The Financial Channel of Wage Rigidity

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The Financial Channel of Wage Rigidity

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Benjamin Schoefer

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Dissertation Advisor: *Author:*

Professor Lawrence Katz   **Benjamin Schoefer**

The Financial Channel of Wage Rigidity

Abstract

Why do firms cut hiring so sharply in recessions? This dissertation explores two answers. Chapters 1 and 2 propose a financial channel of wage rigidity, whereby wage rigidity among incumbent workers forces firms to reduce hiring by squeezing their internal funds. Chapter 3 examines how the procyclicality of quits, through the replacement vacancies they entail, amplifies the cyclical fluctuations of total job openings.

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Introduction

Why do firms cut hiring so sharply in recessions? This dissertation explores two answers. Chapters 1 and 2 propose a financial channel of wage rigidity, whereby wage rigidity among incumbent workers forces firms to reduce hiring by squeezing their internal funds. The first chapter presents a simple model as well as a collage of empirical evidence for the mechanism. The second chapter takes the channel to the macroeconomic context. Chapter 3 examines, empirically and theoretically, how the procyclicality of quits, through the replacement vacancies they entail, amplifies the cyclical fluctuations of total job openings.

The financial channel of wage rigidity proceeds as follows: 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, which I confirm at the industry level. Finally, the cash flow channel may drive a share of the elasticity of labor demand to wages in general.

The replacement channel of quits proceeds as follows: This chapter investigates how the

procyclicality of quits, through the replacement vacancies they entail, amplifies the cyclical fluctuations of total job openings. Using a unique employer survey, I establish that more than half of all job openings aim to fill an *old* job vacated by a *quit*. By contrast, in the leading macro-labor models, all job openings are for *new* jobs. I develop an extended model with procyclical quits and replacement hiring, in which the quit–replacement mechanism can generate considerable cyclical amplification of fluctuations in total vacancies. The amplification relies on imperfect crowd-out of new job creation from replacement hiring, for which I enlist empirical support from local labor market adjustments.

Chapter 1

The Financial Channel of Wage Rigidity: A Simple Model, and Empirical Evidence

1.1 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

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

[2]While at least implicit in all macroeconomic models of wage rigidity, the paradigm is particularly explicit in the search and matching literature (e.g. Shimer (2004), Hall (2005b), Hall and Milgrom (2008), Elsby (2009), Pissarides (2009), Shimer (2010), Michaillat (2012)). The paradigm also guides empirical work: Pissarides (2009), Kudlyak (2014), Haefke *et al.* (2013) Carneiro *et al.* (2012), Martins *et al.* (2012) find new hires' real wages to be substantially more procyclical than incumbents' wages. Nominal wage rigidity is measured off incumbents

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.

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

(e.g. Card and Hyslop (1997)). Qualitative studies tend to investigate incumbents (Bewley (1999), Galuscak *et al.* (2012)). Most theories rationalize wage rigidity among incumbents. Work tying new hires' to incumbents' wage rigidity (Lindbeck and Snower (1989), Gertler and Trigari (2009), Snell and Thomas (2010)) relies on marginal channels. Wage rigidity on both margins would just add the standard marginal channel to the financial one but not attenuate it.

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

[4]For example, dividends and interest (5-10 percent of would need to turn strongly *negative*.

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.[5] 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.[6] Financial constraints arise from a borrowing constraint that uncommitted cash flow (net of dividends and interest) partially alleviates. I parameterize

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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.* (2012b), 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).

the financial frictions in relation to my empirical estimates of the employment-cash flow sensitivity.[7]

I confirm the canonical neutrality of inframarginal wage rigidity (IMWR) in my baseline model, in which financial constraints are slack.[8] 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.[9] As a solution, I discuss the

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[7]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.

[8]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.

[9]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.

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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.[10] Evidence for such marginal wage subsidies to stimulate hiring is mixed.[11] Singapore uses such procyclical payroll taxes on all workers for purposes of macroeconomic stabilization.[12] Ongoing work (Schoefer and Seim (2015)) investigates how such policies might stimulate hiring and investment by stabilizing cash flow rather than by changing factor prices at the margin. We evaluate an age-specific, 10–18 percent cut of employer-borne payroll taxes in Sweden. The empirical design brings also an additional micro-empirical test of this paper's mechanism, and tests whether cash flow effects from wages may drive a share of the wage elasticity of labor demand in general.

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.[13] Corporate finance work investigates leverage as a

Empirical work finds that *un*employed workers appear liquidity constrained (Gruber (1997), Chetty (2008)), yet this paper's channel refers to incumbent workers, with likely smaller consumption responses.

[10]For example, "subsidizing the jobs of incumbent workers in firms that recruit has no employment effects: all it does is to create windfalls for firms." (Cahuc *et al.* (2014)) More broadly, fiscal policy through payroll taxes in e.g. Farhi *et al.* (2013) and Correia *et al.* (2013) also works through standard marginal-cost rather than liquidity channels (but would replicate the flexible-price-/-wage allocation even with liquidity effects).

[11]See Katz (1996) or Egebark and Kaunitz (2014). Cahuc *et al.* (2014) find moderate hiring effects.

[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.

[13]Abowd (1989). Danthine and Donaldson (2002), Draca *et al.* (2011), Favilukis and Lin (2012), 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.

strategic bargaining device in wage setting. Michelacci and Quadrini (2005), [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.[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.[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.[17] By stabilizing cash flow, slightly more procyclical wages would alleviate credit crunches.

In this Chapter, 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. Chapter 2 shows how financial constraints break the neutrality of IMWR in the Diamond-Mortensen-Pissarides model, and calibrates the extended DMP model. It also discusses additional implications of the financial channel of wage rigidity, concludes.

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[14]Matsa (2010), Simintzi *et al.* (2010), Monacelli *et al.* (2011). Benmelech *et al.* (2012a), Guiso *et al.* (2013) and Berk and Walden (2013) investigate the effect of debt on wage contracts.

[15]Lazear *et al.* (2013) document such countercyclical effort in one large firm during the recent recession.

[16]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.

[17]The credit shocks in Greenstone and Mas (2012) and Chodorow-Reich (2014) are accompanied by cash-flow drops; Campello *et al.* (2010) find that constrained firms used up internal funds during the crunch.

1.2 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 1.3. The simple model also serves as a building block for the full model in Section 2.1, 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 β, 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:

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

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

hires' wages w_1 absorb shocks to productivity z:

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

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*:

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

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 λ 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

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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:

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

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)).

1.3 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 procyclicality 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.

1.3.1 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.
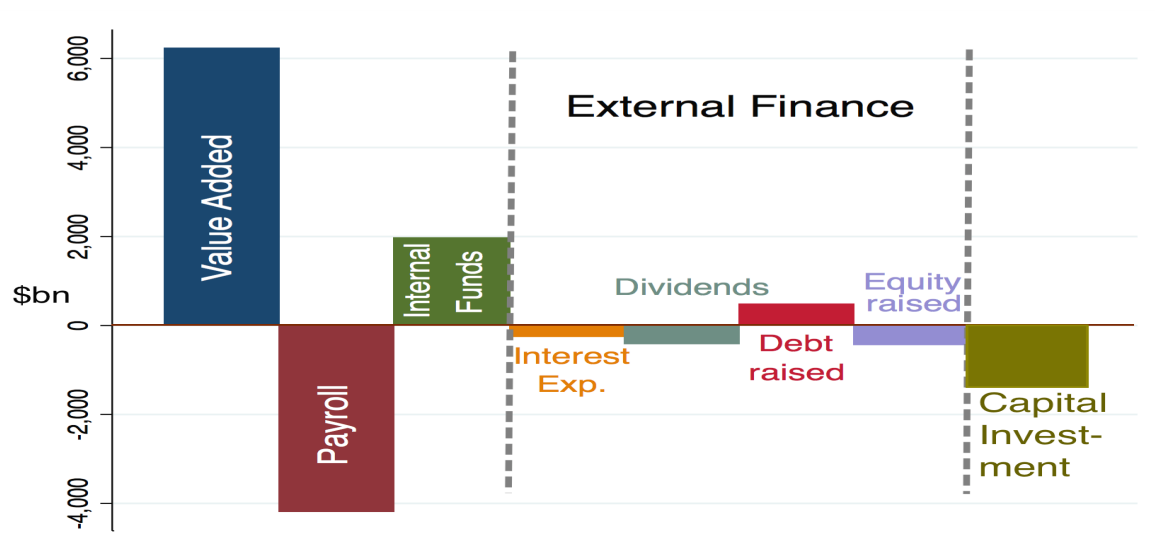
Figure 1.1: *Cash Flow Statement of the U.S. Nonfinancial Corporate Sector, 2006.*

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.

National Accounting. Figure 1.1 presents a cash flow statement of the U.S. non-financial

(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: $\frac{agg. \ CashFlow}{agg. \ CapX}$ ("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 1.2: *Internal Funds and Investment.*

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 1.1): $I \leq \Delta EF + \Delta IF$. 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 1.2a and 1.2b. 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

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percentage point in unemployment:

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

Slightly More Procyclical Wages Could Smooth the Fluctuations in Cash Flow. I conduct a simple national accounting exercise to show that it would suffice for incumbent workers' wages to move as procyclically as new hires' wages. A robust empirical finding is that incumbent workers' wage cyclicality is markedly lower than that of new hires. I present the consensus estimates proposed by Pissarides (2009) in a comprehensive meta study:[18]

$$\frac{dlog(\text{wage}^{\text{Incumbent}})}{d\text{UnempRate}} \approx -1.25\%$$

$$\frac{dlog(\text{wage}^{\text{NewHire}})}{d\text{UnempRate}} \approx -3\%$$

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

$$\underbrace{\frac{dlog(\text{CashFlow})}{d\text{UnempRate}}}_{\text{-3\%}} \cdot \underbrace{\frac{\text{CashFlow}}{\text{Payroll}}}_{0.5} = -1.5\%$$

A slight increase in incumbents' wage procyclicality, to the level of $\frac{dlog(\text{w}^{\text{Inc}})}{d\text{UR}} = 1.25\% + 1.5\% = -2.75\%$, 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

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[18]Typically, log wages of individual i in job j are regressed on detrended unemployment as the cyclical indicator: $ln(w_{ikt}) = \beta_0 + \beta_{UR}UR_t + \beta_X X_{it} + \beta_X X_{jt} + [\text{FEs}] + \varepsilon_{ijt}$. Worker- and firm-level controls, and firm-, worker- and even job-fixed effects, reduce cyclical composition bias. The wage cyclicality measure is the coefficient on unemployment: $e_{w,u} = \beta_{UR} = dlog(w_t)/dUR_t$. 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.

[19]See Bernanke and Gertler (1989)'s financial accelerator through asset prices, Kiyotaki and Moore (1997))'s

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subtracts the mildly procyclical depreciation from cash flow, resulting in higher procyclicality: $dlog(\text{Profits})/d\text{UnempRate} \approx -9\%$. 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 cyclicality 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 1.1 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]

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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)).
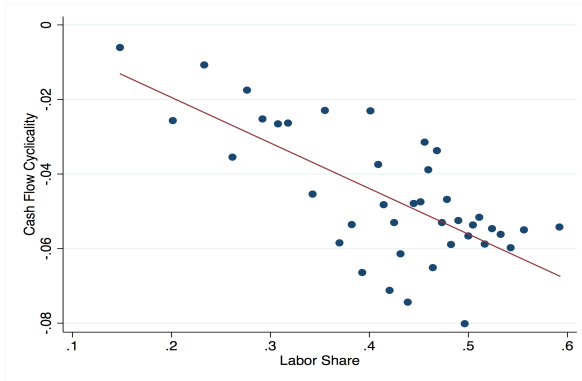
(a) *Industry-level cash flow cyclicality (comovement w/ unemployment; more negative numbers represent stronger procyclicality).*
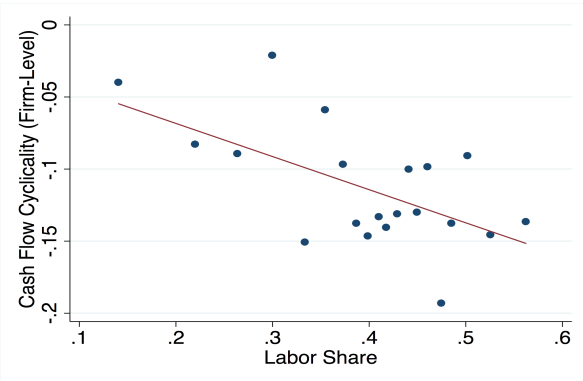
(b) *Firm-level cash flow cyclicality (Compustat; comovement w/ unemployment; more negative numbers represent stronger procyclicality).*
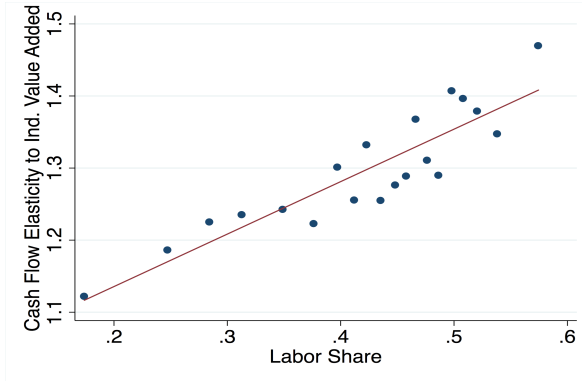
(c) *Cash flow elasticity to industry value added.*
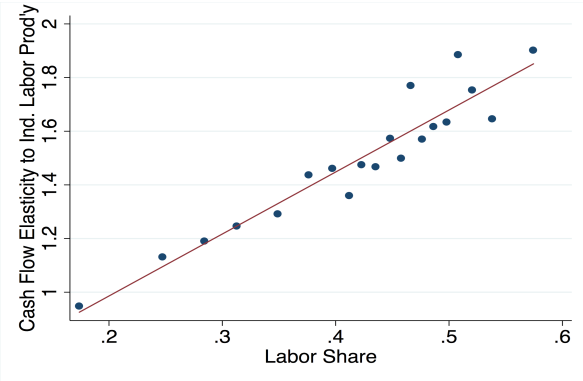
(d) *CF elast. to industry avg. labor productivity.*
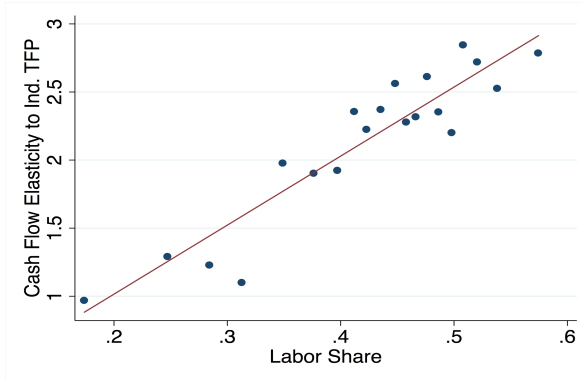
(e) *Cash flow elasticity to industry TFP.*
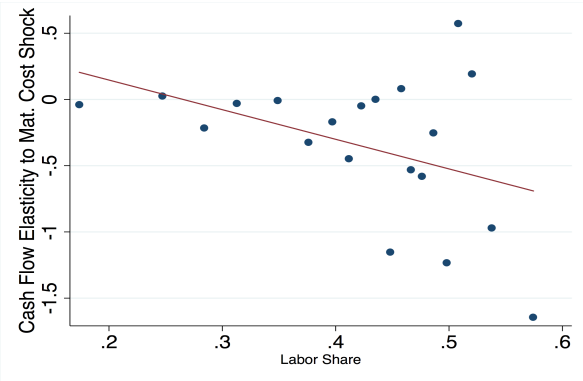
(f) *CF elast. to ind. input price index shock.*

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 1.3: *Industry Cash Flow Dynamics and the Labor Share.*

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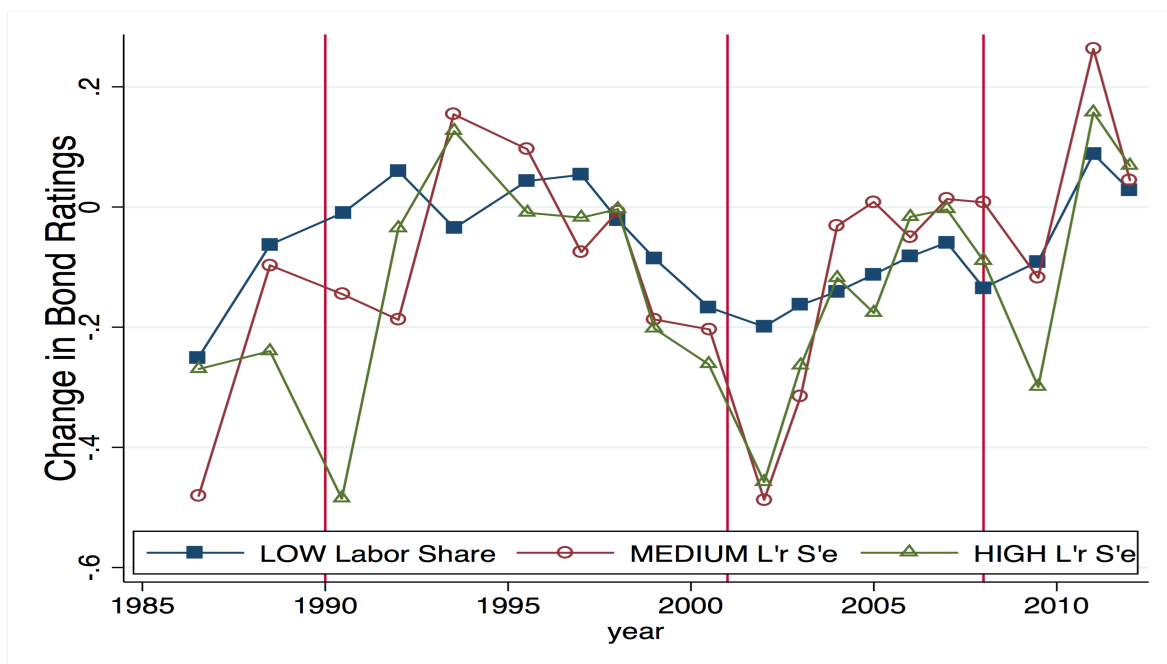
(a) *Bond Rating Changes by Labor Share*
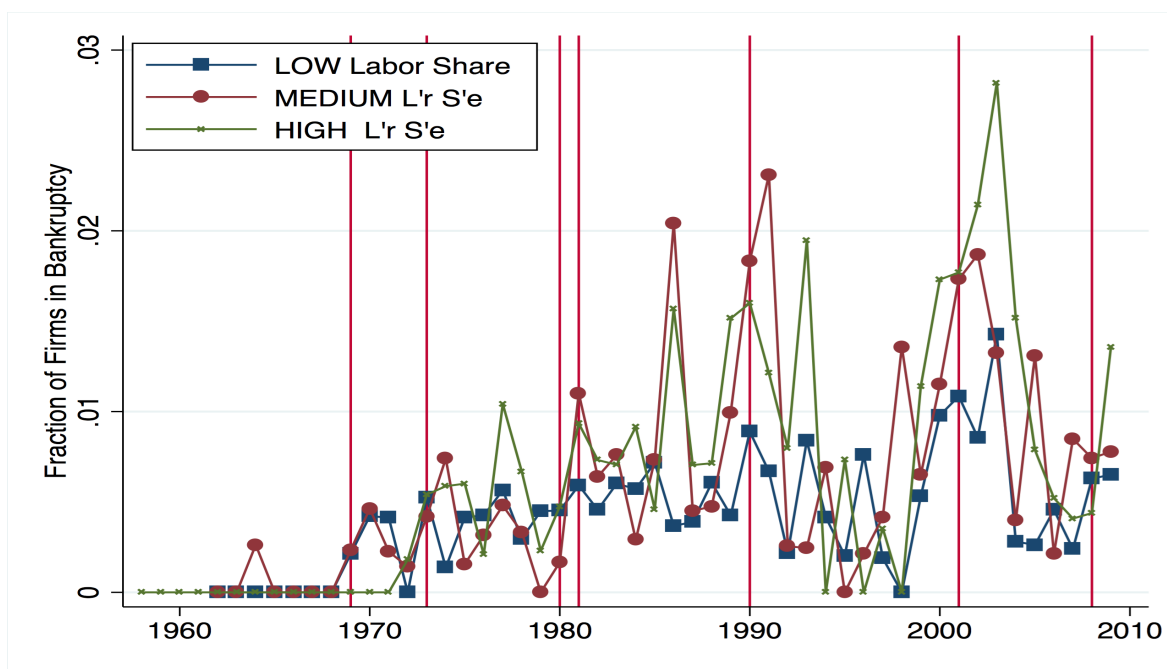
(b) *Bankruptcies by Industry's Labor Share*

Figure 1.4: *The Labor Share and Firms' Financial Conditions over the Business Cycle.*

Industry-level Test: the Labor Share Amplifies Cash Flow Fluctuations. The ideal experiment assigns, all other things equal, different wage cyclicalities to firms or industries. But obtaining clean measures of, let alone suitable variation in, wage rigidity is difficult.[21] 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 σ^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]

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

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 1.3a plots the cross-sectional relationship between labor shares and cash-flow cyclicalities. The industry cyclicality measure mirrors the aggregate one, obtained from industry-level regressions of

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[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.

detrended log cash flow on detrended unemployment ($dlog(\text{CashFlow}_{it})/d\text{UnempRate}_t$). 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 1.3b (U.S. Compustat). Indeed, cash flow is nearly acyclical for low labor shares. If wages were slightly more procyclical, all industries would see their cash flow smoothed.

Further Evidence on Industry-Specific Cash Flow Fluctuations. To rule out confounding factors such as more procyclical product demand, Figures 1.3c–1.3f confirm the relationship between cash flow dynamics and the labor share for industry-specific rather than aggregate shocks. Figure 1.3c plots the elasticity of cash flow to an industry's *change in value added*; Figures 1.3d and 1.3e repeat this exercise with industry-level average *labor productivity* as well as for industry-level *TFP*. Figure 1.3f 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.[24] Figure 1.4a plots these event studies by labor share tercile. Lastly, I investigate firm bankruptcies.[25] In Figure 1.4b, 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

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[24]I translate the 20 S&P grades into equally spaced numerical grades (1, 2, 3,...).

[25]I use a bankruptcy indicator from Chava and Jarrow (2004), Chava *et al.* (2011), Alanis and Chava (2012), which covers all filings in the Wall Street Journal Index, the SDC database, SEC filings and the CCH Capital Changes Reporter. I merge the data with CRSP, and take annual fraction of firms in bankruptcy per industry.

smoother cash flow, such as the one with less wage rigidity, would indeed exhibit smoother employment thanks to the smoother cash flow.

1.3.2 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 .[26] (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 λ) by dissaving, following decision rule $f(\lambda, A)$, with $f_\lambda(\lambda, A) > 0$ and $f_{\lambda A}(\lambda, A) > 0$:

$$\frac{\partial log(n_1^*)}{\partial log(z)} = \frac{1}{\frac{n_1 c}{c'}} \cdot \frac{z}{z - w_0} \cdot \left(1 - \frac{\partial w_0}{\partial z} + \boxed{f_\lambda(\lambda, A)} \cdot \frac{\partial \lambda}{\partial z}\right)$$

from which follows that $\partial \left(\frac{\partial log(n_1^*)}{\partial log(z)}\right) / \partial A < 0$. That is, the more liquid assets the firm holds to compensate for cash flow drops, the less the firm will be forced to cut hiring.

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.[27] The groups' parallel behavior of the outcome variables before and after the recession suggest that the measure

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[26]Duchin *et al.* (2010), Campello *et al.* (2010), Campello *et al.* (2011) and Almeida *et al.* (2012) investigate the role of liquidity in the 2008/09 recession only, and with a focus on investment.

[27]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.

might not be problematically related to non-financial cyclical dynamics of the firm.[28] 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 1.5b and 1.6 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 1.5a 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.[29] 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 firms, in line with the financial channel of wage rigidity.

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[28]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.

[29]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.
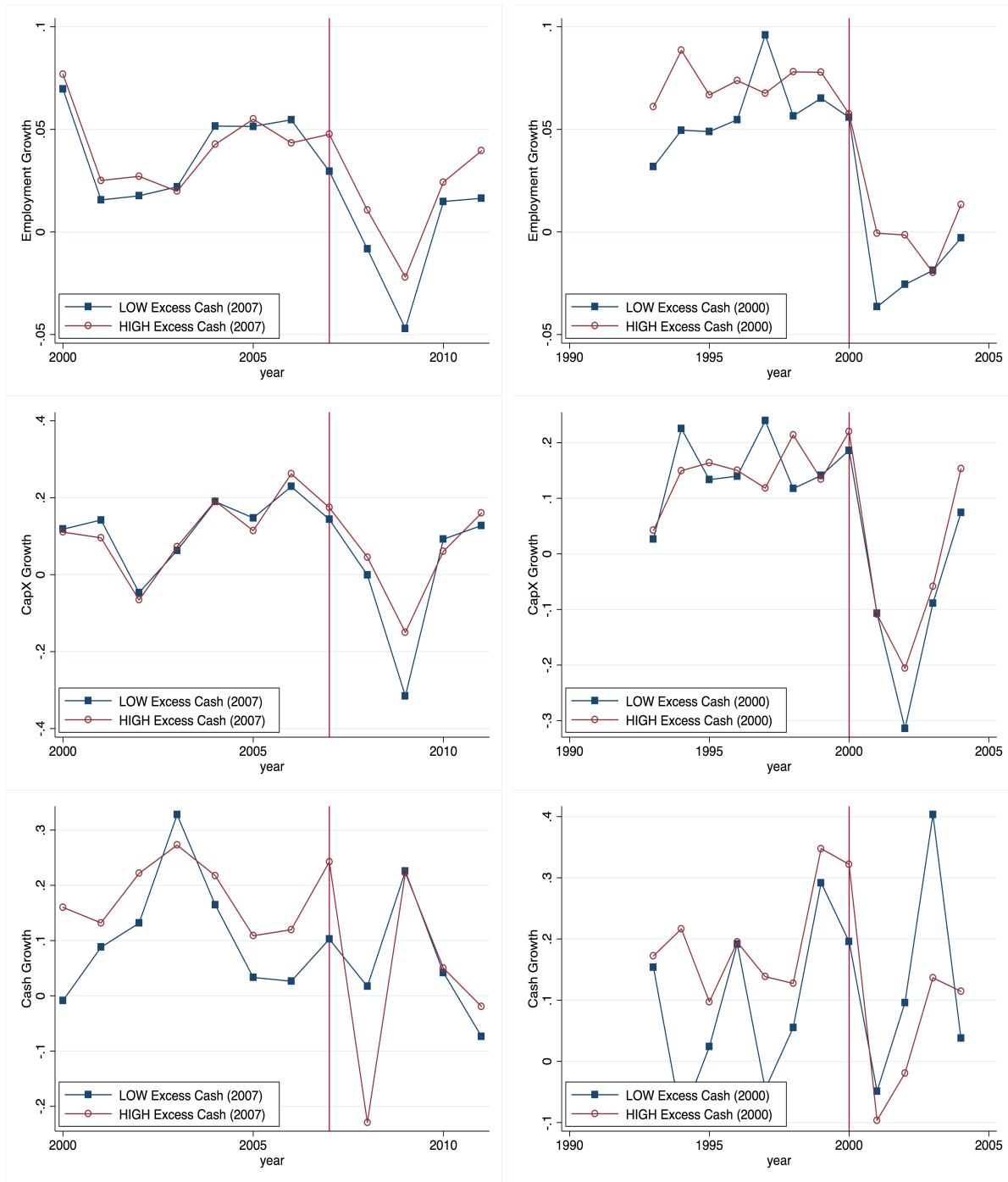
(a) *2007/08 Recession* **(b)** *2001/02 Recession*

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 1.5: *Internal Funds & Recessions*
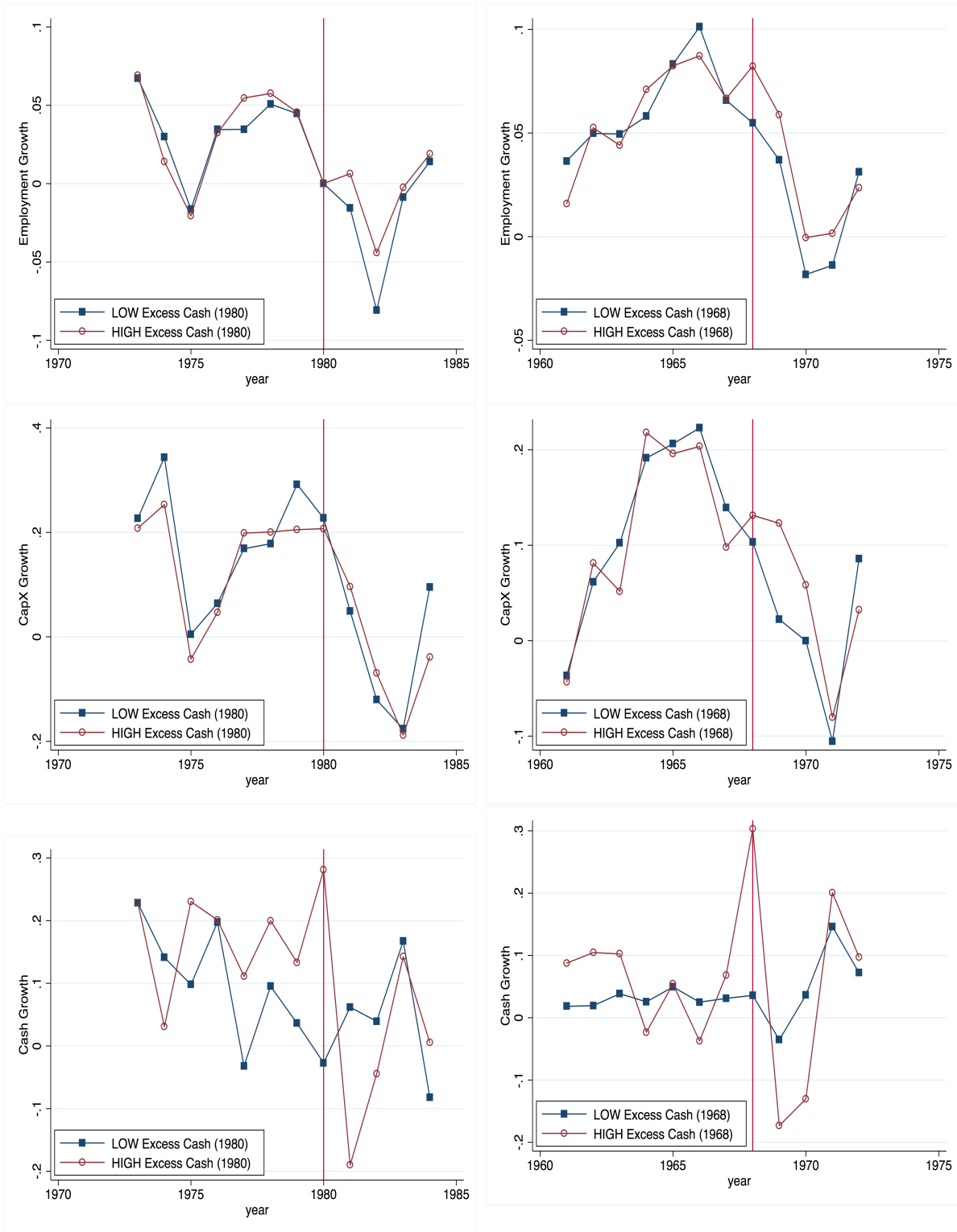
(a) *1982 Recession*

(b) *1970 Recession*

Figure 1.6: *Internal Funds & Recessions (continued).*

Table 1.1: *My Estimates of the Employment Sensitivity to Cash Flow Shocks. Six Identification Designs.*

| | Design | | | *Cash Flow Sensitivity: β (SE)* | |
		Identification (Liquidity Shock)	Data	Investment	Employment
I	Tobin's *q*/ALP & cash flow	Aggregate analysis	Flow of Funds (1950–2013)	0.97 (0.089)	**0.42** (0.043)
II	Tobin's *q* & cash flow; Fazzari *et al.* (1988), Kaplan and Zingales (1997), Benmelech *et al.* (2012b), McLean and Zhao (2014)	"Structural" approach: the empirical designs augment the frictionless model with cash flow. The frictionless investment model uses Tobin's *q* measures constructed from asset prices. Sensitivity estimate: coefficient on cash flow.	Compustat (1950–2012)	0.21 (−0.4) (0.010)	**0.25** (0.009)
III	Oil price shocks & conglomerates; Lamont (1997)	How do internal capital markets in conglomerates transmit an exogenous cash flow shock from oil-related to -unrelated segments?	Compustat (segments) (1985–86)	+ 0.5 (?)	+ 1 (?)
IV	Stock option redemption; Babenko *et al.* (2011)	Cash flow shock from discontinuous redemption of employee stock options once in the money [0.72 (inv.) & 0.61 (emp.) if I deviate from org. spec. by applying reg. kink design]	Compustat, Risk Metrics (1999–2005)	0.37 (0.083)	**0.22** (0.096)
V	DB pension refunding; Rauh (2006), Bakke and Whited (2012)	Mandatory DB pension refunding shocks triggered by asset/liability ratios generate cash flow shocks.	Compustat, IRS F. 5500 (1990–1998)	0.65 (0.32)	**0.72** (0.45)
VI	Real estate collateral; Chaney *et al.* (2012)	Between-firm variation in real-estate holdings and real-estate price changes trigger changes in firms' collateral capacity [IV effect from realized long-term debt response, increases (up to 2x) w/ alt. debt cap. measures]	Compustat 1993–2007	0.41 (0.096)	**0.47** (0.116)

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.

