

# Technological Revolutions and Debt Hangovers: Is There a Link?

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# Introduction

- ▶ Observation:
  - ▶ Before Great Recession: **IT** (late 1990s)
  - ▶ Before Japanese crisis 1990s: **electronics** (1980s)
  - ▶ Before Great Depression: **combustion/electricity** (1910-1925?)
- ▶ Write a business cycle model
  - ▶ Anticipations about the future + imperfect information
  - ▶ Main mechanism: Rational formation of beliefs around tech rev
- ▶ Focus:
  1. Consumption
  2. Medium frequencies

# Model: Productivity

- ▶ Productivity sum of two components:

$$a_t = x_t + z_t$$

- ▶ permanent component

$$\Delta x_t = \rho \Delta x_{t-1} + \varepsilon_t$$

- ▶ transitory component

$$z_t = \rho z_{t-1} + \eta_t.$$

“News and Noise” information structure  
(Blanchard, L’Huillier & Lorenzoni)

► Agents observe:

1. current productivity  $a_t$
2. noisy signal regarding the permanent component  $x_t$

$$s_t = x_t + v_t$$

**Plan:**

1. Study Kalman filter of these agents
2. Put into open economy a la [Aguiar & Gopinath \(2007\)](#)
3. Do structural estimation for the 3 episodes

# Key: Slow Adjustment of Beliefs

Borrow idea from [Hobijn & Jovanovic \(1999\)](#):  
“Technological revolutions come in waves”

## 1. Start of tech rev

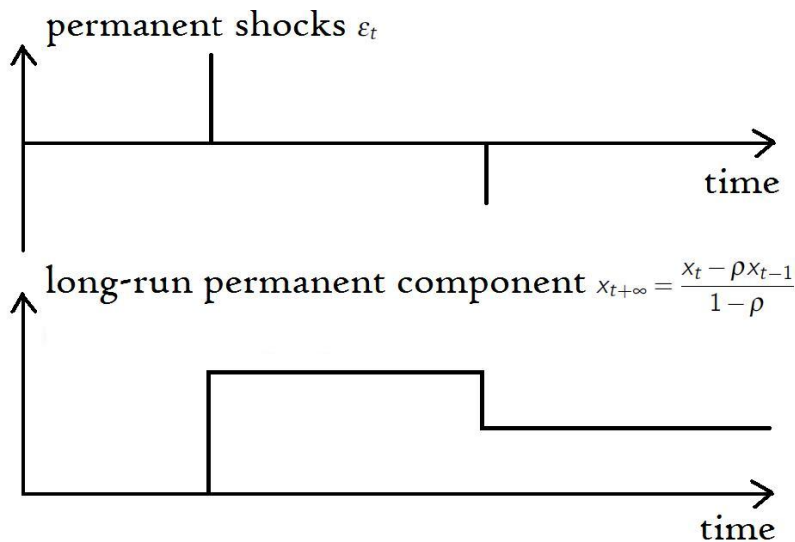
Increase in growth of permanent productivity  
(from the old, deterministic, trend)

## 2. End of tech rev

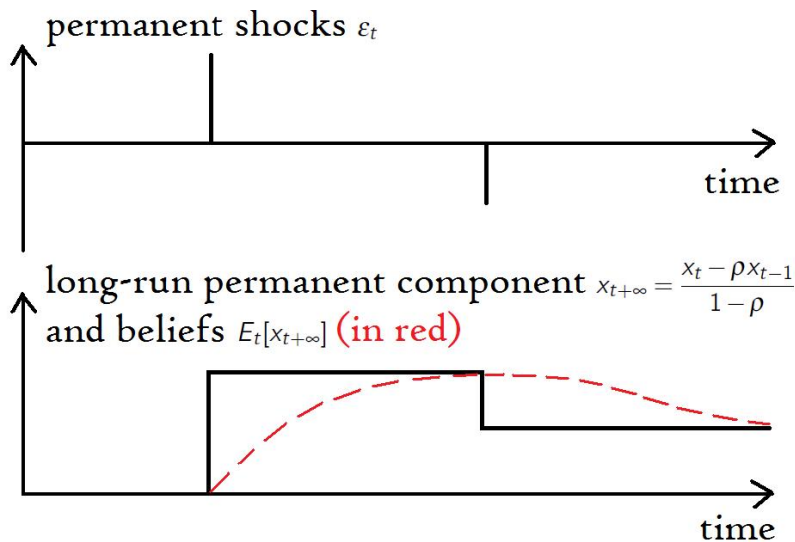
Decrease in growth of permanent productivity  
(from the new trend)

- ▶ Consumers use Kalman filter to update beliefs
  - ▶ Try to track path of permanent component
  - ▶ Slow to adjust beliefs after slowdown
  - ▶ Remain “optimistic” for a while

