The Impact of Labor Market Frictions on Corporate Liquidity Management

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Abstract

We show that labor market frictions are first-order for understanding corporate liquidity management. Empirically, labor share positively forecasts corporate cash holding policies in a cross-section of international firms. Furthermore, the relation between labor share and cash policies is stronger for firms with higher wage rigidity. A model with labor market frictions and liquidity management implies strong links between labor variables and cash holding policies. In particular, labor share is positively associated with firms' investment in cash balances. This is because sticky wages make cash savings more valuable to firms in future states where financing constraints are tightened. A model without wage rigidity does not quantitatively imply these predictions.

JEL classification: D22, E23, E44, G32

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1 Introduction

We study the interactions of labor market frictions and corporate liquidity management. Labor market frictions have been argued to play a central role in driving economic fluctuations (see, e.g., Hall, 1999), yet their impact on corporate cash holding policies, which has been crucial for corporate liquidity management, is not well-understood. We show that labor market frictions have a first-order effect on firms' cash holding policies both empirically and theoretically. On the empirical front, we show that firms' labor share positively forecasts corporate cash growth in a cross-section of international firms. Furthermore, the relations between labor share and cash policies are stronger for firms with higher wage rigidity. On the theory front, we show that when wages are rigid, that is, wages tend to rise and fall by less than output, higher precommitted wage payments are associated with higher marginal value of cash holdings in the future states when financing constraints are tightened. The model predicts that labor share is positively associated with firms' investment in cash balances and that higher wage rigidity makes this relation stronger, consistent with the data.

We start by exploring the relations between labor market variables and corporate cash holding policies using a micro-data panel of global firms with cash growth, investment, employment, and a measure of wage rigidity. We show that firms with higher labor share have higher cash growth going forward. Furthermore, we examine whether this relation is stronger in firms with more rigid wages. Specifically we measure wage rigidity as the inverse of the volatility of wage expense growth. The higher the value of this measure is, the more rigid the wage is. We then interact this wage rigidity measure with labor share to test the effect of wage rigidity on cash holding policies. Importantly, we show that firms with higher degrees of wage rigidity save more in cash when labor share rises. Our findings are robust to the inclusion of well-known predictors of corporate cash holding policies documented in the literature (e.g., Opler, Pinkowitz, Stulz and Williamson 1999) including return volatility, Tobin's Q, financial leverage, size, etc., implying that labor share is as important as the standard determinants of firms' cash saving behavior.

To understand the driving forces of the empirical findings on the link between labor market variations and corporate cash decisions, we build and estimate a heterogeneous firms dynamic model. Unlike standard models with frictionless labor markets, our model features rigid wages and adjustment costs on hiring/firing choices.[1] Wage rigidity here captures the notation that wage bill falls (rises) slower than output and thus are smoother than output. In the model, the actual wage is a weighted average of the target wage and the lagged wage, thus is sticky and backward looking. Due to labor adjustment costs, labor choices are costly to adjust for firms. Both frictions prevent firms from immediately adjusting their labor expenses in response to productivity shocks. On the financing side raising external funds involves financing costs, which capture the wedge between the fundamental value of the equity for managers and the value that outside investors are willing to pay for new equity.[2] This wedge can be due to information asymmetries or agency frictions that affect investors' valuation of new equity. Lastly firms manage liquidity by saving in cash balances.[3]

The model highlights the endogenous interactions between sticky wages, investment and cash holding decisions. Intuitively, when the firm's productivity falls, output falls whereas wages fall less due to wage rigidity, hence labor share rises. Labor share affects cash savings through two channels. First, higher labor share is associated with lower marginal cost of cash saving because high labor share induced operating leverage reduces investment demand which in turn lowers demand for costly external funds, thus lowering the marginal cost of investing in cash. Second, higher labor share is also associated with higher expected marginal value of cash saving. This happens because in future good states when wages do not rise as much as productivity, employment rises even more causing the marginal product of capital to rise more, and hence investment increases even further which leads to higher demand for external financing and the tightening of financing constraint; because cash derives value by relaxing financing constraint in such future states, firms save more in cash precautionarily. In contrast to the rise of labor share scenario, when the current productivity rises, labor

[1]See, for example, Hall (2005) and Shimer (2005) on staggered wage contracts and Davis, Haltiwanger and Schuh (1996) and Bloom (2009) on the implications of labor adjustment costs for firms' investment, output, etc.

[2]See, for example, Myers and Majluf (1984), Bernanke and Gertler (1989) and Carlstrom and Fuerst (1997), Moyen (2004), Hennessy and Whited (2005, 2007) that explores the impact of financial frictions on firms' investment and output dynamics.

[3]See, for example, Froot, Scharfstein and Stein (1993), Riddick and Whited (2009), Bolton, Chen, and Wang (2011), Eisfeldt and Muir (2016), etc., which study the optimal liquidity management under real and financial frictions.

share falls while firms reduce cash balances to finance investment. Therefore, the model implies that rise (fall) in labor share is associated higher (lower) cash savings.

Through the lens of the model, we show that wage rigidity is quantitatively crucial for the model to generate the positive relation between labor share and cash savings. Without wage rigidity, this relation becomes negative.Turning off labor adjustment cost makes the labor share effect on cash saving less strong than the benchmark model, but still positive; however the model's fit to the data is substantially worse. Lastly we study the implications of the heterogeneity of wage rigidity for the relation between labor share and firms' cash growth by varying the degree of wage rigidity. We show that the effect of labor share on cash growth is stronger for firms with higher wage rigidity, consistent with the empirical finding that the relation of labor share and cash growth is more pronounced in firms with more rigid wages.

Literature review Our paper builds on three broad literature. First, the paper is closely related to the literature on the determinants of corporate liquidity management policies. The notion of liquidity management goes back at least to Heynes (1936) who argued that precautionary cash saving and financing constraints are closely linked if financial markets are imperfect.[4] This literature highlights how firms will hoard cash in the presence of financing costs.[5] We add to this literature by showing that labor market considerations also affect firms' cash holding behavior. To the best of our knowledge, we are among the first to consider this link.[6]

Second, this paper is part of the growing literature on the links between labor and finance. One strand of this literature explores the asset pricing implications of labor market frictions

[4]Meltzer (1963), Miller & Orr (1966), and Baumol (1970) are earlier examples emphasizing the transaction motive of firms to hold cash. The recent development in the finance literature on liquidity managemnet and financial constraints include the theoretical work by Froot, Scharfstein and Stein (1993), Holmstrom and Tirole (1998), Riddick and Whited (2009), Bolton, Chen and Wang (2011), Bolton, Wang and Yang (2018), etc., and the empirical work by Almeida, Campello & Weisbach (2004), Bates, Kahle & Stulz (2009), Pinkowitz, Stulz & Williamson (2012), etc. Almeida, Campello, Cunha and Weisbach (2014) provides a survey of the literature.

[5]There is a large literature, for example, Rajan and Zingales (1995), Gomes (2001), Welch (2004), Hennessy and Whited (2005), DeAngelo, DeAngelo and Whited (2005), Bolton, Chen and Wang (2013), etc., that study the impact of various frictions on firms' financing policies.

[6]A notable exception is Ghaly, Dang and Stathopoulos (2017) who study the relations between skilled labor and cash holdings.

by showing that labor market variations are related to the variations in asset prices;[7] another strand explores the corporate finance implications of labor market frictions.[8] We complement to this literature by showing that labor market variables are important in determining corporate cash holdings.

Lastly, our paper is related to the extensive literature on wage rigidities and employment/investment dynamics. Shimer (2005), Hall (2006), Gertler and Trigari (2009), Pissarides (2009), among others, showed that wage rigidities are crucial to explain U.S. labor market dynamics. For example, Hall wrote, “The incorporation of wage stickiness makes employment realistically sensitive to driving forces.” Our paper differs from these macro papers in that we study implications of sticky wages for cash holdings policies.

The rest of the paper is laid out as follows. Section 2 describes the data that we use in the paper and presents the empirical findings on the relation between labor share and cash growth. Section 3 writes down the model. Section 4 presents the main quantitative results of the model. Section 5 inspects the model mechanism. Section 6 concludes.

2 Empirical findings

In this section, we first describe the data that we use in the paper, then we present the empirical findings on the relation between labor share and cash growth.

2.1 Data

We construct the sample following Favilukis, Lin, and Zhao (2019). The accounting data come from Compustat North America (for U.S. and Canadian firms) and Compustat Global (for firms in other countries) Fundamentals Annual files. The security data come from CRSP and Compustat Global Security Daily respectively. The sample period for our firm-level analysis varies across countries for starting years (1986 to 1994) and ends in 2013. We

[7]See Merz and Yashiv (2004), Belo, Lin and Bazdresch (2014), Donangelo (2014), Belo, Li, Lin and Zhao (2018), Favilukis and Lin (2016a, 2016b), Kuhen et al (2016), Favilukis, Lin and Zhao (2018), etc., on the links between labor market fluctuations and asset prices.

[8]See Matsa (2010), Simintzi, Vig and Volpin (2012), Xiaolan (2015), Michaels, Page and Whited (2019), etc., who study the impact of labor frictions on corporate policies.

remove observations from financial firms and utility firms (SIC codes between 6000 and 6999, and between 4000 and 4999 respectively).

In Table 1, we report the number and percentage of annual (firm-year) observations that have non-missing labor expenses (Compustat variable XLR) and cash holdings (defined as the ratio of Compustat item CHE to Compustat item AT) for each of the thirty-nine countries. We filter out outliers and categorize the countries into seven different regions. First of all, for the US firms, around 7.7% (= 14796/192530) of the observations have non-missing labor expenses. Therefore, the sample with labor expenses based on US firms is small and it is difficult to draw a general conclusion from an exercise based on US only sample. This is the main reason that we expand our scope to global firms for our firm-level analysis. Once we gather data from other countries, we find that many countries in fact have decent coverage of labor expenses. In particular, most European countries and several countries in Asia Pacific have more than 50% of their observations with non-missing labor expenses and cash. Japan is an exception — only four annual observations with XLR available — therefore our analysis does not include Japan.

