Information Technology and Productivity in the "New Economy"

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*The views expressed here represent those of the author only and not necessarily those of the Federal Reserve Bank of New York or the Federal Reserve System.

Outline

- The “new economy”
- IT and productivity growth
- Questions

The “New Economy”

What is the New Economy?

- New economy forces
  - Information technology (IT)
  - Globalization
  - Deregulation
- New economy evidence
  - Faster productivity growth (output/hour)
  - Low unemployment and low inflation
  - Strong stock market

What's Left of the New Economy?

- Some parts faded
  - Unemployment jumped to 6% in 2002
  - Stock market, particularly tech, down since 2000
- Some parts remain robust
  - Little inflationary pressure
  - Strong productivity growth (output/hour)

Focus on productivity growth and IT

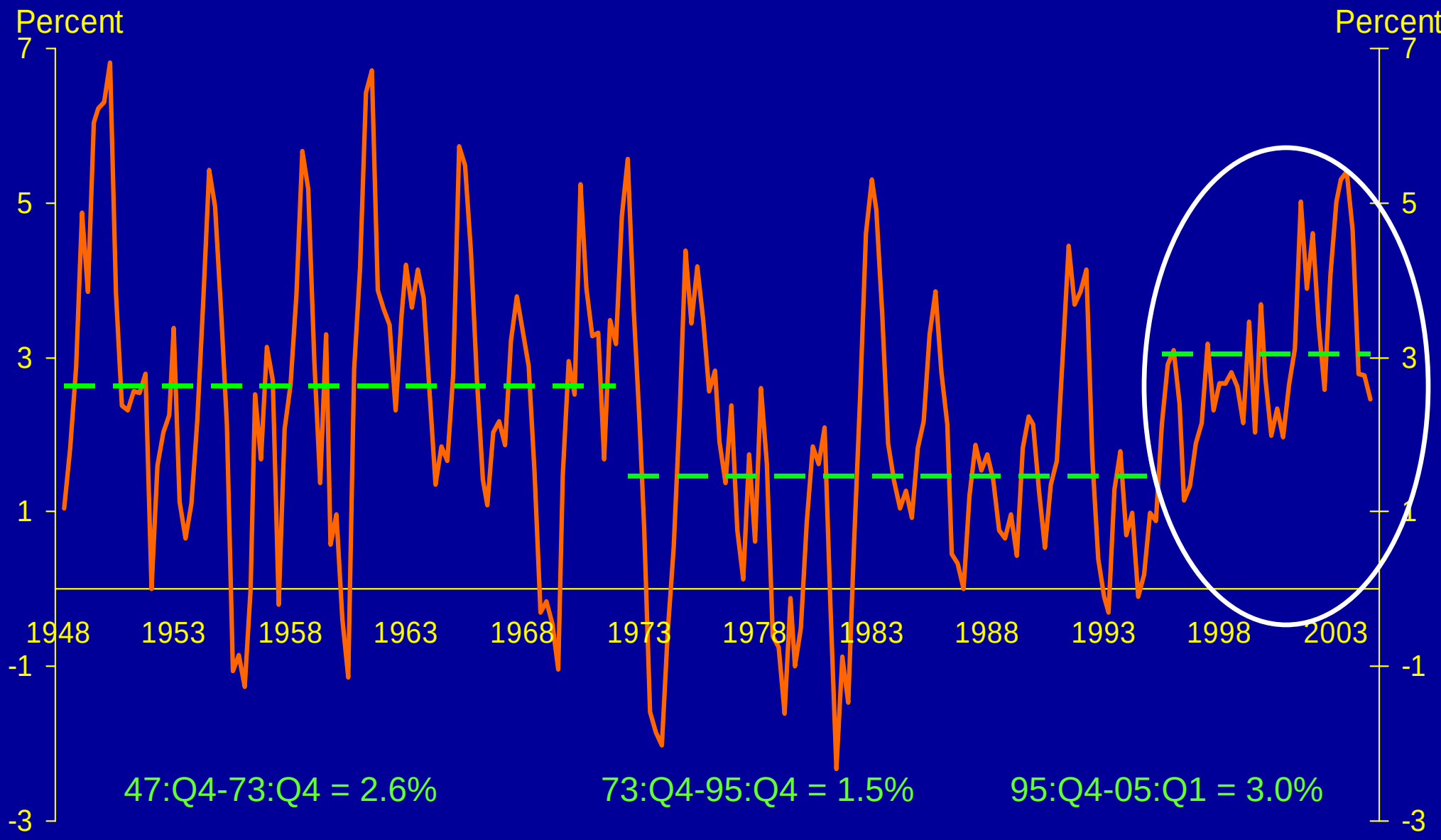
Why Is Labor Productivity Growth Important?

- Productivity determines living standards
- Productivity helps offset inflationary pressures

U.S. Productivity Resurgence

- Productivity surged after 1995

Three Productivity Eras



4-quarter growth in nonfarm business labor productivity.
Dotted line represents averages for 1947:Q4-1973:Q4, 1973:Q4-1995:Q4 and 1995:Q4-2005:Q1. BLS (6/3/05).

