



THE LABOR PRODUCTIVITY PUZZLE

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U.S. RECESSION OF 2008–2009

- Seems puzzling wrt to RBC theory
 - TFP and tax rates barely changed
 - GDP relative to trend fell 5%
 - Hours per capita fell 7%
 - Labor productivity rose 2%



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- Unless key factor included: Intangible investments



MOTIVATION: THE 1990S TECH BOOM

- 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
 - ⇒ Output understated in boom
- Nonneutral technology change w.r.t. its production
 - Hours in R&D-intensive activities abnormally high
 - ⇒ GDP/hour understated in boom



APPLICATION OF THEORY TO 2000S

- Apply our “off-the-shelf” model from 1990s study
 - Feed in paths for TFPs and tax rates
 - Abstract from financial and labor market frictions
- Main findings:
 - Productivity growth slow-down biggest part of story
 - Nonneutrality of TFPs plays only small role
 - Observations in remarkable conformity with theory



THEORY



THEORY

- Household/Business owners solve

$$\max E \sum_{t=0}^{\infty} \beta^t [\log c_t + \psi \log(1 - h_t)] N_t$$

subject to

$$c_t + x_{Tt} + q_t x_{It} = r_{Tt} k_{Tt} + r_{It} k_{It} + w_t h_t \\ - \text{taxes}_t + \text{transfers}_t + \text{nonbusiness}_t$$

$$k_{T,t+1} = (1 - \delta_T) k_{Tt} + x_{Tt}$$

$$k_{I,t+1} = (1 - \delta_I) k_{It} + x_{It}$$

where subscript T/I denotes tangible/intangible



TECHNOLOGY

- Production of final goods and services

$$y_b = A^1 F(k_T^1, k_I, h^1)$$

- Production of new intangible capital

$$x_I = A^2 G(k_T^2, k_I, h^2)$$

Total intangible stock used in two activities



MODEL FOR THE 1990S

- Technological change was nonneutral: $A_t^2/A_t^1 \uparrow$



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⇒ NIPA labor productivity p_t^{NIPA} falls

$$p_t^{NIPA} = \frac{y_{bt}}{h_t^1 + h_t^2}$$



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⇒ More hours to intangible sector: $h_t^2/h_t^1 \uparrow$

⇒ NIPA labor productivity p_t^{NIPA} falls

While true labor productivity p_t rises

$$p_t = \frac{y_{bt}}{h_t^1} = \frac{y_{bt} + q_t x_{It}}{h_t^1 + h_t^2}$$



MODEL FOR 2008–2009

- Nonneutrality still a factor but quantitatively less so
- Intangibles key even if A_t^2/A_t^1 fixed,
 - Decline in $q_t x_{It}$ bigger than y_{bt}
 - Leads to labor wedge with $p_t^{NIPA} \uparrow$ and $p_t \downarrow$

$$p_t^{NIPA} = \frac{y_{bt}}{h_t^1 + h_t^2}, \quad p_t = \frac{y_{bt} + q_t x_{It}}{h_t^1 + h_t^2}$$



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⇒ Labor productivity puzzle not so puzzling



QUANTITATIVE PREDICTIONS



STARTING POINT: NATIONAL ACCOUNTS

NIPA INCOME

NIPA PRODUCT

Capital consumption

Taxes on production

Compensation **less sweat**

Profits **less expensed**

Net interest

Personal consumption

Government consumption

Government investment

Private tangible investment

Net exports



REVISED NATIONAL ACCOUNTS

TOTAL INCOME

Capital consumption
Taxes on production
Compensation **less sweat**
Profits **less expensed**
Net interest
Capital gains

TOTAL PRODUCT

Personal consumption
Government consumption
Government investment
Private tangible investment
Net exports
Intangible investment



REVISED NATIONAL ACCOUNTS

TOTAL INCOME

Capital consumption

Taxes on production

Compensation

Profits

Net interest

TOTAL PRODUCT

Personal consumption

Government consumption

Government investment

Private tangible investment

Net exports

Intangible investment



PARAMETERS AND EXOGENOUS PROCESSES

- Parameters set to match NIPA accounts and hours in 2004
- Exogenous variables:
 - TFPs
 - Tax rates on consumption and labor
 - Nonbusiness activities (paths set to US)
- Household expectations
 - 2004–2006 expect policies to continue
 - 2007–2011 perfect foresight of future path

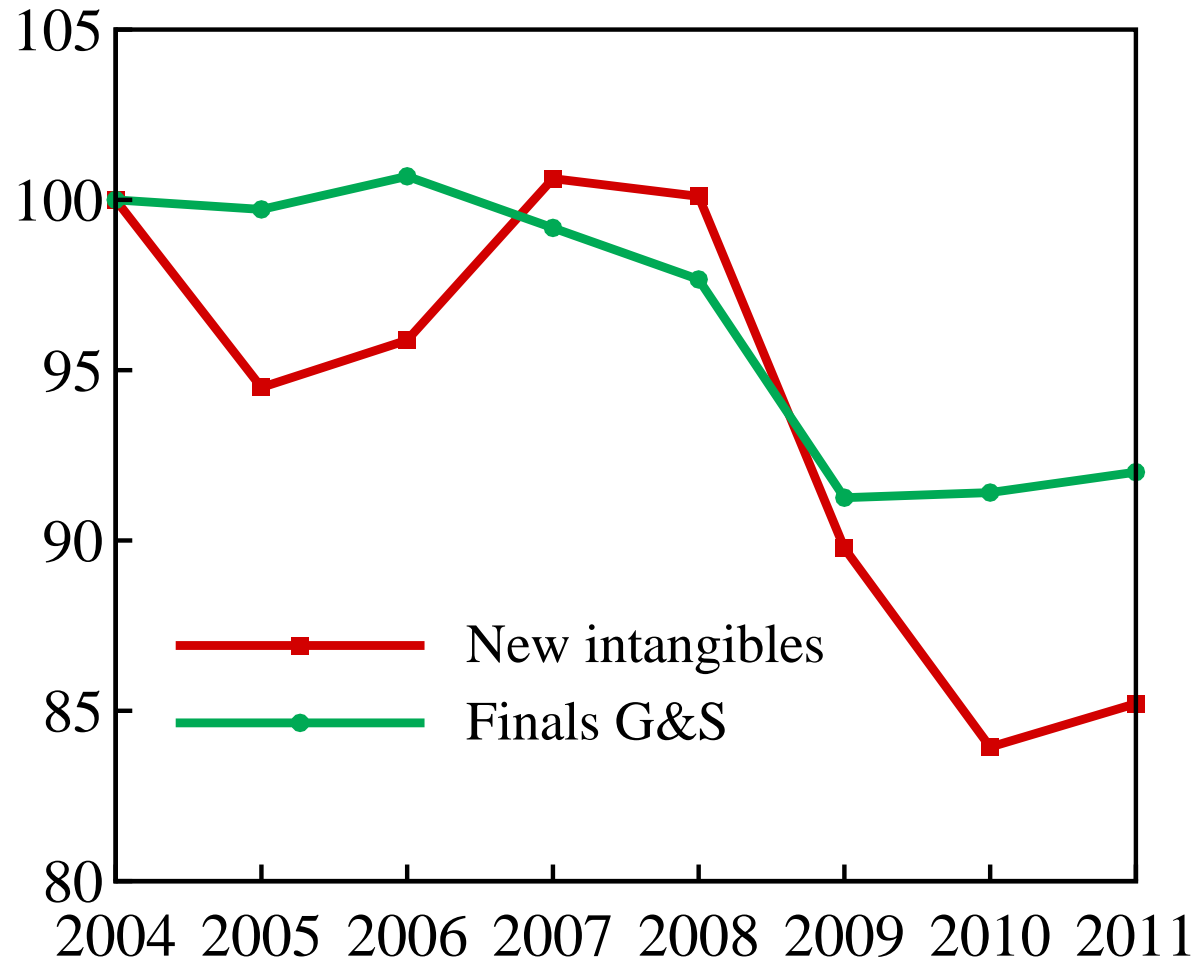


IDENTIFYING TFPs

- Easy in one-sector economy: $A_t = GDP_t^{US} / F(k_t^{US}, h_t^{US})$
- Tricky here since k_{It} latent
- What we do:
 - Choose $\{A_t^1, A_t^2\}$ so $GDP_t^{mod} = GDP_t^{US}$, $h_t^{mod} = h_t^{US}$
 - Check for deviations with observables, e.g., $x_{It}^{mod} \neq x_{It}^{US}$
 - Check for external inconsistencies, e.g., $x_{It}^{mod} < 0$
 - Redo exercise with A_t^2/A_t^1 constant