Table 1 about here

Table 2 reports the basic summary statistics (mean and standard deviation) for our main variables of interest: $CASH$ and LS, where $LS_t = \frac{XLR_t}{(XLR_t+EBITDA_t)}$ is the labor share of value added at year t. The cash holdings (as a ratio of total assets) in most countries are in the range of 10% to 20%. In addition, LS shows more variation across regions in the range of 30% to 70%. In general, developed countries have higher labor share than developing countries.

Table 2 about here

2.2 Firm-level time-series correlations

To understand the impact of labor expenses on cash holding policies, we first conduct firm-level time-series analysis. This is accomplished by calculating the correlation between LS and $\Delta CASH$ ($Corr(LS, \Delta CASH)$) for each individual company using its time-series observations. The distribution of this correlation at country and aggregate level is presented in Table 3. The summary statistics reported include mean, standard deviation, number of firms, and t-statistic corresponding to test $H_0 : Corr(LS, \Delta CASH) = 0$.

The average value of $Corr(LS, \Delta CASH)$ is 0.03 for all countries (18,122 firms together) with a t-stat of 9.92. This indicates that an increase in labor share is associated with an increase in cash holdings. The average value of this correlation is also positive and statistically significant for the majority of the countries. These time-series correlations support that labor obligations are important determinants of firms' cash holding policies.

Table 3 about here

2.3 Panel regressions

Next, we use panel regressions to analyze the impact of labor obligations and labor market frictions on cash holding policy by controlling for a list of well-known determinants of cash holdings. We follow the setup of Opler, Pinkowitz, Stulz, and Williamson (1999) and regress changes in cash ratio on labor share, controlling for other firm characteristic variables. For example, when we use labor share as a determinant for cash holding policy, we run the following predictive regressions

$$\Delta CASH_{it} = a + b \times LS_{it-1} + b_1 \times \mathrm{X}_{it-1} + \epsilon_{it}, \tag{1}$$

where X_{it} is a vector of other determinants for cash holdings.

Following previous studies (e.g., Opler et al 1999, Pinkowitz, Stulz, and Williamson 2012), we control for the following firm characteristic variables at year t: lagged ΔCASH, stock return volatility (σ), book to market ratio (BM), firm size (Size), cash flows (CF), working capital net of cash (WC), investments (Capex), book leverage (Leverage), R&D expenses (RD), dividend payment dummy (Dividend Payer), acquisitions (Acquisitions), debt issuance (DebtIssue), and equity issuance (EquityIssue). Detailed descriptions of these variable constructions are provided in the appendix. We include country or country*year fixed effects in the regressions and cluster standard errors at the firm level.

The regression results for the relation between ΔCASH_t and LS_{t-1} are reported in Table 4. In column (1), we do not include any firm-specific control variables and find that LS is positively (coefficient estimate of 0.27) and statistically significantly (t-stat of 6.08) associated with future cash holding changes.[9] Firms save more cash when facing a higher labor share. The results are consistent with the firm-level time-series correlations in Table 3. In column (2), we test the impact of wage rigidity on the marginal effect of labor obligations on cash holding policy. We interact LS with a measure of wage rigidity, Rigid, defined as the inverse of labor expenses growth volatility. Our wage rigidity measure captures the notion that firms' wage bills growth would be smoother with more rigid wage contracts. We find that the coefficient estimate for the interaction term of Rigid×LS is 0.05 with a t-stat of 2.79. This estimate implies that for the same level of labor share, firms with more rigid wage contracts increases cash holdings more.

In column (3), we augment the specification in column (1) with firm control variables and in column (4) we add country*year fixed effects. The effect of LS on cash holding changes is robustly positive. For example, the coefficient estimate for LS is 0.28 (or 0.26) and the t-stat is 4.94 (or 4.63) in column (3) (or (4)). The findings suggest that the effect of labor share on cash holding policy is beyond the standard firm characteristics documented in the existing literature. We perform similar analysis in columns (5) and (6) for the interaction term of Rigid and LS and find that the rigidity effect also remains robust to controlling for the firm characteristic variables and country*year fixed effects.

Table 4 about here

Overall, our results suggest that labor market frictions, especially wage rigidity, affects corporate liquidity management. In general, firms save more cash when facing higher labor leverage and higher labor market frictions.

[9]Note that for the ease of presentation, we multiply ΔCASH by 100 in the regressions so that it is expressed in percentage point.

3 Model

The model features a continuum of heterogeneous firms facing capital and labor adjustment costs as in Bloom (2009). Furthermore, wages are sticky and depend on past wages. Firms also implement risk management policies by saving in cash as in Riddick and Whited (2009) and Bolton, Chen and Wang (2011). We do not explicitly model financial intermediation, instead we summarize the costs associated with external financing with a simple functional form that captures the basic idea that there is a wedge between internal and external funds and that external funds are more costly than internal funds. Firms choose optimal levels of physical capital investment, labor, and cash holding each period to maximize the market value of equity.

3.1 Technology

There is a large number of firms that produce a homogeneous good. Firms own physical capital (K_t), hire workers (L_t) and produce this good (Y_t). To save on notation, we omit firm index whenever possible. The production function is given by

$$Y_t = Z_t K_t^a N_t^b, \tag{2}$$

where $0 < a, b < 1$ are constants with $a + b < 1$, and

$$\log Z_{t+1} = (1 - \rho_z)\bar{z} + \rho_z \log Z_t + \sigma_z \epsilon_{t+1} \tag{3}$$

Physical capital accumulation is standard, and given by

$$K_{t+1} = (1 - \delta_K)K_t + I_t, \tag{4}$$

where I_t represents investment by the firm at time t and δ_K denotes the capital depreciation rate.

Labor stock accumulation is given by

$$N_t = (1 - \delta_N)N_{t-1} + H_t, \tag{5}$$

where H_t is gross hiring by the firm at time t and δ_N denotes the exit rate.

Following Hayashi (1982), we assume that capital investment entails nonconvex adjustment costs, denoted as G_t, which are given by

$$G_t = c_k \left(\frac{I_t}{K_t} \right)^2 K_t, \tag{6}$$

where $c_k > 0$ is a constant. The capital adjustment costs include planning and installation costs, learning to use the new equipment, or the fact that production is temporarily interrupted.

Similarly, we assume labor hiring and firing also incur convex adjustment costs as in Bloom (2009), which follows

$$\Psi_t = c_n \left(\frac{H_t}{N_{t-1}} \right)^2 N_{t-1}, \tag{7}$$

where $c_n > 0$ is a constant. The labor adjustment costs include training and screening of new workers, advertising of job positions, disruption costs (output that is lost through time taken to readjust the schedule and pattern of production) and separation costs (for example, severance pay).

3.2 Wage

In standard production models wages are renegotiated each period and employees receive the marginal product of labor. To introduce wage rigidity, we follow Shimer (2005) and Hall (2005) and assume that actual average wage W_t is a weighted average of the target wage rate W_t^*, and the last period wage W_{t-1}, given by

$$W_t = (1 - \mu) W_t^* + \mu W_{t-1}, \tag{8}$$

where μ measures the rigidity in wages. Note that without wage rigidity, μ is 0, the actual average wage is equal to the target wage. In general, the target wage W_t^* should be equal to the marginal product of labor $\frac{\partial Y_t}{\partial N_t} = bZ_tK_t^aN_t^{b-1}$. For tractability, we assume the target wage rate is perfectly correlated with the firm productivity Z_t, i.e., $W_t^* = Z_t$ by setting K_t and N_t at their steady state values and renormalizing the constant term to 1. The lagged wage component can be driven by risk to vacancy or shocks to the Nash bargaining process, etc.

3.3 Cash holding

Firms save in cash (L_{t+1}) which represents the liquid asset that firms hold. Cash accumulation evolves according to the process

$$L_{t+1} = (1 + r_l)\, L_t + S_t, \tag{9}$$

where S_t is the investment in cash and $r_l > 0$ is the return on holding cash. Following Cooley and Quadrini (2001) and Henessy, Levy and Whited (2007), we assume that return on cash is strictly less than the risk free rate r_f (i.e., $r_l < r_f$). This assumption is consistent with Graham (2000) who documents that the tax rates on cash retentions generally exceed tax rates on interest income for bondholders, making cash holding tax-disadvantaged. Lastly, cash is freely adjusted.

3.4 External financing

The final part of the model concerns the external financing costs. We do not model financial intermediation costs endogenously associated with asymmetric information as in Myers and Majluf (1984) or agency frictions in Jensen and Meckling (1976). Instead we choose to summarize the costs of external financing in a reduced form way as in Gomes (2001), Hennessy and Whited (2005) and Bolton, Chen, and Wang (2011). The financing costs include both direct costs (for example, flotation costs - underwriting, legal and registration fees), and indirect (unobserved) costs due to asymmetric information and managerial incentive problems, among others.[10]

Corporate profits Π_t are equal to output less wages: $\Pi_t = Y_t - W_t N_t$. Because external financing costs will be paid only if payouts are negative, we define the firm's payout before financing cost (E_t) as operating profit minus investments in capital and cash, less the wage bills and the adjustment costs in capital and labor,

$$E_t = \Pi_t - I_t - G_t - \Psi_t - S_t. \tag{10}$$

When the sum of investment in capital, wage bills and capital and labor adjustment costs and investment in cash exceeds the operating profit, firms can take external sources of funds as a last resource. External equity O_t is given by

$$O_t = \max\left(-E_t, 0\right). \tag{11}$$

As discussed above, issuing equity is costly for firms. We do not explicitly model the sources of this cost. Rather, we attempt to capture the effect of this cost in a reduced-form fashion. In addition, we make general assumptions about the financing costs which include all kinds of costly external financing activities, namely, costs associated with all marginal sources of financing for firms when payouts are negative. Specifically, we parameterize the equity issuance cost function as:

$$\Phi\left(O_t\right) = \left(\eta_0 + \eta_1 O_t\right) \mathbf{1}_{\{O_t > 0\}}, \tag{12}$$

where $\eta_0 > 0$ and $\eta_1 > 0$ are constants.

