

Beyond the Liquidity Trap: the Secular Stagnation of Investment

Callum Jones, Virgiliu Midrigan and Thomas Philippon*

January 2016

PRELIMINARY AND INCOMPLETE

Abstract

We propose an alternative view of the weak recovery of the U.S. economy in the aftermath of the Great Recession. Using a New Keynesian model with capital accumulation and an occasionally binding zero lower bound constraint on nominal interest rates, we find that the slow recovery of the U.S. economy is not driven by weak consumption and depressed asset prices as the standard liquidity trap theory would predict. Instead, the slow recovery is explained by a persistent decline in corporate investment despite favorable economic conditions, as measured by Tobin's Q , profit rates, and funding costs. Taking into account general equilibrium effects, we show that, if investment had followed its traditional pattern, the economy would have escaped the zero lower bound by the end of 2012.

A large and growing literature studies the consequences of a binding zero lower bound (ZLB) on the nominal rate of interest. [Krugman \(1998\)](#) and [Eggertsson and Woodford \(2003\)](#) argue that the ZLB can lead to a large drop in output. [Lawrence Christiano \(2011\)](#) show that the government spending multiplier can be large when the ZLB binds, suggesting a more important role for fiscal policy. [Coibion et al. \(2012\)](#) ask whether the risk of a binding ZLB should lead policy makers to increase the average rate of inflation. [Swanson and Williams \(2014\)](#) study the impact of the ZLB on long rates, that are more relevant for economic decisions.

The ZLB has been proposed as an explanation for the slow recovery of most major economies following the financial crisis of 2008-2009. [Summers \(2013\)](#) argues that the natural rate of interest has become negative, thus creating the risk of a secular stagnation, an environment with low interest rates and output permanently below potential. [Eggertsson and Mehrotra \(2014\)](#) propose a model where secular stagnation can be triggered by a decrease in population growth, among other factors.

Most studies of the liquidity trap are based on simple New-Keynesian models that abstract from capital accumulation. [Fernández-Villaverde et al. \(2015\)](#) study the exact properties of the New Keynesian model around the ZLB. In these models, consumption is depressed because the

*New York University, CEPR and NBER

equilibrium interest rate is higher than the natural rate – the rate that would have cleared the asset market in the absence of price or wage rigidities. In most of the existing models, the ZLB episode is triggered by an increase in households’ patience, that is, an increase in their subjective discount factor.

Explicitly allowing for capital accumulation complicates matters, however, because changes in discount rates imply that consumption and investment move in opposite directions. The shock that triggers the ZLB episode is also a shock that reduces the real rate, and therefore encourages investment. The direct consequence is that, all else equal, it is more difficult to trigger a ZLB episode in a model with capital than in a model where output equals consumption. It is of course still possible to trigger the ZLB, though the shocks required to do so are larger.

The Q theory of investment, postulating quadratic adjustment costs that imply a positive relationship between investment and the marginal returns to capital, is the simplest and most popular theory of investment. One should note first that that the Q theory of investment still holds at the ZLB. A drop in the real rate increases Q , all else equal, and this leads to an increase in investment. To the extent that output declines, however, future profits decline, diminishing the impact on Q . Moreover, the ZLB prevents the real interest rate from falling sufficiently, thus preventing Q from increasing as much as it would in the absence of this constraint.

The issue with this simple explanation of the slow recovery of investment in the aftermath of the U.S. Great Recession is that it is simply inconsistent with the evidence. We show in Section 1 that the reason the US recovery has been weak is that, despite the recovery in consumption, investment has failed to recover. Moreover, investment is low despite the fact that Q has recovered and is in fact fairly high by historical standards. Rather, the reason for the slow recovery is a breakdown in the investment equation, that is, the relationship between Q and investment. This breakdown is apparent when we look at data on stock prices as well as when we construct direct measures of profitability and funding costs.

Section 2 presents a simple New Keynesian model in which we allow for the possibility that the zero lower bound constraint on short term nominal rates binds. We confront the model with four U.S. aggregate time series: consumption, investment, Q and the short term rate. We use a Kalman filter and information about expected duration of the ZLB to back out the four shocks that are necessary for the model to replicate these time-series. Our main finding is that the the bulk of the slow recovery in U.S. real variables is due to a shock to the investment equation. Absent this shock, the U.S. economy would have exited the zero lower bound three years ago and output and employment would have recovered much more rapidly.

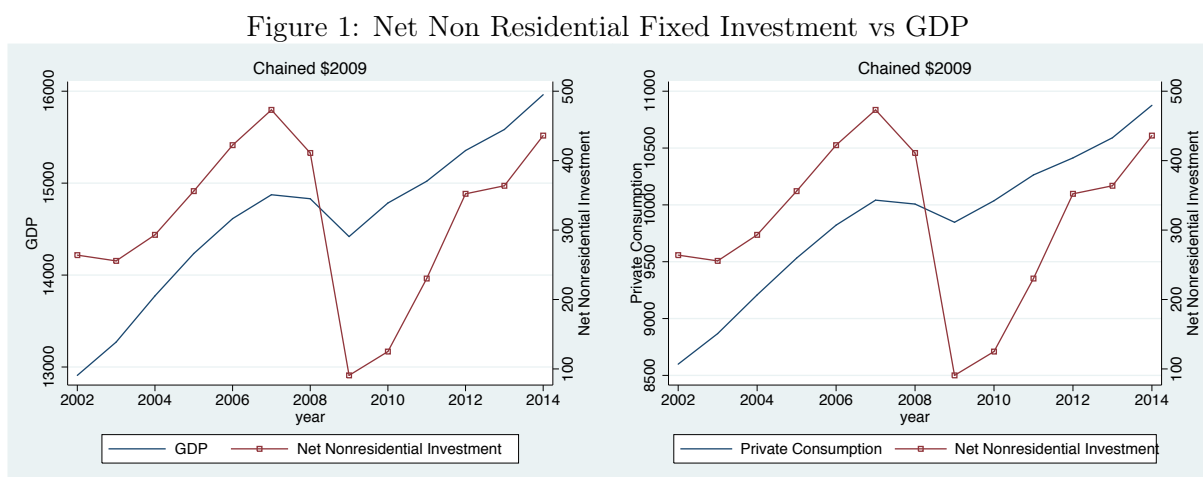
1 Facts

1.1 Net Non Residential Investment

Let us start with non residential investment. Residential investment has of course collapsed after 2006, but non residential investment has also declined sharply. The left panel of Figure 1 shows

the evolution of real GDP and real net non residential fixed investment, which includes structures, equipment, software, and intellectual property products. Both series are measured in chained 2009 dollars. We can see the drop and recovery of real GDP. By 2014, real GDP is higher than its pre-crisis peak. In 2007, GDP was 14873.7 billions, and in 2014 it was 15961.7 billions. By contrast, net investment was 473.1 billion in 2007 but only 436.1 billions in 2014.

