Investment Hangover and the Great Recession

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What caused the Great Recession?

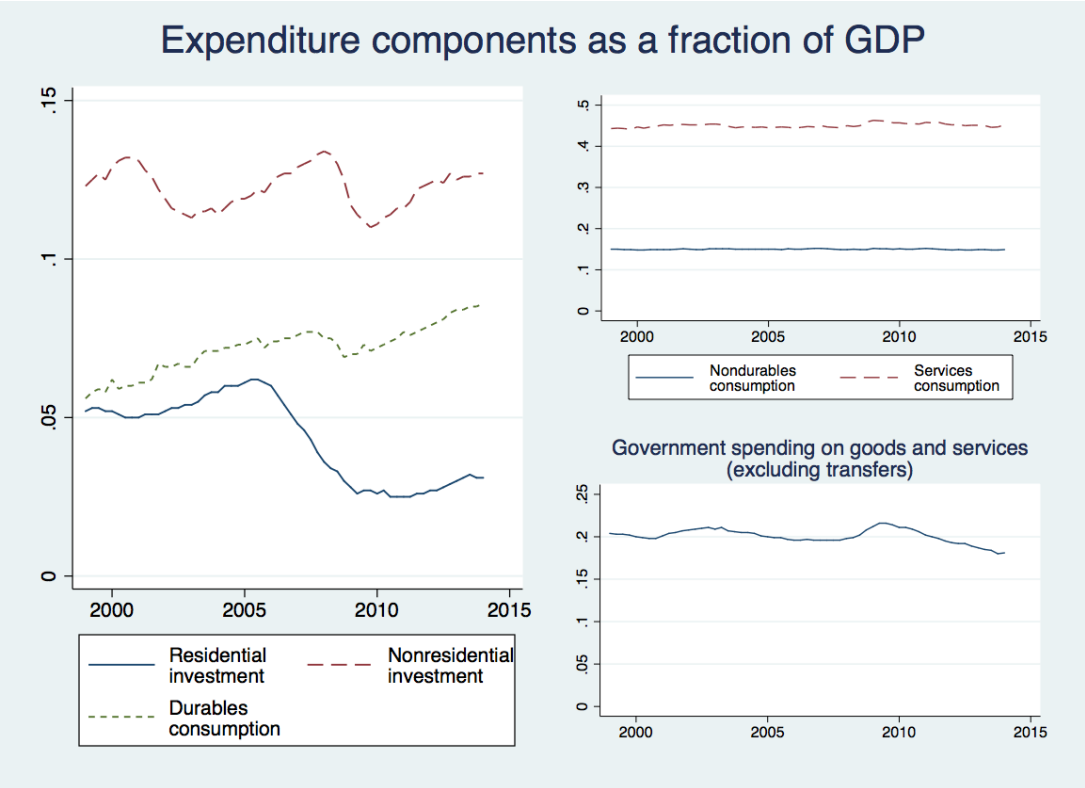
Great Recession: Worst slump since Great Depression. Why?

Recent macro views: **Bust of the housing bubble.**

1. **Financial crisis** and bank lending channel (Bernanke-Gertler, Kiyotaki-Moore, Chodorow-Reich...)
2. **Household deleveraging crisis** reduced consumption (Eggertsson-Krugman, Guerrieri-Lorenzoni, Mian-Sufi...)

