-2009.
Figure 14: The Role of Turnover in Labor Market Fluctuations with and without Financial Constraints.

Notes: Simulated moments: volatility (standard deviation) of labor market tightness variables vs. turnover $\delta$, for model without financial constraints and the financial-constraints model with financial constraints ($\alpha = 0.2$), for a series of economies with inframarginal wage rigidity parameter $\rho = 0.5$ (matching the empirical wage cyclicality differential between new and incumbent workers). The driving force are productivity shocks. The simulated data are quarters, seasonally adjusted and HP-filtered with smoothing parameter $\lambda = 10^5$. Table 2 lists the calibrated parameters.
(a) Survey responses: Which measures of cutting labor costs has the firm used, conditional on having cut labor costs? I exclude firms with less than 5 employees. Survey period was 2007 and 2008. Source: Author’s calculations using firm-level survey micro-data from Wage Dynamics Network.

(b) Cyclical Effects of the Secular Decline in the U.S. Separation Rate? Quarterly data, 1947–2013, constructed form monthly BLS unemployment stock data by duration.

(c) Duration Dependence in Job Separation: Actual separation rate from CPS tenure data vs. (standard DMP) constant separation rate. Source: data and figure from [Hall (2014)] (CPS data).

(d) Share of aggregate compensation in non-wage/salary components. Source: BEA, Compensation of Employees.
Figure 16: Real & Nominal Compensation Backloading (Gini Measure) During Recessions.

Notes: Quarterly averages. Dates denote settlement date of the wage contract. Lower Gini values denote more compensation backloading over the course of a wage contract. See paper for details on the construction of the measures. Source: Universe of Canadian CBAs, 1975–2013, constructed with the Workplace Information and Research Division, Labour Program, Employment and Social Development Canada.

Figure 17: Real & Nominal Compensation Backloading (Gini Measure) on log GDP.

Notes: Gini measures and log GDP are HP-filtered ($\lambda = 1600$). Binned scatterplot of quarterly averages; 7 data points per bin. Dates denote settlement date. Lower Gini values denote more compensation backloading over the course of a wage contract. See paper for details on the construction of the measures. Source: Universe of Canadian CBAs, 1975–2013, constructed with the Workplace Information and Research Division, Labour Program, Employment and Social Development Canada.