Corporate Cash and Employment

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ONLINE APPENDIX

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1 Model's Description

1.1 The Entrepreneur's Problem

Entrepreneurs maximize Equation (2) in the paper subject to (5)-(9), and $\tilde{M}_t \geq 0$. They also take into account the production function $Y_{it} = F(K_{it}, A_{it}l_{it})$. The production function has constant returns to scale so we can write $Y_{it} = A_{it}l_{it}f(k_{it}/A_{it})$, with $f(k) = F(k, 1)$ and with k the capital-labor ratio K/l. All three shocks A_{it}, ϕ_{it} and κ_{it} are known at the beginning-of-period. We denote by $E_t(.)$ the expectation conditional on the beginning-of-period information. The Lagrangian problem is

$$\begin{aligned}
\mathcal{L}_{it} = \; & E_t \sum_{s=t}^{\infty} \beta^{s-t} \{u(c_{is}) \\
& + \gamma_{is} \left[\tilde{M}_{is-1} + Y_{is-1} + (1-\delta)K_{is-1} - r_{s-1}D_{is-1} - r^L_{ts-1}L_{is-1} + D_{is} - c_{is} - K_{is} - M_{is} \right] \\
& + \eta_{is} \left[M_{is} + L_{is} - w_t l_{is} - \tilde{M}_{is} \right] \\
& + \lambda_{is} \left[\phi_{is}(1-\delta)K_{is} - r_s D_{is} \right] \\
& + \nu_{is} \left[\kappa_{is}(1-\delta)K_{is} - r^L_s L_{is} \right] \\
& + \mu_{is} \tilde{M}_{is} \}
\end{aligned}$$

The entrepreneur's program yields the following first-order conditions with respect to l_{it}, c_{it}, K_{it}, D_{it}, M_{it}, $\tilde{M}_{it}$ and L_{it}:

$$w_t \eta_{it} = A_{it} F_{lit} \beta E_t \gamma_{it+1} \quad (1)$$

$$u'(c_{it}) = \gamma_{it} \quad (2)$$

$$\gamma_{it} = \beta F_{Kit} E_t \gamma_{it+1} + (1-\delta)(\phi_{it}\lambda_{it} + \kappa_{it}\nu_{it}) \quad (3)$$

$$\gamma_{it} = \beta r_t E_t \gamma_{it+1} + r_t \lambda_{it} \quad (4)$$

$$\gamma_{it} = \eta_{it} \quad (5)$$

$$\eta_{it} = \beta E_t \gamma_{it+1} + \mu_{it} \quad (6)$$

$$\eta_{it} = \beta r^L_t E_t \gamma_{it+1} + r^L_t \nu_{it} \quad (7)$$

Studying these FOCs indicates which constraints are binding. Since $\gamma_{it} = u'(c_{it}) > 0$, then $\eta_{it} > 0$ according to (5), which implies that both budget constraints are binding. Moreover, using (1), (4) and (5), we obtain:

$$\beta \left(\frac{A_{it}F_{lit}}{w_t} - r_t \right) E_t \gamma_{it+1} = r_t \lambda_{it}$$

This implies that whenever $w_t r_t < A_{it}F_{lit}$, the long-term credit constraint is binding ($\lambda_{it} > 0$). Besides, using (4), (5) and (7), we find:

$$\beta(r_t - r^L_t)E_t \gamma_{it+1} + r_t \lambda_{it} = r^L_t \nu_{it} \quad (8)$$

Therefore, if $r_t > r^L_t$, then the short-term credit constraint is binding ($\nu_{it} > 0$). Finally, using (6) and (7), we find:

$$\beta(r^L_t - 1)E_t \gamma_{it+1} + r^L_t \nu_{it} = \mu_{it}$$

Therefore, if $r^L_t > 1$, then the entrepreneurs hold no excess money ($\mu_{it} > 0$).

Assume now that $r_t > r_t^L > 1$ and make the guess that $\lambda_{it} > 0$ (we will determine later under which conditions the long-term credit constraint is indeed binding). Then all the constraints are binding and we can write $\tilde{M}_{it} = 0$, $D_{it} = \phi(1-\delta)K_{it}/r_t$ and $M_{it} = w_t l_{it} - \kappa_{it}(1-\delta)K_{it}/r_t^L$. We can then rewrite the objective as

$$\begin{aligned} \mathcal{L}_{it} \quad = \quad & E_t \textstyle\sum_{s=t}^{\infty} \beta^{s-t} \{u(c_{is}) \\ & +\gamma_{is}\big[Y_{is-1} + (1-\delta)K_{is-1}(1-\kappa_{is-1}-\phi_{is-1}) \\ & -c_{it} - K_{is}[1-(1-\delta)(\phi_{is}/r_{is} + \kappa_{is}/r_{is}^L)] - w_{is}l_{is}\big] \end{aligned} \tag{9}$$

The optimality conditions with respect to c_{it}, l_{it} and K_{it} are:

$$\gamma_{it} = u'(c_{it}) \tag{10}$$

$$w_t\gamma_{it} = A_{it}F_{lit}\beta E_t\gamma_{it+1} \tag{11}$$

$$[1-(1-\delta)(\kappa_{it}/r_t^L + \phi_{it}/r_t)]\gamma_{it} = \beta E_t\gamma_{it+1}[F_{Kit} + (1-\delta)(1-\phi_{it}-\kappa_{it})] \tag{12}$$

Combining (11) with (12), we obtain:

$$\frac{w_t}{A_{it}} = \frac{[1-(1-\delta)(\kappa_{it}/r_t^L + \phi_{it}/r_t)]F_{lit}}{F_{Kit} + (1-\delta)(1-\phi_{it}-\kappa_{it})}$$

F has constant returns to scale so we can write: $F(K, Al) = Alf(K/Al)$. Therefore, $F_K(K, Al) = f'(K/Al)$ and $F_l(K, Al) = f(K/Al) - Kf'(K/Al)/Al$. As a consequence, $w_t/A_{it} = \tilde{w}(\tilde{k}_{it}, \phi_{it}, \kappa_{it})$, with $\tilde{k}_{it} = K_{it}/A_{it}l_{it}$ and

$$\tilde{w}(\tilde{k}_{it}, \phi_{it}, \kappa_{it}, r_t, r_t^L) = \frac{[1-(1-\delta)(\kappa_{it}/r_t^L + \phi_{it}/r_t)][f(\tilde{k}_{it}) - \tilde{k}_{it}f'(\tilde{k}_{it})]}{f'(\tilde{k}_{it}) + (1-\delta)(1-\phi_{it}-\kappa_{it})} \tag{13}$$

Since F is increasing in l, $F_{lit} = f(\tilde{k}_{it}) - \tilde{k}_{it}f'(\tilde{k}_{it}) > 0$. Besides, since F is concave in K, we have $f'' < 0$. We can show that this implies that $\tilde{w}$ is strictly increasing in $\tilde{k}$. If there exists a solution $\tilde{k}(\tilde{w}_{it}, \phi_{it}, \kappa_{it}, r_t, r_t^L)$ to that equation, then this solution is unique.[1] Finally, k_{it} is then given by $k_{it} = A_{it}\tilde{k}(\tilde{w}_{it}, \phi_{it}, \kappa_{it}, r_t, r_t^L)$.

