A Reassessment of Real Business Cycle Theory

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Downturn of 2008–2009

- Many who observed:
  - GDP and hours fall significantly
  - Labor productivity rise
- Concluded that this time is different

Downturn of 2008–2009

- Many who observed:
  - Rising credit spreads
  - Plummeting asset values
- Concluded financial market disruptions responsible

But, is this time different?

- 2008–2009 is "flip side" of 1990s:
  - GDP and hours depressed, but booming in '90s
  - Labor productivity high, but low in '90s
- In earlier work, found puzzling if abstract from
  - Intangible investment that is expensed
  - Nonneutral technology change w.r.t. its production

Intuition from 1990s Boom

- Intangible investment that is expensed
  - Model output = GDP + unmeasured investment

  $\Rightarrow$ Output understated in boom

- Nonneutral technology change w.r.t. its production
  - Hours in R&D-intensive activities abnormally high

  $\Rightarrow$ GDP/hour understated in boom

... Both imply time-varying labor wedge ...

Application of Theory to 2000s

- Apply "off-the-shelf" model from 1990s study
  - Feed in paths for TFPs and tax rates
  - Abstract from financial and labor market disruptions
- Main findings:
  - Productivity growth slow-down big part of story
  - Aggregate observations in conformity with theory

Is Theory Consistent with Micro Data?

- What changes occurred in sectoral investments?
- What changes occurred in sectoral productivities?
- Are intangible and tangible investments correlated?
- Are there important input-output linkages?

Progress Report

- Lay out the basic theory (KP/LP)
- Extend it to incorporate intangible investments
- Compare and contrast predictions
- Discuss some of the microevidence

Basic Theory

Basic Theory

- Dates back to Kydland-Prescott, Long-Plosser
- With many variations on the original models:
  - Monetary and fiscal factors
  - Monopolistic competition
  - Real and nominal rigidities
  - Heterogeneous firms and households

  etc.

Technology

- Firms maximize pv of expected dividends,

$$d_{st} = p_{st}y_{st} - w_{st}h_{st} - p^m_{st}m_{st} - p_{st}x_{st} - \tau_{kt}p_{st}k_{st}$$
$$- \tau_{pt}\{p_{st}y_{st} - w_{st}h_{st} - (\delta_s + \tau_{kt})p_{st}k_{st} - p^m_{st}m_{st}\}$$

where $y_{st} = a_{st}k^{\theta_s}_{st}h^{\nu_s}_{st}m^{\gamma_s}_{st}$

$$m_{st} = \Pi_j m^{\gamma_{js}/\gamma_s}_{jst}$$

$$x_{st} = (1 + g_n)k_{st+1} - (1 - \delta_s)k_{st}$$

Preferences

- Household maximize expected utility

$$\max E \sum_{t=0}^{\infty} \beta^t u(c_t, \ell_t) N_t$$

subject to

$$(1+\tau_{ct}) \sum\nolimits_s p_{st} c_{st} + \sum\nolimits_s v_{st} s_{st+1}$$
$$\leq (1-\tau_{ht}) \sum\nolimits_s w_{st} h_{st} + \sum\nolimits_s (v_{st} + (1-\tau_{dt}) d_{st}) s_{st}$$

Equilibrium

- Govt spending obligations financed by distortionary taxes
- Households, firms maximize taking prices, policy given
- Total resources constrained by

$$c_{st} + x_{st} + \sum_{l=1}^{S} m_{slt} + g_{st} = y_{st}$$

A Naive Critique

Improvement in the track record of macroeconomics will require the development of theories that can explain why exchange sometimes works well and other times breaks down. Nothing could be more counterproductive in this regard than a lengthy professional detour into the analysis of stochastic Robinson Crusoes.

