



Exploring Productivity

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Outline

- Recent productivity growth
- Policymaking during the latter 1990s
- What did we know, and when did we know it?
- Labor productivity vs. Total factor productivity
- Puzzles for future research



Acceleration

Labor productivity

- 1973-1995, +1-1/2% pa
- 1995-2001, +2-1/2% pa
- 2001-date, +4% pa

How Has this Happened?

- Technology - ICT
- Capital investment – capital deepening
- Falling capital equipment prices
- International Trade



Other Effects

- More unequal income distribution
- Increased poverty (Census Bureau 2004 report)

News

United States
Department
of Labor



Bureau of Labor Statistics

Washington, D.C. 20212

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PRODUCTIVITY AND COSTS

Preliminary Fourth Quarter and
Annual Averages for 2004

The Bureau of Labor Statistics of the U.S. Department of Labor today reported preliminary productivity data—as measured by output per hour of all persons—for the fourth quarter and for the full year 2004. The seasonally adjusted annual rates of productivity change in the fourth quarter and the annual average changes were:

	Fourth quarter	Annual averages 2003-2004
Business sector	2.5	4.0
Nonfarm business sector	0.8	4.1

In the fourth quarter, productivity increased 2.5 percent in the business sector—about the same as in the third quarter, when it increased 2.4 percent (seasonally adjusted annual rates). In nonfarm businesses, productivity grew more slowly in the fourth quarter, 0.8 percent, than in the third quarter, when it rose 1.8 percent. On an annual average basis, productivity rose 4.0 percent in the business sector and 4.1 percent in the nonfarm business sector.

In the manufacturing sector, increases in productivity were:

	Fourth quarter	Annual averages 2003-2004
Manufacturing sector	5.6	4.9
Durable goods manufacturing	7.3	6.1
Nondurable goods manufacturing	3.7	3.9

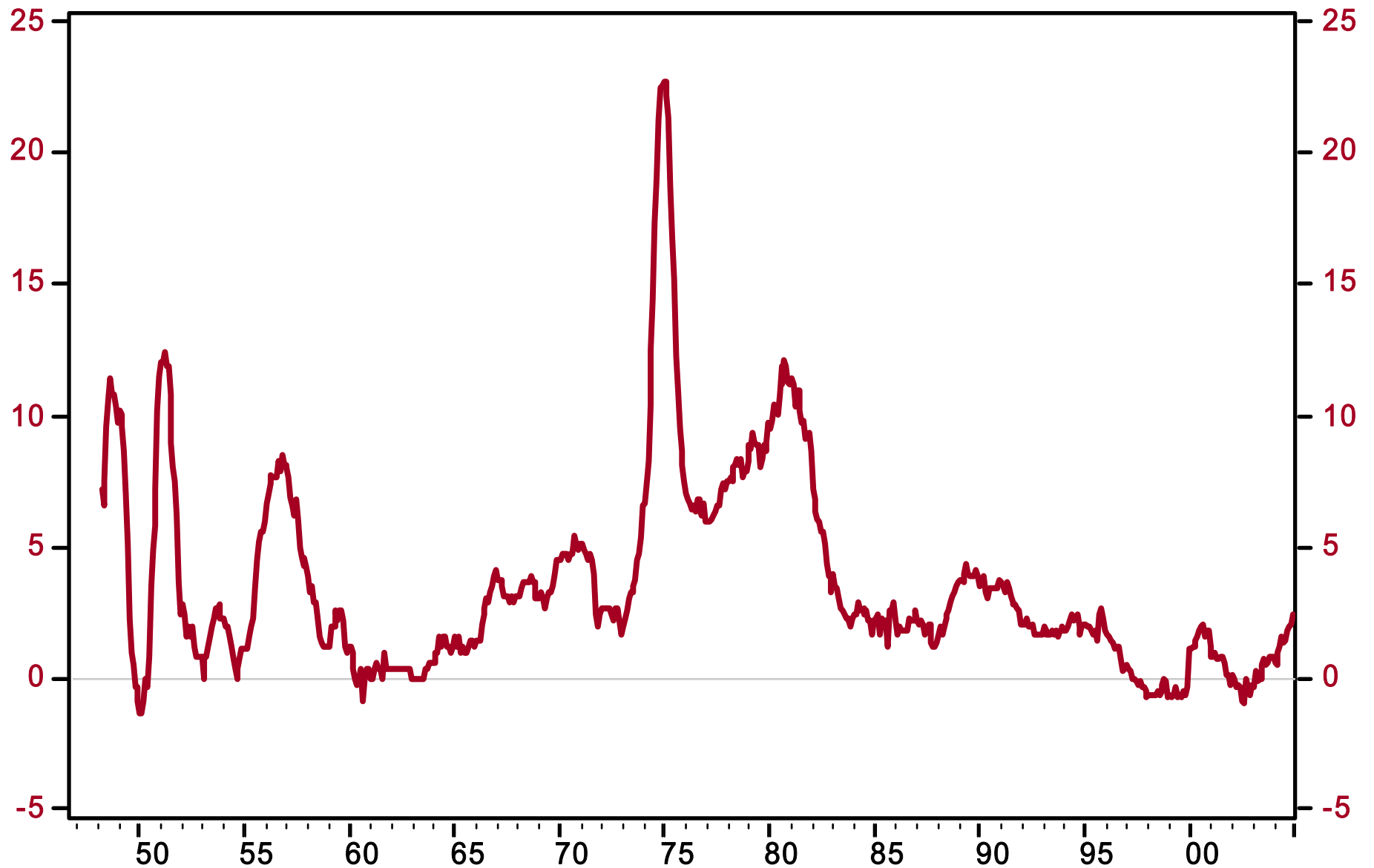
Table A. Productivity and costs: Preliminary fourth-quarter 2004 measures
(Seasonally adjusted annual rates)

Sector	Productivity	Output	Hours	Hourly compensation	Real hourly compensation	Unit labor costs
Percent change from preceding quarter						
Business	2.5	3.3	0.8	4.2	0.8	1.7
Nonfarm business	0.8	2.8	1.9	3.1	-0.3	2.3
Manufacturing	5.6	4.5	-1.0	6.0	2.5	0.4
Durable	7.3	6.6	-0.6	6.1	2.6	-1.1
Nondurable	3.7	2.0	-1.7	5.7	2.2	2.0
Percent change from same quarter a year ago						
Business	2.9	4.2	1.3	4.0	0.6	1.1
Nonfarm business	2.5	4.2	1.6	3.6	0.2	1.0
Manufacturing	4.8	5.0	0.2	3.2	-0.2	-1.5
Durable	5.4	6.7	1.2	2.4	-0.9	-2.8
Nondurable	4.4	2.9	-1.4	4.4	1.0	0.1