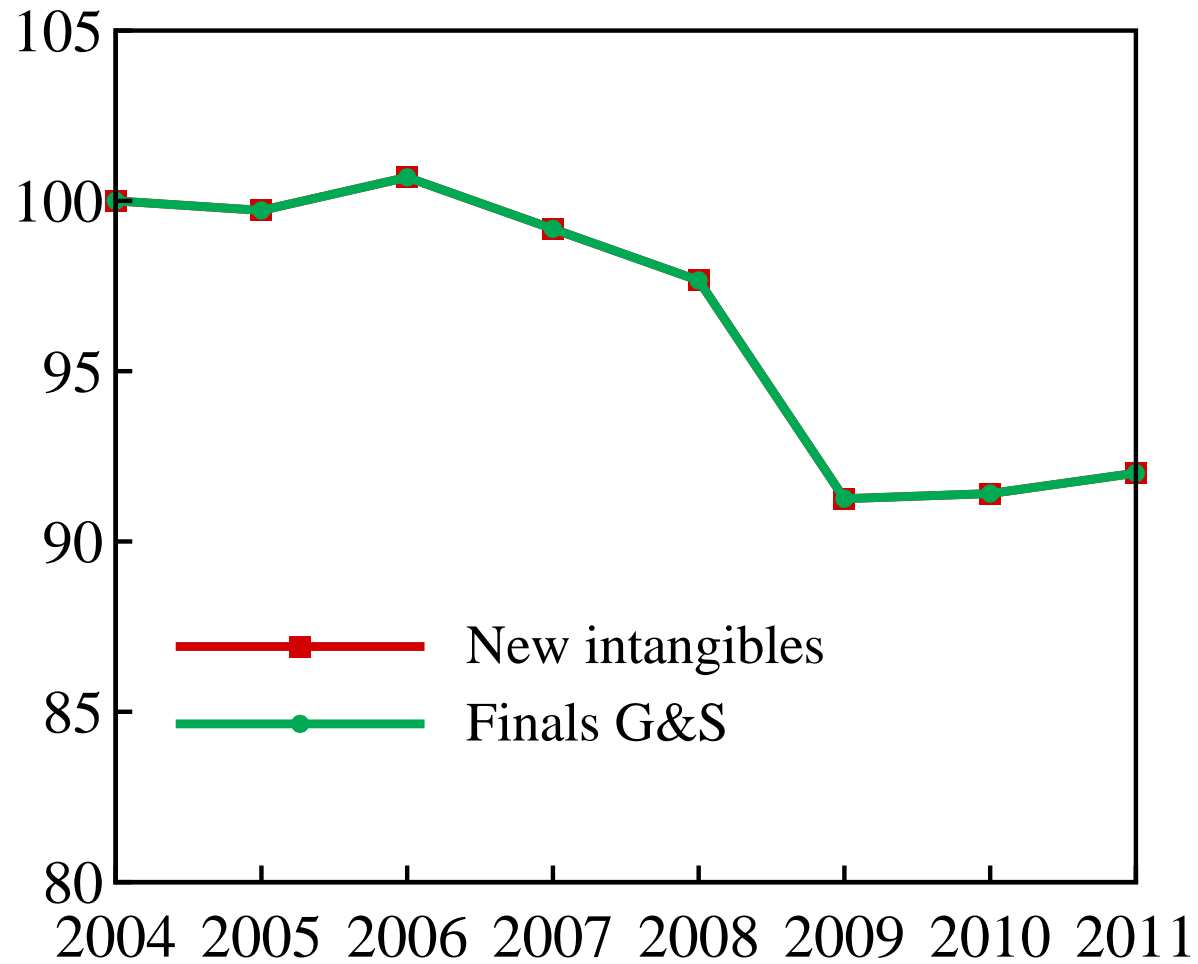


IMPLIED TFPS RELATIVE TO TREND





ALTERNATIVE WITH NEUTRAL TFPs

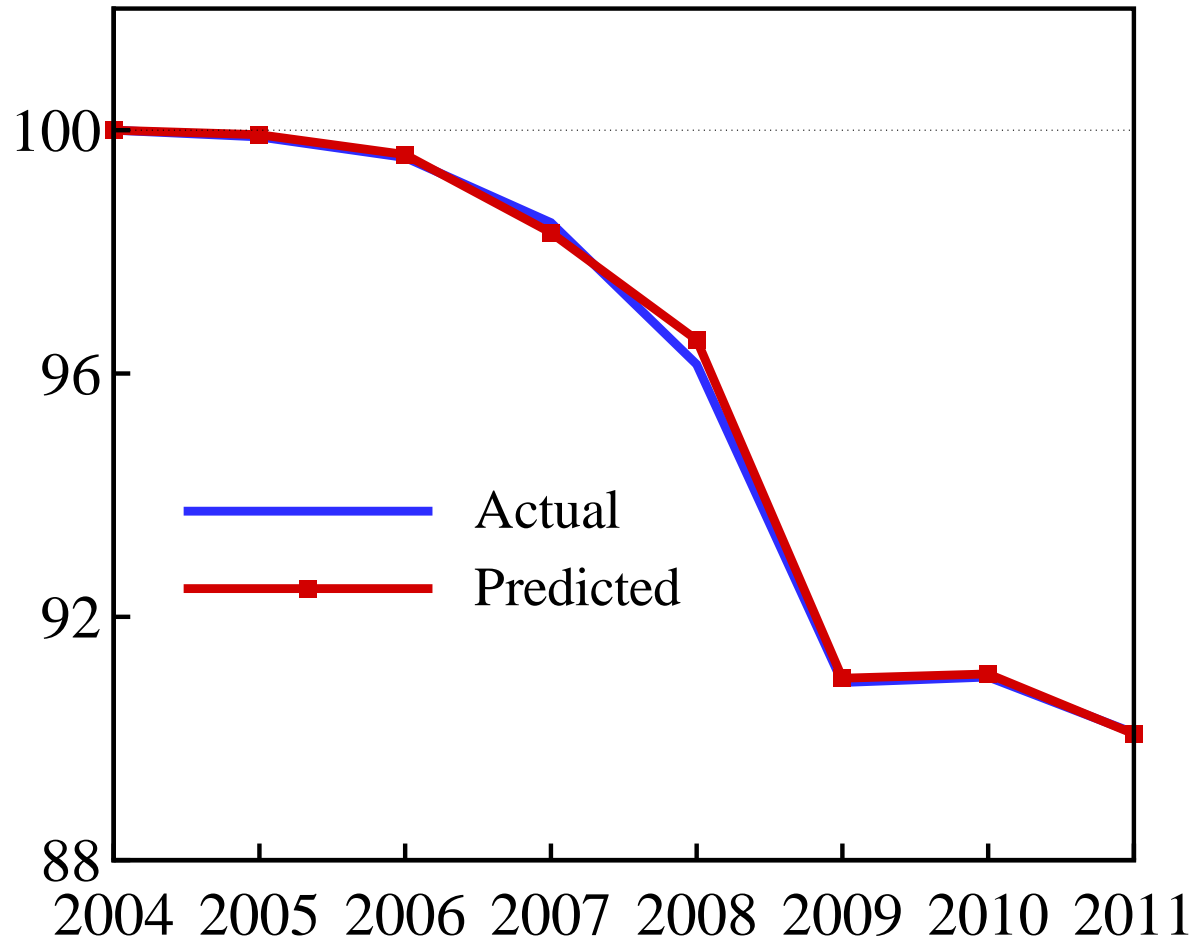




RESULTS

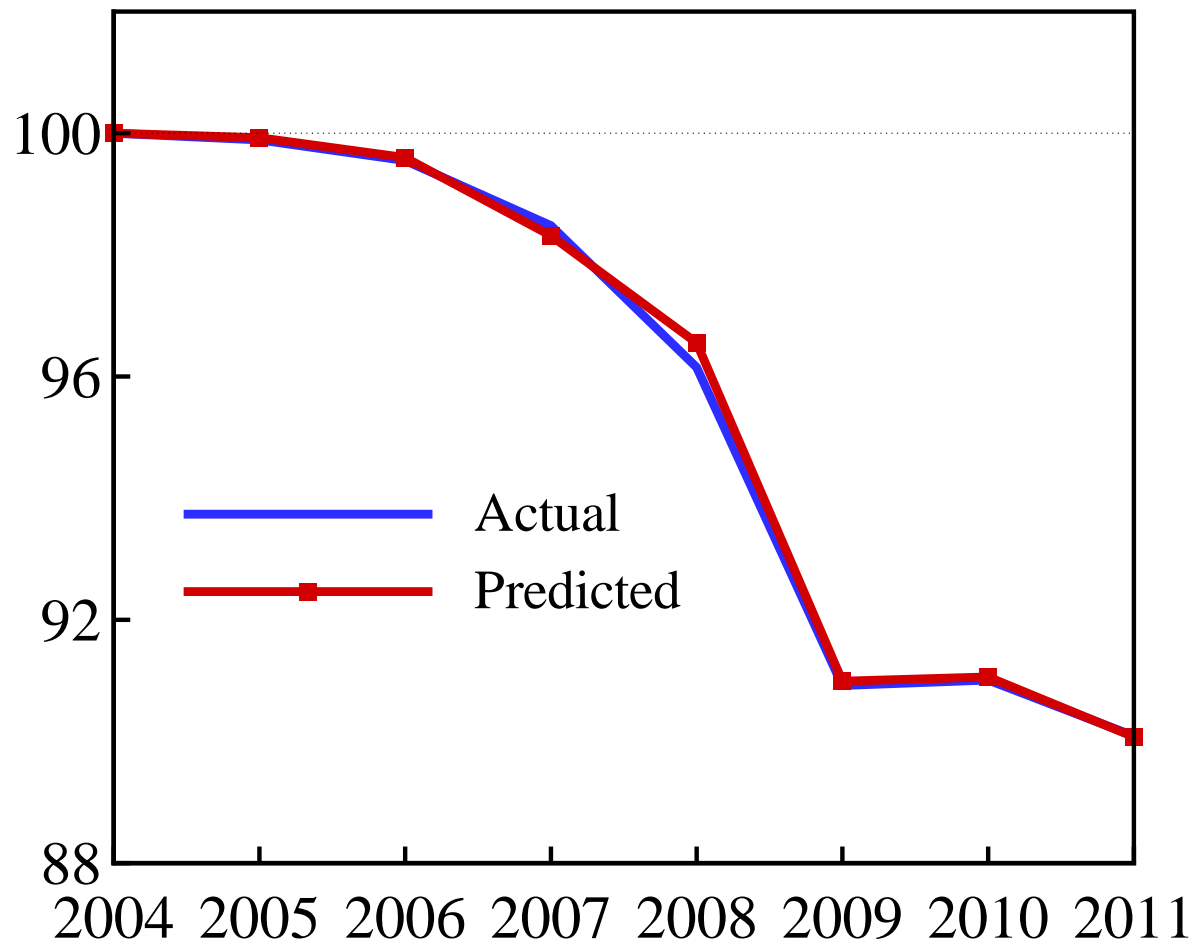


GDP RELATIVE TO TREND





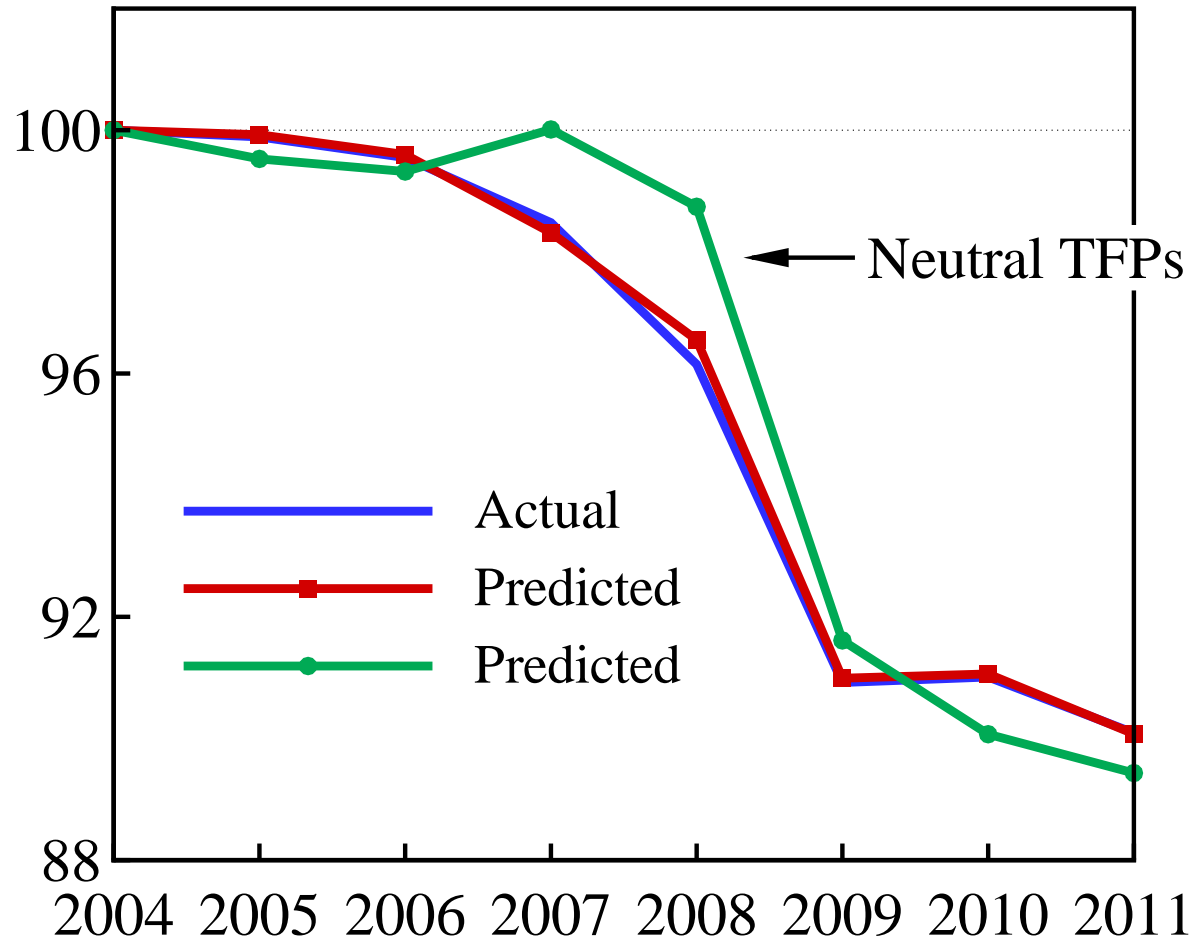
GDP RELATIVE TO TREND



- **Punchline:** model can generate observed patterns

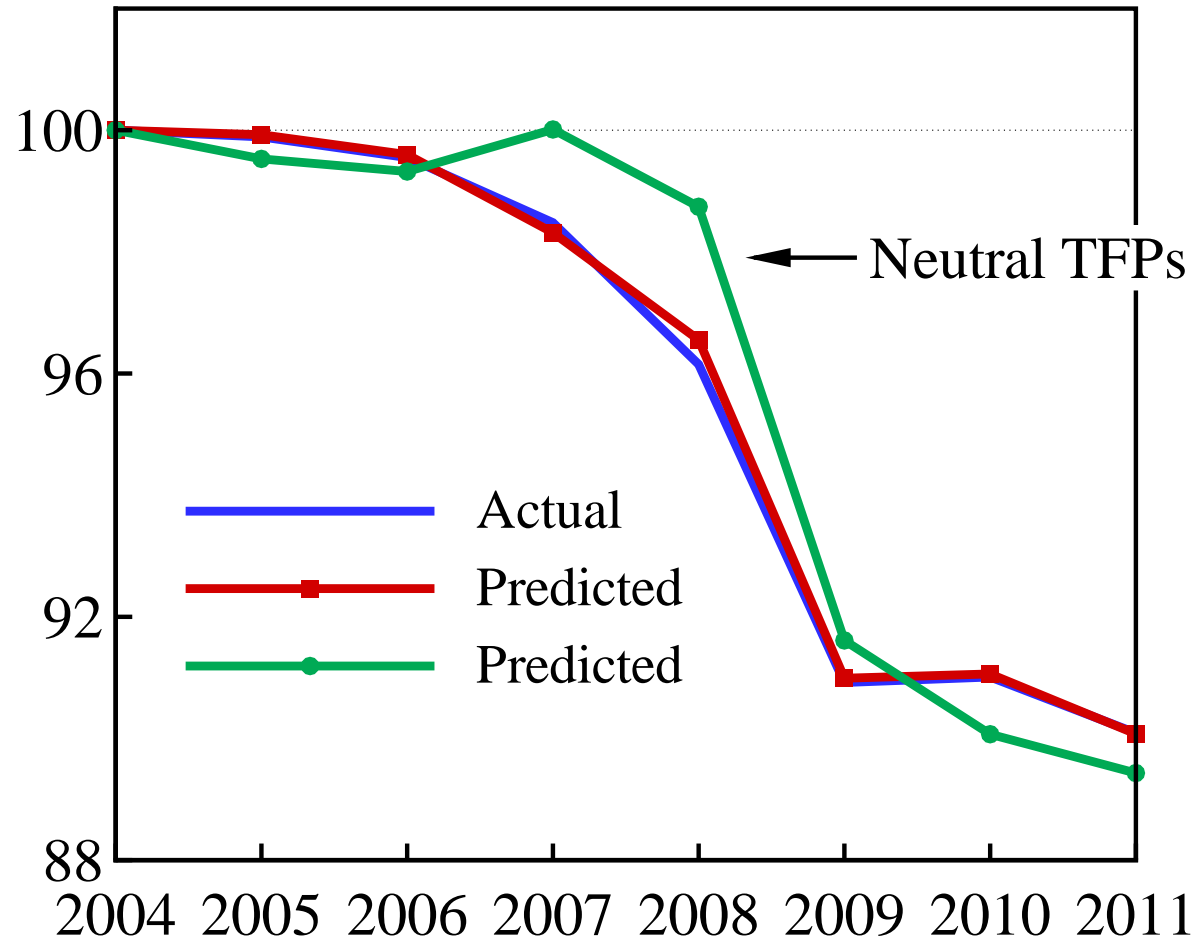