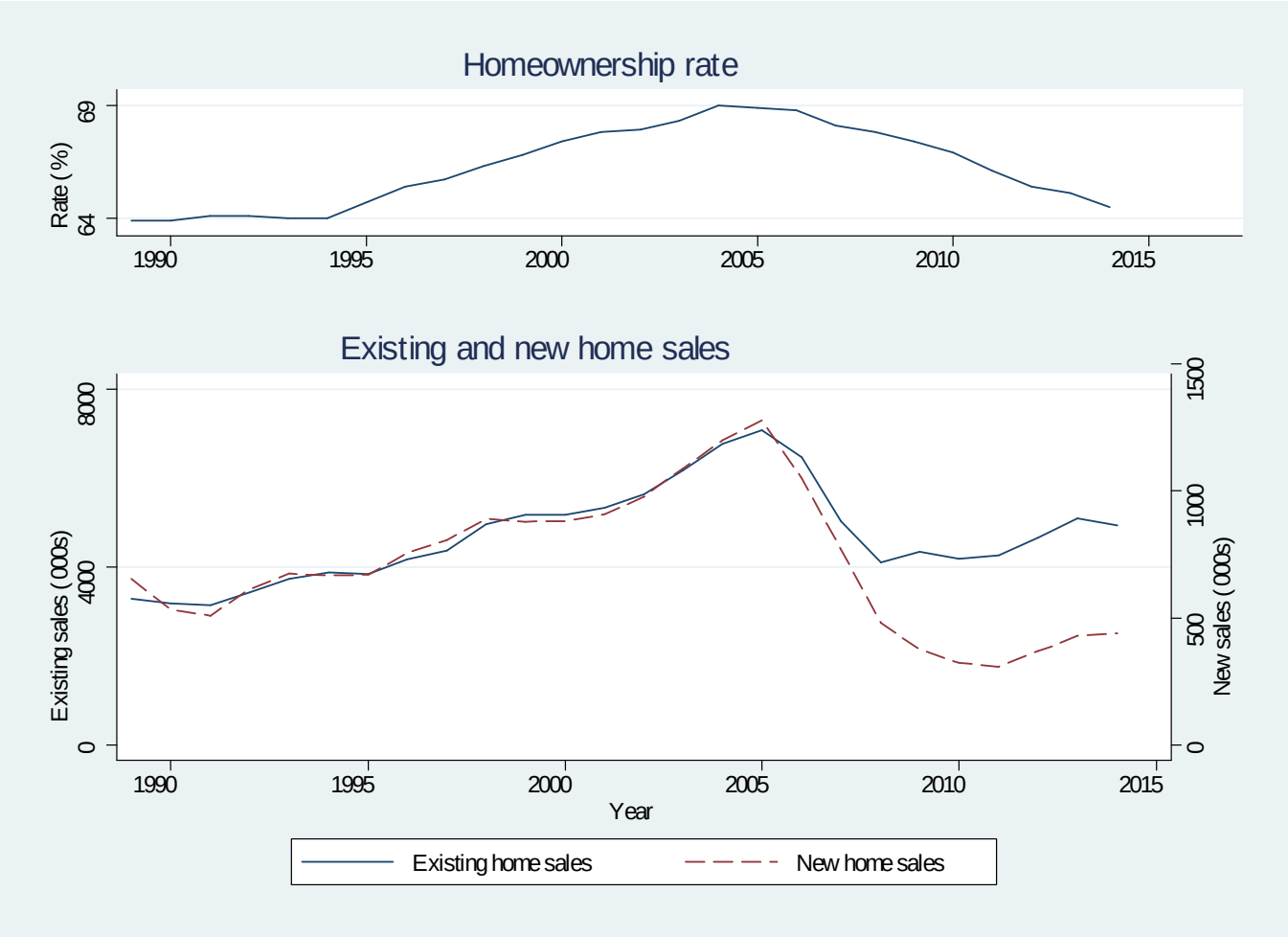
Low demand and recession, exacerbated by **the liquidity trap** (Hall...)

Asymmetric recovery poses a challenge



- **Challenge:** Why is **residential investment left behind** in recovery?
  - This time is different: Typically **leads the recovery** (Leamer, 2007).
- **This paper:** New (complementary) channel: **Investment hangover**.

Key observation: There was also an investment bubble...



...that created an overhang of residential capital.

How does the economy decumulate overbuilt capital?

We build stylized model with **excess initial residential capital**.

- Reduction in residential investment (Hayek...)
- But countered by reduction in the real interest rate and **reallocation.**
- Nonresidential investment picks up. No (economy-wide) recession.

Second key ingredient: **Liquidity trap and bounded r.**

Main result: Limited reallocation and a Keynesian recession.

Overbuilding also induces asymmetric recovery

What happens to nonresidential sectors during the recession?

- Nonresidential investment can initially fall despite low rates.
- Intuition: Low demand & low return (similar to the accelerator).
- Later, low rates dominate and nonresidential investment booms.
- This generates asymmetric recovery, as in the Great Recession.

Policy implications:

- Private investment decisions inefficient due to **demand externalities**.
- Broad policy lesson: Transfer investment to demand-deficient dates.

Related literature/contributions

Housing and deficient demand in the Great Recession:

- Deficient demand: financial frictions, deleveraging, stagnation...
- Housing: Iacovieollo-Pavan (2013), Boldrin et al. (2013)...

Recessions driven by overbuilding/reallocation:

- News-driven cycles/overhang. **Beaudry-Galizia-Portier (2014)**.
- Reallocation vs. aggregate: Lilien (1982), Blanchard-Diamond (1989).
- Supply side frictions to reallocation: Caballero-Hammour (1996)...

General mechanisms during the liquidity trap:

- Low demand reduces investment: Schmitt-Grohe and Uribe (2012)...
- Demand externalities: Farhi-Werning (2013), Korinek-Simsek (2014)...

Roadmap

1. Baseline version: Basic investment hangover mechanism.
2. Extension: Investment response and the acceleration principle.
3. Extension: Aggregate demand externalities, policy implications.

