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. Much empirical evidence, however, 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 lets the calibrated model account for more than 50 percent 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, for which I provide industry-level evidence. Finally, the cash flow channel may drive a share of the elasticity of labor demand to wages in general.

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1 Introduction

In a typical recession, firms cut hiring by 40-50 percent from peak. The resulting dearth of job opportunities accounts for around 70 percent of the increase in unemployment.\(^1\) 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, unlike those of incumbents.\(^2\)

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 amplifies fluctuations by squeezing firms’ internal funds. I find that this financial channel of wage rigidity can account for more than 50 percent of observed cyclical fluctuations of hiring in the U.S. data.

I first empirically establish the dominant role of wage rigidity in amplifying the 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 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.\(^3\) No other drain on aggregate cash flow could realistically stabilize internal funds in recessions.\(^4\) 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. Similarly, corporate bond rating downgrades and bankruptcies cluster in high labor share industries during recessions.

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\(^1\) The hiring measure is vacancy postings. See \cite{Hall2005a, Shimer2012} for the role of fluctuations in hiring, vacancy postings and the job finding rate in aggregate employment fluctuations, and \cite{Davis2006, Davis2013} 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. \cite{Shimer2004, Hall2005b, Hall2008, Elsby2009, Pissarides2009, Shimer2010, Michaillat2012}). The paradigm also guides empirical work: \cite{Pissarides2009, Kudlyak2014, Haeffke2013, Carneiro2012, Martins2012} find new hires’ real wages to be substantially more procyclical than incumbents’ wages. Nominal wage rigidity is measured off incumbents (e.g. \cite{Card1997}). Qualitative studies tend to investigate incumbents (\cite{Bewley1999, Galusca2012}). Most theories rationalize wage rigidity among incumbents. Work tying new hires’ to incumbents’ wage rigidity (\cite{Lindbeck1989, Gertler2009, Snell2010}) relies on marginal channels. Wage rigidity on both margins would just add the standard marginal channel to the financial one but not attenuate it.

\(^3\) \cite{Pissarides2009} 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 of would need to turn strongly negative.
Would the smoother cash flow from less rigid wages generate 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. The cash flow provided by small wage adjustments would 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. 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 workhorse macroeconomic model used to assess the cyclical importance of wage rigidity, the Diamond-Mortensen-Pissarides (DMP) search and matching model. Its long-term employment relationships allow me to isolate the financial channel (which works through incumbents’ wages) from standard amplification (through new hires). Indeed, 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. The paper does not provide new micro-foundations for why the incumbent worker and the firm maintain such wage policies, although I do refer to a variety of potential theoretical underpinnings. Financial constraints arise from a borrowing constraint that uncommitted cash flow (net of dividends and interest) partially alleviates. I parameterize the financial frictions in relation to my empirical estimates of the employment-cash flow

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5 Those shocks 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, which Stein (2003) reviews. 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 (Jensen and Meckling (1976), Stein (1989), Stein (2003), Bertrand and Mullainathan (2005), Blanchard et al. (1994), Malmendier and Tate (2008)) and asymmetric information (Myers and Majluf (1984)). The financial channel of wage rigidity is robust to any link between inputs and cash flow.

6 Wage rigidity is typically directly assumed (Hall (2005b), Shimer (2010), Michaillat (2012), Gertler and Trigari (2009)); some work generates wage rigidity from a specific theoretical micro-foundation (Hagedorn and Manovskii (2008), Hall and Milgrom (2008), Christiano et al. (2013), Eliaz and Spiegler (2013)).
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, with incumbents’ wages 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 a role for internal funds that incumbents’ wages could 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.

However, 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. I first show theoretically how financial constraints break the neutrality of IMWR. Second, I 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 50 percent 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 the financial amplification quantitatively irrelevant. Hiring might thus be much smoother in a counterfactual economy with slightly more procyclical incumbents’ wages.

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. As a solution, I discuss the implementation via procyclical employer-borne payroll tax cuts. Such stabilizers would 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 in terms of stimulating hiring.

Evidence

While hiring is an explicit investment activity in the DMP model, any mechanisms linking employment with cash flow would preserve the results, such as complementarity with capital as the ultimate factor subject to financial constraints. Moreover, the mechanism also applies to capital investment as an outcome.

Bargaining over the entry wage perfectly offsets IMWR in new matches, leaving the present value of wages constant. This ex-ante “present-value neutrality”, too, would be broken under liquidity demand that is fully responsive to short-run fluctuations in liquidity valuation, as explored in a previous version: constrained firms’ countercyclical cash valuation then renders the required wage frontloading costly.

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.

Evidence

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
for such marginal wage subsidies to stimulate hiring is mixed.\textsuperscript{11} Singapore uses such procyclical payroll taxes on all workers for purposes of macroeconomic stabilization.\textsuperscript{12} Ongoing work (Schoefer and Seim (2014)) 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.

The financial channel of wage rigidity appears to be relatively unexplored. DMP models with financial shocks (e.g. Petrosky-Nadeau (2009), Petrosky-Nadeau and Wasmer (2013), Hall (2014)) examine shocks to external finance or discount rates, but have no notion of internal funds and do not consider wage rigidity. 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.\textsuperscript{13} Corporate finance work investigates leverage as a strategic bargaining device in wage setting. Michelacci and Quadrini (2005), \textsuperscript{14} 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.\textsuperscript{15}

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.\textsuperscript{16} I show that it is wage rigidity that renders profits and cash flow so procyclical in the first place. But also in models with shocks to external finance as cyclical driving forces and in their empirical tests, firms’ internal funds must not easily offset those shocks.\textsuperscript{17} By stabilizing cash flow, slightly more procyclical wages than liquidity channels (but would replicate the flexible-price/-wage allocation even with liquidity effects).


\textsuperscript{12} 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, Abowd (1989), Danthine and Donaldson (2002), Draca et al. (2011), Favilukis and Lin (2012), and Donangelo (2014), consider asset prices or profits under wage/labor market frictions but not their real effects on inputs. Rauh (2006) and Bakke and Whited (2012) exploit cash-flow shocks from pension refunding but do not treat the broader point of the liquidity channel of compensation.

\textsuperscript{13} Matsa (2010), Simintzi et al. (2010), Monacelli et al. (2011), Benmelech et al. (2012), Guiso et al. (2013), and Berk and Walden (2013) investigate the effect of debt on wage contracts.

\textsuperscript{14} Lazear et al. (2013) document such countercyclical effort in one large firm during the recent recession.

\textsuperscript{15} See Bernanke and Gertler (1989) for the financial accelerator through net worth, and Kiyotaki and Moore (1997) and Shleifer and Vishny (1992) for the collateral value channel.

\textsuperscript{16} The credit shocks in Greenstone and Mas (2012) and Chodorow-Reich (2014) are accompanied by cash-
would alleviate credit crunches.

