Was the Post-1995 Productivity Growth Upsurge a Will-o'-the Wisp?

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Today's Outline

- Analysis of Quarterly Productivity Dynamics in Context of 2001-04 "Explosion"
- The Role of ICT Investment in the US Productivity Growth Revival
  - Big Role 1995-2000
  - Negative Role 2000-05
- Alternative Explanations of Explosion
- Implications for Future of Productivity Growth
- Where is Technology Going and Will it Continue to Support Rapid Productivity Growth?

This Week's Revisions: Last 8 Quarters from Old (2.28) to New (1.76)

Decomposition of Revision

- Four Quarter Change
  - Ending 2005:Q4 Old 2.51, new 2.11
  - Ending 2006:Q4 Old 2.05, new 1.42
- Combined, AAGR over eight quarters ending 2006:Q4
  - Old 2.28, New 1.76
- Over ten quarters ending 2006:Q4
  - Old 1.89, New 1.48
- AAGR last 10 quarters equal "dismal" 1972-95

Topic #1: Behavior of Productivity Growth in Quarterly Data

- Important to understand the dynamics
- They have nothing to do with the NBER business cycle chronology
- The behavior of productivity is driven by the lag of hours behind output
- This was a topic of the early 1960s, Okun's Law and Walter Oi on labor as a "quasi-fixed factor"

8-quarter Change in NFPB Output and Hours, 1955-2006

Key Implications of Lag in Hours Behind Output

- Productivity Growth is not Synchronized with the utilization of resources
- Because hours lags, productivity leads
- Productivity Growth is fastest at the beginning of the recovery
- The "Early Recovery Productivity Bubble"

Notice the
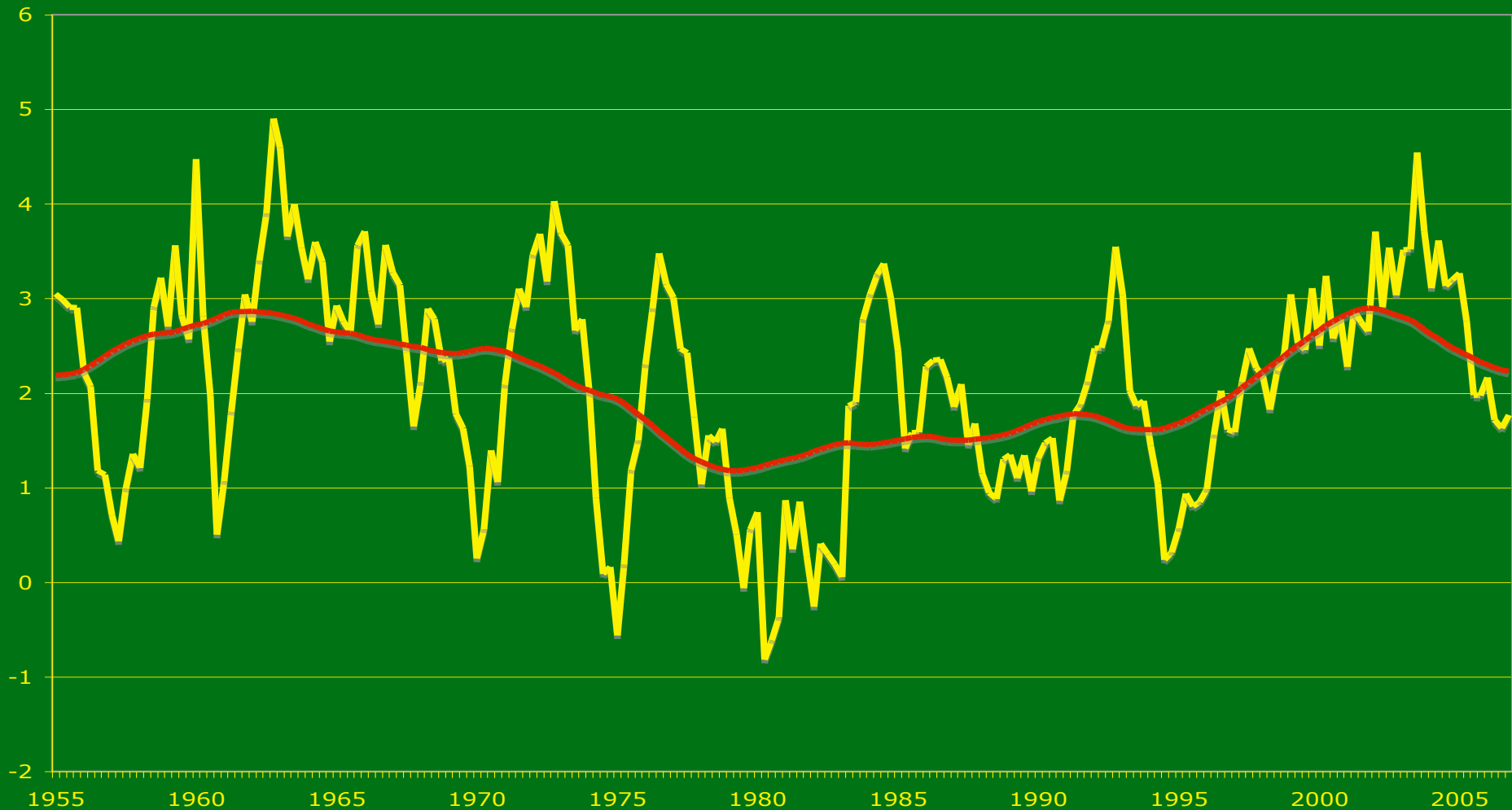# "Early Recovery Bubble",
8-qtr changes 1955-2006