Environment with two types of capital

- Time $t \in \{0, 1, ...\}$ with two goods: consumption and housing.
- Three factors: h_t, k_t, l_t. Production functions h_t and $F(k_t, l_t)$.
- Absent shocks, economy converges to **target level**, h^*.
- We capture **past overbuilding** with $h_0 > h^*$. **Adjustment.**
- No adjustment costs in the baseline model. Evolution:

$$h_{t+1} = h_t \left(1 - \delta^h\right) + i_t^h \text{ and } k_{t+1} = k_t \left(1 - \delta^k\right) + i_t^k.$$

Household decisions

Representative household with preferences, with two simplifications:

$$U\left(\hat{c}_t, l_t, h_t\right) = u\left(\hat{c}_t - v\left(l_t\right)\right) + u^h \mathbf{1}\left[h_t \geq h^*\right].$$

1. Suppose u^h is large. Then, decumulation in single period,

$$h_{t+1} = h^*, \text{ which implies } i_t^h = h^* - h_t\left(1 - \delta^h\right).$$

2. GHH prefs: $u\left(\hat{c}_t - v\left(l_t\right)\right)$, where $c_t = \hat{c}_t - v\left(l_t\right)$ is **net consumption**.
   - Labor supply solves the static problem, $e_t = \max_{l_t} w_t l_t - v\left(l_t\right)$.
   - Consumption-saving solve the dynamic problem:

$$\max_{\{c_t, a_{t+1}\}_t} \sum_{t=0}^{\infty} \beta^t u\left(c_t\right)$$

$$\text{s.t.} \qquad c_t + a_{t+1} + i_t^h = e_t + a_t\left(1 + r_t\right) + \Pi_t.$$

Main ingredient: Lower bound on the interest rate

- Investment sector equates cost of capital to net return,

$$r_{t+1} = R_{t+1} - \delta^k.$$

- **Liquidity trap**: Nominal interest rate is bounded:

$$r^n_{t+1} \geq 0 \text{ for each } t.$$

- Nominal prices are completely sticky (coming) so that,

$$r^n_{t+1} = r_{t+1} \geq 0 \text{ for each } t.$$

Supply side: New Keynesian with extreme stickiness

- Competitive final good sector with, $\hat{y}_t = \left(\int_0^1 \hat{y}_t(\nu)^{\frac{\varepsilon-1}{\varepsilon}} d\nu \right)^{\varepsilon/(\varepsilon-1)}$
- Monopolistic intermediate sector with, $\hat{y}_t(\nu) = F(k_t(\nu), l_t(\nu))$.
- Monopolists have preset nominal price, $P_t(\nu) = P$. Simplicity.
- They face real price, $p_t(\nu) = P_t(\nu)/P = 1$, and thus solve,

$$\Pi_t = \max_{k_t, l_t} F(k_t, l_t) - w_t l_t - R_t k_t \text{ s.t. } F(k_t, l_t) \leq \hat{y}_t.$$

- In equilibrium, **net output** is equal to **net aggregate demand**,

$$y_t = F(k_t, l_t) - v(l_t) = c_t + i_t^k + i_t^h.$$

Monetary policy: Output stabilization without commitment

Monetary policy tries to replicate the efficient benchmark:

- Efficient benchmark maximizes net output in every period,

$$y_t^* = s(k_t) \equiv F(k_t, l_t^*) - v(l_t^*), \text{ where } l_t^* = \arg\max_{l_t} F(k_t, l_t) - v(l_t).$$

- These also imply an interest rate, r_{t+1}^*. Monetary policy,

$$r_{t+1}^n = r_{t+1} = \max\left(0, r_{t+1}^*\right) \text{ for each } t.$$

- This MP is constrained efficient absent commitment power.

Equilibrium is $\left\{h_t, k_t, l_t, \hat{c}_t, c_t, i_t^h, i_t^k, \hat{y}_t, y_t\right\}_t, \left\{w_t, R_t, r_{t+1}, \Pi_t\right\}_t$ s.t...

Properties of the equilibrium

Lemma: Equilibrium features efficient outcomes or the liquidity trap:

1. If $r_{t+1} > 0$, then $y_t = s(k_t), I_t = I_t^*$ and $R_t = s'(k_t)$.
2. If $r_{t+1} = 0$, then $y_t \leq s(k_t), I_t \leq I_t^*$ and $R_t = R(k_t, y_t) \leq s'(k_t)$.

Demand shortage reduces output, employment, **and factor returns,**

$$R_t = (1 - \tau_t) F_k(k_t, I_t) \text{ and } w_t = (1 - \tau_t) F_I(k_t, I_t), \text{ where } \tau_t \geq 0.$$

Investment hangover

- Suppose economy starts with too much residential capital:

$$h_0 = (1 + b_0)\, h^*, \text{ where } b_0 > 0.$$

- The economy reaches date 1 with $h_1 = h^*$ and some k_1.
- From date 1 onwards, no liquidity trap, $r_{t+1} > 0$ for each $t \geq 1$.
- Continuation $\{c_t, k_{t+1}\}_{t=1}^{\infty}$ solves standard neoclassical system.
- Let $c_1 = C(k_1)$ denote the solution where $C(\cdot)$ is increasing.
- Next consider the equilibrium at date 0....

Key insight: Overbuilding is a demand shock

- The residential investment at date 0 is:

$$i_0^h = h^* - \left(1 - \delta^h\right) h_0 = \left(\delta^h - b_0 \left(1 - \delta^h\right)\right) h^*.$$

Overbuilding b_0 represents a negative shock to demand.