GDP RELATIVE TO TREND





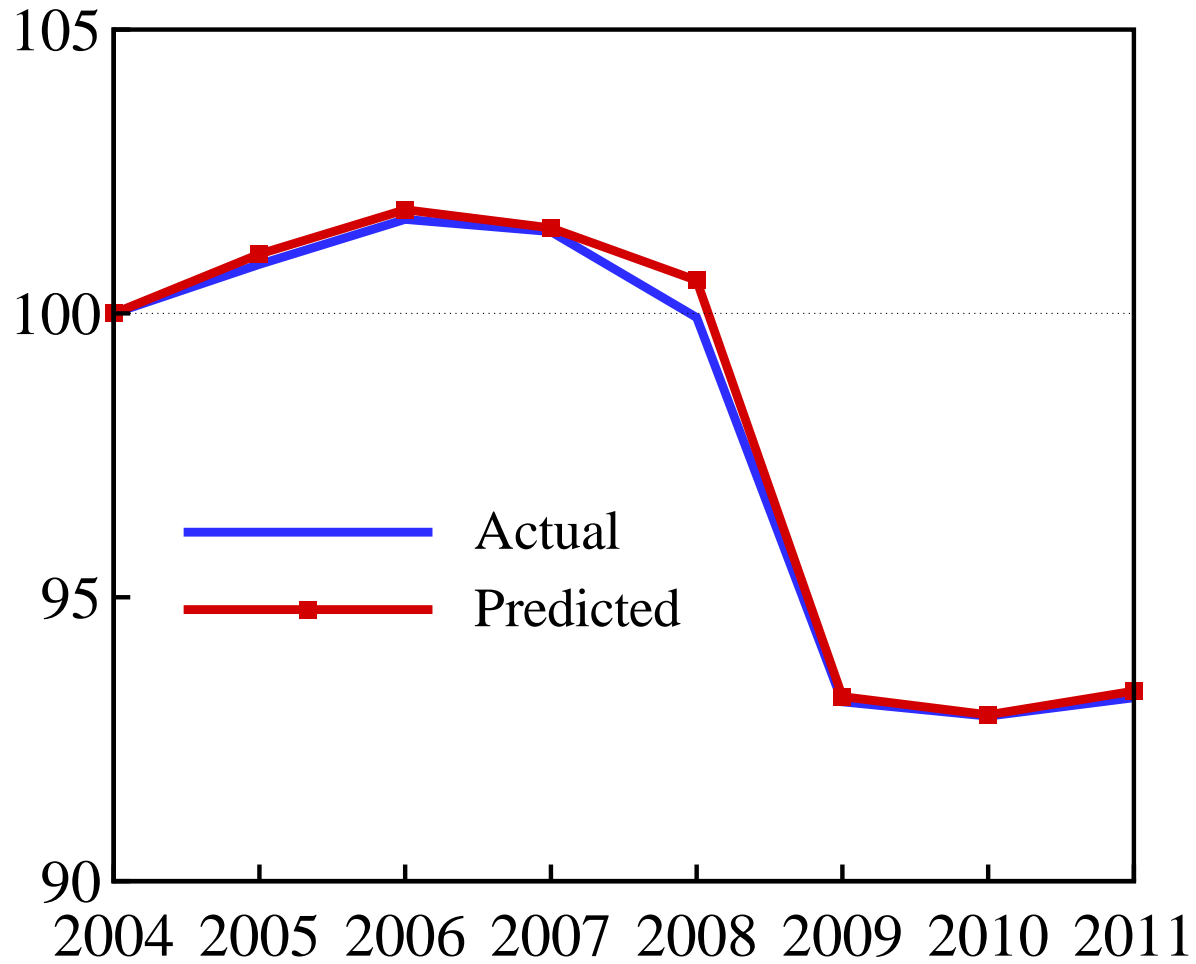
GDP RELATIVE TO TREND



- **Punchline:** $\approx 10\%$ drop even if A_t^2/A_t^1 constant

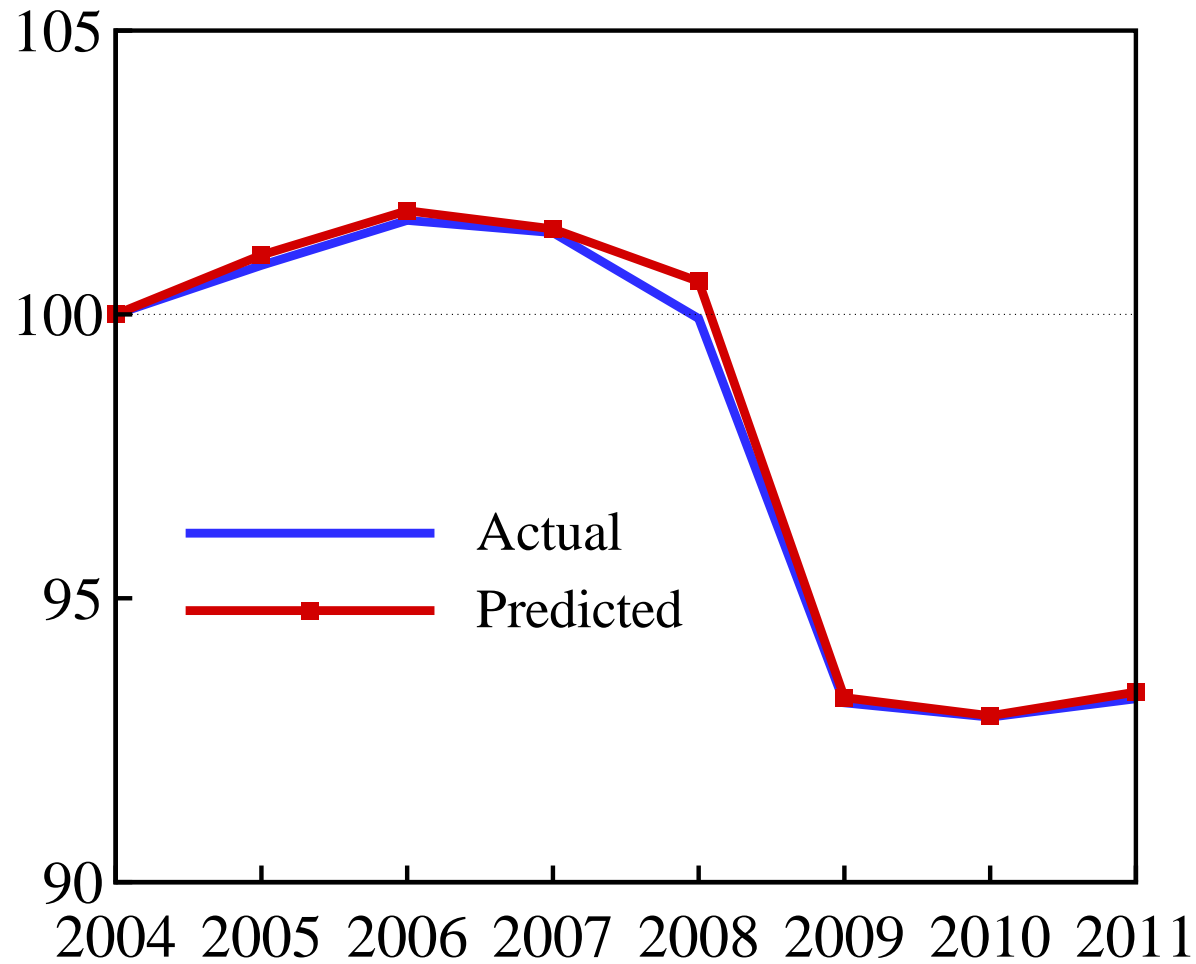


HOURS PER CAPITA





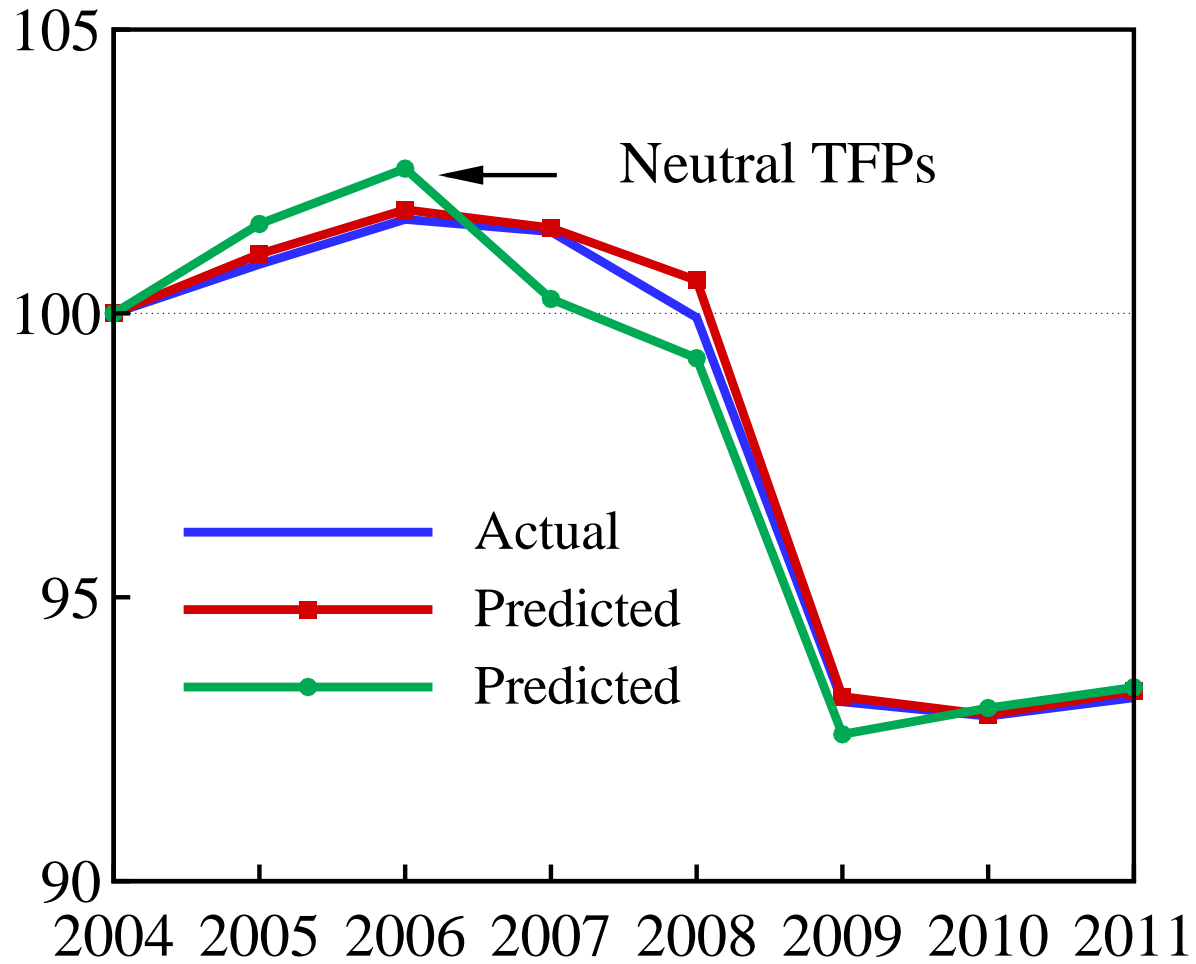
HOURS PER CAPITA



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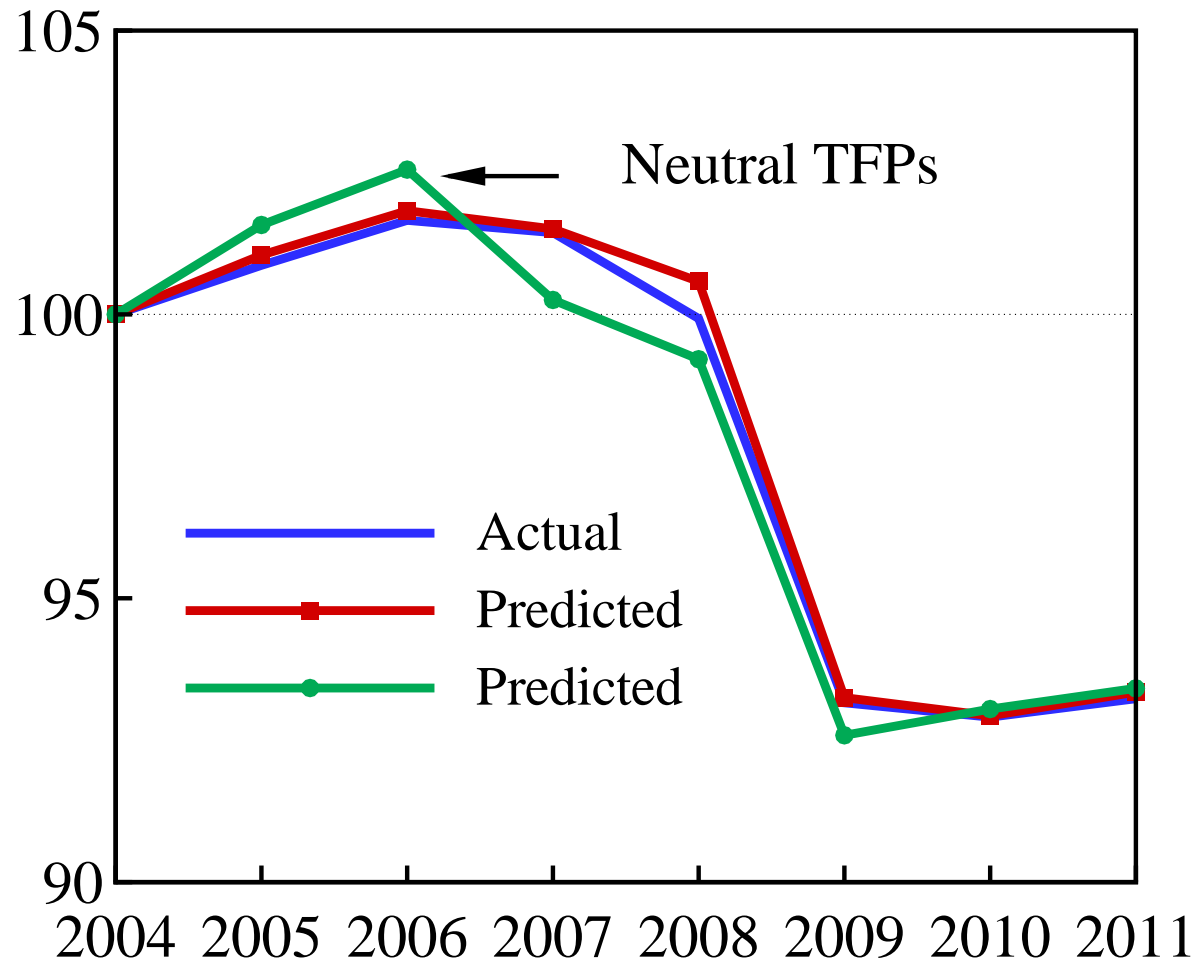