Note that the long-term credit constraint is binding whenever $\tilde{w}_{it}r_t < F_{lit}$. Combining this inequality with (13), we find that this is equivalent to:

$$f'(\tilde{k}_{it}) + (1-\delta)(1-\kappa_{it}-\phi_{it}) > r_t[1-(1-\delta)(\kappa_{it}/r_t^L + \phi_{it}/r_t)] \tag{14}$$

$$\Leftrightarrow \tilde{k}_{it} < (f'^{-1}\Big(r_t[1-(1-\delta)(\kappa_{it}/r_t^L + \phi_{it}/r_t)] - (1-\delta)(1-\kappa_{it}-\phi_{it})\Big)$$

Finally, according to (13), $\tilde{k}_{it}$ is increasing in $\tilde{w}_{it}$, so this inequality is satisfied for $\tilde{w}_{it}$ lower than some $\tilde{w}^*(\kappa_{it}, \phi_{it}, r_t, r_t^L)$ and thus for w_t lower than some $w^*(A_{it}, \kappa_{it}, \phi_{it}, r_t, r_t^L)$.

In order to study how k is affected by ϕ, we differentiate Equation (13) with respect to it and find after rearranging

$$\frac{\partial\tilde{k}_{it}}{\partial\phi_{it}} = \frac{(1-\delta)[f(\tilde{k}_{it}) - \tilde{k}_{it}f'(\tilde{k}_{it})]\left[f'(\tilde{k}_{it}) - r_t + (1-\delta)\left(1-\kappa+\kappa_{it}r_t/r_t^L\right)\right]}{-r_tf''(\tilde{k}_{it})[1-(1-\delta)(\kappa_{it}/r_t^L + \phi_{it}/r_t)][f(\tilde{k}_{it}) + (1-\delta)(1-\phi_{it}-\kappa_{it})\tilde{k}_{it}]}$$

As $f'' < 0$, the denominator is positive. The sign of the numerator depends then on $f'(\tilde{k}_{it}) - r_t + (1-\delta)\left(1-\kappa+\kappa_{it}r_t/r_t^L\right)$. Using (3), (4) and (8), we can establish:

$$\left[f'(\tilde{k}_{it}) - r_t + (1-\delta)\left(1-\kappa+\kappa_{it}r_t/r_t^L\right)\right]\beta E_t\gamma_{it+1} = \lambda_{it}r_t[1-(1-\delta)(\kappa_{it}/r_t^L + \phi_{it}/r_t)]$$

[1] We can show that such a solution always exists in the Cobb-Douglas case.

When the constraint is binding, we have $\lambda_{it} > 0$. Besides, it is reasonable to assume that $1-(1-\delta)(\kappa_{it}/r_t^L+\phi_{it}/r_t) > 0$ (it is sufficient that $\phi_{it}+\kappa_{it} \leq 1$). Therefore, $f'(\tilde{k}_{it})-r_t+(1-\delta)\left(1-\kappa+\kappa_{it}r_t/r_t^L\right)$, so the numerator is positive as well, so $\partial\tilde{k}_{it}/\partial\phi_{it} > 0$. Following similar steps, we find $\partial\tilde{k}_{it}/\partial\kappa_{it} > 0$. Then k_{it} is also increasing in ϕ_{it} and κ_{it}.

Differentiating Equation (13) with respect to $\tilde{w}$, we find after rearranging

$$\frac{\partial\tilde{k}_{it}}{\partial\tilde{w}_{it}} = \frac{[f'(\tilde{k}_{it})+(1-\delta)(1-\phi_{it}-\kappa_{it})]^2}{-f''(\tilde{k}_{it})[1-(1-\delta)(\kappa_{it}/r_t^L+\phi_{it}/r_t)][f(\tilde{k}_{it})+(1-\delta)(1-\phi_{it}-\kappa_{it})\tilde{k}_{it}]}$$

Note that $k_{it} = A_{it}\tilde{k}_{it}$ and $w_t = A_{it}\tilde{w}_{it}$ so

$$\frac{\partial k_{it}}{\partial w_t} = A_{it}\frac{\partial\tilde{k}_{it}}{\partial\tilde{w}_{it}}\frac{\partial\tilde{w}_{it}}{\partial w_t} = \frac{\partial\tilde{k}_{it}}{\partial\tilde{w}_{it}} > 0,$$

$$\begin{aligned}\frac{\partial k_{it}}{\partial A_{it}} &= \tilde{k}_{it} + A_{it}\frac{\partial\tilde{k}_{it}}{\partial\tilde{w}_{it}}\frac{\partial\tilde{w}_{it}}{\partial A_{it}} = \tilde{k}_{it} - \frac{\partial\tilde{k}_{it}}{\partial\tilde{w}_{it}}\tilde{w}_{it} \\ &= \tilde{k}_{it} - \frac{[f'(\tilde{k}_{it})+(1-\delta)(1-\phi_{it}-\kappa_{it})][f(\tilde{k}_{it})-\tilde{k}_{it}f'(\tilde{k}_{it})]}{-f''(\tilde{k}_{it})[f(\tilde{k}_{it})+(1-\delta)(1-\phi_{it}-\kappa_{it})\tilde{k}_{it}]}\end{aligned}$$

In the Cobb-Douglas case, we have

$$\frac{\partial k_{it}}{\partial A_{it}} = \frac{-(1-\alpha)^2(1-\delta)(1-\phi_{it}-\kappa_{it})f(\tilde{k}_{it})}{-f''(\tilde{k}_{it})[f(\tilde{k}_{it})+(1-\delta)(1-\phi_{it}-\kappa_{it})\tilde{k}_{it}]} < 0$$

Proof of Proposition 1 Assume that the credit constraint is binding and that $r_t > r_t^L > 1$. Then the program of the firm is described by (9) and by the FOCs (10)-(13). We make the educated guess that there exists χ such that $c_{it} = (1-\chi)\Omega_{it}$. Combining our guess with (5), (7), (8), (10) and (13), we obtain

$$\chi\Omega_{it} = K_{it} + w_t l_{it} - (1-\delta)(\kappa_{it}/r_t^L + \phi_{it}/r_t)K_{it} = A_{it}l_{it}[\tilde{k}_{it} + \tilde{w}_{it} - (1-\delta)(\kappa_{it}/r_t^L+\phi_{it}/r_t)\tilde{k}_{it}]$$

Replacing $\tilde{w}_{it}$ using (13) and rearranging, we obtain

$$\chi\Omega_{it} = A_{it}l_{it}\frac{[1-(1-\delta)(\kappa_{it}/r_t^L+\phi_{it}/r_t)][f(\tilde{k}_{it})+(1-\delta)(1-\phi_{it}-\kappa_{it})\tilde{k}_{it}]}{f'(\tilde{k}_{it})+(1-\delta)(1-\phi_{it}-\kappa_{it})}$$

As $\Omega_{it+1} = A_{it}l_{it}[f(\tilde{k}_{it})+(1-\delta)(1-\phi_{it}-\kappa_{it})\tilde{k}_{it}]$, we have

$$\chi\Omega_{it} = \frac{[1-(1-\delta)(\kappa_{it}/r_t^L+\phi_{it}/r_t)]\Omega_{it+1}}{f'(\tilde{k}_{it})+(1-\delta)(1-\phi_{it}-\kappa_{it})} \tag{15}$$

Using (10) and (12) under log-utility $u(c) = \log(c)$, we obtain the following Euler equation

$$\frac{1}{c_{it}}[1-(1-\delta)(\kappa_{it}/r_t^L+\phi_{it}/r_t)] = \beta E_t\left\{\frac{1}{c_{it+1}}\right\}[f'(\tilde{k}_{it})+(1-\delta)(1-\phi_{it}-\kappa_{it})]$$

Given that shocks are known at the beginning-of-period, $c_{it+1} = \chi\Omega_{it+1}$ is known at the beginning-of-period, so the Euler equation can be written without the expectations operator

$$\frac{1}{c_{it}}[1-(1-\delta)(\kappa_{it}/r_t^L+\phi_{it}/r_t)] = \beta\frac{1}{c_{it+1}}[f'(\tilde{k}_{it})+(1-\delta)(1-\phi_{it}-\kappa_{it})]$$

Using our guess $c_{it} = \chi\Omega_{it}$ and $c_{it+1} = \chi\Omega_{it+1}$ to replace c_{it} and c_{it+1}, we obtain

$$\beta\Omega_{it} = \frac{[1-(1-\delta)(\kappa_{it}/r_t^L+\phi_{it}/r_t)]\Omega_{it+1}}{f'(\tilde{k}_{it})+(1-\delta)(1-\phi_{it}-\kappa_{it})} \tag{16}$$

Combining (15) and (16) yields $\chi = \beta$.

