Explaining a Productive Decade: An Update*

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Questions Explored in the Paper

- Do we still think that IT was a key driver of the pickup in labor productivity growth over 1995-2000?
- What do the latest data say about productivity developments since 2000?
- How have intangibles influenced productivity growth?
- What is the outlook for labor productivity growth?

Growth in Labor Productivity in Nonfarm Business: What Do the Recent Data Say?

(Average log difference, based on annual average data through 2007 and average of data for 2008:Q1-Q3)

	Percent Change over Period Shown					
Vintage of Data	1995-2000	2000-04	2000-05	2000-06	2000-07	2000-08
Mar. 2005	**2.5**	**3.7**				
Mar. 2007	**2.5**	**3.3**	**3.0**	**2.8**		
Nov. 2008	**2.5**	**3.2**	**2.9**	**2.6**	**2.4**	**2.5**

	Percent Change from Previous Year				
Vintage of Data	2004	2005	2006	2007	2008
Mar. 2007	**2.9**	**2.1**	**1.5**		
Nov. 2008	**2.7**	**1.7**	**1.0**	**1.4**	**2.8**

Growth Accounting Framework

- Start with the Oliner-Sichel (2000, 2002) framework that was designed to focus on IT contribution to growth.
  - Includes three types of IT capital (computer hardware, software, and communications equipment) plus the semiconductor sector.
  - Measures capital deepening contribution from use of IT capital.
  - Measures MFP contribution from production of IT capital and embedded semiconductors.
- Extend this framework to include
  - adjustment costs and variable factor utilization (BFS, 2001)
  - intangible capital (BFOS, 2004).

Growth Accounting Framework (cont.)

- Step 1: Decompose growth in output per hour into contributions from capital deepening, labor quality, and aggregate MFP growth:

$$\dot{Y} - \dot{H} = \sum_j \alpha_j^{IT} \left(\dot{K}_j^{IT} - \dot{H} \right) + \sum_j \alpha_j^{O} \left(\dot{K}_j^{O} - \dot{H} \right) + \alpha^{L} \dot{q} + M\dot{F}P$$

- Step 2: Decompose aggregate MFP growth into sectoral contributions and account for effects of adjustment costs and factor utilization.

$$M\dot{F}P = \sum_i \mu_i M\dot{F}P_i + \mu_S M\dot{F}P_S$$

$$= \xi \dot{W} + \phi(\dot{I} - \dot{K}) + \sum_i \mu_i M\dot{F}P_i^{*} + \mu_S M\dot{F}P_S^{*}$$

Data

- Dataset covers the period from 1973 to the present for nonfarm business in the United States.

- Primary data source is BLS' multifactor productivity database. Supplement this with data from BEA and other sources.

- Dataset is fully up-to-date. Incorporates NIPA data through 2008:Q3. For 2008:Q4, we assume each series grows at its 2008:Q3 rate.

- Results to be presented first are based on published data.

Contributions to Growth in Labor Productivity Based on Published Data: 1973-2008

	1973-1995	1995-2000	2000-2008
1. Growth of labor productivity	1.47	2.51	2.50
Contributions from:			
2. IT capital deepening	**.46**	**1.09**	**.60**
3. Other capital, labor quality, and adjustments to MFP	.59	.30	.60
4. MFP after adjustments	.42	1.12	1.29
5. IT sectors	**.28**	**.75**	**.45**
6. Other nonfarm business	**.14**	**.37**	**.84**

Contributions to Growth in Labor Productivity Based on Published Data: 2000-2008

	2000-2008	2000-2004	2004-2008
1. Growth of labor productivity	2.50	3.31	1.68
Contributions from:			
2. IT capital deepening	**.60**	**.74**	**.47**
3. Other capital, labor quality, and adjustments to MFP	.60	.80	.42
4. MFP after adjustments	1.29	1.78	.79
5. IT sectors	**.45**	**.56**	**.35**
6. Other nonfarm business	**.84**	**1.24**	**.44**

- Industry-level data suggest that rapid 2000-04 productivity gains driven partly by pressure to cut costs and restore profit margins.

Intangible Capital and Investment

- Any intangible asset that generates services beyond the current period should be included in capital stock and output.
- But hard to measure – NIPAs exclude virtually all intangibles except software.
- Roughly $1 trillion of intangible investment excluded from NIPAs annually over 2000-03 (Corrado, Hulten, and Sichel, 2006).
- Types of excluded intangible assets:
  - Knowledge created by R&D
  - Brand equity
  - Firm-specific organizational capital

Measuring Intangible Capital and Investment

- We adopt BFOS framework in which firms use intangible capital as a complement to IT capital in CES production function.
  - Key benefit: Requires no direct data on intangible capital and estimates are completely up-to-date.
  - But not as comprehensive as CHS series. Generates estimates of IT-related intangible assets, not all intangibles.
  - Accordingly, we focus on intangibles that are central to assessing broad contribution of IT to economic growth.
- As a robustness check, compare the estimates of intangibles to those in an update of CHS. Comparison runs through 2007.

Measuring Intangible Capital and Investment (cont.)

- Step 1: Estimate growth of real intangible capital: $\dot{R}_t = \dot{K}_t^{IT} + \sigma\left(\dot{r}_t^{IT} - \dot{r}_t^{R}\right)$

- Step 2: Use data in CHS to estimate series for $\dot{r}_t^{R}$ and calibrate σ.