The right panel of Figure 1 compares investment to private consumption, instead of the entire GDP. Our model will focus on the comparison between consumption and investment during the ZLB period.



Note: Annual Data

1.2 Non Financial Corporate Sector

Figure 1 is based on investment by all economic agents. Let us now focus on the non financial corporate sector, which is the main source of non-residential investment. The main advantage of focusing on the corporate sector is that we can use data on the market value of bonds and stocks, which allow us to disentangle various theories of secular stagnation.

1.2.1 Current Account

Table 1 summarizes the key facts about the balance sheet and current account of the non financial corporate business sector

One reason investment might be low is that corporate profits might be low. This, however, is not the case. Figure 2 shows the ratio of investment to net operating surplus:

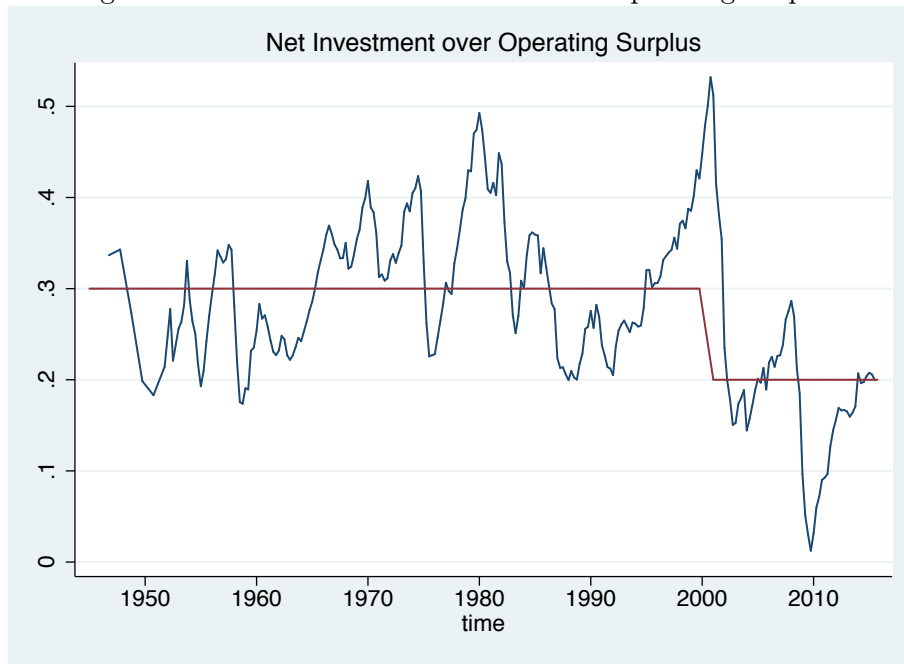
$$NI/OS = \frac{P_t^k (I_t - \delta K_t)}{P_t Y_t - \delta P_t^k K_t - W_t N_t - T_t^y}$$

Table 1: Current Account of Non Financial Corporate Sector

Name	Notations	Value in 2014 (\$ billions)
Gross Value Added	$P_t Y_t$	\$8,641.0
Net Fixed Capital at Replacement Cost	$P_t^k K_t$	\$14,856.7
Consumption of Fixed Capital	$\delta_t P_t^k K_t$	\$1,285.7
Net Operating Surplus	$P_t Y_t - W_t N_t - T_t^y - \delta P_t^k K_t$	\$1,614.3
Gross Fixed Capital Formation	$P_t^k I_t$	\$1610.4
Net Fixed Capital Formation	$P_t^k (I_t - \delta K_t)$	\$324.7

The average of the ratio between 1946 and 2000 is 30%. The average of the ratio from 2000 to 2014 is only 20%. Current investment is low relative to operating margins.

Figure 2: Net Investment Relative to Net Operating Surplus



Note: Quarterly Data

1.2.2 Profitability and Investment

Economic theory of course does not say that the ratio NI/OS should be constant over time. It should depend on the expected future operating surplus, on the capital stock, and the cost of funding new investment. Let us consider these factors in turn. Figure 3 shows the operating return on capital of the non financial corporate business sector, defined as net operating surplus over the replacement cost of capital:

$$\text{Operating Return} = \frac{P_t Y_t - \delta P_t^k K_t - W_t N_t - T_t^y}{P_t^k K_t}$$

This operating return has been quite stable over time (with perhaps a change in the mean about 1970). The yearly average from 1971 to 2014 is 10% with a standard deviation of only one percentage point. The (annual average) minimum is 7.9% and the maximum 11.7%. In 2014, the operating return was 11%, very close to the historical maximum. A striking feature is that the net operating margin was not severely affected by the the great recession, and has been consistently near its highest value since 2010.

Investment decision rely on the comparison of expected returns on capital with funding costs. If the ZLB binds, the funding cost can be artificially high. But once again, this is not the case. Figure 3 also shows the real Baa yield, defined as the nominal Baa yield minus the 4-quarter expected inflation rate from the Livingston survey:

$$r_t^{Baa} - E_t [\bar{\pi}_{t,t+4}]$$

The real funding cost of the US corporate sector has been lower than at any time since 1980.