Combining $c_{it} = (1-\beta)\Omega_{it}$ with the binding constraints (5), (8) and (11), we can easily derive equations (15)-(19) in Proposition 1 of the paper.

Proof of Corollary 1 According to Equation (13) in the paper, a decline in κ_{it} increases the cash ratio through a lower level of external liquid funds and through a lower capital-labor ratio. A decline in ϕ_{it} increases the cash ratio through a lower capital-labor ratio. A decline in A_{it} decreases the cash ratio through a higher capital-labor ratio.

According to Equation (15), the effect on labor depends directly on the effect on the financial multiplier Z_{it}. We can rewrite Z_{it} as follows:

$$Z_{it} = \frac{\beta}{w_t + A_{it}\tilde{k}_{it}[1-(1-\delta)(\kappa_{it}/r_t^L + \phi_{it}/r_t)]}$$

So the effect on Z_{it} depends on the effect on $X_{it} = \tilde{k}_{it}[1-(1-\delta)(\kappa_{it}/r_t^L + \phi_{it}/r_t)]$. In the Cobb-Douglas case, we have

$$\frac{\partial X_{it}}{\partial \phi_{it}} = (1-\delta)f(\tilde{k}_{it})\frac{-\alpha(1-\alpha)(1-\phi_{it}-\kappa_{it})/r_t - (1-\alpha)\left[1-(1-\delta)\left((1-\kappa_{it})/r_t + \kappa_{it}/r_t^L\right)\right]}{|f''(\tilde{k}_{it})|[f(\tilde{k}_{it}) + (1-\delta)(1-\phi_{it}-\kappa_{it})\tilde{k}_{it}]} < 0$$

Similarly, we have $\partial X_{it}/\partial \kappa_{it} < 0$. Therefore, a decline in ϕ_{it} or κ_{it} decreases the financial multiplier Z_{it} and hence has a negative impact on labor. Note finally that, in the Cobb-Douglas case, k_{it} is decreasing in A_{it} as shown earlier. As a result, Z_{it} and l_{it} are increasing in A_{it}.

1.2 The household's problem

The household has utility U_t with the discount factor β:

$$U_t = E_t \sum_{s=0}^{\infty} \beta^s \left[v(c_{t+s}^h, l_{t+s-1})\right] \tag{17}$$

where c_t^h is households' consumption in the beginning-of-period, and l_{t-1} is the labor supplied by the households at the beginning of period t as well. However, note that l_{t-1} is agreed upon at the end of period $t-1$.

The household maximizes this utility subject to her budget constraint

$$w_{t-1}l_{t-1} + R_{t-1}D_{t-1}^h + T_t = c_t^h + D_t^h \tag{18}$$

The household's Lagrangian writes then as follows:

$$\begin{aligned}\mathcal{L}_t^h &= E_t \sum_{s=t}^{\infty} \beta^{s-t} \left\{ \frac{\left(c_s^h - \bar{w}\frac{l_{s-1}^{1+1/\eta}}{1+1/\eta}\right)^{1-\sigma}}{1-\sigma} \right. \\ &\quad \left. + \gamma_s^h \left[w_{t-1}l_{t-1} + R_{t-1}D_{t-1}^h + T_t - c_t^h - D_t^h\right] \right\}\end{aligned}$$

The household's program yields the following first-order conditions with respect to l_t, c_t^h, and D_t^h:

$$w_t E_t \gamma_{t+1}^h = \bar{w} l_t^{1/\eta} E_t \left(c_{t+1}^h - \bar{w}\frac{l_t^{1+1/\eta}}{1+1/\eta}\right)^{-\sigma} \tag{19}$$

$$\left(c_t^h - \bar{w}\frac{l_{t-1}^{1+1/\eta}}{1+1/\eta}\right)^{-\sigma} = \gamma_t^h \tag{20}$$

$$\gamma_t^h = \beta R_t E_t \gamma_{t+1}^h \tag{21}$$

where E_t is the expectation at the beginning-of-period. Combining (19) and (20), we obtain:

$$w_t = \bar{w} l_t^{1/\eta}$$

1.3 Equilibrium with aggregate shocks only

Before characterizing the steady state, we establish the following Lemma:

Lemma 1 *If $r_t > r_t^L > 1$, there exists an increasing function $\Omega^*(A_t, \kappa_t, \phi_t, r_t, r_t^L)$ so that the credit constraint is binding whenever $\Omega_t < \Omega^*$. In that case the dynamics of K_t, M_t, D_t, l_t and Ω_{t+1} follow:*

$$l_t = Z(w_t, A_t, \kappa_t, \phi_t, r_t, r_t^L)\Omega_t \tag{22}$$

$$K_t = k(w_t, A_t, \kappa_t, \phi_t, r_t, r_t^L)Z(w_t, A_t, \kappa_t, \phi_t, r_t, r_t^L)\Omega_t \tag{23}$$

$$M_t = [w_t - \kappa_t(1-\delta)k(w_t, A_t, \kappa_t, \phi_t, r_t, r_t^L)/r_t^L]Z(w_t, A_t, \kappa_t, \phi_t, r_t, r_t^L)\Omega_t \tag{24}$$

$$D_t = \phi_t(1-\delta)k(w_t, A_t, \kappa_t, \phi_t, r_t, r_t^L)Z(w_t, A_t, \kappa_t, \phi_t, r_t, r_t^L)\Omega_t/r_t \tag{25}$$

$$\begin{aligned}\Omega_{t+1} \quad = \quad & [(1-\delta)(1-\kappa_t-\phi_t)k(w_t, A_t, \kappa_t, \phi_t, r_t, r_t^L) \\ & + A_t f[k(w_t, A_t, \kappa_t, \phi_t, r_t, r_t^L)/A_t]Z(w_t, A_t, \kappa_t, \phi_t, r_t, r_t^L)\Omega_t\end{aligned} \tag{26}$$

where

$$Z(w_t, A_t, \kappa_t, \phi_t, r_t, r_t^L) = \frac{\beta}{w_t + [1-(1-\delta)(\kappa_t/r_t^L + \phi_t/r_t)]k(w_t, A_t, \kappa_t, \phi_t, r_t, r_t^L)}$$

is the financial multiplier and

$$w_t = w(A_t, \kappa_t, \phi_t, r_t, r_t^L, \Omega_t)$$

is the equilibrium wage so that $w(A_t, \kappa_t, \phi_t, r_t, r_t^L, \Omega_t)$ is the solution to $l^s(w_t) = Z(w_t, A_t, \kappa_t, \phi_t, r_t, r_t^L)\beta r_t \Omega_t$.