Current Productivity Picture

- Productivity surged after 1995
- Three sources of productivity

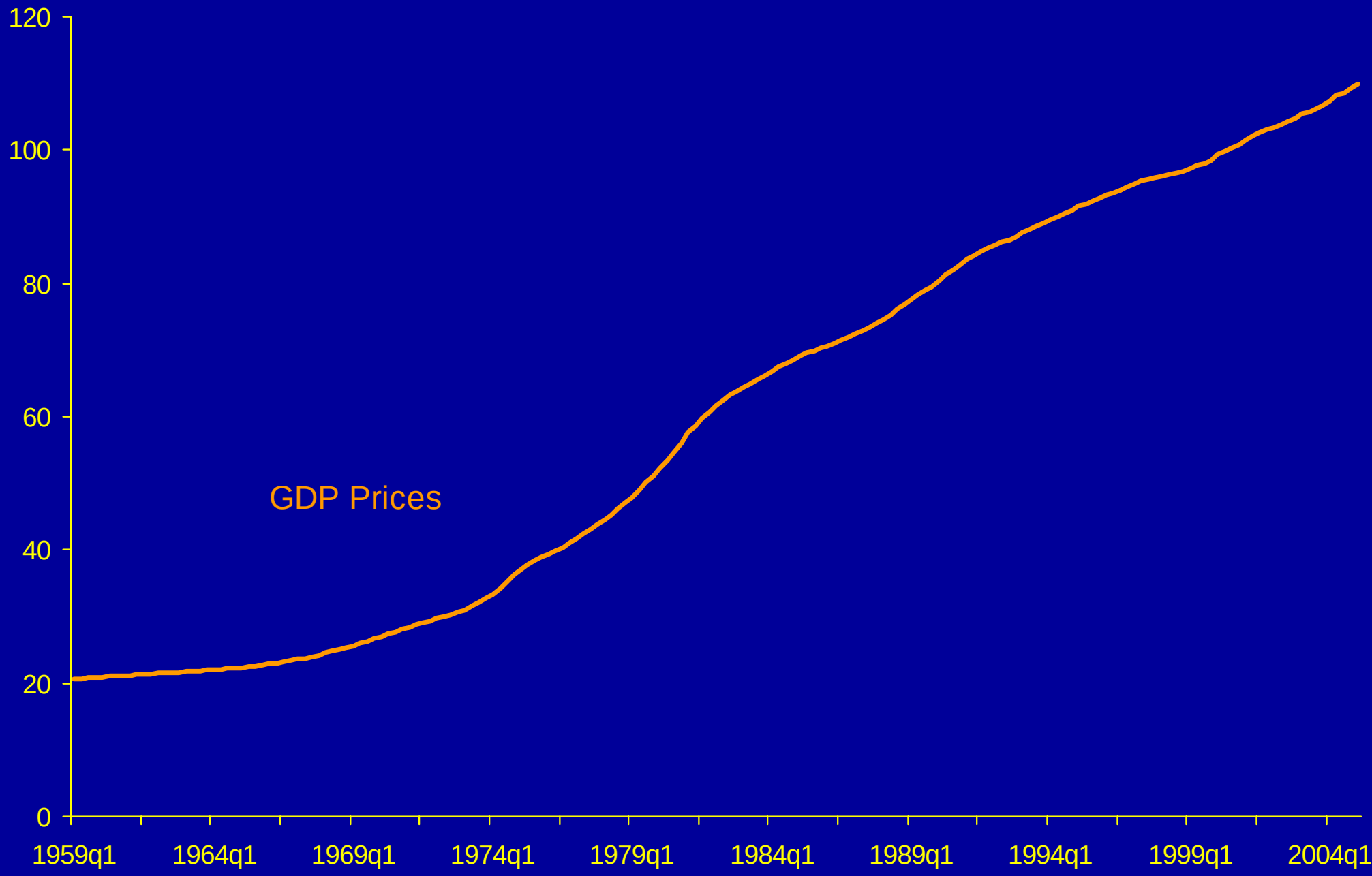
Three Sources of Productivity

- Capital deepening
  - Investment provides more/better capital to labor
  - IT as an input
- Labor quality
  - Compositional changes in the workforce
- Total factor productivity (TFP)
  - Technology and everything else
  - IT as an output

Why is IT Important?

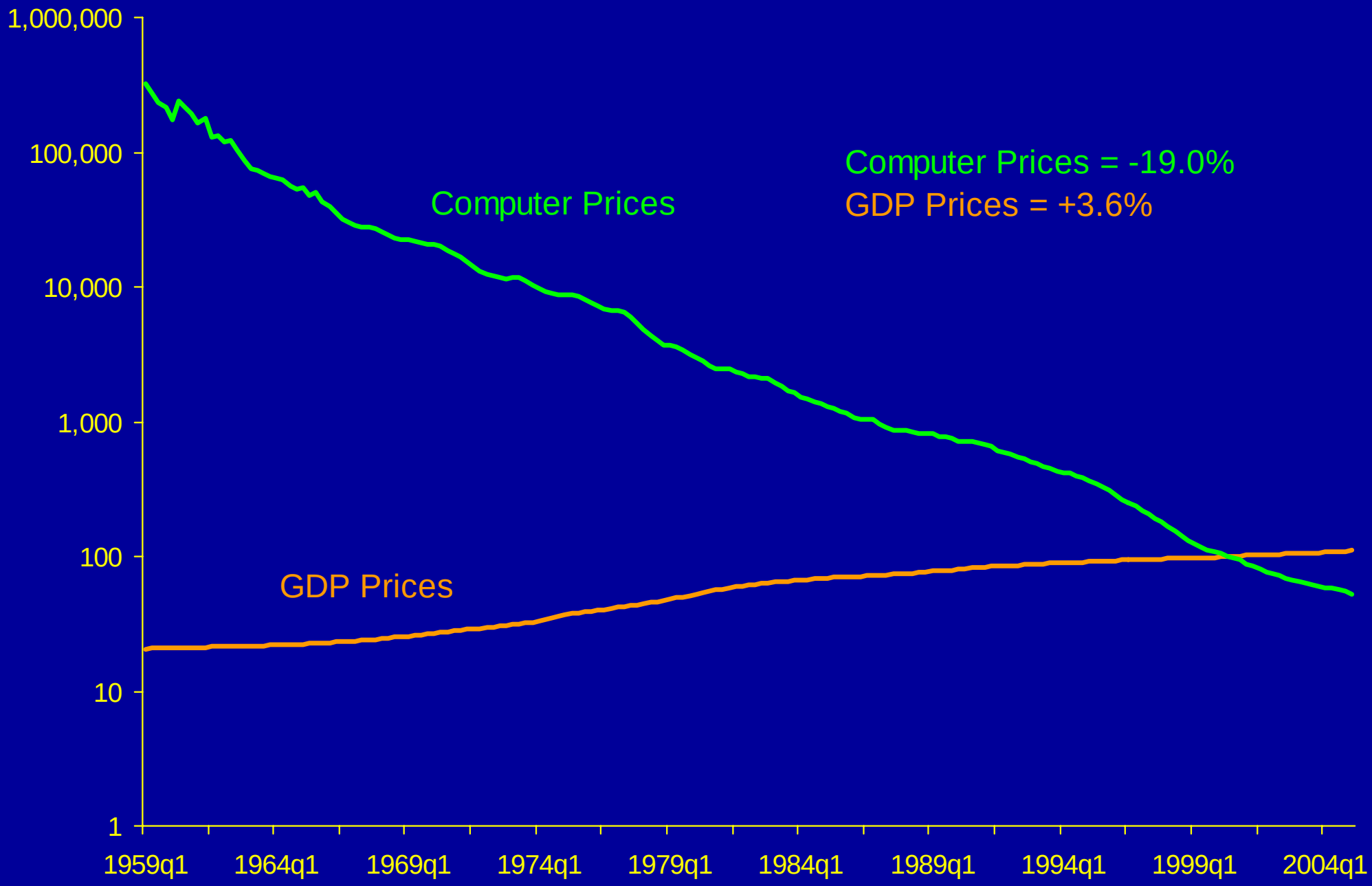
- Enormous technological progress
  - Moore's Law
  - Price of a calculation fell by a factor of 1.2 trillion since the turn of the century (Nordhaus, 2001)
  - Rapidly falling prices

