Preliminary – Comments Welcome

A Retrospective Look at the U.S. Productivity Growth Resurgence

Dale W. Jorgenson, Mun S. Ho, and Kevin J. Stiroh*

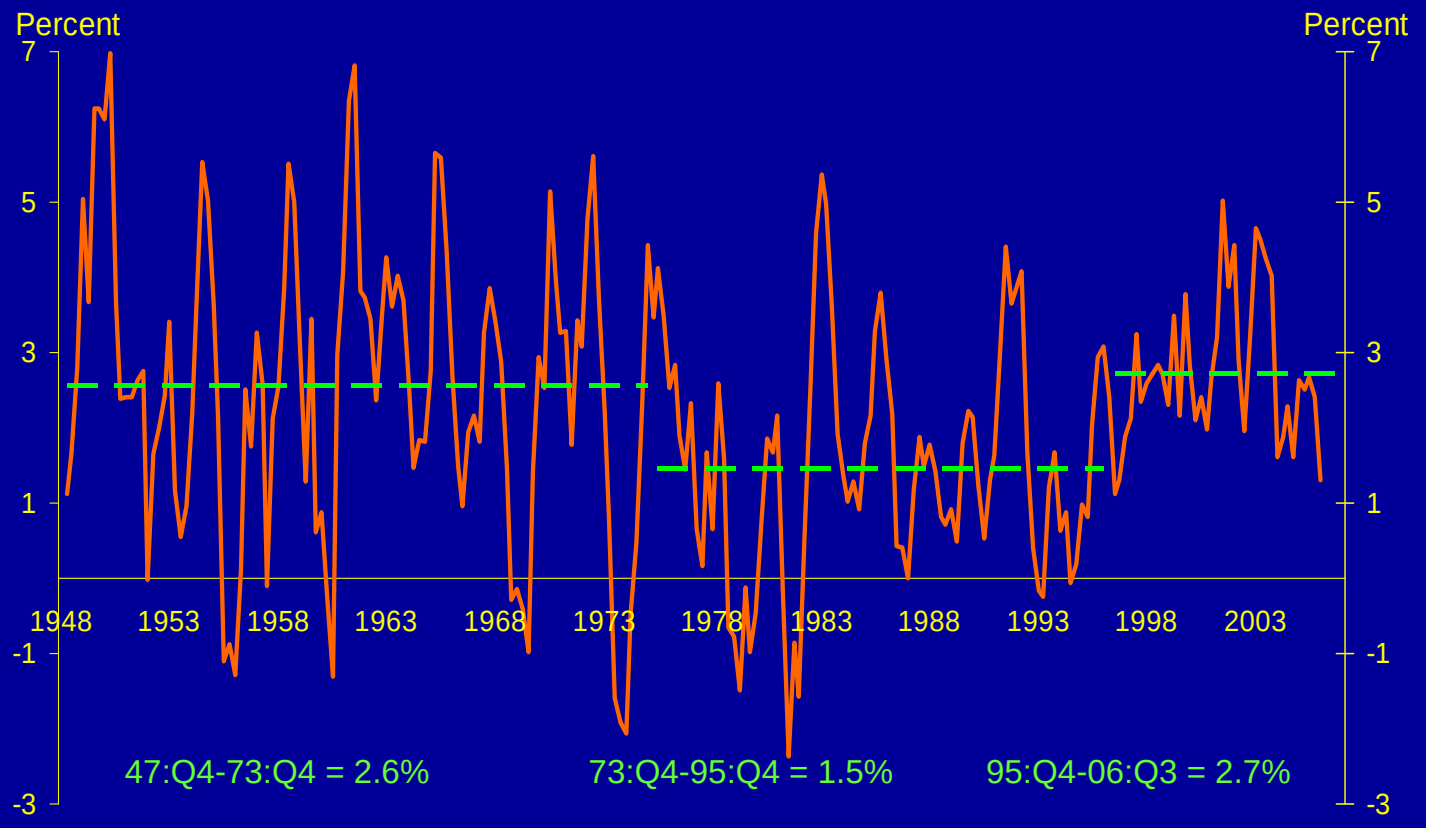
January 2007

*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

- Evolving View of U.S. Productivity Growth
- Sources of Productivity Growth
- Productivity Projections

Three Productivity Eras



4-quarter growth in nonfarm business labor productivity.
Dotted line represents averages for 1948:Q4-1973:Q4, 1973:Q4-1995:Q4 and 1995:Q4-2006:Q3. BLS (11/23/06).