Proof. Note that, as shown earlier, if $r_t > r_t^L > 1$, then Proposition 1 holds and the credit constraint is binding whenever $w_t < w^*(A_t, \kappa_t, \phi_t, r_t, r_t^L)$. Since we also have that the constrained equilibrium wage w is increasing in Ω_t, then there exists an increasing function Ω^* so that $w_t < w^*(A_t, \kappa_t, \phi_t, r_t, r_t^L)$ is equivalent to $\Omega_t < \Omega^*(A_t, \kappa_t, \phi_t, r_t, r_t^L)$. The rest of the Lemma derives from Proposition **??**. ■

Using this Lemma, we can study the steady state. For all the constraints to be binding, so that Proposition 1 and Lemma 1 hold, we must have $r > r^L > 1$ in the steady state, and that the inequality (14) is satisfied. $r^L = 1 + \psi > 1$ is given by the assumption $\psi > 0$. According to (20) and (21), the stationarity of c^h and l implies that $R = 1/\beta$. Since $r = \tau R$, then $r > r^L$ is guaranteed by $\tau/\beta > 1 + \psi$

From Equation (26), we have that the steady-state wage must satisfy:

$$\tilde{w} + \tilde{k}[1-(1-\delta)(\kappa/r^L + \phi/r)] = \beta[f(\tilde{k}) + (1-\delta)(1-\kappa-\phi)\tilde{k}]$$

Replacing $\tilde{w}$ using (13) and rearranging:

$$1-(1-\delta)(\kappa/r^L + \phi/r) = \beta[f'(\tilde{k}) + (1-\delta)(1-\kappa-\phi)]$$

Since $r > r^L$, inequality (14) is satisfied as long as $1/\beta > r = \tau R$. Since $R = 1/\beta$, $1/\beta > r$ if and only if $\tau < 1$. Therefore, the constraints are binding in the steady state if $\beta < \tau < 1$ and $0 < \psi < \tau/\beta - 1$. These conditions implies that for small enough shocks, the equilibrium is constrained.

2 Numerical Method

The algorithm to compute the steady-state distribution of firms in Section IV is as follows:

1. We first choose a grid of wealth Ω_{it}. Our grid is a 1000-value grid over $[5, 65]$. We use the Chebychev nodes to make the grid more concentrated on low values of Ω.

2. We allocate an initial uniform and independent distribution to the values of Ω_{i0}, κ_{i0} and A_{i0}, and make an initial guess on the equilibrium wage w_0.

3. Given the initial distribution on Ω_{it}, κ_{it} and A_{it} and the initial equilibrium wage w_0, we use Proposition 1 and the Markov Chain to compute the new distribution of Ω_{it+1}, κ_{it+1} and A_{it+1}. Using Proposition 1, we compute the corresponding distribution of labor demand l_{it+1}. We aggregate this labor demand $l_{t+1} = \sum_i l_{it+1}di$, and if $l_{t+1} > l^s(w_t)$ (if $l_{t+1} < l^s(w_t)$), then we update the equilibrium wage w_{t+1} upward (downward).

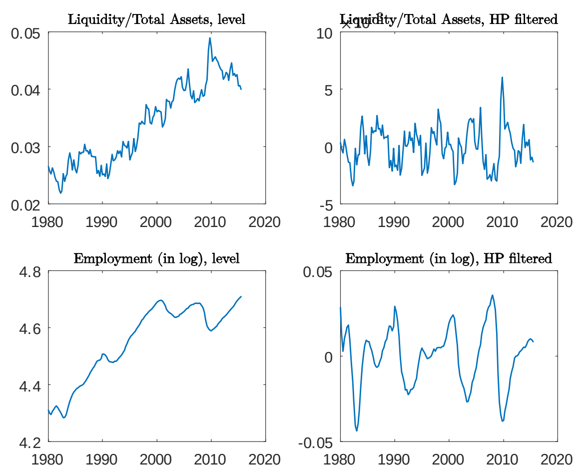
4. We repeat step 3 until the equilibrium wage is reached, i.e. when aggregate labor demand is fully satisfied.

3 Aggregate Data

3.1 Corporate Cash and Employment Comovement

Data description The corporate liquidity measure is built from the Table B.103 of the Flow-of-Funds Accounts. We define cash as the sum of private foreign deposits, checkable deposits and currency, total time and savings deposits and money market mutual fund shares. Corporate employment (in logarithm) is drawn from the Bureau of Labor Statistics. We consider the sample 1980Q1-2015Q3. Figure 1 displays the log of employment and the cash ratio, both in level and HP-filtered.

Figure 1: **Employment (in log) and Cash Ratio**



Employment and cash ratio correlation As shown in the paper, the correlation between the HP-filtered series of employment and the cash ratio is -0.43 and significant at 1%. Table 1 provides some robustness exercises to check the validity of this correlation. It is worth noticing that the correlation between the HP-filtered series of employment and the ratio between liquidity and the one-quarter lagged value of total assets is -0.35 and significant. In addition, the correlation between the share of liquidity to total financial assets (in contrast with total assets) and employment, both HP filtered, is -0.26 and significant. Finally, the correlation when we abstract from the Great Recession is lower (-0.19) but still significant.

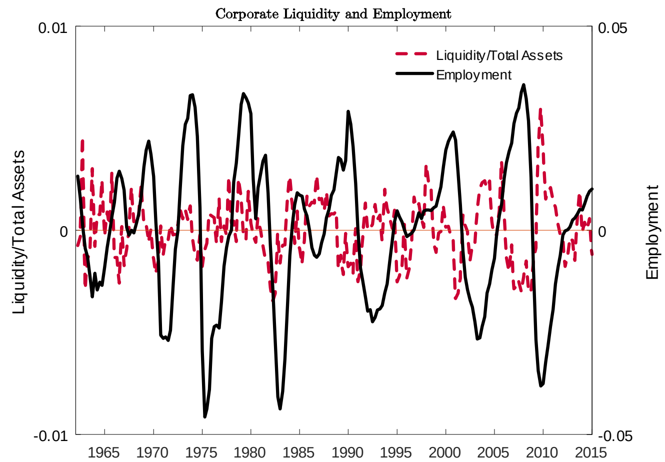
Table 1. Robustness Analysis

Liquidity ratio measure	Sample: Quarterly data	Correlation with employment
$\left(\frac{\text{Liquidity}}{\text{Total assets}}\right)_t$	1980q1-2015q3	-0.43^{**}
$\left(\frac{\text{Liquidity}_t}{\text{Total assets}_{t-1}}\right)$	1980q1-2015q3	-0.35^{**}
$\left(\frac{\text{Liquidity}}{\text{Total financial assets}}\right)_t$	1980q1-2015q3	-0.26^{**}

Note: The table reports correlation between the liquidity ratio and the log of employment. Both are detrended using HP filter. A */** next to the correlation coefficient indicates significance at the 10/5 percent level

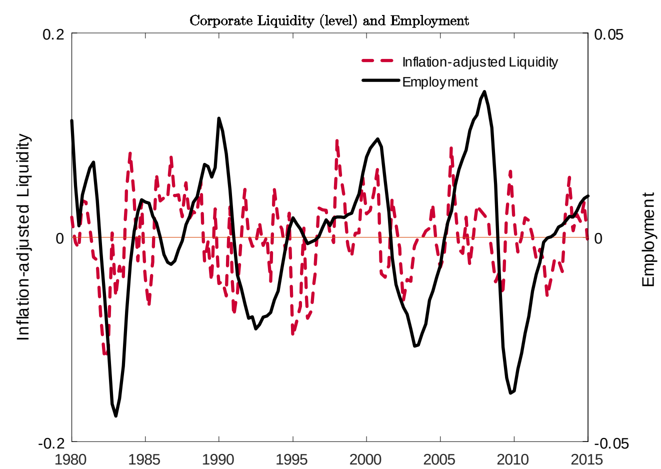
Alternative Sample In the manuscript, aggregate and firm-level stylized facts are computed over a sample starting from 1980. Since Flow-of-Funds Accounts provide data from 1962Q1, we show in Figure 2 the cash ratio and employment (in log, HP-filtered) over a longer period (1962Q1-2015Q3). The unconditional correlation is -0.27 and significant, which is slightly lower than in our benchmark calibration. This suggests that the correlation has been more negative post 1980.