Finally, firms do not incur costs when paying dividends. The effective cash flow D_t distributed to shareholders is given by

$$D_t = E_t - \Phi_t. \tag{13}$$

[10]These costs are estimated to be substantial. For example, Altinkilic and Hansen (2000) estimate the underwriting fee ranging from 4.37% to 6.32% of the capital raised in their sample. In addition, a few empirical papers also seek to establish the importance of the indirect costs of equity issuance. Asquith and Mullins (1986) find that the announcement of equity offerings reduces stock prices on average by -3% and this price reduction as a fraction of the new equity issue is on average -31%.

3.5 Firm's problem

Firms choose capital investment, labor hiring and cash optimally by solving the following maximization problem:

$$V_t = \max_{I_t, H_t, S_t, K_{t+1}, N_{t+1}, L_{t+1}} \left[D_t + \beta E_t V_{t+1} \right], \tag{14}$$

subject to firms' budget constraint (Eq. 10), capital, labor and cash accumulation equations (Eqs. 4, 5 and 9).

4 Main results

This section presents the model solution and the main results. We first calibrate and estimate the model parameters, then we simulate the model and study the quantitative implications of the model for the relationship between labor market variables and cash policies. The full set of parameters is the vector θ that characterizes the firm's revenue function, stochastic processes, wage rigidity, real and financial adjustment costs, return-on-cash and discount rate. The econometric problem consists of estimating this parameter vector θ. Since the model has no analytical closed form solution, this vector cannot be estimated using standard regression techniques. Instead estimation of the parameters is achieved by simulated method of moments (SMM), which minimizes a distance criterion between key moments from actual data (a panel of publicly traded firms from Compustat Global) and simulated data. Because SMM is computationally intensive, only 8 parameters are estimated; the remaining 5 are predefined.

4.1 Simulated Method of Moments

SMM proceeds as follows: a set of actual data moments Ψ^A is selected for the model to match.[11] For an arbitrary value of θ the dynamic program is solved and the policy functions are generated. These policy functions are used to create a simulated data panel of size

[11] See McFadden (1989) and Pakes and Pollard (1989) for the statistical properties of the SMM estimator, and Strebulaev and Whited (2012) for the implementation of SMM in dynamic economic model estimations.

$(N, T+1000)$, where N is close to the number of firms in the actual data, and T is close to the time dimension of the actual data. The first 1000 years are discarded so as to start from the ergodic distribution. The simulated moments $\Psi^S(\theta)$ are then calculated on the remaining simulated data panel, along with an associated criterion function $\Gamma(\theta)$, where $\Gamma(\theta) = \left[\Psi^A - \Psi^S(\theta)\right]' W \left[\Psi^A - \Psi^A(\theta)\right]$, which is a weighted distance between the simulated moments $\Psi^S(\theta)$ and the actual moments Ψ^A.

The parameter estimate θ is then derived by searching over the parameter space to find the parameter vector which minimizes the criterion function:

$$\hat{\theta} = \underset{\theta \in \Theta}{\arg\min} \; \left[\Psi^A - \Psi^S(\theta)\right]' W \left[\Psi^A - \Psi^S(\theta)\right]. \tag{15}$$

Given the potential for discontinuities in the model and the discretization of the state space, we use an annealing algorithm for the parameter search (see Appendix A-1.2). Different initial values of θ are selected to ensure the solution converges to the global minimum.

4.2 Predetermined parameters and estimation

In principle every parameter could be estimated, but in practice the size of the estimated parameter space is limited by computational constraints. We therefore focus on the parameters about which there are probably the weakest priors—the production function parameters, the wage rigidity parameter, the capital and labor adjustment cost parameters, the return on saving parameter and the external financing costs parameter, $\Theta = (a, b, c_k, c_n, \mu, r_s, \eta_0, \eta_1)$. The other parameters are based on values in the data and the prior literature, and are reported in Table 5. Below we briefly discuss how we calibrate the parameters of the baseline model.

We set the capital depreciation rate δ_K is set to be 12% per year following Bloom (2009). The labor exit rate is set to $\delta_K = 24\%$ close to Davis, Faberman and Haltiwanger (2006). The discount factor β is set so that the real firms' discount rate $r_f = 7\%$ per annum, which implies $\beta = 0.93$ annually, consistent with King and Rebelo (1999). We set the persistence and conditional volatility of firms' micro productivity as $\rho_z = 0.74$ and $\sigma_z = 0.123$ following

Hennessy and Whited (2005).

Table 5 about here

Under the null, a full-rank set of moments $\left(\Psi^A\right)$ will consistently estimate the parameters (Θ). The choice of moments is also important for the efficiency of the estimator. This suggests that moments which are "informative" about the underlying structural parameters should be included. Given that we are exploring the impact of labor market frictions on firms' cash policies, we choose the 3 simple means: the average labor share, the average frequency of equity issuance, and the average ratio of cash to total assets; and 6 second moments: the average volatilities of investment rate, net hiring rate, wage payment growth rate, cash growth rate, sales growth rate, and the ratio of equity issuance to assets as the moments to match.

4.3 Baseline estimation results

We compare the moments from the simulation of different model specifications to the real data.

The top panel in Table 6 reports the estimated parameters. The column 1 labelled Baseline presents the results from estimating the preferred specification with both wage rigidity and labor adjustment costs in addition to capital and financial adjustment costs. The estimated shares on capital and labor are 0.18 and 0.66, respectively, consistent with the range of estimates in the literature, e.g., Bond and Soderbom (2005) and Bloom (2009). The estimated adjustment cost parameter $c_n = 0.15$, implying labor hiring/firing costs of 0.9% of sales (not tabulated); the estimated capital adjustment cost is $c_k = 0.01$, implying an investment adjustment cost of 0.1% of sales when firms adjust capital (not tabulated), both are at the low end of the empirical estimates in the literature (e.g., Merz and Yashiv 2007). The estimated wage rigidity parameter $\mu = 0.85$, implying that the average length of the wage contract is $\frac{1}{1-\mu} = 6.6$ years, consistent with Hall (1982) who estimated an average job duration of 8 years for American workers and Abraham and Farber (1987) who estimated similar numbers just for nonunionized workers (presumably unionized workers have even longer durations). Financial adjustment costs imply a fixed cost of 1% and a proportional financing costs of 12% of the proceeds raised from external financial markets (conditional on issuing). The model implied average financing costs are 1.5% of sales (not tabulated). Because external financing costs include both direct costs, e.g., flotation costs and indirect costs due to asymmetric information, there are no empirical estimates for the total cost that we can compare with. Our estimates are close to the range of the estimates in Altinkilic and Hansen (2000) and Hennessy and Whited (2007) for the US data. Lastly, the estimated return on saving $r_s = 0.77r_f$, implying a wedge of $23\%r_f$ between risk free rate and return on cash saving. The standard errors suggest all of these point estimates are statistically significant.

Turning to the fit of the baseline model, column 7 of Table 7 presents the results from the real data moments as a benchmark. Column 1 presents the baseline model simulation results, and finds the baseline model fits the data well. The model generates volatile investment rate, hiring rate and cash growth rates, large labor share and moderate equity issuance fraction, all of which are close to the data. The model implied volatilities of wage payment growth rate and the ratio of issuance to assets are somewhat smaller than the data.

For interpretation, in Tables 6 and 7 we also display results for five illustrative restricted models. First, a model without wage rigidity (labelled as No rigidity), assuming wage rate is equal to the target wage rate. In column 2 of Table 6, we see that estimated capital share and labor share are 0.41 and 0.57 respectively, and that estimated real adjustment costs $c_K = 0.056$, all of which are bigger than the baseline model. Estimated external financing cost parameters are $\eta_0 = 0.002$ and $\eta_0 = 0.076$ which are smaller than the baseline model. The return on cash parameter is also smaller. We also see that No-rigidity model generates a much worse fit of the data than the baseline in column 2 of Table 7. Cash-to-assets ratio is 0.007 much smaller than the data moment at 0.16, and cash growth is also more volatile than the data (0.99 vs 0.73) and the baseline of 0.67, while hiring rate is less volatile (0.19 vs 0.26) and investment rate is more volatile than the data (0.35 vs 0.30).

Second, a model without labor adjustment costs (No Lcost), assuming labor adjustment cost is zero. In column 3 of Table 6, we see that in the No-LCost model, estimated labor share is 0.77 higher than the baseline, while the estimated wage rigidity mu is 0.6, less than the baseline. The return on cash parameter is also smaller. In addition, from Table 7 No-Lcost model generates a too high issuance fraction (0.47) and labor share (0.79) than the data (0.25 and 0.62, respectively). This happens because no labor adjustment costs implies higher equilibrium labor demand and higher wage bills relative to output, and hence higher issuance to finance wage bills and investment.

Third, a model without labor market frictions, e.g., no wage rigidity and no labor adjustment cost and labor exit rate is 1 (labelled as No LFrictions). This model is close to the standard neoclassical model with a frictionless labor market. We see that the estimated return on saving r_s is smaller and estimated financing cost parameters are higher than baseline. We also see that this model implies a worse fit of the data from Table 7: issuance fraction is way too high (0.53 in the model vs 0.25 in the data) while investment and hiring volatilities are too low (0.19 and 0.21 in the model vs 0.30 and 0.29 in the data).

Fourth, a model without capital adjustment cost (No KCost). In Column 6 of Table 6, we see that the estimated parameters are close to the baseline model; in addition, the model's fit to the data is also close to the baseline model except that investment rate volatility is higher than the data (0.33 vs 0.30). Lastly, a model without financial frictions (No-FinCost). In column 6 of Table 6, we see that in the No-FinCost model, the estimated capital and labor adjustment costs are higher than baseline, implies that the typical model (No-FinCost) used in the literature over-estimates the real adjustment costs because the model ignores financial costs. The No-FinCost model's fit is also worse than the baseline, because it implies zero cash holding since the marginal value of holding cash is zero.