PPI: Finished Goods: Capital Equipment

% Change - Year to Year

SA, 1982=100

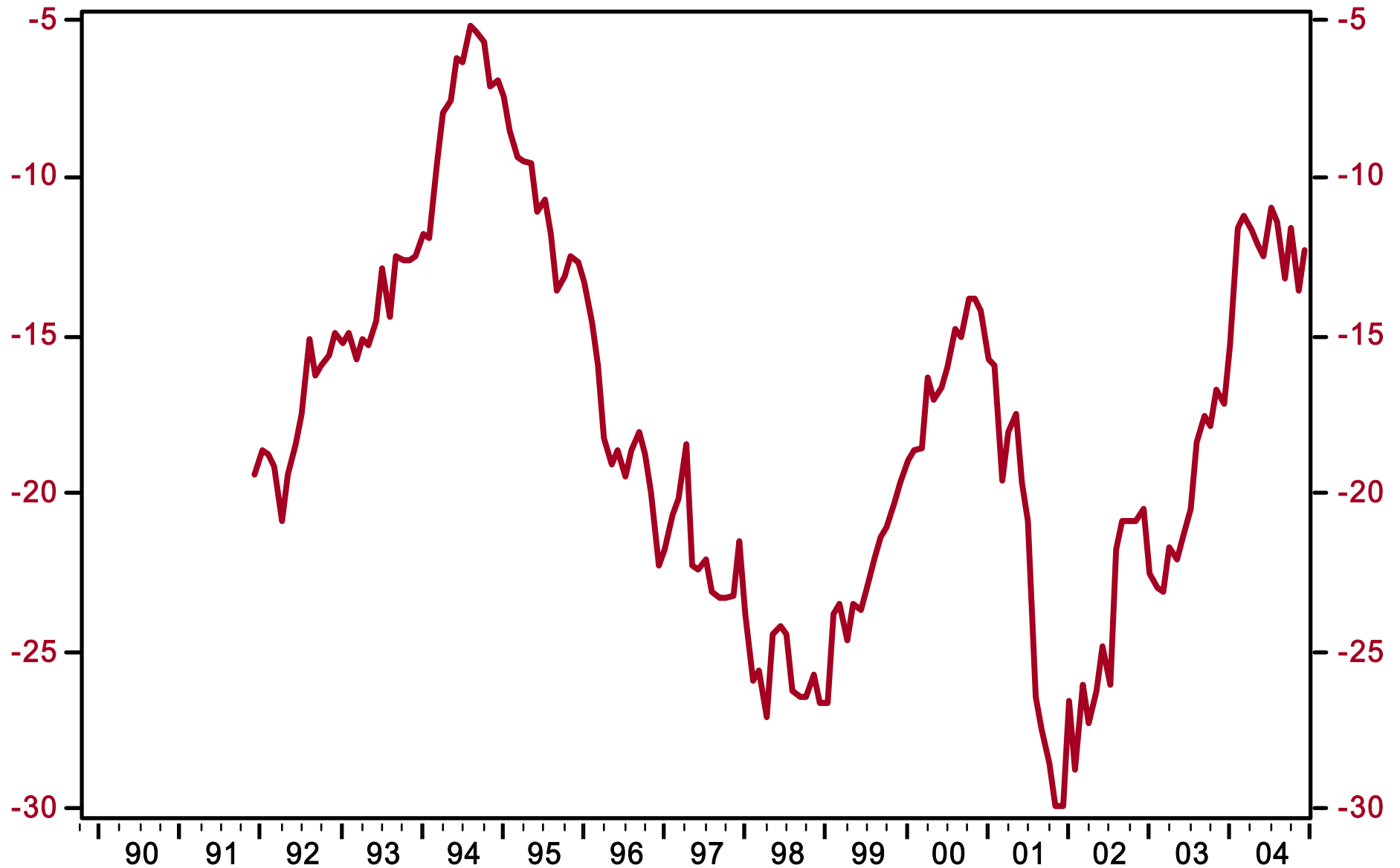


Source: Bureau of Labor Statistics /Haver Analytics

PPI: Electronic Computers

% Change - Year to Year

NSA, Dec-98=100



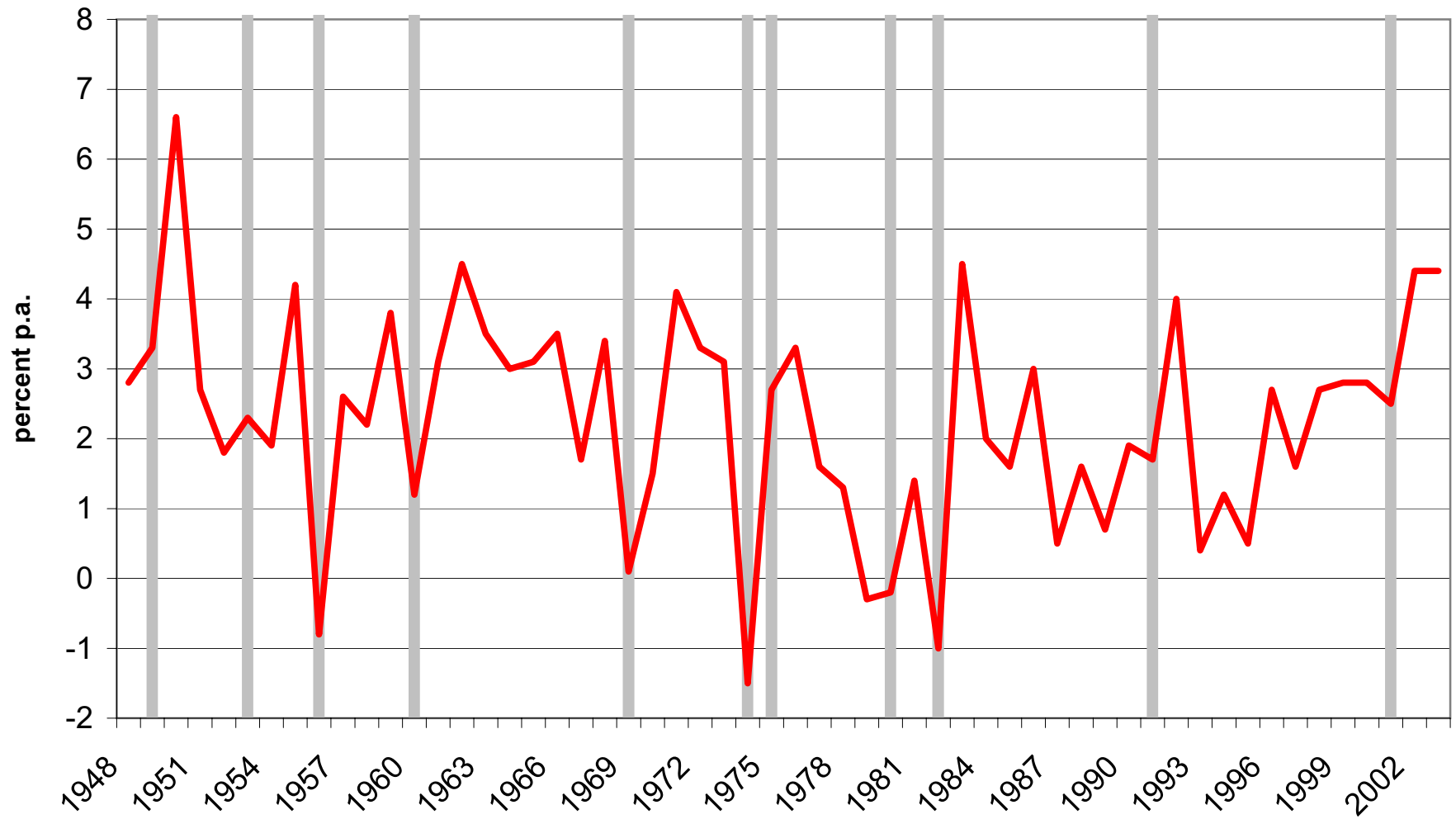
Source: Bureau of Labor Statistics /Haver Analytics



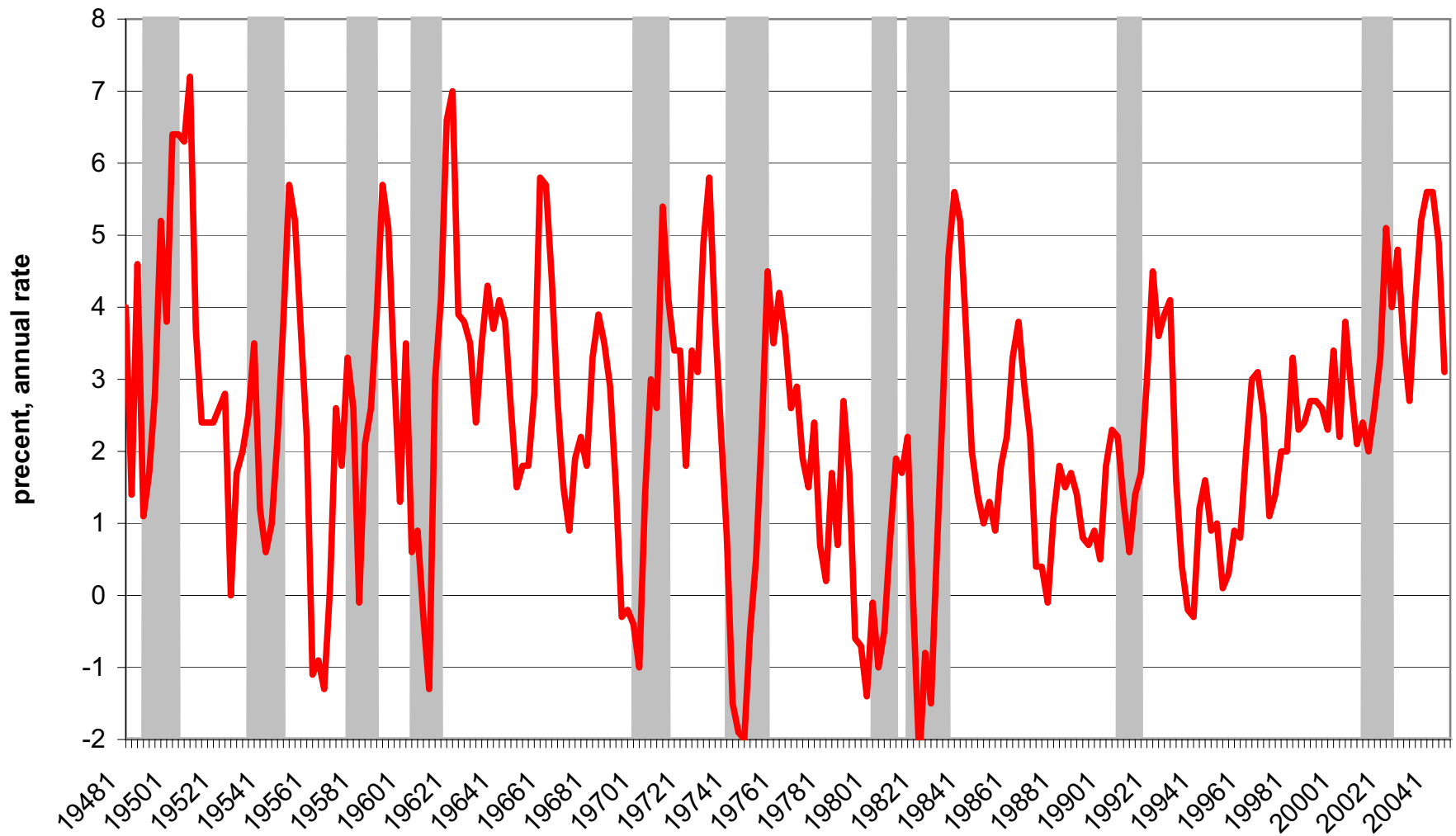
Labor Productivity Growth is Noisy

- Equals growth of output minus growth of labor input
- Empirically, quarterly real GDP growth is approximately a random walk
- Current, revised data show a clear break in trend circa 1995 – but earlier breaks aren't so obvious
- Year-Over-Year annual averages
- Quarterly, year-over-year