Overall Price Level has Risen...



GDP price index, BEA (5/26/05).

…While Computer Prices Fell

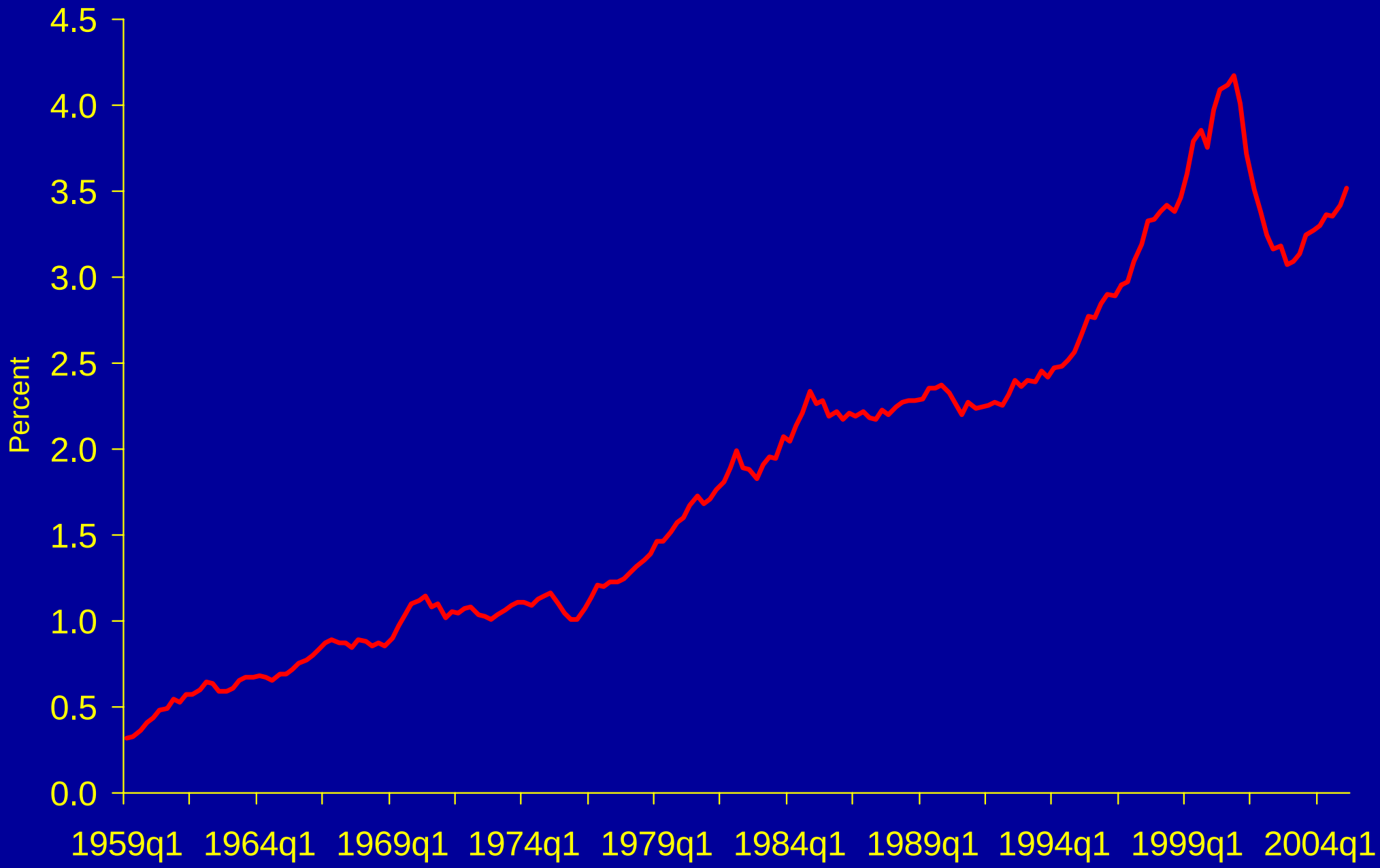


GDP price index and computer price index, BEA (5/26/05).

Why is IT Important?

- Enormous technological progress
  - Moore's Law
  - Price of a calculation fell by a factor of 1.2 trillion since the turn of the century (Nordhaus, 2001)
  - Rapidly falling prices
- Massive investment by U.S. firms
  - 40% of nonresidential business investment in information processing equipment and software ($484B in 2004)
  - Real IT investment grew 16% per year since 1959

IT Share of GDP is Rising



IT investment as a share of GDP. Current dollars, BEA (5/26/05).