Note to Table 1.1: 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 $dPayroll_i^{marginal} = w^{marg} \cdot dEmp_i$, 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: $\widehat{dPayroll}_i^{marginal} = \overline{w}^{marginal} \cdot dEmp_i$. 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: $\frac{w_i^{marg}}{w_i^{avg}} = \frac{dlog(Payroll_i)}{dlog(n_i)} \approx 0.475$, since $\frac{dlog(Payroll)}{dlogn} = \frac{n}{nw^{avg}} \frac{d(Payroll)}{dEmp} = \frac{w^{marg}}{w^{avg}}$, 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.

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 dCashFlow:

$$c(n_1) \leq \underbrace{z_0 n_0 - w_0 n_0 + d\text{CashFlow}}_{\text{Internal Funds}}$$

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:

$$\frac{\bar{w}_t^{marg} \cdot dEmp_t}{Assets_{t-1}} = \beta^q \cdot q + \sigma^E \cdot \frac{Liquidity_t}{Assets_{t-1}} + \beta_X X_{t-1,i} + \alpha_t + \alpha_i + \varepsilon_{it} \qquad (1.1)$$

The interpretation of coefficient σ^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 1.1. [32]

Estimates of the Firm-Level Employment Effects of Cash Flow Shocks. Table 1.1 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

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[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.* (2012b), 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.

estimates of the conventional capital investment sensitivity, which I also include for each design. But in percentage terms, capital expenditure responds twice as strongly, in line with its greater investment character.

Whence the Sensitivity of Labor to Cash Flow? In the model, I rationalize the relationship between cash flow and employment with labor 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.[33] 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:[34]

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

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

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[33]Christiano *et al.* (2005) and Jermann and Quadrini (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.

1.7a. Grouping industries by labor share, I plot their respective percentage employment declines. Figures 1.7b and 1.7c confirm that cash flow and capital expenditure declines also exhibit the labor-share dependence during recessions.
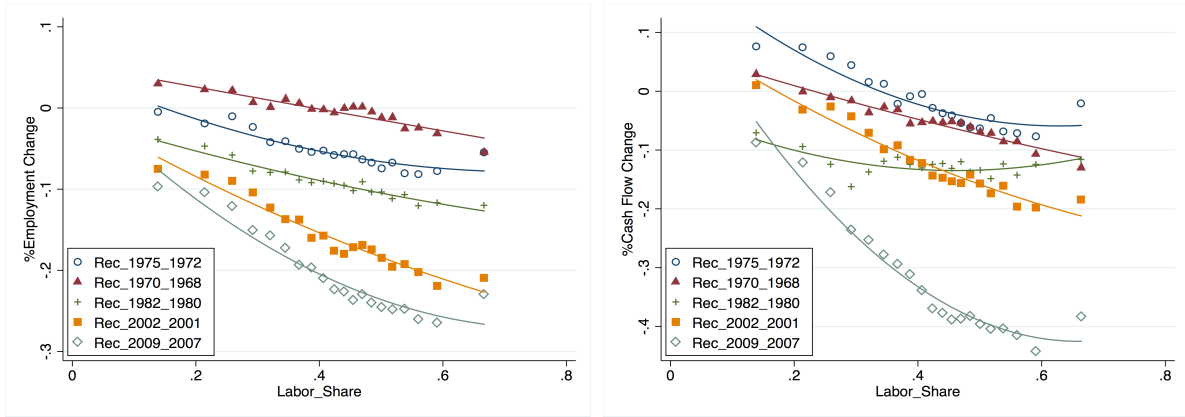
(a) *Recession event studies:* **Employment** *declines by labor share.*

(b) *Recession event studies:* **Cash flow** *declines by labor share.*
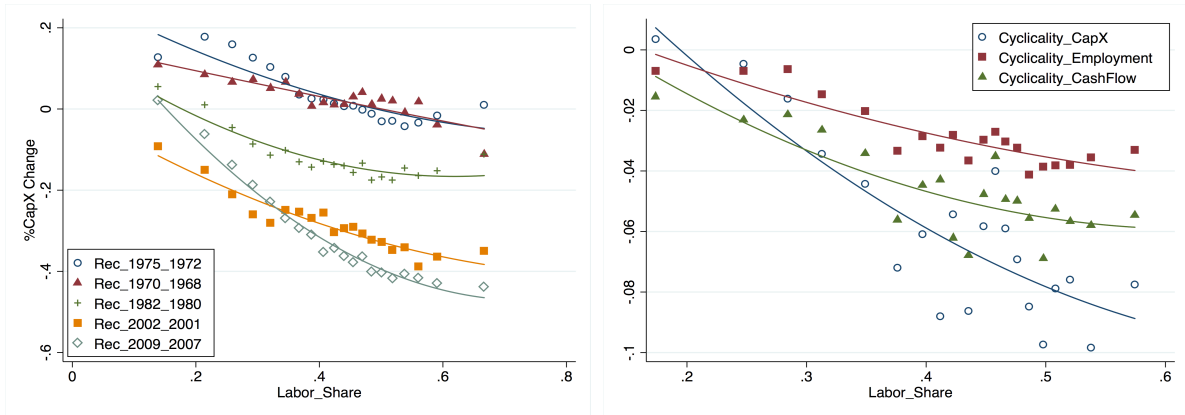
(c) *Recession event studies:* **Capital expenditure** *declines by labor share.*

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

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 1.7: *Industry-level Cyclicalities by Labor Share: Cash Flow, Employment, Investment.*

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 1.7d plots these industry cyclicalities against the labor share. Employment in the lowest labor share group is nearly acyclical, while the highest labor share group's employment falls by 4% for each percentage point increase in unemployment. The 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 1.7d shows alongside employment and cash flow.

1.4 Synthesis

In this Chapter, 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.

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[35]I confirm robustness to monthly employment data (Quarterly Census of Employment and Wages, 1975+).

Chapter 2

Macroeconomic Implications of the Financial Channel of Wage Rigidity

2.1 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 2.2 plots for the U.S. data between 1958 and 2013. Recruitment drops typically by 40-50% from peak in a typical recession; productivity does by an order of magnitude less. Following Shimer (2005), the degree to which new hires' wages absorb productivity shocks has been recognized as the nexus of amplification, 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.[1] 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 2.2, 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 2.2 shows tracks vacancies over the business cycle.

2.1.1 The Labor Market Structure of the DMP Class of Models

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

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[1]See Hall (2005b), Shimer (2010), Michaillat (2012), Gertler and Trigari (2009) for ad-hoc wage rigidity, and Hagedorn and Manovskii (2008), Hall and Milgrom (2008)), Christiano *et al.* (2013), Eliaz and Spiegler (2013) for micro-foundations.

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 δ. In the model, an increase in vacancy posting v leads to tight labor markets $\theta = v/u$. The increase in θ raises job finding rate $f(\theta)$. When having separated exogenously into unemployment at rate δ, job seekers u find a new match faster. Unemployment decreases. That is, unemployment evolves as the inflow into unemployment from employment, δn^-, minus the outflow from unemployment into employment, $f(\theta^-)u^-$:

$$\Delta u = \delta(1 - u^-) - f(\theta^-)u^- \tag{2.1}$$

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 $q(\theta)$.[2] $c(h) = k/q(\theta)$ 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 δ 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.[3]

2.1.2 Inframarginal Wage Rigidity

I introduce inframarginal wage rigidity (IMWR) in a tractable specification that I can directly calibrate to micro-estimates of wage behavior.[4] Period-t wage of an incumbent hired in

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[2]Such procyclical adjustment costs smooth factor demand (Shimer (2010)). Pissarides (2009), Mortensen and Nagypál (2007), Gertler and Trigari (2009) and Christiano *et al.* (2013) consider fixed or quadratic costs.

[3]Both parties *prefer* forming/maintaining the match to their outside options (new search) for typical productivity shocks even with rigid wages, which Hall (2005b) shows circumvents the Barro (1977) critique.

[4]Like most work investigating the consequences of wage rigidity, this paper does not micro-found its version (IMWR). Implicit contracts could generate such patterns, as financial constraints make the firm effectively risk averse. While the model features standard risk-neutral DMP households, household risk aversion would amplify

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 ρ:

$$\underbrace{w_{t,s}}_{\substack{\text{cohort } s\text{'s wage} \\ \text{in period } t}} = \underbrace{\overbrace{w_{t,t}}^{\substack{\text{current} \\ \text{going} \\ \text{wage}}}}_{\substack{\text{cyclical wage} \\ \text{component}}}^{1-\rho} \cdot \underbrace{\overbrace{w_{s,s}}^{\substack{\text{ex-ante} \\ \text{flexible} \\ \text{base wage}}} \overbrace{}^{\substack{\text{IMWR} \\ \rho}}}_{\substack{\text{ex-post rigid} \\ \text{cohort effect}}} \tag{2.2}$$

The parameter controlling IMWR, $\rho \in [0,1]$, shields the incumbent's wage from cyclical market wage $w_{t,t}$ by putting weight on the rigid "cohort effect" $w_{s,s}^\rho$ that persists throughout the match.[5] 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 ρ guides the *relative* wage cyclicality of incumbents vis-à-vis new hires. For small changes in $w_{t,t}$, it maps directly into the wage cyclicality estimates I review in Section 1.3.1:

$$\rho = 1 - \frac{dlog(w_{t,s})}{dlog(w_{t,t})} = 1 - \frac{dlog(w_t^{inc})}{dlog(w_t^{new})} = 1 - \frac{e_{w,u}^{inc}}{e_{w,u}^{new}} \tag{2.3}$$

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 $w_{t,s}$.[6] Payroll Φ 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

employment fluctuations by smoothing wages more.

[5]This specification matches the empirical wage behavior of new vs. incumbent workers in particular documented in Haefke *et al.* (2013) and Kudlyak (2014), and the citations in Footnote 2.

[6]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)).

for payroll recursive and tractable under the conventional constant separation rate δ:[7]

$$\Phi = wh + (1 - \delta) \left(\frac{w}{w^-} \right)^{1-\rho} \Phi^- \tag{2.4}$$

Average wage w^{avg} evolves recursively as the turnover-weighted average of new hires' wage w and lagged w^{avg}:

$$w^{avg} = w \frac{h}{n} + (1 - \delta) \frac{n^-}{n} \left(\frac{w}{w^-} \right)^{1-\rho} w^{avg-} \tag{2.5}$$

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, ρ, directly reduces the responsiveness of incumbents' and thus average wages to market conditions.[8] Figure 2.1 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 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 (2.5) predicts for $\rho = 1$, adjustments in the average wage are sluggish and exclusively through turnover. Calibration Section 2.2 appeals to micro-empirical estimates of wage cyclicalities of new and incumbent workers to calibrate IMWR ρ to lie between 0.5

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[7]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 2.3.

[8]*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.

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.

2.1.3 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 $q(\theta)$:

$$V(\mathbf{s}; n^-, \Phi^-, h, B^-) = \max_{v, B} \left\{ d + \mathbb{E}\beta V(\mathbf{s^+}; n, \Phi, h^+, B) \right\} \tag{2.6}$$

subject to:

$$\Phi = hw + (1 - \delta) \left(\frac{w}{w^-} \right)^{1-\rho} \Phi^- \tag{2.7}$$

$$n = (1 - \delta)n^- + h \tag{2.8}$$

$$h^+ = vq(\theta) \tag{2.9}$$

$$vk \leq \zeta - d + (\Delta B - RB^-) \tag{2.10}$$

$$B \leq \bar{B} \tag{2.11}$$

where β is the discount factor of the managers (and of the firm-owning households).

Financial Frictions. Recruitment expenditure is subject to borrowing constraint (2.10, 2.11), 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

| I. Wage Biographies (○--) By Entry Cohort | II. New Hires' (—) & Average (··) Wages |

Panel A: No IMWR ($\rho = 0$)
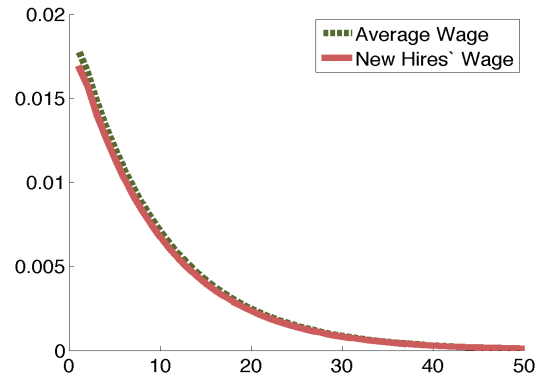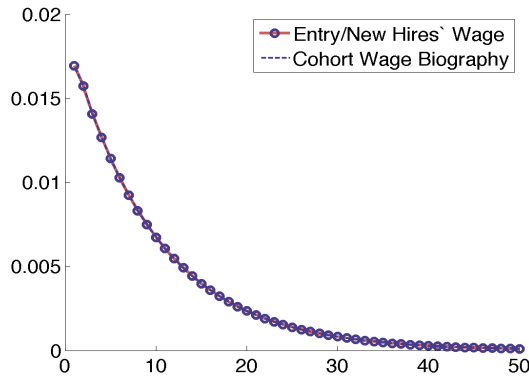
Panel B: Intermediate IMWR ($\rho = 0.5$)
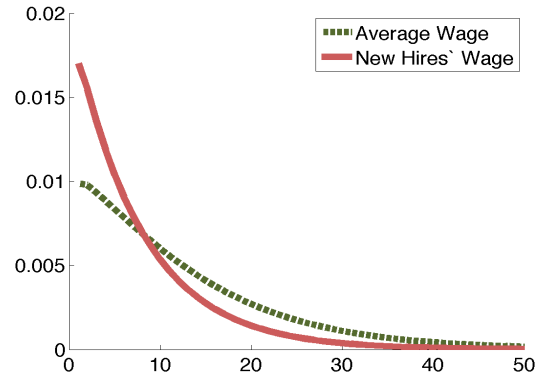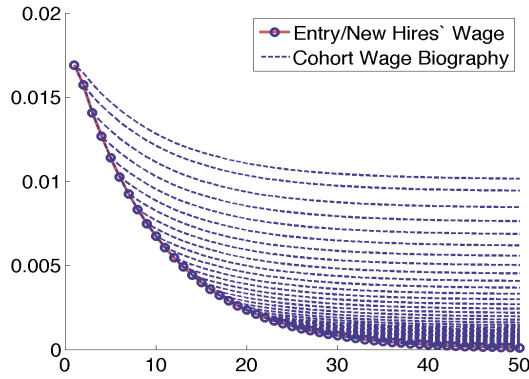
Panel C: Perfect IMWR ($\rho = 1$)
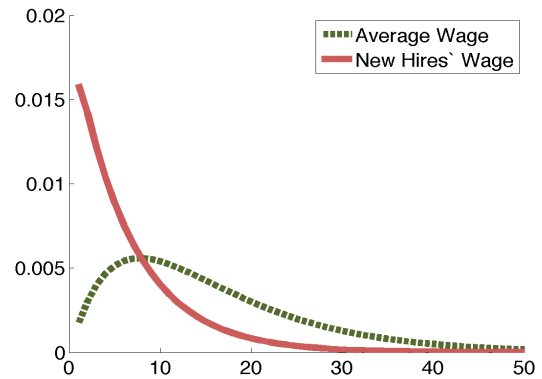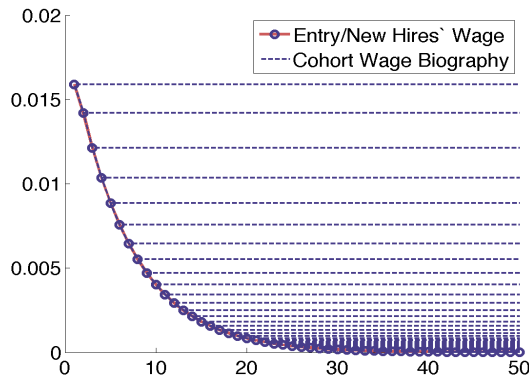
Notes: Wage Dynamics under IMWR $\rho \in \{0, 0.5, 1\}$ in Panels A, B and C. The impulse response of the going wage is to a 1 SD ($\sim 2\%$) shock to productivity. Column I shows wage biographies: the workers' wages by their hiring cohort, along with the going wage. Column II shows impulse responses of new hires' and average wages.

Figure 2.1: *Wage Dynamics Under Three Levels of Inframarginal Wage Rigidity.*

specification.

Liquidity. The firm uses internal funds and potentially external finance to cover recruitment expenditure vk. Liquidity

$$L = \zeta - RB^- - d + \Delta B \tag{2.12}$$

is a function of cash flow ζ plus new net borrowing ΔB, 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,[9] 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: $\bar{B} = (1 - \xi^B)V^{ss}$.

Dividend Policy. Stockholders enjoy the residual claim on cash flow after interest payments $\zeta^{\text{resid}} = \zeta - RB^-$, which financial constraints render positive in equilibrium. Enforcement friction ξ^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.[10]

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[9]Enforcement frictions commonly rationalize collateral constraints (e.g. Jermann and Quadrini (2012)).

[10]Consider one simple story: Managers divert fraction ξ^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 $1 = \mathbb{E}(1 - \xi^D)V^{ss}_\zeta$. Cash value V_ζ exceeds the first-best $V_\zeta(\xi^D = 0)$. Despite enforcement friction ξ^D, a linear incentive scheme lets the managers take optimal marginal actions to maximize the present value of dividends with discount factor β, 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 μ 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 μ are fixed in advance and thus acyclical. I suppress μ in the firm's (the manager's) problem because it scales linearly.

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 $\alpha^r = \partial L / \partial \zeta = 1 - \partial d / \partial \zeta$. For the purposes of calibration, empirical estimation and tractability in the subsequent exposition, I consider a constant retention rule α arising from external-finance frictions such as dividend adjustment costs or agency problems of free cash flow:[11]

$$d = d^{ss}(\xi^D) + (1 - \alpha) \cdot (\zeta_{\text{resid}} - \zeta_{\text{resid}}^{ss}) \tag{2.13}$$

Faction 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: $L = (\zeta - R\bar{B} - d) + \Delta B = (\zeta_{\text{resid}}^{ss} - d^{ss}) + \alpha \cdot (\zeta - \zeta^{ss}) + \Delta B$. 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 1.3.2, 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

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[11]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 α can be rationalized given ξ^D.

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.[12] 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 α.[13] But either way, my empirical calculation in Section 1.3.1 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.[14]

Hiring. Under financial constraints, productivity increases hiring not by making vacancy 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 (2.10) 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

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[12]Chaney *et al.* (2012) find evidence that real estate collateral values affect debt capacity.

[13]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.

[14]Of course, some driving forces (discount rate (Hall (2014)), uncertainty shocks (Bloom *et al.* (2012))) may lead to asset price movements unrelated to profits.

formation will persist over the course of the match:

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

$$\Leftrightarrow \overbrace{\frac{k}{q(\theta^*)}}^{\text{"RecX"}} = \overbrace{\mathbb{E}\beta(z^+ - w^+)}^{\text{Cash flow}} + \underbrace{\overbrace{(1-\delta)\mathbb{E}\beta\frac{k}{q(\theta^+)}}^{\substack{\text{EPV of hiring}\\\text{tomorrow}\\=\text{Rec. exp. tomorrow}}}}_{(1-\delta)\mathbb{E}\beta V_h^{++}(w^{++})} - \underbrace{\overbrace{\beta\frac{(1-\delta)\beta}{1-\beta(1-\delta)}\mathbb{E}\left[(w^{+\rho} - w^{++\rho})w^{++1-\rho}\right]}^{\substack{\text{PV of wage premium due to IMWR}\\\text{vs. match period after}}}}_{V_h^{++}(w^+)-V_h^{++}(w^{++})}$$

(2.14)

For $\rho = 0$, this condition collapses to the standard DMP zero profit condition.[15] Given a wage rule, the condition pins down equilibrium market tightness θ.

When financial constraints on recruitment expenditure (2.10) bind, the condition features Lagrange multiplier τ ("liquidity wedge") and stochastic cash flow valuations through V^{F++}_Φ:

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

(2.15)

Households take dividends and, as in most DMP variants, employment as given.[16] With linear consumption utility, they maximize the present value of income: payroll Φ plus

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

[16]Division into many small, identical households (or separate worker and capitalist households) prevents the worker from internalizing the effect of her wage bargain on dividends. Relying on labor demand vs. supply for employment fluctuations avoids empirically contentious supply elasticities (Chetty *et al.*)). The Real Business Cycle, New Keynesian and DMP models of employment often adopt indivisible labor (Hansen (1985), Rogerson (1988)).

dividends d plus interest RB^- minus new lending ΔB, net of labor disutility γ:

$$V(\mathbf{s}; n^-, \Phi^-, h, B^-) = \Phi + d - \gamma n + RB^- - \Delta B + \mathbb{E}\beta V(\mathbf{s}; n, \Phi, h^+, B) \qquad (2.16)$$

subject to:

$$\Phi = hw + (1 - \delta)\left(\frac{w}{w^-}\right)^{1-\rho}\Phi^- \qquad (2.17)$$

$$n = h + n^-(1 - \delta) \qquad (2.18)$$

$$h^+ = f(\theta)(1 - n) \qquad (2.19)$$

2.1.4 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.[17] 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 ϕ:

$$\max_w \{V_h^H(w)^\phi V_h^F(w)^{1-\phi}\} \qquad (2.20)$$

$V_h^F(w)$ ($V_h^H(w)$) denotes the value of adding a new hire at arbitrary bargain wage $\tilde{w}$ to the firm[18] (household[19]).

The Nash Wage under Financial Constraints and IMWR is defined by $\phi \cdot \psi \cdot V_h^F(w^*) =$

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[17] As a result, no Stole and Zwiebel (1996) bargaining complications arise.

[18] *The firm's incremental match value* is cash flow (valued at $(1 + \alpha(\tau - 1))$) plus continuation value adjusted for the ρ-weighted match-specific wage path: $V_h^F(\tilde{w}) = (1 + \alpha(\tau - 1)) \cdot (z - \tilde{w}) + (1 - \delta) \cdot \mathbb{E}\beta\left[\tau^+ \frac{k}{q(\theta')}\right] + (1 - \delta) \cdot \beta\mathbb{E}\left[(\tilde{w}^\rho - w^{+\rho})w^{+1-\rho} \cdot V_\Phi^{F+}\right]$

[19] *Household:* $V_h^H(\tilde{w}) = (\tilde{w} - \gamma) + (1 - \delta - f(\theta))\mathbb{E}\beta V_h^H(\tilde{w}') + (1 - \delta)\beta\mathbb{E}\left[(\tilde{w}^\rho - w^{+\rho})w^{+1-\rho} \cdot V_\Phi^{H\prime}\right]$

$(1 - \phi) \cdot V_h^H(w^*)$ and solves into:

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

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

where: (2.21)

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

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

When financial constraints are slack ($B < \bar{B}$) and the firm thus values retained cash flow and dividend payout equally ($\tau = 1$), wage bargain (2.21) nests a variety of standard DMP wage bargains.[20] $\psi = V_h'^H(w)/V_h'^F(w)$ represents the relative marginal value from a dollar in wages settled on today. When financial constraints are slack and discount rates symmetric, ψ 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 $\tilde{\phi}$. Through ψ, the wage responds to the firm's financial condition ($V_h'^F(\tilde{w})$), 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 $\mathbb{E}(1 - \delta)\beta\left[\tilde{w}^\rho - w^{+\rho}\right]w^{+1-\rho}$ (the difference between today's and tomorrow's expected going

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

wage). This term is multiplied by the weighted average of the relative cash valuations of the bargaining parties, $\left[\tilde{\phi}\tilde{V}^{+\prime F} - (1 - \tilde{\phi})V^{+\prime H}\right]$, which would equal one without financial constraints.[21] Γ merely adjusts for the evolution of ψ.[22] In Section 2.3, I present empirical evidence from a unique micro-data set that wage contracts appear to insufficiently backload wages in recessions.

2.1.5   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 θ and Nash wage w (θ, w) that solves the firm's vacancy posting condition (2.15) and Nash wage (2.21).*

While smoothing wages by construction, IMWR ρ 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 θ.*

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.

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[21]This term captures the expected present value differential between the current match persisting tomorrow and a freshly priced match tomorrow as a benchmark. This value differential is split by $\tilde{\phi}$; payroll is valued at $V_{\Phi}^{\prime F}$ and $V_{\Phi}^{\prime H}$. $(1 + \alpha(\tau - 1))$ normalizes the firm's cash value in money units.

[22]Γ 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 ψ and ψ' diverge.

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 bargain entry wages in recessions. This neutrality arises from Nash bargaining over the first-period "base wage", through which the bargaining parties offset IMWR by amortizing the present-value productivity change through smoother entry wages. The ex-ante consideration is particular to wage determination within long-term employment relationships such as in the DMP model.[23] 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), Christano 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 ρ amplifies the responses of vacancy posting and labor market tightness to productivity shocks, by amplifying fluctuations in liquidity.*

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.[24] The analytical comparative

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[23]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 Nagypál (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.

[24]$\varepsilon^{\text{DMP}} = \frac{d\theta/\theta}{d\zeta^{\text{marg}}/\zeta^{\text{marg}}} \frac{d\zeta^{\text{marg}}/\zeta^{\text{marg}}}{dz/z} = \left(\frac{1}{\eta}\frac{z}{z-w}\right)\left(1-\frac{dw}{dz}\right)$ and $\varepsilon^{\text{financial}}_{\theta,z} = \frac{d\theta/\theta}{dv/v}\frac{dv/v}{d\zeta^{\text{avg}}/\zeta^{\text{avg}}}\frac{d\zeta^{\text{avg}}/\zeta^{\text{avg}}}{dz/z} = \left(\frac{1}{1-\kappa^u-\kappa^\pi}\cdot\frac{z^{ss}n^{ss}}{\bar{L}}\right)\cdot\alpha\cdot\left(1-(\delta+(1-\delta)(1-\rho)\frac{dw^n}{dz}\right)$ where $\kappa^u = (1-\eta)(1-u)$ and and $\kappa^\zeta = \eta(1-u)\zeta$ represent the attenuating effects of v on θ through u, of θ on ζ respectively.

statics can be reformulated to versions of the hiring elasticities (b) and (d) in the simple model in Section 1.2, with equilibrium labor market tightness θ rather than firm-level hiring h_1:

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

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

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

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

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

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

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 ($dw^{new}/dz = 1$), financial amplification still occurs under:*

- *Binding financial constraints ($B^* = \bar{B}$ 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

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DMP model has zero quantity movements, as recruitment incentives (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.

2.2 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 ρ under financial constraints, I present the results from the simulations in Figures 2.3 and 2.4. Following the literature started by Shimer (2005), I focus on generating realistic fluctuations in hiring, specifically the key labor market variable labor market tightness θ, in response to comparatively smooth shifts in (average) labor productivity z.

Key Empirical Moments. Figure 2.2 plots detrended log labor market tightness and vacancy postings against average labor productivity (quarterly U.S. data, 1953 to 2013).[25] 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

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[25]In this section, I use the HP filter with $\lambda = 10^5$ common in the DMP literature. All insights hold with the more standard smoothing parameter $\lambda = 1600$.

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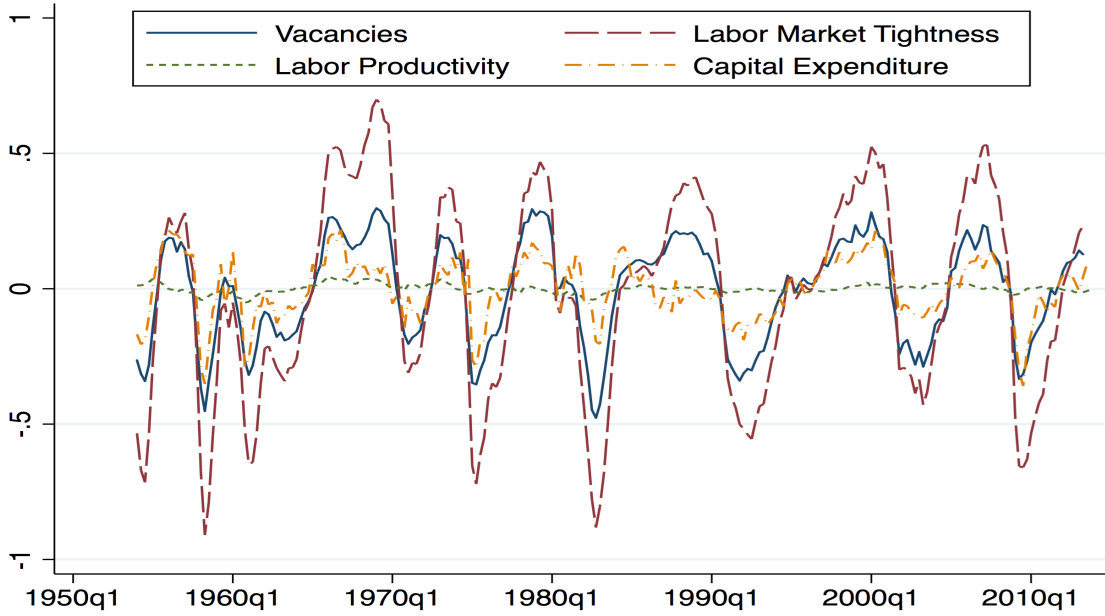
Notes: Hiring: vacancy proxy from Conference Board Help-Wanted Index (composite version by Barnichon (2010)); labor market tightness: ratio of vacancies over (BLS) unemployment rate; (real) capital expenditure: Flow of Funds; average labor productivity: real output over civilian employment. Quarterly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

Figure 2.2: *The Cyclical Behavior of Hiring, Labor Market Tightness, Labor Productivity, and Investment.*

Parameterization. Table 2.1 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 ρ denotes the comovement of incumbents' wages with new hires' wages. Second, I calibrate the financial-friction parameter α, 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 1.3.2.