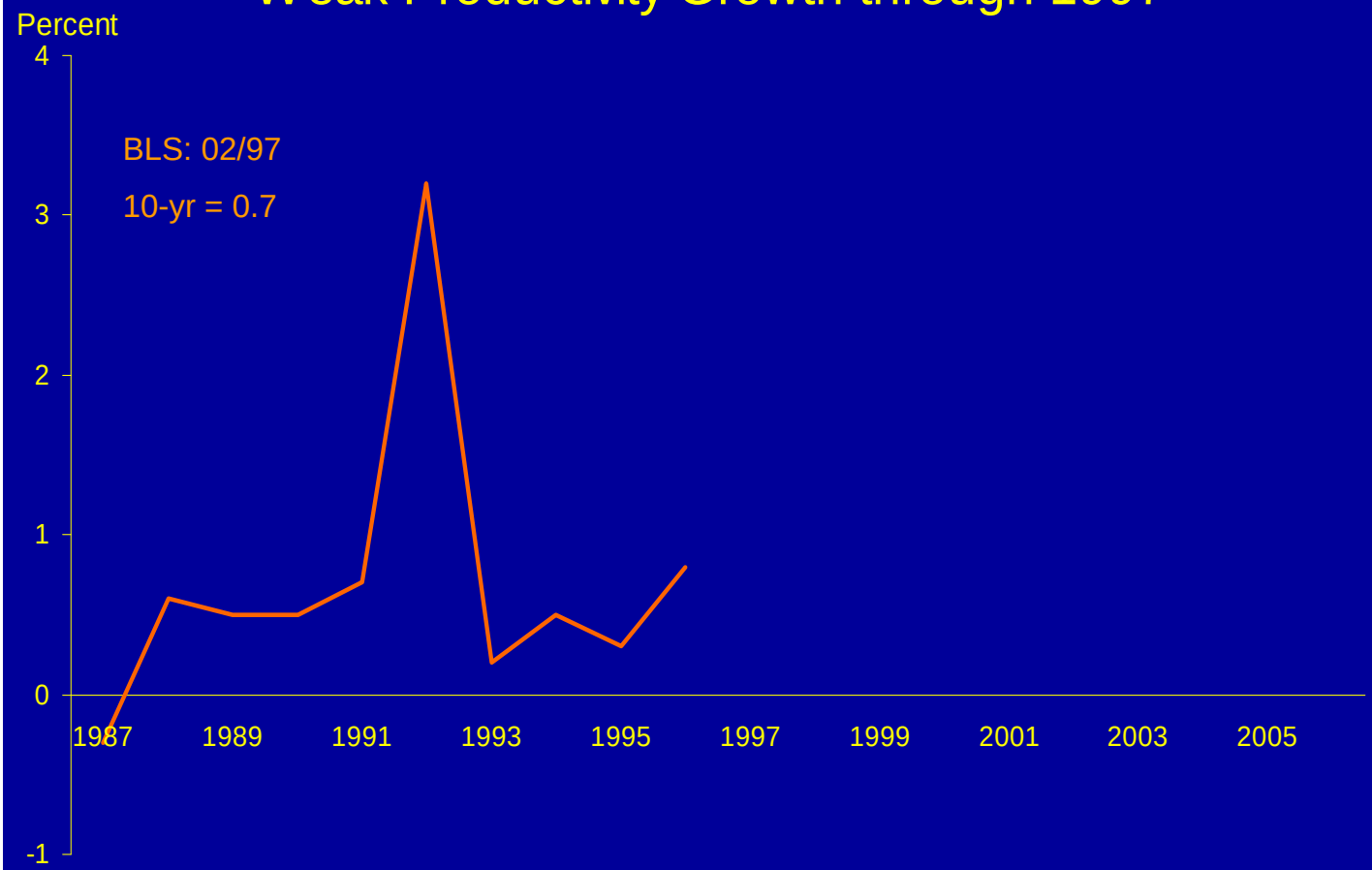
Evolving View of U.S. Productivity Growth

- Pessimism through the early-1990s
  - Computer Productivity Paradox (Solow, '87)
  - Age of Diminished Expectations (Krugman, '93)
- Neoclassical view in mid-1990s
  - Computers are still small (Oliner-Sichel, '94, Jorgenson-Stiroh, '95)
- Some optimists in mid-1990s
  - New economy adherents (*Business Week*)
  - Chairman Greenspan

"…rapid acceleration of computer and telecommunication technologies can reasonably be expected to appreciably raise our productivity and standards of living in the twenty first century certainly, and quite possibly in some of the remaining years of this century."