U.S. Productivity Growth (annual average, percent change)



U.S. Productivity Growth
(year over year, quarterly; percent annual rate)



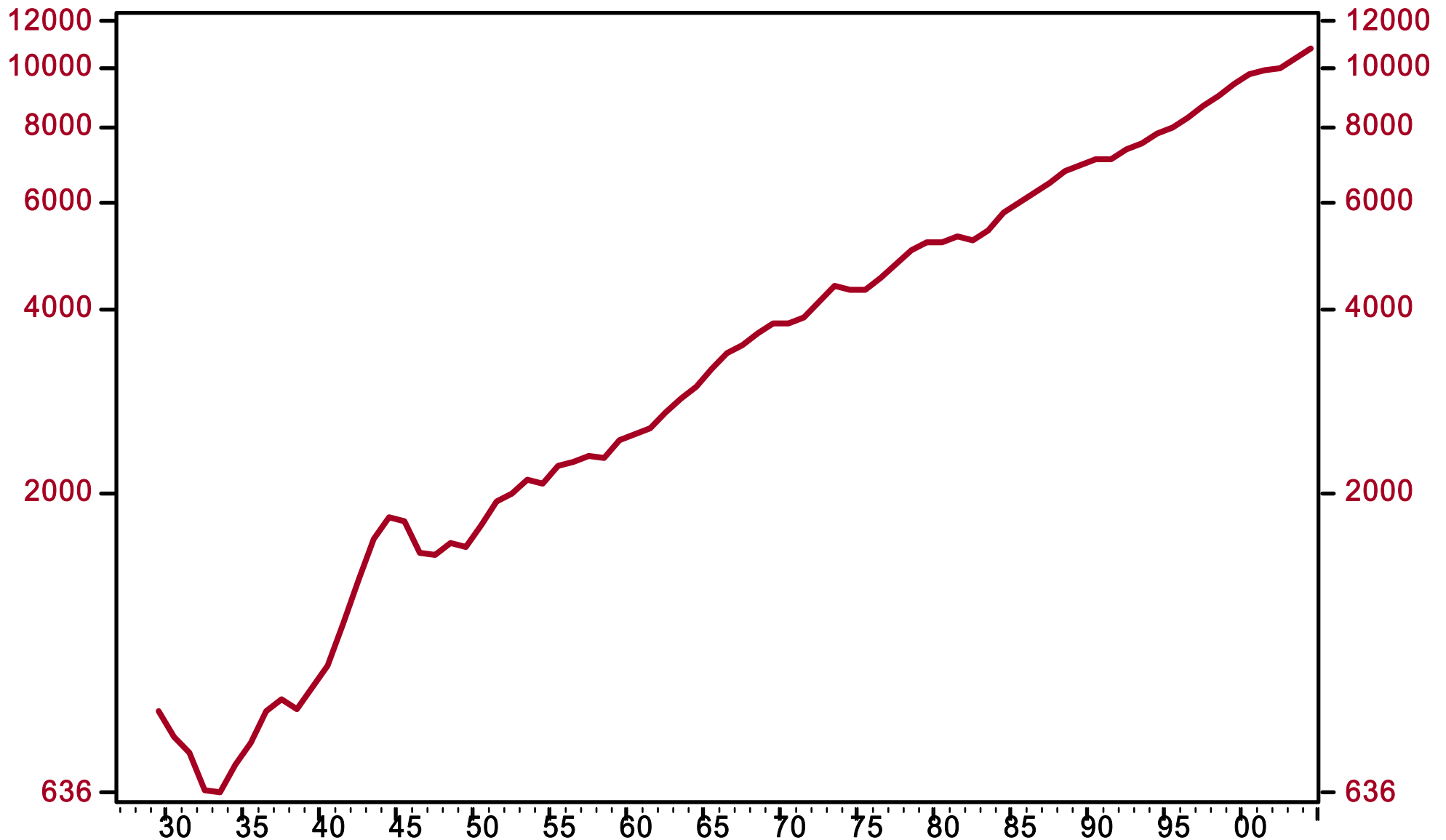


Has the Productivity Boom Made Us Better Off?

- Does it have to?
- Trend growth of real GDP, total and per capita
- Golden Rule of growth theory

Real Gross Domestic Product

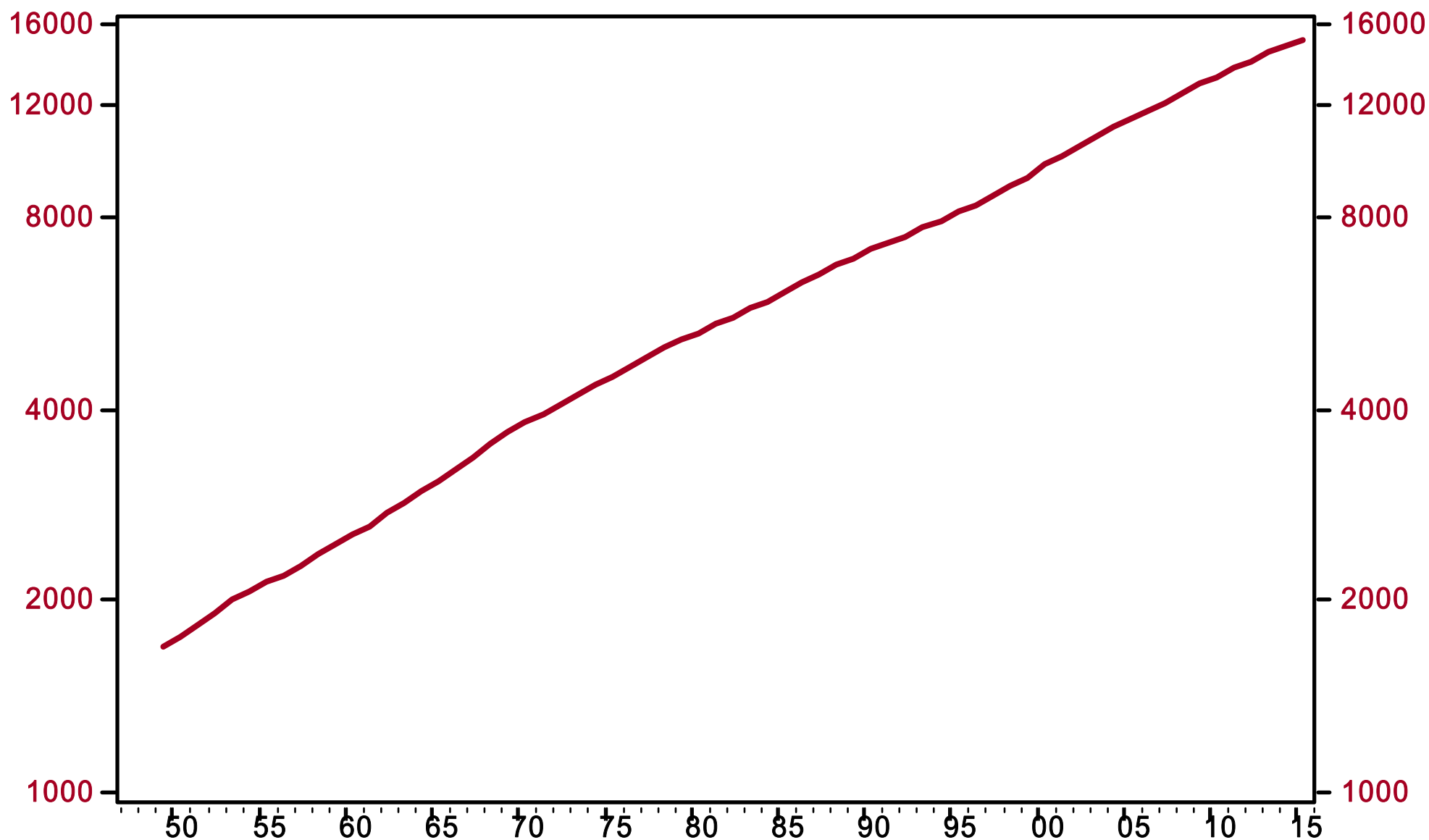
Bil.Chn.2000\$



Source: Bureau of Economic Analysis /Haver Analytics

Real Potential Gross Domestic Product {CBO}

Bil.Chn.2000\$



Changes in CBO Key Assumptions Underlying Long-Run Projections of Potential Output Growth, 2000 to 2005