Next we compare panel regressions results from simulated data under the above different specifications in panel B of Table 6. In particular, to tease out the possible mechanical effect of labor share on cash growth driven by productivity growth, we first regress labor share on productivity growth and take the residuals, then we regress the cash growth rate on the labor share residual. Column 1 presents the baseline simulation results, and finds that increases in labor share are associated with rises in cash growth (slope=2.77). Note that this is result is not driven by the correlation between productivity and cash growth. In column 2 we simulate the No-rigidity model. We see that labor share and cash growth are not correlated after controlling for productivity growth (slope = 0.01); without controlling for productivity growth, labor share and cash growth are negatively correlated with the slope at -1.18 (not tabulated). Hence, wage rigidity is quantitatively important for the model to generate a strong relation between labor share and cash holdings. In column 3 we turn to the model without labor adjustment costs (No LCost) and see that the impact of labor share on cash growth remains positive but the slope drops from 2.77 to 0.71. This implies that labor adjustment costs also matters for cash policies but not quantitatively as important as the wage rigidity channel. Column 4 (No LFrictions) is the frictionless labor model where there is no wage rigidity and labor adjustment and labor exit rate is 1. We see that labor share negatively correlates with cash growth with the slope at -0.52. Column 5 (No KCost) is the model without capital adjustment. Here labor share still significantly predicts cash growth with the slope close to the baseline model at 2.70. Intuitively, removing capital adjustment does not directly affect labor market frictions, thus labor market variables still predict cash policies. Lastly, Column 6 (No FinCost) turns off financial adjustment costs which leads zero cash holding. Hence labor market variables has no relationships with cash holdings.

[Table 7 about here]

5 Inspecting the mechanism

This section inspects the model mechanisms first by comparing the impulse response of different model specifications, then by exploring the interactions of wage rigidity and cash holding policies.

5.1 Impulse responses

To understand the model mechanism, we simulate the impulses of four model specifications: i) the baseline model, ii) the models without wage rigidity, iii) the model without labor adjustment costs and iv) the model without any labor market frictions. To simulate the impulse response, we run the models with $3,000$ firms for 800 periods and then kick the firm productivity down (up) to its low (high) level, i.e., the next lower (upper) grid point above the median value, in period 801 and then let the model to continue to run as before. Hence, we are simulating the response to a one period impulse and its gradual decay.

Figure 1 plots the impulse responses of capital, labor, cash holdings, wage, marginal product of capital (MPK), and labor share to a negative productivity shock. Starting with the baseline model (red line, triangle symbols) we see a significant drop in capital and labor and a gradual return to trend. This is driven by decreases in productivity which decreases investment and hiring. Labor share rises because the wage does not fall as much as output due to wage rigidity. MPK drops because employment decreases. We see that cash holdings increase significantly because firms save precautionarily for future states where investment needs to be financed by costly external equity. This can be seen from Figure 2, where we plot the responses to a positive productivity shock. We see that MPK rises sharply because wage remains low due to wage rigidity, and hence investment increases which leads firms to more likely to take costly external financing. Thus the baseline model generates a positive relation between labor share and cash growth, consistent with the data.

Turning to the model without rigidity (black line, cross symbols), we see more persistent decreases in capital and employment compared to the baseline because the wage moves perfectly with productivity. We also see an decrease in labor share because wage payments decreases faster than output in the model without wage rigidity.[12] Furthermore we see a much smaller increase in cash holdings than the baseline because the marginal value of saving is a lot lower. This can be seen from Figure 2, where in good states MPK does not increase much because wage remains high, thus investment demand is not as high as the baseline and hence financing constraint is not tightening. Thus, when wage is perfectly correlated with productivity, labor share and cash holdings growth are negatively correlated, which is counterfactual.

Next we turn off labor adjustment cost (blue line, circle symbols). We see wage is more volatile than the baseline because of a re-estimated wage rigidity parameter less than the baseline, but it is smoother than the model without wage rigidity. This leads to smaller

[12]Note that wage payment is linear in labor while output is decreasing return-to-scale in labor.

decrease in capital and employment than the baseline and a smaller increase in cash holding. Labor share increases due to the wage rigidity effect. We see labor share and cash growth are still positively correlated but less so than the baseline model. Lastly we also present the model by turning off both wage rigidity and labor adjustment cost, and we set the labor exit rate to 1. Effectively this model has a frictionless labor market where wage is equal to productivity and employment is freely adjusted without time-to-build. We see that capital and labor decrease as in the baseline model but the magnitude is smaller. Cash drops while labor share is flat upon impact, different from the baseline model.

Figure 1 about here

For completeness, we also present the impulses of the same variables to a positive productivity shock in Figure 2. To briefly summarize the main findings: in the baseline model we see labor share drops because the wage does not increase as much as output due to wage rigidity. This in turn leads to an further increase in labor more than the model without wage rigidity for about 4 years, and hence increases in MPK. We see that cash holdings decrease significantly because firms first use cash to finance the increase investment and labor hiring. In contrast, in the model without wage rigidity, labor share rises whereas cash holding decreases, opposite to the baseline. In addition, we see a positive co-movement of labor share and cash savings in the model without labor adjustment costs but somewhat weaker than the baseline.

In sum, wage rigidity is crucial to generate a positive relation between labor share and cash saving as observed in the data.

Figure 2 about here

5.2 The interactions of wage rigidity and cash holding

This section examines the interactions between wage rigidity and cash holding growth. To do this in a panel setting we first solve the wage rigidity model with different values of wage rigidity (μ), and then compare firms' response of cash holding growth to labor share to the same model with a small wage rigidity ($\mu = 0.3$). This comparison is undertaken in following regression, which combines the firms with wage rigidity and firms with flexible wage in one panel

$$\Delta L_{i,t} = a + b \cdot LS_{i,t} + c \cdot (LS_{i,t} \cdot D_i^{Rigid}) + D_i^{Rigid} + \varepsilon_{i,t}, \tag{16}$$

where $\Delta L_{i,t}$ is the cash growth rate, $LS_{i,t}$ are firm labor shares after controlling for productivity growth, D_i^{Rigid} is a dummy variable with value 1 for rigid firms (wage rigidity μ) and 0 for less rigid firms. A positive value on the coefficient b captures the direct impact of labor share, and coefficient c captures the amplification effect of wage rigidity for labor share.

In Table 8 we report the coefficients of b and c for the data and three levels of wage rigidity in the model (columns (2) to (4)). We see in column (2) that in our baseline model rigid firms ($\mu = 0.85$) have a coefficient $c = 2.9$, meaning they increase cash savings much more in response to labor share than less rigid firms ($\mu = 0.3$). In column (3) we reduce wage rigidity from $\mu = 0.85$ to 0.7 and find the coefficient c drops to 2.6, while in column (4) we increase wage rigidity to 0.95 and find much bigger effect of labor on cash with $c = 3.6$. Hence, higher steady-state levels of wage rigidity in our simulation model lead to more positive impacts of labor share on cash saving.

To look at this more generally in Figure 3 we plot the coefficients c associated with different values of wage rigidity μ from 0.4 to 0.95. We see a monotonically increasing relationship between c and the wage rigidity. That is, the more rigid a firm's wage is the more it increases cash holdings when labor share is high.

6 Conclusion

We show that understanding labor markets is crucial for understanding corporate liquidity management. We first use empirical data on a large set of international firms to investigate the links between labor market variables and corporate cash saving behavior. We show that firms with higher labor share have higher cash growth going forward. Furthermore, this relation is stronger for firms with higher wage rigidity.

We then solve and estimate a model with labor market frictions and corporate cash holdings and show that in such a model, the optimal cash holding policies are positively associated with labor share. This is because higher labor share induces higher operating leverage, which reduces investment and makes cash saving less costly by avoiding costly external financing; furthermore, higher labor share is also associated with the higher marginal value of cash saving in future states where financial constraint is tightened due to the increase future investment caused by lower wage in good states.

In all, our theoretical and empirical analyses show that labor market frictions are quantitatively important to explain the impact of labor market variables on corporate cash holding behavior.

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A-1 Numerical algorithm

This appendix describes some of the key steps in the numerical techniques used to solve the firm's maximization problem.

A-1.1 Value function iteration

To solve the model numerically, we use the value function iteration procedure to solve the firm's maximization problem. The value function and the optimal decision rule are solved on a grid in a discrete state space. We specify two grids of 25 points for capital and labor and 20 points for cash, respectively, with upper bounds $\bar{k}, \bar{l}$ and $\bar{n}$ that are large enough to be nonbinding. The grids for capital, labor and cash are constructed recursively, following McGrattan (1999), that is, $k_i = k_{i-1} + c_{k1} \exp(c_{k2}(i-2))$, where $i = 1,...,n$ is the index of grids points and c_{k1} and c_{k2} are two constants chosen to provide the desired number of grid points and two upper bounds $\bar{k}, \bar{l}$ and $\bar{n}$, given two pre-specified lower bounds $\underline{\mathrm{k}}$, $\underline{\mathrm{l}}$ and $\underline{\mathrm{n}}$. The advantage of this recursive construction is that more grid points are assigned around $\underline{\mathrm{k}}$, $\underline{\mathrm{l}}$ and $\underline{\mathrm{n}}$, where the value function has most of its curvature.

The firm productivity shock ε_t^z is an i.i.d. standard normal shock. The state variables firm productivity z has continuous support in the theoretical model, but it has to be transformed into discrete state space for the numerical implementation. We use the method described in Rouwenhorst (1995) for a quadrature of the Gaussian shocks. We use 5 grid points for the z process. In all cases, the results are robust to finer grids as well. Once the discrete state space is available, the conditional expectation can be carried out simply as a matrix multiplication. Spline interpolation is used extensively to obtain optimal investment, hiring and cash that do not lie directly on the grid points. Finally, we use a simple discrete global search routine in maximizing the firm's problem.