IT and Productivity Growth

IT and Productivity: The Story

- Fundamental technological progress
  - Moore's Law
  - Huge productivity gains in IT-production
- Enormous declines in IT prices and increases in IT quality
- Investment in IT
  - Firms substitute toward IT
  - Productivity gains in IT-use

IT and Productivity: The Evidence

- Sources of U.S. productivity growth resurgence
- IT / productivity link across industries and countries
- Case studies of individual industries

IT Drives the U.S. Productivity Resurgence

1995-2003 less 1973-1995

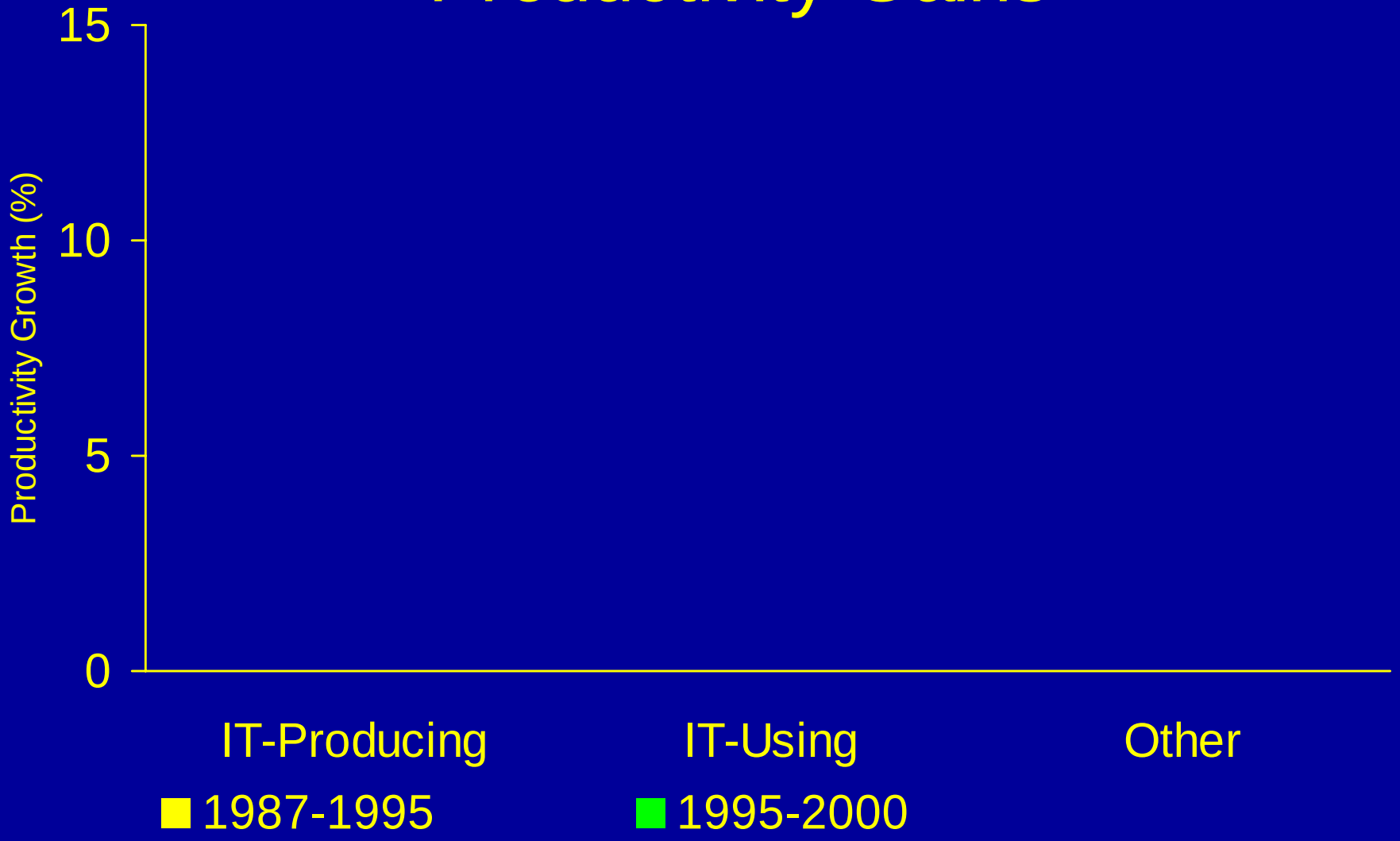
Increase in Labor Productivity Growth	Change 1.6
TFP, IT- Production	0.3
Capital Deepening, IT	0.5
TFP, Other	0.5
Capital Deepening, Other	0.3
Labor Quality	- 0.1

Average annual contribution in percentage points for U.S. business sector.
Source: Jorgenson, Ho, and Stiroh (2004).

What Does the Industry Data Say?

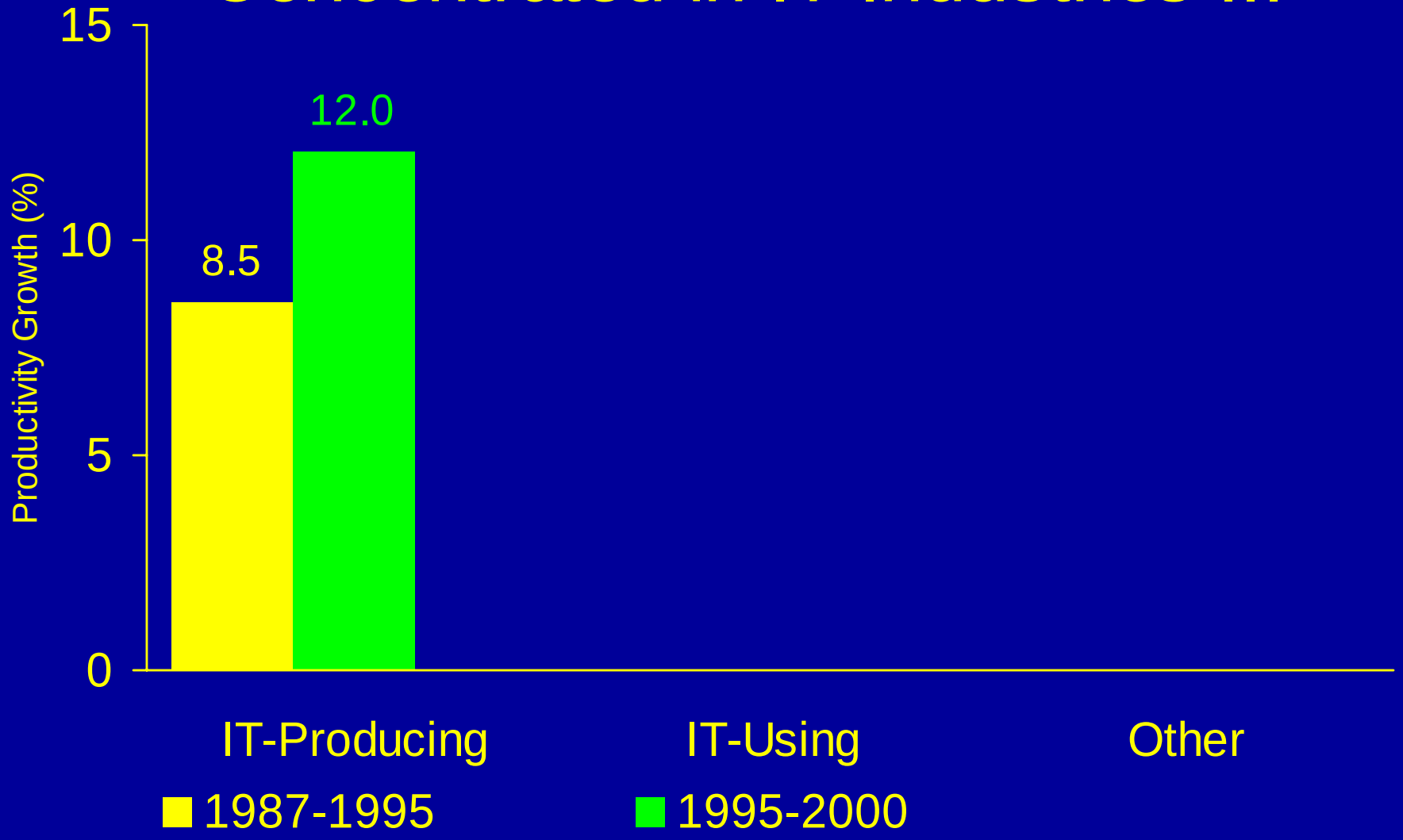
- Examine link between IT and industry productivity
- Compare three sets of industries
  - IT-producing
  - IT-using
  - Other