Methods for Extracting the Underlying Trend

- First method, Hodrick-Prescott Filter, using a "smoother" parameter of 6400 instead of the usual 1600
    - Problem: Still too sensitive to the cycle
- Second method: Kalman filter with feedback from four lagged changes in GDP gap
- Second method is better but I use an average of both to display sensitivity

Deciphering the Long-run Trend

- Summary of Growth Rates that You'll See on Next Chart for the LP Trend
  - 1955:Q1-1972:Q2   2.56
  - 1972:Q2-1995:Q4   1.59
  - 1995:Q4-2000:Q4   2.34
  - 2000:Q4-2004:Q2   2.79
  - 2004:Q2-2006:Q4   2.36
- Max value 2.90 (01:Q4)
- Final value 2.23 (06:Q4)

8-quarter Actual LP Growth vs. the Average Trend

Comparing the two Methods:
Harmony since 1995

The Early Recovery Bubble, How Much "Payback" is Left?

- 2000:Q4-2004:Q2, 14 quarter AAGR
  - Actual 3.51
  - Trend 2.79
  - Difference 0.72, or cumulatively 2.52
- 2004:2-2006:4, 10 quarter average
  - Actual 1.48
  - Trend 2.36
  - Difference -0.88, or cumulatively 2.20
- We've paid back 2.20/2.52 or 87% of the explosion above trend
- Terminal trend (2006:Q4) is 2.23; average growth 2007-08 of 2.07 is consistent with that trend

From Dynamics to Substance: Sources of the Post-1995 Revival to 2000

- Close Agreement in Research Using Growth Accounting Methodology
- 75-80 percent of post-1995 revival was due to ICT investment
  - Direct Productivity Impact of ICT Production
  - Effect of "Capital Deepening," more ICT capital per worker across the economy

What are The Current Decompositions of IT Role?

- Acceleration 1973-95 to 1995-2000 (or 01)
  - IT Share O-S 112 percent
  - IT Share J-H-S current paper 78 percent
- Acceleration 1995-2000 (or 01) to 2000-2005
  - IT Share O-S -80 percent
  - IT Share J-H-S current paper -146 percent
- Something is fishy here – how could there be any fundamental connection between ICT investment and productivity growth?
  - Was there a one-shot character to the ICT boom of the late 1990s?
  - What caused the post-2000 upsurge of labor productivity in the wake of a collapse in ICT investment?

What Was Unique about 1995-2000: Computer Prices and the IT Share

- The chart for the rate of decline of computer prices shows the distinctly one-shot nature of the late 1990s boom
- The chart for the share of ICT investment in GDP shows the same thing
- This raises profound questions:
  - What has happened to Moore's Law? (J-H-S assume continues at rate between 1995-2000 and post-2000)
  - Is the 1995-2000 period even *relevant* for projections out to 2015 or 2025?
  - What caused the 2000-04 acceleration and is that period even *relevant* for future projections?