Figure 2: **Cash Ratio and Employment, alternative sample**



Employment and cash level correlation Figure 3 displays the log of employment and the inflation-adjusted cash level, both in level and HP-filtered. We obtain a correlation of -0.12, insignificant.

Figure 3: **Cash Level and Employment (both in log and HP detrended)**



4 Firm-Level Data

4.1 Data description

The annual firm-level dataset is extracted from Compustat (Compustat North America, Fundamental Annual). We focus on balance sheet data of non-financial firms during the period 1980-2014 We exclude financial and utilities firms (6000<SIC<6999 and 4900<SIC<4949), and firms engaged in major mergers ($sale\_fn$ = "AB"). This is justified by the fact that part of the stock of cash holding is affected by acquisition. We also exclude firms which are not incorporated in US market ($curcd$!= "USD"). We select firms which are active at least 10 years over the sample.

Total assets, AT, is the book value of assets (Compustat data item #6). Employment, EMP, is the number of employees per firm multiplied by 100 (Compustat data item #29). Cash, CHE, is cash and short-term investments (Compustat data item #1). It includes cash, certificates of deposit, commercial paper, marketable securities, money market fund, time deposits, treasury bills listed as short-term. Sales correspond to Compustat data item #117. Capital expenditure, CAPX, corresponds to Compustat data item #128. We define debt as the sum of long-term debt (Compustat data item #9) and debt in current liabilities (Compustat data item #34). We define cash flow, CFLOW, as the income before extraordinary items (Compustat data item #118) + depreciation and amortization (Compustat data item #133) normalized by firm's capital. The latter is measured in the spirit of the perpetual inventory method by "depreciated" total asset and current capital expenditure. We define the leverage ratio, LEV, as the ratio between debt and the book value of assets. The market-to-book value of the firm captures the Tobin's q and it is measured as in Covas and den Haan (2011).[2]

Our sample consists in 18 052 firms. The cash ratio is defined as CHE divided to AT. Table 2 provides firm-level moments.

Table 2. Summary Statistics

	N	Mean	St. Dev	1st quartile	Median	3rd quartile
EMP (#)	185 555	8 288	35 885	94	572	3 500
AT ($m)	204 480	2 179	13 596	14	86	542
SALE ($)	203 675	1 818	10 411	11	81	525
$\frac{\text{CHE}}{\text{AT}}$	203 547	0.19	0.24	0.02	0.09	0.27

4.2 Employment and Cash Ratio Correlation

Table 3 reports the unconditional correlation and some robustness analysis.

Employment and cash ratio relationship We show that the negative correlation between employment and cash ratio is robust when we use OLS with firms-fixed effects, years-fixed effects, and standard control variables.

Benchmark relationship. We estimate the benchmark equation

$$\log(EMP)_{it} = \beta_1 + \beta_2 \left(\frac{CHE}{AT}\right)_{it} + \beta_3 \mathbf{X}_{it} + \zeta \mathbf{y}_t + \xi \mathbf{z}_i + \varepsilon_{it}, \tag{27}$$

[2] The market-to-book ratio is measured as

$$MTB = \frac{(csho \times prcc\_c + pstkl + dvp + lt)}{at},$$

where $csho$ is common shares outstanding (Compustat data idem #25), $prcc\_c$ is the stock price at the close of the firm's fiscal year (Compustat data idem #199), $pstkl$ is liquidating value of preferred stock (Compustat data idem #10), dvp is dividends on preferred stock (Compustat data idem #19), and lt is total liability.

Table 3. Robustness Analysis

	Sample	Correlation
Overall correlation	1980-2014	-0.22^{***}
Year-by-year correlation	1980-2014	-0.22^{***}
Firm-by-firm correlation	1980-2014	-0.19^{***}
Exclude 10% largest firms	1980-2014	-0.21^{***}
Exclude crisis	1980-2007	-0.22^{***}

Note: The table reports correlation between the cash ratio and the log of employment. Both are firm-specific detrended using linear trend. A */**/*** next to the correlation coefficient indicates significance at the 10/5/1 percent level.

where $\log(EMP)_{it}$ is the log of the number of employees, $\frac{CHE}{AT}_{it}$ is the cash ratio, $\mathbf{X}_{it}$ is a vector of firm-specific control variables. We control for unobservable heterogeneity at the firm level by introducing firms fixed effects, given by $\mathbf{z}_i$. The regression also includes sector-year fixed effects through $\mathbf{y}_t$ to account for macroeconomic fluctuations. All variables are firm-specific linearly detrended.

Table 4 reports the results. Each column displays a separate regression. In Column (1), we do not introduce any control variables in the vector $\mathbf{X}_{it}$. In Column (2), we control for the size of the firm measured by the sales ($\log(\text{SALE})_{it}$). In Column (3), we control for both the size of the firm and its cash flow at different horizons (CFLOW_{it}), the latter capturing firms' internal funds. In Column (4), we also introduce the leverage ratio (LEV_{it}) capturing the relative demand for credit and the log of capital expenditures ($\log(\text{CAPX})_{it}$) capturing the investment policy of the firm. We observe a negative and significant relation between the cash ratio and the number of employees. Interestingly, the coefficient is significant for both the current cash ratio and the lag of the cash ratio. In Column (6), we introduce the lagged dependant variable to counteract the potential serial correlation.

Variables in difference. We also perform the benchmark regression by taking the first differences of the variables (log of employment, cash ratio and control variables) instead of the deviation from their linear trend such that we estimate (see Table 5)

$$\Delta \log(EMP)_{it} = \beta_1 + \beta_2 \Delta \left(\frac{CHE}{AT}\right)_{it-1} + \beta_3 \Delta \mathbf{X}_{it-1} + \zeta \mathbf{y}_t + \xi \mathbf{z}_i + \varepsilon_{it}. \tag{28}$$

Table 4. **Benchmark estimation**: Employment and Cash Ratio

Dependent Variable: $\log(\mathrm{EMP}_{it})$	(1)	(2)	(3)	(4)	(5)
$\left(\frac{\mathrm{CHE}}{\mathrm{AT}}\right)_{it}$	-0.980** (0.038)	-0.362** (0.026)	-0.351** (0.027)	-0.342** (0..025)	-0.232** (0..020)
$\log(\mathrm{SALE})_{it}$		0.495** (0.009)	0.497** (0.010)	0.413** (0.010)	0.237** (0.009)
CFLOW_{it}			-0.002 (0.002)	-0.017** (0.003)	-0.007** (0.002)
LEV_{it}				-0.010** (0.002)	-0.006** (0.002)
$\log(\mathrm{CAPX})_{it}$				0.139** (0.004)	0.106** (0.003)
$\log(\mathrm{EMP})_{it-1}$					0.441** (0.011)
R-squared	0.07	0.41	0.41	0.47	0.60
Firm fixed effects	yes	yes	yes	yes	yes
Sector-year fixed effects	yes	yes	yes	yes	yes
Observations	140 497	136 612	119 163	116 743	109 787

Notes: Robust standard errors are in brackets. A */** next to the coefficient indicates significance at the 10/5 percent level

Table 5. **Variables in differences**: Employment and Cash Ratio

Dependent Variable: $\Delta\log(\mathrm{EMP}_{it})$	(1)	(2)	(3)	(4)	(5)
$\Delta\left(\frac{\mathrm{CHE}}{\mathrm{AT}}\right)_{it}$	-0.433** (0.060)	-0.258** (0.039)	-0.307** (0.018)	-0.306** (0.018)	-0.388** (0.020)
$\Delta\log(\mathrm{SALE})_{it}$		0.275** (0.007)	0.285** (0.008)	0.285** (0.008)	0.301** (0.010)
$\Delta\mathrm{CFLOW}_{it}$			-0.001* (0.001)	-0.001* (0.000)	-0.001* (0.000)
$\Delta\mathrm{LEV}_{it}$				-0.001 (0.001)	-0.000* (0.000)
$\Delta\log(\mathrm{CAPX})_{it}$				0.000** (0.000)	0.000** (0.000)
$\Delta\log(\mathrm{EMP}_{it-1})$					-0.106* (0.007)
R-squared	0.04	0.17	0.18	0.18	0.19
Firm fixed effects	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes
Observations	162 046	156 883	127 593	127 062	116 600

Notes: Robust standard errors are in brackets. A */** next to the coefficient indicates significance at the 10/5 percent level

4.3 Additional Results

In this section, we present additional regressions to assess the validity of our main result.

