The Rise of Cloud Computing: Minding Your P’s and Q’s (and K’s)

David Byrne, Federal Reserve Board
Carol Corrado, The Conference Board and Georgetown University
Dan Sichel, Wellesley College and NBER

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Information Technology Landscape: 2017

Cloud Service Providers
- Amazon
- Google
- Microsoft

Software & Content Providers
- Salesforce.com
- Netflix
- Oracle
- Youtube
- ADP
- Facebook

Internet Service Providers

Compute, Storage, & Platform Services

Datacenter
- Firms
- Office
- Mobile Users
- Households

Electronics Key
Computing
Communications
Entertainment
Q’s: How prevalent is cloud computing?

Global Share of IT Services

- Global cloud services revenue:
  - $48 billion (2017Q3, annual rate)
  - Synergy Research Group

- Total IT services
  - Includes application services, business processing services, and infrastructure services (cloud)
K’s: Investment by Major Cloud Providers

Global Capital Expenditure
Amazon, Google, and Microsoft


U.S. Company Global Capital Expenditure:
Selected IT Service Providers

Source. Authors’ tabulation of company financial filings.
Note. Included cloud service providers meet Cisco definition of hyperscale. Included telecommunications service providers are AT&T, Verizon, Sprint, T-Mobile US, Century Link and related companies.
K’s: Is cloud investment in the national accounts?

K’s: Cloud providers making own IT equipment?

Selected NAICS Industries
514 Data processing, internet publishing, other info. services
5415 Computer systems design and related services
511 Publishing industries, except internet (includes software)
K’s: (Speculative) Own-account investment changes the recent IT investment story

Source. Authors’ elaboration of Bureau of Economic Analysis Input-output accounts.
P’s: Data on cloud services

• Prices and characteristics
  • Scraped using the Web Archive
  • 3 products each from 3 vendors
    • Amazon (2009-2016)
    • Microsoft (2014-2016)
    • Google (2014-2016)

• Cloud Service Products
  • **Compute** (renting virtual machines)
  • **Storage** (renting storage)
  • **Database** (user-developed apps)

<table>
<thead>
<tr>
<th>Amazon Observations 2013-2016</th>
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<tbody>
<tr>
<td>Product</td>
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<tr>
<td>Compute</td>
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<td>Database</td>
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<td>Storage</td>
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P’s: Compute services

• Amazon “EC2”
• Hedonic adjacent-quarter regressions
• Controls:
  • Processor power
  • Memory
  • Storage
  • *fixed effects* for region, operating system, bus width, solid state drive
P’s: Storage services

- Amazon “S3” (simple storage solution)
- Matched-model
- Models distinguished by
  - Volume
  - Access speed
  - Region
P’s: Database services

- Amazon RDS
- Hedonic adjacent-quarter regressions
- Controls
  - Processor power
  - Memory
  - Input-output
  - fixed effects for region, type of database software
P’s: Acceleration since entry of Microsoft, Google

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<thead>
<tr>
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<th>2009-2013</th>
<th>2014-2016</th>
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<tbody>
<tr>
<td>Compute (EC2)</td>
<td>-5.1</td>
<td>-10.5</td>
</tr>
<tr>
<td><strong>Google</strong></td>
<td></td>
<td><strong>-11.4</strong></td>
</tr>
<tr>
<td>Database (RDS)</td>
<td>-3.3*</td>
<td>-22.6</td>
</tr>
<tr>
<td>Storage (S3)</td>
<td>-12.1</td>
<td>-25.1</td>
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* Sample for RDS starts 2010:Q2
P’s: The Role of Amazon

**Prices for AWS Services**

- **Compute (EC2)**: 2009-2013: +5, 2014-2016: +10
- **Database (RDS)**: 2009-2013: -10, 2014-2016: -15
- **Storage (S3)**: 2009-2013: -20, 2014-2016: -25

**Cloud Provider Competitive Positioning**

- **Google**: A leader in market share, but a long way to go...
- **Microsoft**: Holding steady, average market growth rate
- **Alibaba**: Gaining market share, in a league of its own...
- **Oracle**, **IBM**, **Salesforce**, **Rackspace**: Strong niche players

Source: Synergy Research Group
Summary

• P’s: Rapid cloud service price declines
  • Indicates continued technical progress in IT
  • Matters for sources-of-growth analysis (how important is IT?)

• Q’s: Volume of cloud services relatively small
  • Early in the adoption cycle?
  • Adoption depresses equipment investment (initially)

• K’s: Capital spending by cloud companies is enormous
  • Comparable to 1990s telecom boom.
  • IT investment may be understated in national accounts
  • Greater K deepening => future productivity gains?
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