BEA Deflators for Computer Hardware and ICT Equip & Software, 1965-2006
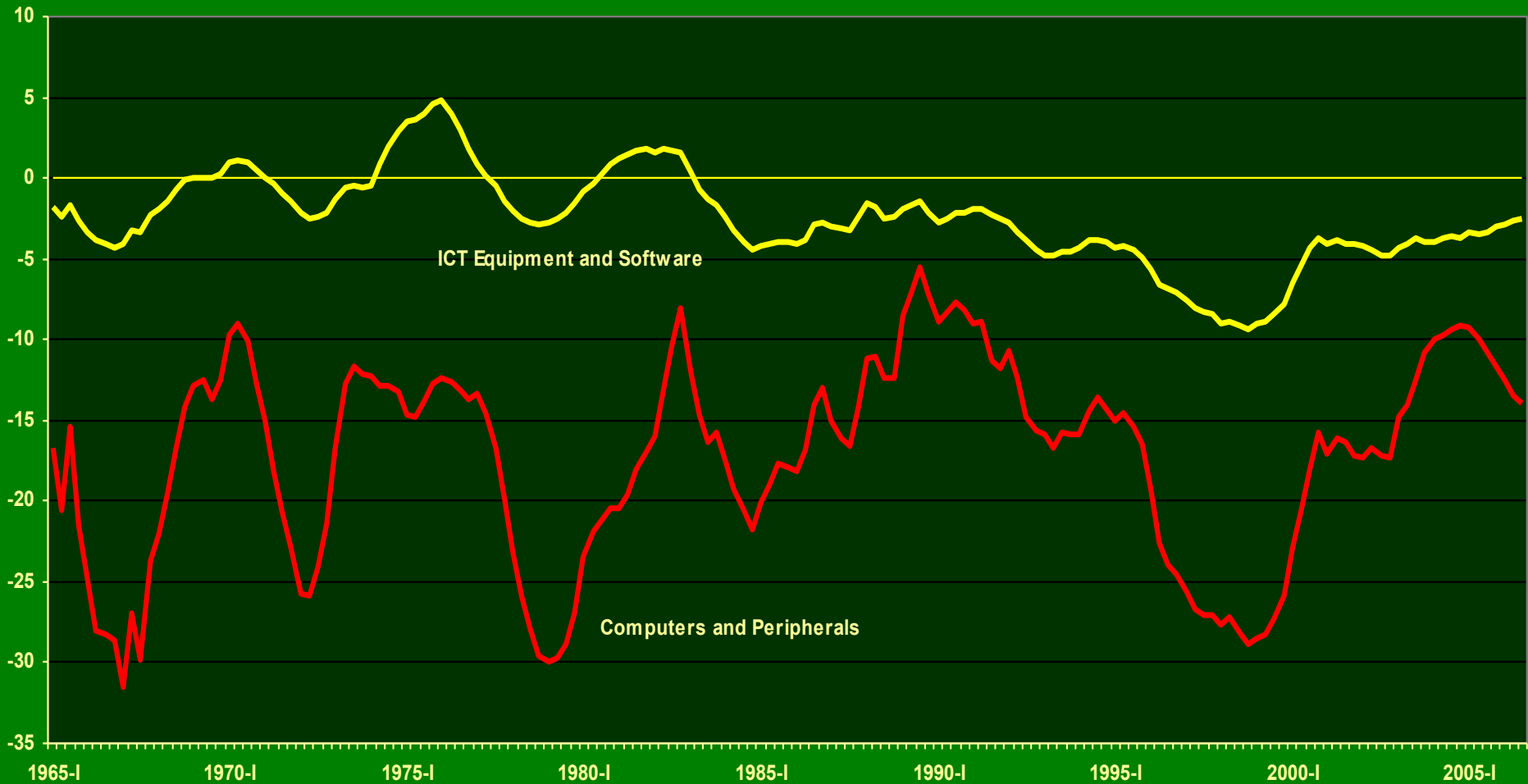