Federal Reserve Chairman Alan Greenspan
National Governors' Association
February 1996

Weak Productivity Growth through 1997

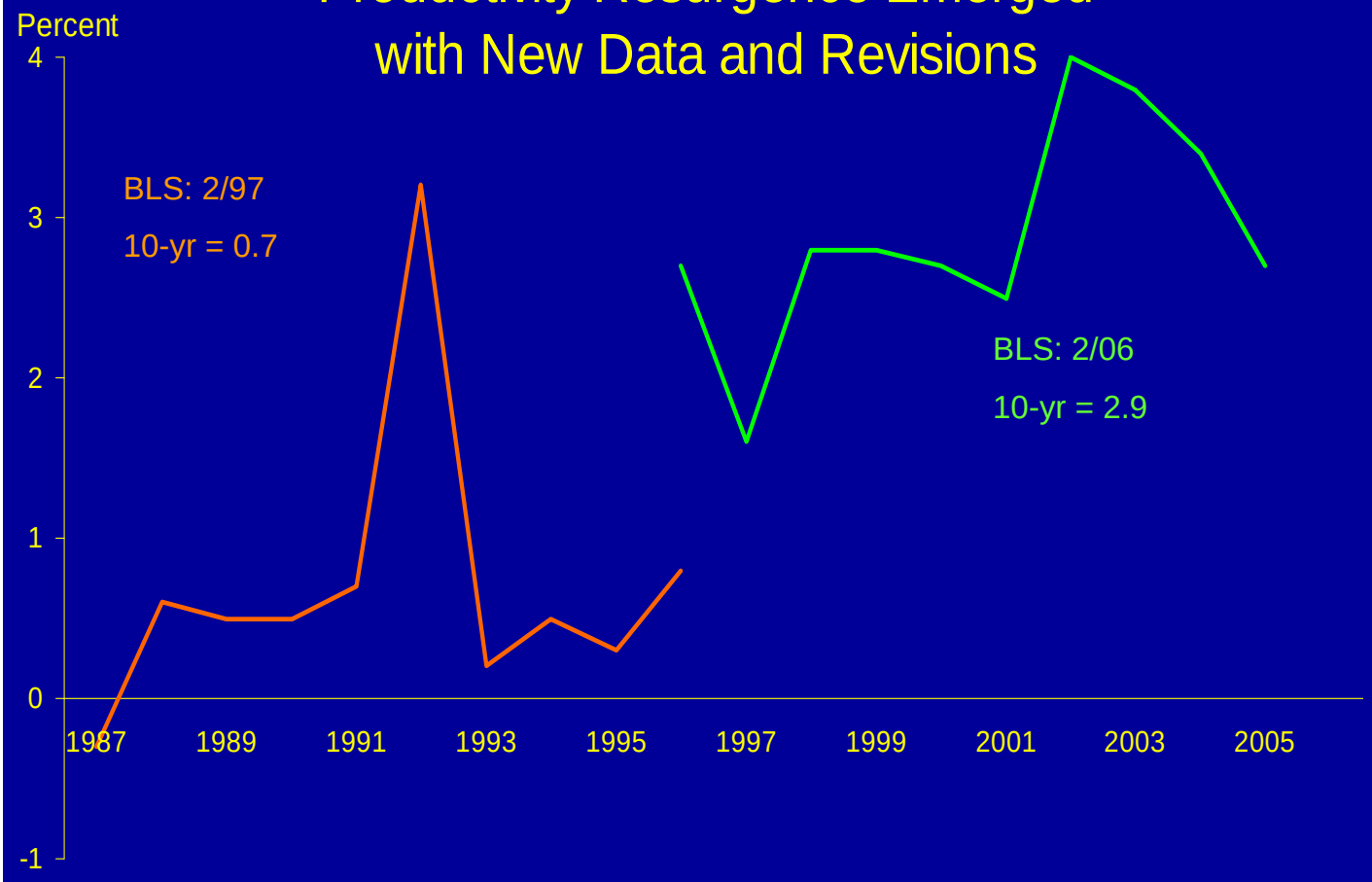


Note: Annual productivity growth for U.S. nonfarm business sector from BLS (2/11/1997) and BLS (2/2006).