A-1.2 Simulated Method of Moments Estimation

To generate the simulated data for the SMM estimation (used to create $\Psi^S(\theta)$ in Equation (15)), we simulate an economy with 3000 firms. This is run for 3000 years, with the first 1000 years discarded to eliminate the effects of any assumptions on initial conditions. We use a simulated annealing algorithm for minimizing the criterion function in the estimation step in Equation (15). This starts with a predefined first. For the second guess onward it takes the best prior guess and randomizes from this to generate a new set of parameter guesses. That is, it takes the best-fit parameters and randomly "jumps off" from this point for its next guess. Over time the algorithm "cools," so that the variance of the parameter jumps falls, allowing the estimator to fine tune its parameter estimates around the global best fit. We restart the program with different initial conditions to ensure the estimator converges to the global minimum. The simulated annealing algorithm is extremely slow, which is an issue since it restricts the size of the parameter space which can be estimated. Nevertheless, we use this because it is robust to the presence of local minima and discontinuities in the criterion function across the parameter space.

To generate the standard errors for the parameter point estimates, we generate numerical derivatives of the simulation moments with respect to the parameters and weight them using the optimal weighting matrix. One practical issue with this is that the value of the numerical derivative, defined as $f'(x) = \frac{f(x+\varepsilon)-f(x)}{\varepsilon}$, is sensitive to the exact value of ε chosen. This is a common problem with calculating numerical derivatives using simulated data with underlying discontinuities, arising, for example, from grid-point-defined value functions. To address this, we calculate four values of the numerical derivative for an ε of +1%, +2.5%, +5%, and -1% of the midpoint of the parameter space and then take the median value of these numerical derivatives. This helps to ensure that the numerical derivative is robust to outliers arising from any discontinuities in the criterion function.

A-2 Model FOC analysis

Note that the analyses below just to glean intuition. Let $q_{K,t}$ and $q_{L,t}$ be the Lagrangian multiplier associated Eqs. (4) and (5). The first-order conditions with respect to $I_t, H_t,$

K_{t+1}, L_{t+1}, and N_{t+1} are, respectively,[13]

$$q_{K,t} = \left(1 + \Phi'(O_t)\mathbf{1}_{\{O_t>0\}}\right)\left[1 + \frac{\partial G_t}{\partial I_t}\right], \tag{17}$$

$$q_{L,t} = \left(1 + \Phi'(O_t)\mathbf{1}_{\{O_t>0\}}\right)\frac{\partial \Psi_t}{\partial H_t}, \tag{18}$$

$$q_{K,t} = \beta \mathbb{E}_t\left\{\left((1 + \Phi'(O_{t+1})\,\mathbf{1}_{\{O_{t+1}>0\}}\right)\left[\frac{\partial E_{t+1}}{\partial K_{t+1}} + (1-\delta_k)\left(1 + \frac{\partial G_{t+1}}{\partial I_{t+1}}\right)\right]\right\}, \tag{19}$$

$$q_{L,t} = \beta \mathbb{E}_t\left\{\left((1 + \Phi'(O_{t+1})\,\mathbf{1}_{\{O_{t+1}>0\}}\right)\left[\frac{\partial E_{t+1}}{\partial N_{t+1}} + (1-\delta_n)\frac{\partial \Psi_{t+1}}{\partial H_{t+1}}\right]\right\}, \tag{20}$$

$$\text{and } \left(1 + \Phi'(O_t)\mathbf{1}_{\{o_t>0\}}\right) = (1 + r_s)\,\beta \mathbb{E}_t\left[\left(1 + \Phi'(O_{t+1})\mathbf{1}_{\{O_{t+1}>0\}}\right)\right]. \tag{21}$$

The left hand sides of Eqs (17) and (18) are the marginal q's of optimal investment and hiring, which are the standard marginal costs of investment and hiring augmented by marginal external financing cost. External financing costs directly affect the optimal investment and hiring demand. Eqs (19) and (20) describe the Euler equations for optimal capital and labor, which equate the total marginal cost of investment and hiring and the expected marginal benefit of capital and labor. It is clear that the cash holding decision affects optimal capital and labor through the trade-off between the increase (decrease) in current marginal cost of external financing and the decrease (increase) in future marginal benefit of the reduction in the cost of external financing.

The equation of interest is the Euler equation for optimal cash holding, Eq. (21), which equates the marginal cost of optimal cash holding and the expected marginal benefit of cash holding. Labor hiring affects the optimal cash holding through two margins: 1) extensive margin $\mathbf{1}_{\{H_t>0\}}$ where firms decide on whether to take external financing. All else equal, the higher the wage/labor stock/hiring, the higher the demand for external financing, and hence the higher the likelihood that firms' marginal cost of cash is increasing. 2) intensive margin. Since external financing costs include a convex component, marginal external financing costs depend directly on the labor and wage. The higher the labor stock and the more persistent the wage, the higher the marginal cost of cash holding is. Clearly future labor/wage at t+1 also affect the marginal benefit of cash, i.e., the more firms hire at t, the more output they

[13]These first-order conditions are taken in the differentiable regions of the relevant variables.

will produce at t+1 which in turn lowers external financing demand and saves on external financing costs.

A-3 Variable construction

Our control variables are constructed as follows:

- $CASH$: Cash is the ratio of Compustat item CHE to total assets (Compustat item AT).
- σ: Stock return volatility is the standard deviation of monthly returns. For US firms, stock returns are retried from CRSP. For firms in other countries, we use data from Compustat Global Security Daily to calculate stock return in month t as

$$RET_t = \frac{PRCCD_t/AJEXDI_t \times TRFD_t - PRCCD_{t-1}/AJEXDI_{t-1} \times TRFD_{t-1}}{PRCCD_{t-1}/AJEXDI_{t-1} \times TRFD_{t-1}},$$

  where $PRCCD_t$ is the closing price at month end, $AJEXDI_t$ and $TRFD_t$ are the corresponding share and return adjustment factors.
- BM: Book to market ratio for equity is defined as $\frac{\text{Book Equity}}{\text{Market Cap}}$, where Book Equity = $CEQ + TXDITC - PSTK$ and Market Cap = $PRCC \times CSHOC$. CEQ: common equity. TXDITC: deferred taxes and investment tax credit. PSTK: preferred stock. PRCC: year end closing price. CSHOC: shares outstanding.
- Size: Firm size is the logarithm of total assets (AT).
- CF: Cash flow is the ratio of EBIT to AT. Note that an alternative definition of $CF = (OIBDP - XINT - TXT - DVC)/AT$ has a correlation of 0.97 with $EBIT/AT$ but CF would be missing for half of the sample. Therefore we use $EBIT/TA$ to measure the cash flows. EBIT: earnings before interest and taxes.
- WC: Working capital net of cash is defined as $(WCAP - CHE)/AT$. WCAP: working capital.

- Capex: Investment is defined as CAPX/AT. CAPX: capital expenditures.

- Leverage: Financial leverage is defined as $(DLTT + DLC)/AT$, where $DLTT$ and DLC are Compustat items for long-term and short-term debt respectively. An alternative measure could be $(DLTT + DLC)/(DLTT + DLC + AT + TXDITC - PSTK - LT)$ and we find that empirically the correlation between these two measures is high (95% correlation).

- RD: R&D is defined as XRD/SALE. RD: research and development expenses. SALE: sales.

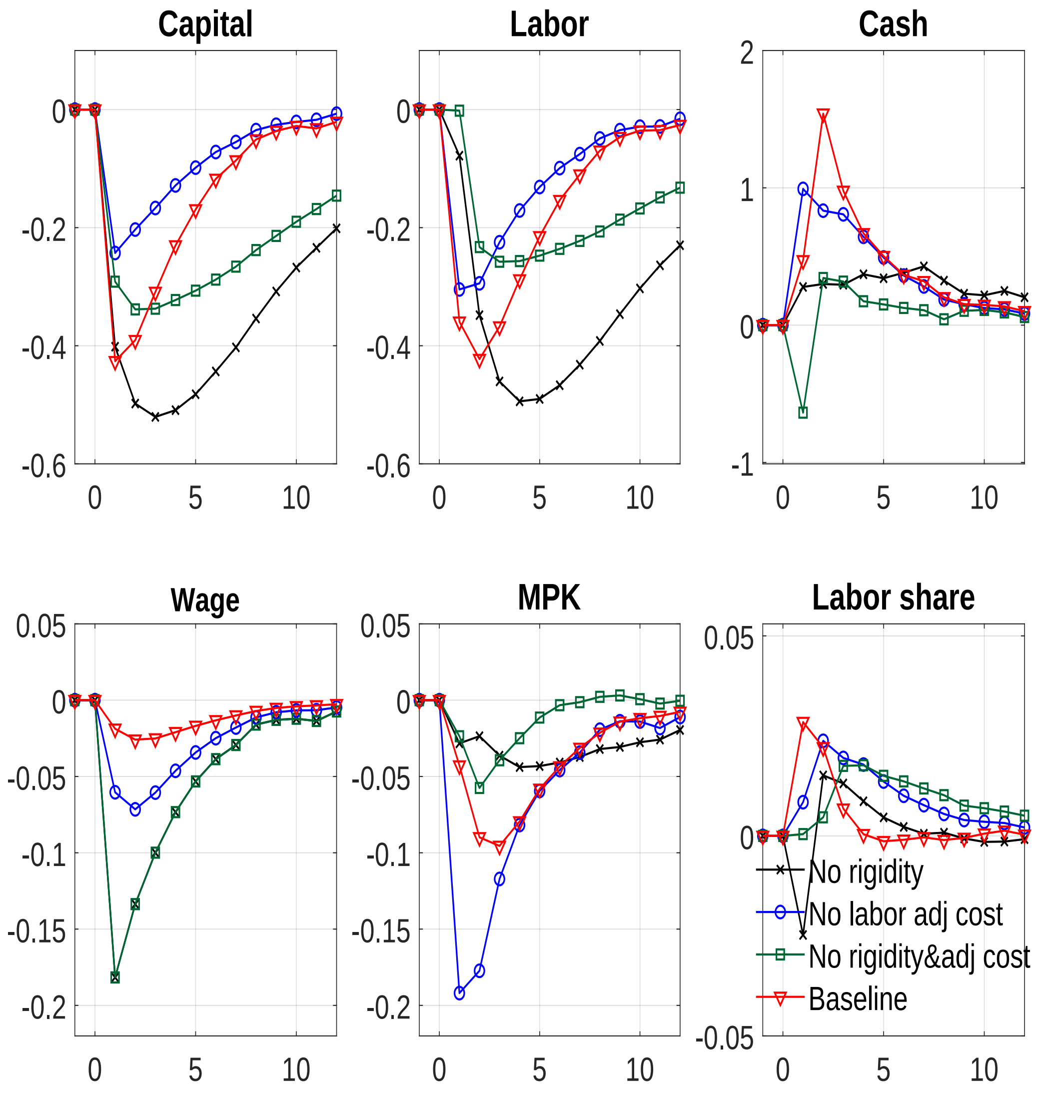
- Dividend Payer: Dividend payment dummy variable is defined as 1 if DVC>0 and 0 otherwise. DVC: common dividends.