Nominal Share of ICT Investment in GDP, 1965-2006
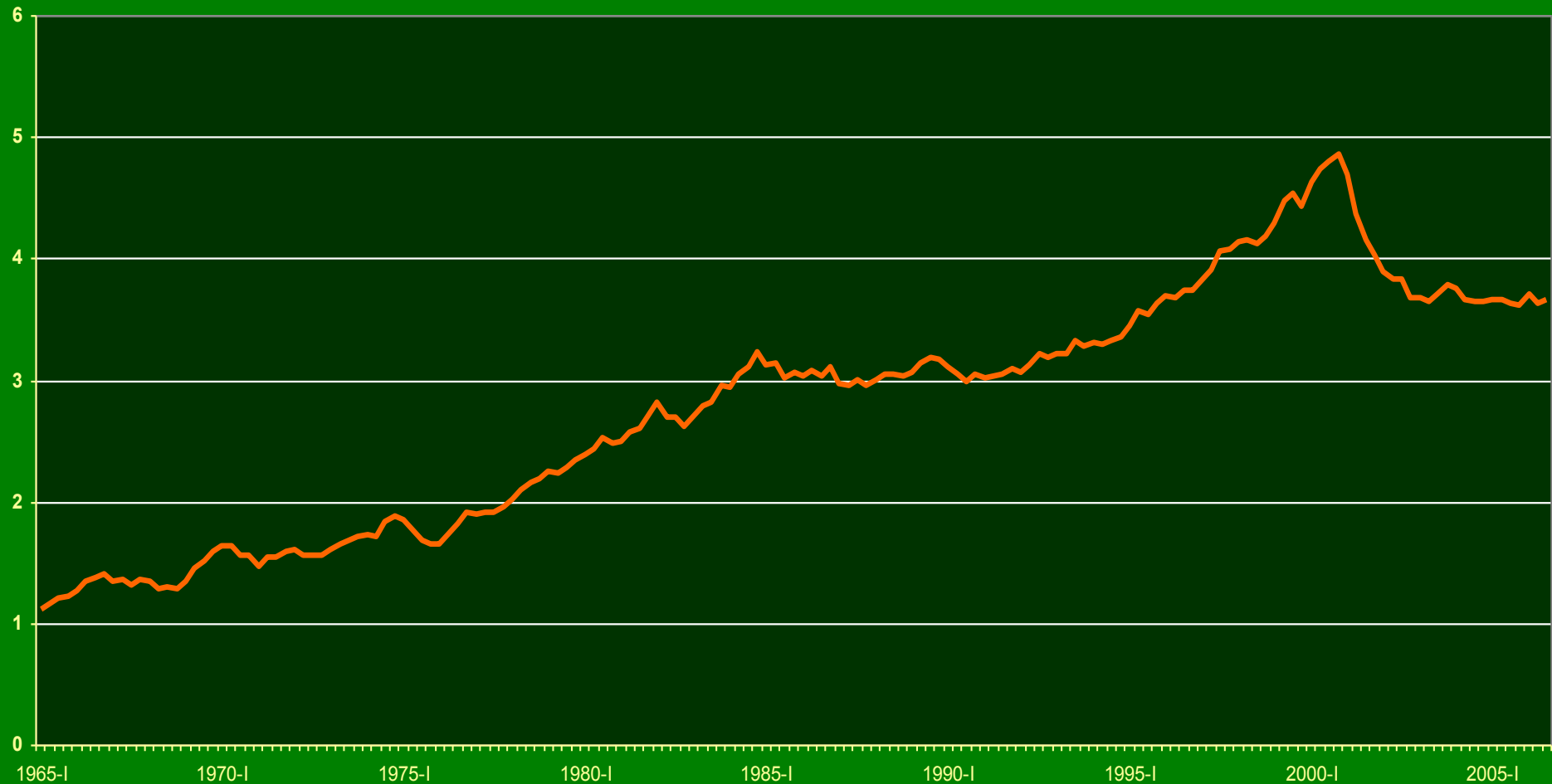
My 2003 BPEA Paper Proposed Three Explanations for 2001-03