Evolving View of U.S. Productivity Growth

- Release of new data and revision of old data proved the optimists correct

Productivity Resurgence Emerged with New Data and Revisions



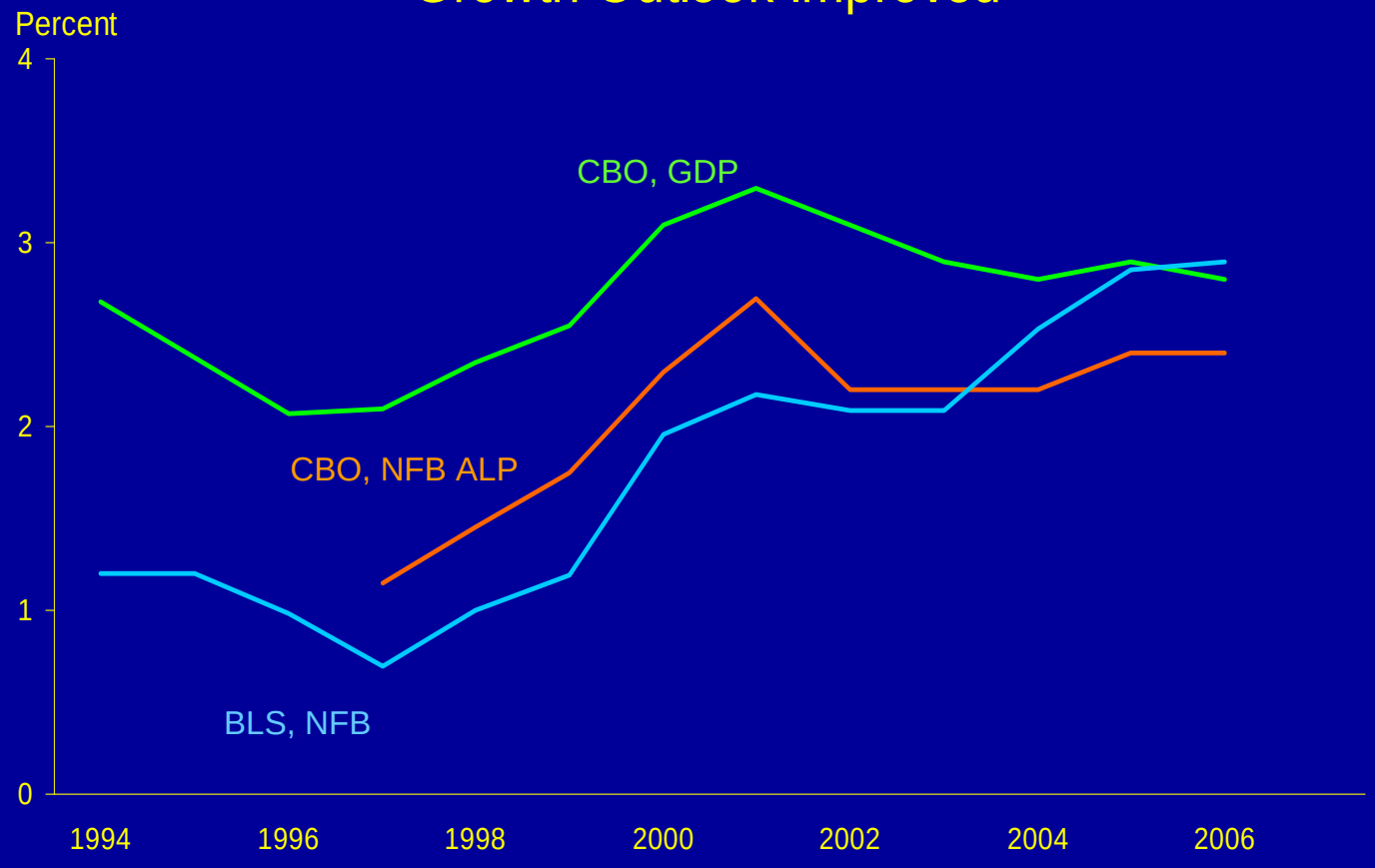
Note: Annual productivity growth for U.S. nonfarm business sector from BLS (2/11/1997) and BLS (2/2006).

Evolving View of U.S. Productivity Growth

- Release of new data and revision of old data proved the optimists correct

- Two effects
  - Stimulated research on the role of IT
    - Macro, industry, firm, and case-study evidence that IT was important
  - Growth and productivity outlook improved dramatically
    - Implications for fiscal and monetary policy

Growth Outlook Improved



Note: CBO data are 10-year projections from January Budget and Economic Outlook of each year. BLS data are average growths for trailing 10 years for nonfarm business sector.