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

Table 2.1: *Parameterization in Calibrated Model; Quarterly Frequency.*

Param'r	Value	Description	Target	Source
		A. Standard DMP Parameters		
σ_z	0.02	Standard deviation of z	⎫ BLS average	⎫
ρ_z	0.95	Autocorrelation of z	⎰ labor productivity	
δ	0.1	Separation rate	Current Pop. Survey	
β^H	0.953	Household discount factor	Annual rate of 4%	
γ	0.6	Labor disutility	Opportunity cost of empl.	⎬ Shimer (2005)
μ	1.355	Matching efficiency	Beveridge curve	
η	$\{0.5, 0.72\}$	Vacancy matching elasticity	Beveridge curve	
ϕ	0.72	Worker bargaining power	Hosios (1990) condition	
k	0.213	Vacancy flow cost	6% S.s. unemp. rate	⎭
		B. Financial Frictions		
α	[0,0.5]	Cash flow-liquidity pass-through	Match employment-cash flow sensitivity estimates	Own estimtes (Section 1.3.2)
L^{ss} $\bar{B}(\xi^B)$ $d^{ss}(\xi^D)$	0.012	Baseline liquidity	Close to s.s. vacancy cost w/o FCs	Internally calibrated
		C. Wage Friction		
ρ	{0,0.5, 0.8,1}	Inframarginal wage rigidity	Cyclicality of wages in new vs. old matches	Pissarides (2009)

($\gamma = 0.6$).[26] I set matching function elasticity parameter η 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 ϕ equal to the elasticity of the matching function η.[27]

Wage Rigidity Parameter ρ. A methodological advantage of seeking amplification from inframarginal wage rigidity ρ is that its calibration is empirically well-defined: ρ 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 ρ 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: $\rho = 1 - dlog(w_{t,s})/dlog(w_{t,t}) = 1 - dlog(w_t^{inc})/dlog(w_t^{new}) = 1 - e_{w,u}^{inc}/e_{w,u}^{new}$. Second, I calibrate ρ 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 $d^{ss}(\xi^D)$), and those guiding the effects of cash flow changes on liquidity (retention parameter α).

Baseline Liquidity $\bar{L}$ depends on borrowing limit $\bar{B}(\xi^B)$ and on dividend target $d^{ss}(\xi^D)$ (via cash flow available for reinvestment). Arbitrary combinations generate the same baseline liquidity $\bar{L}$ and thus production scale. I set it to "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 α guides the firm's propensity to retain cash flow deviations and thereby

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[26]Chodorow-Reich and Karabarbounis (2013) review parameterizations of the opportunity cost of employment and investigate its empirical cyclicality. γ 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.

[27]This Hosios (1990) condition generates constrained efficiency in the standard DMP model.

the force of the financial channel of wage rigidity. I calibrate α 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 1.1, around 0.25 for $\alpha = 0.2$.

2.2.1 Simulated Moments: Slack Financial Constraints (Benchmark Model)

Figure 2.3 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 θ 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 2.3 illustrates the theoretical present-value neutrality of the benchmark model: labor market tightness volatility remains flat in ρ. 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.

2.2.2 Simulated Moments: Binding Financial Constraints

Figure 2.4 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 1.3. The higher ρ, 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 ρ towards $\rho = 0$ would greatly smooth aggregate hiring fluctuations. $\rho = 0$ corresponds to the empirical national accounting calculation in Section 1.3.1, which suggested that in the data too, cash flow would be stabilized under such a wage cyclicality regime.
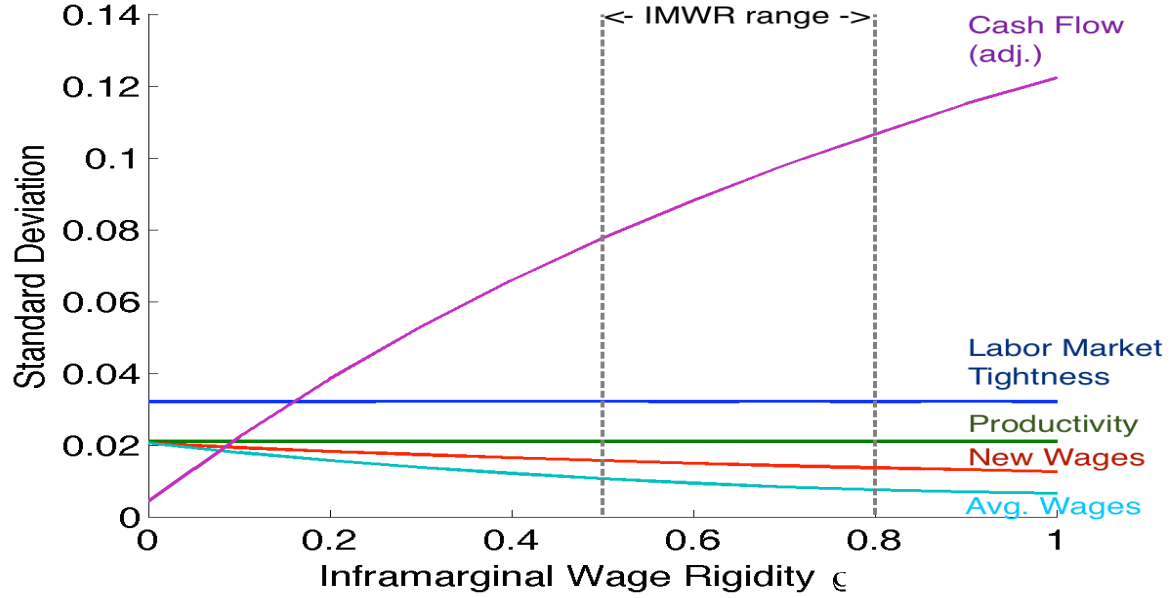
Notes: Inframarginal wage rigidity parameter $\rho \in [0,1]$, where $\rho = 1$ denotes perfect cohort wage effects and where $\rho = 0$ denotes perfect period-by-period (re-)bargaining of the wage. The driving force are productivity shocks. The simulated data are quarters, seasonally adjusted and HP-filtered with smoothing parameter $\lambda = 10^5$. Table 2.1 lists the calibrated parameters.

Figure 2.3: *Simulated Standard Deviations in Benchmark Model without Financial Constraints, for Inframarginal Wage Rigidity $0 \leq \rho \leq 1$.*
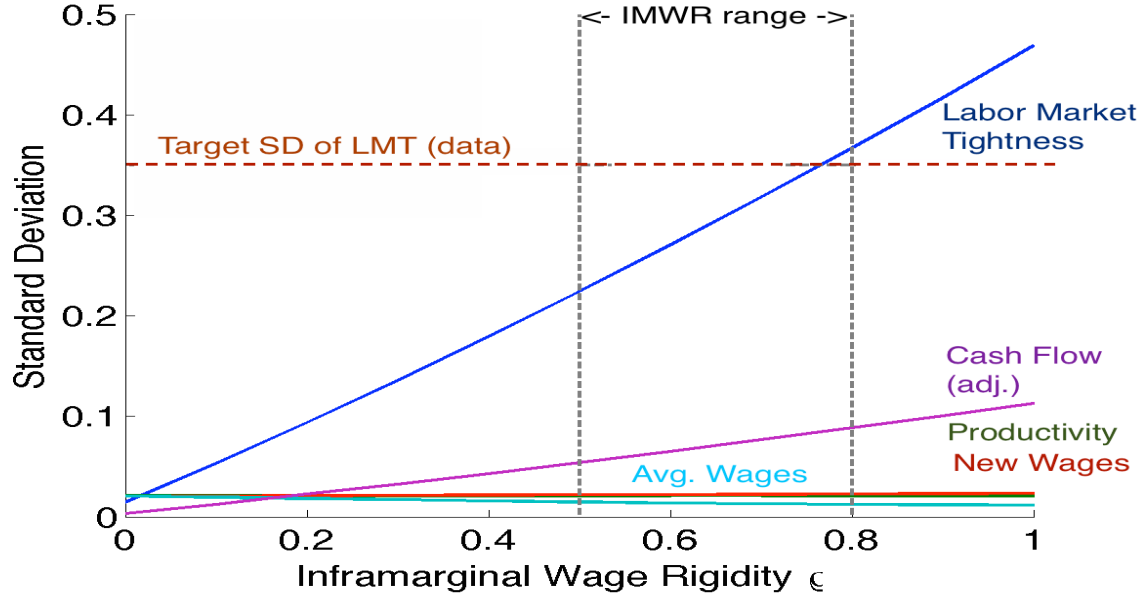
Notes: Inframarginal wage rigidity parameter $\rho = 1$ denotes perfect cohort wage effects and where $\rho = 0$ denotes perfect period-by-period (re-)bargaining of the wage. $\alpha = 0.2$ corresponds to an employment-cash flow sensitivity of 0.25. The driving force are productivity shocks. The simulated data are quarters, seasonally adjusted and HP-filtered with smoothing parameter $\lambda = 10^5$. Table 2.1 lists the calibrated parameters.

Figure 2.4: *Simulated volatilities (standard deviations) of key labor market variables in model with medium financial constraints ($\alpha = 0.2$), for inframarginal wage rigidity $0 \leq \rho \leq 1$.*

2.3 Further Implications of the Financial Channel of Wage Rigidity

I. The Labor Share and Employment Cyclicality. In Section 1.3, 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.[28] This drop is particularly pronounced in the manufacturing sector, which the time series in Figure 2.5a (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.[29] The coefficient on the former interaction is thus identified off changes in the trend labor share. Figure 2.5b 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 procyclicality.[30] All other things equal, shifting income from wages to (possibly more flexible) forms such as capital income might thus attenuate the role of financial factors

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

[29] The panel regression of industry i in year t is: $cyc\_ln(\text{Emp}_{it}) = \boxed{\beta_1 \cdot cyc\_\text{URate}_t \cdot trend\_\text{LaborShare}_{it}} + \beta_2 \cdot cyc\_\text{URate}_t \cdot \text{IndustryFE}_i + \beta_3 \cdot trend\_\text{LaborShare}_{it} + \beta_4 \cdot \text{IndustryFE}_i + \beta_2 \cdot cyc\_\text{URate}_t + \epsilon_{it}$

[30]The panel effect is quantitatively in line with the cross-sectional results. This relationship is robust to production workers instead of total employment, alleviating composition concerns about offshoring or outsourcing of labor-intensive production steps.

in business cycles.

II. Turnover (Separation Rate δ) 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 δ 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 (2.5) illustrated this in the approximation around the steady-state hiring rate: $w^{avg} = \delta w + (1 - \delta) \left(\frac{w}{w^-}\right)^{1-\rho} w^{avg-}$. If a firm's workforce fully turns over each period ($\delta = 1$), IMWR is mute. In contrast, wage flexibility $(1 - \rho)$ represents the "intensive" margin; for $\rho = 0$ stayers' wages adjust fully. Stay around the steady-state hiring rate and consider how cash flow depends on wages mediated by turnover δ and $(1 - \rho)$:

$$\text{CashFlow} = n \cdot (z - \underbrace{[\delta w + \overbrace{\boxed{(1 - \delta)}}^{\text{extensive}} \cdot (w/w^-)^{\overbrace{\boxed{1 - \rho}}^{\text{intensive}}} \cdot w^{avg-}]}_{\text{Average wage } w^{avg}})$$

Financial amplification from wage rigidity depends on how long legacy cohorts hold on to their jobs.[31] Figure 2.6 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 2.7a, 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.

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[31]Another, more subtle effect works through the endogenous smoothing of entry wages in the bargaining.
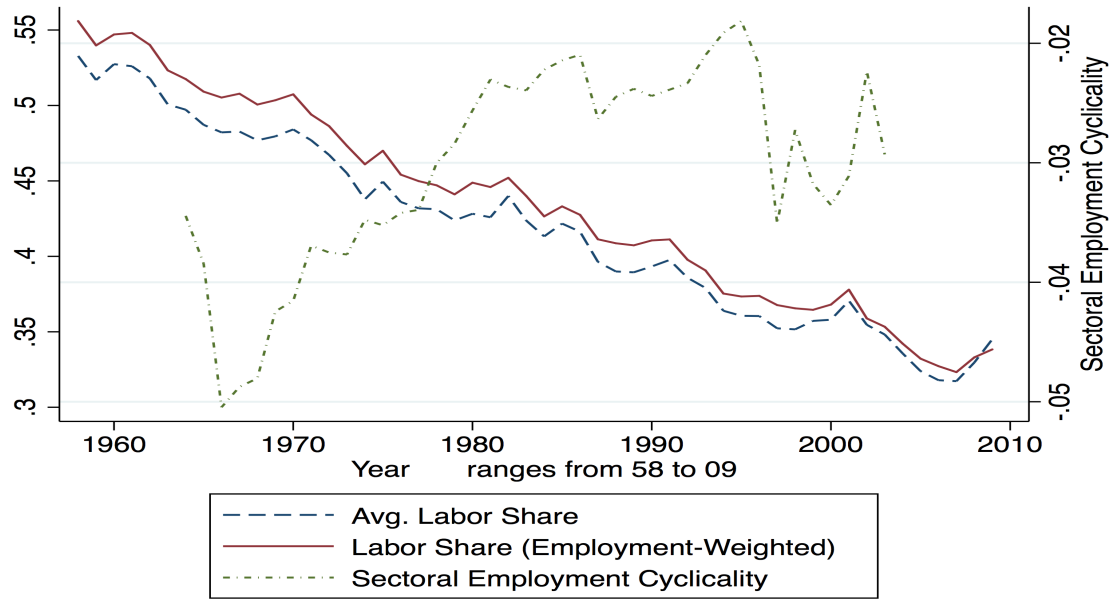
(a) *Evolution of the U.S. manufacturing labor share (unweighted & empl't-weighted) industry averages, vs. sectoral employment cyclicality; (5-year window rolling regression) Source: NBER-CES Manufacturing Industry Data Base, annual data, 1958-2009.*
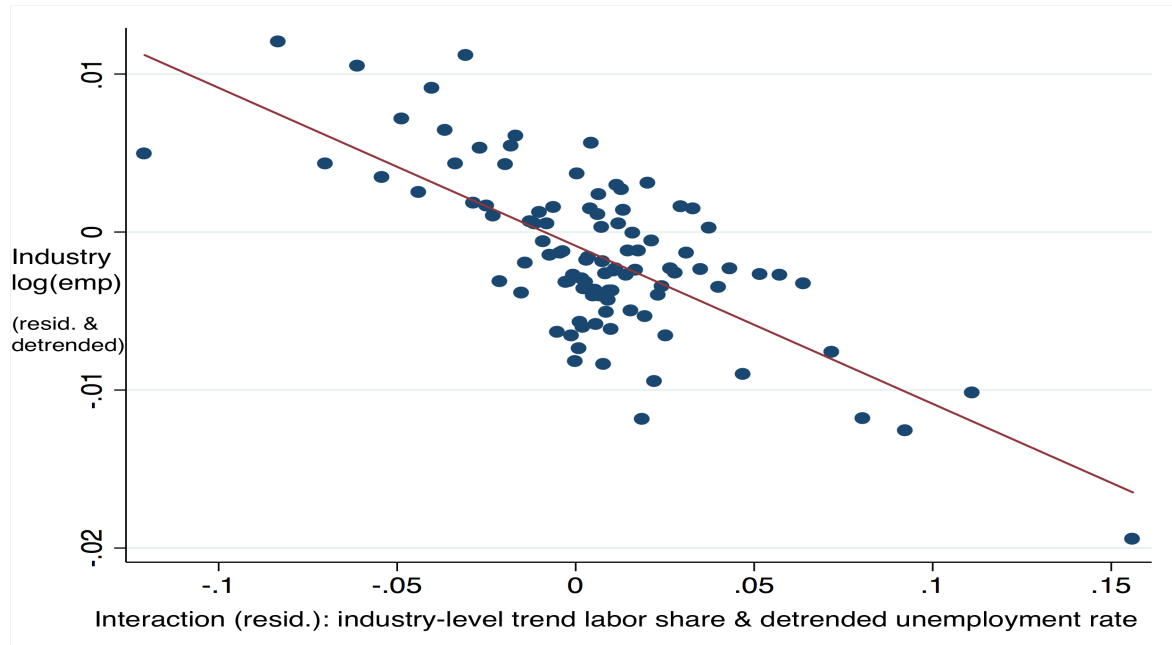
(b) *Changes in emp. cycl'y by long-run changes in labor share. Binned scatterplot, of annual data points (1958–2009) and 473 industries, plots residualized dependent variable and boxed interaction effect from industry i's year-t employment:* $cyc\_ln(Emp_{it}) = \boxed{\beta_1 \cdot cyc\_URate_t \cdot trend\_LaborShare_{it}} + \beta_2 \cdot cyc\_URate_t \cdot IndustryFE_i + \beta_3 \cdot trend\_LaborShare_{it} + \beta_4 \cdot IndustryFE_i + \beta_2 \cdot cyc\_URate_t + \epsilon_{it}$. *Source: NBER-CES Manufacturing Industry Data Base, annual data, 1958-2009.*

Figure 2.5: *Changes in Employment Cyclicality vs. Labor-Share Changes.*
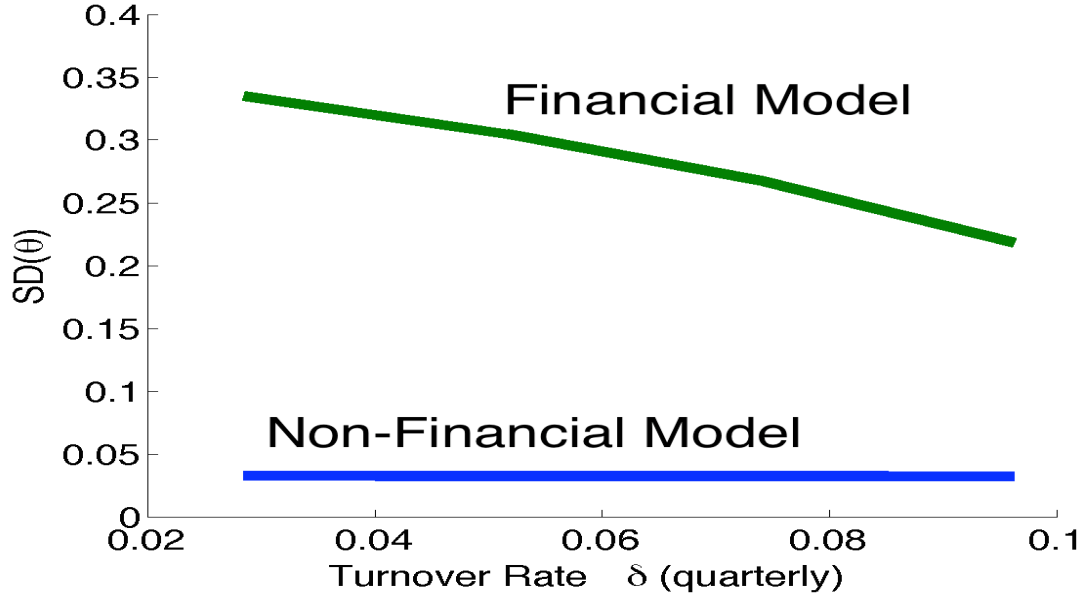
*Notes: Simulated moments: volatility (standard deviation) of labor market tightness variables vs. **turnover** δ, for model without financial constraints and the financial-constraints model with financial constraints ($\alpha = 0.2$), for a series of economies with inframarginal wage rigidity parameter $\rho = 0.5$ (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 2.1 lists the calibrated parameters.*

Figure 2.6: *The Role of Turnover in Labor Market Fluctuations with and without Financial Constraints.*

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.[32] For example, two secular changes in the U.S. economy might have affected the extensive and intensive margin of average-wage cyclicality. First, the secular decline in the U.S. separation rate has lowered the *extensive* margin of wage adjustment.[33] 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 2.7b). 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.[34] 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 2.7b 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 2.7c.[35] 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

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[32]See Lazear (1990), Blanchard and Wolfers (2000), Bertola (1990), Blanchard and Summers (1986), Davis and Haltiwanger (2014). Unrelated cyclical aspects of turnover are explored in Akerlof *et al.* (1988), Ljungqvist and Sargent (2004), Shimer (2005), Fujita (2012).

[33]The secular decline in separations is documented in e.g. Davis (2008).

[34]Card and Hyslop (1997) document the canonical evidence for (downward) nominal wage rigidty; Coibion *et al.* (2013) assess its potential contribution to jobless recoveries in a standard marginal framework.

[35]The particular representation in Figure 2.7c computed from CPS tenure data and taken from Hall (2014).

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.

Methods of Cutting Labor Costs
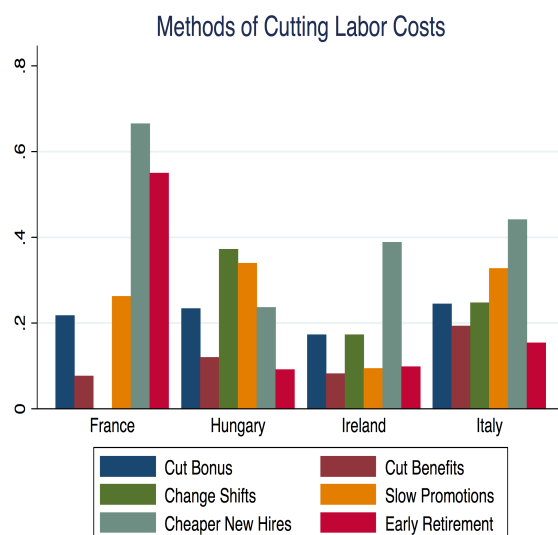
(a) *Survey responses: Which measures of cutting labor costs has the firm used, conditional on having cut labor costs? I exclude firms with less than 5 employees. Survey period was 2007 and 2008. Source: Author's calculations using firm-level survey micro-data from Wage Dynamics Network.*
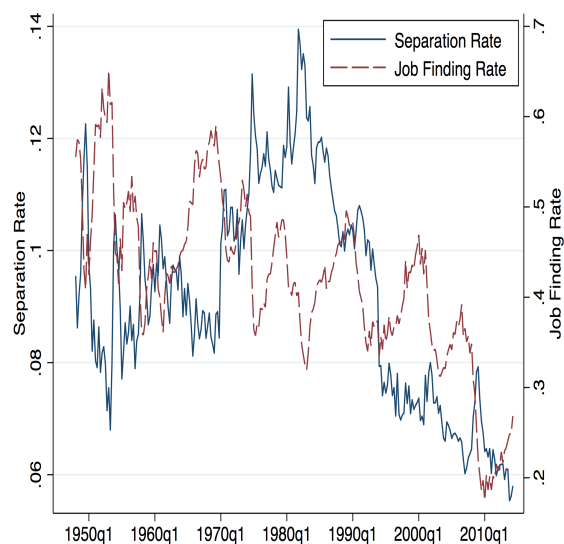
(b) *Cyclical Effects of the Secular Decline in the U.S. Separation Rate? Quarterly data, 1947–2013, constructed form monthly BLS unemployment stock data by duration.*
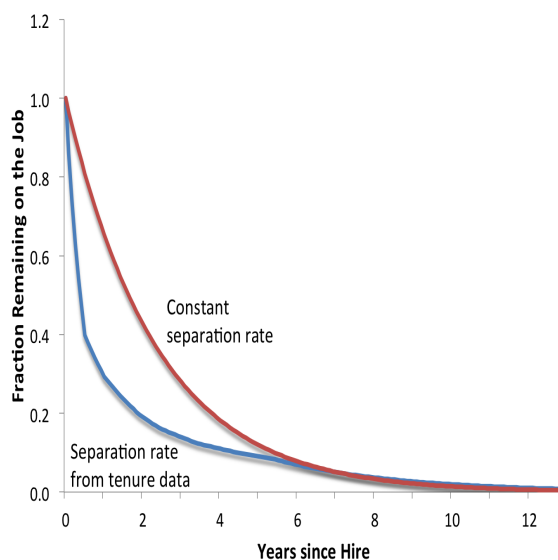
(c) *Duration Dependence in Job Separation: Actual separation rate from CPS tenure data vs. (standard DMP) constant separation rate. Source: data and figure from Hall (2014) (CPS data).*
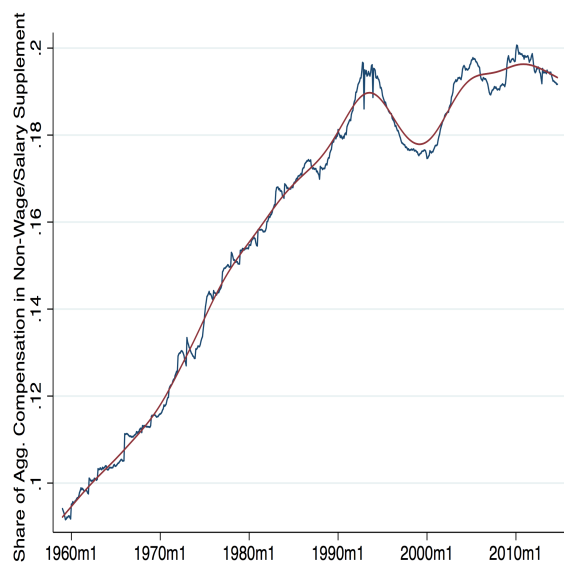
(d) *Share of aggregate compensation in non-wage/-salary components. Source: BEA, Compensation of Employees.*

Figure 2.7: *Turnover, Compensation & the Financial Channel of Wage Rigidity.*

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.[36] 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.[37] The current model side-steps such tenure effects on wages and might therefore underestimate the financial burden that incumbent workers exert, particularly in combination with the similarly side-stepped tenure dependence of the separation rate. In contrast, in standard models without financial constraints such tenure effects would be neutral and bargained away similarly to IMWR.

III. Leverage From Wage Rigidity. Several parallels emerge between wages and interest expenditure, 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.[38] Like debt, wages are renegotiated in extreme financial distress.[39] 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.[40] 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

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[36] See Solon *et al.* (1994) for the composition bias is the cyclicality of the simple average wage.

[37] The data do not distinguish hires from job-to-job transitions and those out of unemployment.

[38] Hall and Lazear (1984) and Kennan (2010) feature information wage rigidity mechanisms that implicitly parallel mechanisms related to informational foundations of debt contracts (Townsend (1979)).

[39] Benmelech *et al.* (2012a) documents airlines renegotiating wage contracts during financial distress.

[40] 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.

cash flow statement of the U.S. nonfinancial corporate sector in Figure 1.1 illustrates. Third, *Fisher (1933) debt deflation* worries about the real burden of firms' debt under disinflation. But wage contracts share the key properties (nominally sticky and long-term) that Jermann *et al.* (2014) highlight as crucial for the debt mechanism. The financial channel of (nominal) wage rigidity implies that similar, if not much larger, effects might arise from wages under disinflation.

IV. Compensation vs. Wages. The financial channel of wage rigidity applies to all components of compensation rather than to 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 2.7d. Micro-empirical studies of wage rigidity tend to focus on (marginal) wage rates.[41] 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.[42] Yet employers call for procyclical requirements to alleviate the financial burden during recessions: "These extraordinary pension funding requirements... could derail the [2009] economic recovery by forcing these employers to either severely curtail their capital investments or make further reductions in their workforces." (American Benefits Council (2009)) 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.[43] Indeed, with firm-level survey micro-data from the Wage Dynamics Network in Figure 2.7a, 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

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[41]Interestingly, Stueber (2012)'s earnings cyclicality micro-estimates are in the wage cyclicality range.

[42]Aaronson *et al.* (2004) write: "Retiree pension obligations are fixed costs... Thus, basic economic theory predicts they should have no effect on firmsÕ decisions." Rauh (2006) exploits cash-flow shocks from pension refunding but does not treat the broader liquidity channel of compensation.

[43]See Weitzman (1986), Kruse (1991) and Lemieux *et al.* (2012) on standard *marginal* benefits from profit sharing and performance pay.

paid employees in recessions.[44]

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[44]E.g. Kahn and McEntarfer (2013), Kahn and McEntarfer (2014), Haltiwanger *et al.* (2014), Schmieder and von Wachter (2010), Mueller (2012).
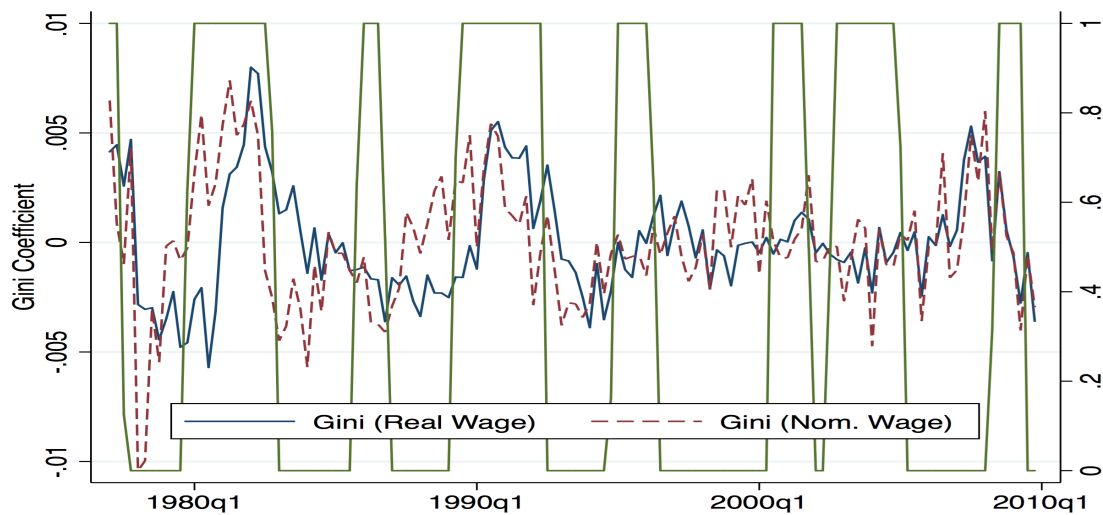
Notes: Quarterly averages. Dates denote settlement date of the wage contract. Lower Gini values denote more compensation backloading over the course of a wage contract. See paper for details on the construction of the measures. Source: Universe of Canadian CBAs, 1975–2013, constructed with the Workplace Information and Research Division, Labour Program, Employment and Social Development Canada.

