Reconsidering the Basic Tenets of Macroeconomics in the Light of the Past Two Years

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Society for Economic Dynamics
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Interest rates

- The zero lower bound on the nominal interest rate matters a lot.

- Nominal interest rates facing private borrowers did not fall to anywhere close to zero—they hardly fell at all.
ANNUAL INTEREST RATE ON 3-MONTH TREASURY BILLS
Nominal Interest Rates Facing Private Borrowers
Prices and wages

- Product price inflation slowed only slightly during the contraction and there was only a small tendency for inflation to fall by more for categories that saw the largest declines in sales volumes
- Wage inflation also slowed only slightly
ANNUAL CHANGES IN OUTPUT AND PRICES

Annual percent change in output

Annual percent change in price

CD: Consumer durables
CN: Consumer nondurables
CS: Consumer services
IS: Business structures
IE: Equipment
IR: Homebuilding
XG: Goods exports
XS: Services exports
MG: Goods imports
MS: Goods services
FD: Federal defense
FN: Federal non-defense
SL: State and local
Canadian and American Car Prices

Ratio of U.S. dollar price of cars in Canada to the U.S. dollar price in the U.S.

Canadian dollar price of the U.S. dollar
EMPLOYMENT AND HOURLY COMPENSATION

Annual percent change in employment

Annual percent change in hourly compensation

-15  -10  -5   0   5

Construction  Manufacturing  Information  Professional and business services  Hospitality  Health, education
Trade, transportation and utilities  Finance
Productivity growth

- Productivity accelerated during the contraction
- Declines in productivity had nothing to do with the huge contraction
Index of Output per Hour, Total U.S. Economy

Beginning of crisis, 2008 Q4
Far from bulging during the sharp contraction, self employment fell in proportion to total employment.
Self-employment as a fraction of total employment
Total household net financial wealth fell by 31 percent.
U.S. Household Wealth

31 percent decline
The contraction in GDP occurred almost entirely in plant, equipment, residential construction, and consumer durables; more than two-thirds of GDP was little affected.
Components of GDP Change

Net exports (-4% of GDP)
Government purchases (18%)
Consumption: non-durables and services (61%)
Investment: Consumer durables, business, residential (25%)
Persistent slack

Almost two years past the financial shock of September 2008, the economy remains slack—in particular, unemployment is only barely below its maximum value.
UNEMPLOYMENT
The basic issue

\[ \beta \frac{v'(x_2)}{v'(x_1)} = \frac{1}{1 + r} \]

\( \beta \) rises and \( r \) fails to fall enough ⇒ excess supply in period 1
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\( X \) rises and \( r \) fails to fall enough \( \Rightarrow \) excess supply in period 1.
1. What happens when a sticky high interest rate creates excess supply?
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2. Why are interest rates sticky?
Research topics

1. What happens when a sticky high interest rate creates excess supply?

2. Why are interest rates sticky?

3. What factors X cause the desire to defer spending?
Simplest setup

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Simplest setup

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\[ r^* = \frac{1}{\beta} - 1 \]

\[ (1 + r) \beta \frac{v'(c_2)}{v'(c_1)} = 1 \]

subject to \( (1 + r)(1 - c_1) = c_2 - 1 \)
Excess Supply of Lending

Equilibrium at zero lending and interest rate $r^*$

Excess supply of lending
1. What happens when a sticky high interest rate creates excess supply?

Supply is 1 and demand is $D < 1$. 
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Lowest qualifying bid not filled if it is lower than the next higher one.
Unique equilibrium

In the limit as the number of bidders goes to $\infty$
Unique equilibrium

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Identical bids in the amount $u_i = 1 - D$
Unique equilibrium

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This bid is the best response to similar bids from all other bidders
In the limit as the number of bidders goes to $\infty$

Identical bids in the amount $u_i = 1 - D$

This bid is the best response to similar bids from all other bidders.

Differentiated bids not an equilibrium because one bidder could insert a bid between two different bids, in which case at least one of the lower bids is not the best response to this and the other bids.
2. Why are interest rates sticky?

Zero lower bound (ZLB) on the nominal interest rate
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When $\bar{r} > r^*$, the ZLB binds and unemployment is positive.
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Role of sticky product price

If prices aren’t sticky, they can move to accommodate a lower real rate

This requires $p'_2 - p'_1 > p_2 - p_1$, that is, more inflation

This can take the form of an immediate drop in the price level, followed by enough inflation to permit even negative real rate
Demand with binding ZLB

\[ r = \bar{r} = \frac{1}{p_2} - 1, \]

so deflation sets the real rate and it fails to clear the output market.
Demand with binding ZLB

\[ r = \bar{r} = \frac{1}{p_2} - 1, \]

so deflation sets the real rate and it fails to clear the output market.