## An Example: Off-trend Permanent Tech Shocks



## An Example: Off-trend Permanent Tech Shocks, cont.



- ▶ Open economy DSGE
- ▶ Use previous information structure
- ▶ Permanent income consumers
  - ▶ Form beliefs about the future path of  $x_t$
  - ▶ These beliefs affect consumption and net exports



# Consumers and Production

- ▶ Representative consumer maximizes

$$E_t \left[ \sum_{t=0}^{\infty} \beta^t \left( \ln(C_t) - \frac{\phi}{1+\phi} N_t^{1+\phi} \right) \right]$$

subject to

$$C_t + B_{t-1} = W_t N_t + Q_t B_t$$

- ▶  $B_t$  is external debt
- ▶ Linear production and competitive goods market

$$Y_t = e^{a_t} N_t.$$

# Resource Constraint and Interest Rate

- ▶ Resource constraint

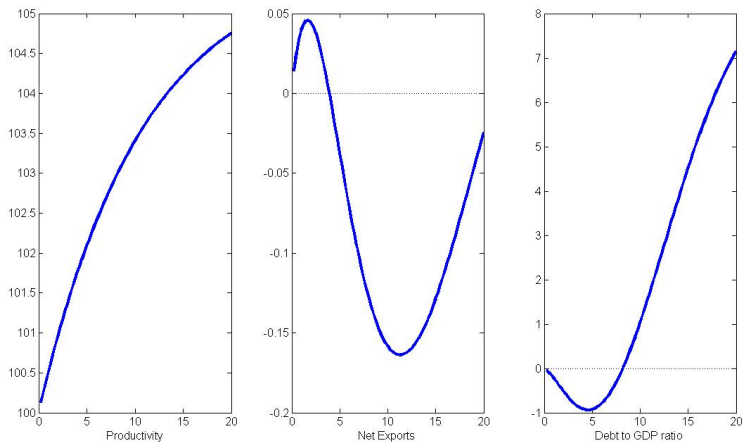
$$C_t + NX_t = Y_t$$

- ▶ Interest rate

$$\frac{1}{Q_t} = R_t = R^* + \psi \left\{ e^{\frac{B_t}{Y_t} - b} - 1 \right\}$$

- ▶  $b$  is steady-state level of  $B/Y$  ratio

# IRFs to a Permanent Tech Shock $\varepsilon_t$



Debt accumulation comes with a delay

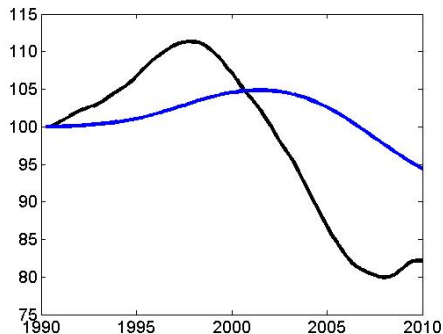
## Parameter Estimates: IT Revolution (US 1990–2010)

Data: labor productivity, and NIPA net exports (using consumption gives similar results)

Parameter	Description	Value
$\rho$	Persistence tech. shocks	0.98
$\sigma_u$	Std. dev. productivity	0.63
$\sigma_v$	Std. dev. permanent tech. shock	0.01
$\sigma_z$	Std. dev. transitory tech. shock	0.62
$\sigma_s$	Std. dev. noise	10.80

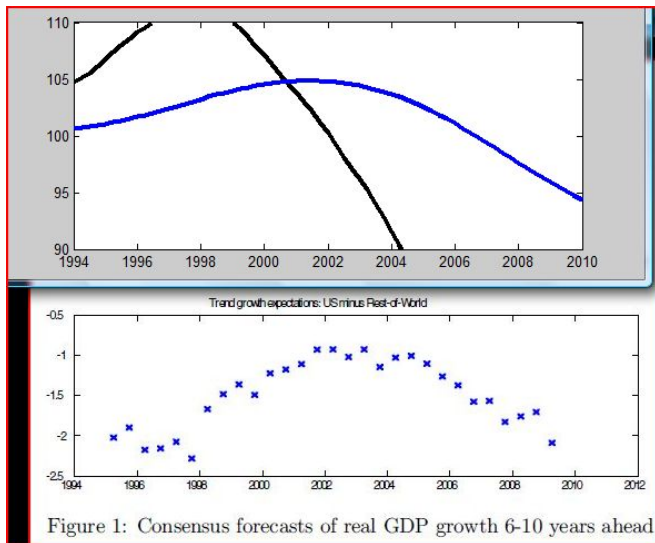
# Estimated States Using Data on $a_t$ and $nx_t$ (U.S. 1990-2010)

Smoothed and detrended long-run component of productivity ( $x_{t+\infty}$ , in **black**), and consumers' contemporaneous beliefs ( $E_t[x_{t+\infty}]$ , in **blue**)