Figure 2.8: *Real & Nominal Compensation Backloading (Gini Measure) During Recessions.*
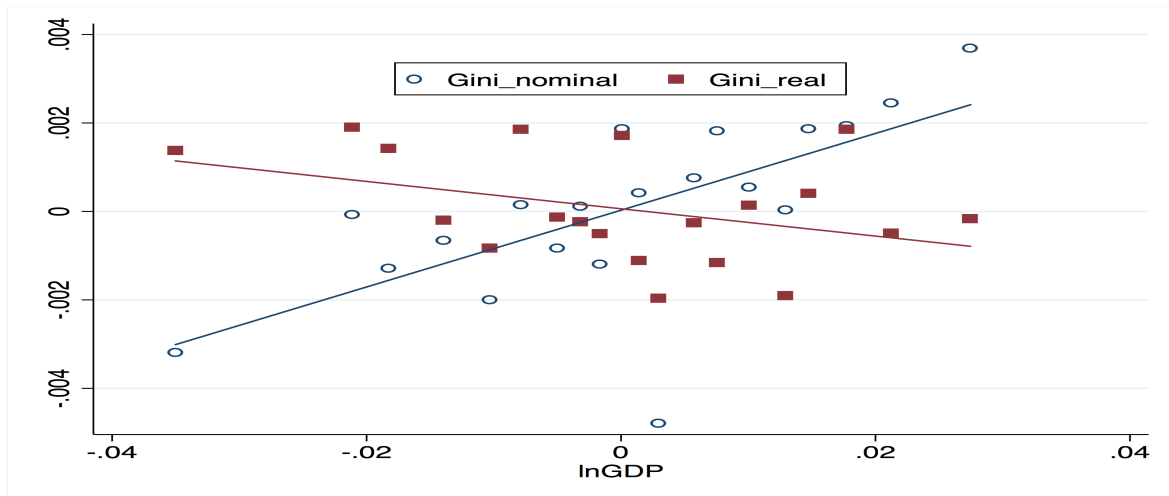
Notes: Gini measures and log GDP are HP-filtered ($\lambda = 1600$). Binned scatterplot of quarterly averages; 7 data points per bin. Dates denote settlement date. Lower Gini values denote more compensation backloading over the course of a wage contract. See paper for details on the construction of the measures. Source: Universe of Canadian CBAs, 1975–2013, constructed with the Workplace Information and Research Division, Labour Program, Employment and Social Development Canada.

Figure 2.9: *Real & Nominal Compensation Backloading (Gini Measure) vs. log GDP.*

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 (2.21) limits such borrowing from workers for lack of state- and period-contingency of wage contracts.[45] Empirical evidence on the dynamic structure of wage contracts and its cyclicality is scarce; existing studies of wage cyclicality 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.[46] 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 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

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[45]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)).

[46]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.

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 2.8 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 2.9 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.[47] Such intertemporal patterns of compensation are typically rationalized as incentive schemes or human capital dynamics.[48] 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

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

[48]See Lazear (1981) and Lazear and Moore (1984) for tenure effects on wages arising from backloaded incentives, and Lazear and Moore (1988) and Gustman *et al.* (1994) for applications to pension benefits. Altonji and Shakotko (1987), Abraham and Farber (1987), Topel (1991) and Dustmann and Meghir (2005) investigate the human capital mechanism.

product of a worker equals the firm-level wage. Incumbent insiders inadvertently discourage hiring by propping up the price of unemployed outsiders along with their own wage. In contrast, in this paper's financial channel, insiders squeeze financial resources that would otherwise be available for hiring. A key distinction of the financial mechanism is its ability to rationalize the coexistence of high unemployment among youth and other outsiders (with comparatively flexible wages) in two-tier labor markets such as Italy, Spain or Portugal, where incumbent insiders enjoy wage and job security. Indeed, some of the best evidence for the wage cyclicality differential between new and incumbent workers comes from Portugal.[49] 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.

2.4   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

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[49]See Martins *et al.* (2012) and Carneiro *et al.* (2012) for Portugal.

channel of wage rigidity also generates new cyclical roles for compensation backloading, the labor share and turnover, which condition its amplification. Finally, in recessions, cuts to employer-borne payroll taxes, for all workers rather than for new hires only, might be a practicable policy tool to stimulate hiring while preserving household labor income.

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

I conclude by pointing out that the financial channel of wages might play a role in labor demand more generally. A corporate finance economist may see cash flow shocks 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):

$$\varepsilon_{n,w}^{\text{Marshallian}} = \varepsilon_{n,w}^{\text{Hicsian}}\Big|_{\overline{\text{Liquidity}}} - \frac{\bar{w}d\text{Employment}}{d\text{CashFlow}} \tag{2.22}$$

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 (2015).

Chapter 3

The Role of Quits and Replacement Hiring in the Cyclicality of Job Openings

3.1 Introduction

This paper paints a picture of recessions as times when few jobs open up because safely employed workers hold on to them more tightly. Indeed, I document that in fact more than half of total job openings target *old* jobs vacated by quits. Since quits dry up in recessions, I find that this quit–reposting mechanism helps explain the fall in total job vacancies. By contrast, the language of the leading macroeconomic models restricts explanations to depressed *new* job creation.[1]

I empirically establish the role of replacement hiring using a unique job vacancy survey that reports on the background of a given job opening. More than half of the job openings firms post are replacement vacancies in response to worker quits. At the firm level, I furthermore find that one quit stimulates 0.7–0.8 hires. In the data, at least half of the hiring

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[1] In those models, firms cut job openings in recessions because new job matches become less profitable. The only effect of a quit on job openings arises from associated market-wide labor supply increases. Yet, the firm does not repost the now-vacant job.

activities by firms therefore target old jobs and are driven by worker turnover. Existing empirical work on the fluctuations of vacancies at the aggregate and the establishment level is based on data that mask this composition.

Motivated by this finding, I propose and investigate the hypothesis that the dramatic decline in quits plays a major proximate role in that in total job openings. In a typical recession, the quit rate falls by half. I document the cyclical comovement of aggregate quits, hires and job openings in the U.S., and provide new local-labor market evidence from Germany. At business cycle frequencies, fewer quits in the aggregate data are associated with fewer job openings, almost one to one.

To formalize the "quit–reposting" mechanism, I augment the Diamond-Mortensen-Pissari-des search-and-matching model of the aggregate labor market, with replacement hiring and procyclical quits. In my extended version, firms repost a job vacated by a quit because it commands a positive equilibrium value, thanks to a sunk, linear creation cost for new jobs.[2] Quits emerge from a simple model of on-the-job search, the success of which depends on aggregate labor demand. Consequently, quits are procyclical, and so are replacement vacancies.

However, I show that in this baseline model, the fact that reposted vacancies dry up along with quits in recessions, has no net effect on *total* job openings. The reason is perfect crowd-out of new job creation from repostings. Such crowd-out is hard-wired into the search and matching equilibrium, which pins down the total level of job vacancies. Since the creation of new vacancies comes at a linear cost, new jobs perfectly absorb shocks to repostings. Repostings have compositional, but no real, effects on labor market fluctuations.

But such crowd-out of new jobs from replacement vacancies is unlikely to be quantitatively relevant in real labor markets. My empirical argument stems from a variety of local labor market findings: In the short run, reduced labor demand from one firm (e.g. closure of a large plant) or industry (e.g. nontradable employment) does not appear to stimulate

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[2]Such sunk and irreversible investments might include job-specific capital or organizational structure. More trivially, decreasing returns might motivate firms to replace quits.

hiring by untreated firms (other firms) or industries (tradable employment) in the same local labor market. Beyond my application to the quit–reposting channel, my empirical argument might help adjudicate the appropriate cyclical feedback of external labor market conditions onto labor demand in broader macro-labor debates.[3]

Motivated by my empirical argument, I refine the model with a parsimonious source of imperfect crowd-out: convex (rather than linear) adjustment costs lead new job creation to only incompletely offset fluctuations in repostings.[4] Due to these increasing marginal costs of substituting for repostings with new jobs, repostings transmit into total job openings. Recessions are times when incumbents stay put in their jobs, and the resulting drop in repostings contributes to the fall in total job opportunities. By contrast, in upswings, tighter labor markets pull employed workers out of their matches, leaving reposted vacancies behind. The degree of crowd-out and the procyclicality of quits determine the amplification of fluctuations in total job openings from the quit–reposting channel. While I assess these cyclical adjustments by simulating the calibrated version of the model, the current paper defers the final word on the quantitative performance of the extended model.

Related Literature. The quit–reposting channel of vacancy fluctuations remains largely absent from the macro-labor literature investigating the cyclical behavior of the aggregate labor market. Barlevy (2002) highlights how reduced on-the-job search leaves workers in worse matches in recessions. Krause and Lubik (2006) and Nagypál (2008) focus on an equilibrium labor-supply channel, by which increased on-the-job-search during upswings stimulates job creation. In contrast, this paper focuses on a firm-level labor-demand effect.[5] An intriguing working paper by Faberman and Nagypál (2008) investigates establishment-level links between employment growth, quits and job openings. Their model features

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[3]For example, Hall and Milgrom (2008) and Hall (2014) criticize the tight theoretical link of the wage with labor market tightness, in favor of "tightness-insulated" wage bargains.

[4]Fujita and Ramey (2007) introduce a similar cost. Their focus is not on repostings but on matching the hump-shaped empirical impulse response of vacancies. Convex costs encourage smooth vacancy creation.

[5]Krause and Lubik (2006) indirectly include, but de-emphasize, a replacement vacancy effect from two-sector production, whereby quits from the "bad" sector into the "good" sector during upswings increase the return to posting vacancies in the bad sector due to complementarities in final-goods production.

a notion of replacement hiring, but the focus is microeconomic, to develop a structural model aimed at fitting cross-sectional establishment-level patterns. Fujita and Ramey (2007) develop a variant of the DMP model that improves on the propagation properties of the standard DMP model. Their solution is a convex creation of new jobs that leads firms to smooth new vacancies in response to shocks, which as a side effect entails reposting of old jobs after separations. That paper features acyclical separations and does not focus on the cyclical behavior of repostings. Yet, the apparatus they propose turns out to be useful for my set-up. The concept of the vacancy chain in labor markets (Akerlof *et al.* (1988)) is loosely related to the replacement-quit micro-mechanism of this paper, but that paper focuses on worker flows, with vacancies merely implicit in their theoretical and empirical work. Importantly, it focuses on the worker amenity benefits of churn, precluding net employment effects. Reicher (2011) investigates such hiring chains and worker flows in a frictionless macroeconomic model with heterogenous firm growth and on-the-job search. Finally, there is an emerging empirical literature that examines the cyclicality of worker churn, which generally finds it to be procyclical (Lazear and Spletzer (2012), Bachmann *et al.* (2013)).

Upon completion of this paper, the author became aware of a paper by Lazear and Spletzer (2012), with which it shares the motivation to link hires with separations and the decline of churn in recessions. However, that paper considers quits only in passing, and does not integrate the channel into a macroeconomic model or debate implications of the cyclicality of churn for ongoing macro-labor debates. And, I present new and distinct evidence on job openings. Lastly, I focus on potential net effects of the quit–reposting mechanism on total employment, rather than merely on churn.

Section 2 presents aggregate, district-level, establishment-level and job-level evidence linking quits with replacement hires and job openings. Section 3 integrates the quit–reposting channel into an extended Diamond-Mortensen-Pissarides model of the labor market. Section 4 provides an empirical argument for limited crowd-out of vacancies, a crucial feature of the preferred model. Section 5 concludes.

3.2 Evidence for Replacement Hiring

Summary of Empirical Evidence. This section presents four pieces of empirical evidence for cyclical implications of quit-driven replacement hiring:

3.2.1 At the **job** level, using a job vacancy survey from Germany, I document that more than half of all job openings are replacement hiring in response to worker quits.

3.2.2 At the **aggregate** level, I reiterate the known fact that quits are very procyclical; I moreover quantitatively relate the fluctuations in the quits to those in hires and vacancies.

3.2.3 At the **district** level, using a German establishment survey, I show that local economic conditions trigger comovement between quits, vacancies and hires that mirror the aggregate fluctuations.

3.2.4 At the **establishment** level, I find that one quit is associated with around 0.7 to 0.8 new hires and an increase in measured job openings, both concentrated within the quit year. This micro-evidence confirms that the aggregate quit–hire/vacancy comovements are firm-level rather than market-level phenomena.

3.2.1 Direct Job-Level Evidence on Replacement Hiring

Figure 3.1 presents direct evidence on the composition of filled job openings from 2000 to 2010 in Germany. The underlying data set is the German Job Vacancy Survey of the IAB, a representative annual survey of 7,500 to 15,000 establishments with information on the number and, importantly, structure of job openings, as well as personnel policies. The data are available to researchers for years 2000 to 2010.[6]

A unique feature of this survey is a supplementary questionnaire that in particular provides additional details on the last successfully filled job opening in the last 12 months. Importantly, it elicits the reason for the hire: did the firm recruit to fill a position vacated

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[6]The survey started in 1989, and has featured an additional quarterly questionnaire since 2006.

by a previous quit (differentiation by temporary vs. permanent)?[7] Or rather as new job creation, that is, in response to a (seasonal vs. permanent) increase in labor demand? This subjective classification of vacancies permits the fine differentiation that would be masked in standard worker and job flow data.

Figure 3.1 reveals that around 60% of job openings are posted in response to quits. The vast majority of the quit-driven vacancies are due to permanent quits (50%), whereas around 10% of vacancies are posted to temporarily fill jobs vacated by a quit. In contrast, between 30 and 40% of vacancies are in response to permanent increases in net employment, and around 10% in response to seasonal demand increases. Thus, among the permanent hires, 55% are replacement hiring. Among the total set of hires, 50% constitute replacement hiring.

This direct empirical evidence for replacement hiring is the key motivating fact of this paper. In future work, I hope to match the job vacancy survey with administrative employee micro-data, allowing to link the profile of the presumed quitter with the type of job opening created and the potential replacement hire. In the current micro-empirical sections, I rely on an establishment survey for worker flows, in order to quantitatively link quits with hires and job openings at the local labor market level (Section 3.2.3) and at the establishment level (Section 3.2.4).

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[7]My reading of the questionnaire suggests the wording to primarily denote quits, rather than separations in general. I plan to continue to validate this interpretation by using the – included – survey questions that classify total separations by type. The author is pending approval for access to the confidential micro-data.

Composition of Job Openings
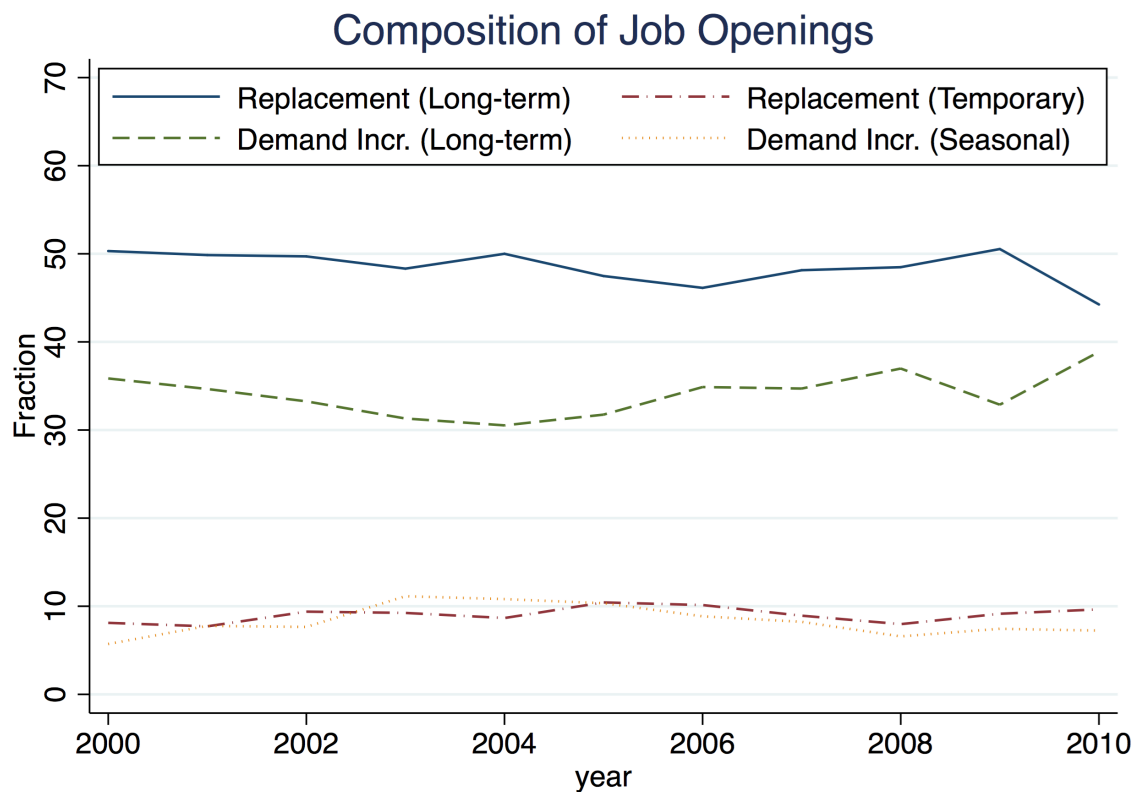
Source: Public-use aggregate summary statistics, IAB Survey of Job Openings, Germany, 2000–2010.

Figure 3.1: *The Composition of Filled Job openings by Reason.*

Quits and Job Openings (LTS and NBER)
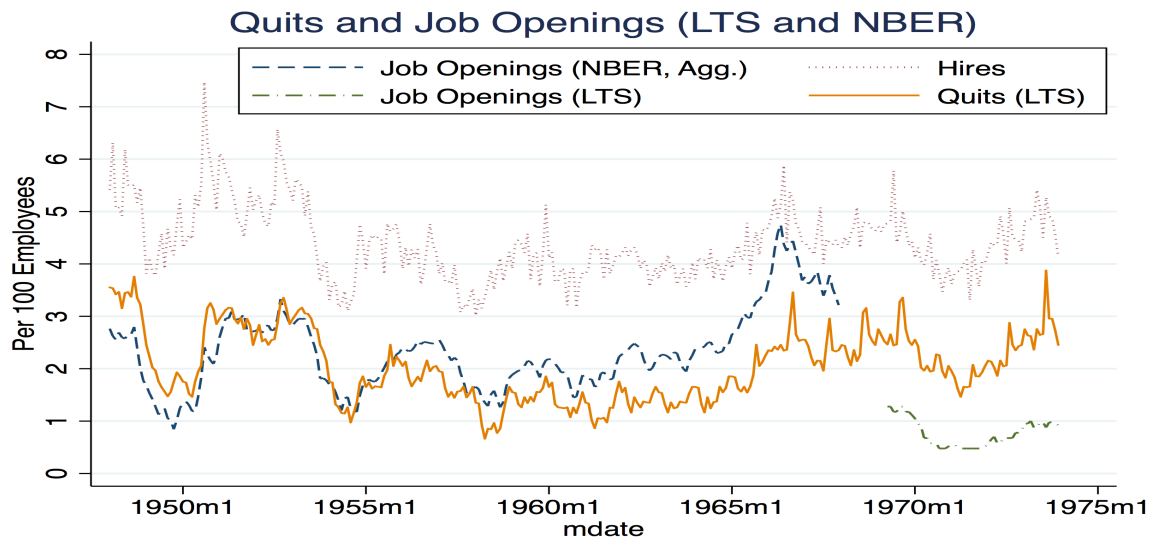
Notes: Monthly data; HP-filtered with $\lambda = 129,600$. Sources: See main text for description of variables.

Figure 3.2: *Aggregate Job Openings, New Hires and Quits.*
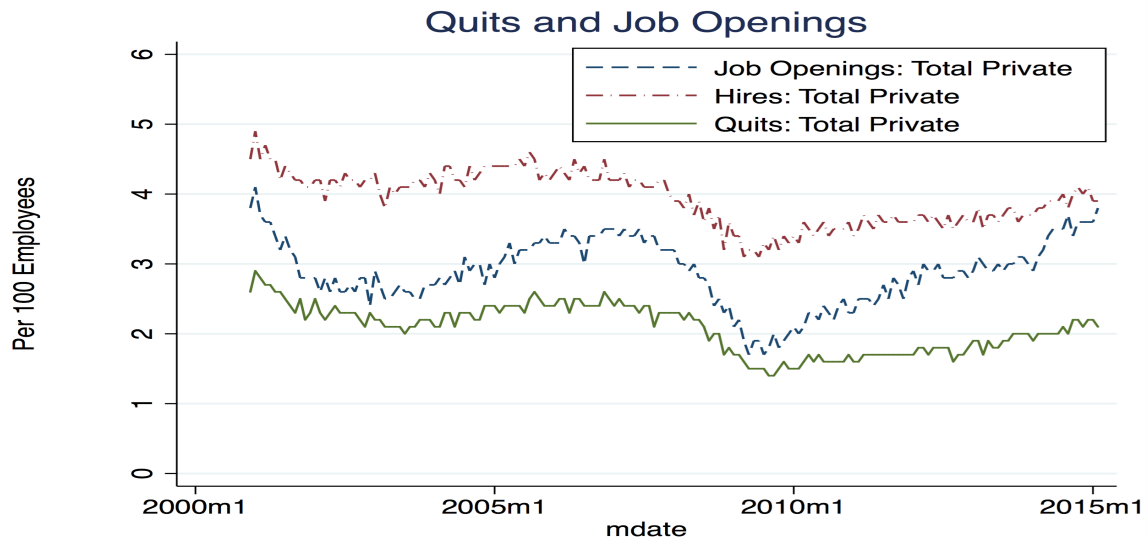
Quits and Job Openings

Notes: Entire private sector covered; aggregate monthly data, 2000–2015. The variables are rates: worker flows per 100 employees. Source: BLS Job Openings and Labor Turnover Survey.

Figure 3.3: *Aggregate Rates of Job Openings, New Hires and Quits, 2000—2015.*

Quits and Job Openings (LTS and NBER)
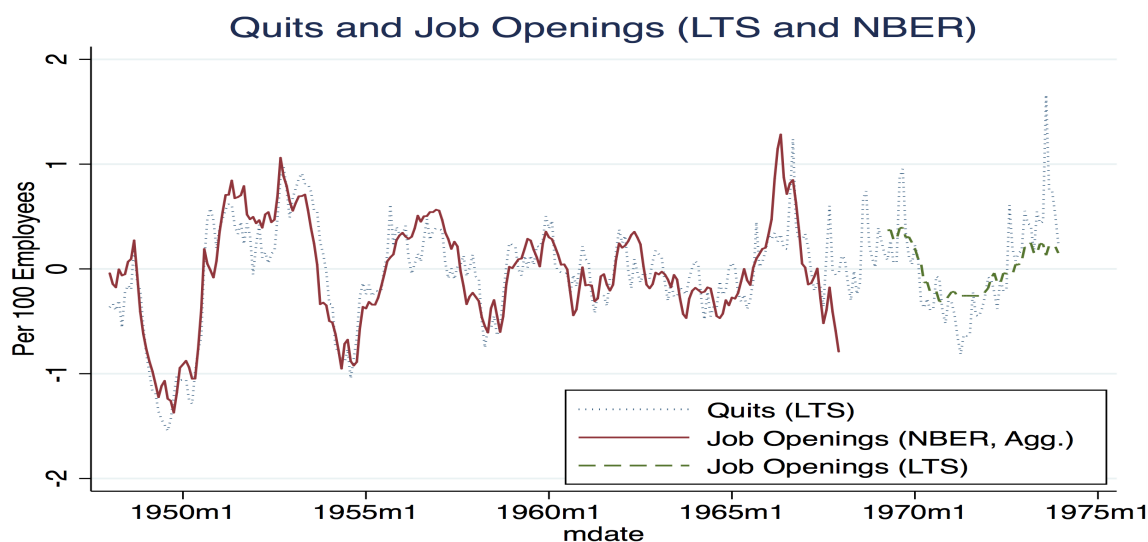
Notes: Quits: manufacturing sector; monthly data; 1947–1974; firm averages of rates (flows per 100 workers). Job openings: aggregate, rescaled (100,000s). HP-filtered with $\lambda = 129,600$. Sources: Labor Turnover Survey (Quits); see main text for description of source of job opening variable.

Figure 3.4: *The Cyclical Behavior of Job Openings and Quits, 1957–1974.*
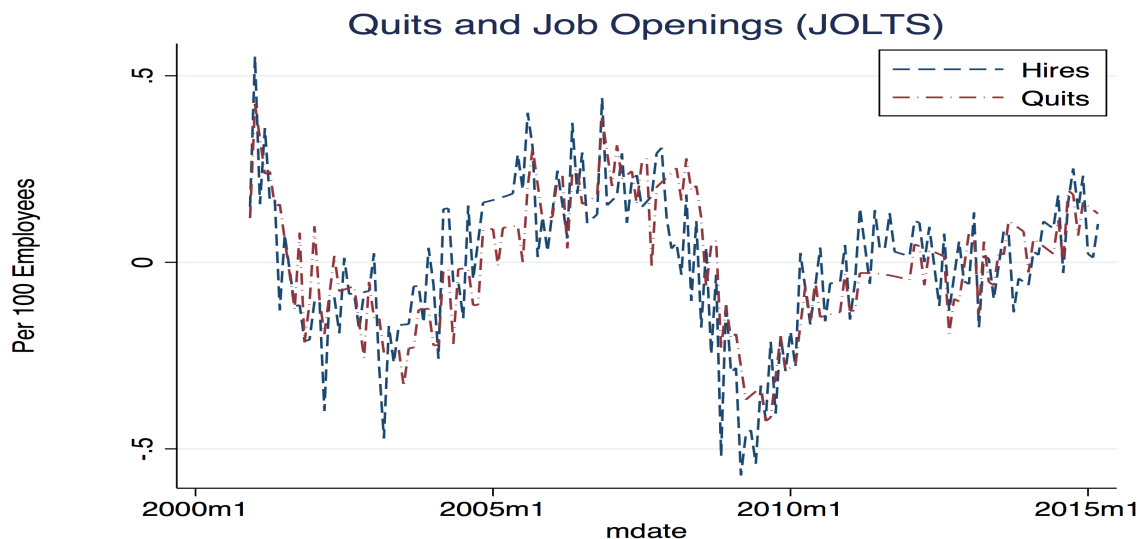
Quits and Job Openings (JOLTS)

Notes: Entire private sector covered; aggregate monthly data, 2000–2015. The variables are rates: worker flows per 100 employees. HP-filtered with smoothing parameter $\lambda = 129,600$. Source: BLS Job Openings and Labor Turnover Survey.

Figure 3.5: *The Cyclical Behavior of the Rates of Job Openings and Quits, 2000–2015.*

Quits and Job Openings (LTS and NBER)
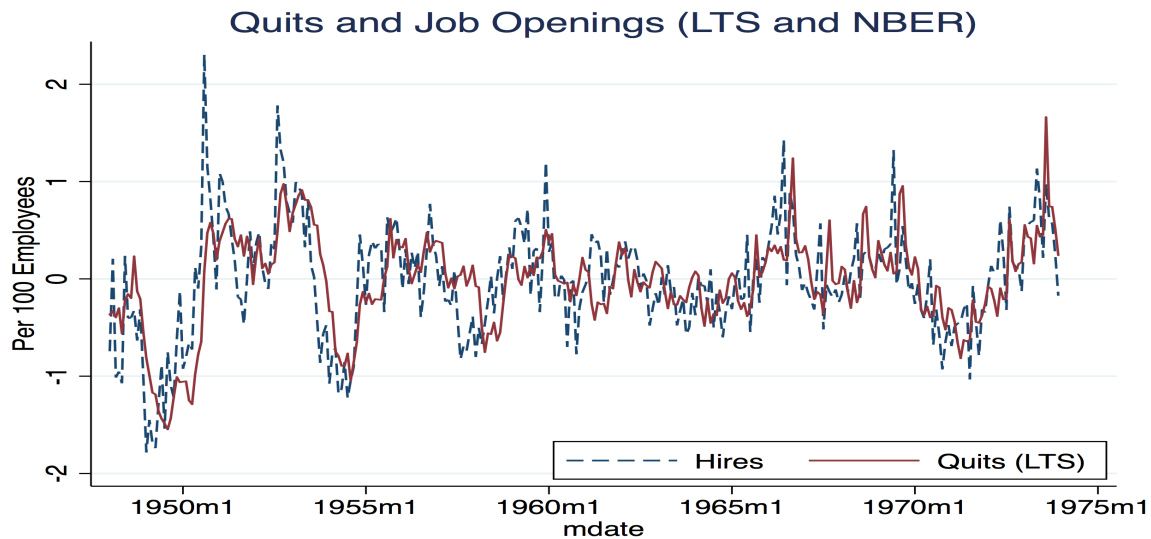
Notes: Manufacturing sector; monthly data; 1947–1974. The variables are firm averages of rates (flows per 100 workers). HP-filtered with $\lambda = 129,600$. Sources: BLS Labor Turnover Survey.

Figure 3.6: *The Cyclical Behavior of New Hires and Quits, 1947–1974.*
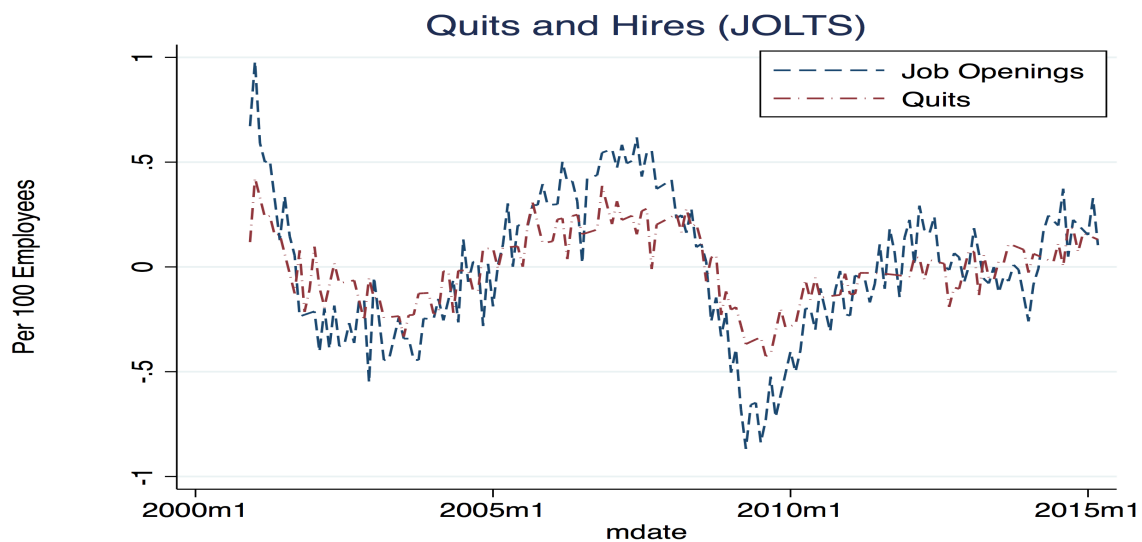
Quits and Hires (JOLTS)

Notes: Entire private sector covered; aggregate monthly data, 2000–2015. The variables are rates: worker flows per 100 employees. HP-filtered with smoothing parameter $\lambda = 129,600$. Source: BLS Job Openings and Labor Turnover Survey.

Figure 3.7: *The Cyclical Behavior of the Rates of New Hires and Quits, 2000–2015.*

3.2.2 Aggregate Facts: Cyclical Comovement of Quits, Job Openings and New Hires

Motivated by the job-level evidence for replacement hiring, I now interpret the cyclical comovement of aggregate quits, hires and job openings. My focus is on synthesizing and linking the, individually known, patterns to clarify a directional link from quits to vacancies. Subsequently, I further corroborate the hypothesized direction from quits to hiring and job openings at the district-level (Section 3.2.3) and at the establishment level (Section 3.2.4).