Compare Post-1995 Productivity Gains



Average annual percentages. IT-using have 1995 IT capital shares above the median.
Update of Stiroh (2002) based on GPO data released in November 2002.

Productivity Gains through 2000 Concentrated in IT Industries ...



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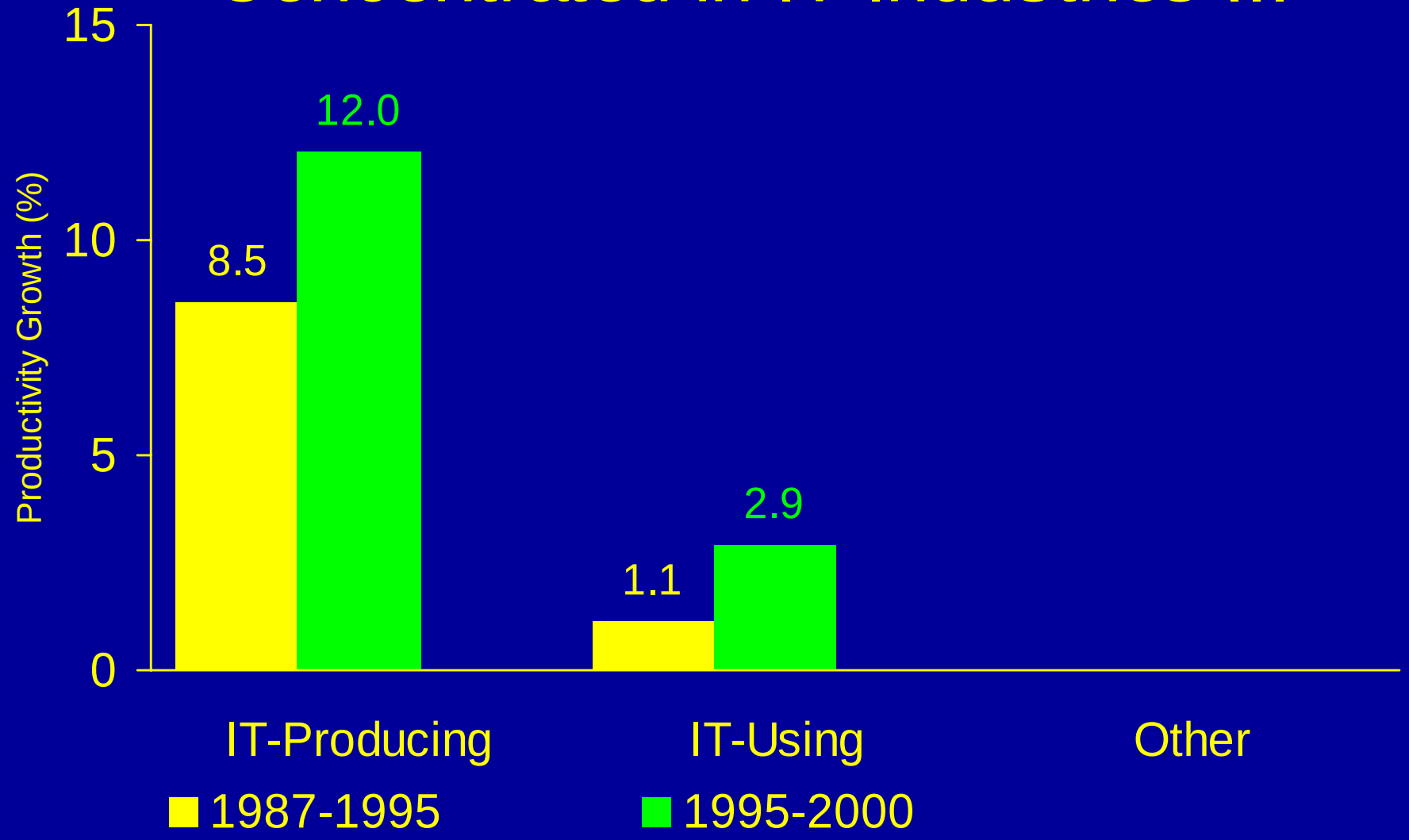