	Projection Period					
	1999-2010	2001-2011	2002-2012	2003-2013	2004-2014	2005-2015
<i>Overall Economy</i>						
Potential Labor Force	1.1	1.0	1.1	0.9	0.8	0.8
Potential Labor Productivity	1.9	2.3	2.0	2.0	2.0	2.1
Potential Real Output	3.2	3.3	3.1	2.9	2.8	2.9
<i>Nonfarm Business Sector</i>						
Potential Hours Worked	1.2	1.1	1.2	1.1	0.9	0.9
Capital Input	4.4	5.2	4.2	4.2	4.0	4.2
Potential TFP	1.4	1.5	1.3	1.2	1.3	1.4
Potential Labor Productivity	2.3	2.7	2.2	2.2	2.2	2.4
Potential Real Output	3.5	3.8	3.4	3.3	3.1	3.3
Publication Date:	Jan. 2000	Jan. 2001	Jan. 2002	Jan. 2003	Jan. 2004	Jan. 2005

Source: Congressional Budget Office, The Budget and Economic Outlook, various issues.



Labor Productivity vs Total Factor Productivity

- Modest gains in TFP
 - Increased growth in Solow residual is a gain in knowledge
 - If TFP grows more rapidly, perhaps that growth is more persistent
- Major increases in Labor Productivity
 - If gains in labor productivity are due to capital deepening due to factor prices, then a slowdown in capital deepening might be the end of rapid productivity gains

TABLE 1

**Output, inputs, factor prices, and TFP—Nonfarm business sector
(average annual percent change)**

	TFP 1	Output 2	Labor input 3	Capital input 4	Average labor share 5	Real wage growth 6	Real rental growth 7
1948–2000	1.18	3.66	1.77	4.06	0.69	1.91	–0.45
1948–1973	1.90	4.10	1.45	3.91	0.69	2.79	–0.14
1973–1995	0.38	2.95	1.98	3.94	0.69	0.76	–0.50
1995–2000	1.13	4.54	2.46	5.37	0.67	2.55	–1.83

Note: Real labor compensation and rental rate of capital are deflated using the output deflator.

Source: Data obtained from the U.S. Department of Labor, Bureau of Labor Statistics website on *Multifactor Productivity*, at www.bls.gov/web/prod3.supp.toc.htm.

Source: Fernald and Ramnath, “The acceleration in U.S. total factor productivity after 1995: The role of information technology,” Federal Reserve Bank of Chicago *Economic Perspectives*, 2004 Q1

$$Y = A \cdot F(K, L).$$

*Table 1***U.S. Productivity Growth, 1873–2003***(average annual percent change, nonfarm business sector)*

<i>Period</i>	<i>Labor productivity</i>	<i>Multifactor productivity</i>	<i>Contribution of capital deepening and labor composition</i>
1873–2003	2.2	1.3	.9
<i>Episode I</i>			
1873–1890	2.6	1.5	1.1
1890–1917	1.5	.8	.7
<i>Episode II</i>			
1917–1927	3.8	2.8	1.0
1927–1948	1.8	1.7	.1
<i>Episode III</i>			
1948–1973	2.9	1.9	1.0
1973–1995	1.4	.4	1.0
<i>Episode IV</i>			
1995–2003	3.0	1.0	1.6

Source: Roger W. Ferguson Jr and William L Wascher, “Distinguished Lecture on Economics in Government: Lessons from Past Productivity Booms, *Journal of Economic Perspectives—Volume 18, Number 2—Spring 2004—Pages 3–28*



FOMC Policymaking During the 1990s

- FOMC transcripts show A.G. suspected productivity growth was increasing as early as 1993 (see also Bob Woodward's book)
- A.G. "intuition" from disaggregate data and personal contacts/examples/anecdotes, not GDP
- A.G. noted negative productivity growth in services since 1980-82... "implausible." Board study by Slifman and Corrado (1996) confirmed negative growth rates.
- Increases in visible, measured productivity growth seemed positively correlated with output measurement quality... real service output poorly measured

- A.G. preferred nonfinancial corporate sector as a measure of aggregate productivity growth
 - Private business sector
 - Nonfarm private business sector
 - Nonfinancial corporate business sector
- Discrepancies suggested problems with price deflators in service sectors and output measures
 - Service and distribution are the largest *users* of information technology but largely are intermediate, not final, output
 - Many published studies (e.g., Triplett and Bosworth; Andrew Sharpe; Sharon Kozicki)

- *Decreases* in the level of service-sector productivity since 1980?
- Discrepancies also reflect changing factor price ratio
 - As total capital cost fell, value added in IT-intensive service sectors collapsed toward wage bill
 - Use of GPO, rather than total output, may be misleading when input prices are changing rapidly
- As late as early 1997, Board staff were marking *down* predicted productivity growth
 - Followed published aggregate figures
 - Dismissed a major trend shift as unlikely

--- OLD PARADIGM ---

Growth needs to be moderate, or slowed, to avoid a pick up in inflation.

--- NEW PARADIGM ---

As a result of investment, productivity, competition, etc., growth can be strong, and even accelerate, without causing inflation to rise.

	<u>Pessimist</u>	<u>Optimist</u>	<u>Optimist</u>	<u>Pessimist</u>
Current view of economy:	INFLATION is about to break out! It's hiding in the lags.	Inflation is probably coming; but how soon is hard to tell.	It's a new era: productivity growth is taming inflation.	DEFLATION is here! There's no pricing power. Global capacity glut looms ahead.
View of Fed:	Behind the curve; providing too much liquidity.	Doing a good job; maybe they can pull this off for a few more quarters.	Doing a great job! Greenspan is a genius! Maybe they can pull this off forever.	Way too tight; only making the deflation worse.
Response to low inflation and strong activity: (e.g., 8/13 PPI and Retail Sales)	Sells stocks short; sells bonds short at low yields.	Buys stocks and bonds on dips; sells them on rallies.	Buys loads of stocks and some bonds whenever possible.	Sells stocks short; buys Treasuries.

“One would certainly assume that we would see this in the productivity data, but it is difficult to find it there. In my judgment there are several reasons, the most important of which is that the data are lousy.”

-- Alan Greenspan, FOMC transcript, 19 Dec 1995

“So, the productivity gains implicit in these data are larger than the ones we are getting in the official data. The one thing we know about the official data on productivity is that they are wrong.”

-- Alan Greenspan, FOMC transcript, 4 Feb 1997

“I have been in a rambling mode today because I think it is appropriate to the levels of confusion that I sense.”

-- Alan Greenspan, FOMC transcript, 2 July 1997

“I do not know what the actual productivity data will turn out to be. I don’t think the staff can predict this; I don’t think we can; I don’t think anybody on the outside can. But it is very important to recognize ... that a significant part of the pressures implicit in the price forecast, to which we are responding, rests on an evaluation of what that residual will be.”

-- Alan Greenspan, FOMC transcript, 12 Nov 1997

“Can we stipulate that measured productivity is distinct from true productivity?”