The Cyclical Behavior of Quits. Quits are highly procyclical. Figures 3.2 and 3.3 plot monthly data on the quit rate (quits per 100 employees) from 1947 to 1981, and from 2000 to 2013 respectively. In recessions, the quits per 100 workers in manufacturing fall from around 0.5 above to -0.5 below trend, with a trend around 2 quits per 100 workers per month. Time series data on quits are very limited: the 1947–1981 data (Figure 3.2) are taken from the BLS Labor Turnover Survey (LTS), which covers the manufacturing sector; the 2000–2013 data (Figure 3.3) are taken from its successor, the Job Turnover and Layoff Survey (JOLTS) for the private sector.[8]

Quits & Job Openings. Besides quit rates, Figures 3.2 and 3.3 plot the available overlapping time series for job opening rates (monthly vacancies per 100 workers). Job opening data compatible with the quits data are only available for some intervals of the U.S. time series.[9] My longest historical data, call it the NBER data, is taken from various government institutions (1946 to 1969, for the private sector),[10] to which I merge the short vacancy coverage of the LTS (1969 to 1971, for manufacturing), and the JOLTS (2000 to 2014, for the

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[8]JTS data on quits go back until 1919; I restrict attention to the years for which I have job opening data (1947 onward).

[9]Recruitment proxies such as the Conference Board Help-Wanted Index do not have a tangible quantitative meaning that is directly relatable to the quits data. However, when translating the index into log deviations, I do confirm that the patterns match up also with the Help-Wanted Index.

[10]That data set is taken from the NBER Macrohistory Database and covers the sum of monthly job openings in nonagricultural industries. The NBER description of macro history series m08313 reads: "Data for October, 1946-October, 1949 is from the U.S. Bureau of the Census; data for September, 1949-1969 is from the U.S. Department of Labor, Bureau of Employment Security, Statistical Supplement, Labor Market and Employment Security; Apri, 1950-May, 1951 was furnished to NBER in a letter of February 25, 1963; data for November, 1956-October, 1963 are in issues dated January, 1960-December, 1963."

entire private sector). Since the 1949–1969 vacancy series comes as a proxy for aggregate vacancies rather than firm-level rates, I rescale it by 100,000 to match the level of the other series, for visual convenience. But I refer the reader to the detrended series for a quantitative and comparable juxtaposition of the time series.

At cyclical frequencies, quits and vacancies move roughly one to one. For example, during the Great Recession, quits per 100 workers fell from 2.5 to 1.5. Job openings per 100 workers moved almost in lockstep, falling from 3.3 to 2. For ease of gauging the cyclical comovement, Figures 3.4 and 3.5 plot the detrended series to tease out the striking one-to-one comovement at business cycle frequencies.

Quits & Hires. A similar pattern holds for quits and new hires (gross accessions). Figures 3.6 and 3.7 plot the detrended time series from LTS and JOLTS for quit and hiring rates. Hires comove almost perfectly with quits. As some of my subsequent micro-empirical investigations (towards the causal direction from quits to job openings) rely on hires rather than vacancy measures, I confirm the aggregate comovement to hold for hires, too.

Quits, Hires, Job Openings and Layoffs
German Establishment Survey
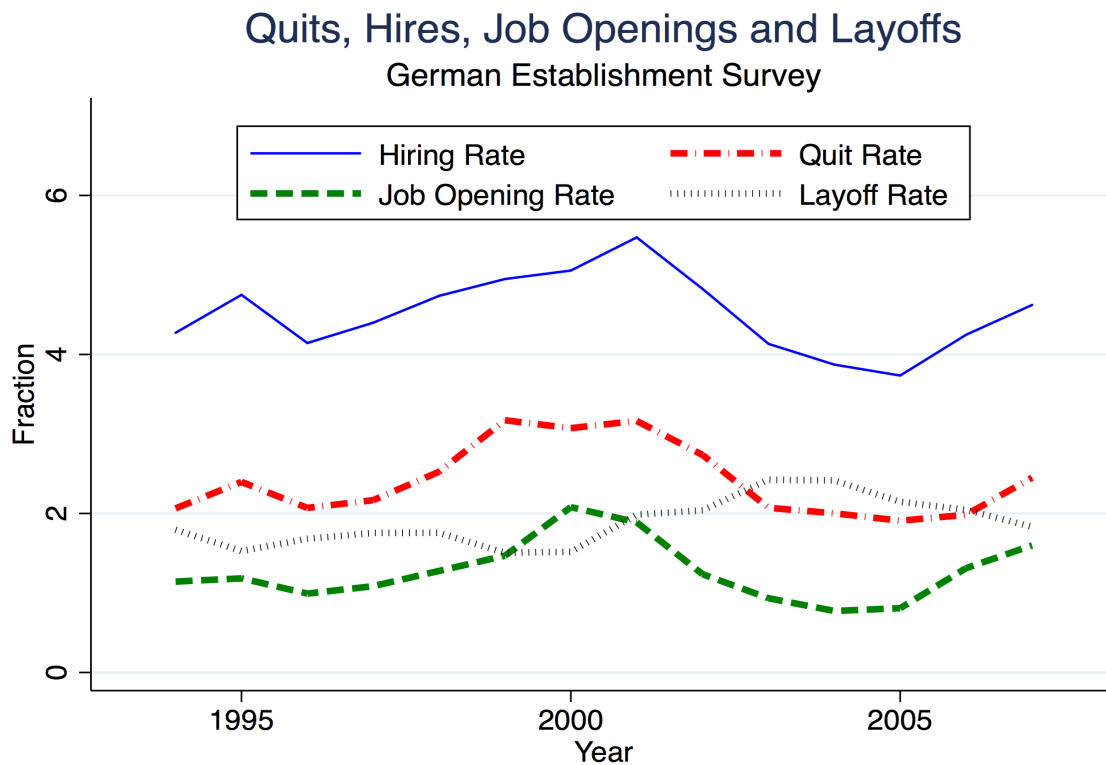
Notes: All variables are per 100 employees. Source: LIAB & IAB Establishment Survey, West Germany, 1993–2008.

Figure 3.8: *Establishment-level Worker Flows in Germany: Quits, Hiring, Job Openings, Layoffs per 100 Workers.*
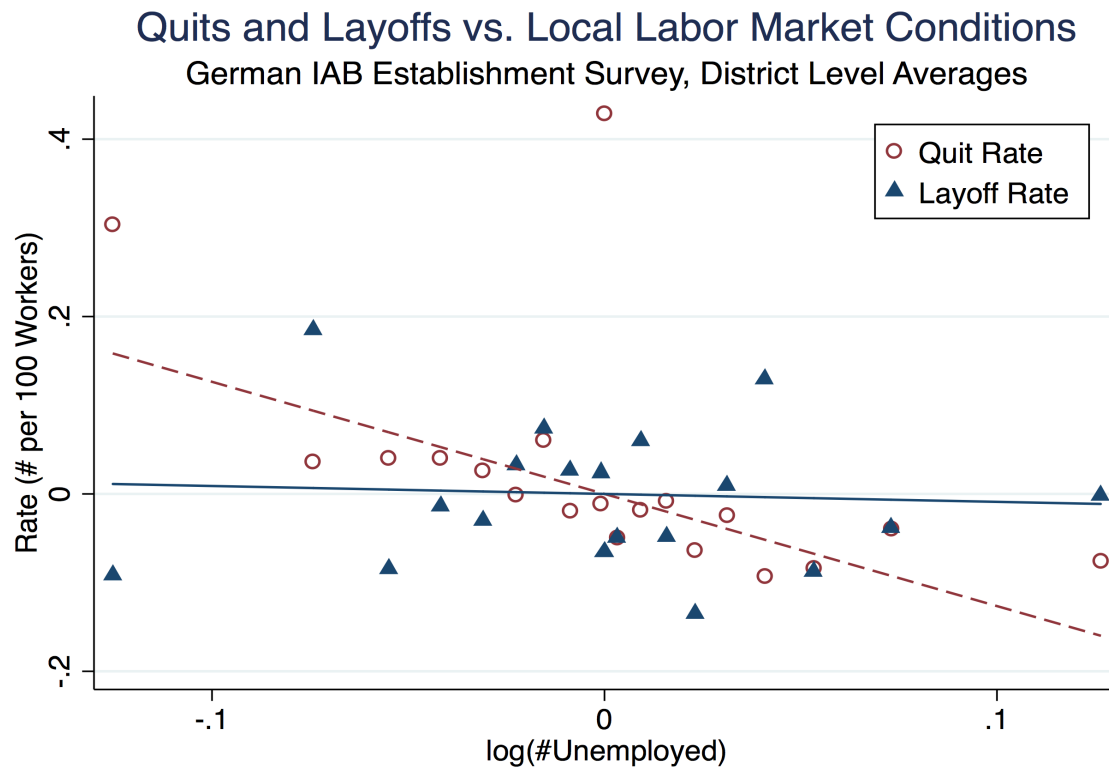
Notes: Establishment behavior with respect to district (Kreis) level economic conditions. All three variables are residualized by year fixed effects, establishment fixed effects and a constant; the micro-data are then summarized in 20 equally sized bins. Quits and layoffs are worker flows per 100 employees. For a description of the binned scatter plot, see Footnote 13. Source: LIAB & IAB Establishment Survey, West Germany, annual data, 1993–2008.

Figure 3.9: *Comovement of Quits and Layoffs with Local Economic Conditions*
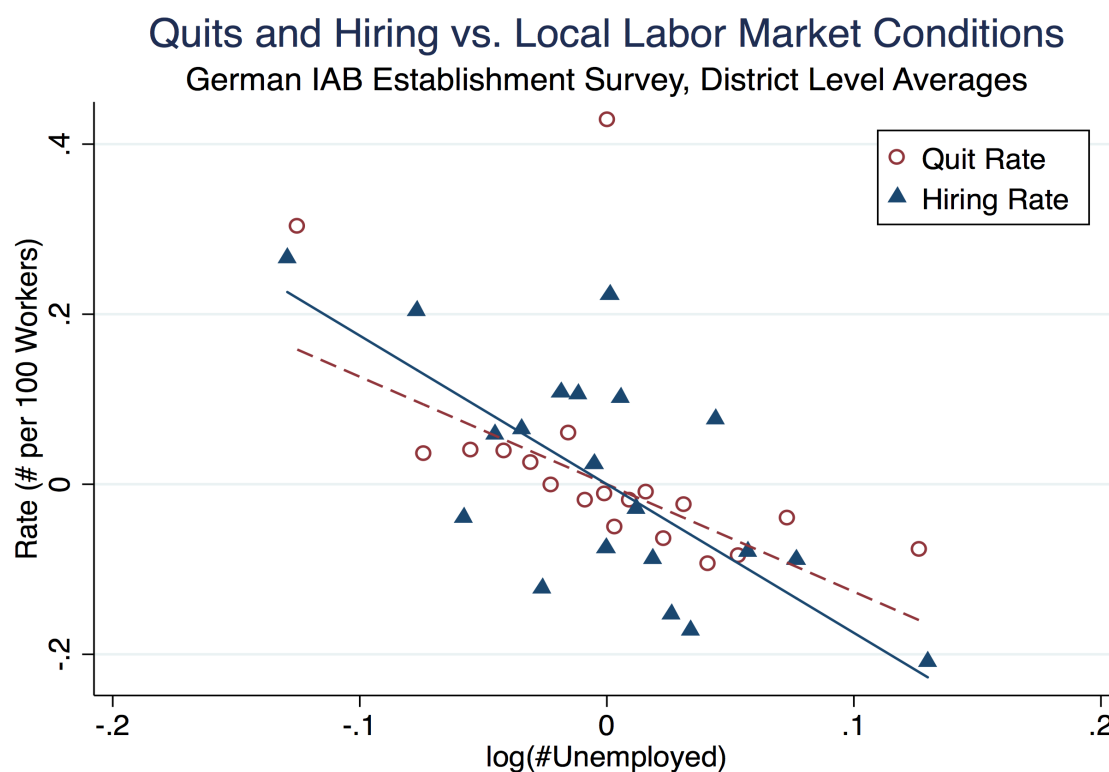
Quits and Hiring vs. Local Labor Market Conditions
German IAB Establishment Survey, District Level Averages

Notes: Establishment behavior with respect to district (Kreis) level economic conditions. All three variables are residualized by year fixed effects, establishment fixed effects and a constant; the micro-data are then summarized in 20 equally sized bins. Quits and hires are worker flows per 100 employees. For a description of the binned scatter plot, see Footnote 13. Source: LIAB & IAB Establishment Survey, West Germany, annual data, 1993–2008.

Figure 3.10: *Comovement of Quits and Hiring with Local Economic Conditions*
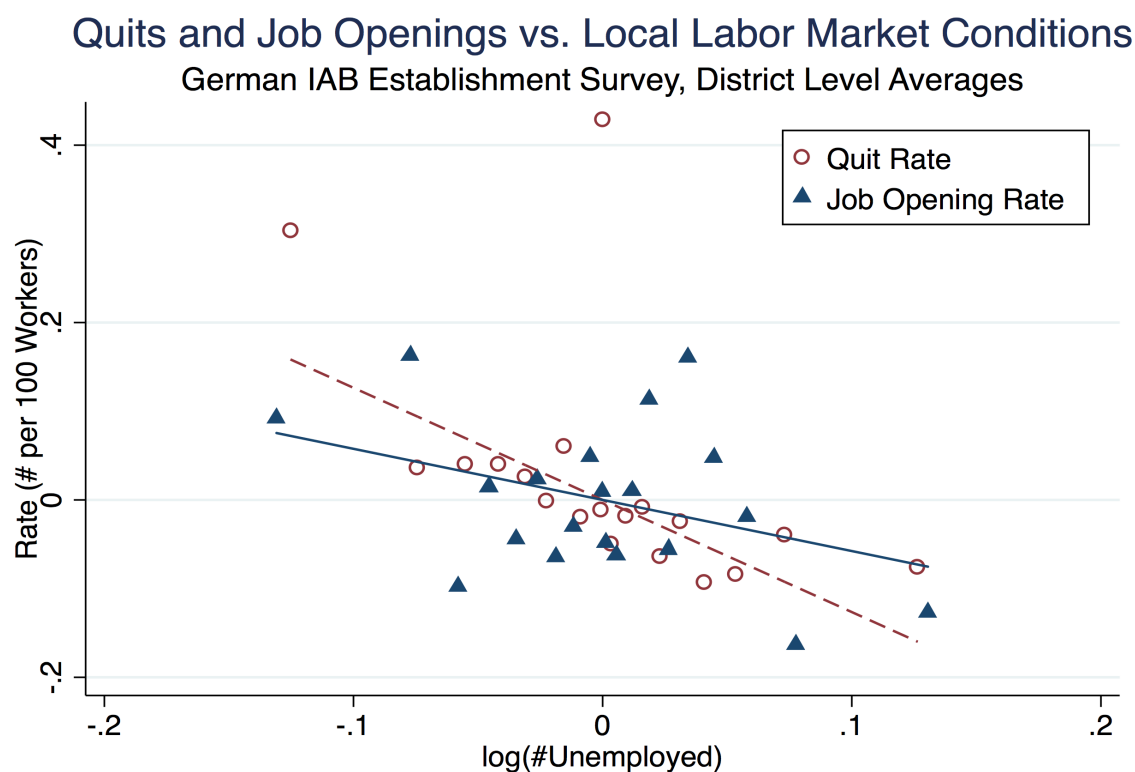
Quits and Job Openings vs. Local Labor Market Conditions
German IAB Establishment Survey, District Level Averages

Notes: Establishment behavior with respect to district (Kreis) level economic conditions. All three variables are residualized by year fixed effects, establishment fixed effects and a constant; the micro-data are then summarized in 20 equally sized bins. Quits and job openings are worker flows per 100 employees. For a description of the binned scatter plot, see Footnote 13. Source: LIAB & IAB Establishment Survey, West Germany, annual data, 1993–2008.

Figure 3.11: *Comovement of Quits and Job Openings with Local Economic Conditions*

3.2.3 District-Level Evidence on the Cyclicality of Quits, Job Openings and Hiring

IAB Establishment Survey Data. My data for this empirical strategy is the longitudinal matched employee-establishment data set from the German Institute for Employment Research (IAB), the LIAB data set ("Linked-Employer-Employee Data from the IAB"). I rely on the accompanying survey ("IAB Establishment Survey"), which is annual, 1993 to 2008, and covers a representative sample of establishments. I restrict my analysis to West Germany which leaves almost 67,000 observations with data on quits (more than 36,000 with positive values), and around 110,000 data points for job openings and hires. The average (median) establishment has 225 (28) employees, and 586 (227) for my preferred panel sample of establishments with at least 50 employees (2003 sample). To not confound extensive-margin or otherwise unrepresentative growth episodes, I exclude employment growth observations exceeding 40% in absolute value.

The Key Variables. The survey includes questions on worker and job flows.[11] Crucially, the survey asks the employer to classify worker flows by type, including quits. The survey also elicits a notion of point-in-time job vacancies. However, since the survey is annual and the worker flow data covers cumulative gross flows, temporal mismatch attenuates the vacancy ratios, and so I primarily focus on hiring outcomes in later sections. I additionally exploit industry identifiers (1-digit, for 9 industries), and geography data (district (Kreis), state (Bundesland)). In line with the aggregate relationships, I construct worker flow rates, that is, I divide the variables by last year's employment. I supplement the establishment data with district-level unemployment data (from the Regional Database Germany, part of the Federal Statistical Office and the Statistical Offices of the Länder). As a measure of local economic/labor market conditions, I use the log number of unemployed workers; thanks to the fixed-effects specifications, the coefficients represent percentage changes.

    Validation: Aggregating the Data Generates U.S.-Like Cyclical Comovement of Quits,

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[11]I use reported worker flows (instead of constructing them from the accompanying administrative employee micro-data), to keep with a coherent definition for survey-only variables such as quits.

Hires and Job Openings. For 1994-2008, Figure 3.8 presents annual averages of the establishment-level ratio of quits, gross hires and vacancies per 100 workers.[12] The time series exhibit the strong – almost one-to-one – cyclical comovements I found in the U.S. data.

Cross-Sectional Comovement: Quits, Hires and Job Vacancies Move with District-Level Labor Market Conditions. In Figures 3.9, 3.10 and 3.11, I present new panel evidence from local labor markets about the behavior of quits, hires and job vacancies. Figure 3.9 plots a binned scatter plot of the quit rate against unemployment. Both variables are residualized with respect to year- and establishment-level fixed effects.[13] That is, the interpretation of the slope is the change in the quit rate within an establishment in response to percent changes in local unemployment. The slope is negative and the linear specification fits the data well. Figure 3.9 also includes the layoff rate, which moves in opposite direction, just the aggregate time series in Figure 3.8.

Figure 3.10 repeats this exercise with the quit rate and the hiring rate. Figure 3.11 does so with vacancies rather than hires. The slopes of both hires and job openings move almost in lock-step with the quit rate. As I will find in the establishment-level regressions in Section 3.2.4, the relationship between hires and quits is tighter than for job openings, which I ascribe partially to the incompatible job opening variable (point in time vs. cumulative[14]). That is, just as the aggregate time series, one quit and one job opening (or one hire respectively) appear to go along.

The fact that local economics replicate the aggregate time-series facts is encouraging.

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[12]I lose the first year, 1993, because I construct the worker flow rates over lagged employment.

[13]A binned scatterplot visualizes the shape of a regression relationship by residualizing the independent and dependent variable by all controls, to then divide the residuals of the former in equally sized bins and finally taking means of both residuals. The binned scatterplot then plots those within-bin means against each other in a scatterplot. The regression lines I depict are based on the micro-observations.

[14]Note that at the establishment level, the vacancy rate appears depressed: many establishments report exactly zero vacant positions. This is in part due to measurement: the vacancy measure is point-in-time (How many jobs are vacant today?). The worker flows are cumulative (How many quits occurred in the last 12 months?). The temporal mismatch likely underlies the *level* differences between hires and vacancies.

Table 3.1: *Regressions: Establishment-Level Hires and Job Openings, and Quits*

Panel A: New Hires$_{it}$/Emp$_{i,t-1}$

	$\frac{\text{Quits}_{i,t}}{\text{Emp}_{i,t-1}} \le 20\%$			$0 < \frac{\text{Quits}_{i,t}}{\text{Emp}_{i,t-1}} \le 20\%$		
	(1)	(2)	(3)	(4)	(5)	(6)
Quits$_{i,t}$/Emp$_{i,t-1}$	.736***	.727***	.733***	.824***	.817***	.821***
	(.067)	(.068)	(.068)	(.086)	(.086)	(.085)
Establishment FEs	✓	✓	✓	✓	✓	✓
Year FEs	✓			✓		
Year × Industry FEs		✓			✓	
Year × State FEs			✓			✓
N	24509	24509	24509	18015	18015	18015
R^2	.64	.64	.64	.66	.67	.67

Panel B: Job Openings$_{it}$/Emp$_{i,t-1}$

	$\frac{\text{Quits}_{i,t}}{\text{Emp}_{i,t-1}} \le 20\%$			$0 < \frac{\text{Quits}_{i,t}}{\text{Emp}_{i,t-1}} \le 20\%$		
	(1)	(2)	(3)	(4)	(5)	(6)
Quits$_{i,t}$/Emp$_{i,t-1}$	.048*	.046*	.047*	.071**	.069**	.068**
	(.026)	(.027)	(.026)	(.035)	(.035)	(.035)
Establishment FEs	✓	✓	✓	✓	✓	✓
Year FEs	✓			✓		
Year × Industry FEs		✓			✓	
Year × State FEs			✓			✓
N	23209	23209	23209	16964	16964	16964
R^2	.37	.37	.37	.35	.36	.35

*Notes: p-values: *: 0.1 **: 0.05, ***: 0.01. The regressions are run on the establishment level. Standard errors are clustered at the establishment level. The sample restriction is West German establishments with at least 50 employees with less than 40% absolute employment change. The data are annual, 1993–2008, from the LIAB sample of the IAB Establishment Survey, which covers a representative sample of German establishments.*

Table 3.2: *Regressions: Establishment-Level Event Studies of Hires and Quits*

Lead/Lag	New Hires$_{it}$/Emp$_{i,t-1}$							
	$\frac{\text{Quits}_{i,t}}{\text{Emp}_{i,t-1}} \leq 20\%$				$0 < \frac{\text{Quits}_{i,t}}{\text{Emp}_{i,t-1}} \leq 20\%$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
-3				-.060				-.115
				(.067)				(.074)
-2			.016	-.008			.060	-.123
			(.096)	(.086)			(.158)	(.132)
-1		.051	.064	.078		.011	.010	-.005
		(.057)	(.098)	(.091)		(.089)	(.150)	(.129)
0	.736***	.753***	.815***	.818***	.824***	.928***	1.03***	.903***
	(.067)	(.068)	(.095)	(.127)	(.086)	(.097)	(.140)	(.164)
$+1$		.050	.079	.192*		.030	.044	.070
		(.069)	(.086)	(.104)		(.102)	(.136)	(.129)
$+2$			.086	-.055			-.001	$-.258$**
			(.085)	(.088)			(.122)	(.122)
$+3$				.161				.037
				(.139)				(.226)
Est. FEs	✓	✓	✓	✓	✓	✓	✓	✓
Y'r FEs	✓	✓	✓	✓	✓	✓	✓	✓
N	24509	11414	5732	2832	18015	6433	2912	1385
R^2	.64	.67	.63	.65	.66	.64	.62	.73

*Notes: p-values: *: 0.1 **: 0.05, ***: 0.01. The regressions are run on the establishment level. Standard errors are clustered at the establishment level. The sample restriction is West German establishments with at least 50 employees with less than 40% absolute employment change. The data are annual, 1993–2008, from the LIAB sample of the IAB Establishment Survey, which covers a representative sample of German establishments.*

Quits and Hires at the Establishment Level
German IAB Establishment Survey
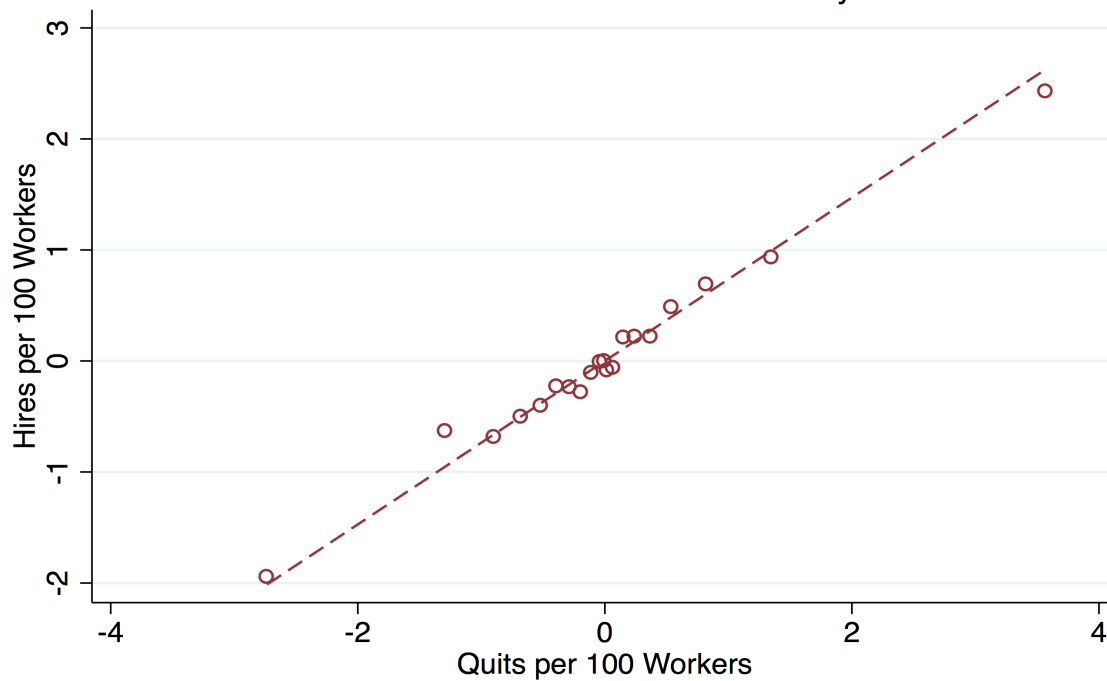
Notes: Binned scatter plot of establishment–year observations, conditional on less than 20% of employment being quits. Both variables are residualized by year fixed effects, establishment fixed effects and a constant. Quits and job openings are measured per 100 employees. For a description of the binned scatter plot, see Footnote 13. Source: LIAB & IAB Establishment Survey, West Germany, annual data, 1993–2008.

Figure 3.12: *Comovement of Quits and New Hires at the Establishment Level*

Quits and Vacancies at the Establishment Level; ≤20% Quits

German IAB Establishment Survey
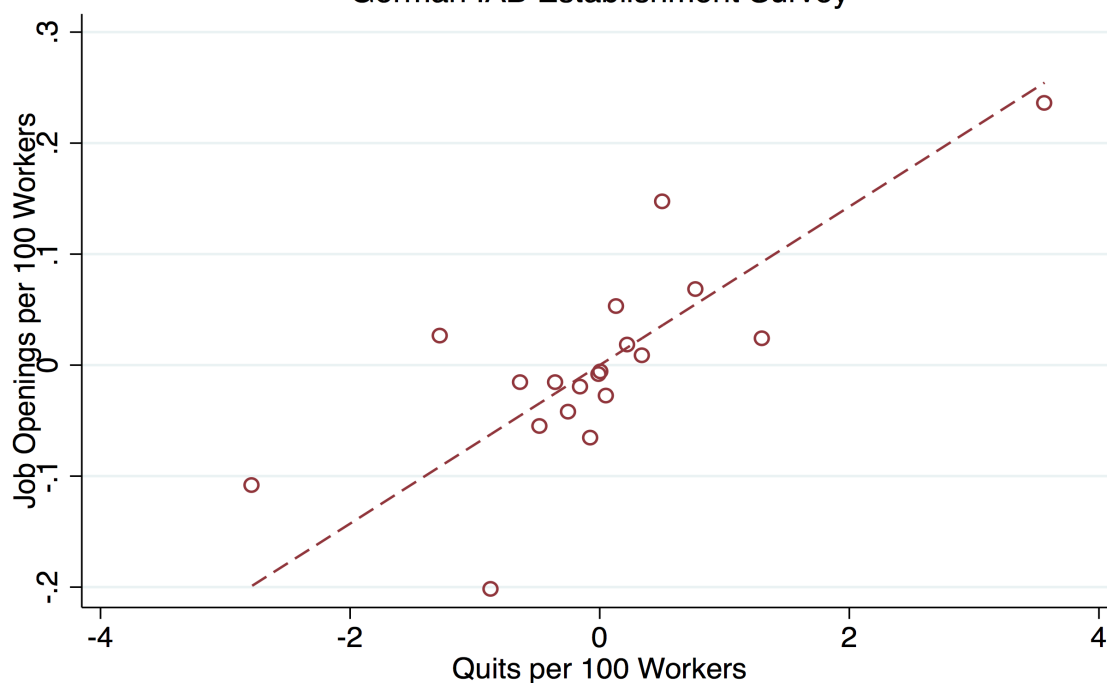
Notes: Binned scatter plot of establishment–year observations, conditional on less than 20% of employment being quits. Both variables are residualized by year fixed effects, establishment fixed effects and a constant. Quits and job openings are measured per 100 employees. For a description of the binned scatter plot, see Footnote 13. Source: LIAB & IAB Establishment Survey, West Germany, annual data, 1993–2008.

Figure 3.13: *Comovement of Quits and Job Openings at the Establishment Level*

3.2.4 Establishment-Level Evidence: The Effect from Quits to Hiring

The replacement-hiring mechanism that this paper explores predicts that a quit triggers a job opening *at the same firm*. I present reduced-form establishment-level evidence for the quit–hiring covariance to indeed arise from the firm level, using the establishment panel survey described in Section 3.2.3. I additionally provide a first stab at pointing to a causal direction from quits to hiring.

The aggregate comovements explored in the previous sections are not sufficient to establish the firm-level quit–replacement mechanism. The findings permit the possibility that the comovements are *market-level* phenomena, that is, that quits in some firms stimulate hiring in other firms, and vice versa. Indeed, economic intuition suggests that quits should arise *in response to* an increase in labor demand (job openings). After all, this is the prediction of most on-the-job-search models, including the minimalistic one in Section 3.3. But even the hypothesized direction from quits to vacancies might stem from a distinct, market-level effect, triggered by labor supply, by which increased on-the-job search in some firms stimulates hiring in *other* firms.[15] Crucially, both competing stories predict market-level – but not firm-level – comovement.

Micro-Empirical Strategies. I investigate the establishment-level analogue of the aggregate time series investigations; that is, the relationship of job openings or hires, with within-firm variation in quits over time. Concretely, I estimate, for firm *i*'s year-*t* outcome (new hires and job openings per 100 workers) for sets of fixed effects described subsequently, and for establishment-level clustered standard errors:

$$\frac{\{\text{NewHires}_{it}, \text{JobVacancy}_{it}\}}{\text{Emp}_{i,t-1}} = \beta_0 + \beta_1 \frac{\text{Quits}_{i,t}}{\text{Emp}_{i,t-1}} + \beta_X \mathbf{X}_{it} + \alpha_i + \alpha_t + \varepsilon_{it} \qquad (3.1)$$

Additionally, I visualize the underlying shape of the estimated relationship in binned scatter plots, which plot the independent and dependent variables, residualized by all controls. I exclude extreme observations (+/-40% employment growth, at most 20% quit–employment

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[15]For versions of this labor-supply mechanism stemming from separations, see e.g. Barlevy (2002) and Nagypál (2008) for endogenous on-the-job search; or Shimer (2005) for exogenous separation shocks.

ratio).

