March 26-29, 2018
Los Angeles, CA
THE ECONOMIC GAINS FROM ENTERPRISE IT: Open Source, DevOps, and Data Analytics

Robert B. Cohen, Ph.D., Senior Fellow, Economic Strategy Institute
ONS North America, March 27, 2018 bcohen@bway.net
How Economists Look at Open Source

• Recent economic studies emphasize the wholesale labor displacing effects of automation. A shared concern is that breakthroughs in AI and adaptive robotics are shifting the terms of human-machine comparative advantage. Tasks get shifted from labor to capital, jobs are lost, there’s less money available to pay workers. “Brilliant machines” – IoT sensors, plus AI and ML -- as thinking robots that will replace wide swaths of labor “tasks”.

• The “AI job displacement” thinking also appears to assume that there will be few changes in industry processes and inputs.
Economists and Open Source: II

- We assert that Open Source is having a pervasive impact on the economy. It is at the heart of applications to manage and operate wide swaths of the economy that will demand large amounts of “tasks” to support data collection, data management and data analytics.
- In addition, it is dramatically lowering the price to develop, deploy and evaluate new software.
- This could easily offset the negative impacts of “brilliant machines”.
- Why? It is driving down the price to develop, deploy and revise key applications.
- It’s opening up areas where labor may begin to recapture “tasks” that contribute to the value created in the economy in areas linked to data and analytics.
An Alternative Economic Viewpoint

• AI will create jobs:
  • Many firms focus their early AI efforts on Machine Operations Management (MOM) and Overall Equipment Effectiveness (OEE). They need to build new skills to meet these goals, 2018-2025.
  • Initiatives like the Linux Foundation’s Acumos Project (acumos.org) are “moving to a future where AI is at the Center of Software.”
  • In the short term, firms are using AI “much more frequently in computer-to-computer activities and much less often to automate human activities.” “Machine-to-machine” transactions are the low-hanging fruit of AI, not people-displacement.
  • Tata survey: firms that gained the most from AI in 2015 expected there to be a need for 3 times as many new employees in specific jobs functions (including those experiencing displacement), than firms that experienced the smallest improvements from AI in 2015.
AI Will Displace Jobs but also Create New Ones

This is a conclusion for the short run. It does not take into account structural changes in the economy – new types of businesses, innovative new processes.

<table>
<thead>
<tr>
<th>Function</th>
<th>Average Percentage of Jobs that Cognitive Technology is Predicted to Eliminate by 2020 (%)</th>
<th>Average Percentage of Jobs that Cognitive Technology is Predicted to Create by 2020 (%)</th>
<th>Net Change in Jobs by 2020 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate level</td>
<td>23%</td>
<td>18%</td>
<td>-5%</td>
</tr>
<tr>
<td>Procurement</td>
<td>21%</td>
<td>14%</td>
<td>-7%</td>
</tr>
<tr>
<td>Legal</td>
<td>21%</td>
<td>15%</td>
<td>-6%</td>
</tr>
<tr>
<td>IT</td>
<td>20%</td>
<td>15%</td>
<td>-5%</td>
</tr>
<tr>
<td>HR</td>
<td>19%</td>
<td>14%</td>
<td>-5%</td>
</tr>
<tr>
<td>Distribution and logistics</td>
<td>19%</td>
<td>15%</td>
<td>-4%</td>
</tr>
<tr>
<td>Finance and accounting</td>
<td>19%</td>
<td>14%</td>
<td>-5%</td>
</tr>
<tr>
<td>Strategic planning and corporate development</td>
<td>18%</td>
<td>14%</td>
<td>-4%</td>
</tr>
<tr>
<td>Marketing</td>
<td>18%</td>
<td>13%</td>
<td>-5%</td>
</tr>
<tr>
<td>Manufacturing or operations</td>
<td>17%</td>
<td>12%</td>
<td>-5%</td>
</tr>
<tr>
<td>Customer service</td>
<td>17%</td>
<td>13%</td>
<td>-4%</td>
</tr>
<tr>
<td>Sales</td>
<td>17%</td>
<td>12%</td>
<td>-5%</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>17%</td>
<td>13%</td>
<td>-4%</td>
</tr>
</tbody>
</table>
Open Source: “Bringing Ideas to Life as Fast as we can Imagine them”