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. 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 determines 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 $w_1h_1$), discounted by $\beta$, minus today’s upfront recruitment expenditure $c(h_1)$. The explicit factor of production is labor, as in the core Diamond-Mortensen-Pissarides (DMP) model:

$$\max_{n_1} \left\{ \beta(zn_1 - w_1n_1) - c(n_1) \right\}$$

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 investment-like costs, e.g. 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 fluctuations? Consider a shock to productivity $z$. Without financial constraints, the cyclicity of hiring depends on how new hires’ flow drops; Campello et al. (2010) find that constrained firms used up internal funds during the crunch.
wages \( w_1 \) absorb shocks to productivity \( z \):

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

(b)

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 hiring incentives are 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 is also inherent in the standard non-DMP macroeconomic models with wage rigidity.

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 out of internal funds – cash flow today:

\[
c(n_1) \leq zn_0 - w_0 n_0
\]  

(c)

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 follows standard labor demand (b). In contrast, if borrowing constraint (c) binds, its Lagrange multiplier \(\lambda\) marks up upfront costs \(c(n_1)\).

Financially constrained hiring 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 average, rather than marginal, cash flow. In fact, since the constraint binds, the extreme financial constraints directly link recruitment with 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 \( z \):

\[
\frac{\partial \log(n_1^*)}{\partial \log(z)} = \frac{1}{\frac{w_1}{c}} \cdot \frac{z - w_0}{z - w_0} \cdot \left(1 - \frac{\partial w_0}{\partial z}\right) \tag{d}
\]

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 may be smooth. 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 empirically establish the quantitative relevance of the financial channel of wage rigidity in two broad steps. I first show that a slight increase in incumbents’ wage procyclical could smooth profits and cash flow with respect to the business cycle. Incumbents’ wages would move only towards the measured procyclicality of new hires’ wages to do the job. Second, I confirm the cash flow consequences of wage rigidity at the industry level, where I exploit variation in the labor share as a mediating factor. 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 firm-level financial constraints. 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. Lastly, I confirm that employment and capital investment are smoother in industries with lower labor shares.

#### 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 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 masked in aggregate statistics, I supplement this known aggregate fact with unique firm-level survey micro-data on the sources of investment finance in Figures 2a and 2b. Even on the firm level, I find that at least 95% of capital investment appears to be funded internally without any financial intermediation.

**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:

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

**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 cyclicity is markedly lower than that of new hires. I present the consensus estimates proposed by Pissarides (2009) in a comprehensive meta study:\footnote{Typically, log wages of individual $i$ in job $j$ are regressed on detrended unemployment as the cyclical indicator: $\ln(w_{itj}) = \beta_0 + \beta_{UR}UR_t + \beta_X X_{it} + \beta_{Xjt} + [FEs] + \varepsilon_{ijt}$. Worker- and firm-level controls, and firm-, worker- and even job-fixed effects, reduce cyclical composition bias. The wage cyclicity measure is the coefficient on unemployment: $e_{w,u} = \beta_{UR} = d\log(w_t)/dUR_t$. Pissarides (2009)’s meta study puts new hires at $e_{w,u}^{new} \approx 3$ vs. at most half for incumbents: $e_{w,u}^{inc} \in [1.0, 1.5]$. Pissarides (2009) and Haefke et al. (2013) also explore productivity as cyclical indicators, to which internal-funds/profit results remain robust.}

\begin{align*}
\frac{d\log(wage^{Incumbent})}{dUnempRate} & \approx -1.25\% \\
\frac{d\log(wage^{NewHire})}{dUnempRate} & \approx -3\%
\end{align*}
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 internal funds 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 \( \frac{d \log(w^{\text{inc}})}{d \text{UR}} = 1.25\% + 1.5\% = -2.75\% \), would smooth cash flow with respect to the business cycle. Incumbents would only move towards the measured cyclicality of an empirically realistic benchmark: new hires’ wages.

**Similar Results Hold for Profits.** Alternative financial amplification mechanisms can arise from fluctuations in firms’ profitability or collateral values.\(^{19}\) Pretax profit additionally subtracts the mildly procyclical depreciation from cash flow, resulting in higher procyclicality: \( \frac{d \log(\text{Profits})}{d \text{UnempRate}} \approx -9\% \). 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 perfectly smooth corporate profits with respect to the business cycle, again only requiring incumbents’ wages to inherit the wage cyclicity of new hires. In summary, because payroll is much larger 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 statement 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 comprehensive jubilee, lenders would need to inject three times more funds than is owed in interest. Similarly, dividends would need to fall by \( \frac{\text{Payroll}}{\text{Dividends}} \cdot 9\% \approx 170\% \).\(^{20}\)

**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

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\(^{19}\)See Bernanke and Gertler (1989)’s financial accelerator through asset prices, Kiyotaki and Moore (1997)’s collateral cycles, and Shleifer and Vishny (1992)’s fire sales.

\(^{20}\)Besides the overwhelming required counterfactual procyclicality, the empirical rigidity in these two components might be a second-best response to financial market imperfections. Debt inherently limits state contingency (Townsend (1979)); dividends might be smooth due to agency frictions (Jensen (1986)).
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 $CF = zn_0 - w_0n_0 = (1 - \sigma^L) \cdot zn_0$.\(^{22}\)

$$\frac{\partial \log(CF)}{\partial \log(z)} = \frac{1}{1 - \sigma^L} \cdot \left(1 - \frac{\partial w_0}{\partial z}\right)$$

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.\(^{23}\) 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 cyclacity measure mirrors the aggregate one, obtained from industry-level regressions of detrended log cash flow on detrended unemployment ($\frac{d\log(CashFlow_{it})}{dUnempRate_t}$). The key finding is that industries with higher labor shares exhibit more procyclical cash flow, as predicted by the fact that average (largely incumbents’) 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

\(^{21}\)For example, Bils et al. (2014) find industry wage stickiness and real wage rigidity measures to be uncorrelated.

\(^{22}\)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 is used external finance dependence proxy (Rajan and Zingales (1998). I find no cross-sectional or panel relationship with leverage in Compustat.

\(^{23}\)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.
factors such as more procyclical product demand, Figures 3c–3f 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 change in value added; Figures 3d and 3e repeat this exercise with industry-level average labor productivity as well as for industry-level TFP. Figure 3f conducts the exercise with shocks to industry-specific price indices of intermediate inputs. As predicted by wage rigidity’s role in mediating cash flow fluctuations, 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 from the Compustat Ratings module (1985 to 2013) to show that within the manufacturing sector, 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.

This section demonstrated evidence for wage rigidity underlying much of the cyclicality of firms’ financial conditions. The next section investigates whether an economy with smoother cash flow, such as the one with less wage rigidity, would indeed exhibit smoother employment thanks to the smoother cash flow.