HOURS PER CAPITA





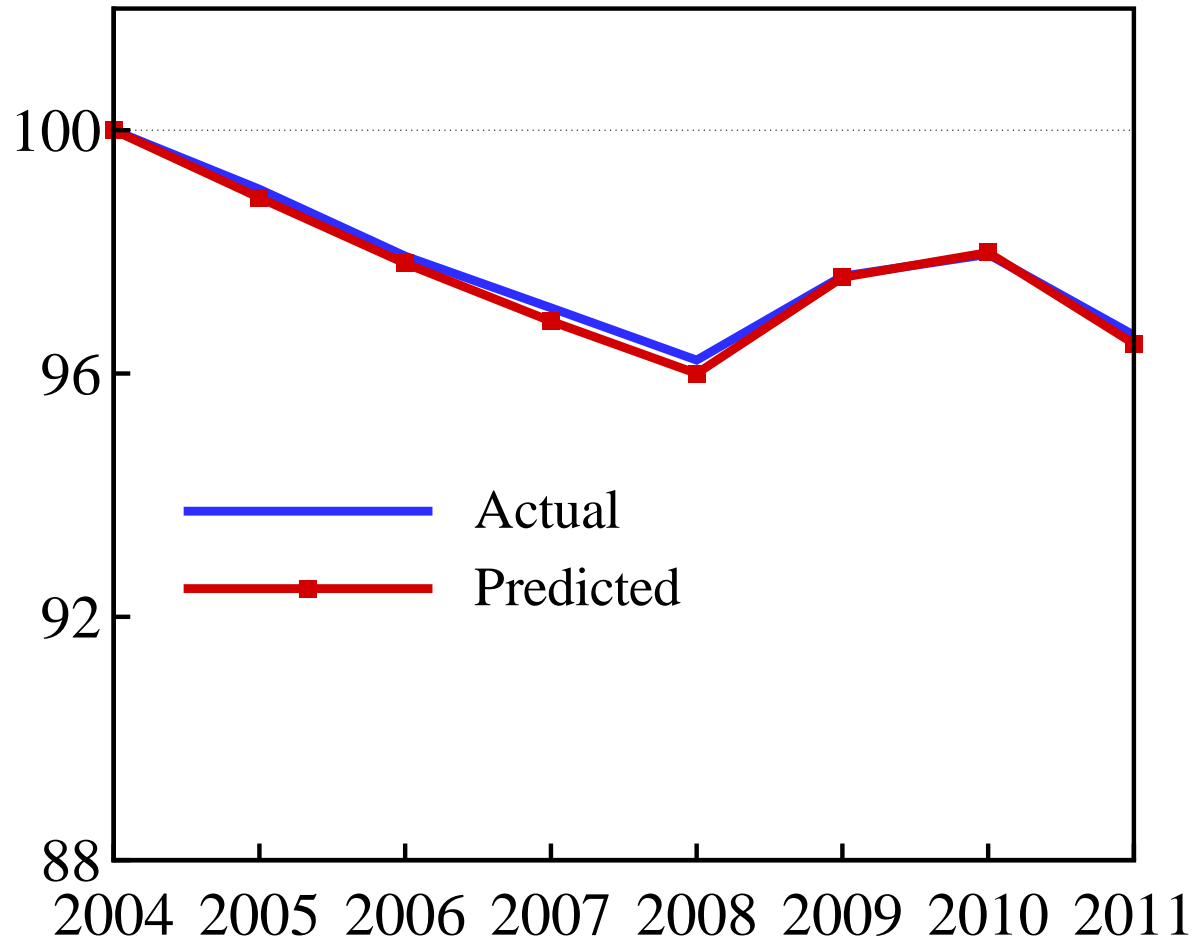
HOURS PER CAPITA



- **Punchline:** $\approx 7\%$ drop even if A_t^2/A_t^1 constant

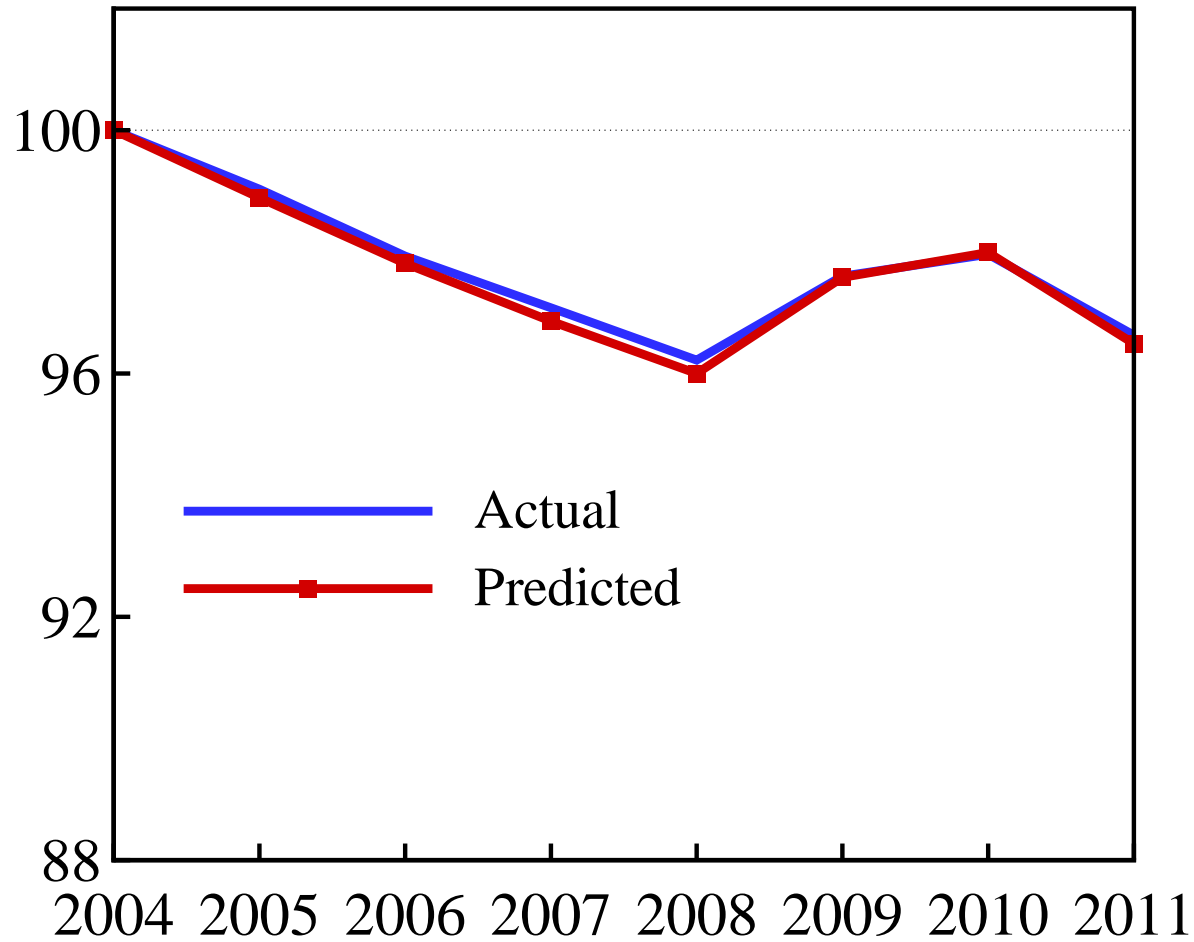


GDP PER HOUR





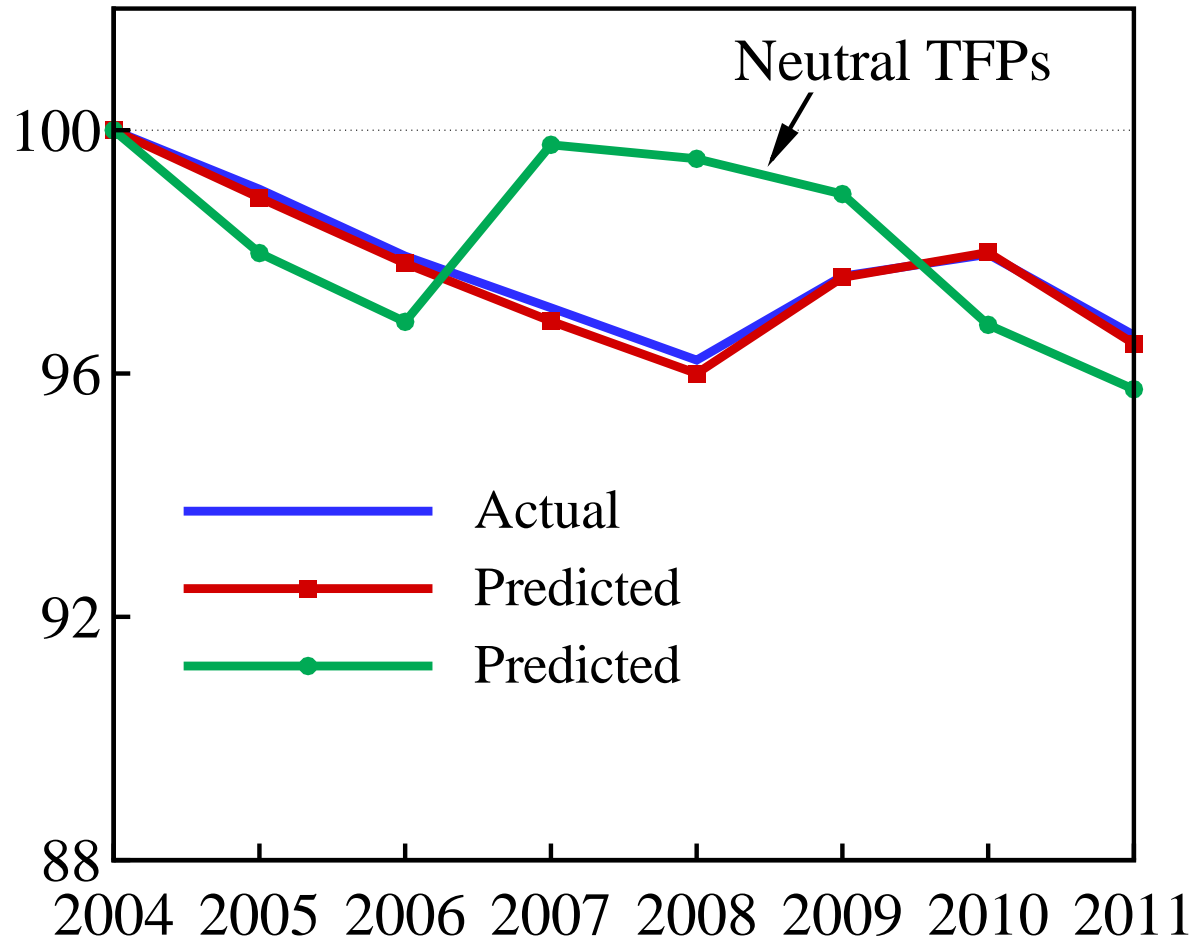
GDP PER HOUR



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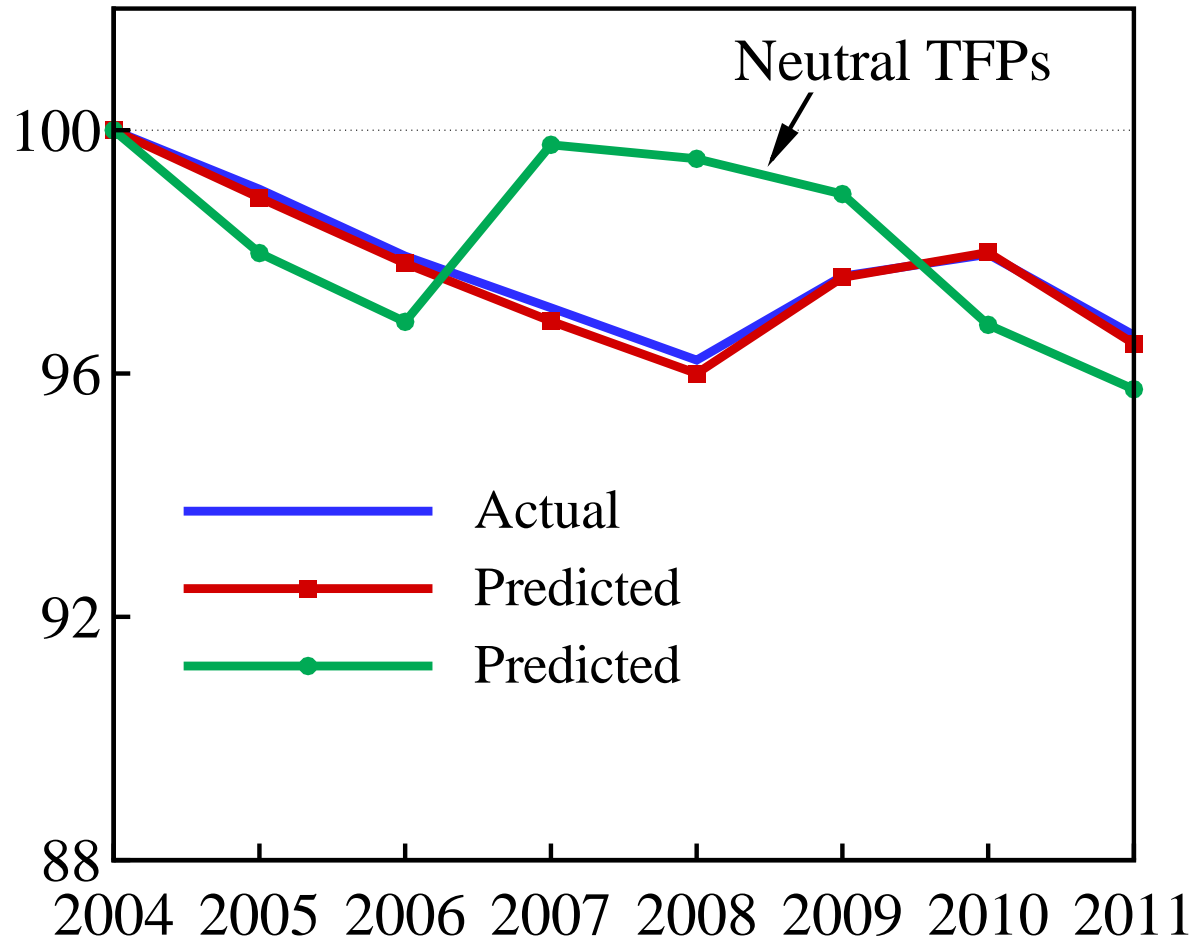