- Equilibrium depends on investment and consumption responses.
- Let $\overline{k}$ denote the solution to $s'\left(\overline{k}\right) - \delta^k = 0$. Then, $r_1 \geq 0$ implies:

$$k_1 \leq \overline{k}.$$

Interest rate bound implies upper bound on investment...

Key insight: Aggregate demand is bounded

- Consumption is similarly bounded,

$$c_0 \leq \overline{c}_0, \text{ where } u'\left(\overline{c}_0\right) = \beta u'\left(C\left(\overline{k}\right)\right).$$

- So there is an **upper bound on aggregate demand**:

$$y_0 \leq \overline{y}_0 \equiv \overline{k} - \left(1-\delta^k\right) k_0 + \overline{c}_0 + \left(\delta^h - b_0\left(1-\delta^h\right)\right) h^*.$$

- The equilibrium depends on a comparison of $\overline{y}_0$ and $s\left(k_0\right)$...

Main result: Overbuilding triggers a recession

- $\overline{y}_0 < s(k_0)$ if and only if $b_0 > \overline{b}_0$, which gives the main result.

Proposition

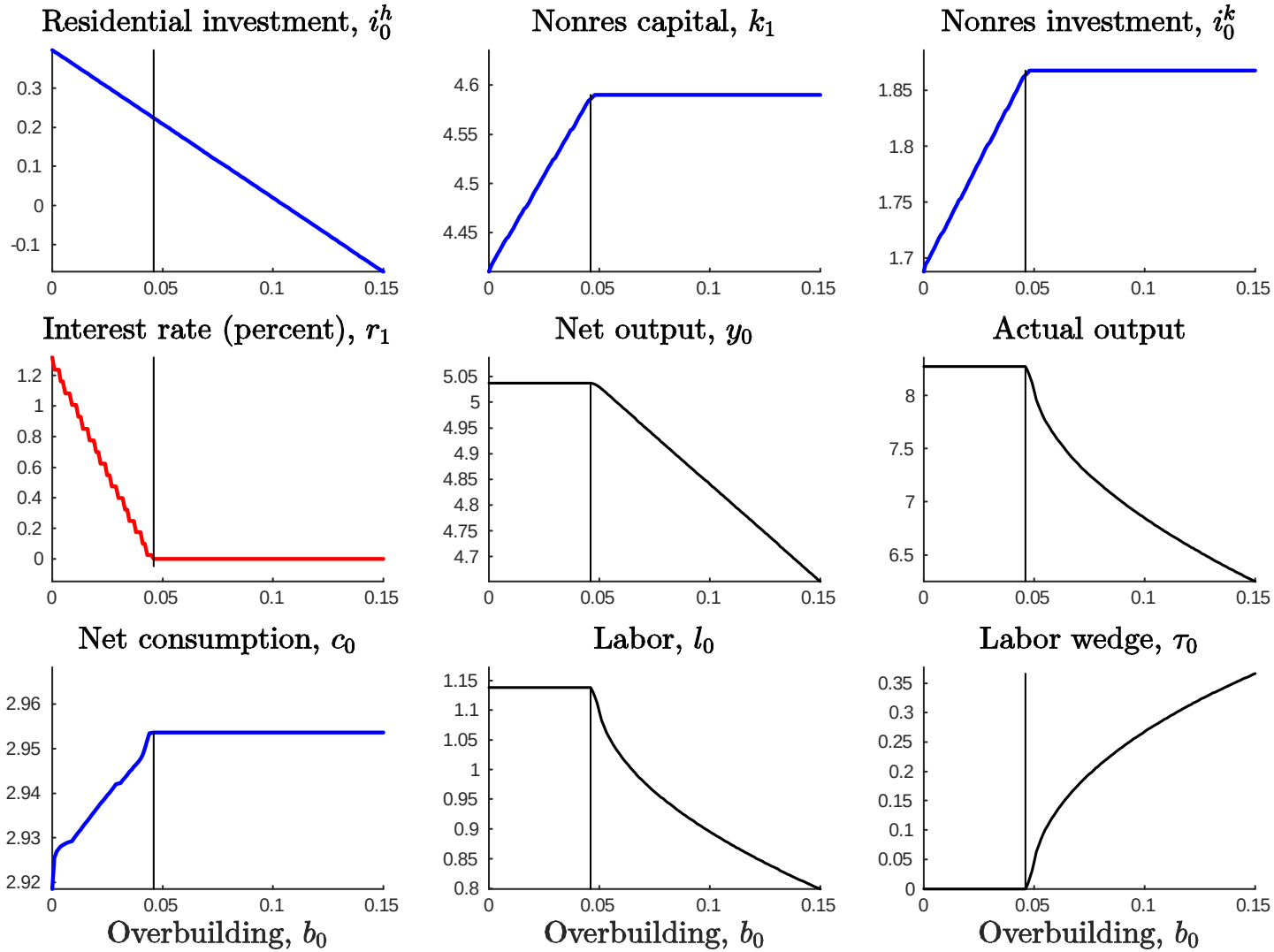
(i) Suppose $b_0 \leq \overline{b}_0$. *Then, efficient outcomes,*

$$r_1 \geq 0, y_0 = s(k_0) \text{ and } l_0 = l_0^*.$$

(ii) Suppose $b_0 > \overline{b}_0$. *Then,* **liquidity trap and recession:**

$$r_1 = 0, k_1 = \overline{k}, y_0 = \overline{y}_0 < s(k_0) \text{ and } l_0 < l_0^*.$$

Moreover, y_0 *and* l_0 *are decreasing in overbuilding,* b_0.