Sources of Productivity Growth

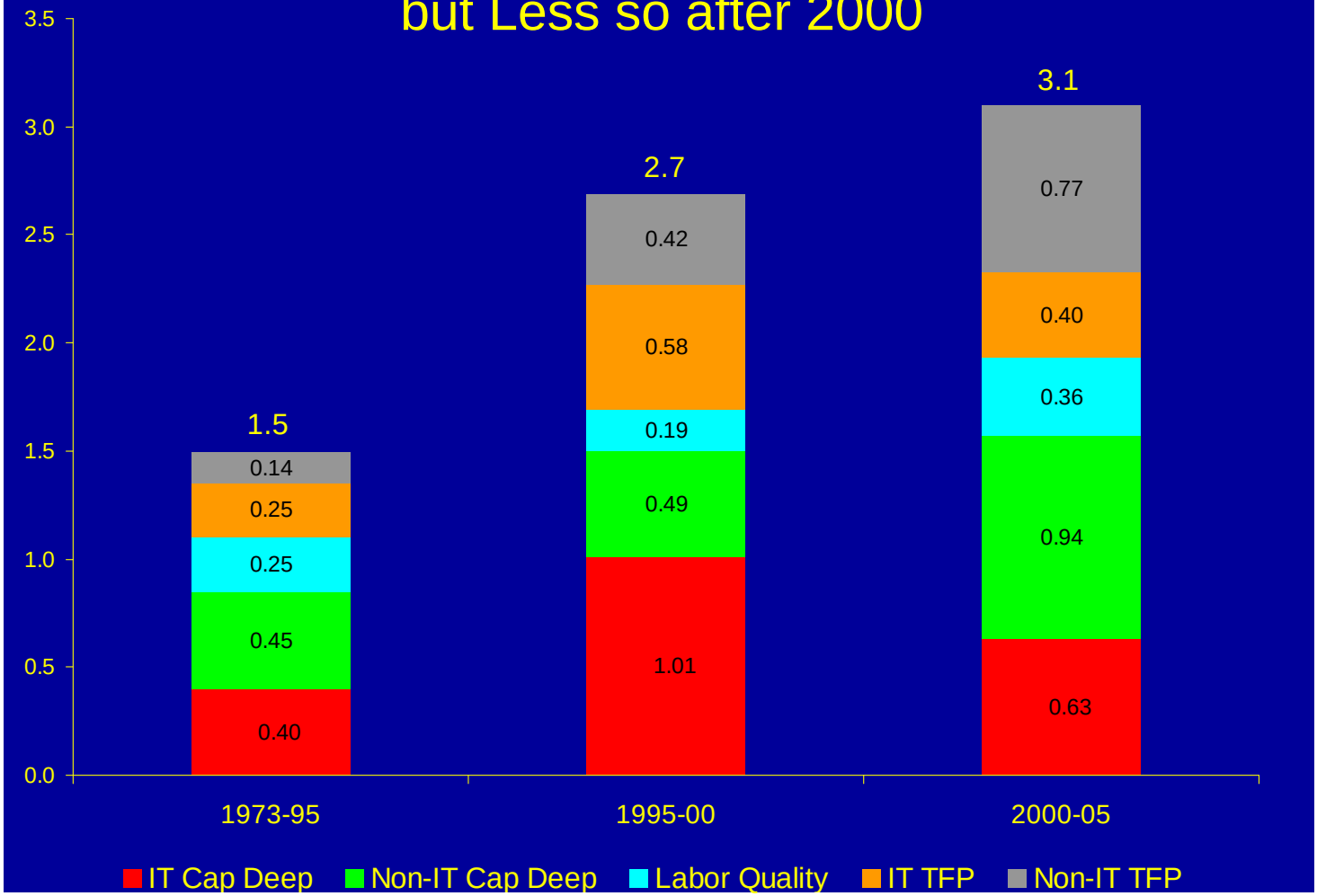
- Standard decomposition

$$\Delta \ln y = \bar{v}_{K_n} \Delta \ln k_n + \bar{v}_{K_{IT}} \Delta \ln k_{IT} + \bar{v}_L \Delta \ln L_Q + \bar{w}_n \Delta \ln A_n + \bar{w}_{IT} \Delta \ln A_{IT}$$

Sources of U.S. Output and Productivity Growth

	1973-1995	1995-2000	2000-2005
Average Labor Productivity	1.49	2.70	3.09
IT Cap Deepening	0.40	1.01	0.63
Non-IT Cap Deepening	0.45	0.49	0.94
Labor Quality	0.25	0.19	0.36
IT TFP	0.25	0.58	0.40
Non-IT TFP	0.14	0.42	0.77
Share Attributed to IT	0.43	0.59	0.33