GDP PER HOUR





GDP PER HOUR



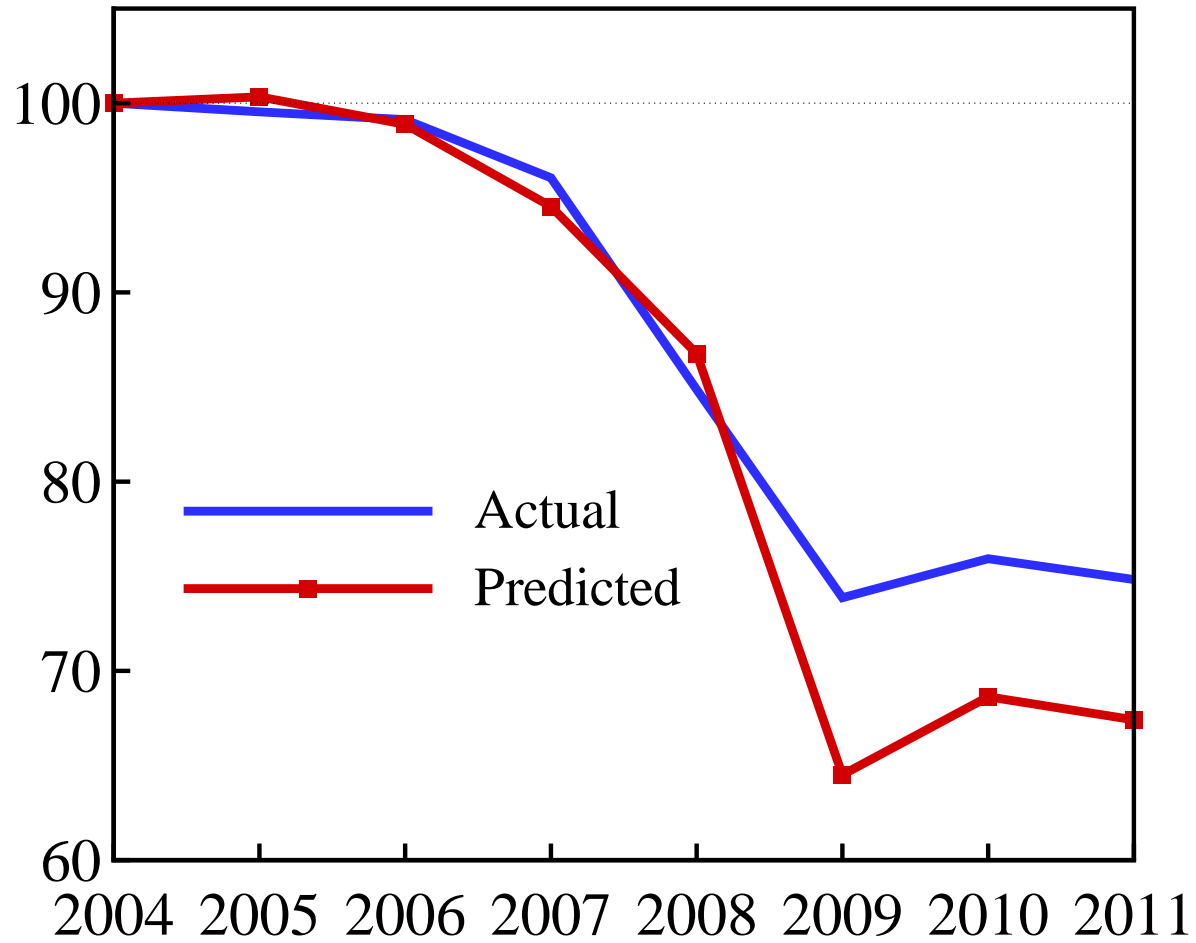
- **Punchline:** increase occurs earlier if A_t^2/A_t^1 constant



ARE THERE SIGNIFICANT DEVIATIONS
IN INVESTMENT AND CONSUMPTION?