4.3.1 Alternative Measure of Firm's Size

In Table 4, we can control for the size using the sales (in log). Alternatively, the size of the firm could be captured by the log of total assets. The results of the benchmark estimation are unchanged, as shown by Table 6.

Table 6. **Alternative measure of firm's size**

Dependent Variable: $\log(\text{EMP}_{it})$	(1)	(2)	(3)	(4)	(5)
$\left(\frac{\text{CHE}}{\text{AT}}\right)_{it}$	-0.980^{**} (0.038)	-0.881^{**} (0.030)	-0.873^{**} (0.031)	-0.813^{**} (0..025)	-0.499^{**} (0..022)
$\log(\text{AT})_{it}$		0.557^{**} (0.008)	0.584^{**} (0.008)	0.528^{**} (0.008)	0.364^{**} (0.008)
CFLOW_{it}			0.001^{**} (0.001)	-0.003 (0.003)	-0.001 (0.002)
LEV_{it}				-0.001 (0.003)	-0.002 (0.003)
$\log(\text{CAPX})_{it}$				0.085^{**} (0.004)	0.069^{**} (0.003)
$\log(\text{EMP})_{it-1}$					0.423^{**} (0.010)
R-squared	0.07	0.44	0.45	0.49	0.62
Firm fixed effects	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes
Observations	140 497	140 497	121 881	118 312	111 141

Notes: Robust standard errors are in brackets. A */** next to the coefficient indicates significance at the 10/5 percent level

4.3.2 Exclusion of the 10% Largest Firms

In Table 4, even the very large firms are included. However, the largest firms may make specific financing decisions (see Covas and den Haan, 2011) or the cash holding of multinational companies might be driven by foreign tax incentives (see Foley et al., 2007). Table 7 show that the results are unchanged when the 10% largest firms are dropped from the sample (i.e for 10 294 firms).

4.3.3 Employment versus Inventories

Inventories, INVT, are available in Compustat (Compustat data item #3). The unconditional correlation between the cash ratio and the log of this variable over the sample 1980-2014 is -0.20 and it is significant at 1%. Notice that the correlation between employment and inventories is 0.57. Table 8 shows the benchmark regression where the dependant variable is the inventories rather than employment. The results are robust confirming that cash is used as for working capital financing.

Table 7. **Exclusion of 10% largest firms**

Dependent Variable: $\log(\text{EMP}_{it})$

	(1)	(2)	(3)	(4)	(5)
$\left(\frac{\text{CHE}}{\text{AT}}\right)_{it}$	-0.923^{**} (0.041)	-0.351^{**} (0.028)	-0.334^{**} (0.029)	-0.329^{**} (0.026)	-0.217^{**} (0.022)
$\log(\text{SALE})_{it}$		0.462^{**} (0.010)	0.460^{**} (0.011)	0.383^{**} (0.011)	0.225^{**} (0.009)
CFLOW_{it}			-0.002 (0.002)	-0.017 (0.004)	-0.008^{**} (0.002)
LEV_{it}				-0.008 (0.002)	-0.005 (0.002)
$\log(\text{CAPX})_{it}$				0.135^{**} (0.004)	0.104^{**} (0.003)
$\log(\text{EMP})_{it-1}$					0.432^{**} (0.012)
R-squared	0.06	0.37	0.37	0.45	0.56
Firm fixed effects	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes
Observations	105 393	101 915	91 825	99 371	84 090

Table 8. **Inventories and Cash Ratio**

Dependent Variable: $\log(\text{INVT}_{it})$

	(1)	(2)	(3)	(4)	(5)
$\left(\frac{\text{CHE}}{\text{AT}}\right)_{it}$	-1.190^{**} (0.043)	-0.612^{**} (0.032)	-0.612^{**} (0.033)	-0.610^{**} (0..031)	-0.502^{**} (0..026)
$\log(\text{SALE})_{it}$		0.704^{**} (0.011)	0.717^{**} (0.012)	0.654^{**} (0.013)	0.404^{**} (0.013)
CFLOW_{it}			-0.001 (0.001)	-0.021^{*} (0.004)	-0.002 (0.003)
LEV_{it}				0.001 (0.002)	0.001 (0.002)
$\log(\text{CAPX})_{it}$				0.096^{**} (0.004)	0.087^{**} (0.003)
$\log(\text{EMP})_{it-1}$					0.382^{**} (0.008)
R-squared	0.07	0.42	0.42	0.44	0.53
Firm fixed effects	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes
Observations	120 990	120 385	104 700	103 172	97 489

Notes: Robust standard errors are in brackets. A */** next to the coefficient indicates significance at the 10/5 percent level

4.3.4 Short-term Debt versus Cash

The total debt is denominated by DLC in Compustat (Compustat data item #34) and it represents the total amount of short-term notes and the current portion of long-term debt that is due in one year. We define the short-term debt as the total debt, DLC, minus the long-term debt denominated by DLTT (Compustat data item #142), which represents debt obligations due in more than one year. We find that the cash ratio is significantly negatively correlated with the share of short-term debt (-0.13) confirming the negative relationship between cash holding decisions and short-term debt. To do further, Table 9 shows the benchmark regression where the cash ratio is replaced by the short-term debt ratio. The results coincides with our intuition since they highlight a positive and significant relationship between employment and the short-term debt ratio.

Table 9. **Employment and short-term Debt**

Dependent Variable: $\log(\text{EMP}_{it})$	(1)	(2)	(3)	(4)	(5)
$\left(\frac{\text{ST Debt}}{\text{Total Debt}}\right)_{it}$	0.036 (0.031)	0.031 (0.023)	0.025 (0.023)	0.056 ** (0..020)	0.003 ** (0..016)
$\log(\text{SALE})_{it}$		0.504** (0.009)	0.507** (0.010)	0.424** (0.010)	0.243** (0.009)
CFLOW_{it}			-0.002 (0.002)	-0.017** (0.004)	-0.008** (0.002)
LEV_{it}				-0.010** (0.002)	-0.005** (0.002)
$\log(\text{CAPX})_{it}$				0.139** (0.004)	0.106** (0.003)
$\log(\text{EMP})_{it-1}$					0.446** (0.011)
R-squared	0.02	0.39	0.40	0.46	0.59
Firm fixed effects	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes
Observations	136 928	133 103	116 469	114 666	107 763

Notes: Robust standard errors are in brackets. A */** next to the coefficient indicates significance at the 10/5 percent level

4.4 Cash Level and Wage Relationship

We show that corporate cash and wages are positively correlated, which goes in favor of the working capital assumption made in the theoretical model.