Figure 3: Operating Return vs. Funding Cost

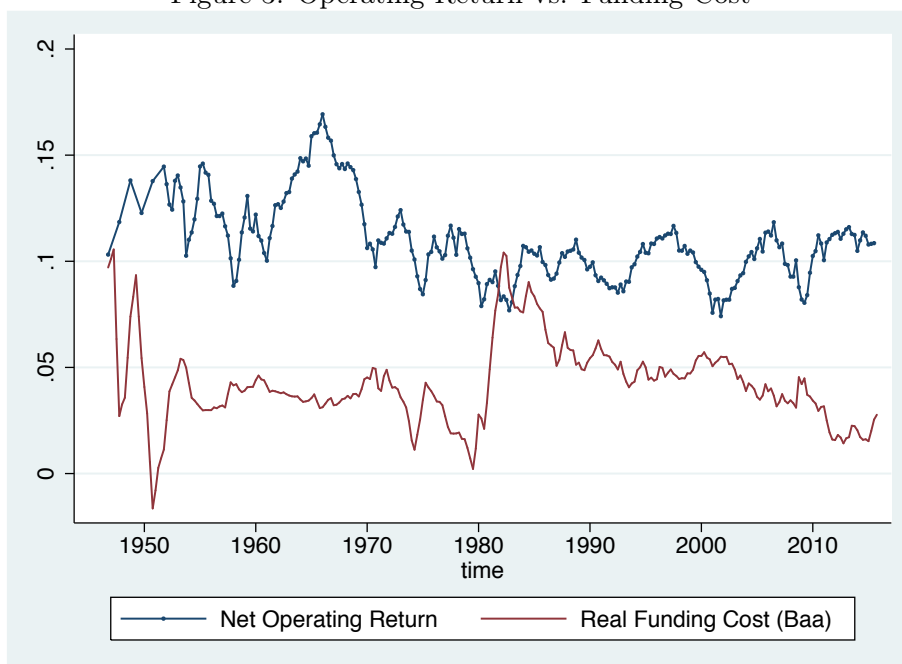


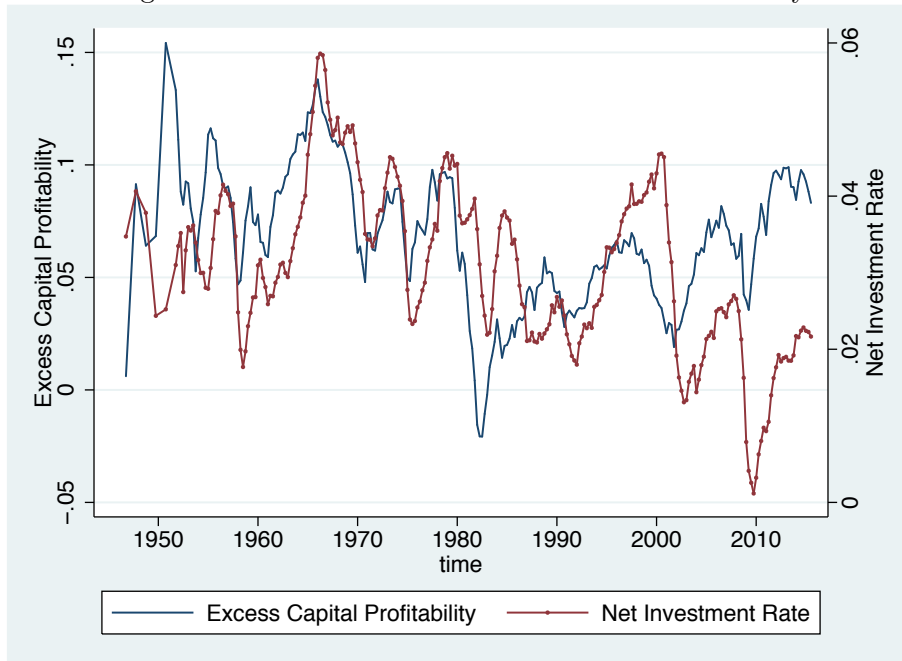
Figure 4 compares the path of net investment to the excess profitability of capital. I define the excess profitability as net operating return minus real funding costs:

$$\text{Excess Profitability} = \frac{P_t Y_t - \delta P_t^k K_t - W_t N_t - T_t^y}{P_t^k K_t} - (r_t^{Baa} - E_t [\bar{\pi}_{t,t+4}])$$

and net investment rate $I_t/K_t - \delta_t$. Since 2000, the investment rate has been surprisingly low

compared to the excess profitability. An interesting question is whether this is a post great depression issue, or whether it started in 2000. Figure 4 suggests the issue was already present before the great recession.

Figure 4: Net Investment Rate vs. Excess Profitability



1.3 Q theory

Figure 5 shows the evolution of gross investment, I/K and average Q , defined as

$$Q = \frac{V^e + (L - FA) - Inventories}{P_k K}$$

where V^e is the market value of equity, L are the liabilities (mostly measured at book values, but this is a rather small adjustment, see Hall (2001)), FA are financial assets. Notice that the BEA measure of K now includes intangible assets (capitalized R&D, advertisement and some intellectual property). As a result Q is lower than in the previous literature.

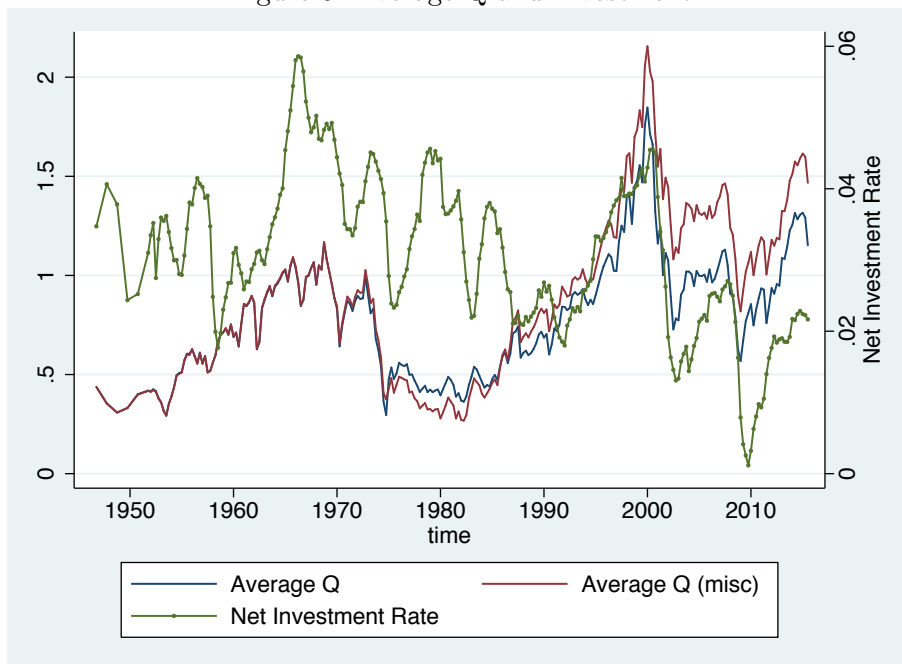
Because financial assets and liabilities contain large residuals, I also compute another measure of Q as