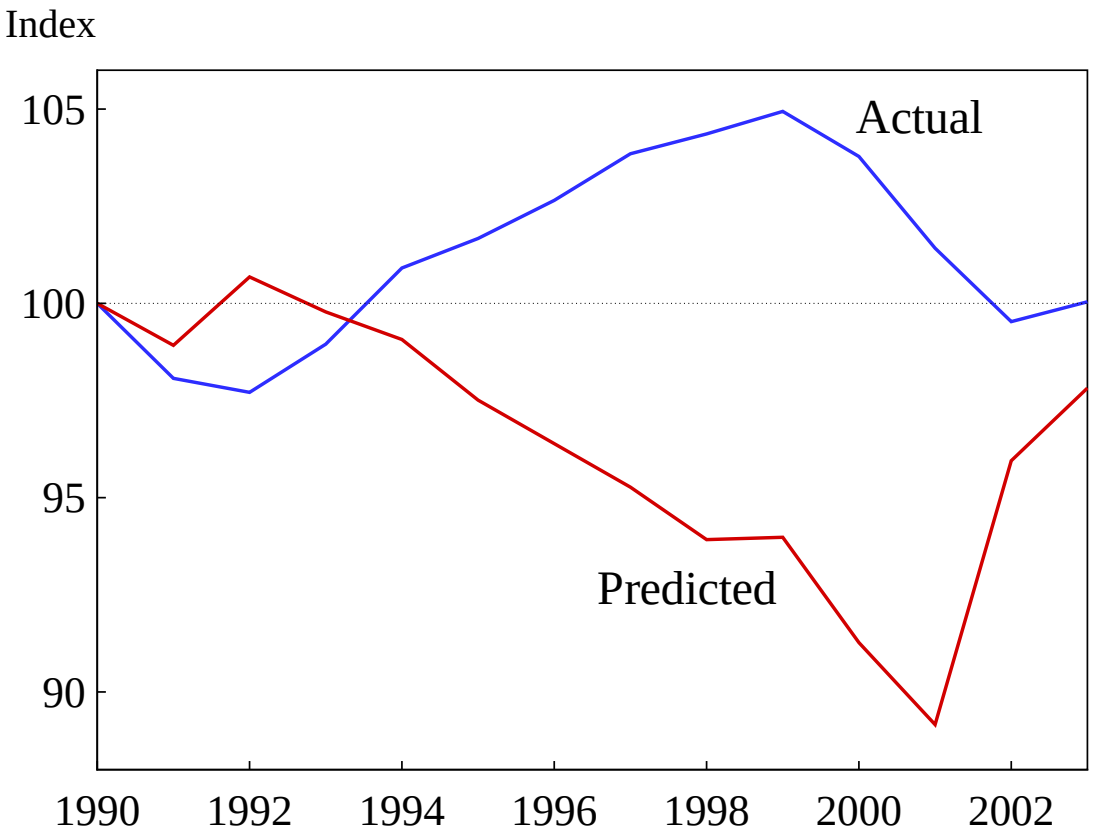
— Larry Summers (Minneapolis Fed QR, 1986)

More Sophisticated Critiques

- Feed in paths for exogenous shocks
- Plot key series like hours and output

For example, in the 1990s...

Predict Hours Depressed, not Booming



Extended Theory

Technology

- Production of final goods and services

$$y_{st} = a_{st}(k^1_{T,st})^{\theta_s}(k_{I,st})^{\phi_s}(h^1_{st})^{\nu_s}(m^1_{st})^{\gamma_s}$$

- Production of new intangible capital

$$x_{I,st} = b_{st}(k^2_{T,st})^{\theta_s}(k_{I,st})^{\phi_s}(h^2_{st})^{\nu_s}(m^2_{st})^{\gamma_s}$$

Total intangible stock used in two activities

Updated Firm problem

- Firms maximize pv of expected dividends,

$$d_{st} = p_{st}y_{st} - w_{st}h_{st} - p^m_{st}m_{st} - p_{st}x_{T,st} - \tau_{kt}p_{st}k_{T,st}$$
$$- \tau_{pt}\{p_{st}y_{st} - w_{st}h_{st} - (\delta_{Ts} + \tau_{kt})p_{st}k_{T,st} - p^m_{st}m_{st}\}$$