Key Micro-Empirical Result: One Quit is Associated with 0.7–0.8 Hires. Table 3.1 presents the regression results on the relationship between new hires and vacant jobs (over last year's employment) against the corresponding ratio of quits to last year's employment, with firm and year fixed effects. Panel A reports on new hires, Panel B on job openings. Columns (1)–(3) present specifications for establishments with less than 20% quit rates; Columns (4)–(6) restricts the sample further to observations with positive contemporaneous quits.

Column (1) in Panel A shows that an increase in the quit rate between observations by 1 quit (in the last 12 months) per 100 workers is associated with an increase of hires by 0.74 per 100 workers. When restricting the sample to establishments with positive quits in Column (4), the coefficient slightly increases to 0.82. Both are highly significant (p-value<0.1%). The binned scatter plot in Figure 3.12 reveals the strikingly linear relationship.

Establishment and year fixed effects have the coefficient on quits be identified off *changes* within establishments – the cyclical implications of which are the focus of this paper. The remaining columns repeat the exercise for finer definitions of the labor market, by including year–industry (1-digit) in Column (2) [and (4)], and year–state fixed effects in Columns (3) [and (6) for the sample with positive quits]. The coefficients are stable. Another way to read this result is in light of a concern about omitted time-establishment-varying drivers of both quits and hiring (e.g. reallocation shocks). While it is impossible to control for all such confounds, the (downward) stability of the coefficient to even coarse sources of such omitted variables is encouraging.

This analysis provides micro-empirical support that the aggregate relationship between quits on the one hand, and hires and job openings on the other hand, is active *within* establishments, rather than being fully driven by (procyclical) market-level reallocation *between* establishments.

Validation I: Episodic Nature of Quits. In two ways, I validate that the design captures episodic quit-rate changes, rather than e.g. trend changes of establishment growth. First, in

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unreported investigations, I estimate the autoregressive coefficient of quits (the coefficient of the quit rate regressed on the lagged quit rate, controlling for establishment fixed effects). It is surprisingly low: .02 for the full sample, .007 for positive-quit observations (both noisy estimates), and -.0175 for observations with less than 20% quits (precisely estimated). Moreover, there remains considerable variation of the quit rate even when regressed on establishment fixed effects ($R^2 = .56$), plus year fixed effects (.58), plus lagged quits (.59).

Validation II: An Event Study Design (Leads and Lags of Quits). Table 3.2 adds 1–3 leads and lags to the specification in Column (1), Panel A in Table 3.1. The goal is an event-study investigation pointing towards episodic quit events, rather than being confounded by differential firm growth patterns or other dynamic confounds that the establishment fixed effects might not have purged.[16] Although the sample size shrinks with the interval, the coefficients on the contemporaneous quit rate are extremely stable. If anything it increases slightly, from 0.74 to 0.82 for the baseline and from 0.82 to 1.0 for the sample with positive contemporaneous quits.[17] As importantly, the coefficients on leads and lags are generally zero.

Remaining Concerns. The micro-empirical findings are consistent with the causal direction from quits to hiring and job openings. But at least three concerns remain.

I. Omitted Variables. Even in the establishment-level design, omitted variables – such as differential structural change – might drive both job openings and quits at the firm, triggering separations in certain jobs *and* the creation of new jobs. Yet, in combination with the job-level evidence in Section 3.2.1 (half of job openings aiming to replace quits in old jobs), I view the preponderance of the evidence as encouraging.

II. Reverse Causality. The survey data cover cumulative worker flows from multiple months. But new hires might actually trigger quits because of low job attachment of new

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[16]I only report the event study results for hiring outcomes. With the current establishment-level job opening proxies, the event-study results for job openings are very unstable between specifications and depending on sample restrictions. In a revision of the paper, I hope to use the IAB Job Vacancy Survey (of which I use aggregate data in Section 3.2.1) rather than the incidental vacancy question on the Establishment Survey, which this Section exploits.

[17]The patterns do not appear to be driven by the sample shrinkage.

workers. For example, Hall (2014) documents a tenure gradient for separations. But the close-to-unitary coefficients would point away from such an explanation. More decisively, the prediction – the hiring event preceding the quit – is testable with the accompanying employee micro-data. Moreover, especially for those early quits, the same job is most likely to be reposted, for a realistic job life-time. Lastly, remember that the job-level evidence for replacement hiring in Section 3.2.1 did hold up for permanent jobs.

III. Cyclical Stability of the Effect. I estimate a constant relationship between quits and hiring. However, a model of endogenous repostings (e.g. with heterogenous match productivity) might suggest a procyclical propensity to repost jobs, similarly if quits were endogenous to job quality. But such cyclical effects would only amplify the reposting mechanism, relative to the constant propensity I shall assume. But it would be interesting to learn more about the endogenous cyclical aspects of the mechanism.

Related Empirical Literature. Davis *et al.* (2006) and Davis *et al.* (2013) document the establishment-level behavior of hires, separations, quits, layoffs and net employment growth, using JOLTS micro-data. My micro-exercise shares similarities with the interesting working paper by Faberman and Nagypál (2008). That exclusively micro-focused paper exploit JOLTS establishment-level data to investigate the cross-sectional patterns of job openings, quits, hiring and net employment growth at the establishment level while allowing for and considering replacement hiring. Lazear and Spletzer (2012) explore separations and hires as jointly determined, using JOLTS data. Bachmann *et al.* (2013) document that between-establishment churn is procyclical, which is in line with this paper's implications.

Though with different foci, two quasi-experimental designs provide very interesting ancillary evidence on the quit–replacement mechanism I consider. First, Isen (2013) examines the firm-level effects of accidental worker deaths, with the goal of estimating the gap between a worker's imputed marginal product and her wage. The "first stage" of his quasi-experimental design is the verification that total employment responds to one accidental worker death. In event studies (Figures 3a, 4a, Appendix Figure 2), he finds that indeed in the event quarter, employment per death drops (by half a worker, suggesting 50% replacement

hiring within the first quarter already). Moreover, within the first year, the firm has virtually caught up to the pre-death employment level. The finding strongly suggests replacement hiring to this type of (exogenous) separation. Second, Doran *et al.* (2015) examine a unique random variation in whether a firm fills a position or not: H1-B visa lottery outcomes. They find no positive effect on total employment (in excess of one), suggesting that at the firm level, jobs that are not filled (in the comparison/control group that loses the lottery) are reposted and filled (Tables 7–9; Figure 2).

3.3   A DMP Model with On-the-Job Search, Procyclical Quits and Replacement Hiring

Motivated by the empirical evidence for replacement hiring in response to quits, I now formalize its cyclical implications. I integrate replacement hiring and procyclical quits into the variant of the Diamond-Mortensen-Pissarides search and matching model of the aggregate labor market. Quits emerge from an economical specification of on-the-job search, the success of which depends on labor market tightness. As a result, quits are procyclical. Replacement hiring – reposting of old jobs vacated by quits – emerges because of a sunk creation cost of new job openings, and so repostings command a positive value in equilibrium.[18] Firms thus optimally repost jobs vacated by quits. Since quits are procyclical, so are replacement vacancies.

In the baseline model with a linear free-entry structure for new jobs, introducing replacement hiring is a side show that only changes the composition of vacancies over the business cycle. But there is perfect neutrality with respect to total job openings. As a result, no other labor market variables are affected. I explain how the this result is at the very core of the DMP class of search and matching models: labor market tightness is the equilibrating variable in the model, pins down *total* vacancies. Thus, new job creation and reposted

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[18]The idea of a sunk creation cost is related to the DMP model explored by Fujita and Ramey (2007), who focus on smoothing out vacancy impulse responses, through convex costs of new vacancies. I repurpose that feature for my focus on procyclical quits and associated repostings.

vacancies are perfect substitutes. I show that this neutrality relies on linear creation costs for new jobs.

I break this perfect crowd-out with a parsimonious twist: a convex (adjustment) cost of creating new jobs. Whether repostings are high or low now has an effect on the marginal cost of new jobs for a given target of job openings.

The key result is amplification of cyclical fluctuations in *total* job openings. Recessions are times when incumbents hold on to their jobs. The resulting drop in repostings contributes to the fall in total job opportunities. By contrast, in upswings, tighter labor markets pull employed workers out of their matches, leaving reposted vacancies behind, which add to total job opportunities.

While the current paper provides only suggestive quantitative judgment, I do illustrate the cyclical behavior of the calibrated models in response to shocks to labor productivity. The precise amplification potential with regards to total job openings, depends on the degree of short-run crowd-out of new job creation from repostings. In Section 3.4, I empirically argue that at business cycle frequencies, such crowd-out appears very limited in the data. This finding points towards the model with net total effects of the quit–reposting mechanism.

3.3.1 Model Set-Up

Labor Market Structure. Firms post vacancies v to meet job seekers s through matching function $\mathcal{M} = \mu v^\eta s^{1-\eta}$. The per-period probability that a job seeker finds a match is $f(\theta) = \frac{s}{\mathcal{M}} = \mu \theta^\eta$, with $q(\theta) = \frac{v}{\mathcal{M}} = \mu \theta^{-\eta}$ as the vacancy matching probability. $\theta = \frac{v}{s}$ denotes labor market tightness.

Job Seekers. There are two types of job seekers $s = u + o$: unemployed job seekers u and employed workers engaging in on-the-job search o.

Unemployed Job Seekers. At probability δ, an employed worker's job becomes obsolete, and she becomes unemployed. Inflow into unemployment is $\delta(1 - u)$, with 1 being the size of the labor force. The outflow from unemployment u into employment is $f(\theta)u$. The law of

motion for unemployment is:

$$u = u^- + u^- f(\theta^-) + \delta(1 - u^-) \tag{3.2}$$

On the Job Search. Fraction λ of employed workers are hit by a permanent match-specific disamenity shock that forces them to look for a new job,[19] while remaining employed. That is, the pool of on-the-job searchers follows a pattern that mirrors the law of motion for unemployment:

$$o = (1 - \delta)o^- + (1 - \delta)\lambda(1 - u^-) - (1 - \delta)o^- f(\theta^-) \tag{3.3}$$

Jobs. There are two types of vacant jobs: continuing jobs and new jobs. New jobs entail a creation cost; reposting continuing jobs do not. When vacant, both job types require the same recruitment flow costs.

New Job Creation. New jobs n are created at sunk cost $c(n)$ and have value N. After creation, they become just like any job opening, yielding value V:

$$N = -c'(n) + V \tag{3.4}$$

There is free entry for new jobs. Thus, $N = -c'(n^*) + V = 0$, which pins down the equilibrium value of vacant jobs at $c'(n^*)$ for $n^* > 0$:

$$V = c'(n^*) \tag{3.5}$$

Value of a Vacant Job is search flow cost k plus the value of a filled job tomorrow at probability $q(\theta)$ and the vacancy continuation value at $1 - q(\theta)$, discounted at β as well as survival probability $1 - \delta$:

$$V = -k + \beta q(\theta)(1 - \delta) \cdot \mathbb{E}J^+ + \beta(1 - q(\theta))(1 - \delta) \cdot \mathbb{E}V^+ \tag{3.6}$$

Value of Unemployment. The value of an unemployed worker is the flow value of being unemployed (γ) plus the continuation value, which at probability $f(\theta)$ results in a switch into

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[19]For simplicity, I suppress or do not allow for associated utility effects from the shock.

employed status tomorrow (when the worker earns value E^+) or staying in unemployment (U^+):

$$U = \gamma + \beta(1 - f(\theta))\mathbb{E}U^+ + \beta(1 - \delta)f(\theta)\mathbb{E}E^+ \tag{3.7}$$

Match Formation and Surplus Sharing. Having set up the external labor market, I now consider the internal workings of matches.

Surplus Value From a Match. Because of search frictions, in equilibrium the firm and the worker strictly prefer forming a match to their outside options of continuing search. Match surplus S is match value M net of the outside options U (unemployment) and V (vacancy):

$$S = M - U - V \tag{3.8}$$

Match Value. Consider the gross value of the match, which is flow productivity z plus the expected continuation value, which is additionally discounted by the survival probability of this particular match (that is, the probability of non-obsoletion and non-quit):

$$M = z + \beta(1 - \delta) \cdot \mathbb{E}[(1 - \lambda \cdot f(\theta))S^+ + U^+ + (1 - \delta)V^+] \tag{3.9}$$

Nash Bargaining. The parties split surplus S following the standard Nash bargain in the DMP literature. I apply it in an abstract fashion, without explicit flow wages. When matched (and indeed at the start of every period), the worker and the firm divide the surplus with bargaining weight ϕ for the worker (outside option: unemployment U) and $1 - \phi$ for the firm (outside option: vacancy value V).

Employer Match Value. The firm obtains its share of the match surplus on top of the outside option:

$$J = (1 - \phi) \cdot S + V \tag{3.10}$$

Employee Match Value. Similarly for the worker,

$$E = \phi \cdot S + U \tag{3.11}$$

Consequently, surplus $S = M - U - V$ is:

$$S = z - b + k + \beta(1-\lambda)\mathbb{E}[S^+ \cdot \{(1 - \delta f(\theta)) - f(\theta)\phi - q(\theta)(1-\phi)\}] \qquad (3.12)$$

Simplifying Features of On-the-Job Search. Two features permit me to introduce on-the-job search into the DMP model with minimal changes to its functioning and intuitions. First, whenever on-the-job search yields a match, the Nash bargain treats the searcher as unemployed, with unemployment value U as her outside option. That is, before she enters into bargaining, she must give irreversible notice to the previous employer. This prevents distracting wage effects from workforce composition onto labor demand. Second, the worker's value functions remain simple because job-to-job transitions occur between homogenous jobs.

New Job Creation. The explicit optimality condition for new job creation comes from vacancy value (3.6), surplus condition (3.12), surplus sharing rule (3.10) and free entry for new jobs (3.5):

$$c'(n^*) = -k + \beta q(\theta)(1-\delta) \cdot \mathbb{E}(1-\phi)S^+ + \beta(1-\delta) \cdot \mathbb{E}c'(n^{*+}) \qquad (3.13)$$

Reposting of Old Jobs and Replacement Hiring. The value of a vacant continuing job is positive in equilibrium, provided positive marginal creation costs of new jobs, $c'(n) > 0$. As reposting a continuing job merely entails the standard DMP recruitment costs, firms optimally repost jobs left vacant by quits.[20] The key implication is that if $c'(n) > 0$ and if vacated jobs are thus reposted, quits affect the stock of vacancies.

Law of Motion for Job Openings. In the presence of vacancy reposting, vacancies of either type have laws of motion. By contrast, in the standard DMP set-up without creation costs, vacancy posting is a period-by-period decision. First, openings for new jobs evolve as

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[20]Implicitly, $c'(n) = 0$ in the standard DMP model, which thus does not feature reposting. I repurpose that feature from Fujita and Ramey (2007) for my focus on procyclical quits and associated repostings. I realistic and parsimonious alternative modeling rationale would feature firm-level decreasing returns.

follows:

$$v^n - v^{n-} = \overbrace{n}^{\text{new}} + \overbrace{-\delta v^{n-}}^{\text{obsoletion}} - \overbrace{q(\theta^-)v^{n-}}^{\text{filled}}$$ (3.14)

Second, the law of motion for replacement job openings mirrors that for new jobs (3.14) except that quits are the inflow:

$$v^r - v^{r-} = \overbrace{(1-\lambda)of(\theta)}^{\text{reposting}} + \overbrace{-\delta v^{r-}}^{\text{obsoletion}} - \overbrace{q(\theta^-)v^{r-}}^{\text{filled}}$$ (3.15)

Total vacancies $v = v^n + v^r$ are determined by the history of new job creation and repostings of old jobs:

$$v - v^- = (v^n + v^r) - (v^{n-} + v^{r-}) = \overbrace{n}^{\text{new}} + \overbrace{(1-\delta)of(\theta)}^{\text{reposting}} - \overbrace{q(\theta^-))v^-}^{\text{filled}} \overbrace{-\delta v^-}^{\text{obsoletion}}$$ (3.16)

Equilibrium. The equilibrium path of the labor market (specifically θ, S, n), for a given productivity process z, and given the laws of motion for vacancies and unemployment, is pinned down as follows. Expression (3.12) pins down the evolution of the surplus. Surplus sharing rule (3.10) pins down the expected value of filled jobs, which enters the value of a vacancy (3.6). The free-entry condition for new jobs (3.5) pins down the value of a vacant job and the number of new vacancies.

3.3.2   When Does Job Reposting Have Net Effects on Total Job Openings?

Under which conditions does vacancy reposting change the *cyclical* dynamics of the labor market? I show that the answer depends on the cost structure of new job creation. In the baseline model, with linear creation cost, new job creation turns out to perfectly offset reposted vacancies. The standard DMP model is a special case of linear creation cost (zero). While alternative model extensions could break the perfect crowd-out, I show that parsimonious and realistic channel to attenuate this perfect crowd-out is a convex (short-run adjustment) cost of new job creation.

Consider the concrete case of convex creation cost $c(n)$ consisting of coefficient κ_1 and,

crucially, quadratic coefficient κ_2:

$$c(n) = \kappa_1 n + \kappa_2 (n - \tilde{n})^2 / 2 \tag{3.17}$$

where $\tilde{n}$ denotes steady-state new job creation. The key implication is that marginal new job comes at the following creation costs:

$$c'(n) = \kappa_1 + \kappa_2 (n - \tilde{n}) \tag{3.18}$$

Preview: κ_1 guides reposting ($\kappa_1 > 0$ triggers it, $\kappa_1 = 0$ precludes it.); κ_2 determines the net effect of reposting on total job openings ($\kappa_2 > 0$ entails a net effect; $\kappa_2 = 0$ entails perfect crowd-out of new job creation).

Zero Creation Costs ($\kappa_1 = 0, \kappa_2 = 0$)*: No Reposting.* First consider this intuitive baseline model, which extends the standard DMP model merely by procyclical on-the-job search. But because of the zero marginal cost of job creation ($c'(n) = 0$, implicit in the standard DMP model), vacated jobs are not reposted in equilibrium, at which a marginal vacancy yields zero value. [21] The general optimality condition for vacancy posting (3.13) collapses to the standard DMP zero profit condition:

$$k = q(\theta) \cdot \beta(1 - \delta)\mathbb{E}(1 - \phi)S^+ \tag{3.19}$$

Labor market tightness $\theta = \frac{v}{s}$ equilibrates the economy. Any equilibrating θ^* (which pins down u, o and s), supports a unique vacancy level, v^*. The evolution of vacancies trivially collapses to the standard period-by-period "spot" version: $v = n$.

Linear Creation Costs ($\kappa_1 > 0, \kappa_2 = 0$)*: Reposting with Perfect Crowd-Out.* A positive, linear creation sunk cost for new jobs generates one key difference from the previous model: a positive asset value of vacant jobs, as the equilibrium marginal vacancy yields a positive value ($c'(n^*) = \kappa_1 = V$). Two consequences emerge. First, – rather than a period-by-period

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[21]Consider the canonical DMP textbook (Pissarides (1990)): "Once a worker leaves, the firm has the option of either closing the job down and reopening another one, or re- advertising it and recruiting another worker to it. In the absence of job destruction and job creation (setup) costs, it is obviously to the firm's advantage to close the job down and create a new one, since by assumption new jobs can be created at maximum productivity."

decision – once created, a new job opening is maintained until filled or obsolete. Second, a quit leaves behind a vacancy with positive asset value. The firm thus optimally reposts that vacated job. Vacancies thus evolve with the path of repostings and of new jobs, that is, law of motion (3.16). The optimality condition for vacancy posting differs from standard DMP zero profit condition only in the positive value of a vacancy generated by creation cost κ_1 – and thus is a "κ_1-profit" condition:

$$k + \boxed{\kappa_1(1 - \beta(1 - \delta))} = q(\theta) \cdot \beta(1 - \delta)\mathbb{E}(1 - \phi)S^+ \tag{3.20}$$

The introduction of reposting, through job creation cost κ_1, leaves the qualitative DMP equilibrium intact. The upfront creation cost shows up as a constant user cost (net of discount $\beta(1 - \delta)$ as the firm retains ownership of the vacancy in subsequent periods). Labor market tightness θ remains the equilibrating variable. Again, given u and θ^*, total job openings v^* are perfectly pinned down, and new jobs immediately and exhaustively fill in the gap between inherited vacancies (incl. repostings) and target *total* vacancies v^*. As a result, there is *perfect crowd-out* of new jobs from repostings, precluding any net effect of fluctuations in repostings on total job openings.

Quadratic Creation Costs $(\kappa_1 > 0, \kappa_2 > 0)$*: Reposting with Imperfect Crowd-out.* Convexity in the creation cost for new jobs adds a crucial twist to the linear creation cost model: The left-hand side of the optimal new-vacancy creation condition features not only recruitment and linear creation costs, but also a term that depends on the number of new positions n, the user cost of the convex component κ_2:

$$k + \kappa_1(1 - \beta(1 - \delta)) + \boxed{\kappa_2 \cdot (n^* - \tilde{n}) \cdot \left(1 - \beta(1 - \delta)\mathbb{E}\frac{n^{*+} - \tilde{n}}{n^* - \tilde{n}}\right)} = q(\theta) \cdot \beta(1 - \delta)\mathbb{E}(1 - \phi)S^+$$
$$\tag{3.21}$$

For each incremental new job, employers now require a higher expected surplus from employment matches. As a result, repostings shift the job creation curve upward, but not one to one. A change in reposted vacancies now transmits into the total amount of job openings. In Section 3.4, I present an empirical argument that points towards such limited crowd-out.

Table 3.3: *Parameter Values of Calibrated Model; Monthly Frequencies*

Parameter	Description	Creation Costs	
		Linear	**Convex**
ρ	Autoreg. of productivity z	0.975	0.975
σ	S.d. of productivity innovation	0.0044	0.0044
λ	Prob(Enter on-the-job search)	0.04	0.04
δ	Obsoletion rate	0.038	0.038
μ	Matching efficiency	0.636	0.636
η	Matching elasticity of vacancies	0.5	0.5
β	Discount factor	0.9967	0.9967
ϕ	Worker's bargaining weight	0.5	0.5
γ	Unemployment flow utility	0.9	0.9
k	Vacancy flow cost	0.13	0.13
	Creation Cost		
κ_1	Linear factor in creation cost	0.4	0.2
κ_2	Quadratic factor in creation cost	**0**	**26**

3.3.3 Calibration, and Simulation of the Cyclical Behavior of Job Openings With and Without Reposting

Next, I calibrate the parameters and obtain simulated time series of the model, to quantitatively evaluate the implications of quit-driven vacancy repostings for the cyclical behavior of total job openings.

As in most cyclical analyses of the DMP model, the driving force lies in log-normally distributed shocks to labor productivity z, where $\rho \in [0,1)$ and $\varepsilon \sim N(0, \sigma_z)$:

$$ln(z) = \rho \cdot ln(z^-) + \varepsilon \tag{3.22}$$

Intuition for Cyclical Dynamics in the Model.

A negative productivity shock lowers the payoff firms obtain from new job matches, net of the (bargaining) share ϕ that labor grasps directly. The value of vacancies V drops along with the job value. By free entry, firms respond by reducing new job creation. Labor market

tightness $\theta = \frac{v}{s}$ falls. Workers find it harder to find jobs, which drives up unemployment and the pool of on-the-job searchers. Markets become slacker, recruitment cost per hire $\frac{k}{q(\theta)}$ falls, and wages, through workers' outside options, take another hit. Both effects attenuate the drop in job creation. But the slackening labor market also reduces quits (successful matches among on-the-job searchers). If vacated jobs are reposted, labor market tightness falls by even more. But with full crowd-out of new jobs from repostings, the identical new equilibrium labor market tightness is obtained, except that compositionally, repostings contribute by less to the vacancy tally. But in the more interesting case with imperfect crowd-out of new jobs, the procyclical quit–replacement channel will *amplify* the total net vacancy response to a productivity shock.

Calibration

Table 3.3 reports the parameter values.[22] I calibrate the parameters to monthly frequencies. $\rho = 0.975$ and $\sigma = 0.0044$ (with steady-state productivity normalized as $\bar{z} = 1$) let the AR(1) process imposed in (3.22), when aggregated to quarters, match the empirical quarterly productivity process. The monthly worker-matching probability of $f(\theta) = 0.45$ (Shimer (2005)) implies obsoletion rate $\delta = 0.038$ with steady-state unemployment $\tilde{u} = \frac{\delta}{f(\tilde{\theta})+\delta} = 0.08$.[23] I set matching function elasticity $\eta = 0.5$ (Petrongolo and Pissarides (2001)), and accordingly the worker's bargaining weight $\beta = 0.5$ (loosely for the sake of the Hosios (1990) condition).[24] With $\mu = 0.6$ (pinned down by the ratio of the measured worker (0.45) and firm matching probabilities ($\sim$0.8) and $\eta = 0.5$, the target of $f(\tilde{\theta}) = \mu\tilde{\theta}^\eta = 0.45$ implies $\theta = 0.5$. I set $\lambda = 0.04$, the rate of entering on-the-job search as an employed worker, to match the share of replacement vacancies to total vacancies that I find in the

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[22]For common parameters, I follow Fujita and Ramey (2007), some of whose features I repurpose here.

[23]The quoted estimate concerns unemployed job seekers, which might be higher (higher effort) or lower (worse access) than for employed searchers. The model has $f(\theta)$ apply to both searchers.

[24]Note that unemployed and employed job seekers enter the matching function the same way, so that elasticity applies to their sum. Empirical estimates of η are estimated off movements in the number of unemployed job seekers only. There is little empirical guidance in the share of unemployed workers in total search effort. I thus preserve the standard coefficient.

German job vacancy survey (around 50%). With the steady-state condition for the pool of on-the-job searchers, the (hard to empirically observe) ratio of employment to unemployed job seekers is around one in steady state: $\frac{\tilde{o}}{\tilde{u}} = (1 - \tilde{u})\frac{(1-\delta)\lambda}{\delta} = 0.93$. The steady-state value of new job creation $\tilde{n}$ is pinned down by $\tilde{o} = (1-u)\frac{(1-\delta)\lambda}{\delta + (1-\delta)f(\tilde{\theta})} = 0.075$ and $\tilde{\theta} = 0.5$, in that $\tilde{v} = \tilde{\theta}(\tilde{o} + \tilde{u}) = 0.078$, and in that from vacancy law of motion (3.16), steady-state vacancies are: $\tilde{n} = q(\tilde{\theta}))\tilde{v} + \delta\tilde{v} - (1-\delta)\tilde{o}f(\tilde{\theta}) = 0.0375$. The inflow of repostings from quits is $f(\theta)(1-\delta)\tilde{o} = \frac{(1-\delta)(1-\tilde{u})\lambda}{\delta + (1-\delta)f(\tilde{\theta})} = 0.0383$. Thus, around half of the job openings are due to quits, and half are new job creation to make up for obsoletion. Consider the stationary steady-state condition for job creation as a function of parameters and steady-state labor market tightness, from surplus condition (3.12) and free entry for new jobs (3.5). Since the quadratic creation cost enters as an adjustment cost from the stationary steady-state level of new jobs, κ_2 does not show up in this condition:[25]

$$\frac{k + (1 - \beta(1-\delta))\kappa_1}{q(\tilde{\theta}) \cdot \beta(1-\delta)\mathbb{E}(1-\phi)} = \frac{1 - \gamma + k}{1 - \beta(1-\lambda)\left\{(1 - \delta f(\tilde{\theta})) - f(\tilde{\theta})\phi - q(\tilde{\theta})(1-\phi)\right\}} \quad (3.23)$$

Given all previous parameterizations, stationary steady-state job creation (3.23) contains three remaining parameters: vacancy maintenance flow cost k, unemployment flow utility γ and the linear component of the job creation cost κ_1. I set $k = 0.13$, and $\kappa_1 = 0.12$ to roughly match the Fujita and Ramey (2007) steady state parameterization. In this condition, κ_1 scales the economy, by guiding the equilibrium value of vacancies required to cover the creation cost of new jobs. κ_2 guides the quadratic adjustment cost of new-job creation from steady state, which I set to $\kappa_2 = 0$ in the linear model and $\kappa = 26$ in the quadratic model. I pragmatically set $\gamma = 0.9$ to obtain sizable employment fluctuations, and similarly $\kappa = 0.2$.[26]

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[25]That is, the stationary steady state eliminates considerations about shocks that would depress the stochastic steady-state vacancies in the convex model.

[26]This is a parsimonious way to obtain sizable fluctuations while leaving the Nash bargain assumption intact. Thanks to the Hagedorn and Manovskii (2008) calibration of household unemployment utility γ close to productivity (0.9), the surplus that the firm obtains is small in the first place. As a result, a small shock to productivity has a large relative impact the total surplus, considering that the worker only has a bargaining share of $\beta = 0.5$.
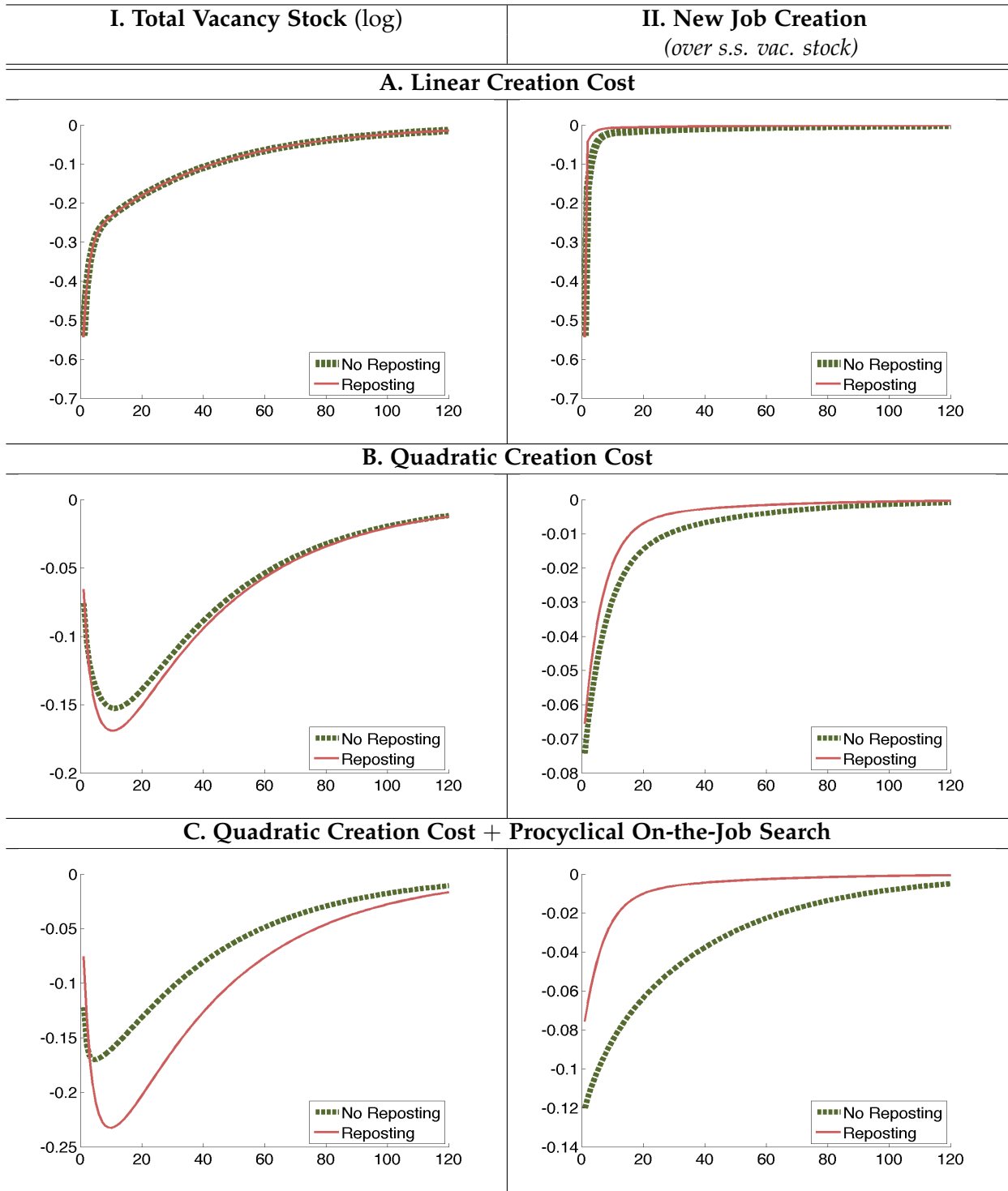
	I. Total Vacancy Stock (log)	**II. New Job Creation** *(over s.s. vac. stock)*

A. Linear Creation Cost

B. Quadratic Creation Cost

C. Quadratic Creation Cost + Procyclical On-the-Job Search

Notes: Simulated (monthly) impulse responses from three variants of the calibrated model: linear, quadratic and quadratic with procyclical on-the-job search. Table 3.3 presents the parameters. The shock is generates roughly a 1 percentage point increase in the unemployment rate ($10 \cdot \sigma_z^{monthly}$). See main text for details.