$$Q^{misc} = Q + \frac{A^{misc} - L^{misc}}{P_k K}$$

where A^{misc} and L^{misc} are the miscellaneous assets and liabilities recorded in the financial accounts. Since $A^{misc} > L^{misc}$, it follows that $Q^{misc} > Q$. It is unclear which measure is more appropriate. In any case, it is well known that measures of Q based on equity are excessively volatile and do not

explain actual investment particularly well (see Philippon (2009)). But in the more recent part of the sample, from 1985 to 2005, the fit is not too bad. What is striking, however, is that investment is low compared to measures of Q after 2005. Since investment is irreversible, it is not surprising that Q could be below one for long periods of time, as in the 1970s. It is, however, more difficult to understand that Q remains consistently above one and yet that investment remains weak.

Figure 5: Average Q and Investment



2 Model

Consider a standard model with adjustment costs. For simplicity, we derive here the flexible price first order conditions. We introduce standard nominal rigidities later, as in the New Keynesian model.

2.1 Households

Households maximize lifetime utility

$$\mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right) \right],$$

subject to the budget constraint

$$S_t + P_t C_t \leq R_t S_{t-1} + W_t N_t.$$

where W_t is the nominal wage and R_t is nominal gross return on savings from time $t - 1$ to time t . The intra-temporal FOCs imply a labor supply curve

$$N_t^\varphi = \frac{W_t}{P_t} C_t^{-\sigma}$$

The household pricing kernel is

$$\Lambda_{t,t+j} = \beta^j \left(\frac{C_t}{C_{t+j}} \right)^\sigma \frac{P_t}{P_{t+j}}$$

and the Euler equation is

$$\frac{C_t^{-\sigma}}{P_t} = \beta \mathbb{E}_t \left[R_{t+1} \frac{C_{t+1}^{-\sigma}}{P_{t+1}} \right]$$

where R_{t+1} is the nominal return on savers' assets. By definition of the pricing kernel $\mathbb{E}_t [\Lambda_{t+1} R_{t+1}] = 1$.

2.2 Firms

We assume a Cobb-Douglass production function with labor augmenting productivity shocks A_t

$$Y_t = K_t^\alpha (A_t N_t)^{1-\alpha}$$

The gross operating surplus is $P_t K_t^\alpha (A_t N_t)^{1-\alpha} - W_t N_t$ and we define the real gross profit rate as¹

$$\mu_t \equiv \frac{Y_t - \frac{W_t}{P_t} N_t}{K_t}.$$

Let I denote gross investment. Investment is subject to convex adjustment costs à la [Lucas and Prescott \(1971\)](#), so distributions (dividends) to capital owners (ignoring taxes for now) are

$$Div_t = \mu_t P_t K_t - P_t^k I_t - \frac{\gamma}{2} P_t^k K_t \left(\frac{I_t}{K_t} - \delta_t \right)^2.$$

Capital accumulates as

$$K_{t+1} = (1 - \delta_t) K_t + I_t$$

where the depreciation rate δ_t can be time varying (as it is very strongly in the data).

Management chooses employment and investment to maximize firm value. Let V_t denote the

¹Note that without sticky prices, we would simply have the first order condition for labor demand

$$(1 - \alpha) P_t \left(\frac{K_t}{A_t N_t} \right)^\alpha = \frac{W_t}{A_t}$$

which implies $A_t N_t = \left(\frac{(1-\alpha)A_t P_t}{W_t} \right)^{\frac{1}{\alpha}} K_t$ and therefore $e^{\mu_t} = \alpha \left(\frac{(1-\alpha)A_t P_t}{W_t} \right)^{\frac{1-\alpha}{\alpha}}$.

cum-dividend value (i.e., at the beginning of time t , before dividends are paid):

$$V_t(K_t) = \max_{I_t} Div_t + \mathbb{E}_t [\Lambda_{t+1} V_{t+1}(K_{t+1})]$$

Given our homogeneity assumptions, it is easy to see that the value function is homogeneous in K .

We can then define

$$\mathcal{V}_t \equiv \frac{V_t}{K_t}$$

where the per-unit value solves

$$\mathcal{V}_t = \max_x \mu_t P_t - P_t^k (x_t + \delta_t) - \frac{\gamma}{2} P_t^k x_t^2 + (1+x) \mathbb{E}_t [\Lambda_{t+1} \mathcal{V}_{t+1}]$$

and

$$x_t \equiv \frac{I_t}{K_t} - \delta_t$$

is the net investment rate. The first order condition for the net investment rate is

$$P_t^k + \gamma P_t^k x_t = e^{-\psi_t} \mathbb{E}_t [\Lambda_{t+1} \mathcal{V}_{t+1}]$$

which we can write as a q-investment equation

$$x_t = \frac{1}{\gamma} (Q_t - 1)$$

where

$$Q_t \equiv \frac{\mathbb{E}_t [\Lambda_{t+1} \mathcal{V}_{t+1}]}{P_t^k} = \frac{\mathbb{E}_t [\Lambda_{t+1} V_{t+1}]}{P_t^k K_{t+1}}$$

is Tobin's Q, i.e. the market value of the firm divided by the replacement cost of capital, all measured at the end of the period. Tobin's Q satisfies the recursive equation

$$Q_t = \mathbb{E}_t \left[\frac{\Lambda_{t+1}}{P_t^k} \left(\mu_{t+1} P_{t+1} + P_{t+1}^k \left((1+x_{t+1}) Q_{t+1} - x_{t+1} - \delta_{t+1} - \frac{\gamma}{2} x_{t+1}^2 \right) \right) \right]$$

which, given the FOC, can be written as

$$Q_t = \mathbb{E}_t \left[\frac{\Lambda_{t+1}}{P_t^k} \left(\mu_{t+1} P_{t+1} + P_{t+1}^k \left(Q_{t+1} - \delta_{t+1} + \frac{1}{2\gamma} (Q_{t+1} - 1)^2 \right) \right) \right]$$

In the logic of the theory, Q_t is the discounted value of operating returns $\mu_{t+1} P_{t+1}$, plus future Q net of depreciation, plus the option value of investing more when Q is high, and less when Q is low.