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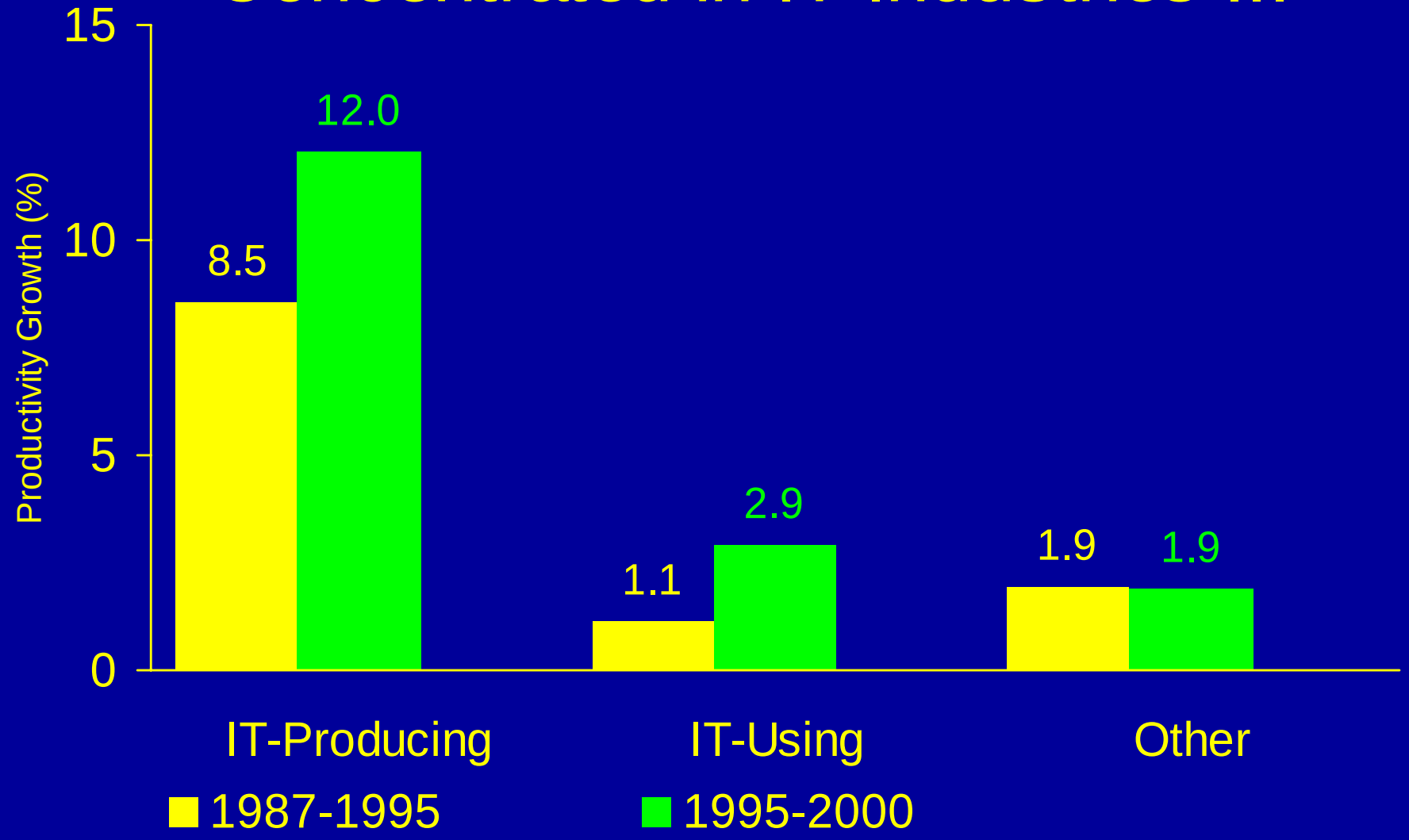

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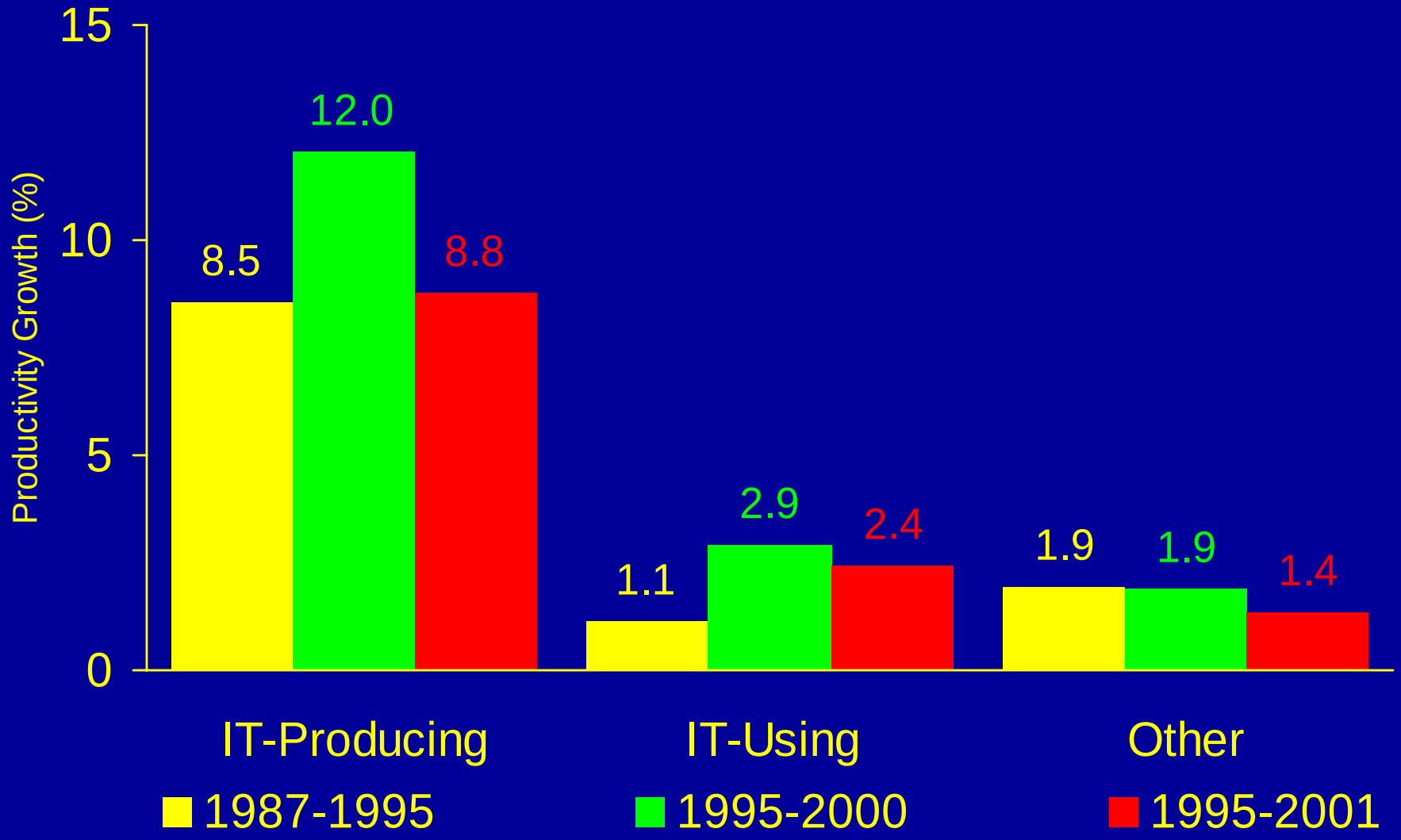
…Including Recession of 2001