- Acquisitions: Acquisition expense is defined as AQC/AT. AQC: acquisition costs.

- DebtIssue: Debt issuance is defined as (DLTIS-DLTR)/AT. DLTIS: long-term debt issuance. DLTR: long-term debt reduction.

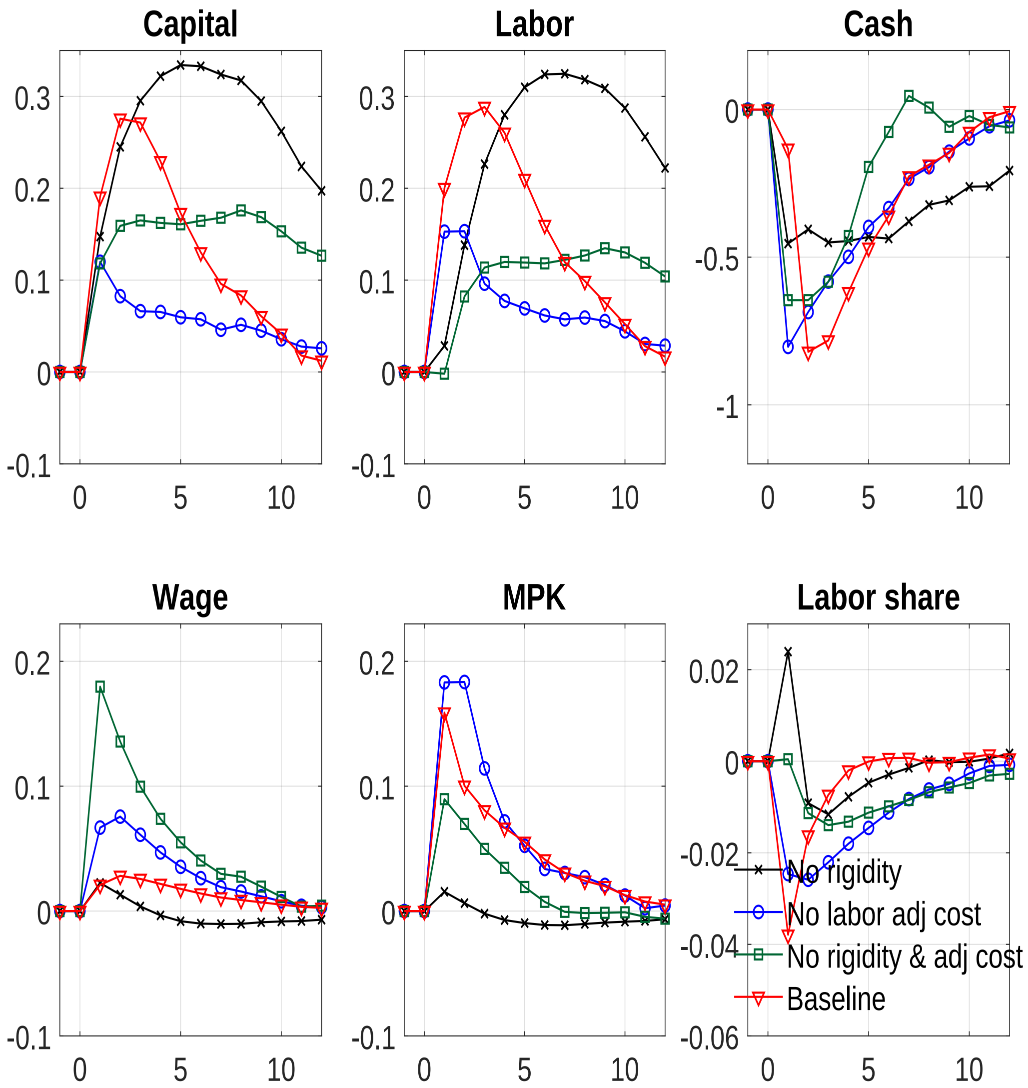
- EquityIssue: Equity issuance is defined as $SSTK/AT$. SSTK is sale of common and preferred stock. SSTK is required to be non-negative. When Market Equity ME_t and ME_{t-1} are available, SSTK is required to be greater than $3\% \times 0.5 \times (ME_t + ME_{t-1})$, following the approach of McKeon(2015). Here, ME_t is defined as $PRCC_t \times CSHO_t$. When PRCC or CSHO are not available in Fundamental Annual, PRCCD and CSHOC in Security Daily are used. All related variables are deflated.

Figure 1: Impulse responses of different model specifications to a negative productivity shock



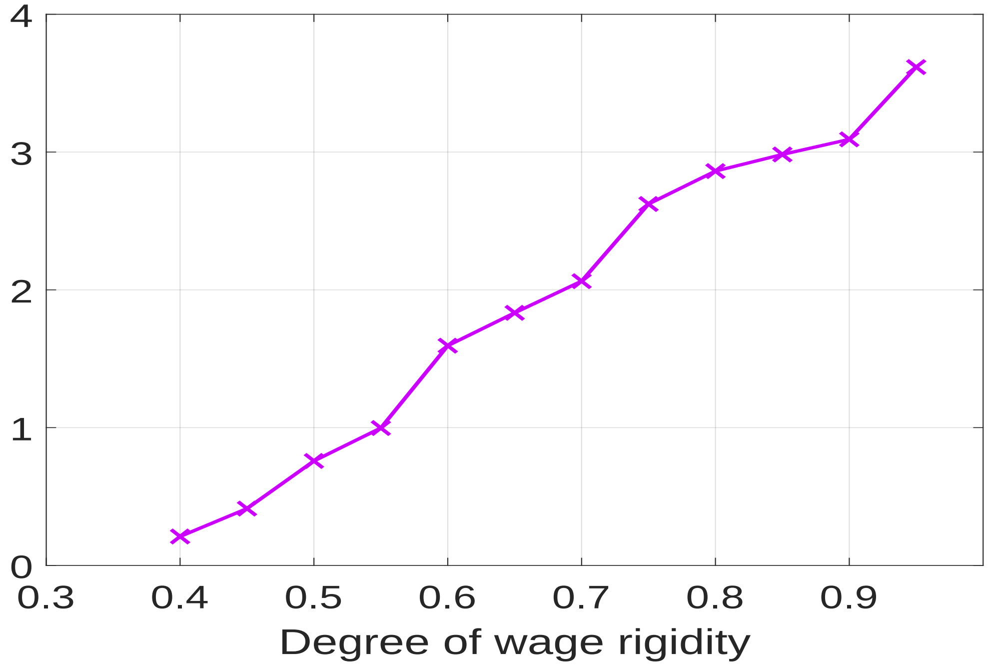
This figure plots the impulse responses of capital, labor, cash, wage, marginal product of capital (MPK), and labor share implied by four models: i) the baseline model with wage rigidity and labor adjustment costs (red triangle), ii) the model without wage rigidity (black crosses), iii) the model without adjustment cost (blue circle) and iv) the model without wage rigidity and labor adjustment cost (green squares). To simulate the impulse response, we run our model with 3,000 firms for 800 periods and then kick the firm productivity down to its low level (the next lower grid point below the median value) in period 801 and then let the model to continue to run as before. Hence, we are simulating the response to a one period impulse and its gradual decay.

Figure 2: Impulse responses of different model specifications to a positive productivity shock



This figure plots the impulse responses of capital, labor, cash, wage, marginal product of capital (MPK), and labor share implied by four models: i) the baseline model with wage rigidity and labor adjustment costs (red triangle), ii) the model without wage rigidity (black crosses), iii) the model without adjustment cost (blue circle) and iv) the model without wage rigidity and labor adjustment cost (green squares). To simulate the impulse response, we run our model with 3,000 firms for 800 periods and then kick the firm productivity up to its low level (the next upper grid point below the median value) in period 801 and then let the model to continue to run as before. Hence, we are simulating the response to a one period impulse and its gradual decay.

Figure 3: Interactions of wage rigidity and cash holding growth



This figure plots the coefficient c of the interaction term of the regression:

$$\Delta L_{i,t} = a + b \cdot \widetilde{LS}_{i,t} + c \cdot (\widetilde{LS}_{i,t} \cdot D_i^{Rigid}) + D_i^{Rigid} + \varepsilon_{i,t}, \tag{22}$$

where $\widetilde{LS}_{i,t}$ are firm labor shares after controlling for productivity growth, D_i^{Rigid} is a dummy variable with value 1 for rigid firms (wage rigidity $\mu > 0.3$) and 0 for less rigid firms (wage rigidity $\mu = 0.3$). We also include firm δ_i and time ϕ_t fixed effects. The x-axis shows different models with wage rigidity parameter μ as 0.4, 0.45,and 0.95 (with 0.05 as an increment).