3.2 How Much 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.

Firms with Cash Buffers Experience Smoother Recessions. I use cross-sectional variation in (U.S. Compustat) firms’ excess cash buffers to approximate the experiment of smoother cash flow from lower wages. I find that firms that happen to enter recessions with such excess internal funds, stabilize their employment and investment by burn through these buffers (I subsequently confirm the causal effect of internal funds on these outcomes using exogenous shocks to firm-level cash flow.) Firms in the simple model now hold assets \( A \) and can smooth negative shocks (which increase the shadow value of liquidity \( \lambda \)) by dissaving.

\[ \text{credit ratings drop more steeply during recessions.} \]

\[ \text{by labor share tercile.} \]

\[ \text{by year (1970 to 2010).} \]

\[ \text{in Figure 4b.} \]

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\[ \text{Firms in the simple model now hold assets } A \text{ and can smooth negative shocks (which increase the shadow value of liquidity } \lambda \text{) by dissaving,} \]
following decision rule \( f(\lambda, A) \), with \( f_\lambda(\lambda, A) > 0 \) and \( f_{\lambda A}(\lambda, A) > 0 \):

\[
\frac{\partial \log(n^*_1)}{\partial \log(z)} = \frac{1}{n^*_c} \frac{z}{z - w_0} \left( 1 - \frac{\partial w_0}{\partial z} + \frac{f_\lambda(\lambda, A)}{z} \frac{\partial \lambda}{\partial z} \right)
\]

from which follows that \( \frac{\partial \left( \frac{\partial \log(n^*_1)}{\partial \log(z)} \right)}{\partial A} < 0 \). 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.

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. The groups’ parallel behavior of the outcome variables before and after the recession suggest that the measure might not be problematically related to non-financial cyclical dynamics of the firm. While the patterns supports the financial mechanism, I next circumvent remaining concerns I subsequently investigate the employment effects of firm-specific cash flow shocks unrelated to investment opportunities, and obtain a dollar-for-dollar measure of the liquidity effect on employment.

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 5b and 6 for the early 70s, 80s, and 2000s recessions), the 2008/09 financial crisis makes for a particularly easy 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 to alleviate the tightening of liquidity, unlike the low-liquidity firms. These results 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

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 firm-level measures of financial constraints. I am intrinsically interested in liquidity.

First, the groups behave similarly before and after the recession. Second, 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 projects, 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. Harford et al. (2014) document precautionary cash holdings among firms with higher refinancing risk. This concern predicts excess liquidity to entail larger, rather than smaller, factor declines.

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.
firms, in line with the financial channel of wage rigidity.

**Firm-Level Employment Effects of Cash-Flow Shocks.** I now support and quantify 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.\(^{30}\) Indeed, the quantitative relevance of the financial channel of wages and their rigidity can be estimated off any such shock $d\text{CashFlow}$:

$$c(n_1) \leq z_0n_0 - w_0n_0 + d\text{CashFlow}$$

I follow the regression specification of the conventional capital investment cash flow sensitivity.\(^{31}\) Instead of capital expenditure as the dependent variable, I use dollar-denominated measures of changes in net employment, mirroring the standard capital expenditure variable:

$$\frac{\bar{w}^\text{marg}_t \cdot d\text{Emp}_t}{\text{Assets}_t-1} = \beta^q \cdot q + \sigma^E \cdot \frac{\text{Liquidity}_t}{\text{Assets}_t-1} + \beta_X X_{t-1,i} + \alpha_t + \alpha_i + \varepsilon_{it} \quad (1)$$

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-change measure in the Appendix alongside Table 1.\(^{32}\)

**Estimates of the Firm-Level Employment Effects of Cash Flow Shocks.** Table 1 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.

\(^{30}\)Alternative underlying mechanisms are agency problems (Jensen and Meckling (1976), Bertrand and Mullainathan (2005), Blanchard et al. (1994), Malmendier and Tate (2008)) and asymmetric information (Myers and Majluf (1984)). The positive mechanisms of this paper are robust to any hiring–cash-flow link.

\(^{31}\)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.

\(^{32}\)The frictionless benchmark can be rationalized with adjustment costs similarly to the capital investment specification. Adjustment costs in labor demand (Hamermesh (1996)) 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 (Benmelech 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.
Whence the Sensitivity of Labor to Cash Flow? In the model, I rationalize the relationship between cash flow and employment with labor as an investment good in its own right, as it is explicitly in the DMP model. This approach allows me to restrict the analysis to only one explicit factor in the model. Moreover, the full (DMP) model has hiring as an explicit investment activity due to the upfront recruitment cost that is central to its dynamics. But the investment-like features of labor include additional aspects such as training (Oi (1962)). Other links are the 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 revenues from production 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 real effects of cash-flow fluctuations amplified by wage rigidity: industries in which rigid wages 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:

$$\frac{\partial \log (n_t^1)}{\partial \log (z)} = \frac{1}{\sigma z} \cdot \frac{1}{1 - \sigma z} \cdot \left(1 - \frac{\partial w_0}{\partial z}\right)$$

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 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 cyclicality measure for each industry. As with the cash flow cyclicality 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

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33 Christiano et al. (2005) and Jermann and Quadri (2012) are examples resorting to working capital.
34 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.
acyclical, while the highest labor share group’s employment falls by 4% for each percentage point increase in unemployment. The cyclicality gradient implies that moving along the labor share distribution by 0.1 lowers an industry’s employment cyclicality by 1 percentage point.35

Third, I construct the analogous cyclicality measure for capital investment, which also increases in the labor share, as Figure 7d shows alongside employment and cash flow.

Synthesis. In this section, I empirically established the quantitative relevance of the financial channel of wage rigidity with a series of new findings:

- **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 Test:** High-labor share industries, in which wage rigidity amplifies cash flow fluctuations, also have more procyclical employment and investment. During recessions, bankruptcies and credit rating downgrades cluster in those high-labor-share industries.

- **Firm-Level Test:** Internal funds matter for employment and its fluctuations. They 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. The quantitative nature of this debate (how volatile is hiring in the given model?) allows me to quantify the amplification from this paper’s financial channel of wage rigidity against existing theoretical benchmarks and empirical moments.

The central DMP debate surrounds the 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)](http://example.com), the degree to which new hires’ wages absorb productivity shocks has

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35I confirm robustness to monthly employment data (Quarterly Census of Employment and Wages, 1975+).
been recognized as the nexus of amplification, as 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 procyclicality of new hires’ wages might question such rigidity as a source of amplification (Pissarides (2009)). My mechanism is robust to wage rigidity on both margins. Its ability to generate amplification from incumbents’ wage rigidity alone avoids this potential empirical tension.

I integrate the financial channel of wage rigidity 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 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 the calibration Section 5 I find that the financial channel of wage rigidity enables 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 similarly 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 \( M(u, v) \), which embodies the search and matching frictions. Matching function \( M(u, v) \) 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 DMP literature to focus on labor market tightness \( \theta = v/u \). \( \theta \) defines the vacancy filling rate \( q(\theta) = M(u, v)/v = M(1/\theta, 1) \) and the unemployed job seeker’s job finding rate \( f(\theta) = M(u, v)/u = M(1, \theta) = \theta q(\theta) \).

Unemployment and Hiring Fluctuations. Since hiring fluctuations quantitatively account for most of the fluctuations in unemployment in the U.S. data (around 70%, 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 \( \theta = v/u \). The increase in \( \theta \) 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 ($\Delta u^{ss} = 0$): $u^{ss} = \delta / (\delta + f(\theta^{ss}))$.