Figure 3.14: *Impulse Responses to Productivity Shock: Vacancy Posting*
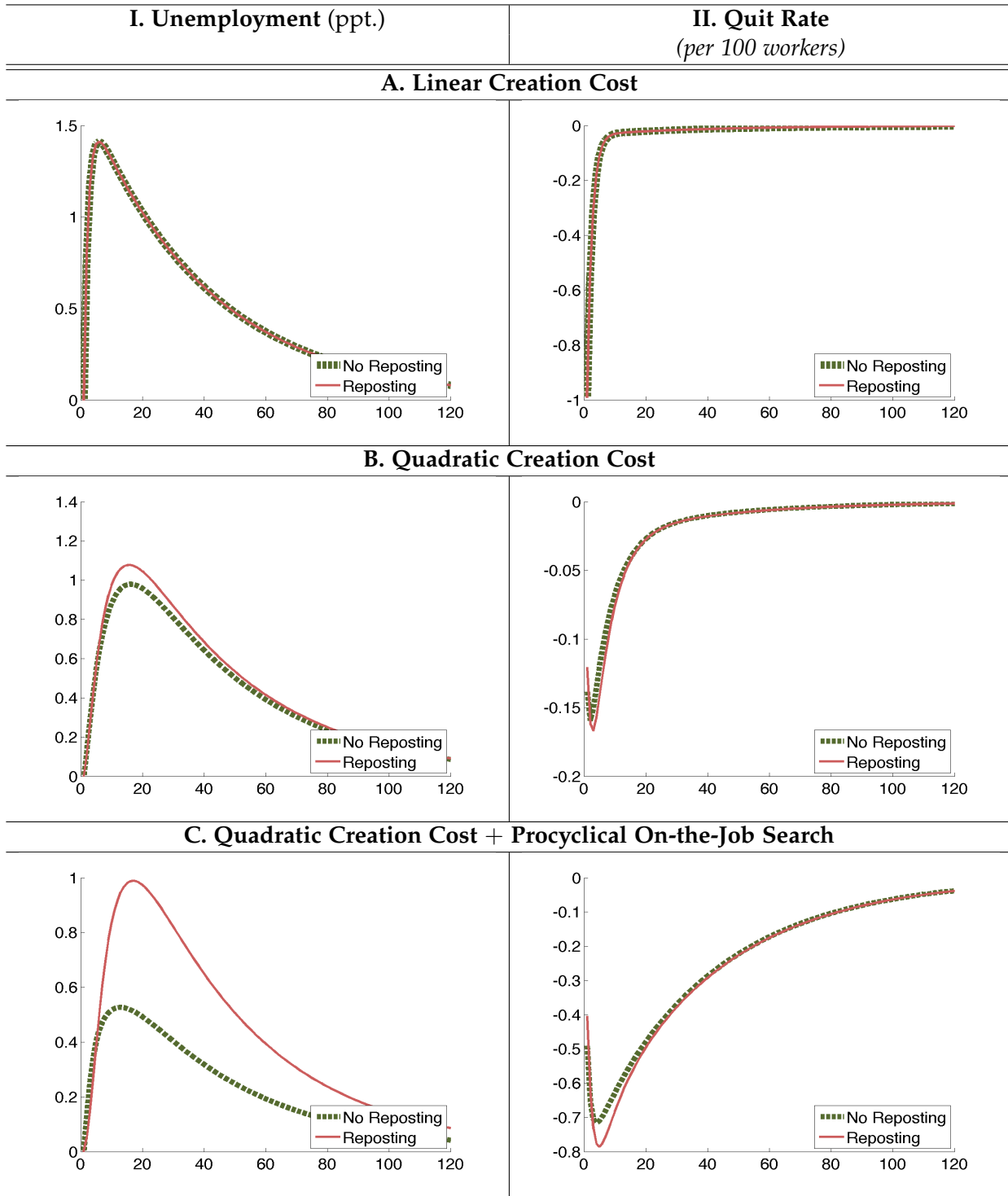
I. Unemployment (ppt.)	II. Quit Rate *(per 100 workers)*

A. Linear Creation Cost

B. Quadratic Creation Cost

C. Quadratic Creation Cost + Procyclical On-the-Job Search

Notes: Simulated (monthly) impulse responses from three variants of the calibrated model: linear, quadratic and quadratic with procyclical on-the-job search. Table 3.3 presents the parameters. The shock is generates roughly a 1 percentage point increase in the unemployment rate ($10 \cdot \sigma_z^{monthly}$). See main text for details.

Figure 3.15: *Impulse Responses to Productivity Shock: Quit & Unemployment*

| | **I. Full Labor Market Tightness** (log) | **II. Naive Labor Market Tightness** (log) |
| | *(vacancies over total searchers)* | *(vacancies over unemployment)* |

A. Linear Creation Cost

B. Quadratic Creation Cost

C. Quadratic Creation Cost + Procyclical On-the-Job Search

Notes: Simulated (monthly) impulse responses from three variants of the calibrated model: linear, quadratic and quadratic with procyclical on-the-job search. Table 3.3 presents the parameters. The shock is generates roughly a 1 percentage point increase in the unemployment rate ($10 \cdot \sigma_z^{monthly}$). See main for details.

Figure 3.16: *Impulse Responses to Productivity Shock: Labor Market Tightness*

| I. Total Job Search (log) | II. On The Job Search (log) |

A. Linear Creation Cost

B. Quadratic Creation Cost

C. Quadratic Creation Cost + Procyclical On-the-Job Search

Notes: Simulated (monthly) impulse responses from three variants of the calibrated model: linear, quadratic and quadratic with procyclical on-the-job search. Table 3.3 presents the parameters. The shock is generates roughly a 1 percentage point increase in the unemployment rate ($10 \cdot \sigma_z^{monthly}$). See main for details.
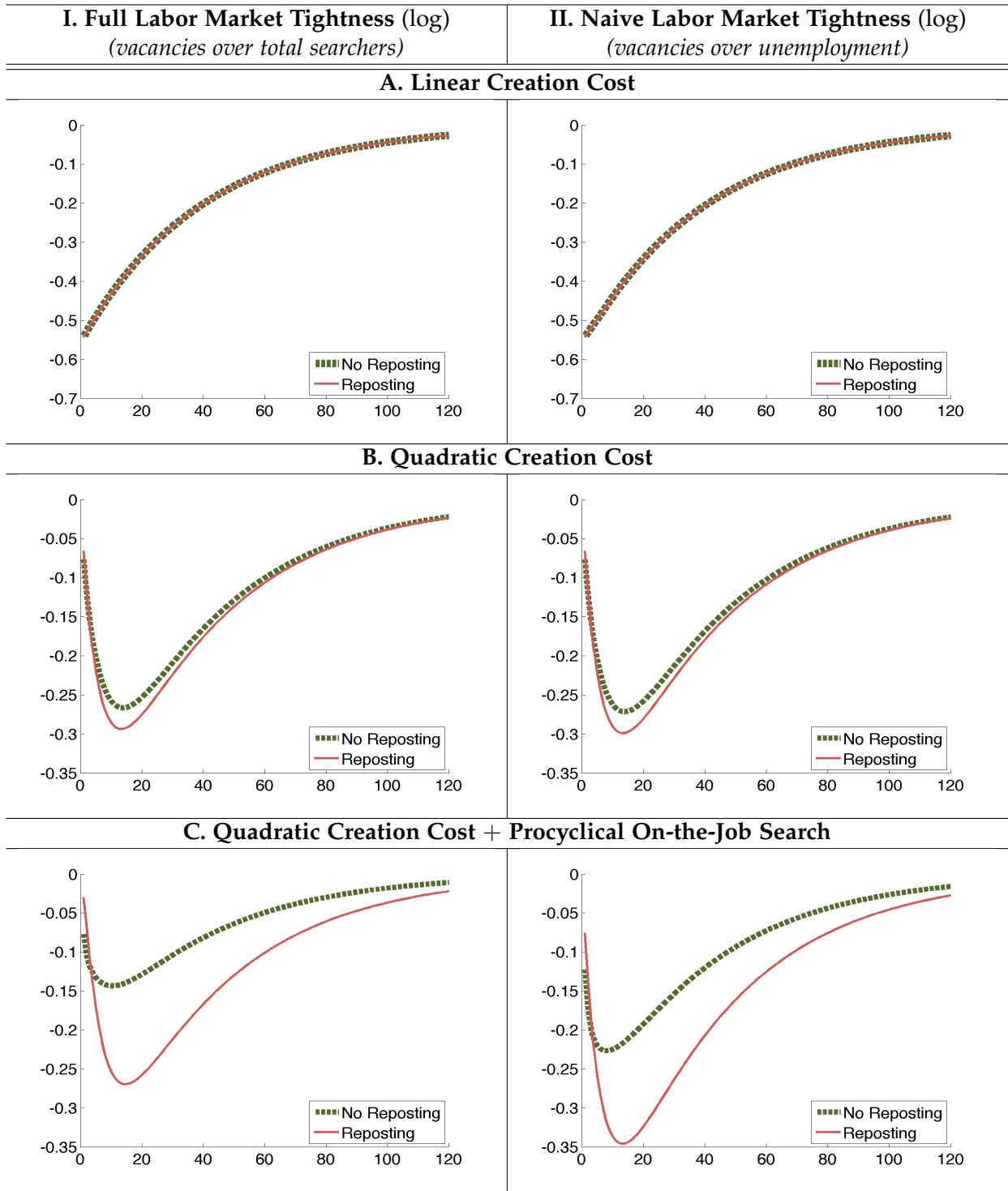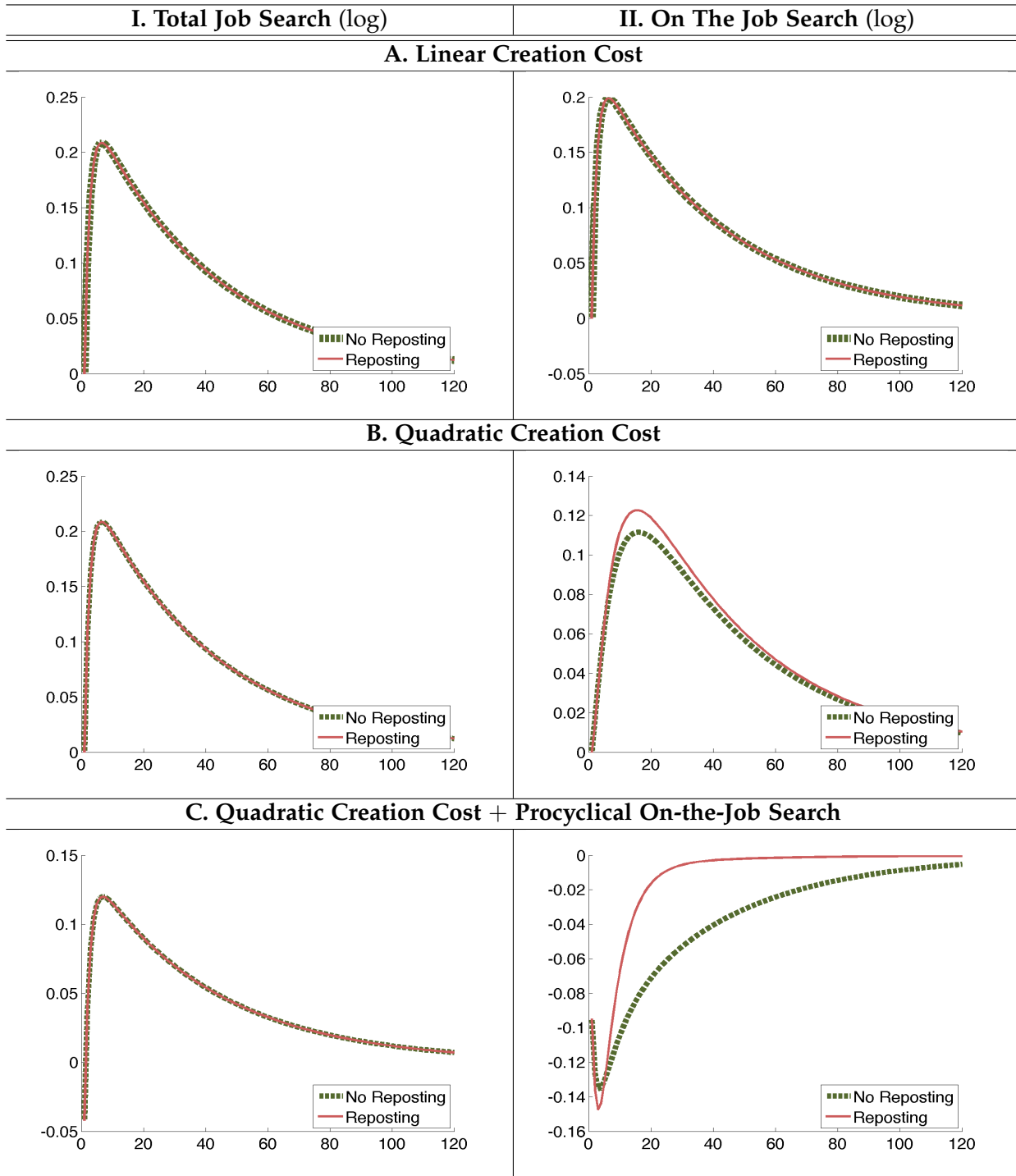
Figure 3.17: *Impulse Responses to Productivity Shock: Job Search*

Results: The Cyclical Behavior of the Simulated Labor Market.

The model is log-linearized around the deterministic steady state. In Figures 3.14–3.17, I report monthly impulse responses (to a sizable ($10 \cdot \sigma_z^{\text{monthly}}$) negative productivity shock that entails a 1 percentage point increase in unemployment) for the following variables: (1) productivity z, (2) the stock of total vacancies v, (3) the inflow of new vacancies n, (4) the quit rate (quits per 100 workers) $100 \cdot f(\theta)o/(1-u)$ and thus the inflow of reposted vacancies, (5) the unemployment pool u, (6) the pool of employed workers searching on the job o.

A **"Difference-in-Difference" Approach.** I compare the two variants (linear vs. quadratic creation costs) in a "difference-in-difference" spirit: First, I set up and calibrate each model *without* reposting.[27] let a quit result in obsoletion rather than in a continuing vacancy. Second, I allow for reposting in each model. The key lesson is how introducing reposting changes the behavior of the labor market "within" each type of creation cost.

Figures 3.14–3.17 present the simulated impulse responses of the calibrated model in response to a sizable negative productivity shock. In each Figure, Panel A (B) presents the linear (quadratic) creation cost model. (Panel C presents the results from a procyclical on-the-job search model that I discuss subsequently.)

Panel A: Compositional Effects with Linear Costs. Consider the impulse responses in Panel A of Figures 3.14–3.17. Total vacancies decreases with the productivity shock. Without reposting, new job creation does the entire job, which drops sharply. The lowering tide of the slackening labor market sinks both boats: the job finding rate of unemployed workers (unemployment inccreases) as well of employed job seekers (quits decrease). Panel A additionally shows the impulse responses for the labor market with reposting of jobs vacated by quits, instead of obsoletion. At first glance, the labor market exhibits perfectly identical patterns. However, the response of total vacancies masks – extremely subtle – compositional differences: the response of new job creation is now muted (in the first period, in which the linear model concentrates the action). The response of total vacancies thus

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[27]I adjust parameters accordingly to maintain similar steady states.

contains repostings. In the background however, reposted vacancies crowd out new job creation one to one – while the equilibrium path of total vacancies remains the same. But in the current specification, this effect remains quantitatively depressed; it becomes noticeable in the subsequent extension to more realistically procyclical quits.

Panel B: Net Effects with Quadratic Creation Costs. Now consider convex adjustment costs in new job creation. By their very nature, convex adjustment costs curb sensitivity to the productivity shock in the first place.[28] Dynamically, convex adjustment costs moreover incentivize firms to smooth the creation of vacancies; the resulting hump-shaped pattern is known to more accurately reflect the empirical impulse response.[29] But convex adjustment costs also curb adjustment of new jobs to *repostings*. First, new vacancies again respond by less when comparing the reposting model with its no-reposting baseline. But in the quadratic model, this crowd-out is now imperfect, and so total vacancies fall by more in the labor market with reposting. As a result, labor market tightness falls, and unemployment increases.

Taking Stock. First, qualitatively, adjustment costs in new job creation thus promote the reposting channel from a purely compositional story to one with net effects on the fluctuations of total vacancies. Yet, whether this additional prediction for net effects is warranted, depends on the degree of such short-run crowd-out in the data. Section 3.4 presents empirical evidence on limited – indeed zero – labor demand spillovers between firms in (local) labor markets. These findings adjudicate in favor of the model with imperfect short-run crowd-out.

Second however, quantitatively the net – and even the gross – effects of reposting remain limited even in the quadratic model. The next Section points to the counterfactually muted quit procyclicality as the constraint, and finds that more realistic cyclical behavior of quits dramatically increases the capacity of the model to yield interesting (net and gross) effects

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[28]I recalibrate the model via the linear cost to pragmatically yield similar overall cyclical behavior as in the linear creation cost set-up. I follow Fujita and Ramey (2007) in targeting the standard deviation of labor market tightness.

[29]Fujita and Ramey (2007) focus on this smoothing effect to match empirical vacancy impulse responses.

from the quit–reposting channel.

Panel C: Extension to Procyclical On-the-Job Search to Overcome the Muted Procyclical-ity of Quits

The Moderate Procyclicality of Quits Attenuates the Quit–Reposting Mechansim. Column II in Figure 3.15 reveals a quantitative shortcoming of the calibrated model: the quit rate of both the linear and the quadratic model appear insufficiently procyclical. In the data, quits (measured as quits per 100 workers) move dramatically over the business cycle: they regularly exceed and fall beneath the trend by 50%. For example, quits in the JLT Survey in Figure 3.2 (for the manufacturing sector), the trend is around 2, whereas fluctuations are +/- 1. For the more recent JOLTS data for 2000 onward and for the entire private sector, Figure 3.3 shows a quit rate of around 3, which fell to 2 during the great recession. By contrast, the unemployment rate and the quit rate in the model covary only very moderately, by less than 0.15 off a baseline quit rate of 3.5 in the model. That is, in a shallow recession with a 1 percentage point increase in unemployment, quits increase from 3.5 to 3.65. This is because in my minimalistic on-the-job search model, the only link between quits and the business cycle is through the job finding rate. Since only a small fraction of employed workers actually searches in the current calibration, changes in the job finding rate have little influence on quits over employment.

Ad-Hoc Solution: Procyclical On-the-Job Search. A solution is to make quits – the inflow of employed workers into on-the-job-search status – more procyclical. This would reconcile a small trend level of quits with sizable cyclical fluctuations therein. I improvise an illustrative solution to this problem in Panel C of the Figures, which plots the impulse responses of an augmented model in which the rate at which employed workers enter on-the-job search (λ) comoves with productivity, rather than being constant.[30] When the unemployment rate now increases by one percentage point in the reposting variant of this

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[30]The reduced-form covariance between λ and productivity (or similarly the value of unemployment) is achieved through the rate of inflow into on-the-job search now being $\lambda^{0.2 \cdot \epsilon_z / \bar{\sigma}_z}$.

augmented model, the quit rate in the model with reposting drops by almost .8 per 100 workers, from a baseline of 3.5 – a much more realistic quit-rate procyclicality. Now, in the no-reposting model, total vacancies decrease with the shock, by almost 25% vs. 17% in the no-reposting variant in Panel C. That is, the effect of reposting is much more pronounced in the quadratic model augmented with realistic procyclicality in quits (i.e. the gap between the reposting and no-reposting variant widens vis-á-vis Panel B). Moreover, when compared to Panel B, the vacancy response is now larger by around 50%.

As a result, labor market tightness drops by much more (25%, or even 35% if considering the naive proxy with only unemployed job seekers[31]). Unemployment therefore increases by much more in the reposting than no-reposting variant. But note that the difference between the reposting variants in Panel B and Panel C are muted. This is because of the reduced congestion externalities from employed job searchers onto their unemployed colleagues.

I conclude that extending the model to a richer version of stronger procyclicality of on-the-job search appears promising, in particular one that divorces the quit propensity from the iron link of proportionality with the job finding rate. Of course, there are other ways to increase the procyclicality of quits beyond proportionality with the job finding rate. For one, a richer model might endogenously render procyclical the probability of a quit given a match, rather than constant (one) in the current set-up.[32]

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[31]The conventional measure is the ratio of job openings per unemployed worker. However, on-the-job search suggests that the correct measure of labor market tightness is the ratio of job openings per job seeker. Total labor supply thus falls by more than the decrease in unemployment suggests. Krause and Lubik (2006) already point out this generic implication of on-the-job search.

[32]Potential ways to endogenize this link is through heterogenous match quality, which in combination with countercyclical risk aversion would lower the reservation match quality of workers to accept counteroffers, because of the layoff risk associated with new jobs early on (see e.g. Hall (2014) for the tenure dependence of separations) or because jobs are experience goods (Jovanovic (1979)). Much more simply, wage rigidity over the course of a match but wage flexibility in new matches would generate such cyclical patterns. Pissarides (2009) reviews evidence for such wage cyclicality structures; for evidence on the relationship between wages and quit rates, see Dickens and Katz (1987), and for review of evidence see Katz (1986).

Additional Issues

I. Convex Adjustment Costs as a Source of Net Effects of Repostings, Attenuate the Sensitivity to Productivity Shocks. The second quantitative shortcoming concerns the sensitivity of the adjustment-cost model to the driving force. While adjustment costs create the room for a net effect of repostings on total hiring, they come at the built-in cost of muting the original response of the job finding rate – which sets off the increase quits and thus repostings in the first place. It is the response of *new* jobs that first triggers quits and repostings by increasing job finding rates for employed searchers.[33]

   II. The Constant and Unitary Probability of Reposting Jobs. In the model, *all* vacated jobs are reposted. This is because jobs are homogenous in productivity. A richer model with heterogeneous productivity would feature a match-productivity threshold for job destruction that is countercyclical.[34] Given the procyclicality of vacancy values that both the linear and the quadratic model feature, the threshold to repost a given vacancy will be countercyclical too. This procyclical propensity to repost ("repostings per quit") would add additional volatility from the quit-reposting mechanism.

3.4   Empirical Support from Local Labor Markets For Imperfect Short-Run Labor-Demand Crowd-Out.

The model showed that the replacement channel can have net, rather than merely compositional, impacts on total job openings, and their cyclical behavior, to the degree crowd-out in the short run is limited. I now present empirical evidence on limited – indeed zero – labor demand spillovers between firms in local labor markets. These findings adjudicate in favor of the model with net effects of the reposting channel. (Of course, alternative mechanisms

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[33]Remember that the entire chain of the quit–reposting mechanism works as follows in the model: replacement hiring occurs in response to quits. Quits occur because on-the-job searchers find a job. (On-the-job search emerges from employed workers entering the state at a constant rate.) Fluctuations in quits (and thus repostings) therefore track the fluctuations in the job finding rate.

[34]In fact, in the data, I found a less than unitary probability of reposting/hiring (.7–.9). But the current discussion concerns fluctuations in that rate.

besides creation cost convexity could limit the crowd-out, and the following evidence would not distinguish them.)

3.4.1 Review of Empirical Evidence

I. Regional Evolutions (Blanchard and Katz (1992)). In a seminal paper on the adjustment of local labor markets to local labor demand shocks, Blanchard and Katz (1992) establish that shocks to total labor demand lead to a limited short-run incidence on the wage but rather result in (un-)employment responses. While the analyses in that paper concerns the entire local labor market, two results speak to the paper at hand: first, adjustment is slow. Second, in response to negative shocks, it is not that jobs move in, even in the long run – instead, labor moves out, and slowly so, to achieve spatial equilibrium.

II. Cross-Industry Spillovers Within Tradable Employment in Local Labor Markets (Carrington (1996), Black *et al.* (2005), Moretti (2010), de Blasio and Menon (2011), Moretti and Thulin (2013)). The literature on local employment multipliers tends to document (long-run) crowd-*in* of non-tradable employment following tradable employment growth. As robustness checks, Moretti (2010) for the United States, de Blasio and Menon (2011) for Italy (2011), and Moretti and Thulin (2013) for Sweden, additionally estimate such spillovers between different tradable industries. They find no economically significant effects. For the short-run, Carrington (1996) finds zero effects of construction of the Trans-Alaskan Pipeline System on employment in tradables. For local coal mining shocks, Black *et al.* (2005) find no effects onto other tradable employment.

III. Nontradable Labor Demand Shocks and Tradable Employment (Mian and Sufi (2014)). Mian and Sufi (2014) investigate the county-level response of non-tradable employment to consumer demand shocks, which they construct from exposure to (instrumented) housing net worth declines during the Great Recession. In stark contrast to the sizable non-tradable results, their robustness checks (Table 7 and Figure 4) document a zero effect on local employment in tradables. I re-interpret their design as follows: the local consumer demand shock serves as an instrument for non-tradable employment, predicting tradable

employment. To the degree that the two sectors' labor markets overlap, my linear benchmark model would predict a positive effect of tradable employment. But the zero effect speaks against crowd-out.

IV. Tradable Labor Demand Shocks and Nontradable Employment (Stumpner (2013)). Stumpner (2013) examines the geographic spread of local consumer demand shocks through inter-country trade, using the Mian and Sufi (2014) set-up for the Great Recession. His main dependent variable is tradable employment (in the faraway counties) expected to be exposed through trade. But in a robustness check (Table 13), he estimates a zero effect on nontradable employment in counties where local tradable employment responds to faraway consumer demand shocks through trade exposure. For the purposes of my paper, this finding indicates that a shock to one sector (tradables, for which I re-interpet Stumpner (2013) to instrument with the trade-exposure instrument) does not appear to entail spillovers to others in the same local labor market (non-tradables). By reversing the spillover analysis of Mian and Sufi (2014), this strategy increases the external validity of both designs for my purpose. Yet, the crucial assumption remains the sufficient labor market overlap between tradabels and nontradables.

V. Between-Firm Spillovers from Firm-Specific (Financial) Shocks (Giroud and Mueller (2015)). Giroud and Mueller (2015), using firm-level data, show that local consumer demand shocks (from the household net worth decline in the Great Recession, see Mian and Sufi (2014)) are associated with strong employment drops in high-leverage firms but none among low-leverage firms. Two specifications let me conclude against sizable labor demand spillovers. First, their control group (low-leverage firms, less prone to the balance-sheet mechanism) does not increase employment in response to the employment decline among high-leverage firms in the same local labor market (Table 2).[35] Moreover, since the authors include fine year–industry–ZIP-code fixed effects in some specifications, the definition of a labor market is much finer than in the previous designs, which relied on the stronger

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[35]Since employment in high-leverage firms moves with local demand shocks, the missing gradient for low-leverage firms precludes negative spillovers.

assumption that tradables and non-tradables overlap in their labor markets.[36]

VI. County-Level Employment Effects of Firm-Specific (Financial) Shocks (Giroud and Mueller (2015), Greenstone and Mas (2012), Benmelech *et al.* (2012b). Second, among the robustness checks (Table 11, Columns 2–4), Giroud and Mueller (2015) provide a specification that splits up counties into above/below-median employment in high-leverage firms. *Total* employment in counties with above-median share of employment in high-leverage firms declines by more, which additionally speaks against a perfect crowd-out.[37] That county-level analysis mirrors previous research on the district-level employment effects of financial shocks. For example, Greenstone and Mas (2012) investigate the county-level employment effects of local lending shocks, which similarly presumably only affect a subset of firms (bank-dependent employers). Benmelech *et al.* (2012b) include a similar analysis as one of their designs (Table 8, with MSA-level variation in exposure to Japanese-affiliated banks during the banking crisis). In a sense, the county-level aggregates are ultimately versions of the Blanchard and Katz (1992) facts.

VII. Local Employment Effects of Plant Closures (Gathmann *et al.* (2014); Berge *et al.* (2015)). Gathmann *et al.* (2014) investigate local labor market effects of (plant-level) mass layoffs, with a focus on testing agglomeration and other spillover mechanisms. In a robustness check (Table 5a, Column 4), they restrict the sample to tradable industries, removing local consumer demand considerations. If anything, they find the opposite spillover: a mass layoff on employment in tradable industries reduces local tradable employment. Moreover, that design also finds positive spillovers *within industries in the same labor market*. The absence of negative spillovers (i.e. crowd-out) even at this micro-empirical event-study design in the same district and within the same industry (and using administrative worker micro-data) adds to the previous studies in defining the labor market most finely. And yet, they find

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[36]However, this zero effect might be because the (negative) product-demand effect and the (potentially positive) labor-demand spillovers cancel out, so the finding does not rule out positive effects (unless the authors were to restrict the regression to tradables).

[37]This test (deviation from perfect crowd-out) is weaker than the previous tests (zero spillovers). A continuous specification of exposure to high-leverage firms might help quantify the spillover.

no positive spillovers in the short run. Berge *et al.* (2015) use similar data and plant closure events, and find zero short-run spillovers in local labor markets. I conclude that if anything, these event studies suggest the opposite sign of the spillovers than predicted by the perfect crowd-out benchmark of the linear model.

3.4.2   Remaining Concerns

I propose that the previous empirical findings present a preponderance of the evidence towards very limited – if not zero – short-run labor demand spillovers. Still, I discuss five remaining potential challenges to external validity, that is, to adjudicating the appropriate degree of crowd-out in the model based on the local labor market evidence.

I. Countervailing Agglomeration Responses. The previous findings might mask negative labor demand spillovers because of countervailing responses in e.g. agglomeration forces, which might be negative.[38] To the degree that those forces are localized, they would not be part of the treatment effect in the aggregate labor market, to which I aim to extrapolate. Similarly, sorting mechanisms such as in Gaubert (2014) might lead to such overestimates.