Residential investment, i_0^h
0.3
0.2
0.1
0
-0.1
0
0.05
0.1
0.15
Nonres capital, k_1
4.6
4.55
4.5
4.45
0
0.05
0.1
0.15
Nonres investment, i_0^k
1.85
1.8
1.75
1.7
0
0.05
0.1
0.15
Interest rate (percent), r_1
1.2
1
0.8
0.6
0.4
0.2
0
0
0.05
0.1
0.15
Net output, y_0
5.05
5
4.95
4.9
4.85
4.8
4.75
4.7
0
0.05
0.1
0.15
Actual output
8
7.5
7
6.5
0
0.05
0.1
0.15
Net consumption, c_0
2.96
2.95
2.94
2.93
2.92
0
0.05
0.1
0.15
Overbuilding, b_0
Labor, l_0
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
0
0.05
0.1
0.15
Overbuilding, b_0
Labor wedge, τ_0
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.05
0.1
0.15
Overbuilding, b_0

Comparative statics of the liquidity trap

$$\overline{b}_0 \equiv \frac{\overline{k} - \left(1 - \delta^k\right) k_0 + \overline{c}_0 + \delta^h h^* - s\left(k_0\right)}{\left(1 - \delta^h\right) h^*}.$$

- Liquidity trap ($b_0 > \overline{b}_0$) more likely if $\overline{k}$ and $\overline{c}_0$ are lower.

Overbuilding is complementary to other demand shocks.

- Liquidity trap also more likely if k_0 higher.

Overbuilding of two types of capital is complementary.

Comparative statics with respect to durability

- To analyze durability, consider two housing capitals, h^d and h^n.
- Suppose each has target level $h^*/2$ but different durability:

$$\delta^{h^d} < \delta^{h^n}, \text{ with } \left(\delta^{h^d} + \delta^{h^n}\right)/2 = \delta^h.$$

Proposition

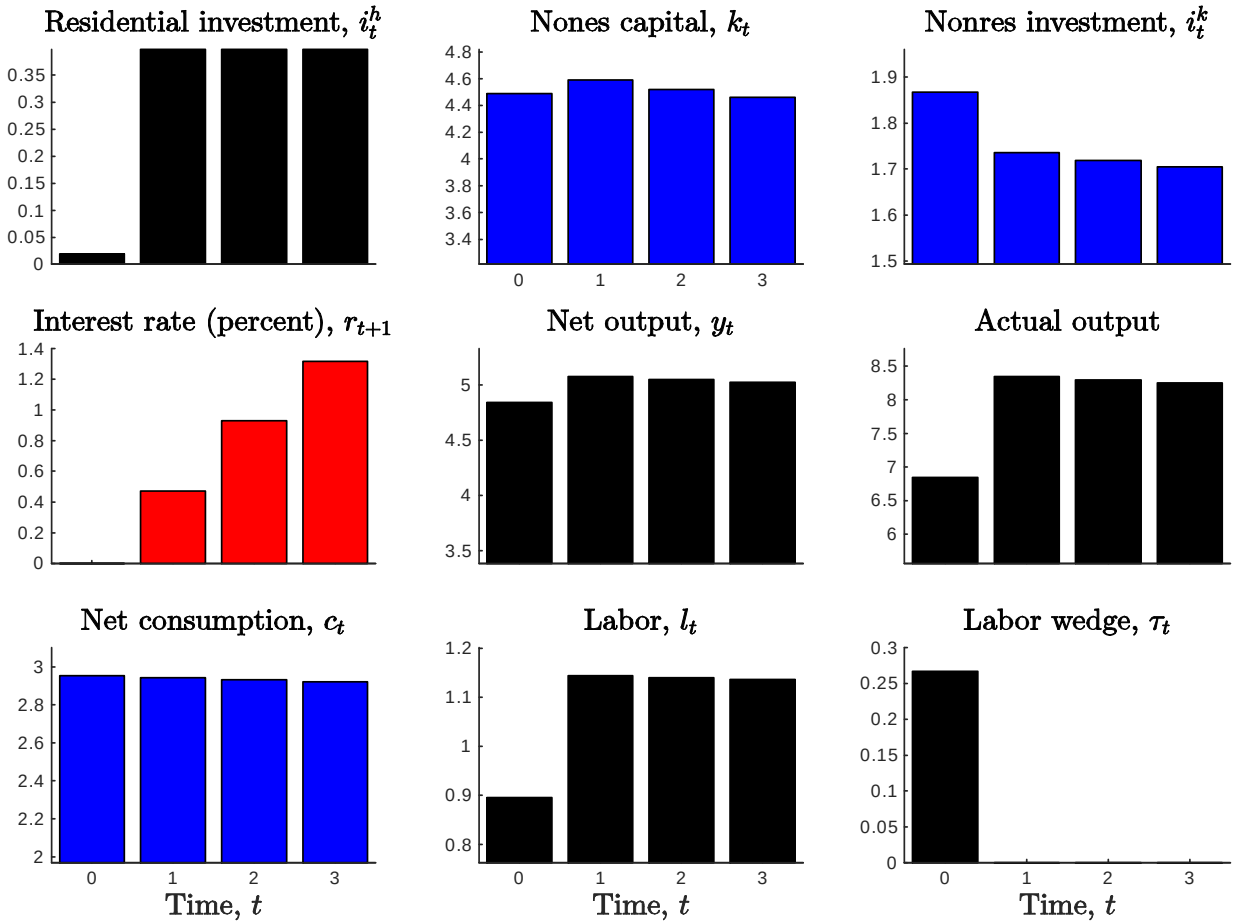
Given average overbuilding $\left(b_0^d + b_0^n\right)/2 = b_0$, **the incidence of liquidity trap** $1\left[l_t < l_t^*\right]$ **is increasing in overbuilding of durable capital** b_0^d**.**

