Comments on Brynjolfsson, McAfee, Sorell, Zhu

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Thanks

- Thank you to the organizers for giving me the excuse to read the paper and the opportunity to comment.

Bottom line on BMSZ

- Paper covers period in ICT investment. Worthwhile to understand effect on industry structure.
  - Disposed to believe changes to enterprise IT brought about changes in industry structure, and it is worthwhile to collect statistical data about it.
- I will make some circuitous remarks. In case it gets lost along the way, my bottom line:
  - Columns 9-11 of Table 5 – i.e., the dif-on-dif for revenue as a function of ICT intensity – raises intriguing questions about what happened in the economy in 90s.
- I came to this conclusion by a path different than the one taken by the authors. I am not persuaded “business process replication” is a key driver of the findings.
  - But I do think something interesting did happen. I hope you find it informative about different ways to think about the topic addressed by this paper.

What BMSZ paper does (conceptual)

- Poses the question: How would industry structure change if the cost of moving business process innovations between locations within the same organization declined dramatically?
- Provides several cases to motivate question: these provide detail about the invention of business process improvements with the use of new IT and how it spreads to another establishment at the same organization.
- Proposes several implications – from these examples – for concentration and volatility.
  - These implications arise if (a) these examples generalize to all large firms, (b) if new IT became especially better at permitting spreading of process improvements after 1996; (c) if this is the only factor shaping concentration, and volality.

What BMSZ paper does (statistical)

- Addresses the question: How did industry structure change and did those changes differ between ICT-intensive and other industries in ways consistent with increasing concentration and more volatility?
- Presents data on the change in “sales” and “enterprise value” organized around these implications.
  - Focused on 1987-2004, largely due to data availability.
  - Combines Compustat data about publicly traded firms, their ICT investments, their sales, their enterprise value, etc with industry level data from BEA.
- Performs several statistical tests. The most interesting is a diff-on-diff w.r.t. the firm variables, asking whether the patterns for ICT-intensive firms changed after 1996.
  - High ICT *interpreted* as industries where cheap business process replication was especially common.

My comments fall into three categories, then my bottom line.

- **General Purpose Technologies.**
- **The evolution of enterprise IT.**
- **Statistical griping.**
- **My bottom line.**
  - …which you have already heard.

Outline

- **General Purpose Technologies.**
- The evolution of enterprise IT.
- Statistical griping.
- My bottom line.

Get more implications if conceptual question framed in terms of GPT…

- Basic proposition: ICT is a GPT. A new and innovative GPT, by itself, is not particularly useful and does not bring about meaningful economic change.
  - Becomes useful as users/vendors "co-invent" to make the GPT useful in particular circumstances.
- Basic proposition: Co-invention costs comprise majority of cost of translating GPTs into useful processes.
  - Social scale economies in co-invention brings down co-invention costs, but often these are elusive or difficult to create.
  - There are multiple channels for social scale economies to arise in the IT sector. Users/vendors/consultants all can play a role.
- Key writers are Bresnahan & Trajtenberg, Helpman & Trajtenberg on GPTs, Danny Quah on "weightless economy", many others.

What brings co-invention costs down: social scale economies.

- SSE in co-invention costs depends on who finds it, creates it, etc. Inherently a question about industrial org.
  - When suppliers find it: “write-once, sell many times.” E.g., EDS, SAP, Oracle, MS OS, Netware, salesforce.com, many examples.
  - Local labor markets become focal for it: “agglomeration based on mobility of technical talent.” Rte 128, Valley, Manhattan.
  - When large companies find it: “Solve it once and port to other parts of the organization.” The CVS example in BMSZ paper.
  - When consultants find it: “Hire the consultant who solved the same problem for someone else.” (Arora & Forman)
  - When idealist programmers find it: “Share it in open source.”
- Viewed this way, BMSZ paper focuses on case studies of change in co-invention costs within organizations.
  - Begs question: What happened to other mechanisms for SSE in co-invention costs at same time at same time?

Skepticism. Why focus on only inside org & not elsewhere?

- Conceptual model is incomplete for empirical purpose. Why did the cost of co-invention change for in-house, but not for other channels? No complete explanation.
  - Consulting markets, labor markets, software markets should and can transmit anything comparatively technically straightforward.
  - Nothing has stood in the way of these other channels undergoing dramatic technical change in the past, why should it in this case, particularly in the 1990s?
  - Widely discussed in the 1990s: The role of “Silicon Valley” style capitalism and consulting houses as a mechanism for transmitting knowledge, a.k.a., co-invention.
- Paper has a few theoretical arguments about why ideas do not move across firm boundaries, but it is easy to find case studies where it does. Unsatisfying loose end.

Skepticism. What stands in the way of social economies of scale?

- BMSZ paper acts as if one change brought it about. Nothing about multiple costly adjustments.
  - Particularly relevant when organizations face relentless and continual set of options from new GPTs. Invariably adjusting to one, then another, sometimes get it right, not other times.
- Problematic because co-invention costs high when problems are idiosyncratic, constantly adjusting.
  - The legacy system comes house programming or reflects complicated problems with no standardized or coherent solution.
  - Users are costly to help because they are not technical. (Bresnahan & Greenstein on co-invention costs in IT use.)
- Organizations costly to help for variety of reasons.
  - Prior business processes not coherently designed to suit latest IT (Brynjolfsson and co-authors.)

Boiling it down: Account for private & social costs of co-invention.

