

**15.575: IT and Productivity**

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## Agenda

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1. Big Picture
2. Assignments
3. Stiroh
4. Break
5. Yang
6. Gordon
7. Arguments and Conclusions
8. Research Strategy for Papers

## Overall Issues and Questions

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How does IT matter?

How “much” does IT matter?

IT Productivity ≠ Impact of IT

- What do we mean by “*productivity*”? or value creation?
- How to measure it?

## Big Picture: Questions on the effect of IT in productivity

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The aggregated effect is positive...

- but what about its magnitude?

It does vary across sectors:

- Manufacturing of durable goods and IT industry (e.g. software)
- IT-Intensive sectors (finance, health care, etc.)
- “The Rest” (agriculture, SMEs in non-technology areas, etc.)

IT and the workplace: “skill-biased technical change”

- Substituting versus complementing labor
- Affecting labor at all?

Some issues:

- Impact of IT depends of the context
- How to measure the effect of IT on productivity?
  - Endogeneity
  - Lack of information
  - Correlation between shocks, inputs and outputs
- Evidence and scholarly work: bias towards results with the “right” sign and magnitude

## Assignments

| Application               | Impact   | Input Vars.   | Output Var.                       | Issues/problems  |
|---------------------------|----------|---|-----------------------------------|--|
| physicians patients Email | Positive | Physicians treating patients over email,<br>Control group: non-email interaction  | No. patients seen                 |  |
| IT in auto industry       | Positive | HW, HW,<br>IT-based inputs,<br>Non-IT capital (PP&E),<br>Labor, Materials,<br>Process changes   | Gross sales                       | Cross-section analysis (within and across)<br>Simultaneity bias (year dummies)   |
| Internet Banking          | Positive | Transactions completed w/o banking people,<br>Employees working with costumers,<br>System investment costs,<br>IT maintenance                       | Transactions per employee         | Solutions developed in-house, constant quality index?<br>Effect on surplus instead of productivity: How to capture this? |
| Supply Chain Mgmt. (SCM)  | Positive | IT Capital: HW, SCM SW, other SW.<br>Non-IT Capital: Equip., inventory, working K,<br>Firm heterogeneity: experience of workforce and fixed effects | Uptime of production line (hours) | Specific production within one industry<br>Differentiate effect of SCM and other software                                |

## Assignments

| Application                       | Effect                | Input Vars.   | Output Var.  | Issues/problems   |
|-----------------------------------|-----------------------|---|--|---|
| IT in non-tech SMEs in LDC        | Non-positive (so far) | IT capital (hard/software), time?<br>Non-IT Capital<br>Workforce education, age<br>IT-subsidy and access to credits | Sales/revenue                                      | Sample: SMEs with 10 years of tax filling in one nation<br><br>Test by different specifications: Endogeneity of inputs, fixed effects, simultaneity and heterogeneity |
| Document collaboration tool       | Positive              | New processes,<br>Group dynamics,<br>Organization   | No of papers,<br>No of hours per paper,<br>Quality | Creativity, Quality,<br>Complementary changes   |
| Data mining                       | Positive/<br>Negative | Firm level to distinguish btw use   | Firm level dep on firm "goals"                     | Macro/micro, Complementary changes, Specific vars for each app  |
| Simulations and complex computing | Positive              | No of scientists,<br>Cap stock of hardware,<br>cap stock of lab equip   | Approved drugs per year                            | IT builds/enhances on 2nd Ind rev, Diminishing returns, Compl changes   |
| "New" POS                         | Positive              | IT assets "used"<br>Org size  | Sales data   | Substitution IT/clerks,<br>Complimentary changes  |

## Assignments

| Application                         | Impact                | Input Vars.  | Output Var.  | Issues/problems   |
|-------------------------------------|-----------------------|--|--|---|
| PC computing in mutual fund company | Positive              | HW, SW configs,<br>No of PC's,<br>Investment,<br>Support costs,<br>Org struct vars | No of "pages",<br>Quality,<br>Timeliness                         | Quality adjusting,<br>Unit of purchase,<br>Valuing production units   |
| Semi-conductors                     | Positive              | ?  | Sales,<br>Manufacturing<br>, Data over<br>time                   | CQI, Substitution, Intermediate<br>inputs/outputs, Time lag in<br>impact, Industry effects  |
| MS Powerpoint                       | Positive/<br>Negative | No of staff for creation,<br>Avg time for creation,<br>Costs and investment        | Decision<br>quality, No of<br>decisions,<br>User<br>satisfaction | Scope (Ind, Org, Industry),<br>Context (is \$ appropriate),<br>Simplification/"dumbing down"<br>(too much?),<br>Reengineering or substitution |

## Stiroh – Meta-Analysis

### Purpose

- “*put some order and structure on the set of divergent results [on productivity effect of IT]”*”
- How to estimate IT-elasticity? *What and How*

### Issues

1. Building datasets
2. Measuring output:
  - Gross output regression: more natural measure of firm output
  - Value added regression: omitted variable bias → upward-biased estimation
  - Estimation in levels or per-unit of labor?: no statistical difference if returns are constant
3. Decomposing capital
4. Unobserved heterogeneity?: Fixed or random effects
5. Differences across industries?: Dummies or Split samples?
6. Differences over time: shorter or longer?
7. Control for overall technological progress?
8. Endogeneity of inputs: instruments to handle it → HARD
  - Need “*vars. correlated with inputs but uncorrelated with productivity shocks*”

## Stiroh – Meta-Analysis (cont.)

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### Interesting Points

- Approach: meta-analysis
- Application of different methodologies

### Conclusion

- IT does matter...but one needs to be cautious in quantifying its impact (e.g normal vs. excess returns)

## Guest Speaker

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**Prof. Shinkyu Yang**  
**Leonard N. Stern School of Business**  
**New York University**

## Does the “New Economy” Measure Up... - Gordon

### Purpose

- IT is not a third industrial revolution – is it?
- Sceptic’s (or Gordon’s) case start with a close examination of the recent productivity revival.
- Explores limitations of computers for affecting productivity.
- ¾ of computer investments has been in industries with no perceptible trend increase in productivity – thus Solow’s paradox is intact and there is a need to explain it.