Firm-level analysis Compustat provides data about "staff expense", denoted by XLR (Compustat data item #42) which includes salaries, wages, pension costs, profit sharing and incentive compensation, payroll taxes and other employee benefits. The sample consists in 2 224 firms. Table 10 provides firm-level moments of a set of variables. Compared to the benchmark sample, see Table 2, we observe that firms are on average larger in terms of number of employees (29 443 rather than 9322 in the benchmark) and the average cash ratio is lower (0.15 rather than 0.19 in the benchmark). Notice that the overall correlation between the log of employment and the cash ratio (both firm-specific detrended) is -0.18 and still significant.

Table 10. Summary Statistics

	N	Mean	St. Dev	1st quartile	Median	3rd quartile
EMP (#)	20 467	26 754	65 695	313	4 200	24 154
AT ($m)	22 204	7 669	26 102	29	403	3 957
$\frac{\text{CHE}}{\text{AT}}$	22 166	0.15	0.24	0.03	0.08	0.19

Table 11 shows that there is a positive relationship the amount of staff expense in $t+1$ and the cash holding in t (both expressed in log). Column (1) shows the conditional correlation between og(XLR)$_{it+1}$ and log(CHE)$_{it}$ without including any control variables but firm fixed effects and sector-year fixed effects. In Column (2), we control for the current value of the amount of staff expense and the size of the firm measured by the log of total assets (log(AT)$_{it}$) the estimation regression being estimated by OLS. Alternatively in Column (3), the size of the firm is measured by the log of sales (log(SALE$_{it}$)). Finally in Column (4), we use the typical Arellano–Bond estimation to take into account the Nickell bias.

Industry-level analysis To check the validity of our results, we use NBER-CES Manufacturing Industry Database which provides the "Total Payroll" by industry from 1958 to 2009. In compustat database, we consider at the industry level (by SIC) the *median* (for each year) of: the total amount of cash, the staff expenses and the total asset value. This allows us to merge the two databases such that the merged dataset is made up of the amount of cash and staff expenses at the industry level. Notice that the number of observations is drastically reduced (1608 observations, 103 industries), the sample consists in industries with larger firms than previous while the cash ratio is similar.

As previously, we analyze the relationship between cash holding (log(CHE)) in t and the staff expenses (log(XLR)) in $t+1$ (both expressed in log) for these two types of industries. To capture how labor share affect the correlation, we interact labor share with the level of cash. Table 12 provides the results. Despite the low number of observations, we can see that the interaction term is significant, meaning that the correlation is stronger for high-labor-share industries.

Table 11. Wages and Cash

Dependent Variable: $\log(\text{XLR})_{it+1}$				
	(1)	(2)	(3)	(4)
$\log(\text{CHE})_{it}$	0.165 ** (0..010)	0.015** (0.004)	0.041** (0.004)	0.021** (0.00)
$\log(\text{XLR})_{it}$		0.530** (0.023)	0.627** (0.03)	0.728** (0.01)
$\log(\text{AT})_{it}$		0.239** (0.012)		
$\log(\text{SALE})_{it}$			0.110** (0.01)	0.180** (0.00)
R-squared	0.30	0.97	0.97	
Sector-year fixed effects	yes	yes	yes	no
Firm fixed effects	yes	yes	yes	no
Estimation	OLS	OLS	OLS	SYS-GMM
Hansen test (p-value)	–	–	–	0.70
Arellano-Bond test (p-value), AR(2)	–	–	–	0.22
Observations	18 644	18 642	18 100	18 133

Notes: Robust standard errors are in brackets. A */** next to the coefficient indicates significance at the 10/5 percent level. In Column (4), the estimation is by two-step system GMM. All explanatory variables dated in t-2 and longer are used as instruments.

Table 12. Wages and Cash (industry level)

Dependent Variable: $\log(\text{XLR})_{it+1}$	
$\log(\text{CHE})_{it}$	-0.139** (0.072)
LABSHARE_{it}	-1.520** (0.873)
$\log(\text{CHE})_{it+1} \times \text{LABSHARE}_{it}$	0.438** (0.166)
$\log(\text{AT})_{it}$	0.719** (0.048)
R-squared	0.85
Firm fixed effects	yes
Time fixed effects	yes
Observations	1 533

5 Model-based Shocks, Simulated Data and IRFs

5.1 Model-based Shocks to Technology, Credit and Liquidity

In this section, we describe the construction of technology, credit and liquidity series, see Figure 5 in the manuscript.

Data construction All data are expressed in a quarterly frequency and the sample period is 1980Q1-2015Q3. Capital stock series (K_t) is built by using the equation

$$K_{t+1} = K_t - Depreciation_t + Investment_t, \tag{29}$$

where *Depreciation* is measured as "Consumption of Fixed Capital" in non-financial corporate business sector (Flow of Funds, Table F8, line 14). *Investment* is measured as "Total Capital Expenditures" in non-financial corporate business sector (Flow of Funds, Table F102, line 11). Both variables are deflated by P_t, the "Price Indexes for Gross Value Added" in the Business sector (NIPA table 1.3.4, line 2).. We start the recursion in 1952Q1 and the initial value K_0 is chosen so that the capital-output ratio does not display any trend during the sample 1952-2004 (in line with Jermann and Quadrini, 2012). The wage bill ($w_t \ell_t$) is measured by "Hourly Compensation Index" multiplied by "Hours Worked" in the nonfarm business sector from BLS (PRS85006103 and PRS85006033, respectively), deflated by P_t. Series M_t is the sum of "Private Foreign Deposits", "Checkable Deposits and Currency", "Total Time and Savings Deposits", "Money Market Mutual Fund Shares", from the non-financial corporate business sector (Flow of Funds, Table B102, lines 9-12, respectively). Output, Y_t, is measured as the Gross Value Added of the Business sector (NIPA Table 1.3.5). The series is deflated by P_t. Debt series (D_t) is measured by credit market instruments (liabilities) from the non-financial corporate business sector (Flow of Funds, Table D3). The long-term interest rate, $\hat{r}_t$, is measured by the 10-year treasury constant maturity rate (mnemonic DGS10 in Fred Economic Data). In the following, all hatted variables are detrended series, using the HP filter. TFP, credit and liquidity series are build based on Equations (29)-(31) in the manuscript. Notice that δ is set to 0.025, $\alpha = 0.30$, while $K/Y = 6.46$, $M/Y = 0.23$, $wl/Y = 0.68$, and $\kappa = 0.075$ are calibrated using the baseline model's steady-state.

5.2 Simulated data using short-term loans

In the paper, we rely on Equation (31) to compute $\hat{\kappa}_t$. This approach relies on measures of the cash ratio and of the wage bill. As an alternative approach, we use here Equation (8), which gives a more direct measure of $\hat{\kappa}_t$:

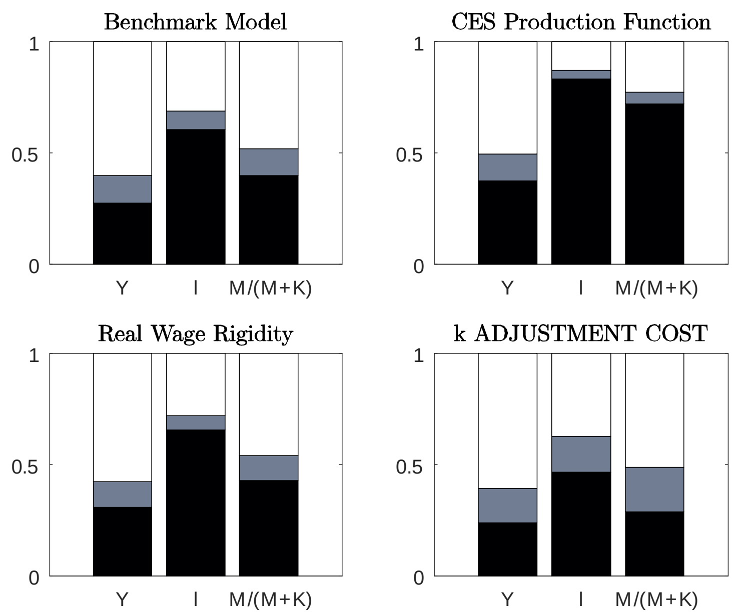
$$\hat{\kappa}_t = \hat{L}_t - \hat{K}_t. \tag{30}$$

where $\hat{L}_t$ is based on our measure of short-term loans. This measure has two drawbacks, as compared to the baseline approach: (i) it is available on a much smaller time period and (ii) it is restricted to bank loans. We present the results here for comparison purposes. As can be seen in Figure 5, the overall fit of the model is comparable to the baseline approach based on Equation (31).