Individual demand \( D \) is first-period consumption that satisfies

\[ (1 + r)\beta \frac{v'(c_2)}{v'(D)} = 1 \text{ subject to } (1 + r)(1 - u - D) = c_2 - 1. \]
Rationing equilibrium when the ZLB binds

Equilibrium requires zero net intertemporal trade, so it satisfies

$$(1 + r) \beta \frac{v'(1)}{v' (1 - u)} = 1$$
Rationing equilibrium when the ZLB binds

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\[(1 + r)\beta \frac{v'(1)}{v' (1 - u)} = 1\]

With log utility,

\[u = 1 - \frac{1}{\beta(1 + r)}\].
Unemployment as a Function of the Rate of Deflation

Unemployment function
ADD CAPITAL

\[
\max_{c_1, c_2, k} v(c_1) + \beta v(c_2)
\]
Add capital

\[ \max_{c_1, c_2, k} v(c_1) + \beta v(c_2) \]

s.t. \( c_2 = (1 + r)[(1 - u)x_1 - c_1 - k] + x_2 + f(k) \)
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v'(c_2)(1 + r - f'(k)) = 0
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v'(c_2)(1 + r - f'(k)) = 0
\]

\[
f'(k(r)) = 1 + r
\]
Excess Supply of Lending in Economy with Capital
ZLB equilibrium with capital

\[ r = \bar{r} = \frac{1}{p_2} - 1 \]
ZLB equilibrium with capital

\[ r = \bar{r} = \frac{1}{p_2} - 1 \]

\[ (1 + r)\beta \frac{v'(x_2 + f(k(r)))}{v'((1 - u)x_1 - k(r))} = 1 \]
Unemployment as a Function of the Rate of Deflation in the Model with Capital
Dynamic model

The economy lasts for many years and households last as long as the economy
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Dynamic model
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The length of a period is a calendar quarter.

Investment incurs standard quadratic adjustment costs with $\kappa = 8$.

Households have constant intertemporal elasticity of substitution, $\sigma = 0.3$. 
Scenario

Deflation at a rate 1 percent per quarter above the stationary equilibrium real interest rate
Deflation at a rate 1 percent per quarter above the stationary equilibrium real interest rate

ZLB binds for 8 quarters
Extra Unemployment

![Graph showing extra unemployment over quarters]

- Extra unemployment peaks sharply in the first quarter.
- There is a rapid decline in the second quarter, with a near-zero level starting from the third quarter.

The graph shows a significant increase in extra unemployment, followed by a quick decrease, indicating a high and immediate impact that diminishes over time.
Responses of Consumption and Investment to Deflation
# Unemployment Responses for Alternative Parameter Values

<table>
<thead>
<tr>
<th>Variation</th>
<th>Unemployment in first quarter</th>
<th>Unemployment in fifth quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case</td>
<td>0.043</td>
<td>0.022</td>
</tr>
<tr>
<td>Lower capital adjustment cost ($\kappa=4$)</td>
<td>0.073</td>
<td>0.036</td>
</tr>
<tr>
<td>Shorter period of deflation and ZLB (4 quarters)</td>
<td>0.023</td>
<td></td>
</tr>
<tr>
<td>Higher intertemporal substitution in consumption ($\sigma=1$)</td>
<td>0.065</td>
<td>0.033</td>
</tr>
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Other factors could operate by lowering the equilibrium real rate $r^*$ rather than raising $\bar{r}$.

One is deferral of consumption from the precautionary response to higher consumption volatility.

Another, related, is the increase in the risk premium for capital.
Deferral of consumption caused by volatility

$$\mathbb{E}_t \left[ (1 + r_t) \beta \frac{\tilde{c}_{t+1}^{-1/\sigma}}{c_t^{-1/\sigma}} \right] = 1$$
Deferral of consumption caused by volatility

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\[c_{t+1} = E_t \tilde{c}_{t+1}\]
Deferral of consumption caused by volatility

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\mathbb{E}_t \left[ (1 + r_t) \beta \frac{\tilde{c}_{t+1}}{c_t}^{1/\sigma} \right] = 1
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\[
c_{t+1} = \mathbb{E}_t \tilde{c}_{t+1}
\]

\[
x_t = \mathbb{E}_t \left( \frac{\tilde{c}_{t+1}}{c_{t+1}} \right) - 1 > 0
\]
DEFERRAL OF CONSUMPTION CAUSED BY VOLATILITY

\[\mathbb{E}_t \left[ (1 + r_t) \beta \frac{\tilde{c}_{t+1} - 1/\sigma}{c_t - 1/\sigma} \right] = 1\]