**Vacancy Costs.** For matching frictions to matter, vacancy posting must be costly. Firms incur flow cost $k$ to maintain a vacancy and pay hiring cost $k/q(\theta)$, as a given vacancy fills at rate $q(\theta)$.

$$
c(h) = k/q(\theta) \text{ is convex in the aggregate.}
$$

**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 bargaining set of bilaterally rational wages, search frictions provide a theoretically appealing setting for wage rigidity.

### 4.2 Inframarginal Wage Rigidity

I introduce inframarginal wage rigidity (IMWR) in a tractable specification that I can directly calibrate to micro-estimates of wage behavior. Period-$t$ wage of an incumbent hired in period $s$ is the geometric mean of two components, the cyclical one indexed to the going wage and the rigid cohort effect, weighted by IMWR parameter $\rho$:

$$
w_{t,s} = w_{t,t}^{1-\rho} \cdot w_{t,s}^{\rho}
$$

(3)

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” $w_{t,s}^{\rho}$ 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 cyclicity 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:

\[
\rho = 1 - \frac{d\log(w_{t,s})}{d\log(w_{t,t})} = 1 - \frac{d\log(w_{t}^{inc})}{d\log(w_{t}^{new})} = 1 - e^{\frac{e_{inc}}{e_{new}}} \tag{4}
\]

**Inframarginal 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 wage rigidity from the standard amplification arising from marginal (new hires’) wages.

**Payroll.** The role financial frictions create for payroll and average wages requires me to keep track of the hiring history: each worker cohort \(s\) (hired in period \(s \leq t\), of which \(n_{t,s} = (1 - \delta)^{t-s}n_{s,s}\) 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 for payroll recursive and tractable under the conventional constant separation rate \(\delta\):

\[
\Phi = wh + (1 - \delta) \left(\frac{w}{w^{-}}\right)^{1-\rho} \Phi^{-} \tag{5}
\]

**Average wage** \(w^{avg}\) evolves recursively as the turnover-weighted average of new hires’ wage \(w\) and lagged \(w^{avg}\):

\[
w^{avg} = w \frac{n}{n} + (1 - \delta) \frac{n^{-}}{n} \left(\frac{w}{w^{-}}\right)^{1-\rho} w^{avg^{-}} \tag{6}
\]

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

**Wage Dynamics under IMWR.** The degree of IMWR, \(\rho\), directly reduces the responsiveness of incumbents’ and thus average wages to market conditions.\(^{43}\) Figure 10 illustrates this wage smoothing for a given path of new hires’, incumbents’ and their average wages, for three levels of IMWR \(\rho \in \{0, 0.5, 1\}\). The impulse is a 1-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

---

\(^{41}\)Most macro-labor models apply homogeneous remuneration; in some work, Calvo (1983)-style wage-stickiness generates between-union or between-firm wage variation (e.g. Erceg et al. (2000), Galí (2009)).

\(^{42}\)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.

\(^{43}\)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.
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 C), 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 B, I plot the resulting wage dynamics, which now mirror the cohort effects and the wage shielding of incumbents found in the micro data.

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 affects recruitment, and 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.

The Firms maximize the expected present value of dividends (whose policy I describe next) by posting vacancies $v$ to obtain 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:

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

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

$$h^+ = vq(\theta)$$

$$vk \leq \zeta - d + (\Delta B - RB^-)$$

$$B \leq \bar{B}$$

where $\beta$ is the discount factor of the managers (and of the firm-owning households).

Financial Frictions. Recruitment expenditure is subject to borrowing constraint (11, 12), which may or may not bind. The financial block consists of three steps. First, I rationalize with a collateral constraint why the firm would not rid itself of scarce funds by simply taking out more loans. Second, I appeal to a similar friction for why stockholders too refrain from providing funds (by reducing dividends temporarily) to let the firm produce at the first-best scale. Third, I derive the retention rate of cash flow shocks as the crucial statistic for the cash flow channel and introduce it in a parsimonious dividend-friction specification.
**Liquidity.** The firm uses internal funds and potentially external finance to cover recruitment expenditure $v_k$. Liquidity

$$L = \zeta - RB^* - d + \Delta B$$

is a function of cash flow $\zeta$ plus new net borrowing $\Delta B$, minus interest expenditure $RB^*$ minus dividends. 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 on debt. 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. To isolate the cash flow channel, I grant firms access to external finance written on the (steady-state) book value of assets: $\bar{B} = (1 - \xi_B)V^{**}$.

**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.\(^\text{45}\)

When financial constraints are slack, any dividend policy with the same present value is optimal, as debt can 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, empirical estimation and tractability in the subsequent exposition, I consider a constant retention rule $\alpha$ arising from external-finance

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\(^{44}\)Enforcement frictions commonly rationalize collateral constraints (e.g. Jermann and Quadrini (2012)).

\(^{45}\)Consider one simple story: Managers divert fraction $\xi_D$ of funds into projects that yield private non-monetary benefits but no or unseizable cash flow. Shareholders therefore demand dividends $d$ such that their (Euler) condition is $1 = \mathbb{E}(1 - \xi_D)V^{**}$. Cash value $V_{\zeta}$ 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 $\max_\mu (1 - \mu) \pi(e(\mu))$, 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 acyclic. I suppress $\mu$ in the firm’s (the manager’s) problem because it scales linearly.
frictions such as dividend adjustment costs or agency problems of free cash flow:

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

(14)

**Fraction α of Cash-Flow Fluctuations Transmits into Liquidity and Hiring.** Uncommitted external funds available for reinvestment plus changes in net debt make up total liquidity:

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

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 shocks fully pass through into liquidity and thus hiring.

**Alternative Amplification from Collateral Channels.** Financial amplification arises from inframarginal cash flow only, 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. \(^{47}\) This paper’s key mechanism is in principle agnostic to which particular link generates the required reduced-form effect of cash flow on inputs, which I estimate empirically and to which I calibrate the model’s dividend policy \( \alpha \). \(^{48}\) 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 the cash flow and such a collateral financial amplification channels would be shut off. \(^{49}\)

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

\(^{46}\)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 an underlying mechanism of 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 (ruling out highly nonlinear “Mirrlees” first-best schemes, as common in contract theory). 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 \( \xi^D \).

\(^{47}\)Chaney et al. (2012) find evidence that real estate collateral values affect debt capacity.

\(^{48}\)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 asset price drops than the ideal one-time cash flow shocks in my empirical designs.