- What are private & social costs of investing in an innovative part of enterprise IT, such as ERP?
  - Hassle of standardizing all installations, training appropriate personnel, installing systems organization wide, purchasing software, settling on one option and foreclosing others.
  - Suppliers had to invent the underlying software.
  - Not just the cost of one isolated invention. Appropriate economic accounting recognizes all other costs that enabled co-invention.
- I share the general view of this paper that enterprise ICT has brought about impressive gains.
  - But co-invention does not (and did not!) happen at no cost. Scale without mass is an economically inappropriate label b/c scale in co-invention does not happen without cost.

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What parts of enterprise IT shape industry structure b/w 87 & 04?

- What were drivers of change in cost of business process replication? History in paper incomplete in ways that shape interpretation of coefficients.
- Computer historian, James Cortada, has written a three volume set of books on enterprise IT in last three decades. Called the *The Digital Hand* (Oxford Press).
  - Highlights relentless technical change, and highlights three big changes among those: EDI, PC, and Internet. Why those? Cortada (paraphrase): “Because they had the capacity to alter a range of business processes simultaneously.”
- Forman & Goldfarb’s Handbook review of use of new technology in enterprise computing literature.
  - Focuses on factors that shape incentives to adopt new technology. Direct productivity benefits to adoption of new IT, but uncertain as technology/opportunities/environment changes.

There have been many significant GPTs in enterprise computing.

- Consider the Forman & Goldfarb approach: continuous opportunity and change in enterprise computing. Many GPTs in Enterprise IT from 97-04.
  - Client-server architectures (starts approx 1989).
  - EDI (starts early 80s, gains momentum in late 1980s)
  - GUI oriented office PC (1990, see Doms)
  - Browser based web participation and email (1994)
  - TCP/IP based inter-establishment networking (1996)
  - Open source initiatives – Linux, most prominently…(mid90s)
  - Mobile computing for non-technical user (late 90s?)'
  - Electronic buying/selling (late 90s?).
- Continuous reconsideration of the best enterprise wide configuration for ICTs to try to achieve direct productivity improvements big driver of ICT investment.

Boiling it down: Diffusion of commercial web after 96.

- Commercial Internet not available until 92.
  - W3C is not founded until 93, first commercial browser not until late 94. Easy to attribute acceleration in ICT investment post 96 to this “unanticipated positive technical shock” from the diffusion of the commercial Internet and variable attempts to exploit.
- ICT investment beyond 96 motivated by many productivity-enhancing reasons.
  - Diffusion of browsing & email generates growth in PC/routers/LANs investment from 1996 onward.
  - Diffusion of advanced applications to local networks, inter-networking, and other enterprise applications, such ERP.
  - See Atrostic et al, or Doms, or Forman, Goldfarb & Greenstein.
- Industry leadership might change as a result of aggressive investments after 1996. Firm seek productivity boost & other direct gains. More than merely business process replication. But variable & uncertain.

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Is data on enterprise value meaningful after 1997?

- Stock values for all publicly traded IT producing firms in the US were way out of whack in late 90s.
  - There was a speculative investment bubble. Wall St, VCs, young firms, consultants, all had poor incentives to report what was happening in even handed ways. Investors bought into to it for a while. Speculators especially.
  - Volatility in EV hard to interpret from late 1990s. It was volatile, but that was due to speculative bubble. Not anything due to business process replication.
  - Many of biggest users of IT are IT producers. Are results robust to excluding them? Number of robustness checks needed.
  - Many firms benefited from bubble (e.g., for Intel, Microsoft, IBM, Cisco, Oracle, many others) and some eventually lost big (e.g., JDS Uniphase, Corning, Lucent, Nortel, Worldcom, many others). Cannot tell how this shapes these data.
  - Some heavy IT users also were over-hyped. Any way to exclude firms whose prices were too high during this time period?

Reconciling BMSZ with other studies of enterprise IT in 90s.

- Forman's paper on adoption of Internet in business. Co-invention costs for browsing & email were low, while high for advanced uses over LANs or for internetworking.
  - Variance in adoption, but large ICT installations early adopters, with some having better installed base than others. Useful explanation for why large ICT-intensive orgs differ after 96.
- Forman, Goldfarb & Greenstein extend to entire medium large establishment economy in 2000. Is it consistent with the premise of BMSZ? Evidence is mixed.
  - At industry level: high ICT and high use of advanced Internet positively correlated, which is the story BMSZ want to tell.
  - Establishments that are part of multi-establishment orgs *are* more likely to use advanced Internet than single estabs (BMSZ story), but locating in big city as important (Labor markets). A large single establishment in a city is at no disadvantage (not the BMSZ story).

How representative are these data on industry wide trends?

- Intriguing results on change in revenue over the 1990s, but not sure how to interpret them as indicative of economy wide trends.
  - BMSZ has data for publically traded companies.
  - No comparison with private firms or with all ICT users.
  - What fraction of ICT in economy is covered? What fraction of revenue in an industry is covered? Are large and small firms both covered.
    - ICT intensive industries undergoing change in revenue.
    - No sense of economic relevance of coefficients.
- No direct measure of business process replication.
  - Only an asserted association of high ICT with such an effect.
  - Allows for many alternative interpretations. My preferred alternative: uncertain and variable productivity boosts from wide variety of projects initiated by firms to generate new products/processes/services/competitive advantages

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Bottom line

- I think it is quite interesting to do a dif-on-dif for firm revenue, looking to see whether ICT intensity mattered more after 1996 for firm performance.
  - This is columns 9-11 of Table 5.
- Raises many challenging & intriguing questions.
  - About role of new technical innovation in electronic commerce → in changing firm leadership in some industries linked to ICT.