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International Comparisons

- Compare U.S. to Europe and OECD

U.S. Shows Strong Productivity Gains after 1995

	1976-1995	1996-2003	Change
U.S.	1.16	2.46	1.30
Euro Area	2.09	0.84	-1.25
OECD	1.81	1.86	0.05
Spain	2.39	0.74	-1.65
Japan	2.43	1.48	-0.95
Canada	1.06	1.48	0.43

Note: Average annual growth in business sector productivity.

Source: OECD Economic Outlook.

Explaining the U.S. / Europe Divergence

van Ark and co-authors

- Both have rapid growth in IT-production, but Europe has smaller share
- Smaller gains in IT-using industries
  - Particularly Retail and Finance
  - Labor and product market rigidities
- Faster growth in “New Europe” than in “Old Europe”

Case Studies

- Trucking Industry
  - Electronic vehicle management systems and GPS
  - More efficient operations and monitoring
  - Fewer empty backhauls and less waiting to load/unload
- Emergency vehicles
  - Computerized “enhanced 911” system
  - Better matching of equipment
  - Improved health outcomes and lower patient costs
- Retail
  - Technology allows scale and scope
  - Better information on customers, inventories
  - Supply chain management

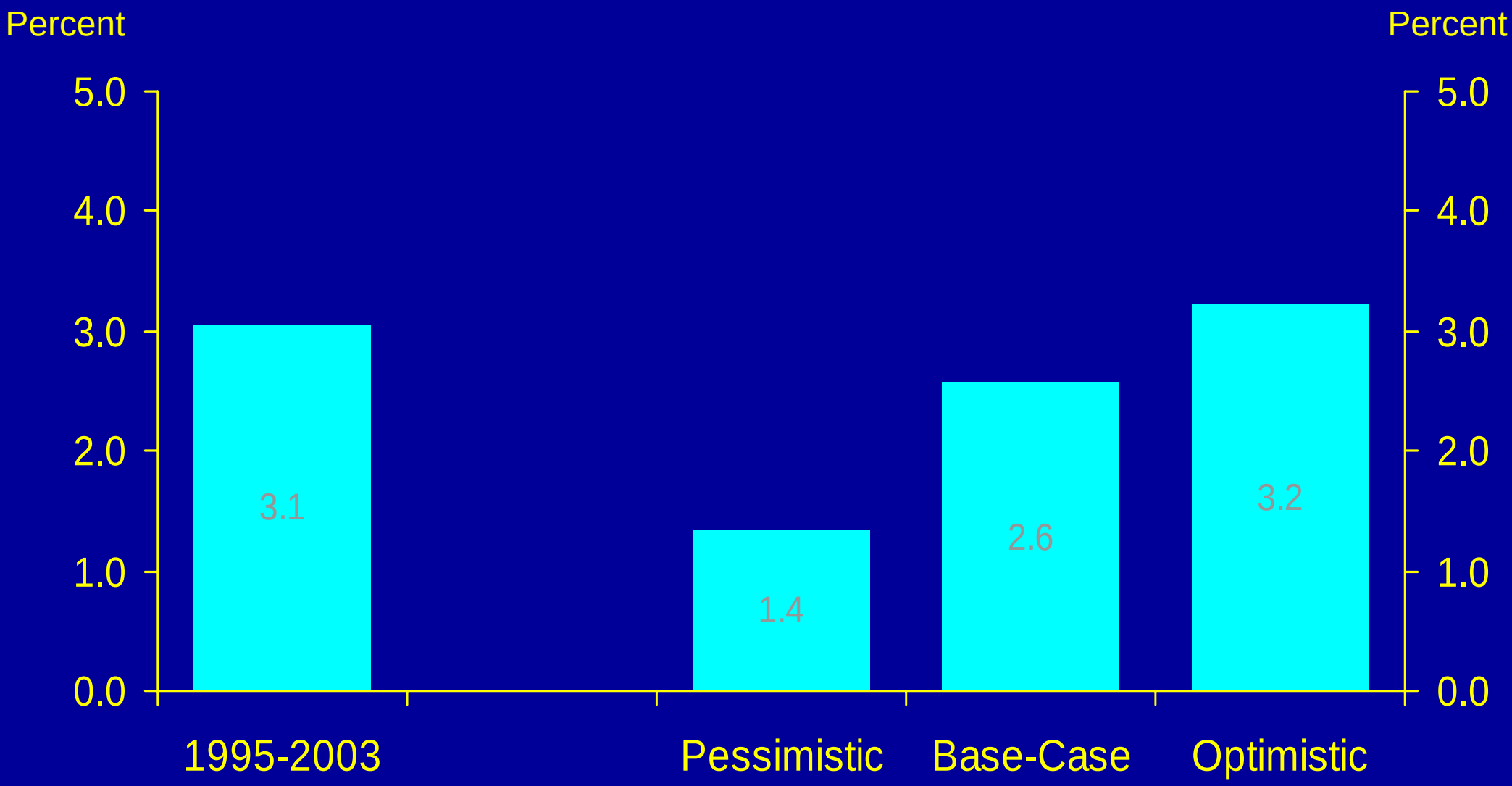
IT and Productivity

- Consensus that IT is important for productivity
- Evidence from many sources
  - Aggregate
  - Industry
  - International
  - Firm