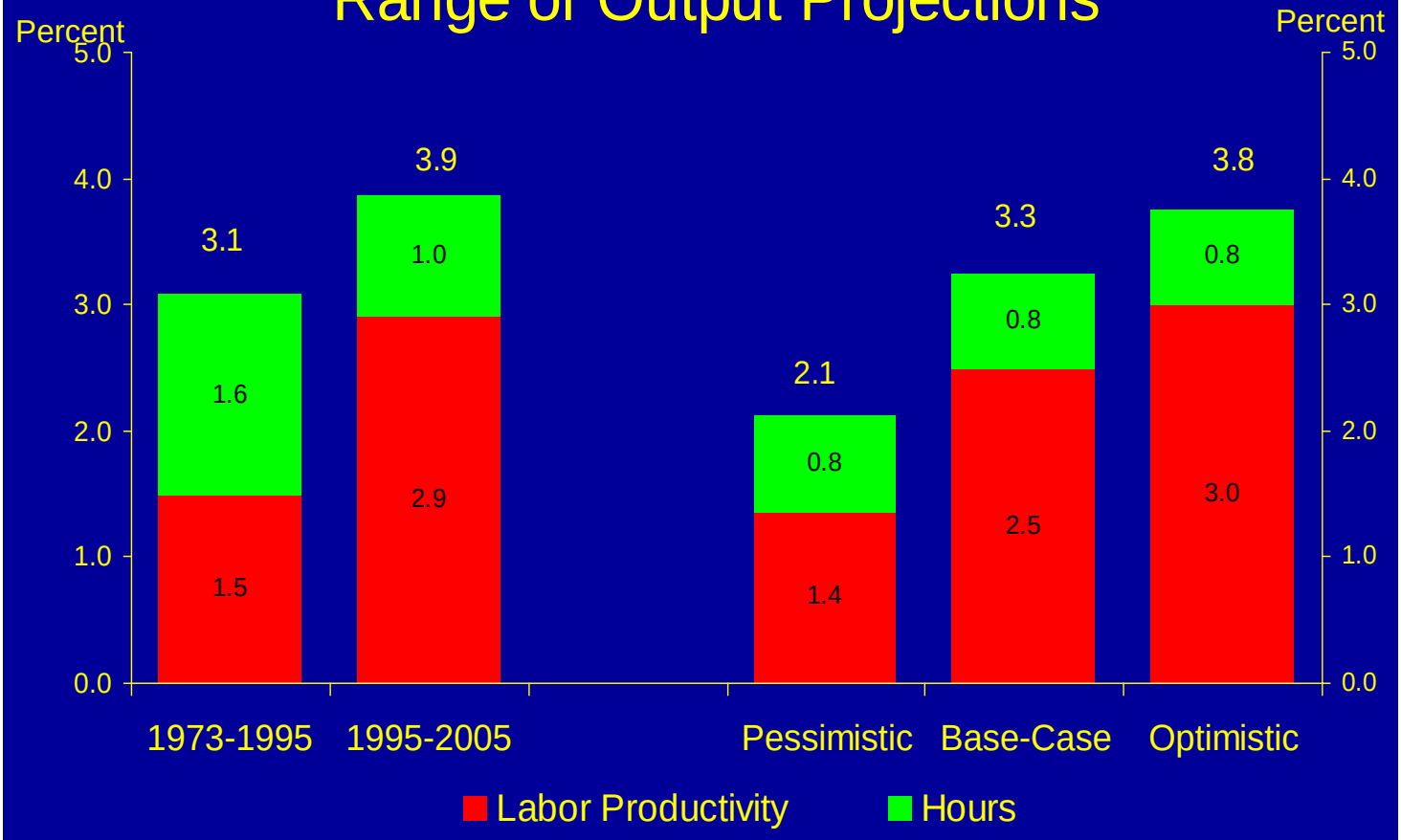
IT is Important for Productivity Growth, but Less so after 2000



Productivity Outlook

- Project productivity growth for next decade
  - Steady-state growth calibrations
    - Output and reproducible capital grow at same rate
    - Hours and labor supply grow at same rate
- Uncertainty about technological progress
  - Pessimistic, base-case, optimistic
  - Based on
    - Historical record
    - *International Technology Roadmap for Semiconductors*

Range of Output Projections



Average annual growth rate for U.S. private sector. Numbers do not sum due to rounding.

