Liege Competition and Innovation Institute

LCII Policy Briefs

Issue 2015/2

July 2015

# *Competition in the Market for Flexible Resources: An Application to Cloud Computing*

by

**Wing Man Wynne Lam**

Post-doctoral Researcher, LCII& HEC-ULg, wingmanwynne.lam@ulg.ac.be

*Can more competition promote efficient investment in the market for cloud computing or in the other markets for flexible resources? My recent research develops a new theory of capacity investment in flexible and fixed resources and explains the need for far more data on costs and demand to speak about the issue of competition in these markets.*

***Introduction*** – Cloud computing, the leasing of computing capacity on an unprecedented scale, has transformed the way firms use IT. Instead of buying their own on-premise servers, firms can rent computing power from a third party such as Microsoft Azure or Amazon Web Service (AWS). An important decision of firms today is to decide how to allocate investments between cloud computing, which allows firms to better manage rises and falls in demand, and local computing, which accommodates the average demand of firms.

Moreover, there is another element in this market—demand correlation—that complicates firms' investment decision. Demand correlation means that the demands of two firms either move in the same direction (positive correlation) or the opposite direction (negative correlation). In particular, retailers have huge computing spikes during holiday seasons, and accounting firms needs extra computing power during tax seasons. Harms and Yamartino (2010) argue that even the largest cloud provider will not be able to fully resolve issues related to these correlations by aggregating demand.[i] Thus, investing efficiently requires firms to take into account the degree of demand correlation. This problem is further compounded by the fact that demand is largely uncertain.

In the past decade, investments in cloud computing have increased significantly, and are expected to continue to grow.

The worldwide spending on public cloud services is expected to reach $47.4 billion in 2013 and $107 billion in 2017, says International Data Corporation (IDC). Yet, given the enormous amount of investment in cloud computing, the literature on the economic effects of cloud computing on investments is surprisingly thin.[ii] Most studies instead focus on the technical aspects, but cloud computing is more than just a technological improvement.

***How to promote efficient investment? More Competition? –*** Lam (2015) is the first to examine the investment incentives of the cloud providers and the cloud users under different market structures.[iii] Two important element of the model are that first, there are two types of resources (cloud vs. local computing), and second, demand is uncertain and correlated across firms.



The main result shows that market power of the monopolist cloud provider distorts investment incentives, while competition restores efficiency. However, the extent of improvement depends critically on investment costs and the degree of demand correlation.

This is because as correlation increases, cloud providers either "win big" (when the demand realization is high) or "lose big" (when the realization is low). Providers need to balance the expected demand with the cost of investment. When investment costs are low, losing is cheap and providers tend to invest more as correlation increases. Conversely, when investment costs are high, providers focus more on minimizing the cost of losing, and therefore tend to invest less as correlation increases. The extent to which competition improves welfare over the monopoly case will then be different, depending on these costs and benefits. Specifically, when the efficiency advantage of cloud computing over local computing is small enough, the extent to which investment is distorted under monopoly is smaller, and hence competition is more likely to be effective.

***Data on costs and demand are the key –*** The result implies that information on costs and demand in the market for cloud computing, for which few data are currently available, should be gathered as they have important consequences for investment. For example, there is still a lot of uncertainty on the cost conditions in the cloud industry. Although it is often argued that the marginal cost of producing an extra unit of computing power is close to zero, the costs of energy consumption, cooling, and management of a large server farm are far from negligible.

Some industry experts (see, for instance, Jeff Bezos in Stone, 2013) envisioned that cloud computing would transform today's IT into a utility.[iv] Like electricity, computing power would then be bought and sold at spot prices instead of today's non-contingent prices. Despite the additional consideration of firms would price high during peak periods and low during off-peak periods under spot pricing, the main result that investments depend on investment costs and the degree of correlation remains valid.[v]

***Broader Applications of the Model: electricity and car-sharing*** **–** The model can be applied to other markets, where firms can invest in multiple resources (flexible vs. fixed) and demand is correlated across firms. For example, in the electricity market, firms can consume electricity from utility companies or install their own electricity generators; in car-sharing, people can drive their own cars or share with others. Moreover, demand is correlated in that time and weather are common drivers of demands in electricity and car-sharing: people consume more electricity in their workplace in the daytime, and at home in the evening; people most want a taxi during busy times and under bad weather. Thus, at a more general level, my results could also be extrapolated to gain a better understanding on incentives for vertical integration in these markets.

***Conclusion*** – Cloud computing revolutionizes the Internet economy, but its impact on firms' investment incentives has been unclear to economists. By providing a pioneering analysis of such issue, my model reveals that the desirability of introducing competition in the market for cloud computing depends on investment costs and the degree of demand correlation. More empirical work on this front is needed.



[i] Rolf HARMS and Michael YAMARTINO, 2010. The Economics of the Cloud. *Microsoft White Paper*.
[ii] Chaim FERSHTMAN and Neil GANDAL, 2012. Migration to the Cloud Ecosystem: Ushering in a New Generation of Platform Competition. *Communications & Strategies Digiworld Economic Journal*, 85(1): 109-123.
[iii] Wynne LAM, 2015. Competition in the Market for Flexible Resources: an application to cloud computing. *CORE Discussion Paper*.
[iv] Brad STONE, 2013. *The Everything Store: Jeff Bezos and the Age of Amazon*. Little, Brown and Company, United States.
[v] However, since electricity is not storable, whereas computing power is, replicating the regulations in the energy markets in the cloud computing market may not be optimal.

## Previous LCII Policy Brief issues


Policy Brief 2015/1: "“Not on my network!” App exclusion and the net neutrality debate"
Policy Brief 2014/3: "Uber, concurrent déloyal ou champion de l'économie de partage ?"
Policy Brief 2014/2: "“Settle'em all”: Generalized Commitments and the Under and Over Enforcement of Antitrust Law"
Policy Brief 2014/1: "“Financial Fair Play” or “Oligopoleague” of Football Clubs? An Antitrust Review"


The LCII Policy Brief is a quarterly publication. It can be downloaded from www.lcii.eu