

Cloud Computing and Economic Implications

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1. Background

Cloud computing has become one of the major topics among the information technology architecture. Cloud computing provides services from centralized data centers thus free firms from investing in and owning a huge computer resources. This new technology has penetrated rapidly in Japanese economy. IPA (2012) shows that use rate of SaaS (Software as a Service, one of the service models of cloud computing) has grown from 19.5% in 2010 to 33.7% in 2011.

Vast amount of articles have been published on cloud computing, but the concerns and academic disciplines are diverse. For example, some studies focus on technological architecture, and others discuss on security and privacy. Some studies argue market governance such as competition law and regulation. Despite of the wide spread of cloud computing and its benefit on business, its effect on economy as a whole is not known well.

The main focus of this study is on the economic impact of the diffusion of cloud computing. This study reviews prior studies on macroeconomic effect of cloud computing and presents the research framework that can offer foundation to assess the economic impact of cloud computing in Japan.

2. Prior studies on the economic effect of cloud computing

This paper focuses on the effect on macroeconomic variables such as GDP, employment and productivity. In this regard, Etro (2011) provides comprehensive analysis using DSGE modeling. On the other hand, Ross (2011) focuses on the effect on human resource management, especially on the change of skills of IT engineers. Cudanov et al. (2011) discuss the effect on organizational performance and structure, focusing on the flexibility of IT resources that is enabled by cloud computing. As these studies provide core knowledge for the interest of this paper, this section introduces these prior studies.

Macroeconomic impact of cloud computing has been discussed in the series of studies by Etro (2009, 2011). These studies have focused on the cost reduction effect of cloud computing and analyzed its macroeconomic impact by simulation based on dynamic stochastic general equilibrium (DSGE) model. Underlying perception of these studies on cloud computing is that cloud computing turns IT cost from fixed costs into marginal costs of production. These studies assume the following effects. First, cost reduction of IT investment lowers initial barrier of entry and foster the

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establishment of small and medium size enterprises (SME). Second, the increase of SME would have a positive effect on employment and GDP. Third, they also analyze the impact on public accounts arguing that public spending is lowered and tax income is increased by the diffusion of cloud computing.

Etro (2009, 2011) experimented these hypotheses for EU countries by DSGE model that is based on the above hypotheses. Diffusion of cloud computing boosts GDP from 0.05% to 0.15% in short term, and 0.1% to 0.3% in medium term. The estimates on business creation and job creation also are shown in Table 1.

Table 1. Macroeconomic impact of cloud computing

	Speed of diffusion	Short term	Medium term	Unit
GDP	Slow	+0.05	+0.1	Percentage points per year
	Rapid	+0.15	+0.3	
Business Creation	Slow	+73,256	+83,478	Number of firms per year
	Rapid	+378,640	+430,973	
Job Creation	Slow	+300,000	+70,000	Number of workers per year
	Rapid	+1,000,000 or more	+700,000	

Notes: Impact on GDP and business creation is taken from Etro (2009), and impact on job creation is taken from Etro (2011). *Source:* Etro (2009) and Etro (2011)

Besides cost reduction effect, Cudanov et al. (2011) emphasize the benefit of flexible scalability of cloud computing. They argue that firms have to invest in ICT infrastructure expecting the future demand. However, the investment does not meet the actual demand of ICT because it is difficult to expect actual demand perfectly, and investment is conducted once a certain terms, not daily basis. Because of this gap of demand and investment, excessive investment happens under low demand and opportunity loss happens under high demand period. Cudanov et al. (2011) did not present the ways to measure the amount of these losses, but these flexibility certainly is one of the benefits of cloud computing.

On the impact on employment, Ross (2011) discussed impact on ICT workers in user firms. From user firms' point of view, adaptation of cloud computing is similar to outsourcing because these firms utilize resources outside the firms. Ross (2011) argues that along with the transition from in-house operation to utilization of cloud computing, jobs and the role of ICT workers in user firms would be affected. In particular, it pointed out that "ICT workers employed in support roles in large organization where ICT is not the primary focus of the organization – such as in universities – may

face a higher risk of redundancy in a Cloud computing environment”. It has pointed out that the role of ICT workers shifts from “a technical to more of a *liaison* role as they engage with external service providers”. This effect on ICT workers in user firms is not assessed by Etro (2011) that rather focuses on the cost saving for new start-ups.

3. Framework for analysis of economics effect of cloud computing

As seen in the previous sections, several studies provide the perspectives on the effect of cloud computing, but there are missing points in prior studies.

First, negative effect of reduced revenue for domestic ICT firms has not been taken into consideration. In addition to the cost reduction effect of cloud computing, it is possible that Japanese firms import foreign cloud services instead of utilizing domestic services. This reduction of revenue would affect economy though multiplier effect.