- Intuition: **Depreciation "erases" overbuilt capital:**

$$\overline{y}_0 = \overline{k} - (1-\delta)\, k_0 + \overline{c}_0 + \delta^h h^* - b_0^d \left(1 - \delta^{h^d}\right) \frac{h^*}{2} - b_0^n \left(1 - \delta^{h^n}\right) \frac{h^*}{2}.$$

Overbuilding durable capital (housing, structures) is bigger concern.

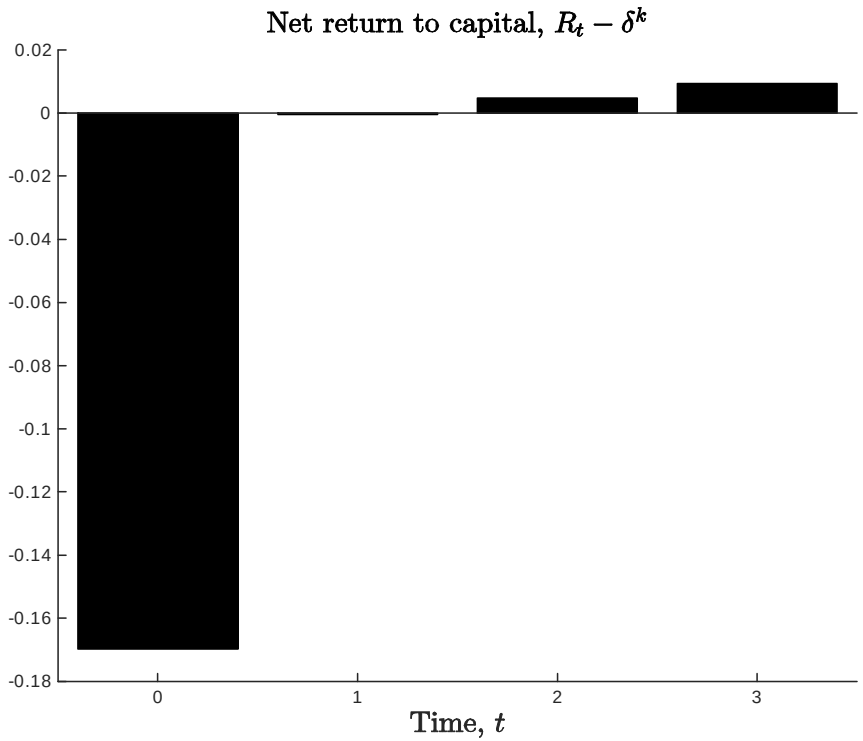
Dynamics and aftermath of the recession



Rate r is low in the aftermath. **Not secular stagnation**, but **fragility**.

How about the other sectors?

- Note that overbuilding (weakly) increases k_1 and c_0.
- Recession is confined to the residential sector.
- But the return to capital at date 0 is very low:



- This suggests capital could also fall, if it could respond...

Understanding the investment response

- To analyze k response, we spread decumulation over time.
- Assume, disinvestment is subject to "adjustment costs,"

$$i_t^h \geq i^h \text{ for each } t, \text{ for some } i^h < \delta^h h^*.$$

- Suppose h_0 is such that decumulation is complete in T periods.
- Then, the residential investment path satisfies

$$i_t^h = \begin{cases} i^h < \delta^h h^* & \text{if } t \in \{0, ..., T-1\} \\ \delta^h h^* & \text{if } t \geq T \end{cases}.$$

- The rest of the equilibrium is unchanged.