Productivity Outlook

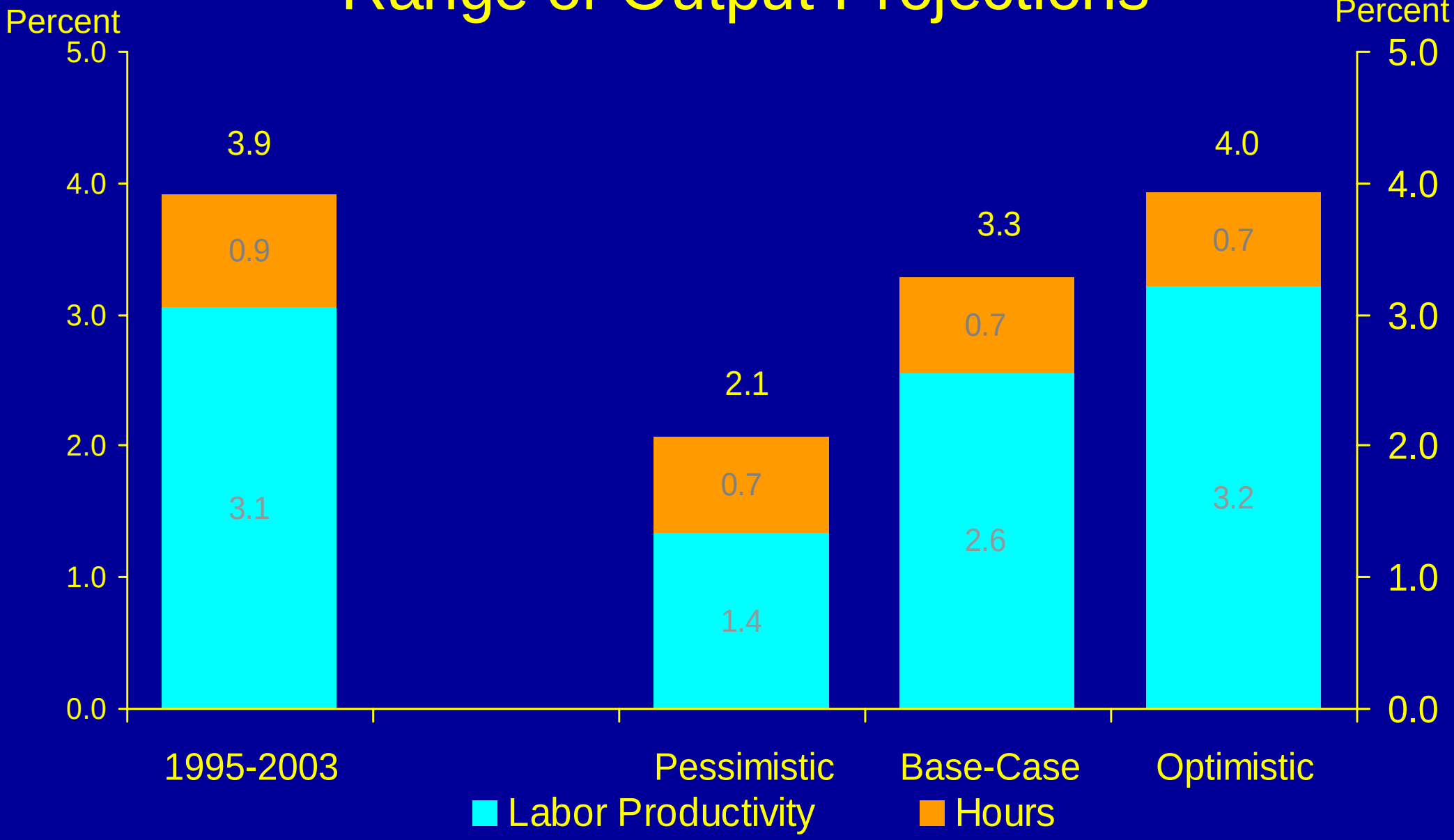
- Project productivity growth for next decade
- Uncertainty about technological progress
  - Pessimistic
  - Base-case
  - Optimistic
- Range of technology forecasts
  - *International Technology Roadmap for Semiconductors*
  - Intel

Range of Productivity Projections



Average annual growth rate for U.S. private sector.
Source: Jorgenson, Ho, and Stiroh (2004).

Range of Output Projections



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Projection Conclusions

- Base-case projection of 2.6% labor productivity growth for next decade
- Consistent with consensus view
- Implications
  - Some cyclical decline from 2002-2004 pace
  - Some structural decline from post-1995 pace
  - No evidence of return to pace of 1970's and 1980's

Questions

What Changed in 1995?

- Acceleration of IT technological progress
  - Shift to 2-year semiconductor cycle (Jorgenson, 2001)
- Widespread use of Internet and e-commerce
  - (OECD, 2000) and Nordhaus (2000)
- Emergence of open-source software
  - (DeLong, 2000)
- Learning-by-doing

Can IT Technological Progress Continue?

- Pessimistic view
  - Diminishing returns (Gordon, 2000)
  - End of Moore's Law (Mann, 2000)
- Optimistic view
  - Silicon pipeline is full for the next decade or two
  - New technologies
    - DWDM
    - Blue lasers
    - Molecular-scale electronics
    - Nano and quantum computing
- Hard to predict long-run technological advances

Will Firms Continue to Invest in IT?

- Possible impediments
  - Rising interest rates
  - National security
  - Decline in investment funds due to current account
  - Saturation point for IT
- Reasons for optimism
  - Changes in “locus of innovation” and new applications
    - Health care
  - Relative price changes are driving investment

Does the “dot.com” Bubble Debunk the Importance of IT and Productivity?

- No
- Basic error was confusing productivity and profits
- Ultimate winner will be consumers as profits are competed away and prices fall

Is IT the Whole Story?

- No

- Firms need complementary innovations
  - Human capital
  - Organization structure
  - Information flows
  - Workplace practices

Conclusions

Conclusions

- IT has made important contributions to U.S. productivity gains
- This is the core of truth in the “new economy” hype
  - Technological progress lowers the price of IT
  - Lower prices spur IT investment
- Consensus that U.S. productivity growth will continue