where $m_{st} = \Pi_j m_{jst}^{\gamma_{js}/\gamma_s}$

$$x_{T,st} = (1 + g_n)k_{T,st+1} - (1 - \delta_{Ts})k_{T,st}$$

$$x_{I,st} = (1 + g_n)k_{I,st+1} - (1 - \delta_{Is})k_{I,st}$$

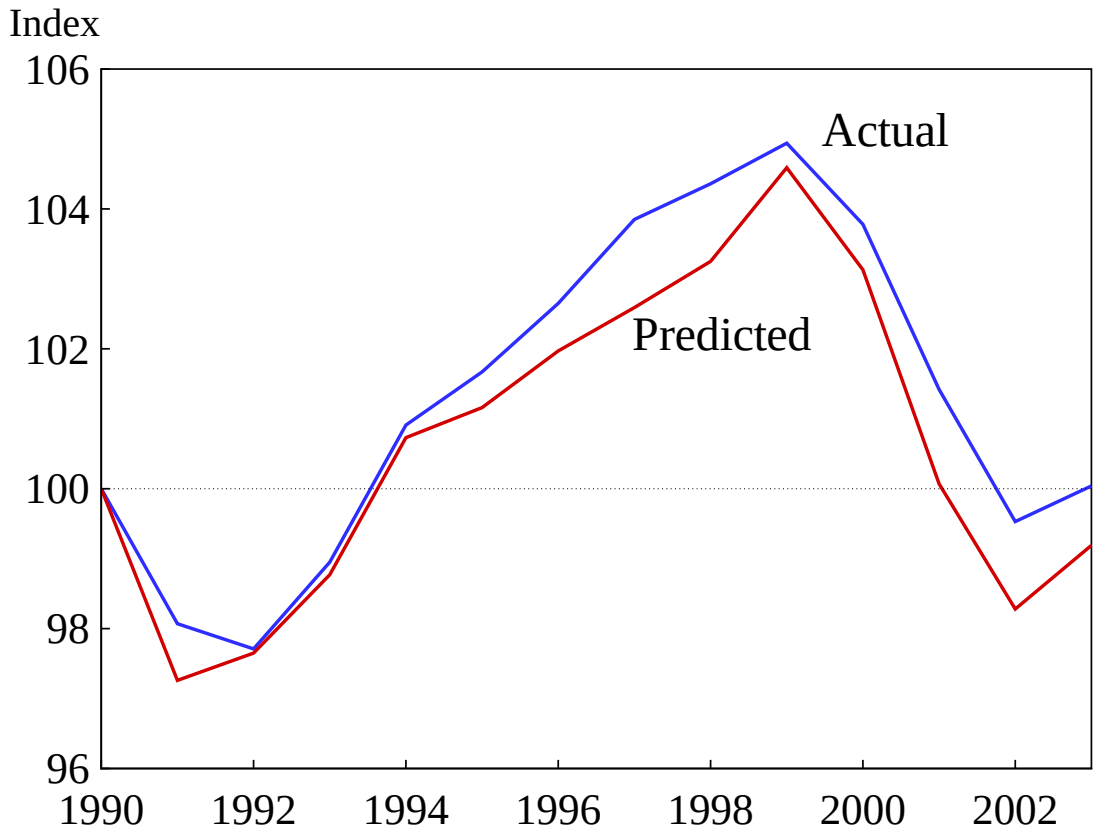
Model Predictions

- Investments fluctuate more than output
- Leads to time-varying labor wedge ($q_t x_{Ist}$)

$$\underbrace{\frac{y_t}{h_t^1 + h_t^2}}_{\text{NIPA productivity}} \neq \underbrace{\frac{y_t + q_t x_{Ist}}{h_t^1 + h_t^2}}_{\text{true productivity}}$$