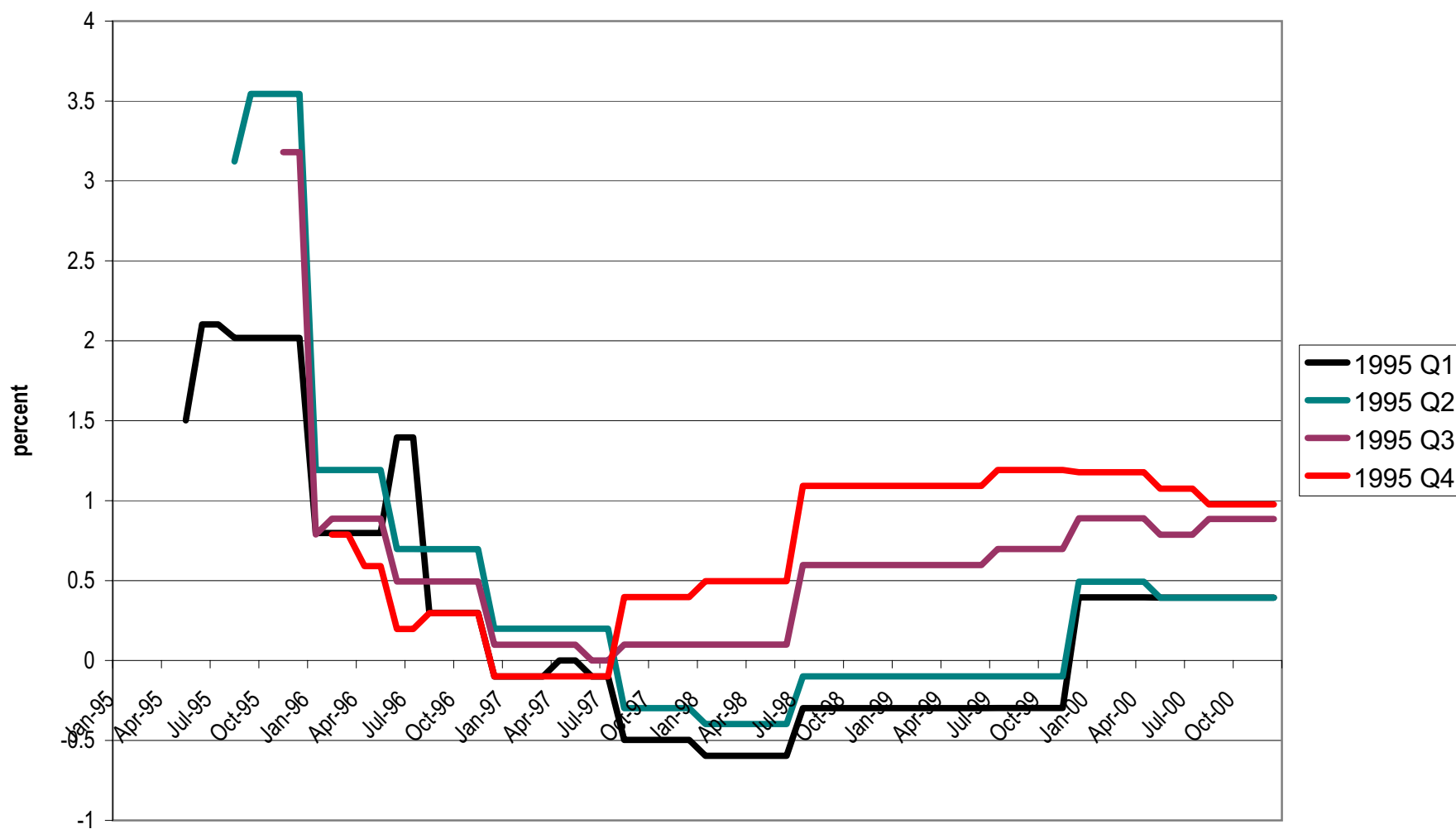
-- Alan Greenspan, FOMC transcript, 2/3 Feb 1998

“The productivity numbers are very rough estimates because we are measuring a whole set of product outputs from one set of data and a whole set of labor inputs from a different set. That they come out even remotely measuring actual labor productivity is open to question in my view.”

-- Alan Greenspan, FOMC transcript, 31 Mar 1998

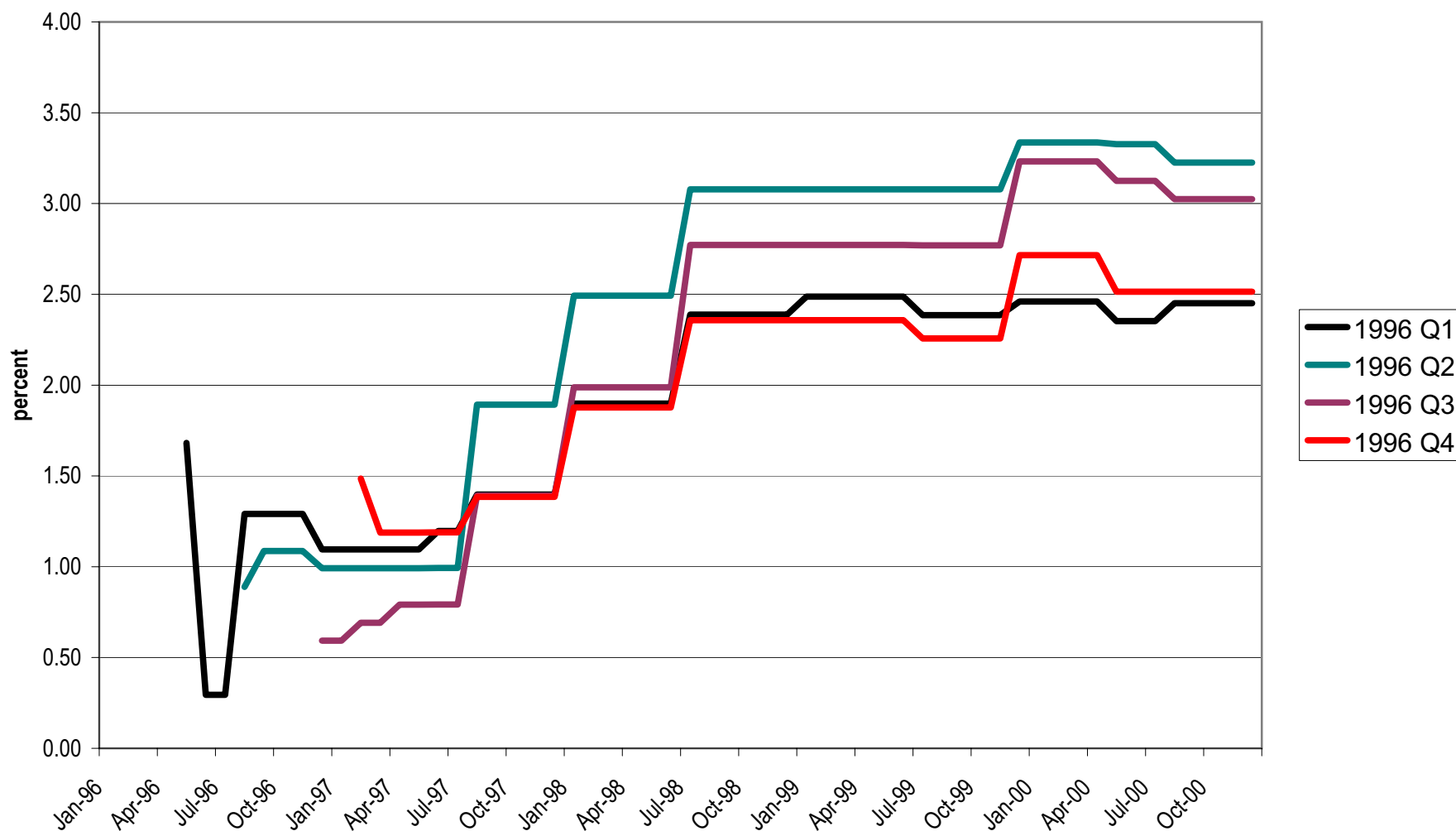
Labor Productivity Growth, 1995

(year over year percent change, quarterly; monthly figures, Jan 1995 - Dec 2000)