\(^{49}\)Of course, some driving forces (discount rate (Hall (2014)), uncertainty shocks (Bloom et al. (2012))) may lead to asset price 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:

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

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

When financial constraints on recruitment expenditure (11) bind, the condition features Lagrange multiplier \( \tau \) (“liquidity wedge”) and stochastic cash flow valuations through \( V^{F++}_\Phi \):

$$
\tau \frac{k}{q(\theta^*)} = \mathbb{E} \beta (1 + \alpha (\tau^+ - 1)) (z^+ - w^+) + (1 - \delta) \mathbb{E} \beta \tau^+ \frac{k}{q(\theta^*)} + (1 - \delta) \beta^2 \mathbb{E} \left[ (w^+ + \rho - w^{++}\rho)w^{++1-\rho} \right] V^{F++}_\Phi
$$

Households take dividends and, as in most DMP variants, employment as given. With linear consumption utility, they maximize the present value of income: payroll \( \Phi \) plus divi-
dends $d$ plus interest $RB^-$ minus new lending $\Delta B$, net of labor disutility $\gamma$:

$$V(s; n^-, \Phi^-, h, B^-) = \Phi + d - \gamma n + RB^- - \Delta B + E\beta V(s; n, \Phi, h^+, B)$$  \hspace{1cm} (17)$$

subject to:

$$\Phi = hw + (1 - \delta) \left( \frac{w}{w^-} \right)^{1-\rho} \Phi^-$$  \hspace{1cm} (18)$$

$$n = h + n^- (1 - \delta)$$  \hspace{1cm} (19)$$

$$h^+ = f(\theta)(1 - n)$$  \hspace{1cm} (20)$$

### 4.4 Wage Determination: Nash Bargaining

The DMP wage rule – Nash bargaining – closes the model. It splits the match surplus under rational expectations about IMWR and financial constraints. There is full commitment within contracts with respect to the base wage; the indexation to the going wage is external. Upon being matched, the parties set wage $\tilde{w}$ to maximize the geometric average of each party’s value from employment of one incremental worker at wage $\tilde{w}$, weighted by household bargaining power $\phi$:

$$\max_w \{V_H^F(w)^{\phi}V_F^F(w)^{1-\phi}\}$$  \hspace{1cm} (21)$$

$V_F^F(w)$ ($V_H^F(w)$) denotes the value of adding a new hire at arbitrary bargain wage $\tilde{w}$ to the firm\textsuperscript{53} (household\textsuperscript{54}).

**The Nash Wage under Financial Constraints and IMWR** is defined by $\phi \cdot \psi \cdot V_F^F(w^*) = (1 - \phi) \cdot V_H^H(w^*)$ and solves into:

$$\tilde{w}^* = (1 - \tilde{\phi}) \gamma + \tilde{\phi} \left( z + \frac{\tau}{1 + \alpha(\tau - 1)} k \theta \right) + \E(1 - \delta)\beta \left[ (\tilde{w}^\rho - w^+) w^{1-\rho} \cdot \left[ \tilde{\phi} V_F^F - (1 - \tilde{\phi}) V_H^H \right] \right] + \Gamma$$

where:

$$\tilde{\phi} = \frac{\phi \psi}{\phi \psi + (1 - \phi) \geq \phi} \hspace{1cm} \psi = \frac{V_H^H}{V_F^F} \cdot \tilde{V}_F^F = \frac{V_H^H}{1 + \alpha(\tau - 1)}$$

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

\textsuperscript{52}As a result, no Stole and Zwiebel\textsuperscript{1996} bargaining complications arise.

\textsuperscript{53}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: $V_h^F(\tilde{w}) = (1 + \alpha(\tau - 1)) \cdot (z - \tilde{w}) + (1 - \delta) \cdot E\beta \left[ \frac{\tau + k}{\eta(\theta \phi)} \right] + (1 - \delta) \cdot \beta E \left[ (\tilde{w}^\rho - w^+) w^{1-\rho} \cdot V_F^F \right]$

\textsuperscript{54}Household: $V_h^H(\tilde{w}) = (\tilde{w} - \gamma) + (1 - \delta - f(\theta)) E\beta V_h^H(\tilde{w}') + (1 - \delta) \beta E \left[ (\tilde{w}^\rho - w^+) w^{1-\rho} \cdot V_F^F \right]$
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 standard 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 symmetric, \(\psi\) constantly equals one – and is implicitly suppressed in the standard model.

When financial constraints bind \((B = \bar{B}\) and thus \(\tau > 1)\), the firm values cash more than the worker. The Nash wage takes this into account through a small “tax” on wages \(\psi > 1\), which entails effective bargaining weights \(\bar{\phi}\). Through \(\psi\), the wage responds to the firm’s financial condition \((V_h^F(\bar{w}))\), falling in recessions to partially alleviate the liquidity squeeze.

But is the Nash wage sufficiently flexible for the firm to borrow from (new) workers to relax tight cash flow? No, for lack of state- and period-contingent compensation contracts. Interestingly, even “flexible” DMP bargaining \((\rho = 0)\), period by period, would therefore not fully offset the liquidity squeeze. Moreover, IMWR institutionalizes recessionary wage concessions in form of the cohort effect, which persists throughout the match. In anticipation, the worker is even less willing to lower wages when liquidity tightens temporarily. This dynamic consideration is captured by the IMWR-amortization term \(\Gamma\), which merely adjusts for the evolution of \(\psi\). In Section 6, I present empirical evidence from a unique micro-data set 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, which can be defined analogously to the standard DMP equilibrium:

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 solves the firm’s vacancy posting condition \([16]\) and Nash wage \([22]\).

\[55\] Without financial constraints, the IMWR wage is the standard DMP wage \(\bar{w}_{\rho=0} = \phi(z + \theta k) + (1 - \phi)\gamma\) plus an amortization term that reflects the difference between tomorrow’s going wage \(w^{+}\) and the match wage at hand: \(\bar{w}_{\rho>0} = w_{\rho=0} + \frac{(1 - \delta)}{1 - \beta(1 - \delta)} \beta \delta E(1 - \delta) \beta (w^{+\rho} - \bar{w}^{\rho}) w^{1-\rho}\). For \(\rho = 0\), this expression collapses to the standard DMP Nash wage of perfect period-by-period rebargaining: \(\bar{w}_{\rho=0} = \bar{w}_{\rho=0}\). \(\rho = 1\) nests the special case of (neutral) perfectly rigid inframarginal wages considered in [Shimer, 2004].

\[56\] 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 \(\bar{\phi}\); payroll is valued at \(V^H(\bar{w})\) and \(V^H(\bar{w})\). \((1 + \alpha(\tau - 1))\) normalizes the firm’s cash value in money units.

\[57\] \(\Gamma\) 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.
While smoothing wages by construction, IMWR $\rho$ turns out to be perfectly neutral with respect to all DMP quantity variables in the absence of financial constraints:

**Proposition 1. (Quantity Neutrality of IMWR when Financial Constraints are Slack)** IMWR affects the responsiveness of flow wages to productivity 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 formal proof is in the Appendix. The intuitions are simple. Ex post, say in a recession, the fact that incumbent workers’ wages are too high does not distort hiring. 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.

Hiring is also not distorted ex ante by the fact that IMWR endogenously props up new hires’ 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.\[58\] 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 (2005), Elsby (2009), Pissarides (2009), Shimer (2010), Michaillat (2012), Mortensen & Nagypal (2007), Christiano et al. (2013). It also mirrors the [Lazear (1990) argument that under favorable theoretical conditions, severance payments can be perfectly offset by entry wages.

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 responses of vacancy posting and labor market tightness to productivity shocks, by amplifying fluctuations in liquidity.