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\[x_t = \mathbb{E}_t \left( \frac{\tilde{c}_{t+1} - 1/\sigma}{c_{t+1} - 1/\sigma} \right) - 1 > 0\]

\[\beta(1 + r_t)(1 + x_t)\frac{c_{t+1}}{c_t - 1/\sigma} = 1\]
Risk premium for capital

\[ 1 + \tilde{r}_{k,t+1} = \frac{(1 - \alpha)A_t(1 - u_t)^\alpha k_{t+1}^{-\alpha} + (1 - \delta)\tilde{q}_{t+1}}{q_t} \]
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\[
(1 + r_{k,t+1}) \frac{1 + x_t}{1 + y_t} \beta \left( \frac{c_{t+1}}{c_t} \right)^{-1/\sigma} = 1
\]
\[ r_{k,t+1} = (1 + r_t)(1 + y_t) - 1 \]
Capital risk premium continued

\[ r_{k,t+1} = (1 + r_t)(1 + y_t) - 1 \]

\[ (1 - \alpha)A_t(1 - u_t)k_t^{-\alpha} = (1 + r_t)(1 + y_t)q_t - (1 - \delta)q_{t+1} \]
Parameter values

Stationary Euler equation: $\beta(1 + r)(1 + x) = 1$
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\( r = 0.02 \) at annual rate, the real return to short-term Treasury debt
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This relation pins down only the product $\beta(1 + x) = 0.965$ at quarterly rates
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This relation pins down only the product $\beta(1 + x) = 0.965$ at quarterly rates

Frederick and Loewenstein, *J. Econ. Lit* 2002, Table 1, on evidence from experiments and surveys has values of $\beta$ mostly well below one
With log-normality,

\[ 1 + x = \mathbb{E} \left( \frac{\tilde{C}_{t+1}}{C_t} \right)^{-1/\sigma} = e^{\nu^2/2\sigma^2 + \nu^2/2\sigma^2} \]
**Volatility and \( x \)**

With log-normality,

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Primiceri and van Rens *J. Mon. Econ.* 2009 estimate the volatility by the rate of growth of the cross-sectional variance of consumption within cohorts and have privately communicated that it corresponds to a quarterly standard deviation of log-consumption change of about 7 percent.
Level and change of consumption deferral rate $x$

With $\nu = 0.07$ and $\sigma = 0.3$, the corresponding value of the deferral rate is $x = 0.036$, with $\beta = 0.969$, at quarterly rates.
LEVEL AND CHANGE OF CONSUMPTION DEFERRAL RATE $x$

With $\nu = 0.07$ and $\sigma = 0.3$, the corresponding value of the deferral rate is $x = 0.036$, with $\beta = 0.969$, at quarterly rates.

I entertain an increase of 0.015 in $x$ at the beginning of the crisis, to $x' = 0.051$, which implies an increase in the standard deviation of quarterly log consumption change to $\nu' = 0.083$. 
LEVEL AND CHANGE OF CONSUMPTION DEFERRAL RATE $x$

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I have not found any source of information about how consumption volatility changes in recessions.
Level and change of capital risk premium $y$

$$y = \frac{r_k - r}{1 + r} - 1 = 0.0075$$
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I entertain a first-quarter increase in the crisis of 0.025, to $y' = 0.0325$
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If the increase on the capital side is smaller than the increase on the consumer side, an unrealistically large fraction of the reduction in output takes the form of lower consumption rather than lower investment.
Scenario

Rate of deflation of 0.45 percent per quarter
Stationary safe real interest rate of $r^* = 0.50$ percent per quarter
Thus stationary nominal safe interest rate is 0.05 percent per quarter
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**Scenario**

Rate of deflation of 0.45 percent per quarter
Stationary safe real interest rate of $r^* = 0.50$ percent per quarter
Thus stationary nominal safe interest rate is 0.05 percent per quarter

A shock hits the economy that raises the consumption volatility deferral rate $x$ by 0.015 in the initial quarter and raises the capital risk premium $y$ by .025 in the initial quarter

The two factors subside to normal levels at a rate of 20 percent per quarter.
Unemployment

Quarter

Extra unemployment

0.00
0.01
0.02
0.03
0.04
0.05
0.06
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Consumption and Investment with ZLB Binding
Consumption and Investment, ZLB not binding
RETURN TO CAPITAL $r_k$ AND THE SAFE REAL RATE $r$

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**Return to investment**

**Safe real interest rate**

**Safe nominal interest rate**

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Quarter