Next we have the market clearing conditions. In the goods market, we have

$$Y_t = K_t^\alpha (A_t N_t)^{1-\alpha} = C_t + \frac{P_t^k}{P_t} \left(\delta_t + x_t + \frac{\gamma}{2} x_t^2 \right) K_t$$

In the financial markets, households own the claims issued by firms. The returns on savings are

therefore

$$R_{t+1} = \frac{V_{t+1}}{V_t - Div_t}$$

which is equivalent to

$$S_t = V_t - Div_t$$

Finally we specify monetary policy as a standard Taylor rule.

2.3 Log-Linear Model with $\delta_t = \delta$, and $P_t^k = P_t$

The steady state is described in the Appendix. We describe here the log-linear equations of the model. As usual, lower case letters denote logs: $n \equiv \log(N)$. We define the real wage as

$$\omega_t \equiv w_t - p_t$$

and we denote wage and price inflation by π_t^p and π_t^w . We assume the standard Calvo model of price and wage setting:

$$\begin{aligned}\pi_t^p &= \beta \mathbb{E}_t [\pi_{t+1}^p] + \lambda_p \psi_t \\ \psi_t &= \omega_t + n_t - y_t - \log(1 - \alpha) \\ \pi_t^w &= \beta \mathbb{E}_t [\pi_{t+1}^w] + \lambda_w (v_t - \omega_t) \\ v_t &= \varphi n_t + \sigma c_t\end{aligned}$$

The variables ψ_t and v_t are the marginal cost and the marginal rate of substitution, in log-deviations from steady state. The elasticities of inflation to marginal costs are $\lambda_p \equiv \frac{(1-\theta_p)(1-\beta\theta_p)}{\theta_p} \frac{1}{1+\frac{1-\alpha}{\epsilon_p}}$ and $\lambda_w \equiv \frac{(1-\beta\theta_w)(1-\theta_w)}{\theta_w} \frac{1}{1+\varphi\epsilon_w}$, where θ 's are the Calvo parameters and ϵ 's are the elasticities of substitution between varieties of goods and labor.²

Output and the real wage are given by

$$\begin{aligned}y_t &= \alpha k_t + (1 - \alpha)(n_t + a_t) \\ \omega_t &= \omega_{t-1} + \pi_t^w - \pi_t^p\end{aligned}$$

The gross profit rate is³

$$\mu_t \equiv \frac{e^{y_t} - e^{\omega_t + n_t}}{e^{k_t}}$$

²The real marginal cost is $\Psi = W \frac{\partial N}{\partial Y}$, so in logs we have

$$\psi = w + n - y + \log \frac{\partial n}{\partial y} = w + n - y - \log(1 - \alpha).$$

³Note that, using the production function, we could also write $\log(\mu_t) = \log(\alpha) + \frac{1-\alpha}{\alpha} (\log(1 - \alpha) + a_t - \omega_t)$, or $\log(\mu_t) = \log(\alpha) + y - k - \frac{1-\alpha}{\alpha} \psi_t$.

The resource constraints are

$$\begin{aligned} k_{t+1} &= k_t + x_t \\ e^{y_t} &= e^{c_t} + \left(\delta + x_t + \frac{\gamma}{2} x_t^2 \right) e^{k_t} \end{aligned}$$

and investment follows the (log linear) q-theory equation⁴

$$x_t = \frac{q_t}{\gamma}$$

For financial markets, it is easier to define real variables. The log real pricing kernel, defined as $\lambda_{t+1} \equiv \log \Lambda_{t+1} + \pi_{t+1}$, is

$$\lambda_{t+1} = \log \beta - \sigma (c_{t+1} - c_t)$$

The Euler equation is $\mathbb{E}_t [e^{\lambda_{t+1} + i_t - \pi_{t+1}}] = 1$, which we can write using a log linear approximation as

$$\mathbb{E}_t [\lambda_{t+1} + i_t - \pi_{t+1}] = 0$$

The same kernel prices corporate capital as

$$q_t = \mathbb{E}_t \left[\lambda_{t+1} + \log \left(\mu_{t+1} + q_{t+1} + 1 - \delta + \frac{1}{2\gamma} q_{t+1}^2 \right) \right]$$

This completes the model. Finally, monetary policy follows a Taylor rule for the nominal interest rate

$$i_t^* = -\log(\beta) + \phi_p \pi_t^p + \phi_w \pi_t^w + \phi_y (n - \bar{n})$$

but the actual short rate is constrained by the zero lower bound

$$i_t = \max(0; i_t^*)$$

Note that there are other conditions satisfied in equilibrium but they are redundant. Using real value $v = \log V - p$, and real return $r_{t+1} = \log R_{t+1} - \pi_{t+1}$:

$$\begin{aligned} \frac{Div_t}{P_t} &= e^{k_t} \left(\mu_t - \delta - x_t - \frac{\gamma}{2} x_t^2 \right) \\ r_{t+1} &= v_{t+1} - \log(e^{v_t} - Div_t) \\ \mathbb{E}_t \left[e^{\lambda_{t+1} + r_{t+1}} \right] &= 1 \end{aligned}$$

2.4 Shocks

We introduce the following shocks to the model:

⁴Recall that we have defined $x_t \equiv \frac{I_t}{K_t} - \delta_t$ as the net investment rate. Therefore, strictly speaking, we have $K_{t+1} = (1 + x_t) K_t$ or in logs $k_{t+1} = \log(1 + x_t) + k_t$. Since the net investment rate is small, we use the approximation $\log(1 + x_t) \approx x_t$. Similarly, in the q-investment equation $x_t = \frac{1}{\gamma} (e^{q_t} - 1)$ we approximate $e^{q_t} \approx 1 + q_t$ so get $x_t = \frac{q_t}{\gamma}$.