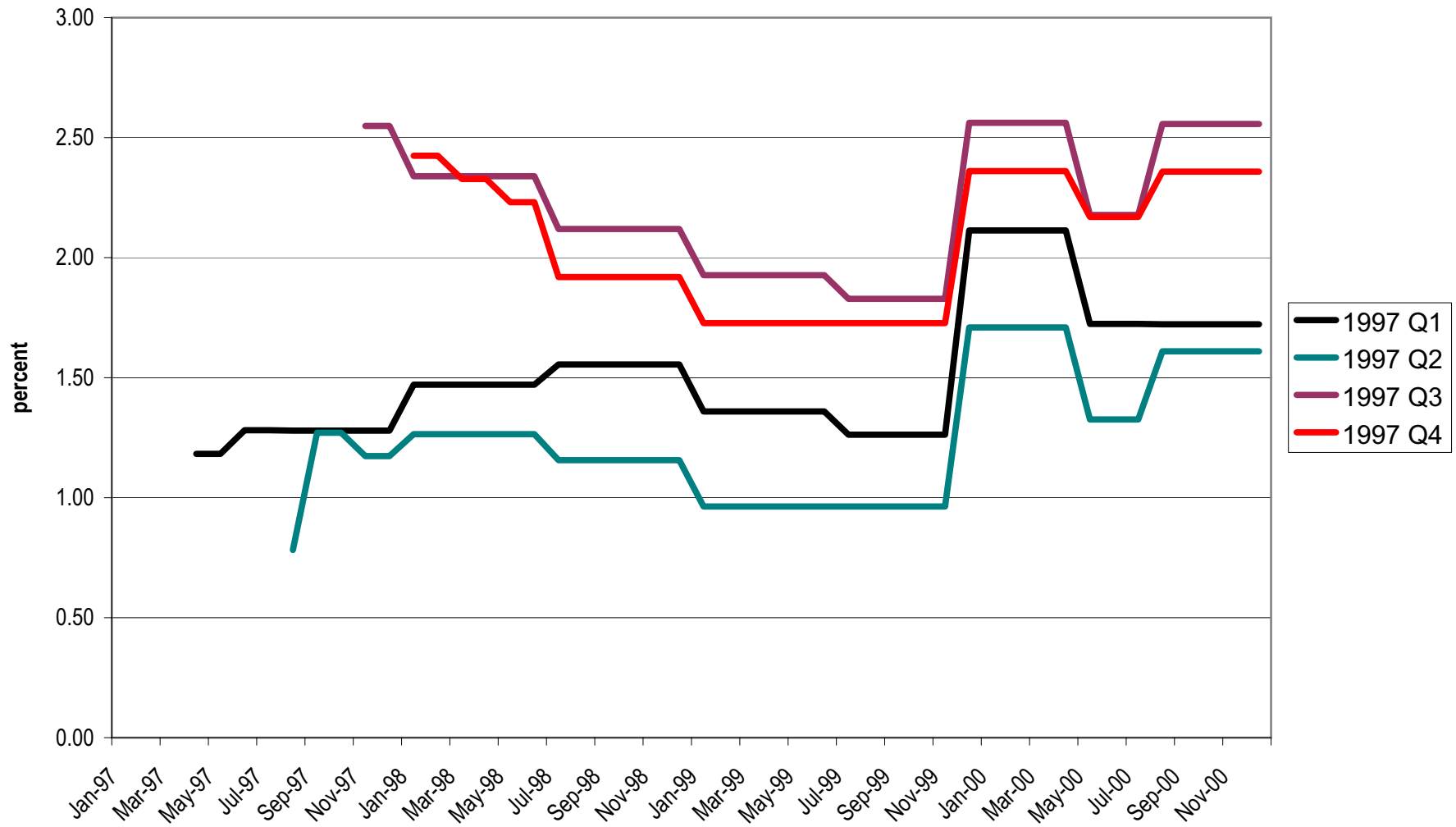
Labor Productivity Growth, 1996

(year over year percent change, quarterly; monthly figures, Jan 1996 - Dec 2000)



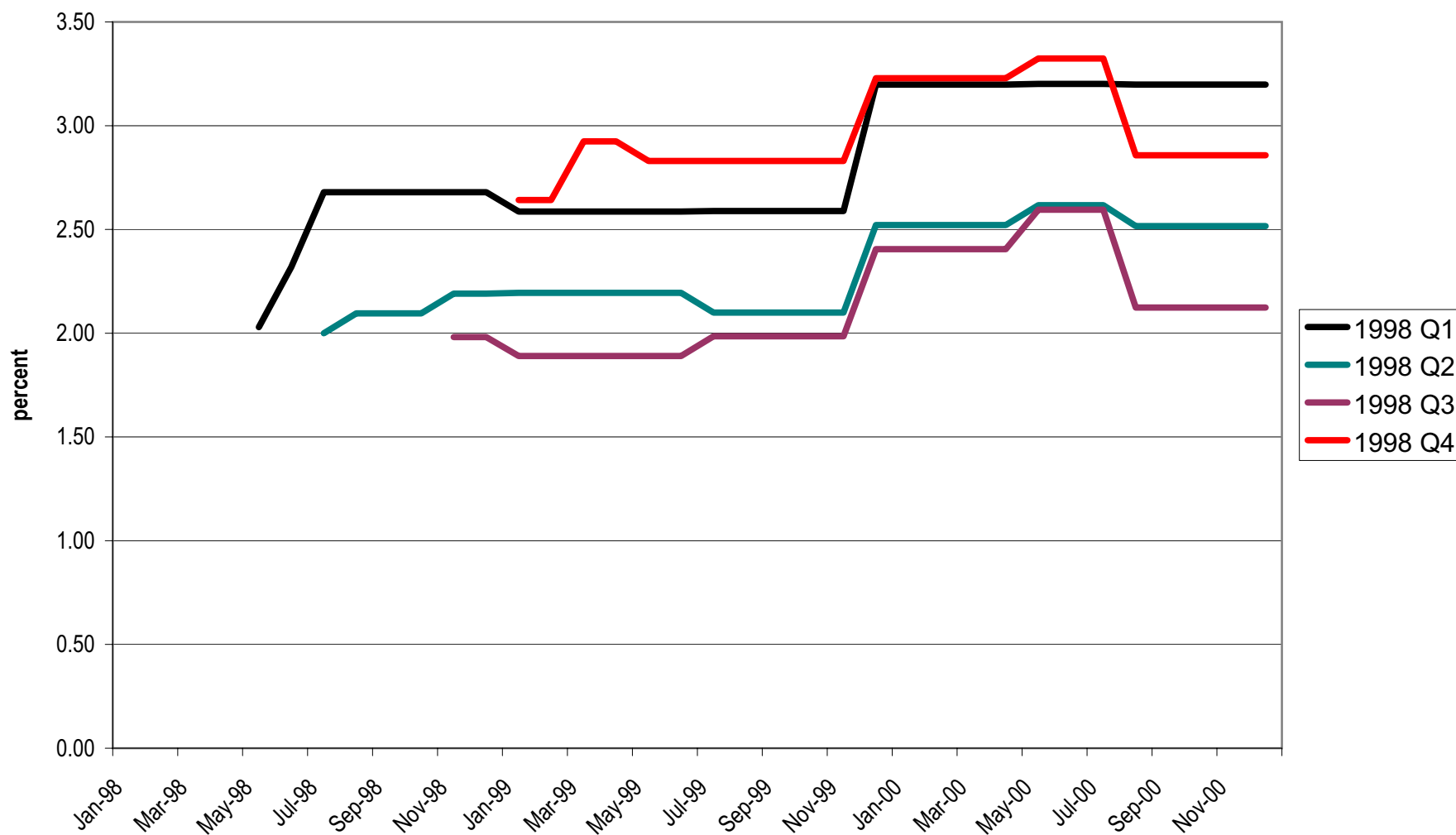
Labor Productivity Growth, 1997

(year over year percent change, quarterly; monthly figures, Jan 1997 - Dec 2000)

