Proposal for NBER/CRIW conference: Measuring and Accounting for Innovation in the 21st Century
May 26, 2016

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Cloud Computing: Implications for Economic Measurement and Growth

The provision of computing services is undergoing a tectonic shift as more and more firms shift from in-house provision toward the cloud. In cloud computing, users rent computing capacity, storage, and applications, paying for what they use. Amazon, Google, and Microsoft, for example, now make available for rent a wide range of computing services via the cloud.

While these dramatic changes have received considerable attention in the business and financial media, research has only begun to focus on these developments [see Byrne and Corrado (2016)] and official measures tracking this new activity are, largely, nonexistent. This paper will take steps toward developing price and quantity measures for cloud computing in the form of a satellite national income and product account for this category of services. In doing so, the paper will highlight a consequential transformation underway in the economy and shed light on several key measurement issues.

- ***As highlighted by Byrne and Corrado, the usage of information and communications technology (ICT) is more intensive than suggested by the traditional approach of measuring ICT usage.*** Byrne and Corrado note that cloud server workloads rose 13 percent per year on average from 2006 to 2013. We will build on their results to document further that providers of cloud computing obtain higher utilization from their infrastructure than would be the case if individual firms were installing their own ICT systems. Such an increase in utilization implies that a given quantity of hardware and software (as would be captured in current official measures) is generating more computing services today than would have been the case in the past. Documenting the extent to which this transformation has occurred should enhance our understanding of the role of ICT in economic growth and the prospects for future ICT-enabled growth.

- ***Patterns of usage of ICT across industries may be quite different than suggested by the traditional approach of measuring purchases of computer hardware, software, and communications equipment.*** In particular, current official measures likely are giving a misleading view of which sectors are using ICT because the underlying infrastructure is purchased by the providers of cloud services rather than the users of the ICT services. And, in current official measures, it is the purchaser who is attributed as using the ICT rather than the ultimate user.

- ***Investment in ICT capital may be understated.*** Annual capital expenditure by cloud service providers Google, Amazon, and Microsoft has risen tenfold to $22 billion since 2005, suggesting a major capacity expansion is underway. In addition, investment in ICT hardware by cloud service providers may be understated because these firms perform substantial own-account ICT investment. We will use reported cloud service revenues to impute a measure of cloud capital stock, including intangible assets such as software.

- ***A preliminary read on prices of cloud computing services raises important questions about official price indexes for high-tech products.*** Official measures of prices for high-tech products have exhibited very sluggish declines recently relative to historical patterns. Yet, preliminary analysis (from trade press reports and an initial set of pricing data from Amazon Web Services) suggests that prices for cloud computing have been falling more rapidly in recent years than have official measures of prices of the underlying hardware and software inputs. This discrepancy raises a number of questions. Are the providers of cloud services obtaining rapid gains in multifactor productivity? Is competition among cloud providers driving down margins? Are the official measures of prices of computer hardware and software biased? Measures of prices of cloud computing services will provide valuable insights into these questions.

- ***The widespread availability of computing services provides an opportunity to advance the measurement of prices of high-tech goods and services.*** Prior to this time, ICT users typically obtained computing services from a combination of hardware, software, communications equipment, and labor. Price measurement followed that pattern by developing indexes for each of these inputs. However, this procedure, still employed in the national accounts, suffers from two inherent problems. First, it measures inputs (hardware and software) rather than outputs (computing services). Second, hardware and software often are not separate, individual products, but rather were purchased and used together. This point is obvious for, say, an iPhone, but it also was the case even in the late 1980s and 1990s when significant amounts of software would come pre-installed on computers. Price indexes for cloud computing would help to shed light on both of these shortcomings by coming closer to actually pricing the desired output rather than inputs.

Citations

Byrne, David and Carol Corrado, “ICT Prices and ICT Services: What do they tell us about productivity and technology?” mimeo, April 2016.