- Productivity shock:

$$a_t = \rho_a a_{t-1} + \epsilon_{a,t}$$

- Discount rate shock to the pricing kernel

$$\begin{aligned}\lambda_{t+1} &= \log \beta - \sigma (c_{t+1} - c_t) + \zeta_t^d \\ \zeta_t^d &= \rho_d \zeta_{t-1}^d + \epsilon_t^d\end{aligned}$$

- A shock to the investment equation

$$\begin{aligned}x_t &= \frac{q_t}{\gamma} + \zeta_t^x \\ \zeta_t^x &= \rho_d \zeta_{t-1}^x + \epsilon_t^x\end{aligned}$$

- A shock to the valuation of corporate assets

$$\begin{aligned}q_t &= \mathbb{E}_t \left[\lambda_{t+1} + \log \left(\mu_{t+1} + q_{t+1} + 1 - \delta + \frac{1}{2\gamma} q_{t+1}^2 \right) \right] + \zeta_t^q \\ \zeta_t^q &= \rho_d \zeta_{t-1}^q + \epsilon_t^q\end{aligned}$$

3 Simulation Results

3.1 Estimation of the Model

The parameters of the model are calibrated in the standard way. We perform simulation over the period 1986:1 to 2015:1. Our data includes

$$Data = \left(\log(C_t); \frac{I_t}{K_t} - \delta_t; \log(Q_t); \log(1 + r_t^{3m}); T_t \right)_{t=[1986:1;2015:1]}$$

where C is real consumption per capita, r_t^{3m} is the 3-month Treasury Bill rate, T_t is the expected duration of the ZLB, and the other variables are as defined earlier. We use the Kalman filter to recover the four shocks introduced above:

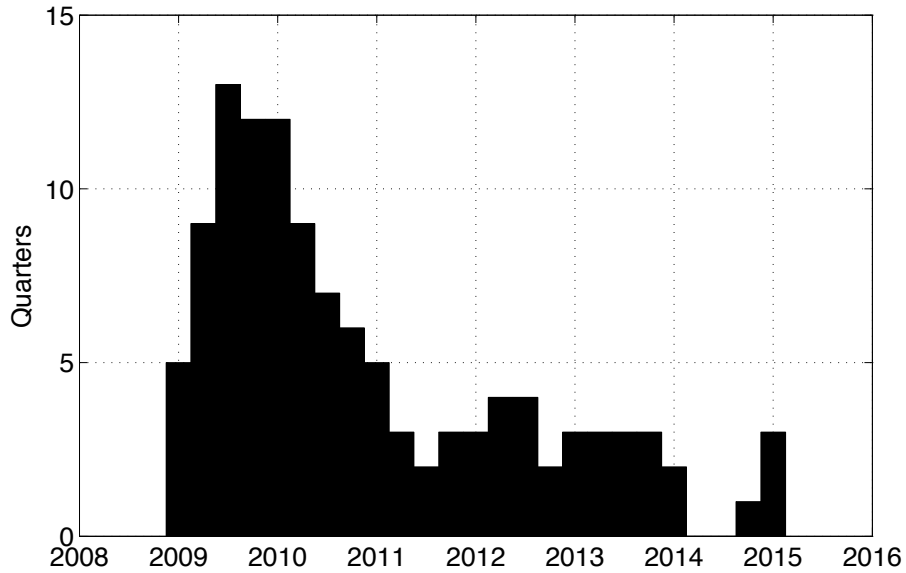
$$Shocks = \left(a_t, \zeta_t^d, \zeta_t^x, \zeta_t^q \right)$$

A critical issue, however, is the presence of the ZLB. It implies that the short rate becomes uninformative when it reaches 0. For any time t where $i_t = 0$, what matters for agents in the model is the expected duration of the ZLB episode, which we call T_t . So what enters the Kalman filter in period t is either i or T , whichever is strictly positive.

There are several ways to construct T . We can use a measure constructed by Morgan Stanley from the Fed Funds Futures contracts. We can also fit a Taylor rule to the pre-ZLB period to

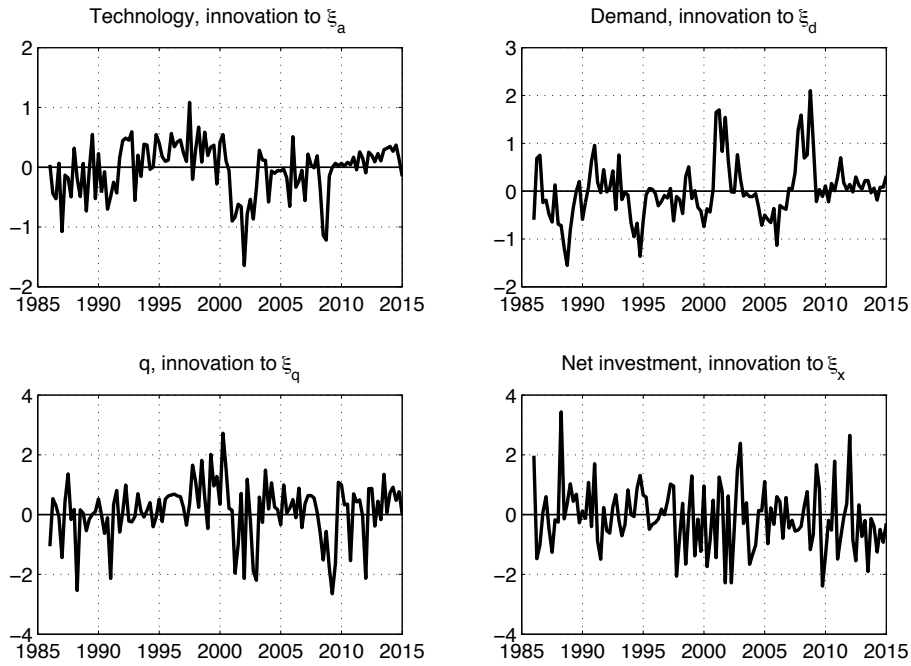
compute the desired rate i^* and assume that the duration of the ZLB depends on i^* . These are different ways to parameterize the agents' expectations at the ZLB. Figure 6 presents our series for T_t , based on i^* . In 2010, agents in the model anticipate the ZLB to last about 3 years. By 2015, the agents anticipate a lift off in the near future. [In the next step, we will estimate the model using long rates, following Swanson and Williams (2014)]