Bottom line: no deviation of aggregate data with theory

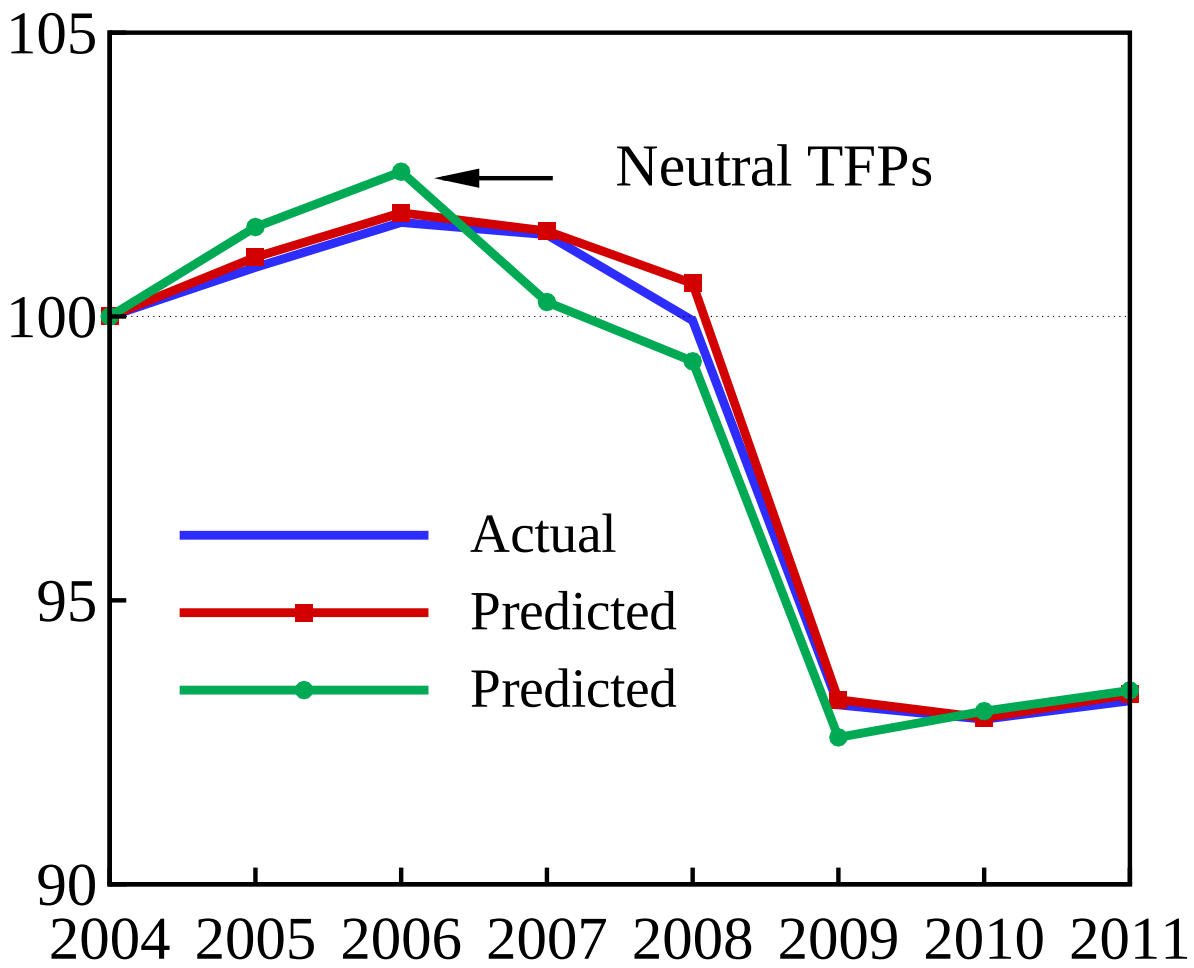
Now Predict Hours Booming in 1990s



Preliminary look at 2008-2009

- Can choose productivity parameters to fit GDP and hours
- Thus, no logical inconsistency

Hours in 2008-2009



What about micro data?

BEA Comprehensive Revision 2013

- *Intellectual property products* investment included:
  - R&D
  - Artistic originals
  - Software (first introduced in 1999)
- While much investment still missing, category is large...