- Open Source facilitates rapid revisions to critical applications
  - Control over a supply chain
  - Response to new consumer data

- Opportunity where there is big cost to the firm, but low marginal cost and disproportionate return on investment
  - Makes it easier for Amazon, Google to innovate, but attractive to JPMC
  - Key: taking in lots of information and making sense of it as rapidly as possible.
Economic Drivers of Open Source

- Propensity to Shift to Open Source

- Low Marginal Cost drives shift to Open Source

Marginal Cost = Fixed (Salaries, Equipment) + Variable costs (materials, shipping, hosting costs)

Factors that reduce MC: lower cost of Capital or Labor, increased Computing Speed or Power, Improved Software

As Code Commits or Deploys increase in number, complexity of analysis grows, shift to Open Source

Speed of Software Revision Needed

Complexity of Analysis
Demand for Open Source Increases with Demand for Analytics

- Analytics manages software release cycle – NBC Universal
- SW decides what is good compared to current release
- Make Go/No Go decision based on software information
- Blockchain (big cost/low marginal cost) supports rapid analysis of new revenue areas – JPMorganChase
- Ability to insure validity of transactions/exchanges
- Grows GitHub/Open Source use
Revealing the Economics of DevOps

- DevOps has created a revolution in software development. Some, like Gene Kim, argue that its impact may be greater than the manufacturing revolution of the late 1800s to mid-1900s.
- In 2015, the 20% of firms that had broadly adopted DevOps were
  - 3.4 x more likely to have seen growth in their market share
  - 2x more likely to have increased their revenues
  - 2.9 x more likely to have increased their profits, as compared to the 80% non-adopters
- ING was able to increase its mobile app deploys from 200/month to 18,000/month in 2 years.
## 30 Days to 5 Days to 2 Hours: Speeding App Deploys

| Target: “Infrastruct as Code” | Capital One |
| Fall/Wint ‘15 F/W ‘16 | 1 release/qtr’15 to 1/day ‘16; Code commits 100s/day ‘16 |
| Platforms 1 1.5 | 100 production teams |
| Teams 3 25 | 20+ Apps with release automation |
| Apps 3 42 | 34 -- Max # of releases per day for 1 app. |
| Deploys/day 2-3 90 | |
| Mins to Productn 1440 5 | |
ANZ Bank Case: CA Release Automation

- Needed to understand transaction flow in the bank
- Bank focused on Application Performance Management
- Let perform deep dives into application level to obtain code-level visibility
- Big decrease in incidents due to app releases – eliminated 10-15 high severity incidents. Now only 1-2 or none.
- 4 hours to restart affected servers reduced to 20 minutes.
- APM extended to 20 apps.
ING Case study: Results of DevOps

• Software deployments: 200/month to 18,000/month in 2 years
• Time to market: 13 weeks to less than 1 week
• Mobile banking app evolved to highest ranked bank app on iStore
  • Updates for different mobile versions overnight
  • Tested for app performance in detail before release
## DevOps Economic Gains Tied to App Performance

### Most Critical DevOps Tools

<table>
<thead>
<tr>
<th>Tool</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application performance monitoring</td>
<td>38%</td>
</tr>
<tr>
<td>Performance testing</td>
<td>37%</td>
</tr>
<tr>
<td>Functional testing</td>
<td>33%</td>
</tr>
<tr>
<td>Enterprise security</td>
<td>30%</td>
</tr>
<tr>
<td>Release automation</td>
<td>28%</td>
</tr>
<tr>
<td>Capacity management</td>
<td>27%</td>
</tr>
<tr>
<td>Application development lifecycle</td>
<td>25%</td>
</tr>
<tr>
<td>Change/configuration management</td>
<td>24%</td>
</tr>
<tr>
<td>Project and program management</td>
<td>24%</td>
</tr>
<tr>
<td>Service virtualization</td>
<td>24%</td>
</tr>
<tr>
<td>Hybrid cloud management</td>
<td>21%</td>
</tr>
<tr>
<td>Infrastructure management</td>
<td>17%</td>
</tr>
<tr>
<td>Virtual lab management</td>
<td>15%</td>
</tr>
<tr>
<td>Network performance management</td>
<td>11%</td>
</tr>
</tbody>
</table>
Data Analytics and the Internet of Things