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\[58\] 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 (1983)-like set-ups with stochastic albeit full wage reset. The key wage results (rigid average and inframarginal wages, EPV neutrality) go through.
Analytical Expressions: Standard Marginal vs. Financial Amplification. Before evaluating the dynamic behavior of the calibrated model, I provide the key intuitions by deriving analytical comparative statics from the deterministic steady state. I highlight the key nexus of new hires’ vs. average wages for the two cases, and relegate uninteresting terms into $X^{DMP}$ and $X^{\text{financial}}$, which are just functions of parameters. The analytical comparative statics can be reformulated to versions of the hiring elasticities (b) and (d) in the simple model in Section 2, with equilibrium labor market tightness $\theta$ rather than firm-level hiring $h_1$:

Standard amplification – when financial constraints are slack ($B < \bar{B}$) – occurs through new hires’ wages:

$$\left. \frac{\partial \log(\theta)}{\partial \log(z)} \right|_{B < \bar{B}} = X^{DMP} \cdot \left( 1 - \frac{dw^{\text{new}}}{dz} \right) \frac{d\text{CashFlow}^{\text{new}}/dz}{dw^{\text{new}}/dz}$$

How new hires’ wages respond, mediates how productivity shocks change marginal cash flow, namely the firms’ incentives to hire.

Financial amplification – when financial constraints bind ($B < \bar{B}$) – occurs through the average wage:

$$\left. \frac{\partial \log(\theta)}{\partial \log(z)} \right|_{B = \bar{B}} = X^{\text{financial}} \cdot \alpha \cdot \left( 1 - [\delta + (1 - \delta)(1 - \rho)] \frac{dw^{\text{new}}}{dz} \right) \frac{d\text{CashFlow}^{\text{avg}}/dz}{dw^{\text{avg}}/dz}$$

How the average wage responds, mediates how productivity shocks affect total cash flow, which in turn affects hiring through financial constraints.

Financial and standard amplification thus 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.

**Proposition 3. (Financial Amplification under Flexible New Hires’ Wages)** With perfectly procyclical new hires’ wages ($dw^{\text{new}}/dz = 1$), financial amplification still occurs

$$\varepsilon^{DMP} = \frac{d\theta/\theta}{dz} \frac{d\text{CashFlow}/\text{CashMarg}}{dz/\theta} = \left( \frac{1}{\theta} \right) \left( 1 - \frac{dw^{\text{new}}}{dz} \right)$$

and

$$\varepsilon^{\text{financial}} = \frac{d\theta/\theta}{dv/v} \frac{dv/\theta}{\eta} \frac{d\text{CashFlow}/\text{CashMarg}}{dz/\theta} = \left( \frac{1}{1 - \kappa^v - \kappa^\theta} \cdot \frac{z^{\varepsilon^v} z^{\varepsilon^\theta}}{L} \right) \cdot \alpha \cdot (1 - (\delta + (1 - \delta)(1 - \rho)) \frac{dw^{\text{new}}}{dz}$$

where $\kappa^v = (1 - \eta)(1 - u)$ and $\kappa^\theta = \eta(1 - u) \zeta$. $\zeta$ represent the attenuating effects of $v$ on $\theta$ through $u$, of $\theta$ on $\zeta$ respectively.
under:

- **Binding financial constraints** \((B^* = \bar{B} \text{ and } \alpha > 0)\), **and**

- **Incumbent workers’ wage rigidity** \((IMWR \rho > 0)\).

When new hires’ wages fully absorb productivity changes \((dw^n/dz = 1)\), the standard DMP model has zero quantity movements, as recruitment incentives \((\text{cash flow } z - w)\) are flat in productivity. For \(\rho = 0\), the same holds for the financial model: marginal as well as inframarginal wages absorb productivity shocks, and cash flow is flat in productivity. Finally consider \(\rho > 0\) and \(dw^n/dz = 1\), i.e. new hires’, but not incumbents’, wages absorb the productivity shock completely. Under financial constraints, the procyclical cash flow from IMWR \(\rho > 0\) renders firms’ recruitment responsive to productivity shocks through its effect on financial resources even if new hires’ wages absorb the productivity shock one to one.

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 \(z\), translate the simulated data into quarterly frequencies, and apply the same cyclical and seasonal adjustments as to the empirical moments. To highlight the role of inframarginal wage rigidity \(\rho\) under financial constraints, I present the results from the simulations in Figures 11 and 12. Following the literature started by [Shimer (2005)](http://example.com), I focus on generating realistic fluctuations in hiring, specifically the key labor market variable labor market tightness \(\theta\), in response to comparatively smooth shifts in (average) labor productivity \(z\).

**Key Empirical Moments.** Figure 9 plots detrended log labor market tightness and vacancy postings against average labor productivity (quarterly U.S. data, 1953 to 2013). The standard deviation of labor market tightness is around 35%; that is, it is not uncommon for labor market tightness to drop beneath or exceed its trend by 35%. The volatility of hiring contrasts with the smoothness of (average) labor productivity (2% standard deviation), the driving force in the model. The denominator of labor market tightness (vacancies) and its numerator (unemployment) fluctuate in opposite directions: the standard deviations of vacancies and unemployment are almost 20%; their correlation is \(-0.88\).

\[60\text{In this section, I use the HP filter with } \lambda = 10^5 \text{ common in the DMP literature. All insights hold with the more standard smoothing parameter } \lambda = 1600.\]
Parameterization. Table 2 presents the parameters of my augmented DMP model. Besides the standard DMP parameters, I calibrate two new key features to microempirical estimates: first, inframarginal wage rigidity $\rho$ denotes the comovement of incumbents’ wages with new hires’ wages. Second, I calibrate the financial-friction parameter $\alpha$, which guides the impact of the financial channel of wage rigidity, to the range of the empirical employment-cash flow sensitivity that I estimate in Section 3.2.

For the Standard DMP Features, I largely preserve the parameters provided by Shimer (2005) and the follow-up literature, in setting the opportunity cost of employment 0.4 ($\gamma = 0.6$) $^{61}$ I set matching function elasticity parameter $\eta$ equal to 0.7, roughly what I too obtain when regressing the job-finding rate on labor market tightness at quarterly frequencies. As standard in the literature, I set household bargaining power $\phi$ equal to the elasticity of the matching function $\eta$. $^{62}$

Wage Rigidity Parameter $\rho$. A methodological advantage of seeking amplification from inframarginal wage rigidity $\rho$ is that its calibration is empirically well-defined: $\rho$ guides the cyclical comovement of incumbents’ with new hires’ real wages, which Pissarides (2009) puts at 1–1.5% and 3% per unemployment percentage point respectively. I calibrate IMWR $\rho$ with two strategies. First, I calibrate it analytically, as for small changes in $w_{t,t}$, it maps directly into the empirical micro-estimates of their respective wage cyclicalities: $\rho = 1 - \frac{\text{dlog}(w_{t,s})}{\text{dlog}(w_{t,t})} = 1 - \frac{\text{dlog}(w_{t,\text{inc}})}{\text{dlog}(w_{t,\text{new}})} = 1 - \frac{e_{w,u}^{\text{inc}}}{e_{w,u}^{\text{new}}}$. Second, I calibrate $\rho$ internally in terms of the relative movements of incumbents’ and new hires’ simulated wages. I find $\rho \in [0.5, 0.8]$.