BEA Comprehensive Revision 2013

- Private fixed nonresidential investment, 2012

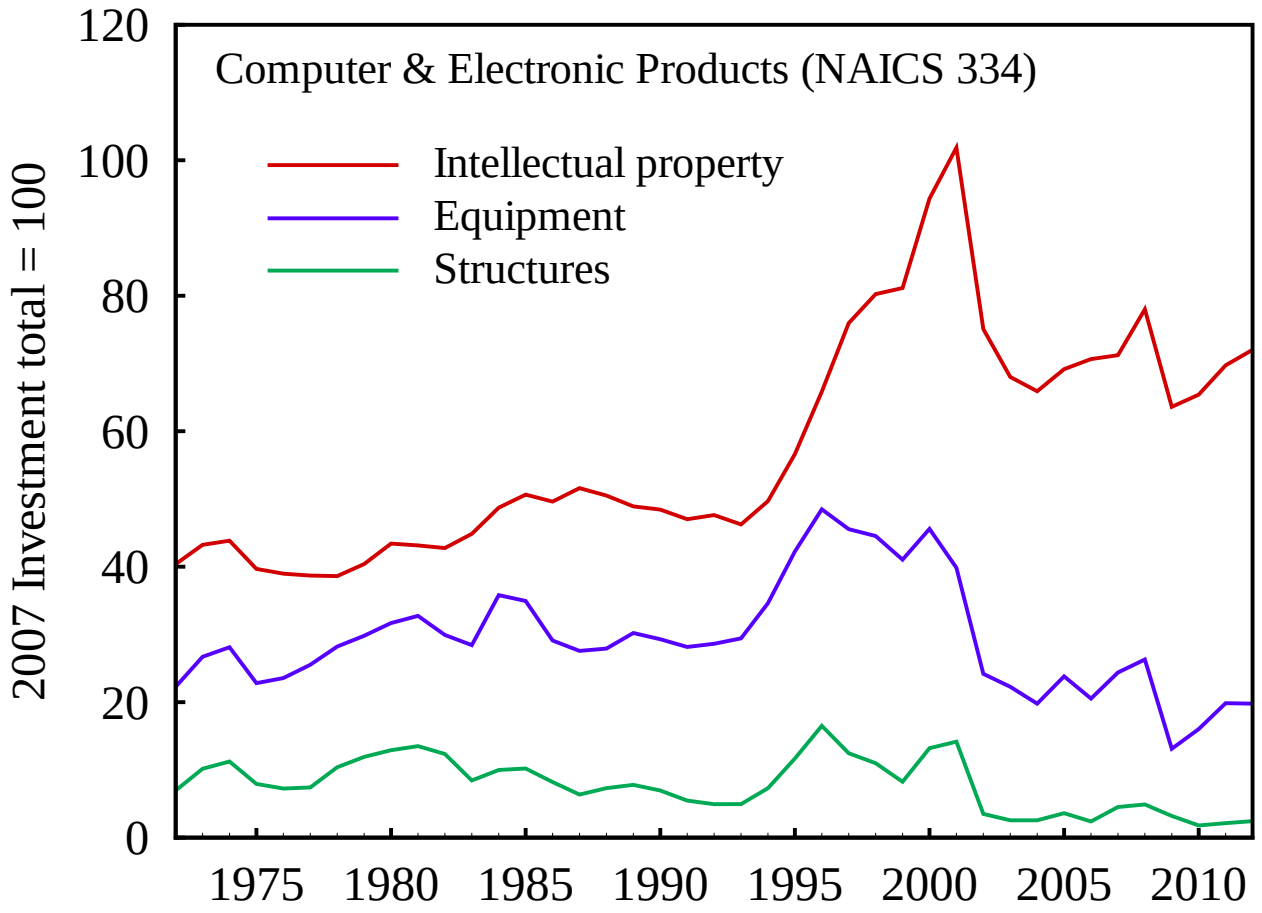
  22% Structures

  45% Equipment

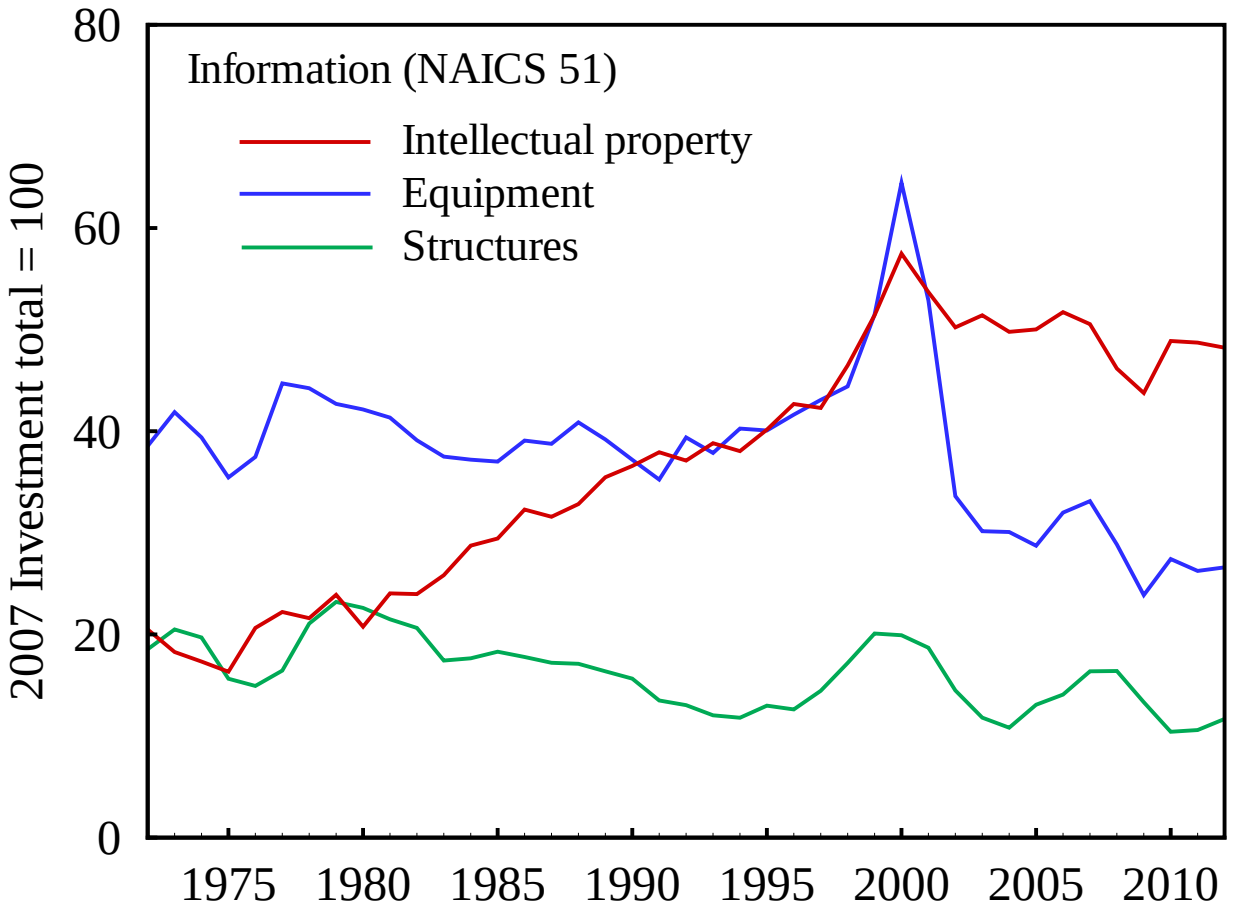
  33% Intellectual property

- Also have data for detailed industrial sectors

Computer & Electronic Products



Information



Other Microevidence

- SEC requires 10-K reports from public companies
- Have company info on
  - R&D expenses
  - Advertising expenses
- Data show simultaneous large declines in 2008–2009

Top 500 Advertisers (COMPUSTAT)

Statistic	% of Domestic company total	% Decline in 2008–2009
Ad expenses	96.5	-10.8
R&D expenses	46.6	-16.2
PP&E expenses	27.5	-18.2
Employees	50.2	-2.2
Sales	38.6	-3.5

Top 500 R&D Spenders (COMPUSTAT)

Statistic	% of Domestic company total	% Decline in 2008–2009
Ad expenses	44.7	-19.6
R&D expenses	92.3	-11.9
PP&E expenses	25.9	-21.7
Employees	24.4	-4.4
Sales	34.2	-15.3

Strong I-O Linkages

- Use BEA's 2007 input-output benchmark
- Find 66% of output has intermediate uses from
  - Manufacturing (NAICS 31-33)
  - Information (NAICS 51)
  - Professional and business services (NAICS 54-56)
- And to sectors that do much less intangible investment

Recap

- Intangible investments are:
  - Expensed for tax purposes
  - Only partly measured in GDP
  - Estimated to be as large as tangibles
  - Correlated with tangibles
  - Picked up in typical productivity measures
- And, in our view, worthy of further investigation

Future research

- Need full exploration of microevidence for 2008-2009
- Main challenge is using theory to measure the unmeasured