Liquidity trap over multiple periods

- As before $h_T = h^*$ and $\{c_t, k_{t+1}\}_{t=T}^{\infty}$ is neoclassical.
- Conjecture equilibrium with liquidity trap at each $t < T$.
- Consumption path $\{\overline{c}_t\}_{t=0}^{T}$ determined by Euler and $c_T = C\left(\overline{k}\right)$.
- Capital stock when the trap ends satisfies $k_T = \overline{k}$.
- We still need to characterize $\{k_t\}_{t=1}^{T-1}$...

Liquidity trap over multiple periods

- Investment at each date $t-1$ equates net benefits and costs:

$$R\left(k_t, y_t\right) - \delta^k = 0.$$

- Output at each $t < T$ determined by aggregate demand:

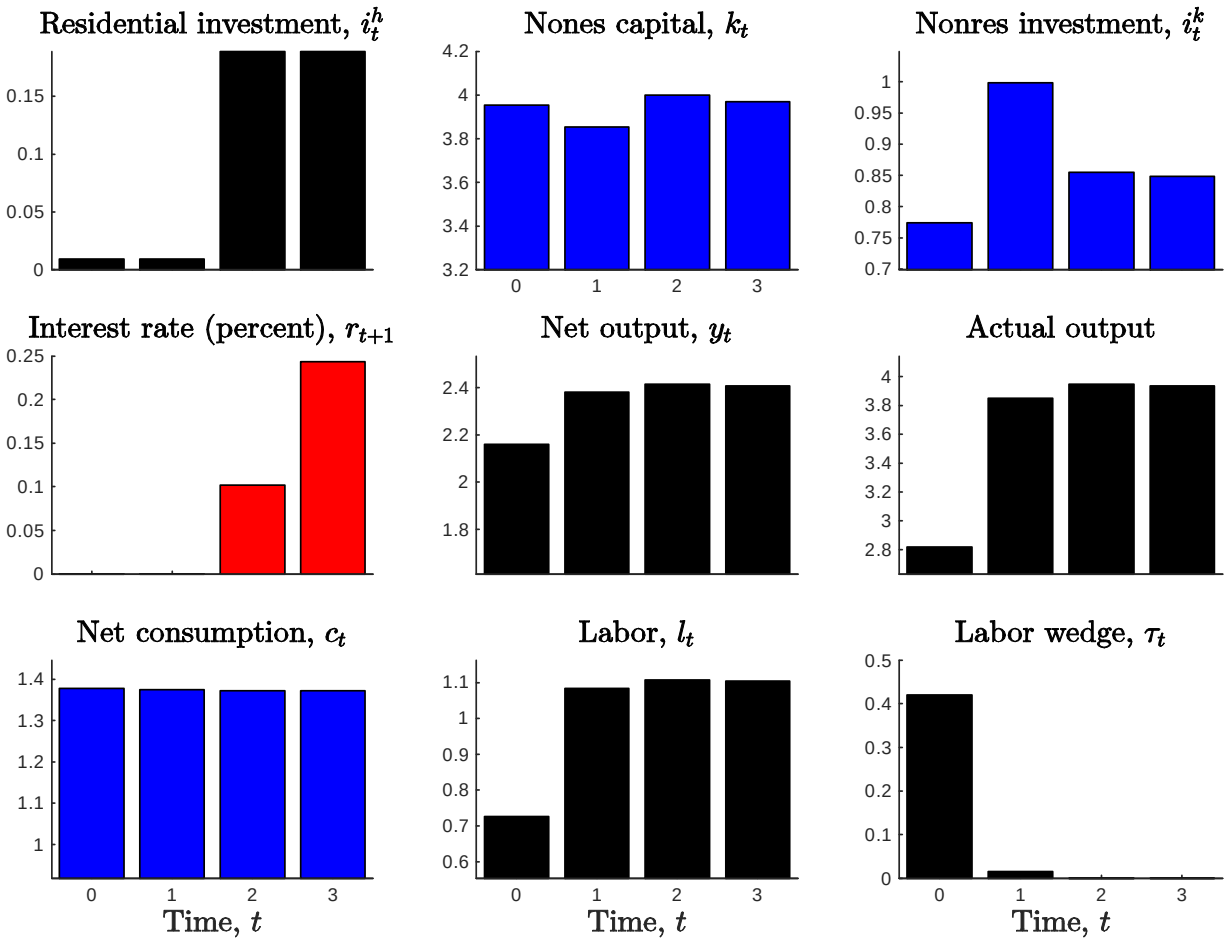
$$y_t = \overline{c}_t + k_{t+1} - \left(1 - \delta^k\right) k_t + i^h.$$

- We can solve these equations backwards starting with $k_T = \overline{k}$.
- The resulting path is an equilibrium as long as $y_0 < s\left(k_0\right)$.