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

Baseline Liquidity $\bar{L}$ depends on borrowing limit $\bar{B}(\xi^B)$ and on dividend target $d^{\text{ss}}(\xi^D)$ (via cash flow available for reinvestment). Arbitrary combinations generate the same baseline liquidity $\bar{L}$ and thus production scale. I set it to “almost” match the steady state labor market tightness in the unconstrained model, and for financial constraints to bind and internal funds to affect input decisions, while the economy is otherwise close to the frictionless benchmark. 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

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$^{61}$ Chodorow-Reich and Karabarbounis (2013) review parameterizations of the opportunity cost of employment and investigate its empirical cyclicality. $\gamma$ increases standard amplification through its mechanical effect on the match surplus (Hagedorn and Manovskii (2008), Ljungqvist and Sargent (2014)). When I consider 0.7 ($\gamma = 0.3$), the financial results go through.

$^{62}$ This Hosios (1990) condition generates constrained efficiency in the standard DMP model.
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 \( \alpha = 0.2 \).

5.1 Simulated Moments: Slack Financial Constraints (Benchmark Model)

Figure 11 plots the key volatilities of the simulated data against IMWR \( \rho \in [0, 1] \) with slack financial constraints. First consider the standard DMP model that implicitly sets \( \rho = 0 \) (no IMWR). 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, the Shimer (2005) puzzle. Second, the procyclicality 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 the bargaining parties to frontload compensation during recessions. Figure 11 illustrates the theoretical present-value neutrality of the benchmark model: labor market tightness volatility remains 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 standard deviations of key labor market variables by different levels of IMWR under financial constraints. Rather than a mere accounting variable, 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. As in the case without financial constraints, the model also generates fluctuations in cash flow thanks to IMWR.

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, thus enables the DMP model to account for more than half of the fluctuations of hiring in the U.S. data. Interpreted in counterfactual terms, the calibrations suggest that reducing inframarginal wage rigidity $\rho$ towards $\rho = 0$ would greatly smooth aggregate hiring fluctuations. $\rho = 0$ corresponds to the empirical national accounting calculation in Section 3.1 which suggested that in the data too, cash flow would be stabilized under such a wage cyclicality regime.

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, crucially, the interaction between the industry fixed effect and that cyclical indicator. The coefficient on the former interaction is thus 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...
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 $w_{avg}$ illustrated this in the approximation around the steady-state hiring rate: $w_{avg} = \delta w + (1 - \delta) \left( \frac{w}{w_{avg}} \right)^{1-\rho} w_{avg} - \rho w_{avg}$.

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 $(1-\rho)$:

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

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 volatility of hiring quite sensitive to lowering the separation rate. Firm-level survey evidence supports the role of turnover in wage adjustment: in Figure 15a I document that firms 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

66Another, more subtle effect works through the endogenous smoothing of entry wages in the bargaining.

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. I plan to investigate this prediction with industry variation of turnover levels and 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 over the job spell. This simplification masks the substantial duration dependence of match separation 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 rigid *average* wage – remain on the job throughout the recession, squeezing cash flow by longer. Incorporate 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.* Moreover, 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

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68 The secular decline in separations is documented in e.g. [Davis (2008)](https://doi.org/10.1146/annurev-economics-073007-084502).
69 Card and Hyslop (1997) document the canonical evidence for (downward) nominal wage rigidity; Coibion et al. (2013) assess its potential contribution to jobless recoveries in a standard marginal framework.
70 The particular representation in Figure 15c computed from CPS tenure data and taken from Hall (2014).
71 See Solon et al. (1994) for the composition bias is the cyclicity of the simple average wage.
72 The data do not distinguish hires from job-to-job transitions and those out of unemployment.
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, which has received more attention in its capacity as a drain on corporate resources in low-cash-flow states of the world. 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 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 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 [illust] 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 wage rates only. Non-wage/-salary compensation (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]. Micro-empirical studies of wage rigidity tend to focus on (marginal) wage rates. But anecdotal and survey evidence indicates that employers do worry about the financial burden of rigid inframarginal labor costs, such as their contributions to retirees’ and incumbents’ defined-benefit pensions. Standard frameworks deem the rigidity of DB funding requirements irrelevant. Yet employers

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74 Benmelech et al. (2012) documents airlines renegotiating wage contracts during financial distress.
75 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 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.
76 Interestingly, Stueber (2012)’s earnings cyclicality micro-estimates are in the wage cyclicality range.
77 Aaronson et al. (2004) write: “Retiree pension obligations are fixed costs... Thus, basic economic theory predicts they should have no effect on firms decisions.” Rauh (2006) exploits cash-flow shocks from pension
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)) The financial channel of wage rigidity predicts cyclical consequences from moving to more cyclically flexible compensation structures such as defined-contribution plans, performance pay or profit sharing.\(^{78}\)

Indeed, with firm-level survey micro-data from the Wage Dynamics Network in Figure 15a, I document that firms consider cutting incumbents’ non-wage/-salary compensation (bonus and benefits, promotions) a crucial tool of labor cost reductions. Moreover, some evidence suggests that particularly high-wage firms cut hiring and that firms direct firing to highly paid employees in recessions.\(^ {79}\)

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 for lack of state- and period-contingency of wage contracts.\(^ {80}\) Empirical evidence on the dynamic structure of wage contracts and its cyclicity is scarce; existing studies of wage cyclicity may mask heterogeneity in overlapping wage contracts by investigating average flow wages. I document new empirical evidence for limited cyclical compensation backloading (“wage-path rigidity”), using unique wage contract micro data: the universe of Canadian collective bargaining agreements from 1975 to 2013.\(^ {81}\) 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.

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

\(^{78}\)See Weitzman (1986), Kruse (1991) and Lemieux et al. (2012) on standard marginal benefits from profit sharing and performance pay.


\(^{80}\)A priori, a variety of frictions may prevent the bargaining parties from cyclically backloading compensation. Berk and Walden (2013) discuss human capital risk as a constraint on 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)).

\(^{81}\)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.
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 $3 \cdot 10^{-4}$. That is, the average contract neither front- nor back-loads compensation appreciably. Moreover, the dispersion is tiny: the 25th (1st) and 75th (99th) percentiles are $-0.004$ ($-0.019$) and $0.005$ ($0.017$). But how much cyclical variation is there in compensation backloading? Figures 16 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 17 plots the Gini coefficient against detrended log GDP. Real compensation appears to exhibit mildly procyclical compensation backloading. I conclude that at least collective wage bargaining appears to leave little room for cyclical compensation backloading and exhibits “wage-path rigidity.”

In ongoing work, I investigate the cyclicality of other forms of compensation (pensions, employee stock options, non-salary benefits, bonuses), and the cyclicality of tenure gradients using German administrative matched employer-employee data. Such intertemporal patterns of compensation are typically rationalized as incentive schemes or human capital dynamics. The financial channel of wage rigidity suggests a liquidity aspect to their cyclical variation.