### Interesting Points

- Aggregate numbers are not enough – 12 % vs 88 %
- Much of the revival is in computer producing industries
- The time span is too short (1995-99) for a “real” and sustainable revival
- Price decline has been in progress for a long time – productivity increase in the past not the future?
- Diminishing returns – cf word processing
- 4 factors for the conflict: 1) Marketshare protection 2) recreation of old activities 3) duplicative activities 4) consumption on the job.

-Gordon – short presentation and discussion of the paper. How much discussion do we want here as opposed to later?

-Aggregate numbers are impressive but the revival seems to have taken place within the 12 % whereas in the 88 % capital deepening has been unproductive.

## Does the “New Economy” Measure Up... - Gordon

### Conclusion

- Productivity growth in 12 %.
- Time rich vs time poor.
- Consumer surplus yes but productivity no?

### Issues

- Focus on hardware since software (as in Jorgenson) is troublesome – Consequences?
- Fair to compare to industrial revolutions?
- A bit narrow minded? – ”...always need two pilots...”.
- Consumer surplus and social welfare vs productivity?
- Is IT mismeasured?

-Gordon – short presentation and discussion of the paper. How much discussion do we want here as opposed to later?

-What is multifactor productivity? Can Erik explain or is it common knowledge?

-Two questions raised: 1) Has the new economy reached into the 88 %? 2) The timeline is much shorter than for earlier “golden eras” (p 54) – raises the issue of permanence vs temporary.

-Lagging in labor hours and productivity (p 54-55)?

-What does p 56 mean? I have trouble getting my head around it...

-Supply graph move or demand graph move?? p 61-62

-Computers has been around for almost 50 years – perhaps the prod increases are in the past not in the future (p 65). Also cmp diminishing returns.

## Arguments

### Supporting IT Productivity

1. Complements labor
2. Replace labor (routine tasks)

### Rejecting IT Productivity

1. What do you mean by productivity?
2. Past vs. future performance
3. Need for organizational / skill complements
4. Diminishing returns?

### Methodology Issues

1. Endogeneity of inputs
2. Unobserved heterogeneity
3. Simultaneity
4. Differences across industries
5. Noisy data and outliers

## Conclusions and questions for research

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1. How big is the role of IT in economic growth when controlling for the evolution of their price?
  - Constant quality price

## Research Strategy for Papers

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**The End ;-)**

## Back-Up Slides

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## Brynjolfsson, Hitt, Yang

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### Purpose

- “New, intangible, organizational assets complement IT capital”
  - [5 Hypotheses](#)

### Issues

- Relevance (and measurement) of intangible assets (organizational capital)

### Interesting Points

- Effect of computer capital versus other Property, Plant and Equipment (PPE)
- Building of ORG by using principal components
- Use of stock market valuation value creation:
  - investors consideration of intangible assets into their valuation of firms
- Proxies
- Question: what is your output variable?

### Conclusions

- ORG and PPE virtually not-related

## Information Technology and the U S Economy - Jorgenson

### Purpose

- Highlight and discuss problems with measuring IT and productivity as well as looking into the actual numbers.

### Issues

- Constant Quality Index – an Important Tool.
  - A way to separate observed price between changes in performance and changes in price that hold performance constant.
- Software – Prepackaged vs Own and Investment vs Expenditure.
- IT Services – Not included in GDP but are in "output" concept.
- 3 measurement issues:
  - Underestimation of IT investments on growth.
  - Problem of hours worked as measure of labor input.
  - Production Possibility Frontier vs Aggregate Production Function .

- Jorgenson – short presentation and discussion of the paper. How much discussion do we want here as opposed to later?

-Perhaps Erik could talk a bit about constant quality index (p 7)?

-Should we discuss hedonic models?

-GDP vs output concept in terms of IT services.

-Underestimation occurs due to little accuracy in measurements of capital stock due to failure to capture an increase in capital quality (p 17).

-Same problem with labor – labor hours and labor input not the same thing cf labor quality (p 18).

-PPF – a framework to analyse the impact of IT on growth (p 19-22). Can Erik explain this?

-PPF takes CQI into account as well as the costs of adjustments.

## Information Technology and the U S Economy - Jorgenson

### Interesting Points

- 3 types: Computers, Software, Communications equipment.
- Capital input contribution to productivity increased between 1990-95 and 1995-99.
- Importance of semiconductor industry.
- Substitution of IT for other forms of capital.
- Identifying the impact of investment in IT at the industry level is critical.
- A lot of numbers...

### Conclusions

- Foundation of growth resurgence is in the deployment and development of semiconductors.
- IT prices will continue to fall for some time but it is difficult to extrapolate this into the indefinite future.
- IT does matter but we need to be very careful how we interpret and analyse data.
- Leaves some big question marks "for future research" – which are most important?

- Jorgenson – short presentation and discussion of the paper. How much discussion do we want here as opposed to later?

-Interesting research opportunities: 1) Software 2) CQI 3) Gaps in data.

-Total factor productivity (p 25) – Can Erik explain this?

-Should we present any data? For example, 70 % of increased output growth can be attributed to no-IT products (p 27). 50 % of TFP acceleration can be attributed to IT compared to 4.26 % in GDP (p 27).