15.575: IT and Productivity

Carlos Osorio – Daniel Kindström
Agenda

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

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

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

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

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

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

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?
- Skeptic’s (or Gordon’s) case start with a close examination of the recent productivity revival.
- Explores limitations of computers for affecting productivity.
- % 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.
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

<table>
<thead>
<tr>
<th>Supporting IT Productivity</th>
<th>Rejecting IT Productivity</th>
<th>Methodology Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Complements labor</td>
<td>1. What do you mean by productivity?</td>
<td>1. Endogeneity of inputs</td>
</tr>
<tr>
<td>2. Replace labor (routine tasks)</td>
<td>2. Past vs. future performance</td>
<td>2. Unobserved heterogeneity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Noisy data and outliers</td>
</tr>
</tbody>
</table>
Conclusions and questions for research

1. How big is the role of IT in economic growth when controlling for the evolution of their price?
   - Constant quality price
The End ;-)
Brynjolfsson, Hitt, Yang

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

Constant Quality Index – an important tool. A way to separate observed price 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.

Erik could talk a bit about constant quality index (p. 7).

PPF – a framework to analyze 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.
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).