Proposition

There exists i_2^h such that, if $i^h < i_2^h$, then investment is nonmonotonic:

$$k_0 > k_1 \text{ and } k_1 < k_T = \overline{k}.$$



- **With severe shock, investment response is nonmonotonic.**
- **Recovery (period 1) is asymmetric, as in the Great Recession.**

Similarities with the accelerator theory

- This resembles the accelerator theory (Clark, Metzler, Samuelson...)
- Linearize $R(k_t, y_t) = \delta^k$ around $(k, y) \simeq \left(\overline{k}, s\left(\overline{k}\right)\right)$, to obtain:

$$k_t \simeq \alpha + \beta y_t.$$

- Assuming $\delta^k \simeq 0$, we further obtain the approximation:

$$i_t^k \simeq k_{t+1} - k_t \simeq \beta\left(y_{t+1} - y_t\right) \text{ for each } t \geq 1.$$

Investment depends on changes in y_t, as in the accelerator.

Differences from the accelerator theory

Initial capital stock important: Investment at date 0,

$$i_0^k \simeq k_1 - k_0 \simeq \alpha + \beta y_1 - k_0.$$

- Unlike future dates, y_0 and k_0 are **inversely related.**
- Accelerator qualified for the earlier phase of the recession.

Liquidity trap (constrained r_t) important. Otherwise dampening.

Rational expectations vs. backward-looking expectations of y_t.

Policy implications

- We focus on policies for controlling investment.
- Consider version with $u(c_0) - v_0(l_0)$ at (only) date 0.
- Output, $y_0 = F(k_0, l_0)$ and labor wedge, $1 - \tau_0 = \frac{v_0'(l_0)}{u'(c_0)F_l(k_0,l_0)}$.
- **Lemma:** If $b_0 > \overline{b}_0^{sep}$ (and no adj. cost), then recession with

$$r_1 = 0, \tau_0 > 0, y_0 = \overline{y}_0 < y_0^*, \text{ and } R_0 = (1 - \tau_0) F_k(k_0, l_0) < R_0^*.$$

- Start with ex-post (recession-management) policies at date 0.
- Then introduce date -1 and investigate ex-ante policies.

Ex-post policies: Slowing down investment

- Should the planner stimulate h investment at date 0?
- Agents' value from raising $h_1 \geq h^*$ is $u'(c_0)\left(\frac{1-\delta^h}{1+r_1} - 1\right) < 0$.
- Constrained planner that sets $h_1 \geq h^*$. Marginal value:

$$u'(c_0)\left(\left(1-\delta^h\right) - \underbrace{(1-\tau_0)}_{\text{planner's cost of capital}} + \underbrace{\frac{dc_0}{dh_1}\tau_0}_{\text{additional benefit}}\right).$$

Slow down disinvestment, $h_1 > h^*$, when $\tau_0 > \tilde{\tau}_0$ (i.e., $b_0 > \tilde{b}_0$).

- **Lower cost of capital, due to aggregate demand externality.**

Ex-ante Anticipated investment overhang

- Consider date -1 with two states $\{H, L\}$ for date 0.
- L is the same as before, H features higher target $\left(1+\lambda^H\right) h^*$.
- Start with, $h_{-1} = \left(1+\lambda^H\right) h^*$ and $k_{-1} = k^*$. Believe $\pi^H \in (0,1)$.
- Equilibrium features $h_0 = \left(1+\lambda^H\right) h^*$ and k_0 determined by,

$$u'\left(c_{-1}\right) = \beta \left(\begin{array}{c} \pi^H \left(R_0^H + 1 - \delta^k\right) u'\left(c_0^H\right) \\ + \left(1-\pi^H\right) \left(R_0^L + 1 - \delta^k\right) u'\left(c_0^L\right) \end{array} \right).$$

- **Lemma:** If $\lambda^H > \overline{b}_0^{sep}\left(k^*\right)$ and $\pi^H \in (\overline{\pi}, 1)$, then liquidity trap in L.

Ex-ante: Restricting investment

- Constrained planner that sets h_0, k_0. Chooses $h_{0,pl} = \left(1 + \lambda^H\right) h^*$.
- Chooses k_0 by solving ex-ante planning problem. Determined by:

$$u'\left(c_{-1}\right) = \beta \left(\begin{array}{c} \pi^H \left(R_0^H + 1 - \delta^k\right) u'\left(c_0^H\right) \\ + \left(1 - \pi^H\right) \left(R_0^L + \underbrace{\left(1 - \tau_0\right)\left(1 - \delta^k\right)}_{\text{discounting durable part}} \right) u'\left(c_0^L\right) \end{array} \right)$$

Restrict ex-ante investment, $k_{0,pl} < k_0$, which yields $\tau_0 > \tau_{0,pl} > 0$.

- **Postpone building to state L. Aggregate demand externality.**

Broad lesson: Substitute investment to demand-deficient dates.

Conclusion: Investment hangover and Great Recession

- Model of **investment hangover**, with Austrian&Keynesian features.
- **Overbuilding** induces reallocation of resources to other sectors.
- **Liquidity trap limits reallocation** and creates Keynesian recession.
- **Investment (accelerator)** and **consumption (multiplier)** can fall.
- Investment (plus output & consumption) recovers **before housing**.
- Private investment choices inefficient due to **demand externalities**.

Applications beyond the Great Recession:

- Overbuilding of other sectors: Railroads, industrial plant/structures...
- Constraints on the interest rate for other reasons: Currency unions...