• As Firms use data analytics more widely, they have focused on different economic benefits.
  • Automaker – Supply chain management, vehicle distribution
  • Aircraft Manufacturer – managing Lean Production, supply chain
  • Bank – estimating risk; blockchain for new revenues
  • Agriculture Equipment – Precision Ag, optimizing growing conditions
  • Jet Engine Mfr – Services business model;
  • UPS – predictive analysis; optimal routing
Early Stage and Later Stage Analytics Gains

**Early:**
- Supply chain or product distribution optimization
- Data analytics, based on IoT, identifies inefficiencies; changes can be implemented over months.
- Drives expansion of data analysis/data science positions
- Increases need for rapid software development

**Later:**
- “Brilliant Factory”: AI and ML added to IoT: Tesla, Caterpillar, FedEx, Goldman Sachs
- Evaluates data in real time – firehose speed.
- Adjusts equipment or processes immediately
- Data becomes far more important; as do computing power and speed
Estimating Economic Gains

- Need to examine the processes that have large disruptive impacts:
  - Software development: DevOps and App Performance Management
  - Analytics: Evaluating manufacturing, service, and distribution in as close to real time as possible.
  - Open Source: Economics of creating common platforms (IAG), software and using Open Source (GitHub), Creating new Open Source Tools/AI development for neural networking, machine learning and deep learning. AI enhances data analytics.
Challenges for Economic Analysis

- High Auto-Correlation Among Factors; Open Source impacts software development, as does TensorFlow and NVIDIA chips. Data analysis drives app development and a move to more AI/ML based systems.
- Firms need to “see into code”. As firms expand their internal processes, they need to get alerts before software or infrastructure creates a problem.
- Open Source offers a way to share innovative apps and speed/correct coding. Creating common basic platforms such as Automotive Grade Linux for Vehicle to cloud connectivity.
- This makes analysis complicated. Many different effects need to be analyzed to understand how the new “Open Source” system impacts the economy.
Conclusions

• Open Source is having impacts on the economy that few economists appreciate.

• It and related innovations in data analysis and DevOps have created a “new software ecosystem” that may reverse the current decline in labor-demanding growth.

• We are vastly underestimating the impact of the “new software ecosystem” on the economy. We don’t understand its impacts, including how it can change the nature of work.

Slide 5. Many of Autor and Salomon’s assumptions about “brilliant machines” are challenged by results from Tata Services. It finds, in the short term, that “the companies we surveyed – in 13 manufacturing and service industries in North America, Europe, Asia-Pacific, and Latin America – are using AI much more frequently in computer-to-computer activities and much less often to automate human activities.” “Machine-to-machine” transactions are the low-hanging fruit of AI, not people-displacement.” See Satya Ramaswamy, “How Companies are Using AI,” Harvard Business Review, April 2017. https://hbr.org/2017/04/how-companies-are-already-using-ai Ramawammy also asserts that using AI for intrusion detection makes IT security experts more valuable to their firms, not less. In a related study from Tata Services, Getting Smarter by the Day: How AI is Elevating the Performance of Global Companies, p. 11, ”companies with the biggest revenue and cost improvements from AI in 2015 see the need for at least three times as many new employees in each function by 2020”, as compared to companies with the smallest improvements from AI in 2015.” Acumos project: “The Linux Foundation Launches Open Source Acumos AI Project,” March 26, 2018. https://www.linuxfoundation.org/press-release/the-linux-foundation-launches-open-source-acumos-ai-project/
Sources

• Slide 5: Also see “Machine-to-machine” transactions are the low-hanging fruit of AI, not people-displacement.” Peter C. Evans and Marco Annunziata, “Industrial Internet: Pushing the Boundaries of Minds and Machines,” GE Imagination at Work, November 26, 2012. https://www.ge.com/docs/chapters/Industrial_Internet.pdf


• Slide 7: “Bringing Ideas to life” Talk by Michael Connor of Coca-Cola at AWS Re:Invent 2016, December 1, 2016. https://aws.amazon.com/serverless/videos/video-lambda-coca-cola/ In discussing “serverless computing,” Connor noted that “serverless” brings ideas to life as fast as we can imagine them.” Response to consumer data is also from Coca-Cola talk.

• Slide 8. Developed by author based on discussion with Ed Warnicke of Cisco.

• Slide 9. Based upon author’s discussion with Andi Mann of CA Technologies.
Sources

- Slides 15 and 16. Based on the author’s unpublished case studies.