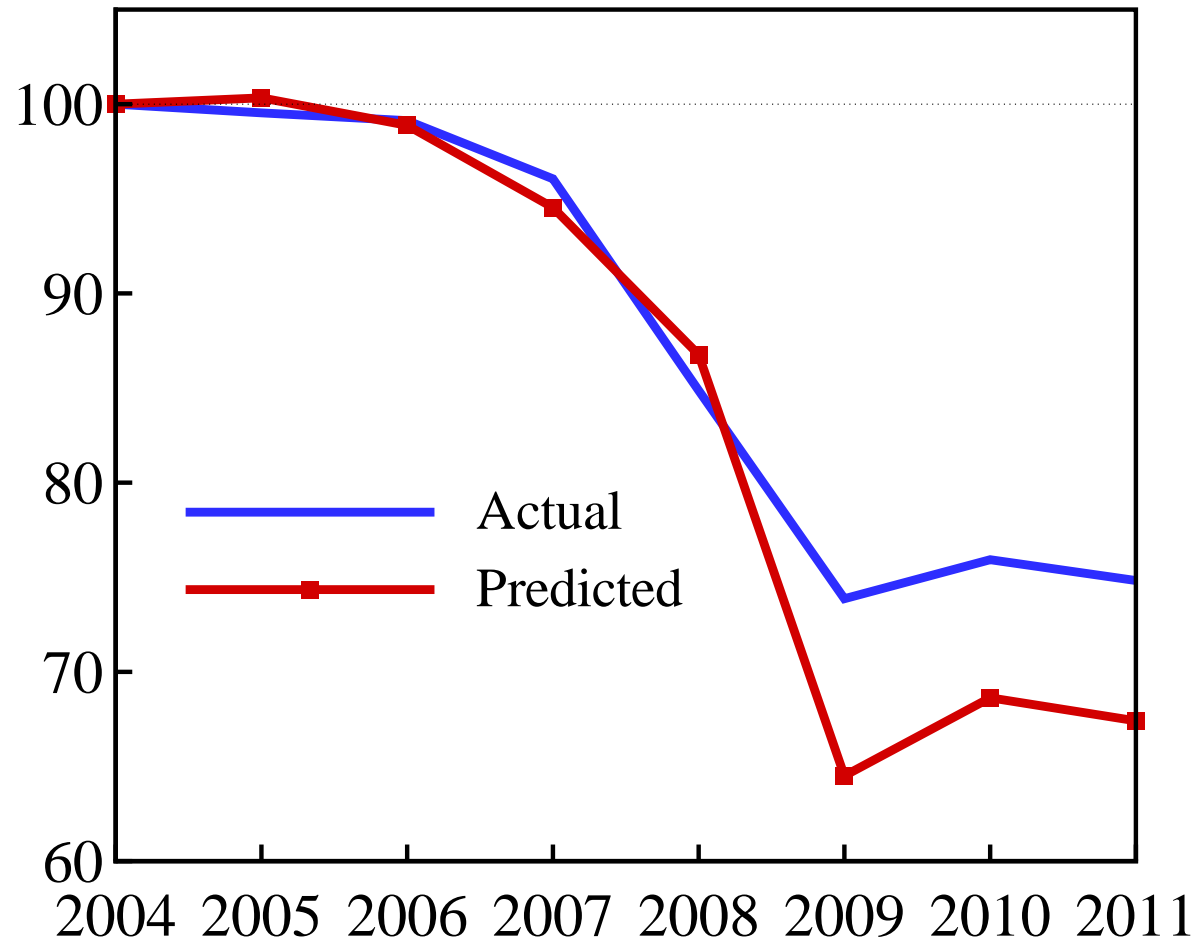


TOTAL TANGIBLE INVESTMENT RELATIVE TO TREND





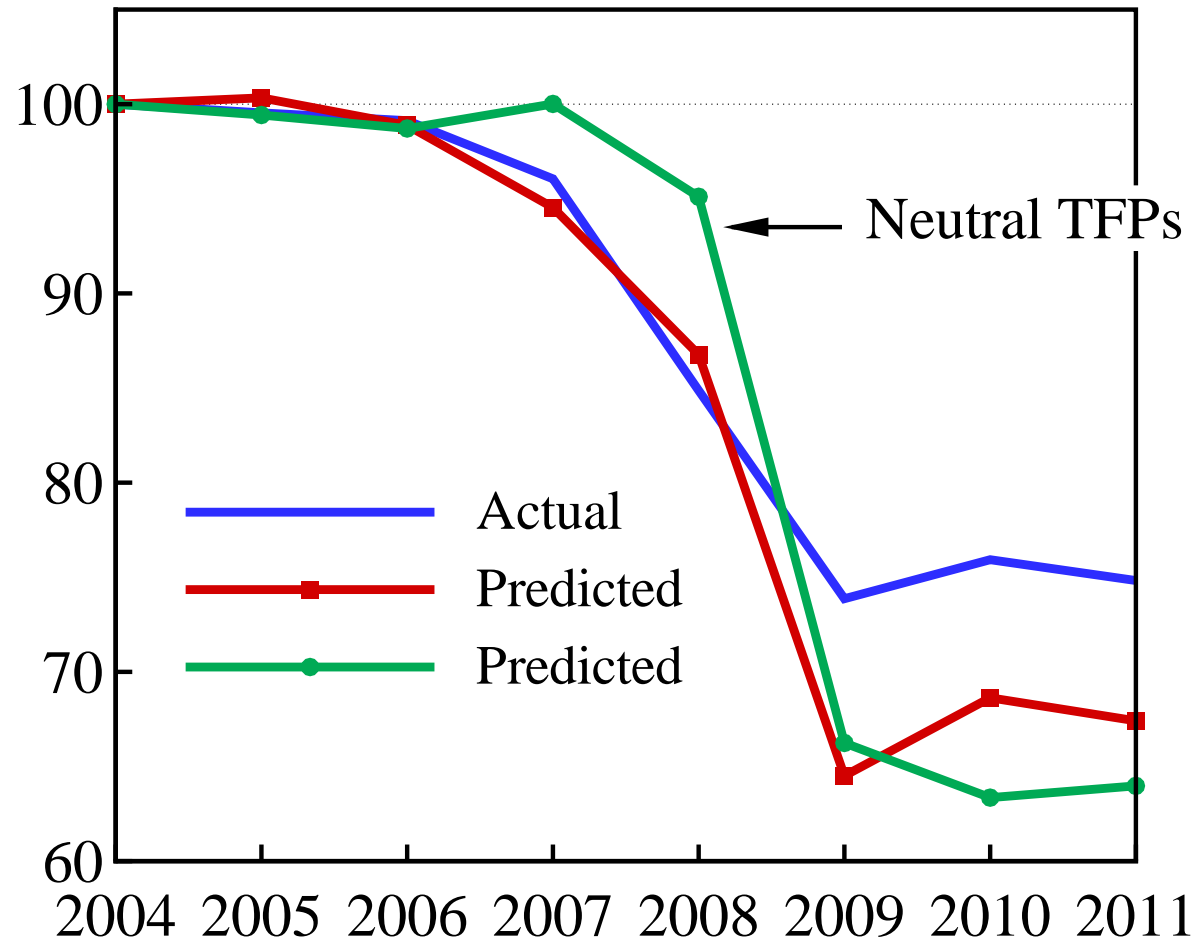
TOTAL TANGIBLE INVESTMENT RELATIVE TO TREND



- **Punchline:** model wo/ frictions overpredicts fall



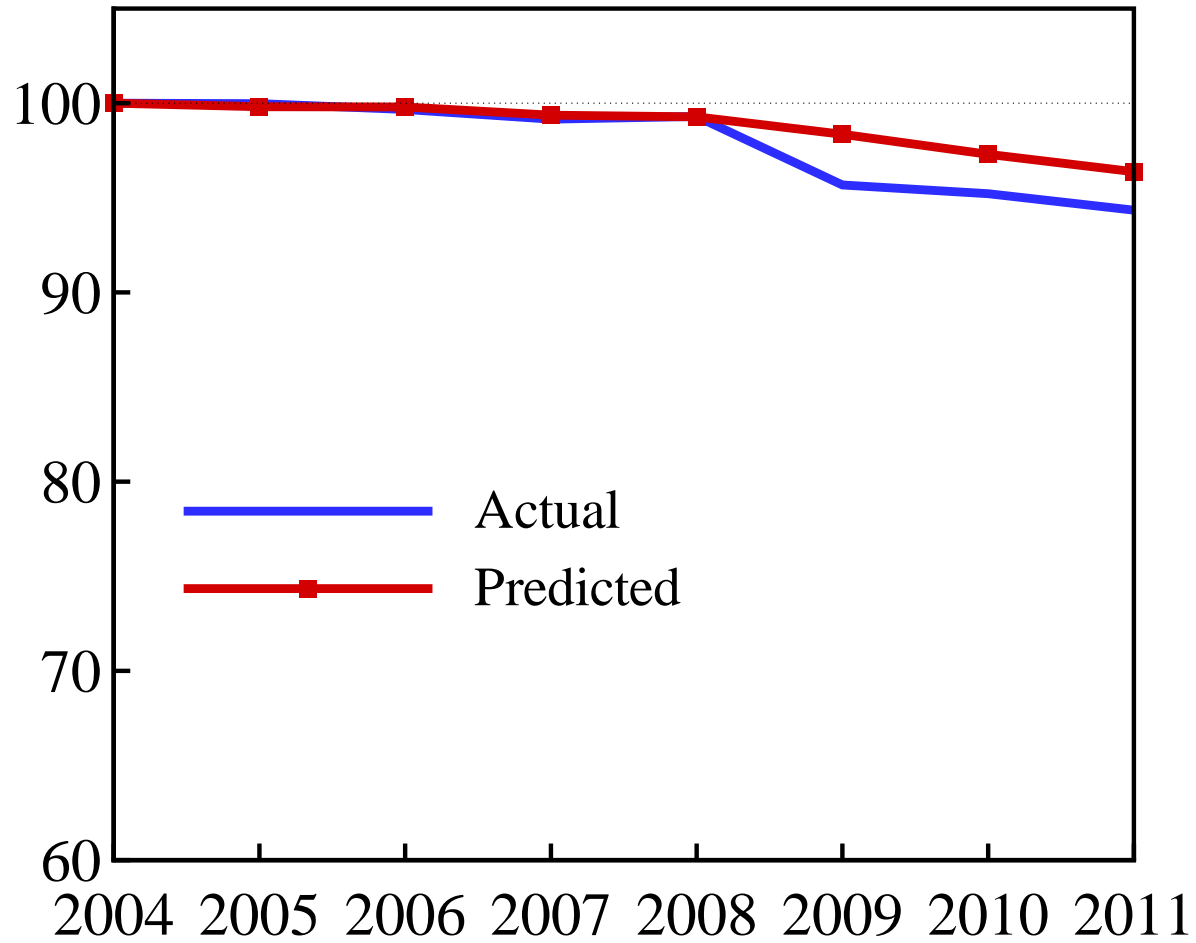
TOTAL TANGIBLE INVESTMENT RELATIVE TO TREND



- **Punchline:** model overpredicts fall even if TFPs neutral

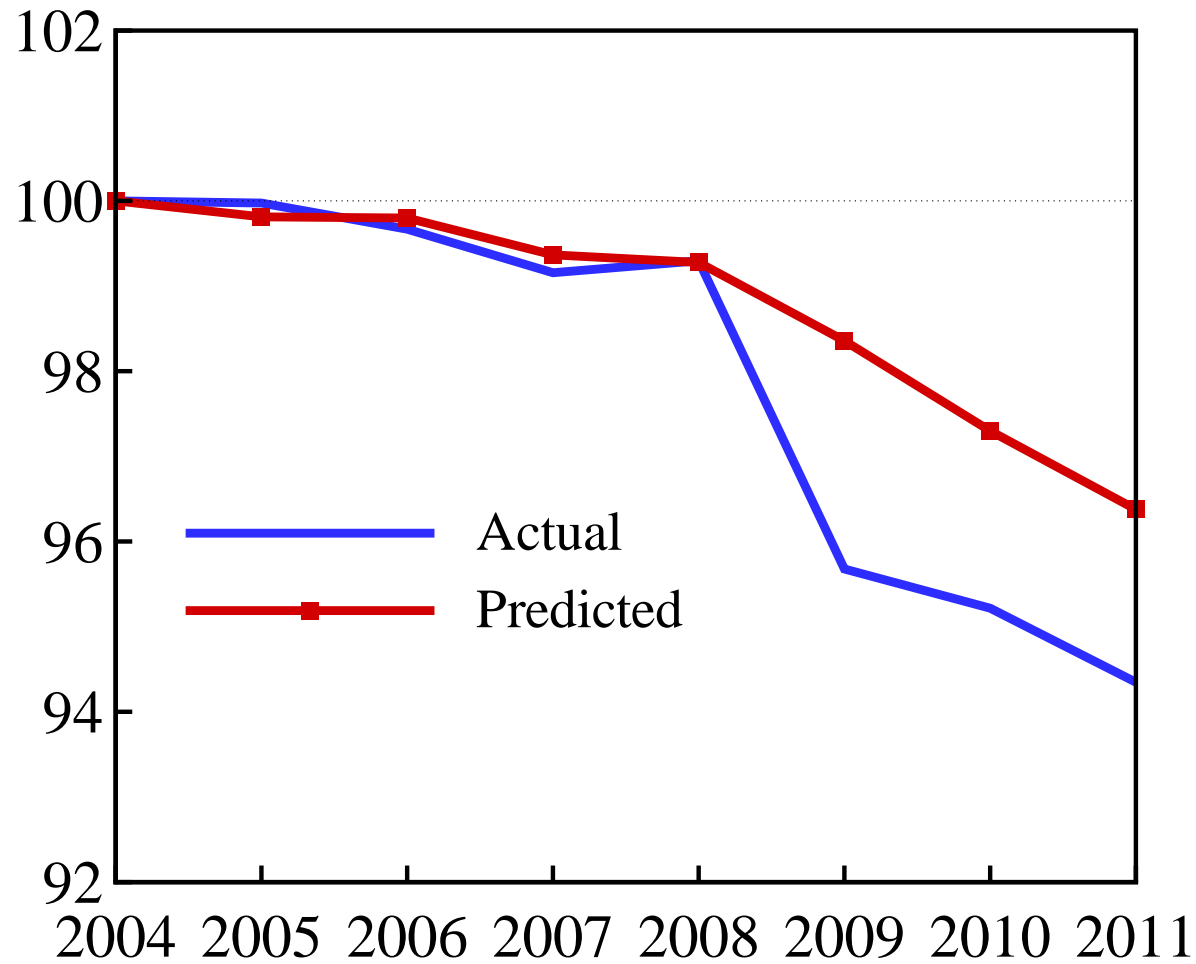


TOTAL CONSUMPTION RELATIVE TO TREND





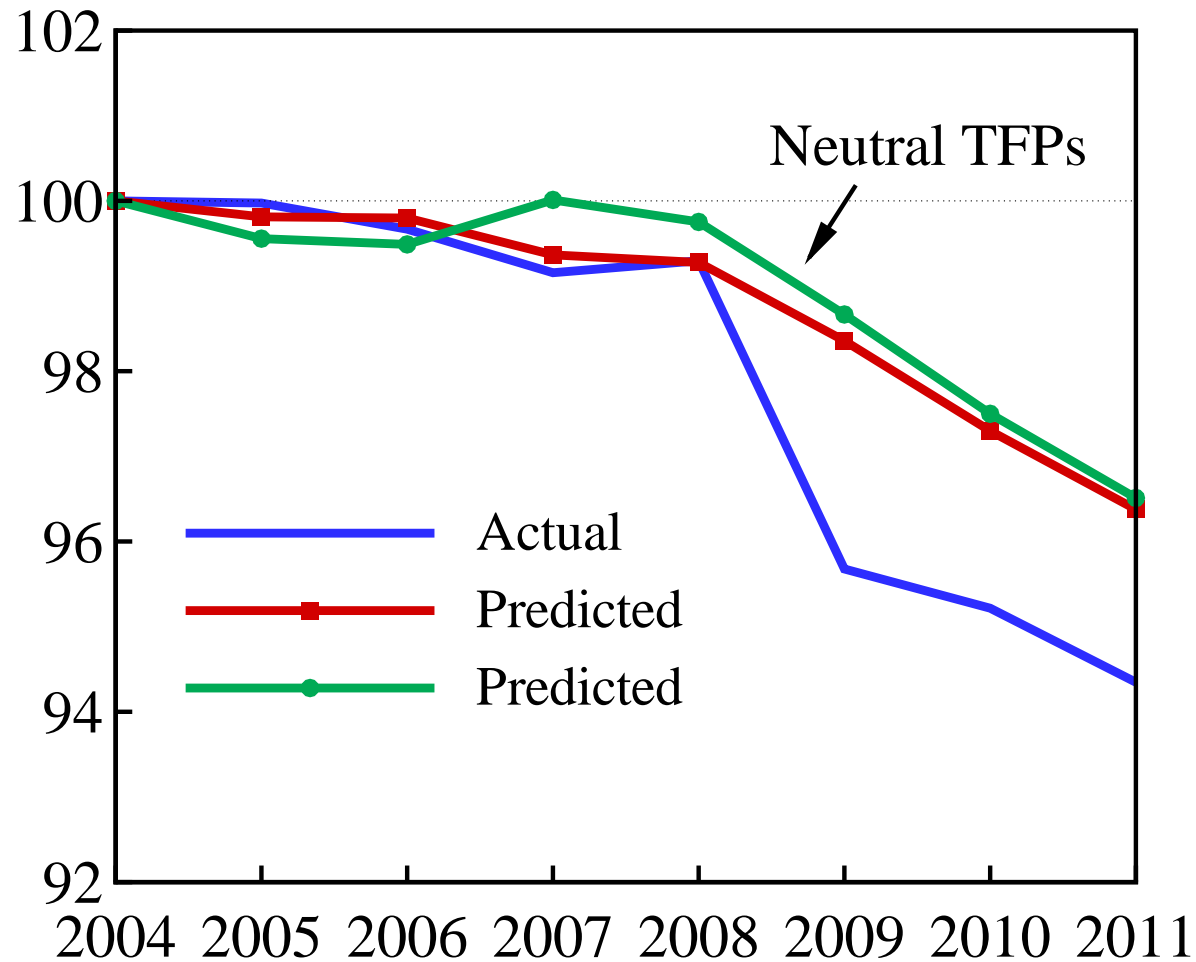
TOTAL CONSUMPTION RELATIVE TO TREND



- **Punchline:** deviation is about 2%



TOTAL CONSUMPTION RELATIVE TO TREND



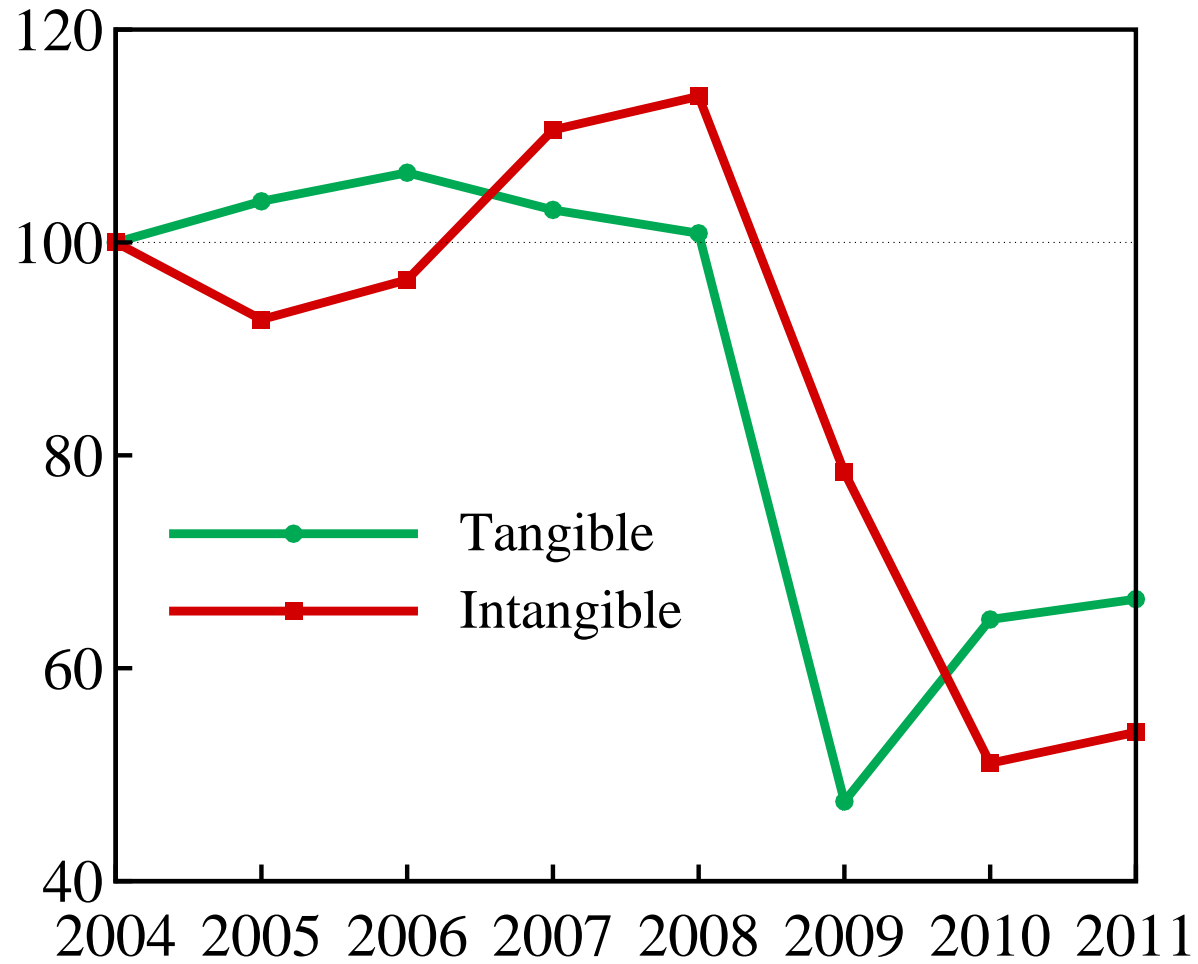
- **Punchline:** model predictions similar with neutral TFPs



DO INTANGIBLE INVESTMENTS LOOK CRAZY?