- First Explanation: Cyclical Dynamics
  - Productivity Always Grows Fastest in the Early Part of the Expansion
  - "Early Recovery Productivity Bubble"
- Second Explanation: Savage Corporate Cost Cutting, Elements Unique to 2001-03 (compare to 1991-93), many citations to Nordhaus
  - Post-2000 Collapse of stock market and profits
  - Restatement of profits due to accounting scandals
  - Sharp divergence NIPA profits from S&P Profits 1997-2000
  - Extremely low ratio 2001-02 of S&P Reported Earnings to S&P Operating Earnings (One-time charges)
  - Much higher ratio of executive compensation based on stock options, hence pressure to boost share price by cutting costs

Third Explanation, Delay and Intangible Capital

- O-S and J-H-S Growth Accounting Requires that Full Productivity Payoff from Computers Occurs the Instant they Are Produced, Much Less Installed
- Basu *et. Al.* and Yang-Brynjolfsson have emphasized complementary, unmeasured, and delayed investments in intangible capital
- Makes sense that a big invention, the late 90s marriage of computers and communication, would take time to have its full prody impact
  - My favorite example, airport check-in e-kiosks
  - Immelt of GE and Chambers of Cisco, "learning curve 3, 5, even 7 years"

My Conclusions About the Relevance of 1995-2000 and 2000-04

- The ICT boom of 1995-2000 was a unique event created by the invention of the internet. The fast decline in computer prices and high share of ICT investment will not happen again
- The full productivity payoff of the ICT investment bubble plausibly had a lag of three years or more, same timing as cost cutting
- Thus fast productivity and slow employment growth in 2001-03 were flip sides of the two big explanations, cost-cutting and intangible delay
- Layered on top of a standard cyclical early recovery bubble

Where Then Does that Leave Us?

- We can't base future projections on simple averages that are dominated by 1995-2004
- We should pay attention to what's happening to the trend as the actual numbers after 2004:Q2 roll in
- Cyclical "Payback" is almost complete. Any further actual numbers < 2.1 will pull down the trend further
- My current trend of 2.23 is below J-H-S projection out ten years from now

To Project Potential GDP, Need Total Economy Productivity
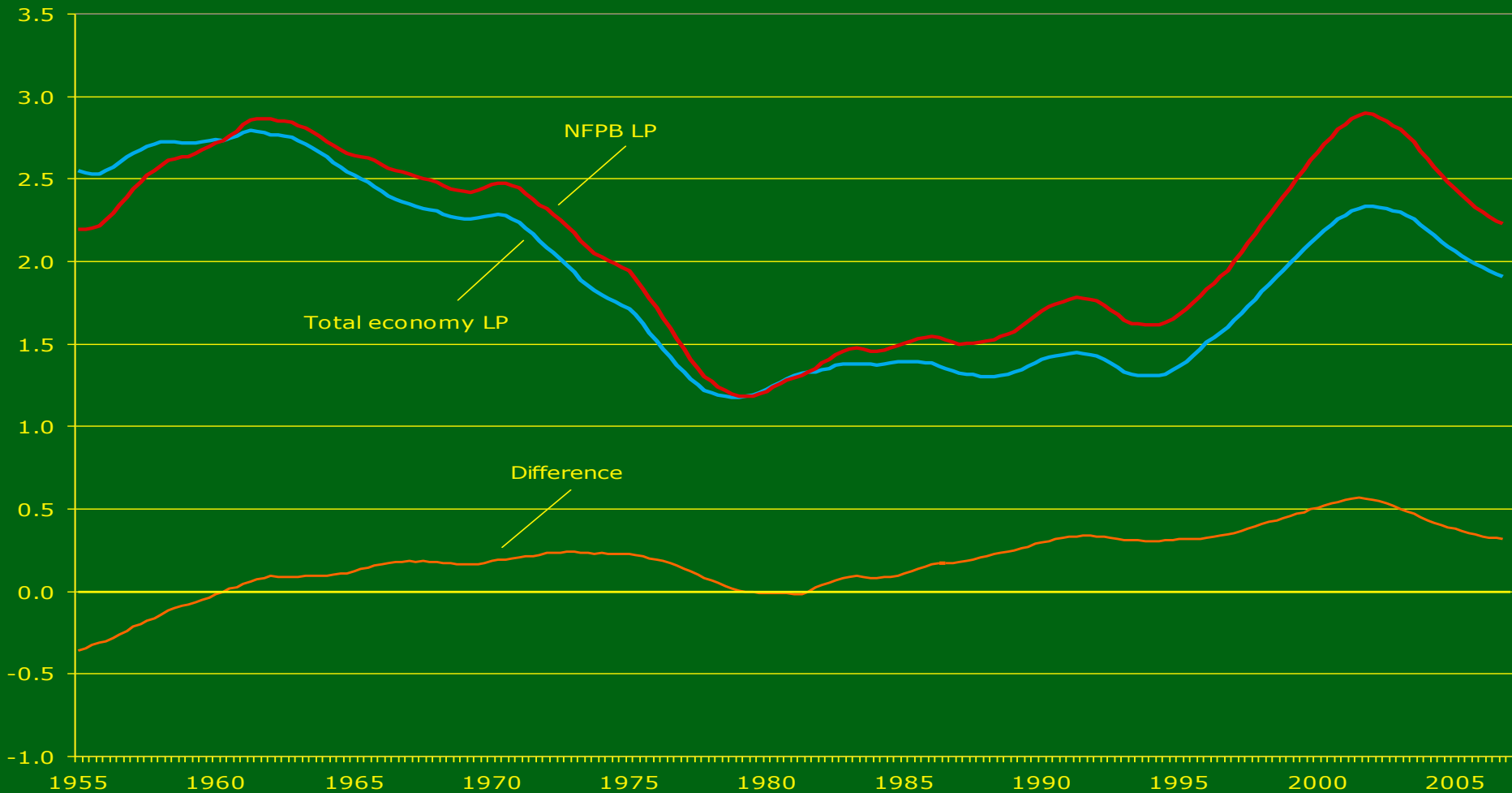
Implications for Potential GDP Growth