II. Spatial Equilibria. The macroeconomic laboratory of local labor markets might be biased towards less negative spillovers because of spatial equilibria. For one, investigating total county-level employment might confound firms' intensive labor demand responses with the extensive margin of substituting to employment in other locations. However, Gathmann *et al.* (2014); Berge *et al.* (2015), Giroud and Mueller (2015) mainly consider establishment-level intensive employment responses; Giroud and Mueller (2015) additionally decompose the employment responses, and find effects for both margins.[39]

III. Local Constraints on Wage/Price Adjustment. Local wage or price adjustment to local shocks might be constrained relative to a market-wide, aggregate shock. The latter is the

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[38]Indeed, agglomeration stories are part of the explanations in Gathmann *et al.* (2014); similarly for the crowd-in of nontradable employment in the 10-year Census perspective in Moretti (2010).

[39]Moreover, for their particular shock, Giroud and Mueller (2015) in fact find the opposite effect within firms: firms' establishments in other locations respond in the same rather than opposite direction, which however might be specific to the financial mechanism they explore.

relevant scale for business cycles. Local estimates would thus overestimate the nontradable employment responses to consumer demand shocks, but they underestimate the potential negative spillovers onto employment in untreated tradables. I view this as a valid, important and hard-to-resolve concern to my inference, as well as to that empirical literature in general.

IV. Non-Linear Effects and Small Shocks. Second, the true underlying relationship might be non-linear, and the shocks I review might be too small to reveal detectable spillovers.[40] That is, the crowd-out might still occur at business-cycle-sized employment fluctuations. Fortunately, the local shocks are not small: I intentionally include in my review designs that, first, appear to explain much of aggregate employment declines during recessions or arise from aggregate shocks.

V. Mismeasurement of Labor Market Overlaps. Third, the spillovers might be estimated off labor demand agents with insufficient labor market overlaps. Properly defined and measured labor markets might yield negative spillovers. The ideal refinement would sort firms by shared labor markets. In the between-industry dimension for example, a measure of labor-market proximity might be obtained a priori, e.g. by occupational similarities, or with revealed choices, e.g. by estimating worker transition matrices between industries (an "industrial commuting zone"). Cruder ways would be to include year–industry–location fixed effects in an within-industry analysis, with firm-level data. But some of the designs do approximate this experiment: Giroud and Mueller (2015) show robustness to ZIP code–industry–year fixed effects in some specifications, thus comparing treated and untreated firms in the same local industry. Gathmann *et al.* (2014) in fact find that within-industry spillovers are positive (rather than negative); competitors in the local labor market thus react the opposite way than expected by the full-crowd out benchmark.

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[40]In principle the geographic variation would permit estimating non-linearities in treatment intensity.

3.4.3 Further Macro-Labor Implications of the Limited Local Labor Demand Spillovers

The perfect crowd-out of vacancy posting predicted by the DMP model has the implication that in a local labor market, an increase in labor demand by one firm depresses the labor demand of another firm. Collecting and reviewing a variety of a local labor market findings that I argue indirectly speak to this comparative static, I find little evidence for this prediction in the short run. While I draw this implication for my particular case of crowd-out of new jobs from reposted jobs, my empirical argument might help adjudicate the appropriate cyclical feedback of labor market tightness onto labor demand in the broader macro-labor debate. For example, Hall and Milgrom (2008) and Hall (2014) criticize the tight theoretical link of the wage with labor market tightness, and discuss bargaining protocols that are "tightness-insulated".The evidence I synthesize, review and evaluate in light of one particular macro-labor mechanism might also provide evidence for such tightness-insulated wage bargaining protocols.

3.5 Conclusion

This paper told a story of recessions as times when few jobs open up because workers with jobs stay put. Total measured job openings decline not only because new job creation declines, but also because reposting of old jobs dries up. By contrast, in upswings, tighter labor markets pull employed workers out of their matches, leaving reposted vacancies behind. Through this quit–reposting mechanism, the dramatic decline of quits might be a proximate contributor to the fall of total measured job openings in recessions.

The data support the quit–reposting mechanism. Highly procyclical, quits comove almost one to one with job openings and hires at business-cycle frequencies, in the aggregate and in local labor markets. With unique vacancy-level data, I establish the – commonsensical – notion that half of all job openings are actually driven by quits, rather than due to creation of new jobs. At the establishment level, I find that one quit triggers 0.7–0.8 replacement hires.

The procyclicality of quits should therefore render vacancy repostings very procyclical.

However, when I integrate reposting incentives and procyclical quits into the leading macro-labor models, a hard-wired feature turns out to precludes cyclical net effects from repostings: new job creation perfectly offsets fluctuations in reposted jobs. But I point to empirical evidence from local labor markets that such short-run crowd-out appears very limited in reality. I thus augmented my model with convex adjustment costs in new job creation, which attenuates the crowd-out of new jobs from repostings.

In this preferred model that is supported by the data, the quit–rehiring mechanism entails interesting – and potentially quantitatively important – amplification of the cyclical fluctuations in total job openings, a central macroeconomic variable.

References

AARONSON, D., RISSMAN, E. R. and SULLIVAN, D. G. (2004). Assessing the jobless recovery. *Economic Perspectives-Federal Reserve Bank of Chicago*, **28**, 2–20.

ABOWD, J. A. and LEMIEUX, T. (1993). The Effects of Product Market Competition on Collective Bargaining Agreements: The Case of Foreign Competition in Canada. *The Quarterly Journal of Economics*, **108** (4), 983–1014.

ABOWD, J. M. (1989). The effect of wage bargains on the stock market value of the firm. *The American Economic Review*, pp. 774–800.

ABRAHAM, K. G. and FARBER, H. S. (1987). Job duration, seniority, and earnings.

AKERLOF, G. A. and KATZ, L. F. (1986). Do Deferred Wages Dominate Involuntary Unemployment as a Worker Discipline Device? *NBER Working Paper*, (w2025).

—, ROSE, A. K., YELLEN, J. L., BALL, L. and HALL, R. E. (1988). Job switching and job satisfaction in the US labor market. *Brookings Papers on Economic Activity*, pp. 495–594.

ALANIS, E. and CHAVA, S. (2012). Shareholder bargaining power and debt overhang. *Working Paper*.

ALMEIDA, H., CAMPELLO, M., CUNHA, I. and WEISBACH, M. S. (2013). Corporate liquidity management: A conceptual framework and survey. *Working paper*.

—, —, LARANJEIRA, B. and WEISBENNER, S. (2012). Corporate Debt Maturity and the Real Effects of the 2007 Credit Crisis. *Critical Finance Review*, **1** (1), 3–58.

ALTONJI, J. G. and SHAKOTKO, R. A. (1987). Do wages rise with job seniority? *The Review of Economic Studies*, **54** (3), 437–459.

AMERICAN BENEFITS COUNCIL (2009). Jobs in Peril: Assessing the Impact of Increases in Defined Benefit Plan Funding Obligations on Employment During an Economic Recession. *Optimal Benefit Strategies, LLC*.

BABENKO, I., LEMMON, M. and TSERLUKEVICH, Y. (2011). Employee stock options and investment. *The Journal of Finance*, **66** (3), 981–1009.

BACHMANN, R., BAYER, C., SETH, S. and WELLSCHMIED, F. (2013). Cyclicality of job and worker flows: New data and a new set of stylized facts.

BAKKE, T.-E. and WHITED, T. M. (2012). Threshold events and identification: A study of cash shortfalls. *The Journal of Finance*, **67** (3), 1083–1111.

BARLEVY, G. (2002). The sullying effect of recessions. *The Review of Economic Studies*, **69** (1), 65–96.

BARNICHON, R. (2010). Building a composite help-wanted index. *Economics Letters*, **109** (3), 175–178.

BARRO, R. J. (1977). Long-term contracting, sticky prices, and monetary policy. *Journal of Monetary Economics*, **3** (3), 305–316.

BENMELECH, E., BERGMAN, N. K. and ENRIQUEZ, R. J. (2012a). Negotiating with labor under financial distress. *Review of Corporate Finance Studies*.

—, — and SERU, A. (2012b). Financing labor. *Working paper*.

BERGE, P. v., SCHMILLEN, A. *et al.* (2015). *Direct and indirect effects of mass layoffs: evidence from geo-referenced data*. Tech. rep., Institut für Arbeitsmarkt-und Berufsforschung (IAB), Nürnberg [Institute for Employment Research, Nuremberg, Germany].

BERK, J. B. and WALDEN, J. (2013). Limited capital market participation and human capital risk. *Review of Asset Pricing Studies*, **3** (1), 1–37.

BERNANKE, B. and GERTLER, M. (1989). Agency costs, net worth, and business fluctuations. *The American Economic Review*, pp. 14–31.

BERTOLA, G. (1990). Job security, employment and wages. *European Economic Review*, **34** (4), 851–879.

BERTRAND, M. (2004). From the invisible handshake to the invisible hand? How import competition changes the employment relationship. *Journal of Labor Economics*, **22** (4), 723–765.

— and MULLAINATHAN, S. (2005). Profitable investments or dissipated cash? Evidence on the investment-cash flow relationship from oil and gas lease bidding. *Working paper*.

BEWLEY, T. F. (1999). *Why wages don't fall during a recession*. Harvard University Press.

BILS, M., CHANG, Y. and KIM, S.-B. (2014). How sticky wages in existing jobs can affect hiring. *Working paper*.

BLACK, D., MCKINNISH, T. and SANDERS, S. (2005). The economic impact of the coal boom and bust. *The Economic Journal*, **115** (503), 449–476.

BLANCHARD, O. and WOLFERS, J. (2000). The role of shocks and institutions in the rise of European unemployment: the aggregate evidence. *The Economic Journal*, **110** (462), 1–33.

BLANCHARD, O. J. and KATZ, L. F. (1992). Regional evolutions. *Brookings papers on economic activity*, pp. 1–75.

—, Lopez-de Silanes, F. and Shleifer, A. (1994). What do firms do with cash windfalls? *Journal of Financial Economics*, **36** (3), 337–360.

— and Summers, L. H. (1986). Hysteresis and the European unemployment problem. In *NBER Macroeconomics Annual 1986, Volume 1*, MIT Press, pp. 15–90.

Bloom, N., Floetotto, M., Jaimovich, N., Saporta-Eksten, I. and Terry, S. J. (2012). Really uncertain business cycles. *Working paper*.

Budd, J. W., Konings, J. and Slaughter, M. J. (2005). Wages and international rent sharing in multinational firms. *Review of Economics and Statistics*, **87** (1), 73–84.

Cahuc, P., Carcillo, S. and Le Barbanchon, T. (2014). Do Hiring Credits Work in Recessions? Evidence from France.

Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics*, **12** (3), 383–398.

Campello, M., Giambona, E., Graham, J. R. and Harvey, C. R. (2011). Liquidity management and corporate investment during a financial crisis. *Review of Financial Studies*, **24** (6), 1944–1979.

—, Graham, J. R. and Harvey, C. R. (2010). The real effects of financial constraints: Evidence from a financial crisis. *Journal of Financial Economics*, **97** (3), 470–487.

Card, D. (1990). Unexpected inflation, real wages, and employment determination in union contracts. *American Economic Review*, **80** (4), 669–88.

—, Cardoso, A. R. and Kline, P. (2013). Bargaining and the gender wage gap: A direct assessment. *Working paper*.

— and Hyslop, D. (1997). Does inflation âĂIJgrease the wheels of the labor marketâĂİ? In *Reducing inflation: Motivation and strategy*, University of Chicago Press, pp. 71–122.

Carneiro, A., Guimarï£¡es, P. and Portugal, P. (2012). Real wages and the business cycle: Accounting for worker, firm, and job title heterogeneity. *American Economic Journal: Macroeconomics*, **4** (2), 133–52.

Carrington, W. J. (1996). The alaskan labor market during the pipeline era. *Journal of Political Economy*, pp. 186–218.

Chaney, T., Sraer, D. and Thesmar, D. (2012). The collateral channel: How real estate shocks affect corporate investment. *The American Economic Review*, **102** (6), 2381–2409.

Chava, S. and Jarrow, R. A. (2004). Bankruptcy prediction with industry effects. *Review of Finance*, **8** (4), 537–569.

—, Stefanescu, C. and Turnbull, S. (2011). Modeling the loss distribution. *Management Science*, **57** (7), 1267–1287.

Chetty, R. (2008). Moral hazard versus liquidity and optimal unemployment insurance. *Journal of Political Economy*, **116** (2), 173–234.

—, Guren, A., Manoli, D. and Weber, A. (). Does Indivisible Labor Explain the Difference between Micro and Macro Elasticities? A Meta-Analysis of Extensive Margin Elasticities. In *NBER Macroeconomics Annual 2012, Volume 27*.

Chodorow-Reich, G. (2014). The employment effects of credit market disruptions: Firm-level evidence from the 2008–9 financial crisis. *The Quarterly Journal of Economics*, **129** (1), 1–59.

— and Karabarbounis, L. (2013). The cyclicality of the opportunity cost of employment. *Working paper*.

Christiano, L. J., Eichenbaum, M. and Evans, C. L. (2005). Nominal rigidities and the dynamic effects of a shock to monetary policy. *Journal of Political Economy*, **113** (1), 1–45.

—, — and Trabandt, M. (2013). Unemployment and business cycles. *NBER Working Paper*, (w19265).

Christofides, L. N. and Oswald, A. J. (1992). Real wage determination and rent-sharing in collective bargaining agreements. *The Quarterly Journal of Economics*, pp. 985–1002.

Coibion, O., Gorodnichenko, Y. and Koustas, D. (2013). Amerisclerosis? The puzzle of rising US unemployment persistence. *Brookings Papers on Economic Activity*, (2), 1–82.

Correia, I., Farhi, E., Nicolini, J. P. and Teles, P. (2013). Unconventional fiscal policy at the zero bound. *The American Economic Review*, **103** (4), 1172–1211.

Danthine, J.-P. and Donaldson, J. B. (2002). Labour relations and asset returns. *Review of Economic Studies*, **69** (1), 41–64.

Davis, S. J. (2008). The decline of job loss and why it matters. *The American Economic Review*, pp. 263–267.

—, Faberman, R. J. and Haltiwanger, J. (2006). The flow approach to labor markets: New data sources and micro-macro links. *The Journal of Economic Perspectives*, pp. 3–26.

—, — and Haltiwanger, J. C. (2013). The Establishment-Level Behavior of Vacancies and Hiring. *Quarterly Journal of Economics*, **128** (2).

— and Haltiwanger, J. (2014). Labor market fluidity and economic performance. In *Federal Reserve Bank of Kansas City Jackson Hole Conference in August*.

de Blasio, G. and Menon, C. (2011). Local effects of manufacturing employment growth in italy. *Giornale degli Economisti e Annali di Economia*, pp. 101–112.

Dickens, W. and Katz, L. F. (1987). Inter-industry wage differences and theories of wage determination. *NBER Working Paper*.

Dittmar, A. and Mahrt-Smith, J. (2007). Corporate governance and the value of cash holdings. *Journal of Financial Economics*, **83** (3), 599–634.

Donangelo, A. (2014). Labor mobility: Implications for asset pricing. *The Journal of Finance*, **69** (3), 1321–1346.

DORAN, K., GELBER, A. and ISEN, A. (2015). The effects of high-skilled immigration on firms: Evidence from h-1b visa lotteries. *working paper*.

DRACA, M., MACHIN, S. and REENEN, J. V. (2011). Minimum Wages and Firm Profitability. *American Economic Journal: Applied Economics*, **3** (1), 129–51.

DUCHIN, R., OZBAS, O. and SENSOY, B. A. (2010). Costly external finance, corporate investment, and the subprime mortgage credit crisis. *Journal of Financial Economics*, **97** (3), 418–435.

DUSTMANN, C. and MEGHIR, C. (2005). Wages, experience and seniority. *The Review of Economic Studies*, **72** (1), 77–108.

EGEBARK, J. and KAUNITZ, N. (2014). Do payroll tax cuts raise youth employment? *Working paper*.

ELIAZ, K. and SPIEGLER, R. (2013). Reference-dependence and labor-market fluctuations. *Working paper*.

ELSBY, M. W. (2009). Evaluating the economic significance of downward nominal wage rigidity. *Journal of Monetary Economics*, **56** (2), 154–169.

—, HOBIJN, B. and ŞAHIN, A. (2013). The decline of the US labor share. *Brookings Papers on Economic Activity*, **2013** (2), 1–63.

ERCEG, C. J., HENDERSON, D. W. and LEVIN, A. T. (2000). Optimal monetary policy with staggered wage and price contracts. *Journal of Monetary Economics*, **46** (2), 281–313.

FABERMAN, J. and NAGYPÁL, E. (2008). Quits, worker recruitment, and firm growth: theory and evidence. *working paper*.

FARHI, E., GOPINATH, G. and ITSKHOKI, O. (2013). Fiscal devaluations. *Working paper*.

FARRE-MENSA, J. and LJUNGQVIST, A. (2013). Do measures of financial constraints measure financial constraints? *working paper*.

FAVILUKIS, J. and LIN, X. (2012). Wage rigidity: A solution to several asset pricing puzzles. *Working paper*.

FAZZARI, S. M., HUBBARD, R. G., PETERSEN, B. C., BLINDER, A. S. and POTERBA, J. M. (1988). Financing constraints and corporate investment. *Brookings Papers on Economic Activity*, **1988** (1), 141–206.

FISHER, I. (1933). The debt-deflation theory of great depressions. *Econometrica*, pp. 337–357.

FROOT, K. A., SCHARFSTEIN, D. S. and STEIN, J. C. (1993). Risk management: Coordinating corporate investment and financing policies. *The Journal of Finance*, **48** (5), 1629–1658.

FUJITA, S. (2012). Declining labor turnover and turbulence. *Working paper*.

— and RAMEY, G. (2007). Job matching and propagation. *Journal of Economic Dynamics and Control*, **31** (11), 3671–3698.

GALÍ, J. (2009). *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework*. Princeton University Press.

GALUSCAK, K., KEENEY, M., NICOLITSAS, D., SMETS, F., STRZELECKI, P. and VODOPIVEC, M. (2012). The determination of wages of newly hired employees: Survey evidence on internal versus external factors. *Labour Economics*, **19** (5), 802–812.

GATHMANN, C., HELM, I. and SCHÖNBERG, U. (2014). Spillover effects in local labor markets: Evidence from mass layoffs. *working paper*.

GAUBERT, C. (2014). Firm sorting and agglomeration. *Unpublished manuscript, Princeton University*.

GERTLER, M. and TRIGARI, A. (2009). Unemployment Fluctuations with Staggered Nash Wage Bargaining. *Journal of Political Economy*, **117** (1), 38–86.

GIROUD, X. and MUELLER, H. M. (2015). *Firm Leverage and Unemployment during the Great Recession*. Tech. rep., National Bureau of Economic Research.

GREENSTONE, M. and MAS, A. (2012). Do Credit Market Shocks Affect the Real Economy? Quasi-Experimental Evidence from the Great Recession and Normal Economic Times. *Working paper*.

GRUBER, J. (1997). The consumption smoothing benefits of unemployment insurance. *American Economic Review*, **87** (1), 192–205.

GUISO, L., PISTAFERRI, L. and SCHIVARDI, F. (2013). Credit within the firm. *Review of Economic Studies*, **80** (1), 211–247.

GUSTMAN, A. L., MITCHELL, O. S. and STEINMEIER, T. L. (1994). The role of pensions in the labor market: A survey of the literature. *Industrial and Labor Relations Review*, pp. 417–438.

HAEFKE, C., SONNTAG, M. and VAN RENS, T. (2013). Wage rigidity and job creation. *Journal of Monetary Economics*, **60** (8), 887–899.

HAGEDORN, M. and MANOVSKII, I. (2008). The cyclical behavior of equilibrium unemployment and vacancies revisited. *American Economic Review*, **98** (4), 1692–1706.

HALL, R. E. (2005a). Employment efficiency and sticky wages: Evidence from flows in the labor market. *Review of Economics and Statistics*, **87** (3), 397–407.

— (2005b). Employment fluctuations with equilibrium wage stickiness. *American Economic Review*, pp. 50–65.

— (2014). High discounts and high unemployment. *NBER Working Paper*, (w19871).

— and LAZEAR, E. P. (1984). The excess sensitivity of layoffs and quits to demand.

— and MILGROM, P. R. (2008). The Limited Influence of Unemployment on the Wage Bargain. *The American Economic Review*, pp. 1653–1674.

Haltiwanger, J., Hyatt, H. and McEntarfer, E. (2014). Cyclical Reallocation of Workers Across Employers by Firm Size and Firm Wage. *Working paper*.

Hamermesh, D. S. (1996). *Labor demand*. Princeton University Press.

Hansen, G. D. (1985). Indivisible labor and the business cycle. *Journal of Monetary Economics*, **16** (3), 309–327.

Harford, J., Klasa, S. and Maxwell, W. F. (2014). Refinancing risk and cash holdings. *The Journal of Finance*, **69** (3), 975–1012.

Hosios, A. J. (1990). On the efficiency of matching and related models of search and unemployment. *The Review of Economic Studies*, **57** (2), 279–298.

Isen, A. (2013). Dying to know: Are workers paid their marginal product? *working paper*.

Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *The American Economic Review*, pp. 323–329.

— and Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, **3** (4), 305–360.

Jermann, U. and Quadrini, V. (2012). Macroeconomic effects of financial shocks. *American Economic Review*, **102** (1), 238–71.

—, Schmid, L. and Gomes, J. (2014). Sticky leverage. In *2014 Meeting Papers*, 40, Society for Economic Dynamics.

Jovanovic, B. (1979). Job matching and the theory of turnover. *The Journal of Political Economy*, pp. 972–990.

Kahn, L. B. and McEntarfer, E. (2013). Worker flows over the business cycle: the role of firm quality. *working paper*.

— and — (2014). Employment Cyclicality and Firm Quality.

Kaplan, S. N. and Zingales, L. (1997). Do investment-cash flow sensitivities provide useful measures of financing constraints? *The Quarterly Journal of Economics*, pp. 169–215.

Karabarbounis, L. and Neiman, B. (2013). *The global decline of the labor share*. Tech. rep., National Bureau of Economic Research.

Katz, L. F. (1986). Efficiency wage theories: A partial evaluation. In *NBER Macroeconomics Annual 1986, Volume 1*, MIT Press, pp. 235–290.

— (1996). Wage subsidies for the disadvantaged. *NBER Working Paper*.

— and Summers (1989). Industry rents: Evidence and implications. *Brookings Papers on Economic Activity. Microeconomics*, **1989**, 209–290.

Kehoe, P., Midrigan, V. and Pastorino, E. (2014). Debt Constraints and Employment. *Working paper*.

Kennan, J. (2010). Private information, wage bargaining and employment fluctuations. *The Review of Economic Studies*, **77** (2), 633–664.

Kiyotaki, N. and Moore, J. (1997). Credit cycles. *Journal of Political Economy*, **105** (2), 211–48.

Krause, M. U. and Lubik, T. A. (2006). The cyclical upgrading of labor and on-the-job search. *Labour Economics*, **13** (4), 459–477.

Kruse, D. L. (1991). Profit-sharing and employment variability: Microeconomic evidence on the Weitzman theory. *Industrial and Labor Relations Review*, pp. 437–453.

Kudlyak, M. (2014). The cyclicality of the user cost of labor. *Journal of Monetary Economics*.

Lamont, O. (1997). Cash flow and investment: Evidence from internal capital markets. *The Journal of Finance*, **52** (1), 83–109.

Lazear, E. P. (1981). Agency, earnings profiles, productivity, and hours restrictions. *The American Economic Review*, pp. 606–620.

— (1990). Job security provisions and employment. *The Quarterly Journal of Economics*, pp. 699–726.

— and Moore, R. L. (1984). Incentives, productivity, and labor contracts. *The Quarterly Journal of Economics*, pp. 275–296.

— and — (1988). Pensions and turnover. In *Pensions in the US Economy*, University of Chicago Press, pp. 163–190.

—, Shaw, K. L. and Stanton, C. (2013). Making do with less: Working harder during recessions.

— and Spletzer, J. R. (2012). Hiring, churn, and the business cycle. *The American Economic Review*, **102** (3), 575–579.

Lemieux, T., MacLeod, W. B. and Parent, D. (2012). Contract form, wage flexibility, and employment. *The American Economic Review*, **102** (3), 526–531.

Lindbeck, A. and Snower, D. J. (1989). The insider-outsider theory of employment and unemployment. *MIT Press*, **1**.

Lintner, J. (1956). Distribution of incomes of corporations among dividends, retained earnings, and taxes. *The American Economic Review*, pp. 97–113.

Ljungqvist, L. and Sargent, T. J. (2004). European unemployment and turbulence revisited in a matching model. *Journal of the European Economic Association*, **2** (2-3), 456–468.

— and — (2014). The fundamental surplus in matching models. *working paper*.

Malmendier, U. and Tate, G. (2008). Who makes acquisitions? CEO overconfidence and the market's reaction. *Journal of Financial Economics*, **89** (1), 20–43.

MARTINS, P. S., SOLON, G. and THOMAS, J. P. (2012). Measuring what employers do about entry wages over the business cycle: A new approach. *American Economic Journal: Macroeconomics*, **4** (4), 36–55.

MATSA, D. A. (2010). Capital structure as a strategic variable: Evidence from collective bargaining. *The Journal of Finance*, **65** (3), 1197–1232.

MCLEAN, R. D. and ZHAO, M. (2014). The business cycle, investor sentiment, and costly external finance. *The Journal of Finance*, **69** (3), 1377–1409.

MERZ, M. and YASHIV, E. (2007). Labor and the market value of the firm. *The American Economic Review*, pp. 1419–1431.

MIAN, A. and SUFI, A. (2014). What explains the 2007–2009 drop in employment? *Econometrica*, **82** (6), 2197–2223.

MIAN, A. R. and SUFI, A. (2012). What explains high unemployment? The aggregate demand channel. *NBER Working Paper*.

MICHAILLAT, P. (2012). Do matching frictions explain unemployment? Not in bad times. *The American Economic Review*, **102** (4), 1721–1750.

MICHELACCI, C. and QUADRINI, V. (2005). Borrowing from employees: Wage dynamics with financial constraints. *Journal of the European Economic Association*, **3** (2-3), 360–369.

MONACELLI, T., QUADRINI, V. and TRIGARI, A. (2011). Financial markets and unemployment. *Review of Asset Pricing Studies*.

MORETTI, E. (2010). Local multipliers. *The American Economic Review*, pp. 373–377.

— and THULIN, P. (2013). Local multipliers and human capital in the united states and sweden. *Industrial and Corporate Change*, **22** (1), 339–362.

MORTENSEN, D. T. and NAGYPÁL, E. (2007). More on unemployment and vacancy fluctuations. *Review of Economic Dynamics*, **10** (3), 327–347.

MUELLER, A. I. (2012). Separations, sorting and cyclical unemployment.

MYERS, S. C. and MAJLUF, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, **13** (2), 187–221.

NAGYPÁL, É. (2008). Worker reallocation over the business cycle: The importance of employer-to-employer transitions. *working paper*.

OI, W. Y. (1962). Labor as a quasi-fixed factor. *The Journal of Political Economy*, **70** (6), 538–555.

OPLER, T., PINKOWITZ, L., STULZ, R. and WILLIAMSON, R. (1999). The determinants and implications of corporate cash holdings. *Journal of Financial Economics*, **52** (1), 3–46.

PETRONGOLO, B. and PISSARIDES, C. A. (2001). Looking into the black box: A survey of the matching function. *Journal of Economic Literature*, pp. 390–431.

Petrosky-Nadeau, N. (2009). Credit, vacancies and unemployment fluctuations. *working paper*.

— and Wasmer, E. (2013). The cyclical volatility of labor markets under frictional financial markets. *American Economic Journal: Macroeconomics*, **5** (1), 193–221.

Pissarides, C. A. (1990). *Equilibrium unemployment theory*. MIT press.

— (2009). The unemployment volatility puzzle: Is wage stickiness the answer? *Econometrica*, **77** (5), 1339–1369.

Rajan, R. G. and Zingales, L. (1998). Financial Dependence and Growth. *American Economic Review*, pp. 559–586.

Rampini, A. A. and Viswanathan, S. (2010). Collateral, risk management, and the distribution of debt capacity. *Journal of Finance*, **65** (6), 2293–2322.

Rauh, J. D. (2006). Investment and financing constraints: Evidence from the funding of corporate pension plans. *The Journal of Finance*, **61** (1), 33–71.

Reicher, C. A. M. (2011). *Hiring chains and the dynamic behavior of job and worker flows*. Tech. rep., Kiel Working Papers.

Rogerson, R. (1988). Indivisible labor, lotteries and equilibrium. *Journal of Monetary Economics*, **21** (1), 3–16.

Schmieder, J. F. and von Wachter, T. (2010). Does Wage Persistence Matter for Employment Fluctuations? Evidence from Displaced Workers. *American Economic Journal: Applied Economics*, pp. 1–21.

Schoefer, B. and Seim, D. (2015). Price vs. Liquidity Effects of Payroll Tax Cuts: Evidence from Sweden. *ongoing work*.

Sharpe, S. A. (1994). Financial market imperfections, firm leverage, and the cyclicality of employment. *The American Economic Review*, **84** (4), 1060–1074.

Shimer, R. (2004). The consequences of rigid wages in search models. *Journal of the European Economic Association*, **2** (2-3), 469–479.

— (2005). The cyclical behavior of equilibrium unemployment and vacancies. *American Economic Review*, pp. 25–49.

— (2010). Labor markets and business cycles. *USA: Princeton University*.

— (2012). Reassessing the ins and outs of unemployment. *Review of Economic Dynamics*, **15** (2), 127–148.

Shleifer, A. and Vishny, R. W. (1992). Liquidation values and debt capacity: A market equilibrium approach. *The Journal of Finance*, **47** (4), 1343–1366.

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

SNELL, A. and THOMAS, J. P. (2010). Labor contracts, equal treatment, and wage-unemployment dynamics. *American Economic Journal: Macroeconomics*, pp. 98–127.

SOLON, G., BARSKY, R. and PARKER, J. A. (1994). Measuring the cyclicality of real wages: How important is composition bias? *The Quarterly Journal of Economics*, **109** (1), 1–25.

STEIN, J. C. (1989). Efficient capital markets, inefficient firms: A model of myopic corporate behavior. *The Quarterly Journal of Economics*, pp. 655–669.

— (2003). Agency, information and corporate investment. In G. Constantinides, M. Harris and R. M. Stulz (eds.), *Handbook of the Economics of Finance*, Elsevier.

STOLE, L. A. and ZWIEBEL, J. (1996). Intra-firm bargaining under non-binding contracts. *The Review of Economic Studies*, **63** (3), 375–410.

STUEBER, H. (2012). Are real entry wages rigid over the business cycle? empirical evidence for germany from 1977 to 2009. *IAB Discussion Paper*, (201206).

STUMPNER, S. (2013). *Trade and the geographic spread of the Great Recession*. Tech. rep., Working Paper, UC Berkeley. 62.

TOPEL, R. (1991). Specific capital, mobility, and wages: Wages rise with job seniority. *Journal of Political Economy*, pp. 145–176.

TOWNSEND, R. M. (1979). Optimal contracts and competitive markets with costly state verification. *Journal of Economic Theory*, **21** (2), 265–293.

WEITZMAN, M. L. (1986). *The share economy: Conquering stagflation*. Harvard University Press.

YASHIV, E. (2000). Hiring as investment behavior. *Review of Economic Dynamics*, **3** (3), 486–522.

ZWICK, E. and MAHON, J. (2014). Do Financial Frictions Amplify Fiscal Policy? Evidence from Business Investment Stimulus. *Working paper*.