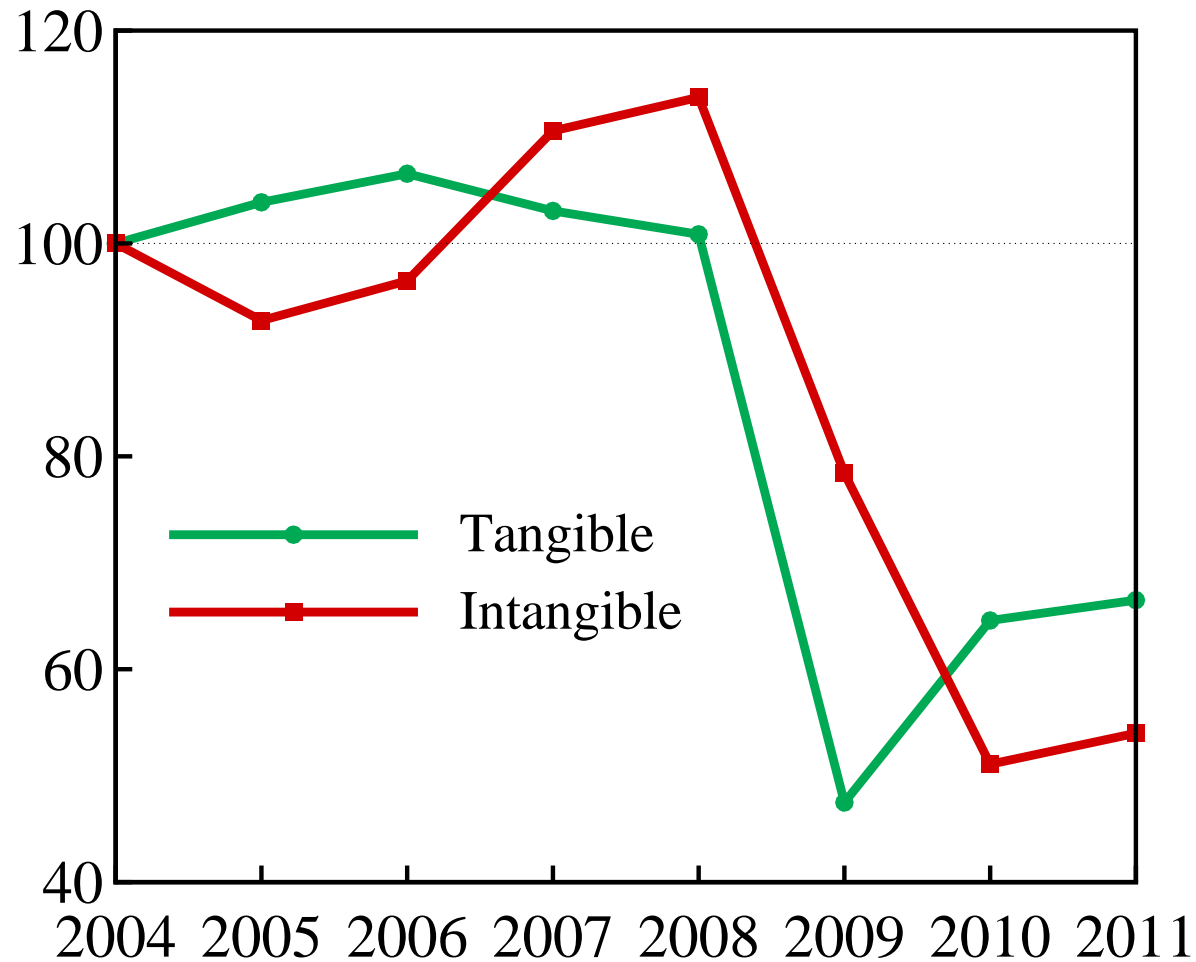


PREDICTED BUSINESS INVESTMENTS





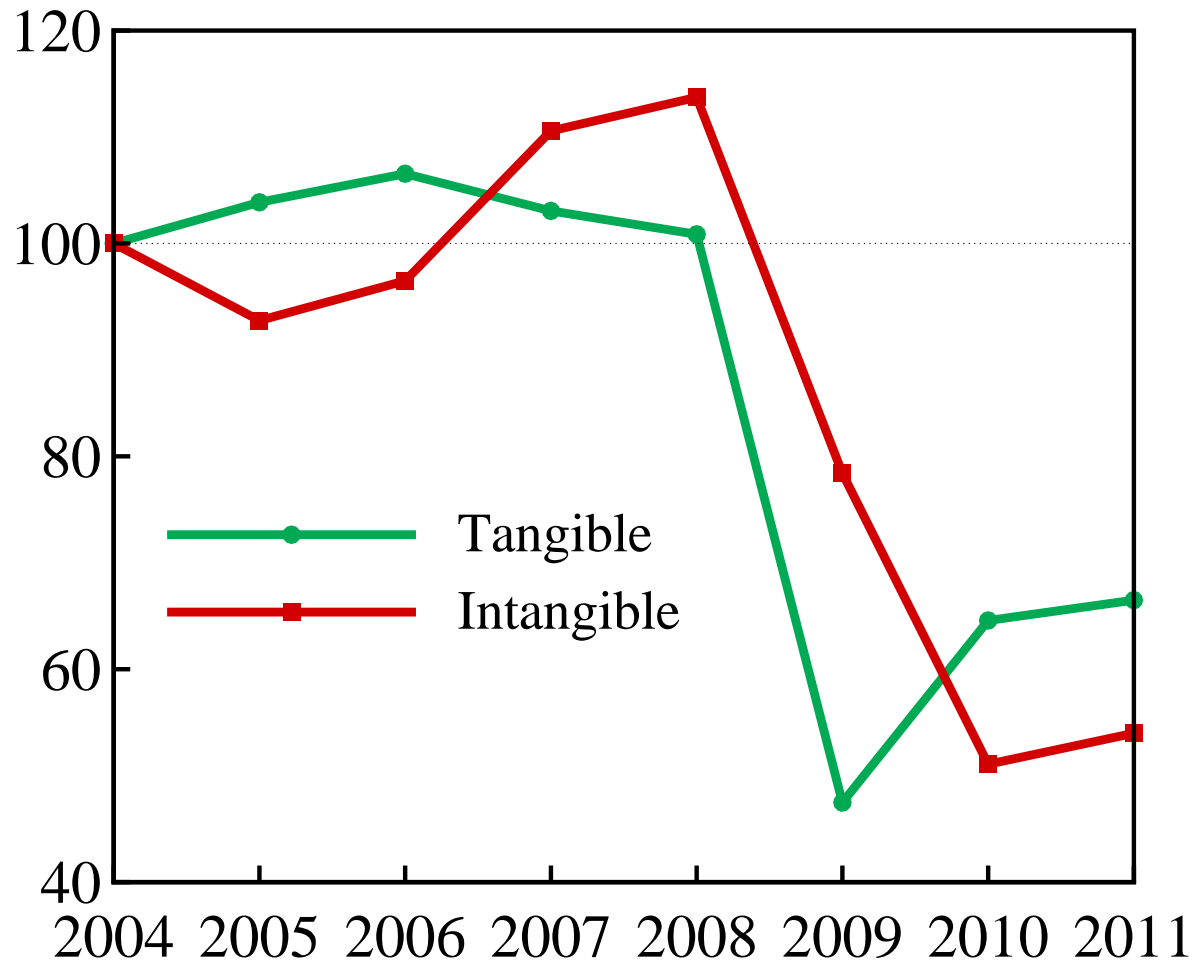
PREDICTED BUSINESS INVESTMENTS



- **Punchline:** model doesn't predict negative intangibles



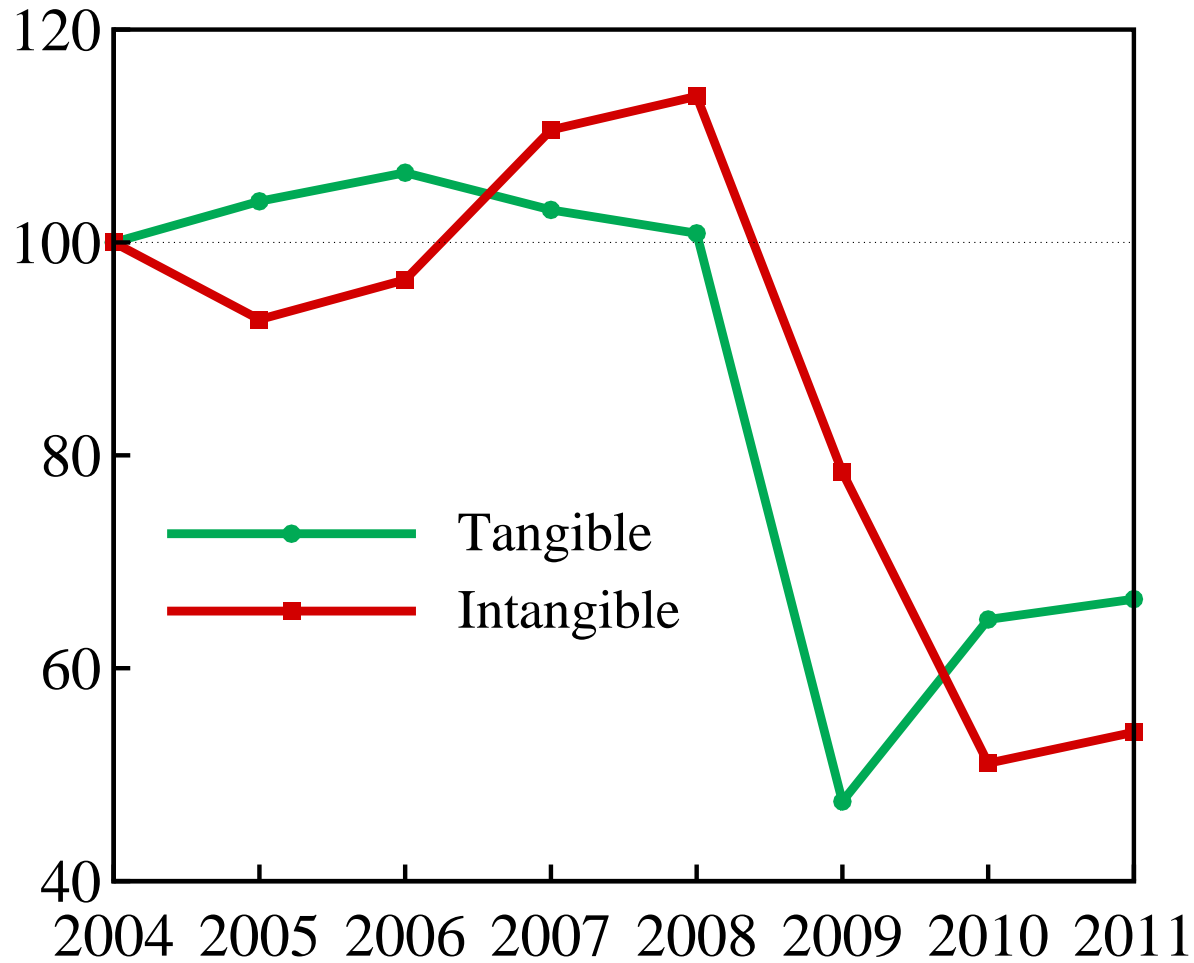
PREDICTED BUSINESS INVESTMENTS



- **Punchline:** model instead predicts similar declines



PREDICTED BUSINESS INVESTMENTS



- **Punchline:** what evidence do we have for the US?



SUMMARY OF DEVIATIONS IN INVESTMENTS

2009–2011 Averages, % Below Trend

	Tangible Investment		Intangible Inv. Business
	Aggregate	Business	
Model	–33	–40	–40
Data	–25	–23	{–33, –13}

↑

{Advertising, R&D}



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{Advertising, R&D}

- In US, tangible decline in range of intangible declines



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{Advertising, R&D}

- In model, tangible decline same as intangible decline



SUMMARY OF DEVIATIONS IN INVESTMENTS

2009–2011 Averages, % Below Trend

	Tangible Investment		Intangible Inv.
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{Advertising, R&D}

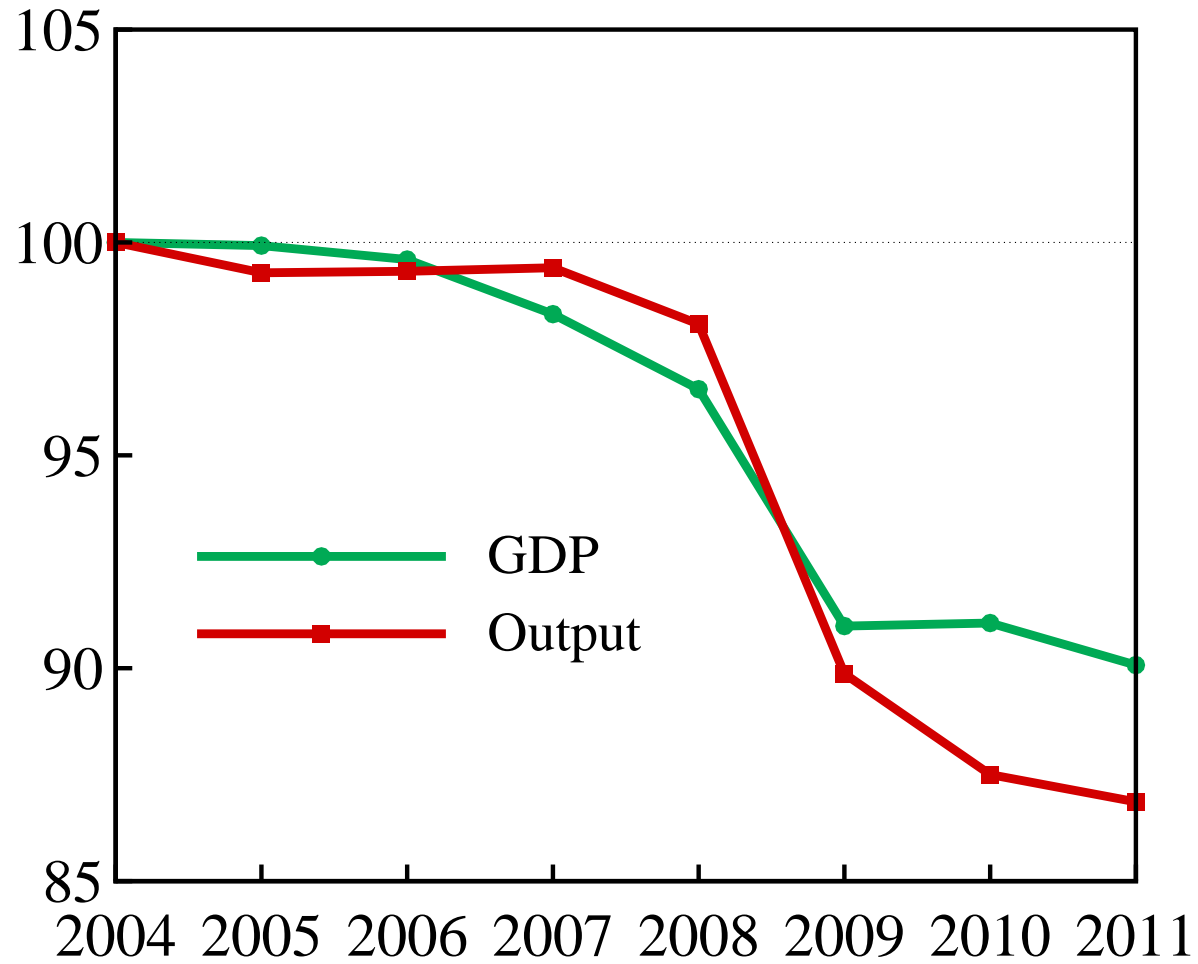
- But overall, model overpredicts fall in investment



WHAT IS THE PREDICTED FALL IN OUTPUT?