Table 1: No. of annual observations with non-missing labor expenses and cash

This table reports the number of annual (firm-year) observations for each individual country. In particular, the number of annual observations with non-missing labor expenses (Compustat variable XLR) and cash (Compustat CHE/AT) is reported in the column titled "# Obs w XLR/CASH". The percentage of observations with non-missing labor expenses and cash is reported for each country (column titled "Within country % of obs w XLR/CASH"). The last column titled "For all countries % of obs w XLR/CASH" presents the percentage of observations with non-missing labor expenses and cash contributed by each country to the final sample of all observations with non-missing labor expenses and cash (total # of obs = 175218).

Country	Start Year	End Year	All Obs	# Obs w XLR	# Obs w CASH	# Obs w XLR/CASH	Within country % of obs w XLR/CASH	For all countries % of obs w XLR/CASH
Region: Europe								
Austria	1989	2013	1449	1350	1448	1349	93.10	0.77
Belgium	1989	2013	1789	1625	1783	1623	90.72	0.93
Denmark	1989	2013	2319	2127	2315	2127	91.72	1.21
Finland	1989	2013	2145	2048	2145	2048	95.48	1.17
France	1989	2013	11507	10719	11437	10702	93.00	6.11
Germany	1989	2013	11749	10690	11725	10684	90.94	6.10
Greece	1994	2013	2538	1591	2531	1589	62.61	0.91
Italy	1989	2013	3443	3276	3441	3276	95.15	1.87
Netherlands	1988	2013	3014	2765	3009	2764	91.71	1.58
Norway	1989	2013	2693	2415	2677	2406	89.34	1.37
Poland	1994	2013	4082	3099	4045	3098	75.89	1.77
Portugal	1989	2013	810	729	807	729	90.00	0.42
Spain	1989	2013	2068	2027	2065	2024	97.87	1.16
Sweden	1989	2013	6104	5191	6100	5191	85.04	2.96
Switzerland	1989	2013	3543	3211	3530	3204	90.43	1.83
United Kingdom	1987	2013	28060	22763	27973	22728	81.00	12.97
Region: North America								
Canada	1986	2013	32954	5379	28377	5377	16.32	3.07
United States	1986	2013	192530	14796	156616	14647	7.61	8.36
Region: Japan								
Japan	1987	2013	56403	4	56312	4	0.01	0.00
Region: Asia Pacific (ex. Japan)								
Australia	1987	2013	21579	13165	21317	13066	60.55	7.46
China	1987	2013	29100	1102	29004	1100	3.78	0.63
Hong Kong	1989	2013	1800	1203	1800	1203	66.83	0.69
India	1989	2013	33324	30520	31607	29372	88.14	16.76
Indonesia	1990	2013	4239	2990	4237	2989	70.51	1.71
Malaysia	1988	2013	13038	8629	12571	8555	65.62	4.88
New Zealand	1989	2013	1501	612	1473	612	40.77	0.35
Philippines	1989	2013	2005	1273	1962	1256	62.64	0.72
Singapore	1989	2013	8091	5601	8014	5592	69.11	3.19
S. Korea	1993	2013	10527	68	10525	68	0.65	0.04
Taiwan	1991	2013	17265	1633	17256	1629	9.44	0.93
Thailand	1989	2013	6020	3646	6020	3646	60.56	2.08
Region: Other America (ex. Canada and U.S.)								
Argentina	1989	2013	787	286	786	286	36.34	0.16
Brazil	1991	2013	3810	1713	3801	1712	44.93	0.98
Chile	1987	2013	1808	394	1803	394	21.79	0.22
Mexico	1990	2013	1596	313	1590	312	19.55	0.18
Region: Middle East								
Israel	1989	2013	3397	2505	3087	2310	68.00	1.32
Pakistan	1994	2013	3095	2328	2960	2302	74.38	1.31
Turkey	1989	2013	2247	1187	2240	1187	52.83	0.68
Region: Africa								
South Africa	1989	2013	3881	2058	3865	2057	53.00	1.17
Total			538310	177031	494254	175218		

Table 2: Summary statistics on cash and labor share

This table reports the summary statistics on cash, labor expenses growth, and labor share. We define cash as the ratio of Compustat item CHE to total assets (Compustat item AT) and labor share as $LS_t = \frac{XLR_t}{(XLR_t+EBITDA_t)}$ for year t. We report the mean and standard deviation of these variables within each country. The average values of the corresponding statistics for all the countries are reported in the last row "Total".

	$CASH$		LS	
Country	Mean	St.D.	Mean	St.D.
Region: Europe				
Austria	0.13	0.15	0.72	0.62
Belgium	0.14	0.17	0.67	0.62
Denmark	0.17	0.20	0.74	0.73
Finland	0.14	0.15	0.65	0.54
France	0.15	0.16	0.69	0.69
Germany	0.16	0.18	0.71	0.78
Greece	0.08	0.11	0.48	0.94
Italy	0.12	0.13	0.64	0.64
Netherlands	0.12	0.15	0.69	0.63
Norway	0.19	0.21	0.60	1.03
Poland	0.11	0.14	0.61	0.83
Portugal	0.06	0.07	0.55	0.41
Spain	0.09	0.10	0.63	0.53
Sweden	0.19	0.20	0.71	1.18
Switzerland	0.17	0.17	0.62	0.59
United Kingdom	0.17	0.21	0.57	0.87
Region: North America				
Canada	0.18	0.24	0.63	0.98
United States	0.20	0.24	0.63	0.89
Region: Japan				
Japan	0.18	0.13	0.52	0.02
Region: Asia Pacific (ex. Japan)				
Australia	0.26	0.27	0.62	1.30
China	0.19	0.15	0.39	0.71
Hong Kong	0.19	0.17	0.49	0.99
India	0.07	0.11	0.51	0.71
Indonesia	0.11	0.12	0.37	0.72
Malaysia	0.13	0.14	0.45	0.83
New Zealand	0.11	0.18	0.61	1.00
Philippines	0.14	0.18	0.40	0.80
Singapore	0.19	0.16	0.42	0.90
S. Korea	0.15	0.12	0.29	0.76
Taiwan	0.20	0.16	0.60	0.93
Thailand	0.10	0.12	0.50	0.73
Region: Other America (ex. Canada and U.S.)				
Argentina	0.07	0.08	0.38	0.70
Brazil	0.12	0.14	0.46	0.81
Chile	0.06	0.10	0.53	0.63
Mexico	0.08	0.08	0.59	0.30
Region: Middle East				
Israel	0.26	0.25	0.58	0.71
Pakistan	0.08	0.11	0.33	0.58
Turkey	0.10	0.12	0.50	0.71
Region: Africa				
South Africa	0.13	0.14	0.58	0.62
Total	0.14	0.15	0.56	0.74

Table 3: Time-series correlation between labor share and cash policy

This table reports the distribution of the firm-level time-series correlation between labor share and cash policy ($Corr(LS, \Delta CASH)$). For every firm, we calculate $Corr(LS, \Delta CASH)$ using its time-series observations. Then we report the mean and standard deviation of these correlations within each country; we also report the same summary statistics for all countries in the last row "Total". The t-stat is for testing whether $Corr(LS, \Delta CASH) = 0$.

		$Corr(LS, \Delta CASH)$		
Country	Mean	St.D.	No of firms	t-stat
Region: Europe				
Austria	-0.01	0.33	119	-0.49
Belgium	0.08	0.33	134	2.98
Denmark	0.03	0.36	173	1.02
Finland	0.03	0.33	152	1.29
France	0.04	0.31	906	3.95
Germany	0.02	0.31	881	1.92
Greece	0.00	0.35	199	0.03
Italy	0.02	0.32	296	1.29
Netherlands	0.06	0.33	226	2.57
Norway	0.04	0.36	252	1.69
Poland	0.01	0.38	395	0.73
Portugal	0.05	0.34	68	1.20
Spain	0.06	0.30	151	2.57
Sweden	0.04	0.34	505	2.73
Switzerland	0.06	0.29	237	3.25
United Kingdom	0.04	0.36	2186	4.82
Region: North America				
Canada	0.03	0.44	886	2.31
United States	0.02	0.41	1865	1.76
Region: Japan				
Japan				
Region: Asia Pacific (ex. Japan)				
Australia	0.04	0.37	1712	4.75
China	0.08	0.34	134	2.63
Hong Kong	0.00	0.35	130	-0.01
India	0.01	0.28	2501	0.91
Indonesia	0.03	0.35	322	1.70
Malaysia	0.01	0.34	914	1.17
New Zealand	0.11	0.40	97	2.83
Philippines	0.01	0.36	139	0.33
Singapore	0.01	0.34	630	0.82
S. Korea	-0.07	0.46	12	-0.56
Taiwan	0.02	0.46	69	0.38
Thailand	0.05	0.35	424	2.83
Region: Other America (ex. Canada and U.S.)				
Argentina	0.09	0.44	44	1.35
Brazil	-0.02	0.37	221	-0.85
Chile	0.06	0.45	91	1.29
Mexico	0.04	0.44	54	0.66
Region: Middle East				
Israel	-0.01	0.39	311	-0.34
Pakistan	-0.03	0.34	249	-1.21
Turkey	0.07	0.40	174	2.16
Region: Africa				
South Africa	0.02	0.36	263	0.74
Total	0.03	0.35	18122	9.92