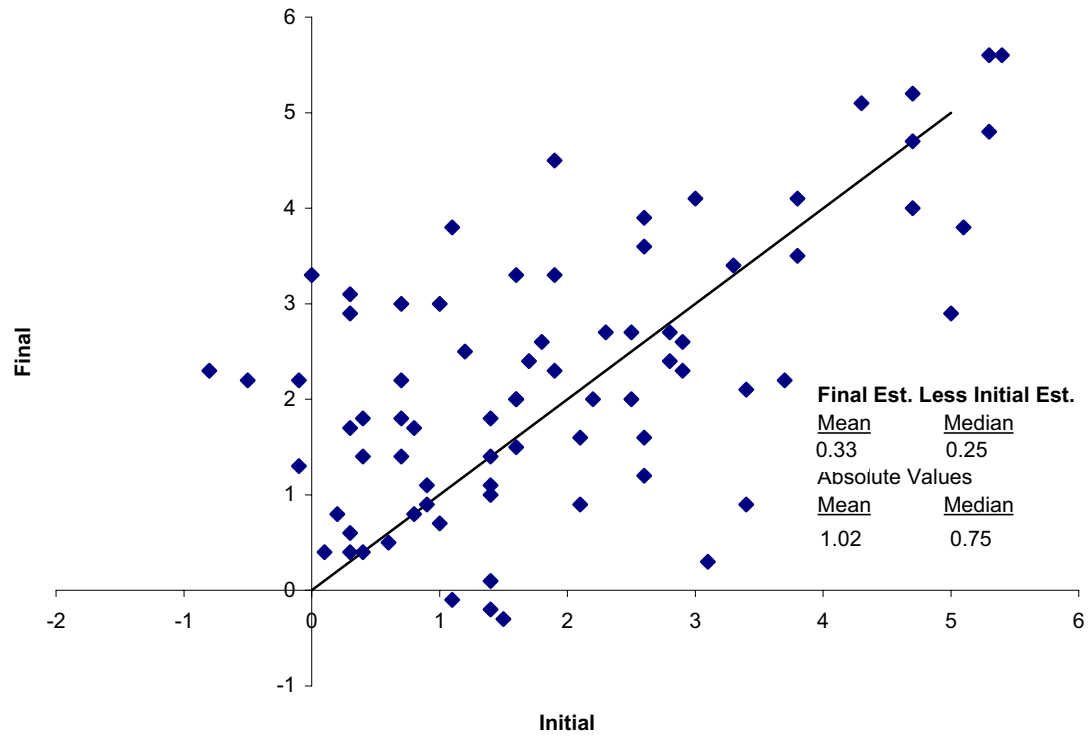


Labor Productivity Growth, 1998

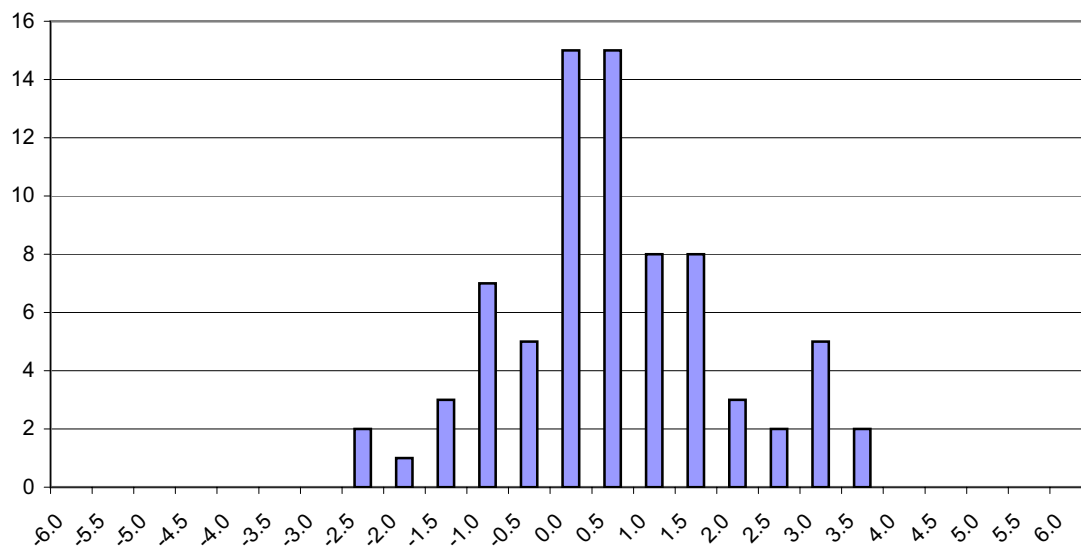
(year over year percent change, quarterly; monthly figures, Jan 1998 - Dec 2000)



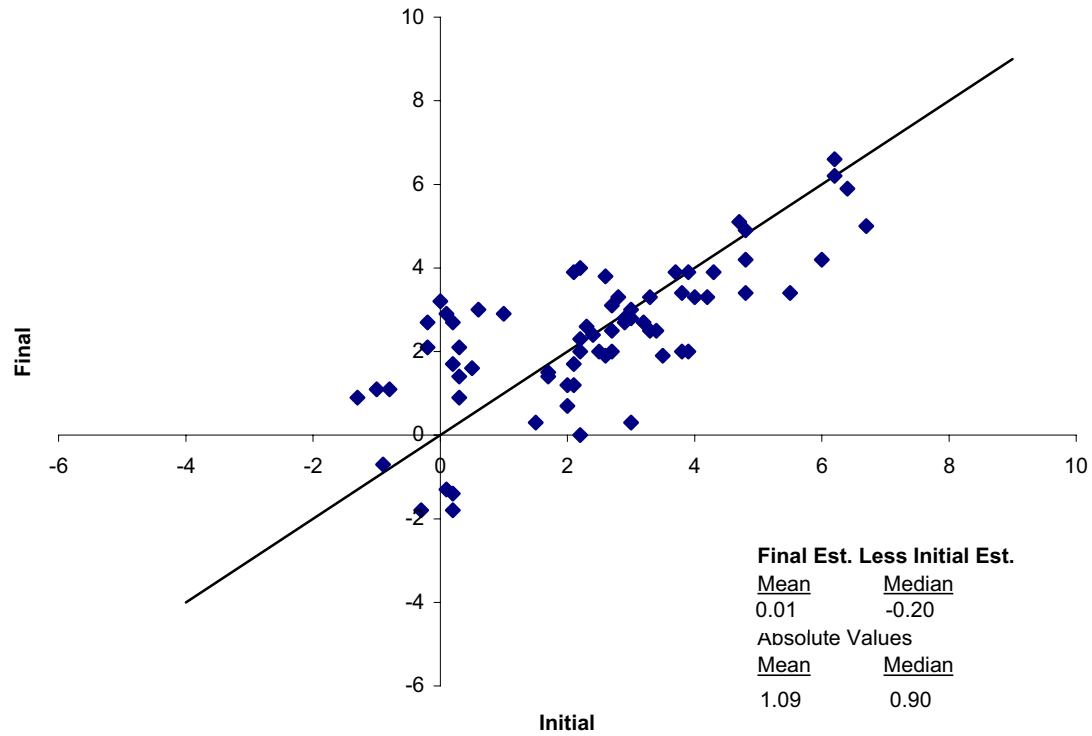
Nonfarm Business Sector **Labor Productivity** (Four-Quarter Growth Rate)



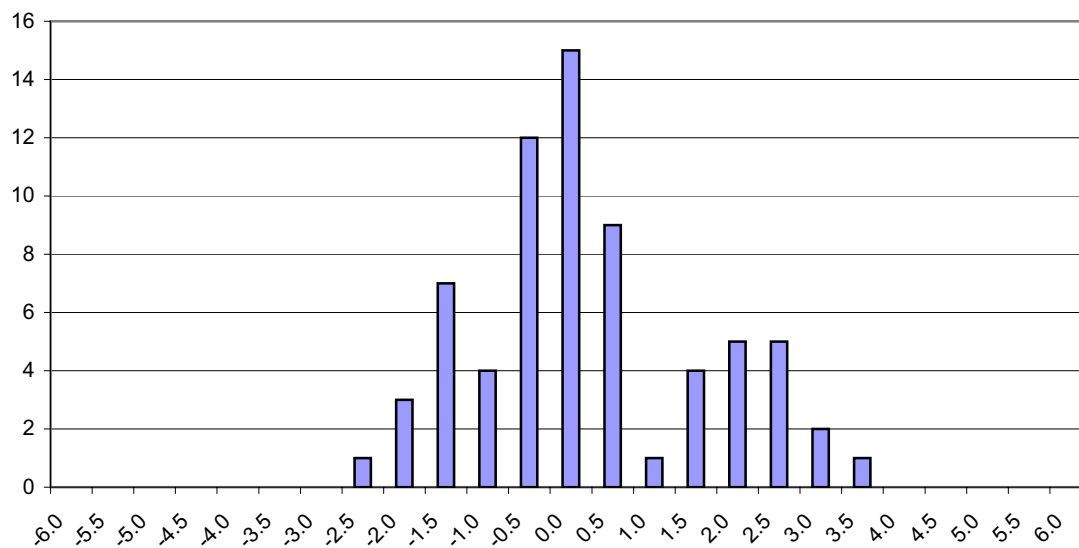
Nonfarm Business Sector **Productivity (Final-Initial)**



Nonfinancial Corps
Labor Productivity
 (Four-Quarter Growth Rate)



Nonfinancial Corps
Productivity (Final-Initial)





Industry-Level Data

- Studies published as late as 2000 found little or no productivity acceleration increase in services
- Studies published in 2002 found significant service industry increases during the latter 1990s

TABLE 2

Total factor productivity growth by industry in private non-farm business, 1990–2000
(percent change, annual rate)

	Productivity (value-added terms)^b		Share of nominal value added	
	pre-1995	post-1995	Acceleration	2000
Private non-farm economy (adjusted for labor quality) ^a	0.59	1.92	1.32	100.0
Contribution of labor quality	0.32	0.16		
Private non-farm economy (not adjusted for labor quality)	0.91	2.08	1.17	
Mining	3.08	-2.15	-5.23	1.6
Manufacturing	2.40	2.76	0.36	20.6
Nondurables	1.02	-1.20	-2.22	8.7
Durables	3.47	5.61	2.14	12.0
Construction	0.39	-0.98	-1.38	6.1
Transportation	1.69	1.53	-0.16	4.2
Communication	2.31	0.15	-2.16	3.7
Electric/gas/sanitary	0.42	0.17	-0.25	2.9
Wholesale trade	1.66	5.37	3.71	9.2
Retail trade	0.83	5.33	4.50	11.8
Finance & insurance	0.44	3.39	2.96	10.7
Finance	1.31	4.90	3.59	7.5
Insurance	-1.49	-0.06	1.44	3.2
Business services & real estate	1.12	0.40	-0.72	13.9
Business services	0.60	-1.40	-2.00	7.1
Real estate	1.55	2.34	0.79	6.8
Other services	-1.89	0.08	1.97	15.2
ICT producing ^c	5.52	11.02	5.50	5.3
Non ICT producing	0.61	1.54	0.93	94.7
Well-measured industries ^d	1.80	3.17	1.37	54.2
Well-measured (excluding ICT producing)	1.35	2.24	0.88	48.9