Alternative Growth Projections

	Date	Horizon	Productivity	+ Hours	= Output
		Nonfarm Business			
Gordon	Sep '06	25-year	2.1		
Global Insight	Sep '06	30-year	2.3	0.8	3.1
CBO	Aug '06	10-year	2.4	0.8	3.2
Jorgenson, Ho, Stiroh	Oct '06	10-year	2.5	0.8	3.3
Macroadvisors	Nov '06	3-year	2.5	0.9	3.4
		GDP			
Aaronson et al.	Sep '06	10-year		0.4	
Gordon	Oct '06	25-year	1.8	0.7	2.5
SSA	Mar '06	10-year	1.9	0.7	2.6
CBO	Aug '06	10-year	2.1	0.7	2.8
Global Insight	Sep '06	30-year	2.1	0.7	2.8
Macroadvisors	Nov '06	3-year			3.1

Conclusions

- Productivity outlook evolved rapidly
  - Release of new data and revisions of old
- IT remains important, but less in 2000s than in 1990s
- Outlook remains solid, but edging down
  - Part of post-2000 gains appear transitory
  - JHS from 2.6% to 2.5%
    - Impact of BLS employment revisions about 2.4%
  - Little evidence that “productivity slowdown” will return

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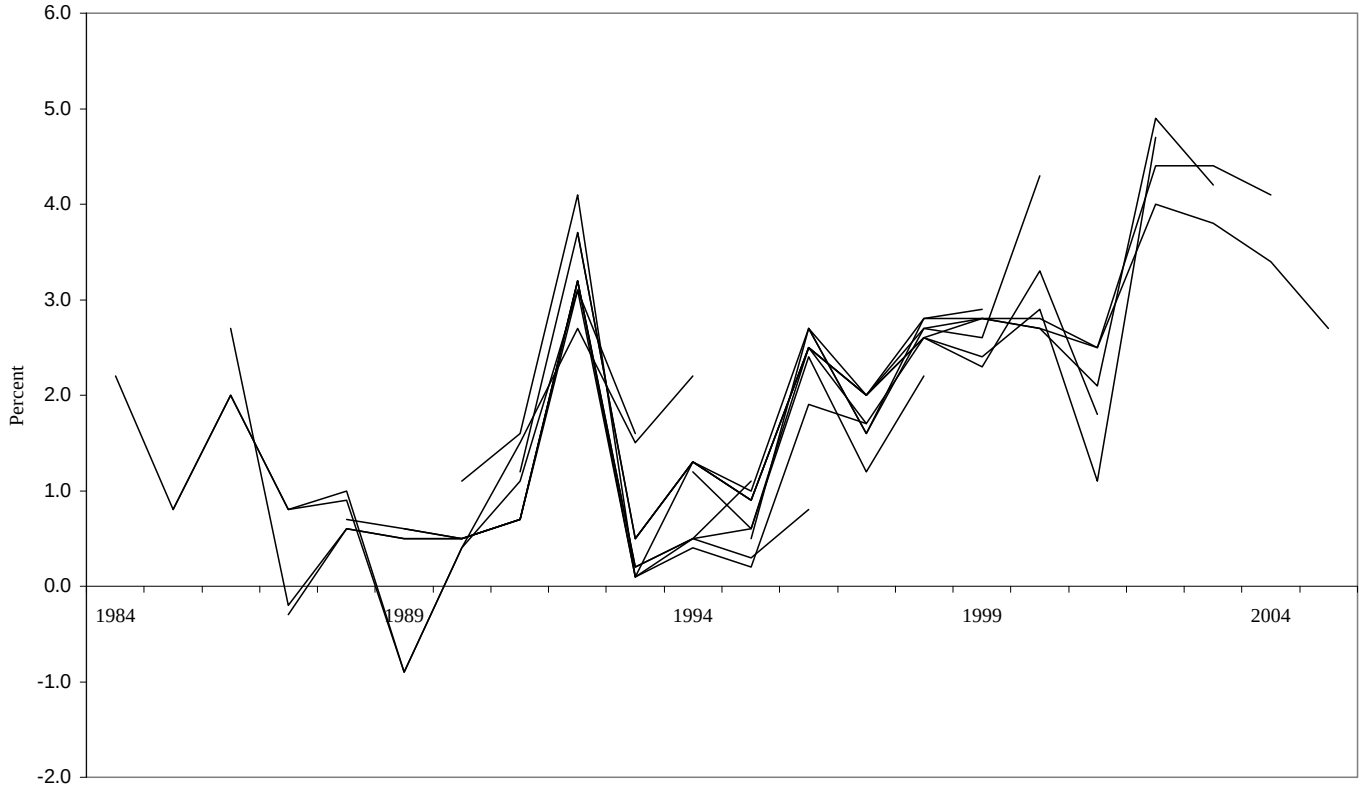
Reference Charts