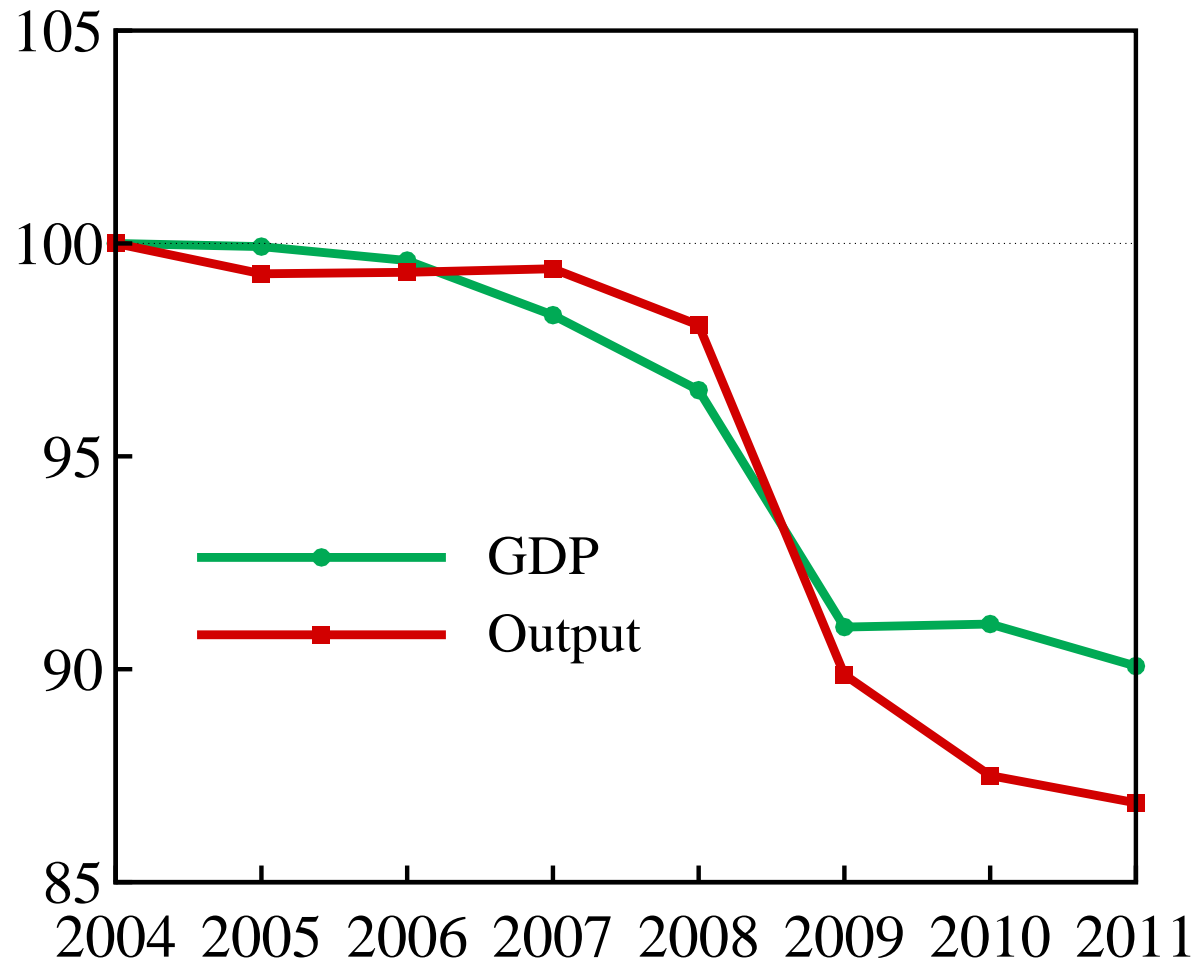


GDP vs. TOTAL OUTPUT





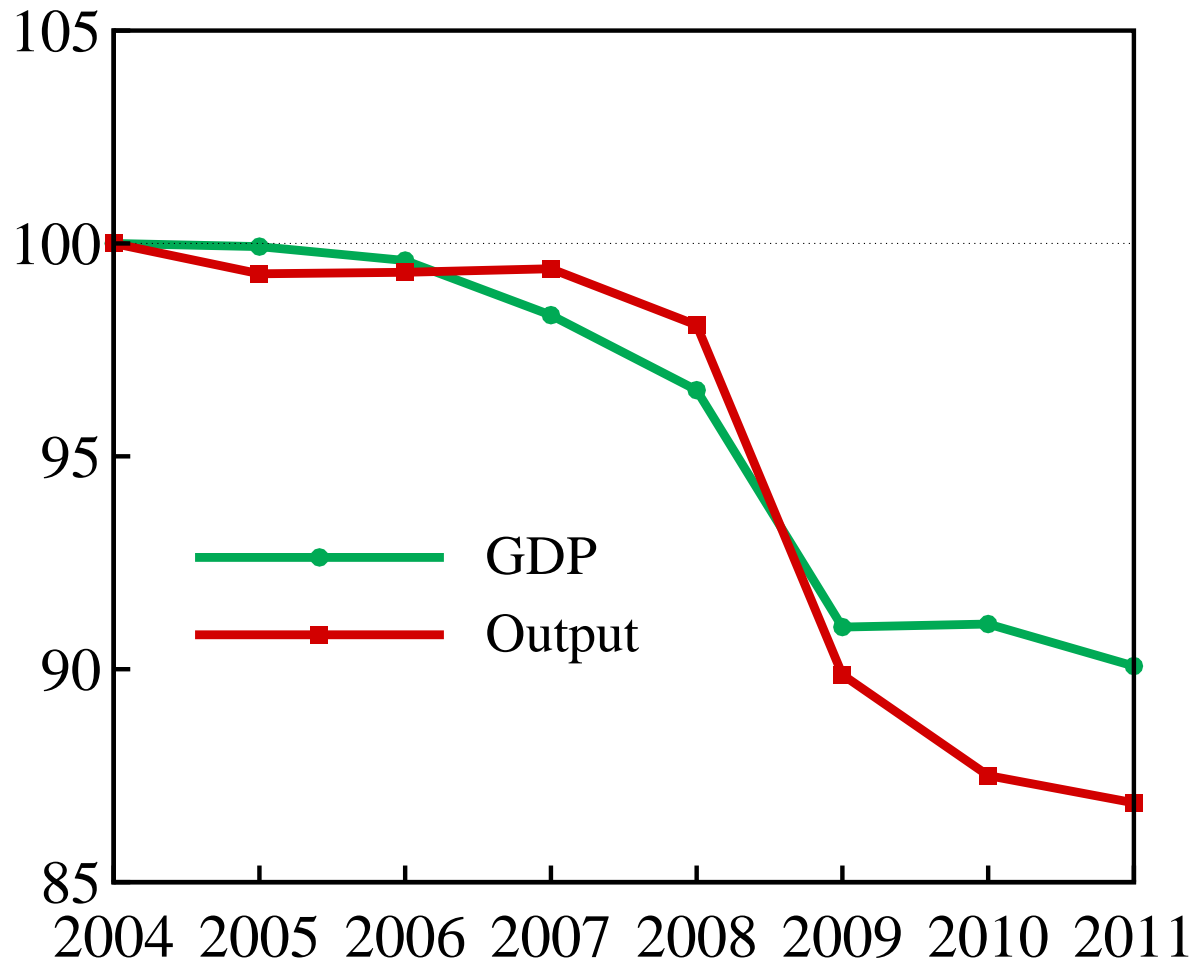
GDP vs. TOTAL OUTPUT



- **Punchline:** fall in predicted output is about 13%



GDP vs. TOTAL OUTPUT



- **Punchline:** think of 13% fall as an upper bound



ANY EVIDENCE FOR LOW TFPs?



ANY EVIDENCE FOR LOW TFPs? YES.

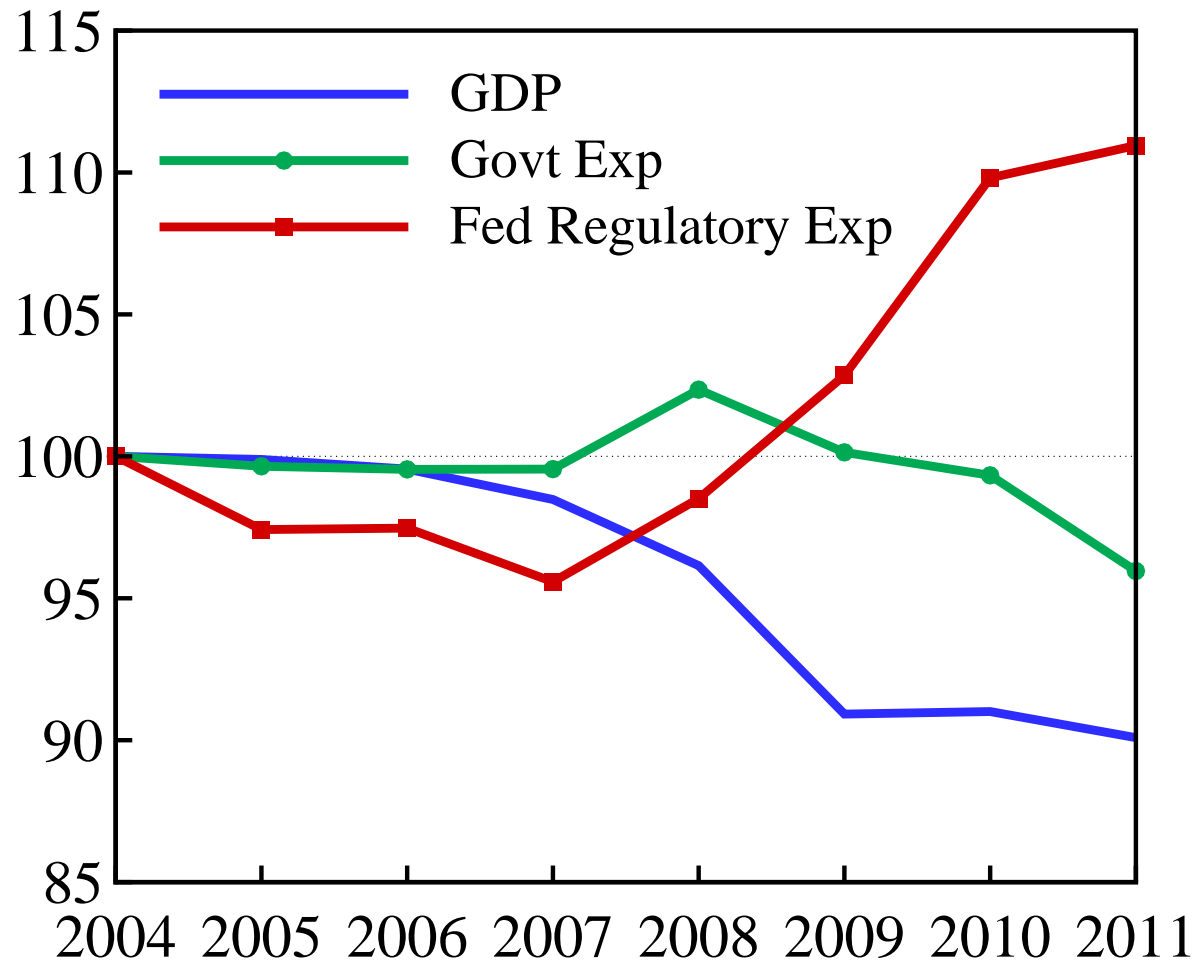


INCREASED REGULATORY COSTS

- Dramatic changes:
 - GDP and US employment fell
 - Federal regulatory spending and employment rose
- Time series look like mirror images...



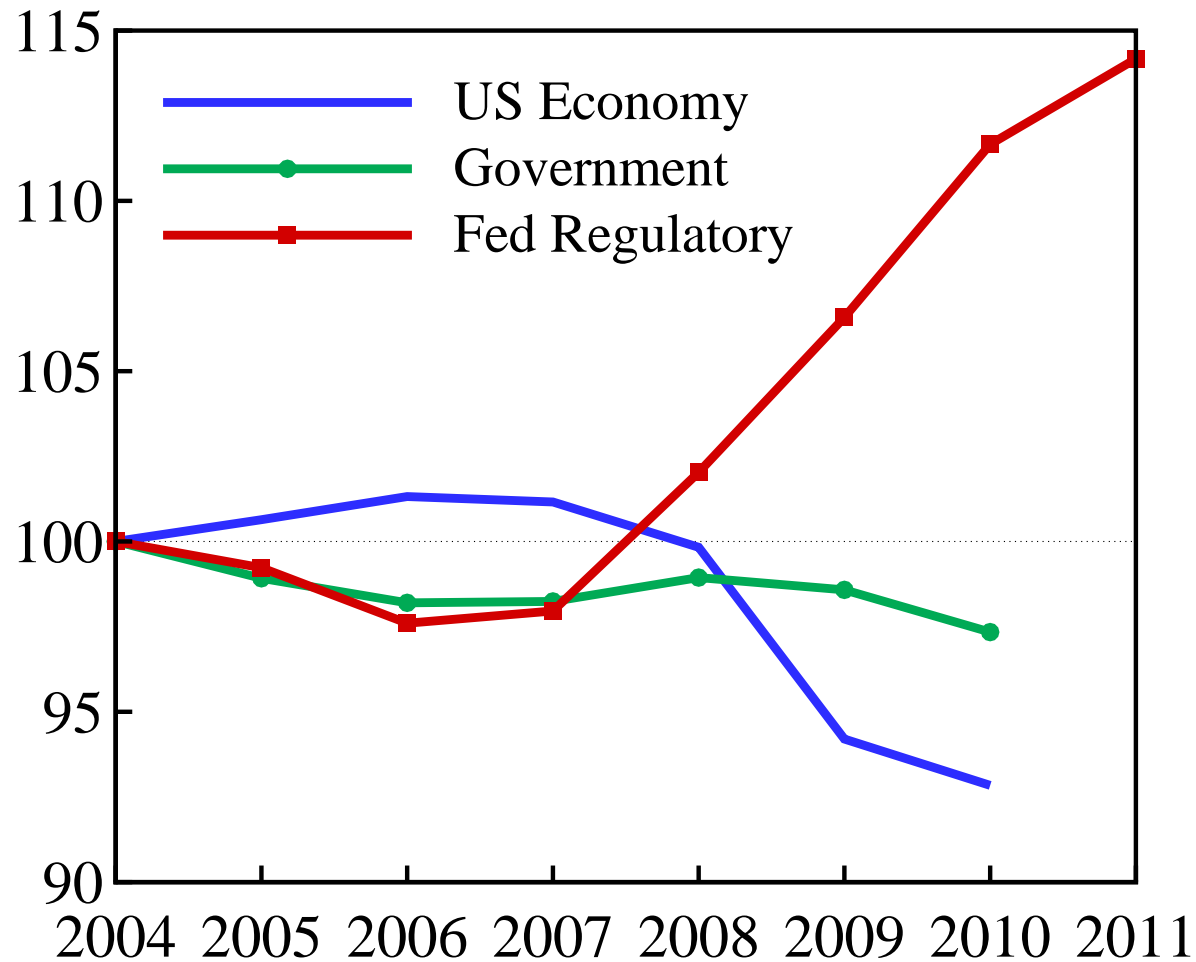
GDP AND REUGULATORY SPENDING



- **Punchline:** GDP and spending paths are mirror images



US AND REGULATORY EMPLOYMENT



- **Punchline:** employment paths are mirror images



CONCLUSION

- US downturn of 2008-2009 and slow recovery
 - Generated many critiques of standard macro theory
 - Motivated new friction-packed business cycle theories
- But, if model includes intangible investments
 - Theory does remarkably well over 2004–2011
 - Labor productivity puzzle is no longer a puzzle