- Step 3: Chain together annual series for $\dot{R}_t$ and scale resulting levels. Scaling factor chosen to be consistent with income shares for intangibles in CHS.

- Step 4: Estimate real intangible investment: $N_t = R_t - \left(1-\delta^{R}\right)R_{t-1}$

- Step 5: Incorporate series for intangible capital and investment into growth accounting framework.

Estimated Growth of Real Intangible and IT Capital

(Average annual rate over period shown, in percent)

	1973-1995	1995-2000	2000-2008
1. Real intangible capital	6.8	7.7	-1.8
2. Real IT capital	15.6	20.4	8.6
3. IT minus intangible	***8.8***	***12.7***	***10.4***
Memo:			
4. Real intangible investment	5.7	12.0	-7.0

- Intangible capital has grown more slowly than IT capital because relative user cost of IT capital has declined. Gap was widest during 1995-2000.
- Growth of both IT and intangible capital has been weak since 2000.

Growth of Real Intangible Capital and Investment: Comparison to CHS

(Average annual rate over period shown, in percent)

	1973-1995	1995-2000	2000-2007
Intangible capital			
1. Our estimate	6.8	7.7	-1.3
2. CHS*	5.2	7.4	2.9
Intangible investment			
3. Our estimate	5.7	12.0	-7.3
4. CHS*	5.2	8.4	1.8

*CHS (2006) extended to 2007.

- Our estimates of growth vary more than CHS's across periods.
- But both show the same broad pattern – strong growth during 1995-2000 followed by weakness after 2000.

Contributions to Growth in Labor Productivity with Added Intangibles: 1973-2008

	1973-1995	1995-2000	2000-2008
1. Growth of labor productivity	1.58	2.97	2.00
1a. Based on published data	***1.47***	***2.51***	***2.50***
Selected contributions:			
2. IT capital deepening	.44	1.02	.56
3. New intangible capital deepening	.22	.37	-.10
4. MFP after adjustments	.35	1.31	.94
4a. Based on published data	***.42***	***1.12***	***1.29***

- Adding intangibles boosts productivity growth over 1995-2000 and makes post-2000 performance less impressive.
- Robustness check: Same qualitative story if we use CHS intangibles, though post-2000 slowdown in productivity growth not as large.

Contributions to Growth in Labor Productivity with Added Intangibles: 2000-2008

	2000-2008	2000-2004	2004-2008
1. Growth of labor productivity	2.00	2.66	1.34
1a. Based on published data	***2.50***	***3.31***	***1.68***
Selected contributions:			
2. IT capital deepening	.56	.69	.44
3. New intangible capital deepening	-.10	.02	-.23
4. MFP after adjustments	.94	1.19	.69
4a. Based on published data	***1.29***	***1.78***	***.79***

- Adding intangibles doesn't change basic story since 2000 – strong productivity growth through 2004 with a slowdown thereafter.

Steady-State Framework

- Use steady-state machinery from Oliner-Sichel (2002). Five-sector model (four IT sectors and rest of nonfarm business.)
- Exclude intangibles beyond those in NIPAs.
- Impose steady-state conditions (e.g., investment and capital stock grow at the same rate for each type of capital).
- Steady-state growth of Y/H equals growth in MFP and labor quality plus capital deepening induced by MFP.
- Specify range of values for the roughly 30 parameters in the model.

Steady-State Results

- Model and chosen parameter values imply range for steady-state growth in labor productivity of 1.4 percent to 2.8 percent.

- Midpoint of range is 2.1 percent, down from 2.3 percent as of early 2007.

- Sources of downward revision:
  - Slightly slower MFP growth in non-IT sectors.
  - Smaller output share for the semiconductor sector.

Alternative Estimates of Future Growth in Labor Productivity

(Percent per year)

Source	Early 2007	Most Recent
Oliner/Sichel steady-state	**2.3**	**2.1**
Gordon	**2.0**	**2.0**
Global Insight	**2.2**	**1.9**
Macro Advisers	**2.2**	**2.1**
CBO	**2.3**	**2.2**
Kahn and Rich	**2.5**	**1.9**
Mean estimate	**2.2**	**2.0**

Conclusions

- Do we still think that IT was a key driver of the pickup in labor productivity growth over 1995-2000? Yes.
- What do the latest data say about productivity developments since 2000?
  - Rapid growth concentrated during 2000-04, driven in part by intense pressure to cut costs.
  - Since 2004, labor productivity growth has averaged less than 1¾ percent, only about half the pace over 2000-04.
  - Contribution from use of IT capital has moved down since 1995-2000.
  - MFP growth jumped during 2000-04, but has dropped back since then for both IT-producing sector and other nonfarm business.

Conclusions

- How have intangibles influenced productivity growth?
  - Accounting for intangibles makes the gains over 1995-2000 larger and takes some of the luster off the performance since 2000.
  - This conclusion is unchanged from our Brookings paper.
- What is the outlook for trend growth in labor productivity?
  - Midpoint of range from steady-state analysis is 2.1 percent, down from 2.3 percent as of early 2007.
  - Most other analysts have also revised down their estimates. Average of these estimates is about 2 percent.
  - Wide confidence band around all of these estimates.