- Labor Productivity Growth
  - Base-Case J-H-S 2.49 percent over 10 years
  - Gordon 2.0 percent over 10 years, maybe less over 25
- Potential GDP Growth
  - J-H-S hours growth projection is about the same as mine, 0.8.
  - Total economy productivity = NFPB − 0.3
    - 2.0 − 0.3 = 1.7
  - Potential GDP growth = productivity + hours growth
    - 1.7 + 0.8 = 2.5

The Optimists Stake Their Hope in "Moore's Law"

- Clearly Moore's Law accelerated in the late 1990s but has since decelerated
- Even if Moore's Law continues at its previous pace, who needs all that speed?
- There's nothing I need to do that I can't do on my 3-yr-old laptop, except read the keys!
- I can't buy a new computer because much of my software would have to be reinstalled (by whom?) to work with Vista

A Classic Case of Diminishing Returns

- My PC that produced this set of slides has at least 100 times the power as my first 1983 PC

- But there is a fixed factor, my brain and my ten fingers.

Since Windows 95 and Office 97, What has Changed?

- Virtually nothing has changed except fine-tuning
- The "Great Invention" of 1995-2000 was the *marriage* of the PC with communications
- Erik's "intangible capital" hypothesis argues that it took a long time for people to figure out how to make the hardware useful

For Me the Benefits of the PC and Internet were Huge, but They're Largely Over

- E-mail since 1993, what's new?
  - More e-mail from students, less from friends
- Never see Research Assistants
  - All research and co-authorship is done via e-mail attachments
- Nothing New since 1999

Since 2000, Distinguish Productivity from Consumer Benefits

- Games, iPods, downloading videos, etc., may be great for consumers but it doesn't raise productivity
  - Possible source of "new product" bias in CPI
- Consumer broadband indirectly raises business productivity by raising the demand for Amazon-type software

ICT is not the First Industry to Encounter Diminishing Returns

- Commercial aircraft will always need two pilots
- Trucks will always need one driver
- Many services still require in-person contact: doctors, nurses, dentists, lawyers, professors, management consultants, bartenders, wait staff, barbers, beauticians
- Others need contact between an object and a person: grocery cashiers, valet parkers, auto repair, lawn maintenance, restaurant chefs, and every kind of maintenance from home roofers to Delta Airlines mechanics repairing engines.

As Diminishing Returns Set in, The Hurdle Rises

- This is Jack Triplett's point from the Chicago AEA meetings of 1998
- To Growth the Stock of Inventions at a rate of 10% per year:
  - With 100 existing inventions, we need 10 new ones per year
  - With 110, we need 11
  - With 120, we need 12
  - And with 200, we need 20 new ones per year
- Continuous Increase in the "Hurdle"

What are the Next Great Inventions, You Tell Me

- There's the great telecom convergence
  - Cable, phone, broadband all provided by one company, consumer convenience
  - Surely soon there will be no need for wires inside the house, just a big wireless router next to the electric meter
  - Indeed electric and gas meters will be read automatically
- But this is all small and incremental

Questions for Panelists and Audience

- Explain why Diminishing Returns does not Apply
- Explain why the Hurdle is not rising, from 10 to 11 to 12 inventions
- Think up a reason to be optimistic about future productivity growth