Figure 6: Expected Duration of ZLB
 Durations for Kalman filter



Once we have chosen a particular series for T_t , we can recover the shocks following the methodology described in Jones (2016). 7 presents the shocks

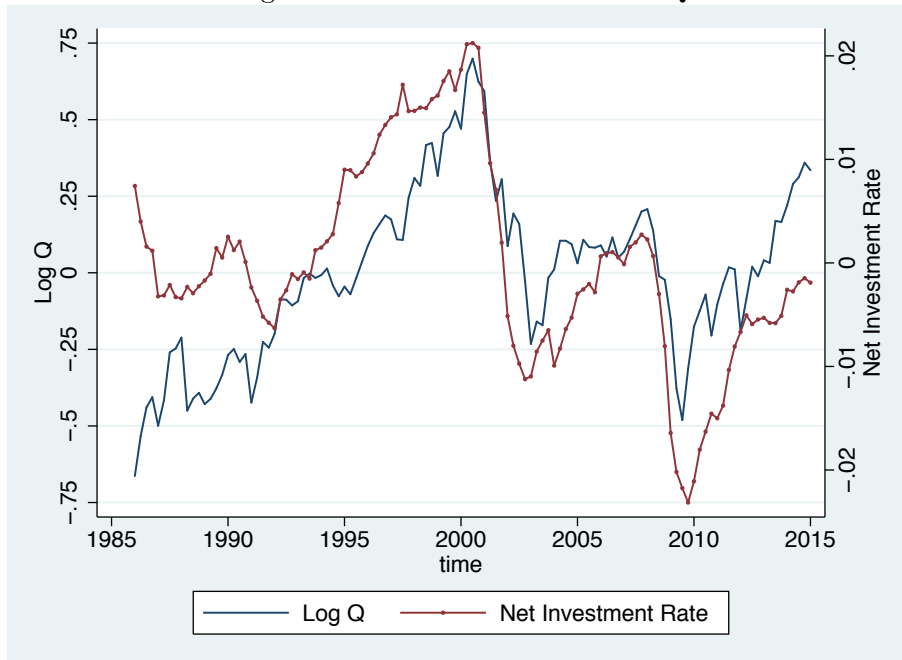
Figure 7: Model-Implied Shocks



Notes: Quarterly data, shocks in units of standard deviation.

Our main interest is in the shock to the investment equation. Note that it comes from the residual of the standard Q equation. The actual data that we feed into the model is presented in Figure 8.

Figure 8: Model: Investment and Q

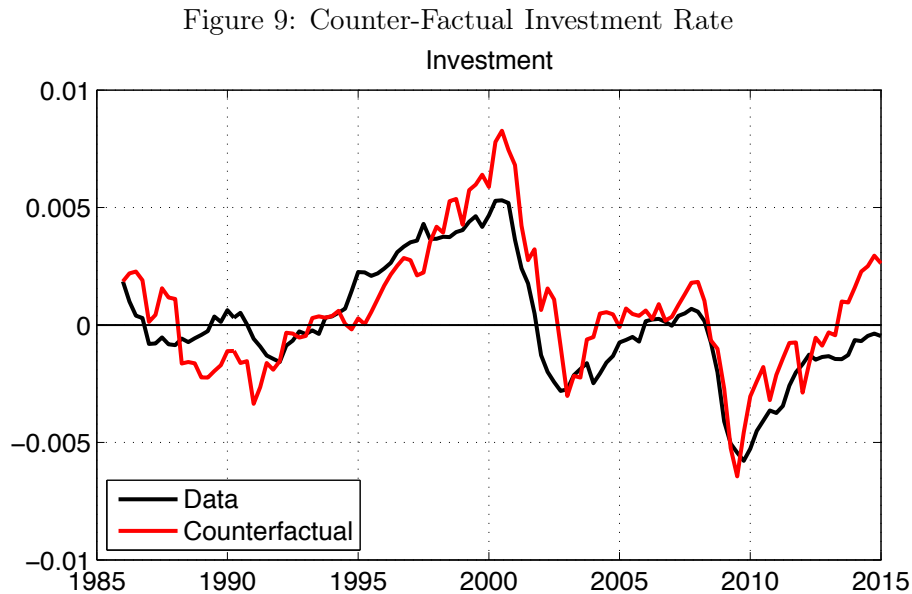


Now that we have recovered the shock, we turn to the counter-factual.

3.2 Counter-Factual

We now present our main results.

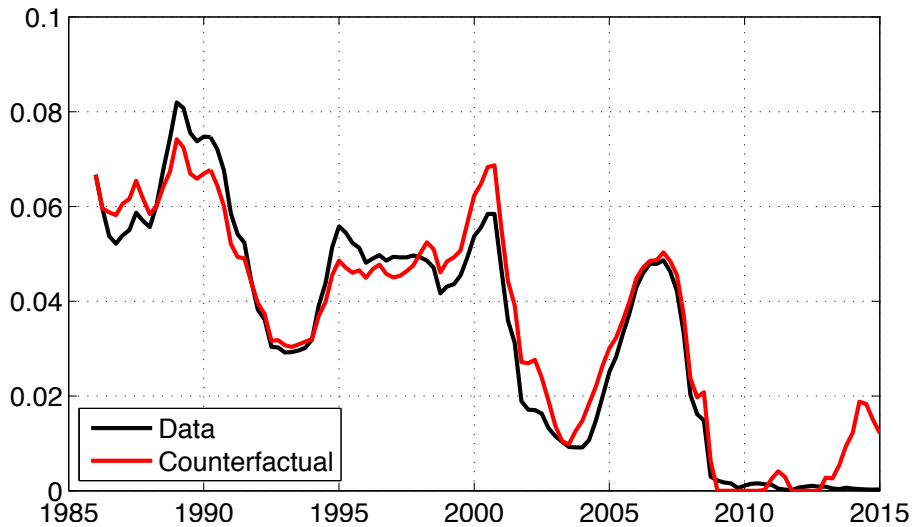
Figure 9 shows the path of investment implied by the model if we switch off the ζ^x shocks. It shows that, without the negative shocks to the investment equation, the net investment rate would have been about 0.30% higher, which is 1.2% annualized, and since K/Y is about 2.4 in our calibration, this corresponds to a large increase in aggregate demand of 2.9%.