5.3 Additional IRFs

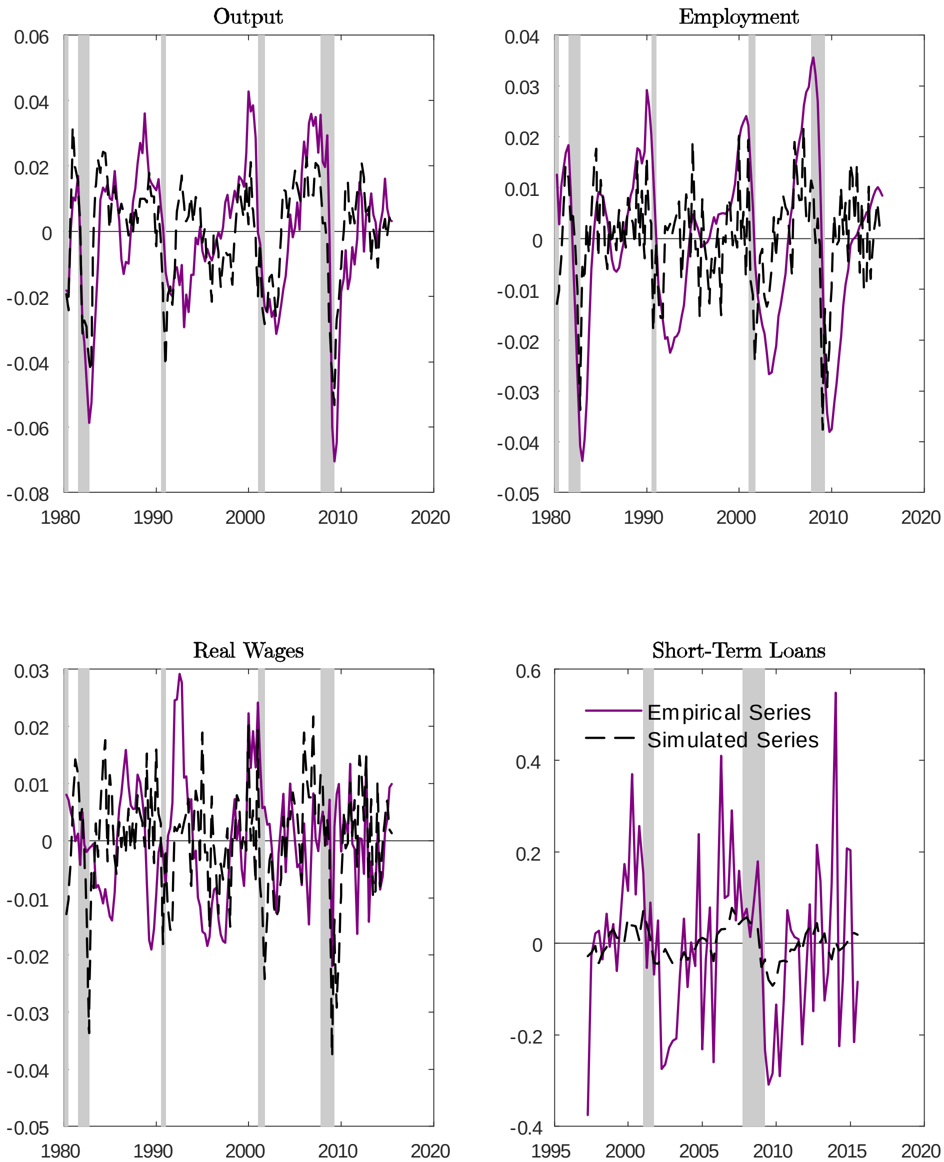
Figure 6 compares the IRFs of a set of variables in percentage deviation from the steady state to a liquidity shock (κ_t), under partial adjustment of the wage: $\hat{w}_t = \zeta \hat{w}_{t-1} + (1-\zeta)\widehat{mrs}_t$ where $\widehat{mrs}_t$ is the marginal rate of substitution between consumption and leisure. See Section 4.4.1 in the paper. The line with crosses sets ζ to 0.5 as suggested by Blanchard and Galí (2010). The dashed line sets ζ to 0.9 and the solid line set ζ to 0.99.

Figure 4: **Contribution of model-based shocks to output volatility: Robustness**



Column Y is output, l is labor and M/(M+K) is cash ratio.

Figure 5: **Simulated and Empirical Macroeconomic Variables.**



Note: Output and wages are expressed in real terms, deflated by the price index for gross value added in the business sector. All series are expressed in log and HP-filtered.

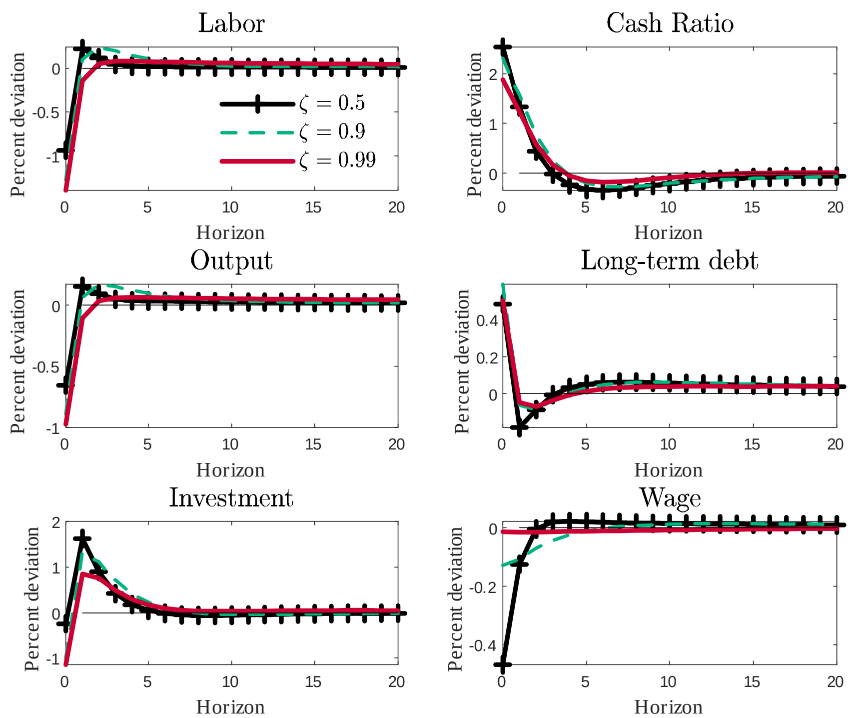


Figure 6: Impulse reponse functions to a liquidity shock (κ_t), for different degrees of wage rigidity (ζ).