Figure 2: Evolution of U.S. Productivity Data

Nonfarm Business Productivity



Note: Data are the annual growth rates of nonfarm business productivity for the trailing 10 years from February of each year, as reported in various BLS productivity releases.

Table 1: Sources of U.S. Output and Productivity Growth
1959-2005

	1959-2005	1959-1973	1973-1995	1995-2000	2000-2005
Private Output	3.58	4.18	3.08	4.77	2.93
Hours Worked	1.38	1.36	1.59	2.07	-0.16
Average Labor Productivity	2.20	2.82	1.49	2.70	3.09
Contribution of Capital Deepening	1.17	1.40	0.85	1.51	1.56
Information Technology	0.43	0.21	0.40	1.01	0.63
Non-Information Technology	0.73	1.19	0.45	0.49	0.94
Contribution of Labor Quality	0.27	0.28	0.25	0.19	0.36
Total Factor Productivity	0.77	1.14	0.39	1.00	1.17
Information Technology	0.25	0.09	0.25	0.58	0.40
Non-Information Technology	0.52	1.05	0.14	0.42	0.77
Share Attributed to Information Technology	0.31	0.11	0.43	0.59	0.33

Notes: Data are for the U.S. private economy. All figures are average annual growth rates. A contribution of an input reflects the share-weighted growth rate. Capital is broadly defined to include business capital and consumer durables. Information technology includes computer hardware, software, and communications equipment. Share Attributed to Information Technology is the average contribution of information technology capital deepening plus the average contribution of information technology total factor productivity divided by average labor productivity for each period.

Table 2: Changes in the Sources of Productivity Growth

	1995-2000 less 1973-1995	2000-2005 less 1973-1995	2000-2005 less 1995-2000
Average Labor Productivity	1.22	1.60	0.39
Contribution of Capital Deepening	0.66	0.72	0.05
Information Technology	0.61	0.23	-0.39
Non-Information Technology	0.05	0.49	0.44
Contribution of Labor Quality	-0.06	0.11	0.17
Total Factor Productivity	0.62	0.78	0.17
Information Technology	0.34	0.16	-0.18
Non-Information Technology	0.28	0.62	0.35
Share Attributed to Information Technology	0.78	0.24	

Notes: All figures are average annual growth rates taken from Table 1. Share Attributed to Information Technology is the average contribution of information technology capital deepening plus the average contribution of information technology total factor productivity divided by average labor productivity for each comparison period.

Table 3: Output and Labor Productivity Projections

	Projections		
	Pessimistic	Base-case	Optimistic
	Projections		
Private Output Growth	2.12	3.25	3.76
Average Labor Productivity Growth	1.36	2.49	3.00
	Common Assumptions		
Hours Growth	0.76	0.757	0.76
Labor Quality Growth	0.15	0.149	0.15
Capital Share	0.42	0.423	0.42
Reproducible Capital Stock Share	0.81	0.809	0.81
IT Output Share	0.05	0.046	0.05
	Alternative Assumptions		
TFP Growth in IT	8.05	9.52	10.77
Implied IT-related TFP Contribution	0.37	0.43	0.49
Other TFP Contribution	0.14	0.45	0.59
Capital Quality Growth	0.86	1.72	2.05

Notes: In all projections, hours growth and labor quality growth are from internal projections for 2005-2015, capital share and reproducible capital stock shares are 1959-2005 averages, and the IT output shares is the 1995-2005 average. The pessimistic case uses 1973-1995 average growth of IT-related TFP growth, non-IT TFP contribution, and capital quality growth. The base-case uses 1990-2005 averages, and the optimistic case uses 1995-2005 averages.

Table 4: Alternative Growth Projections

	Date	Horizon	Productivity	+	Hours	=	Output
		Nonfarm Business					
Gordon	Sep '06	25-year	2.1				
Global Insight	Sep '06	30-year	2.3		0.8		3.1
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Notes: All estimates are average annual growth rates. Jorgenson et al. estimates are for business sector including consumer durables. SSA estimate is imputed hours growth.