Table 4: Labor share and cash holdings

This table reports the panel regression results of analyzing whether labor share is associated with firm cash holding policy. We regress the changes in cash ratios (ΔCASH) from year t to $t+1$ on labor share (LS) and other control variables in year t. We also interact the labor share with a labor expense rigidity measure Rigid, defined as the inverse of the labor expenses growth volatility. The other variables include lagged ΔCASH, stock return volatility (σ), book to market ratio (BM), firm size (Size), cash flows (CF), working capital net of cash (WC), investments (Capex), book leverage (Leverage), R&D expenses (RD), dividend payment dummy (Dividend Payer), acquisitions (Acquisitions), debt issuance (DebtIssue), and equity issuance (EquityIssue). We also control for country or country*year fixed effects. The details of the variable constructions can be found in the appendix. The t-statistics reported in the parentheses below each coefficient estimate are based on robust standard errors clustered at the firm level. Statistical significance levels of 1%, 5%, and 10% are indicated with ***, **, and * respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
LS	0.27***	0.15***	0.28***	0.26***	0.18**	0.17**
	(6.08)	(2.60)	(4.94)	(4.63)	(2.48)	(2.32)
Rigid×LS		0.05***			0.04**	0.04**
		(2.79)			(2.20)	(2.01)
Rigid		0.01			0.01	0.01
		(1.09)			(0.89)	(1.29)
lagΔCASH			-0.19***	-0.19***	-0.19***	-0.19***
			(-37.32)	(-37.53)	(-36.93)	(-37.12)
σ			0.42***	0.10	0.46***	0.15
			(2.78)	(0.61)	(3.06)	(0.90)
BM			0.22***	0.18***	0.22***	0.18***
			(8.69)	(6.63)	(8.70)	(6.56)
Size			0.08***	0.09***	0.09***	0.10***
			(5.09)	(5.40)	(5.65)	(6.01)
CF			-0.51*	-0.48	-0.52*	-0.49
			(-1.72)	(-1.63)	(-1.72)	(-1.63)
WC			3.39***	3.54***	3.36***	3.50***
			(17.47)	(18.02)	(17.26)	(17.84)
Capex			-5.38***	-4.83***	-5.48***	-4.91***
			(-9.85)	(-8.79)	(-9.96)	(-8.89)
Leverage			3.53***	3.57***	3.49***	3.53***
			(20.50)	(20.38)	(20.38)	(20.28)
RD			-0.37**	-0.37**	-0.29*	-0.29*
			(-2.31)	(-2.27)	(-1.82)	(-1.78)
Dividend Payer			0.23***	0.18***	0.21***	0.15**
			(3.60)	(2.66)	(3.29)	(2.29)
Acquisitions			-6.01***	-4.78***	-5.89***	-4.60***
			(-7.17)	(-5.48)	(-6.98)	(-5.24)
DebtIssue			-5.48***	-5.25***	-6.93***	-6.64***
			(-2.81)	(-2.70)	(-3.48)	(-3.35)
EquityIssue			-6.54***	-6.19***	-6.36***	-5.95***
			(-10.44)	(-9.63)	(-9.92)	(-9.05)
Observations	157674	154751	98506	98506	97431	97431
R-squared	0.003	0.003	0.064	0.078	0.063	0.077
Country FE	Yes	Yes	Yes		Yes	
Country*Year FE				Yes		Yes

Table 5

Predetermined parameters

This table presents the predetermined parameter values under baseline calibration.

Description	Notation	Value	Justification
Technology			
Subjective discount factor	β	0.992	Long-run average value for U.S. firm-level discount rate (King and Rebello (1999))
Rate of depreciation for capital	δ_k	0.12	Capital depreciation rate 12% per year
Exit rate for labor	δ_n	0.24	Labor turnover 24% per year
Stochastic process			
Persistence of firm productivity	ρ	0.78	Hennessy and Whited (2005)
Conditional volatility of frm productivity	σ	0.17	Hennessy and Whited (2005)

Table 6

Model SMM estimated parameters and regression result

This table reports the estimated model parameter values and the corresponding SMM standard errors in the brackets below in panel A and model implied regression slopes of cash growth rate ($\Delta L_{i,t}$) on labor share ($W_{i,t}N_{i,t}/Y_{i,t}$ after controlling for productivity growth) in panel B. Columns (1) to (6) are baseline model (Baseline), the model without wage rigidity (No Rigidity), the model without labor adjustment cost (No LCost), the model without wage rigidity and labor adjustment cost and labor exit rate being 1 (No Lfrictions), the model without capital adjustment cost (No KCost), and the model without financial adjustment cost (No FinCost).

	(1) **Baseline**	(2) **No Rigidity**	(3) **No LCost**	(4) **No Lfrictions**	(5) **No KCost**	(6) **No FinCost**
A: SMM estimated parameters						
a: capital share	0.176	0.408	0.196	0.301	0.153	0.1847
	(0.0001)	(0.000)	(0.0002)	(0.0001)	(0.0003)	(0.0001)
b: labor share	0.657	0.573	0.766	0.665	0.667	0.6972
	(0.000)	(0.0001)	(0.001)	(0.000)	(0.001)	(0.0001)
c_k: capital adjustment cost	0.011	0.048	0.056	0.054	0	0.0382
	(0.000)	(0.000)	(0.001)	(0.001)	na	(0.001)
c_n: labor adjustment cost	0.148	0.183	0	0	0.153	0.1352
	(0.000)	(0.000)	na	na	(0.000)	(0.001)
μ: wage rigidity	0.852	0	0.600	0	0.833	0.766
	(0.0001)	na	(0.0001)	na	(0.0002)	(0.0001)
r_l: return on saving	0.751	0.670	0.572	0.384	0.835	na
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	na
η_0: fixed financing cost	0.010	0.002	0.009	0.005	0.012	0
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	na
η_1: linear financing cost	0.118	0.076	0.094	0.154	0.097	0
	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	na
B: Model regression coefficients						
$\Delta L_{i,t}$ on labor-share$_{i,t}$	2.766	0.010	0.713	-0.517	2.707	na

Table 7

SMM estimation results

Column (7) reports the data moments estimated from Compustat Global. Columns (1) to (6) are baseline model (Baseline), the model without wage rigidity (No Rigidity), the model without labor adjustment cost (No LCost), the model without wage rigidity, labor adjustment cost and exit rate being 1 (No Lfrictions), the model without capital adjustment cost (No KCost), and the model without financial adjustment cost (No FinCost), respectively. The moments the SMM targets are equity issuance fraction (Issuance fraction$_{i,t}$), cash-to-asset ratio (Cash-to-asset ratio$_{i,t}$), labor share defined as $W_{i,t}N_{i,t}/Y_{i,t}$ (Labor share$_{i,t}$), the investment rate volatility ($\sigma\left(I_{i,t}/K_{i,t}\right)$), hiring rate volatility ($\sigma\left(N_{i,t+1}/N_{i,t}\right)$), cash growth volatility ($\sigma\left(L_{i,t+1}/L_{i,t}\right)$), real sales growth volatility ($\sigma\left(Y_{i,t+1}/Y_{i,t}\right)$), labor expense growth volatility ($\sigma\left(W_{i,t+1}N_{i,t+1}/W_{i,t}N_{i,t}\right)$) and issuance-to-asset volatility ($\sigma\left(H_{i,t}/K_{i,t}\right)$)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Baseline	**No Rigidity**	**No LCost**	**No Lfrictions**	**No KCost**	**No FinCost**	**Data**
Issuance fraction$_{i,t}$	0.267	0.258	0.466	0.531	0.224	0.303	0.247
Cash-to-asset ratio$_{i,t}$	0.114	0.007	0.209	0.113	0.104	0	0.162
Labor share$_{i,t}$	0.658	0.582	0.786	0.670	0.668	0.699	0.621
$\sigma\left(I_{i,t}/K_{i,t}\right)$	0.318	0.338	0.195	0.223	0.327	0.349	0.298
$\sigma\left(N_{i,t+1}/N_{i,t}\right)$	0.247	0.213	0.208	0.166	0.239	0.258	0.260
$\sigma\left(L_{i,t+1}/L_{i,t}\right)$	0.672	1.071	0.768	0.818	0.736	0	0.731
$\sigma\left(Y_{i,t+1}/Y_{i,t}\right)$	0.312	0.253	0.303	0.179	0.309	0.338	0.379
$\sigma\left(W_{i,t+1}N_{i,t+1}/W_{i,t}N_{i,t}\right)$	0.270	0.239	0.268	0.193	0.266	0.293	0.506
$\sigma\left(H_{i,t}/K_{i,t}\right)$	0.082	0.077	0.184	0.041	0.082	0.224	0.217

Table 8

Interactions between wage rigidity and cash holding

This table reports the coefficients b and c of the regression: $\Delta L_{i,t} = a + b \cdot LS_{i,t} + c \cdot (LS_{i,t} \cdot D_i^{Rigid}) + D_i^{Rigid} + \varepsilon_{i,t},$, where in the model $\Delta L_{i,t}$ are cash growth, $LS_{i,t}$ are firm labor share after controlling for productivity growth, D_i^{Rigid} is a dummy variable with value 1 for more rigid firms (wage rigidity parameter $\mu > 0.3$) and 0 for less rigid firms ($\mu = 0.3$). Column (1) reports regression results from the data where rigid firms are the top 10th percentage (or 90th percentile) and less rigid firms are the remaining ones in rankings of the measure of rigidity. In column (2) rigid firms are from the baseline model with wage rigidity parameter $\mu = 0.85$, and in columns (3) and (4) rigid firms are from models with wage rigidity parameter $\mu = 0.75$ and $\mu = 0.95$, respectively. Less rigid firms are from the model with $\mu = 0.3$ and stay the same in columns (2)-(4). All model coefficients are significant at the 1% level with firm-clustered standard errors.

	(1)	(2)	(3)	(4)
	Data	$\text{Rigid}_{\text{Baseline}}$	$\text{Rigid}_{\text{Less}}$	$\text{Rigid}_{\text{More}}$
Rigidity μ		0.85	0.75	0.95
$\widetilde{LS}_{i,t}$	0.88	0.143	0.143	0.141
$\widetilde{LS}_{i,t} \cdot D_i^{Rigid}$	2.06	2.623	2.982	3.616