TABLE 1—AVERAGE LABOR PRODUCTIVITY GROWTH RATES, 1977–2000

	Annual growth rate (percent)			Acceleration	
	1977–1995	1987–1995	1995–2000	1995–2000 less	1995–2000 less
				1977–1995	1987–1995
Value-Added—Aggregate Measures					
Private industries (BEA)	0.92	1.03	1.92	1.00	0.89
Private industries (sector aggregate)	0.97	0.98	2.29	1.32	1.31
Gross Output—Aggregate Measures					
Private industries	NA	1.24	2.23	NA	0.99
Gross Output—Broad Sectors					
Agriculture, forestry, and fishing	1.38	0.58	−0.28	−1.66	−0.86
Mining	2.28	3.14	2.16	−0.12	−0.98
Construction	−1.23	−0.87	−1.65	−0.42	−0.78
Durable goods manufacturing	3.14	3.97	6.20	3.07	2.24
Nondurable goods manufacturing	1.64	1.48	2.72	1.07	1.24
Transportation and public utilities	NA	2.27	2.23	NA	−0.05
Wholesale trade	2.14	3.23	3.99	1.85	0.75
Retail trade	0.42	0.97	3.14	2.71	2.17
Finance, insurance, and real estate	NA	2.33	3.40	NA	1.07
Services	NA	0.40	1.05	NA	0.66
Gross Output—Industry Averages					
Mean—61 Industries	NA	1.68	2.55	NA	0.87
Median—61 Industries	NA	1.50	1.97	NA	0.32
Mean—49 Industries	1.61	1.80	2.69	1.08	0.89
Median—49 Industries	1.45	1.48	1.83	0.58	0.53

Source: Kevin Stiroh, “Information Technology and the U.S. Productivity Revival: What Do the Industry Data Say?”, *American Economic Review*, December 2002.

TABLE 2—DUMMY VARIABLES TESTS OF POST-1995 ACCELERATION OF INDUSTRY LABOR PRODUCTIVITY

1987–1995 vs. 1995–2000					
Constant	1.678*** (0.394)	1.365** (0.497)	— —	— —	— —
Post-1995 dummy	0.870 (0.529)	0.881** (0.389)	0.964** (0.410)	0.727* (0.391)	0.710* (0.426)
Weights		yes	yes	yes	yes
Industry fixed effects			yes	yes	yes
Drop IT-producing industries				yes	yes
Drop FIRE outliers				yes	yes
Drop durable goods manufacturing					yes
Number of observations	793	793	793	741	624
Number of industries	61	61	61	57	48
1977–1995 vs. 1995–2000					
Constant	1.605*** (0.414)	1.139* (0.557)	— —	— —	— —
Post-1995 dummy	1.084** (0.453)	1.259** (0.511)	1.482*** (0.496)	1.132** (0.492)	1.143** (0.542)
Weights		yes	yes	yes	yes
Industry fixed effects			yes	yes	yes
Drop IT-producing industries				yes	yes
Drop FIRE outliers				yes	yes
Drop durable goods manufacturing					yes
Number of observations	1,127	1,127	1,127	1,058	874
Number of industries	49	49	49	46	38

TABLE 3—DUMMY VARIABLE TESTS OF RELATIVE POST-1995 LABOR PRODUCTIVITY ACCELERATION
FOR IT-INTENSIVE INDUSTRIES

	Primary indicator of IT intensity				Alternative indicators of IT intensity		
					IT share	IT capital	Composite
					of output	per FTE	
1987–1995 vs. 1995–2000							
Constant	1.912*** (0.367)	1.177* (0.564)	—	—	—	—	—
IT-intensive dummy	−0.252 (0.847)	0.433 (0.861)	—	—	—	—	—
Post-1995 dummy	−0.006 (0.448)	−0.604 (0.400)	−0.456 (0.407)	−0.456 (0.407)	0.243 (0.376)	0.873 (0.607)	0.259 (0.367)
Post-1995 dummy × IT-intensive dummy	1.942** (0.844)	2.192*** (0.457)	2.109*** (0.446)	1.786*** (0.512)	1.320** (0.517)	0.403 (0.716)	1.302** (0.515)
Weights		yes	yes	yes	yes	yes	yes
Industry fixed effects			yes	yes	yes	yes	yes
Drop IT-producing industries				yes			
Drop FIRE outliers				yes			
Number of observations	741	741	741	689	741	741	741
Number of industries	57	57	57	53	57	57	57
1977–1995 vs. 1995–2000							
Constant	1.635*** (0.423)	0.799 (0.643)	—	—	—	—	—
IT-intensive dummy	−0.061 (0.562)	0.486 (0.817)	—	—	—	—	—
Post-1995 dummy	0.291 (0.309)	−0.413 (0.225)	−0.118 (0.201)	−0.118 (0.201)	0.471 (0.261)	1.160 (0.658)	0.352 (0.263)
Post-1995 dummy × IT-intensive dummy	1.620* (0.812)	2.355*** (0.508)	2.262*** (0.465)	1.824*** (0.518)	1.739** (0.597)	1.018 (1.042)	2.085*** (0.507)
Weights		yes	yes	yes	yes	yes	yes
Industry fixed effects			yes	yes	yes	yes	yes
Drop IT-producing industries				yes			
Drop FIRE outliers				yes			
Number of observations	1,127	1,127	1,127	1,058	1,127	1,127	1,127
Number of industries	49	49	49	46	49	49	49



Productivity Puzzles: How Little We Know!

1. Sources of the 1973 Productivity Slowdown

- Pervasive across countries (all OECD countries except Ireland)
- Output/hr 1950-73 grew 4.64% p.a.; 1973-2003, 2.15% p.a.
- Causes?
 - Energy price shocks
 - Slower demand growth
 - Measurement problems
 - Slower capital intensity growth
 - Welfare state
 - Changing demographics
 - A Golden Age, followed by Return to Normalcy
 - Is 1-1/2 to 2% p.a. the norm?



2. Explanations for the Post-2000 U.S. Productivity Growth Acceleration

- Two productivity growth increases
 - post-1995
 - increased investment in ICT (information and communication technology)
 - post-2000
 - not ICT based; ICT investment flagged (recession)
 - 2000-2003, business output per hour 3.8% p.a.
 - 2002: 4.3%, 2003: 4.5%
 - business sector real output grew at 2% pace
 - Implies U.S. divergence from OECD trend



Sector Shares

- 1998-2000: manufacturing accounted for 47% of total economy labor productivity growth, but was only 14% of total output; services accounted for 56%.
- 2000-2003: manufacturing contribution dropped to 31% while services increased to 71%.
- Manuf: 1998-2003, output per hour +6.6% p.a.
- Services: 1998-2000: +1.7% p.a., 2000-2003: 3.3% p.a.
- Services accounted for all the post-2000 productivity growth acceleration
 - Professional and business services .48 share
 - Information services .37 share
 - Wholesale trade .34 share
 - Retail trade .30 share



- Capital deepening: growth of capital-labor ratio 1.2% pa 1995-2000; 3.0%pa 2000-2003.
 - Reflects lower rate of labor input growth:
+2.0% 1995-2000, -1.0% 2000-2003.
- Reflects lower capital investment growth:
1995-2000, 3.1%pa, 2000-2003, 2.0%pa
- Causes:
 - Outsourcing of low productivity work to low-wage countries
 - Increased international competitive pressures to cut costs
 - Business re-organization, more effective use of ICT investments (esp in ICT-using sectors)



3. Higher European Labor Productivity Levels

- 2003 data: 8 EU countries with average productivity > US
- Output per hour
- Luxembourg (1.225), Norway (1.1197), Belgium (1.090), Ireland (1.076), Netherlands (1.052), France (1.049), Germany (1.039), and Denmark (1.002).
- EU incomes lower: lower employment ratio and fewer annual hours
- Low productivity workers more likely to be unemployed
- Similar amount of work in fewer hours?



4. Absence of Post-1995 Productivity Acceleration in Europe

- U.S., Canada and Australia had product acceleration
- Europe: 1995-2003, 1.77% pa; 1973-95, 2.39% pa
- 11 of 16 countries had slower product growth in second period
- U.S.: 1.87 from 1.12 % pa
- Flexible labor markets?
- Not as much investment in ICT as US

5. Productivity Effects of the Internet

- Reduced cost of sharing, finding, sending information
- Knowledge at low cost
- Steam engine?
- Electric dynamo?



6. Productivity Growth in the Government/Non-market Sector

- Measure non-market sector of economy
- Education, government
- Degrees granted; research published

7. Negative Productivity Growth in the Construction Sector

- Estimates based on existing data are unreliable
- 1977: 120.4; 2003, 94.2
- Lack of technical progress?
- Work/safety rules?



Exploring Productivity Questions?