On the other hand, cost reduction, together with reallocation of workers in user firms that is pointed out by Ross (2011), would affect TFP of Japanese firms. If the impact on TFP can be estimated, the effect on overall economy can be assessed through DSGE analysis with standard New IS/LM modeling. Similarly, the benefit of avoiding opportunity loss that is pointed out by Cudanov et al. (2011) can be translated in the increase of demand for user firms. If the amount of opportunity loss can be estimated, the effect also can be assessed by New IS/LM modeling.

By combining the prior studies and missing points, overall framework of the analysis on the economic impact of cloud computing is organized as in Figure 1.

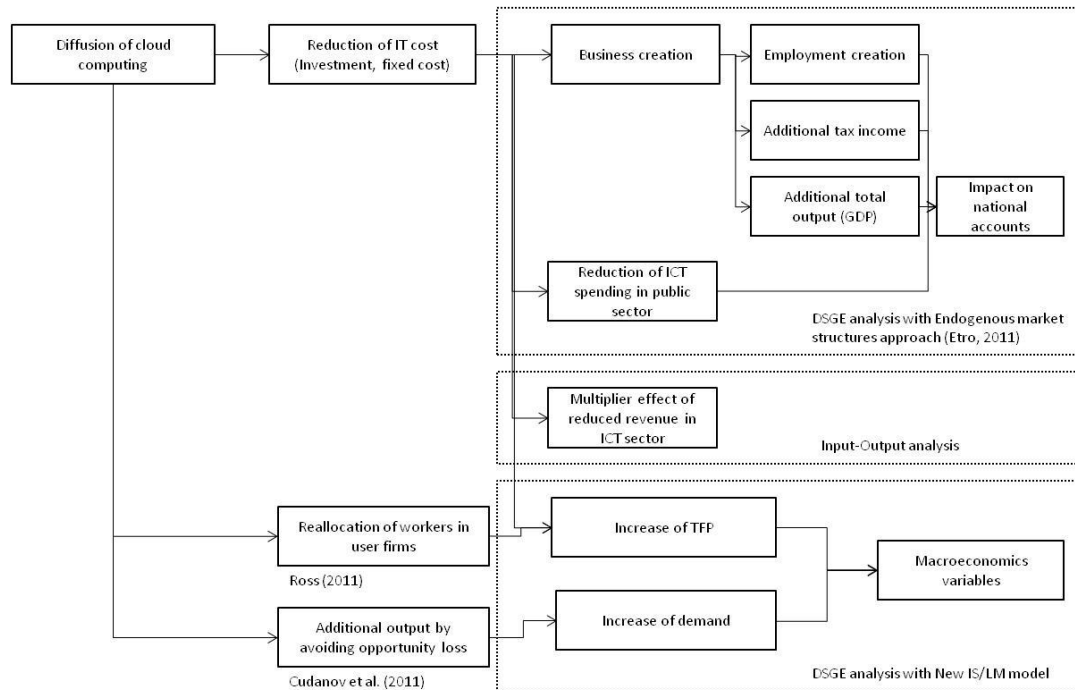


Figure 1. Framework of economic impact of cloud computing

The primary impact of cloud computing is the reduction of IT cost, reallocation of workers in user firms, and additional output by avoiding opportunity loss. Reduction of IT cost would affect economy positively by business creation and reduction of spending in public sector as shown by Etro (2011). However, the cost reduction can be translated in the reduction of revenue in ICT sector. This negative effect can be assessed by input output analysis.

As shown above, the reduction of IT cost and reallocation of workers in user firms can affect TFP. Avoiding opportunity loss also can result in the increase of demand. The impact of these changes in TFP and demand on economy can be assessed by macroeconomic framework such as New IS/LM model.

4. Conclusion

This study analyzes prior studies on macroeconomic impact of cloud computing and presents the framework that can offer overarching understanding on the issue. As shown in Figure 1, prior studies focus mostly on the positive side of cloud computing, and empirical analyses are quite limited. Figure 1 provides more comprehensive aspects of the impact of cloud computing and suggests the future research opportunities.

As Etro (2011) suggests, actual effect on economy depends on the country-specific characteristics. In this regards, it is also meaningful to follow and adjust the approach of prior studies and compare the results internationally. This study further discusses the research directions to assess macroeconomic impact of cloud computing in Japan.

References

- Cudanov, M., Krivokapic, J., and Kronic, J. (2011) The influence of cloud computing concept on organizational performance and structure. *Management*, Vol.60, No.9, pp.18-25.
- Etro, F. (2011) The economics of cloud computing. *IUP Journal of Managerial Economics* 9, Vol.2, No.5, pp.7-22.
- Etro, F. (2009) The economic impact of cloud computing on business creation, employment and output in europe: An application of the endogenous market structures approach to a GPT innovation. *Review of Business and Economics*, Vol. 54, No.2, pp.179-208.
- IPA (2012) IT jinzai hakusho 2012 [IT human resources white paper 2012].
- Ross, P. (2011) How to keep your head above the clouds: Changing ICT worker skill sets in a cloud computing environment. *Employment Relations Record*, Vol.11, No.1, pp.62-74.