VI. Insider-Outsider Effects Through Liquidity. In establishing a link between incumbent workers’ wages and the labor market prospects of outsiders, this paper’s amplification mechanism is broadly related to the Lindbeck and Snower (1989) insider-outsider model. The key difference is the mechanism underlying that link: 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

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82 Guiso et al. (2013) document steady-state variation of tenure wage profiles by local financial development.
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.

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, 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 more than half of 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

84 See Martins et al. (2012) and Carneiro et al. (2012) for Portugal.
labor demand more generally. A corporate finance economist may see cash flow shocks and financial constraints 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):

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

(23)

Having estimated this employment-cash flow sensitivity to lie between 0.2 and 0.6, I speculate whether a share of the short-run effect of wages on employment might actually be driven by the liquidity channel of wages. A testable prediction is that financially constrained firms’ labor demand elasticities are higher due to the cash flow effect. We take this prediction to the micro-data using firm-specific labor cost shocks in [Schoefer and Seim (2014)].
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 \[\frac{dw}{dz} = (1 - \rho)\frac{dw}{dz} \] IMWR \(\rho\) attenuates incumbent worker’s wages response productivity shocks vis-à-vis new hires’ wages.

1.2 \[\frac{d\Phi}{dz} = \frac{d\Phi}{dz} = 0\] labor market tightness is not affected by incumbents’ payroll.

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

2.1 \[\frac{dw}{dz} \leq \frac{dw}{dz} \] IMWR \(\rho\) smooths new hires’ base wages in response to productivity shocks \(dz\) (e.g. here with law of motion \(z = (1 - \rho)\bar{z} + \rho z + dz\)):

\[
\frac{dw}{dz} \bigg|_{\rho \geq 0} = \frac{1}{1 + \rho \frac{\beta(1-\delta)(1-r_z)}{1-\beta(1-\delta)}} \frac{dw}{dz} \bigg|_{\rho = 0} \leq \frac{dw}{dz} \bigg|_{\rho = 0}
\]

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

\[
\frac{dE_{PV}(w)}{dz} = \frac{dw_{s,s}}{dz_s} \bigg|_{\rho \geq 0} = \frac{1 + \rho \frac{\beta(1-\delta)(1-r_z)}{1-\beta(1-\delta)}}{1 - \beta(1-\delta)r_z} \frac{dw_{s,s}}{dz_s} \bigg|_{\rho = 0}
\]

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

\[
\frac{k}{q(\theta_{p=0})} = \mathbb{E}\beta(z^+ - w_{p=0}^+) - \frac{(1-\delta)\beta^2}{1-\beta(1-\delta)} \mathbb{E} [(w^+\rho - w^{++}\rho)w^{++1-\rho}] + (1-\delta)\beta \mathbb{E} \frac{k}{q(\theta^+)}
\]

\[
= \mathbb{E}\beta(z^+ - w_{p=0}^+) + (1-\delta)\mathbb{E}\beta \frac{k}{q(\theta_{p=0})} = \frac{k}{q(\theta_{p=0})}
\]
Table

Note to Table 1: Firm-Level Cash-Flow Shocks; Description of Identification Strategies. Data. 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 $\bar{w}_{marg}$ 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 $dPayroll_{marginal}^{i} = w_{marg} \cdot dEmp_{i}$, 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: $\hat{dPayroll}_{marginal}^{i} = \bar{w}_{marg} \cdot dEmp_{i}$. 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: $\frac{w_{marg}}{w_{avg}} = \frac{dPayroll_{i}}{dlog(n_{i})} \approx 0.475$, since $\frac{dPayroll_{i}}{dlog(n_{i})} = \frac{n_{w_{avg}}}{n_{w_{marg}}} \frac{dPayroll}{dEmp} = \frac{w_{marg}}{w_{avg}}$, as $\frac{dPayroll}{dEmp} = w_{marg}$. 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>
<thead>
<tr>
<th>Design</th>
<th>Identification (Liquidity Shock)</th>
<th>Cash Flow Sensitivity: $\beta$ (SE)</th>
<th>Data</th>
<th>Investment</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Tobin's q/ALP &amp; cash flow</td>
<td>0.42 (0.043)</td>
<td>Flow of Funds (1950-2013)</td>
<td>0.97</td>
<td>(0.089)</td>
</tr>
<tr>
<td>II</td>
<td>“Structural” approach: the empirical designs augment the frictionless model with cash flow. Tobin's q measures constructed from asset prices. Sensitivity estimate: coefficient on cash flow.</td>
<td>0.25 (0.009)</td>
<td>Compustat (1950-2013)</td>
<td>0.21 (0.4)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>III</td>
<td>How do internal capital markets in conglomerates transmit an exogenous cash flow shock from oil-related to -unrelated segments? Cash flow shock from discontinuous redemption of employee stock options.</td>
<td>0.37 (0.083)</td>
<td>Compustat, &amp; Risk Metrics</td>
<td>0.72 (0.096)</td>
<td>(0.45)</td>
</tr>
<tr>
<td>IV</td>
<td>Stock option redemption</td>
<td>0.41 (0.096)</td>
<td>Compustat</td>
<td>0.72 (0.096)</td>
<td>(0.45)</td>
</tr>
<tr>
<td>V</td>
<td>DB pension refunding shocks</td>
<td>0.47 (0.116)</td>
<td>Compustat, IRS F 5500 (1990-1998)</td>
<td>0.47 (0.116)</td>
<td>(0.096)</td>
</tr>
<tr>
<td>VI</td>
<td>Real estate collateral</td>
<td>0.51 (0.148)</td>
<td>Compustat</td>
<td>0.51 (0.148)</td>
<td>(0.096)</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>( \eta )</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>
</tbody>
</table>

**A. Standard DMP Parameters**

<table>
<thead>
<tr>
<th>Param’r</th>
<th>Value</th>
<th>Description</th>
<th>Target</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<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{B}(\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>
</tbody>
</table>

**B. Financial Frictions**

<table>
<thead>
<tr>
<th>Param’r</th>
<th>Value</th>
<th>Description</th>
<th>Target</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \rho )</td>
<td>{0.05, 0.5, 0.8, 1}</td>
<td>Inframarginal wage rigidity</td>
<td>Cyclicality of wages in new vs. old matches</td>
<td>Pissarides (2009)</td>
</tr>
</tbody>
</table>

**C. Wage Friction**
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
Figure 5: Internal Funds & Recessions

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).
I. Wage Biographies (0--) By Entry Cohort

II. New Hires’ (--) & Average (••) Wages

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

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

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

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.
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: $\text{cyc ln(Emp}_{it}) = [\beta_1 \cdot \text{cyc}_{URate_t} \cdot \text{trend}_{LaborShare}_{it}] + \beta_2 \cdot \text{cyc}_{URate_t} \cdot \text{IndustryFE}_i + \beta_3 \cdot \text{trend}_{LaborShare}_{it} + \beta_4 \cdot \text{IndustryFE}_i + \beta_2 \cdot \text{cyc}_{URate_t} + \epsilon_{it}$. 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).

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 (λ = 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.