Notes: Quarterly data, shocks in units of standard deviation.

The increase in aggregate demand from investment would have had a significant impact on the equilibrium rate. Figure 10 shows the path of short term rates implied by the model if we switch off the ζ^x shocks. It shows that, without the negative shocks to the investment equation, the economy would have exited the ZLB by the end of 2012.

Figure 10: Counter-Factual Short Term Rate
Short rate, i_t , annualized



Notes: Quarterly data, shocks in units of standard deviation.

We conclude that the slow recovery of the U.S. economy is not driven by weak consumption and depressed asset prices as the standard liquidity trap theory would predict. Instead, the slow recovery is explained by an apparent lack of willingness of businesses to invest despite favorable economics conditions, i.e. despite historically high profit margin, high asset prices and low funding costs.

4 Conclusions

We have studied a simple New Keynesian model in which shocks occasionally trigger the zero lower bound on interest rates. We find that the slow recovery of the U.S. economy is not driven by weak consumption and depressed asset prices as the standard liquidity trap theory would predict. Instead, the slow recovery is explained by an apparent lack of willingness of businesses to invest despite favorable economics conditions, i.e. despite historically high profit margin, high asset prices and low funding costs.

From the perspective of our model, the primary reason for the slow recovery of investment and output following the Great Recession is a breakdown in the investment equation relating Tobin's Q to investment. If this view is correct, it would have profound implications for the design of monetary and fiscal policy. In any case, modeling explicitly the sources of this breakdown is an important avenue for future research

References

- Coibion, O., Y. Gorodnichenko, and J. Wieland (2012). The optimal inflation rate in new keynesian models: Should central banks raise their inflation targets in light of the zlb? *Review of Economic Studies* 79, 1371–1406.
- Eggertsson, G. and N. Mehrotra (2014). A model of secular stagnation. NBER WP 20574.
- Eggertsson, G. and M. Woodford (2003). The zero bound on interest rates and optimal monetary policy. *Brookings Papers on Economic Activity* 1, 139–234.
- Fernández-Villaverde, J., G. Gordon, P. Guerrón-Quintana, and J. F. Rubio-Ramírez (2015). Non-linear adventures at the zero lower bound. *Journal of Economic Dynamics and Control* 57, 182–204.
- Hall, R. E. (2001). The stock market and capital accumulation. *American Economic Review* 91(5), 1185–1202.
- Jones, C. (2016). Unanticipated shocks and forward guidance at the zero lower bound. mimeo NYU.
- Krugman, P. (1998). It's baaack: Japan's slump and the return of the liquidity trap. *Brookings Papers on Economic Activity* 2, 137–205.
- Lawrence Christiano, Martin Eichenbaum, S. R. (2011). When is the government spending multiplier large? *Journal of Political Economy* 119(1), 78–121.
- Lucas, R. E. and E. C. Prescott (1971). Investment under uncertainty. *Econometrica* 39, 659–682.
- Philippon, T. (2009). The bond market's q. *The Quarterly Journal of Economics* 124, 1011–1056.
- Summers, L. H. (2013). Why stagnation might prove to be the new normal. Financial Times.
- Swanson, E. and J. Williams (2014). Measuring the effect of the zero lower bound on medium- and longer-term interest rates. *American Economic Review* 104, 3154–3185.

Appendix

Steady state

Normalize $P = P^k = 1$ (so W is real wage) and $A = 1$. As usual in this class of model with a representative saver, the discount rate is pinned down by the rate of time preference: $\Lambda = \beta$ and $R = \beta^{-1}$. Constant capital requires $x = 0$ and $Q = 1$, which pins down the required return on capital

$$1 = \beta(\mu + 1 - \delta)$$

The steady state equilibrium conditions are:

$$\begin{aligned}\Lambda &= \beta \\ R &= \beta^{-1} \\ \mu &= \frac{1}{\beta} - 1 + \delta \\ \mu &= \alpha \left(\frac{1 - \alpha}{W} \right)^{\frac{1 - \alpha}{\alpha}} \\ W &= (1 - \alpha) \left(\frac{K}{N} \right)^\alpha \\ I &= \delta K \\ Y &= C + I \\ Y &= K^\alpha N^{1 - \alpha} \\ W &= N^\varphi C^\sigma \\ V &= \frac{Div}{1 - \beta} \\ Div &= K^\alpha N^{1 - \alpha} - WN - I\end{aligned}$$

We can combine the equations to get the standard MPK condition

$$\alpha \left(\frac{K}{N} \right)^{\alpha - 1} = \mu \implies \frac{N}{K} = \left(\frac{\mu}{\alpha} \right)^{\frac{1}{1 - \alpha}}$$

From the capital labor ratio we get Y/K and W . Then $Y = C + I$ implies

$$\left(\frac{N}{K} \right)^{1 - \alpha} = \frac{C}{K} + \delta \implies \alpha \frac{C}{K} = \frac{1 - \beta}{\beta} + (1 - \alpha) \delta$$

so we know C/K . And the labor supply condition pins down K :

$$K = \left(W \left(\frac{C}{K} \right)^{-\sigma} \left(\frac{N}{K} \right)^{-\varphi} \right)^{\frac{1}{\varphi + \sigma}}$$

Which we can use to get steady state employment

$$N = \frac{N}{K} \times K$$