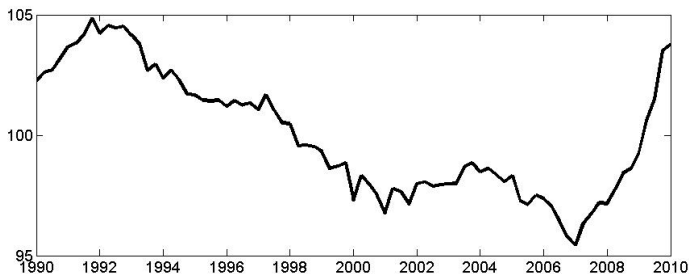
Estimation suggests optimism came with a delay

# Out-of-Sample Check: Comparison With Survey Evidence



## Reason for delay: productivity-to-consumption ratio, US (1990–2010)

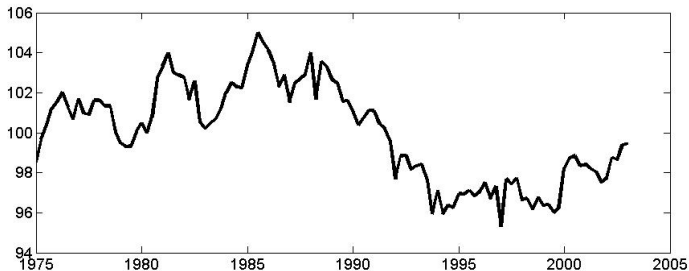
- ▶ IT Revolution: productivity boom in the 1990s
- ▶ Wavy-form:



- ▶ Declining productivity growth rates over the period:  
1.87% for 1990:1–2005:1; 1.18% for 2005:2–2010:1

## Japan (1975–2003)

- ▶ Electronics Revolution: productivity boom in the 1980s
- ▶ Wavy-form (productivity-to-consumption ratio):

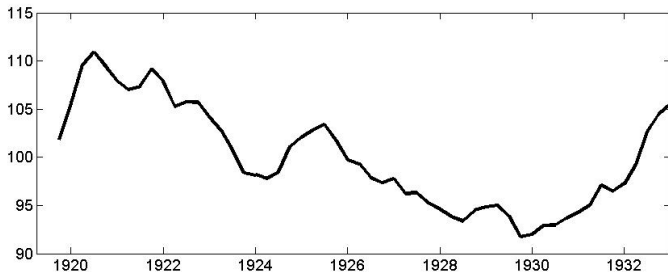


- ▶ Declining productivity growth rates over the period:  
3.22% for 1975:1–1990:1; 1.06% for 1990:2–2003:1



## US (1919–1933)

- ▶ Combustion/Elec. Revolution: productivity boom in the 1920s
- ▶ Wavy-form (productivity-to-consumption ratio):



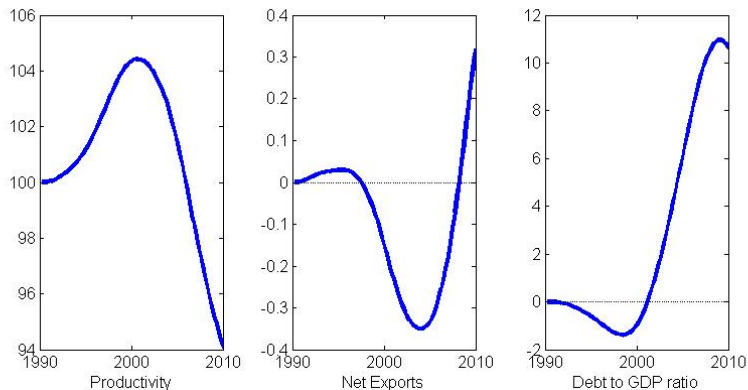
- ▶ Declining productivity growth rates over the period:  
2.82% for 1920:1–1926:1; -0.91% for 1926:2–1933:1

# Dynamics of Debt-to-Output Ratio

Depends on three elements:

1. Persistence of permanent technology process:  $\rho$   
(income effect + persistence of beliefs)
2. Relative size of standard deviations:  $\sigma_v, \sigma_z, \sigma_s$   
(speed of learning)
3. Timing of the shocks  
(degree of optimism before slowdown)

# Dynamics of Debt-to-Output Ratio Implied by the Estimated Model



In 2010: **low productivity** and **high debt**

# Conclusions

- ▶ Contribution to literature on tech rev
  - ▶ Investigate implications for the cycle
- ▶ Point out: tech rev precede private debt crisis
  - ▶ Attempt to understand why
  - ▶ Slow adjustment of beliefs seems key
- ▶ Analyze implications for debt dynamics after 2010
  - ▶ High levels of debt + productivity slowdown  
⇒ Long, debt related, consumption slump