論文の内容の要旨

論文題目　An Empirical Analysis of the Productivity Effects of Information Technology (IT) in Japan: The Impact on the Macro Economy and Firm Performance

（日本における IT と生産性に関する実証分析:
マクロ経済と企業パフォーマンスに対する影響）

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At the macroeconomic level, there is now a consensus that Information Technology (IT) has played a crucial role during the U.S. growth resurgence since the late 1990's (Jorgeson, 2001; Oliner and Sichel, 2002). The macroeconomic impact of IT has also been recognized in the major OECD countries as well (Coleccia and Schreyer, 2002; van Ark et al., 2002). Jorgenson and Motohashi (2005) have rigorously compared the sources of economic growth in Japan and the U.S. and find that the level of IT investments in Japan also rose sharply during the late 1990's, contributing substantially to GDP growth.

While Japan was experiencing a serious economic downturn during the 1990's, other Asian countries, as represented by the Newly Industrialized Economies (NIE's), developed rapidly recording a high rate of economic growth. Many of these Asian economies possess a large IT producing sector, and it is expected that these economies are using IT as an effective tool to drive their economies. However, past international comparisons of the effects of IT on economic growth are limited mainly to the U.S., Japan, and the EU nations, so the impact of IT in Asian countries is unclear. One major aim of this study is to bridge this void in the literature and include Asia in the international comparison of the effects of IT, in order to benchmark the macroeconomic IT performance of Japan against other Asian economies that are rapidly developing.

In the process of selecting the country to benchmark in Asia, China and Korea may be the natural two candidates due to the size of the economy and the IT producing sector. However, in this study, we focus on Korea in order to conduct a rigorous comparison of the contribution of IT to economic growth at the level of Jorgenson and Motohashi (2005). The Korean economy is still sustaining an annual economic growth rate of over 4% and possesses a large IT producing sector. A comparison with Korea reveals whether or not the Japanese economy is behind Asia in terms of utilizing and

producing IT.

In this study, the sources of economic growth between Japan and Korea are compared focusing on the role of IT. The Japanese data of Jorgenson and Motohashi (2005) has been extended to 2004, which enables us to take a look at the situation in Japan after 2000. A similar database was constructed for Korea using Input-Output (I-O) Tables, the manufacturing census/surveys, various IT statistics, and trade statistics. The definition of IT assets is in accord with those of Jorgenson and Motohashi (2005), taking all three types of software investments (prepackaged, custom, and own-account) into account. Internationally harmonized price indexes have been constructed for Korea based on Japanese IT price indexes in order to control for the differences in the method of constructing IT price indexes in these two countries.

In terms of the input side, the results of the growth accounting report that despite the large difference in the overall GDP growth rate, the contribution of IT capital services in Japan is not far behind the level of Korea. The results indicate that a large portion of the difference in the growth rates between these two economies is attributable to the contribution of non-IT capital services and labor input.

Both Japan and Korea possess a large IT producing sector, and the results of the sources of TFP growth reveal that the IT sector contributes substantially to TFP growth in both of these economies. However, in recent years, the IT sector of Korea has been expanding rapidly, and coupled with the swift technological progress of IT, the contribution of TFP of the IT sector to the overall TFP growth rate of the entire economy is increasing sharply. The results report that the contribution of the TFP growth rate of the IT sector is larger in Korea compared with Japan in recent years. However, the contribution of TFP growth of the non-IT sector is larger in Japan in recent years.

After the contribution of the macroeconomic growth rate has been estimated, this study also examines the effects of IT at the firm-level in Japan. Micro data of the ICT Workplace Survey and the Basic Survey of Business Structures and Activities (BSBSA) of the Japanese Ministry of Economy Trade and Industry (METI) was linked to perform analyses of the effects of IT on firm performance.

The first set of firm-level analysis examines the impact of organizational change on the productivity effects of IT. The specific type of organizational change of focus is the change in decision rights accompanying IT investments. Past studies in the U.S. and Japan indicate that the role of organization is a crucial factor that distinguish the successful and non-successful users of IT at the firm-level (Brynjolfsson and Hitt, 2000; Bresnahan et al., 2002; Hirano, 2006; Shinozaki, 2006). In terms of the type of organization that is complementary with IT, past studies of the U.S. indicate that an

organization with a decentralized decision making structure has a higher productivity effect of IT (Bresnahan et al., 2002). However, the decision making structure of Japanese firms has been more decentralized than its Western counterparts (Aoki, 1986), and the benefits of centralization induced by IT may increase firm performance in Japan.

In the Management Information Systems (MIS) literature, there are studies that indicate the positive effects of centralization as well as decentralization. On the one hand, the decrease in decision information costs caused by IT may lead to centralization and the coordination advantage of centralization may increase firm performance. On the other hand, the reduction of agency costs and the increase of information sharing amongst line workers induced by IT may lead firms to decentralize decision rights. Therefore, it is not clear whether either centralization and/or decentralization impacts IT performance of firms.

In this study, the change in the productivity effects of IT due to changing decision rights is examined for both centralization and decentralization in Japan. The results indicate that in Japan, not only decentralization but also centralization of decision rights increases the productivity effects of IT. We obtain robust results taking firm heterogeneity into account, which is indicated to be a large factor that affects the parameter estimates of the contribution of IT in past studies. Furthermore, our analysis reveals that these effects of changing decision rights are pronounced in large firms and firms in the non-manufacturing sectors in Japan.

The second firm-level analysis sheds light on the mechanism of how IT impacts productivity. Firms are increasing collaborating intimately with partners of a supply chain using IT. Using a Supply Chain Management (SCM) system, firms now share critical information such as sales and inventory data with partners of the supply chain to increase the efficiency of individual firms in the supply chain. Although past studies have indicated the positive productivity effects due to adopting SCM systems (Aral et al., 2006), the mechanism that leads to higher productivity is unclear.

Motivated by various theoretical models of inventory reduction effects due to information sharing in a supply chain, we hypothesize that firms that adopt SCM systems reduce inventory levels and that these inventory reductions lead to higher productivity due to an increased efficiency of the production process. Our empirical results reveal that firms that adopt SCM systems do indeed have lower inventory levels and that these reductions in inventory levels increases productivity of firms. These results are consistent with past studies that indicate that Japanese firms' IT investments are geared towards cost reductions and increasing the efficiency of

business processes (Motohashi, 2007). Furthermore, our results reveal that these effects are more marked in firms that have a high sales variance, indicating that firms that are facing uncertain demand are gaining a larger advantage due to information sharing, which is consistent with theoretical models of supply chains.

The results of the macroeconomic analysis indicate that IT capital is still a major driving force of the Japanese economy after the 2000's and Japan is not behind Asia in terms of IT use. However, due to the slow-down of non-IT capital accumulation and the decline of the labor input in recent years, Japan lags far behind in terms of the contribution of non-IT capital and labor inputs. Therefore, increasing the productivity effects of IT and increasing TFP by effectively using IT is a critical task for the entire economy.

The firm-level analysis complements the macroeconomic analysis by incorporating organizational factors and specific types of IT systems into the analysis to shed light on the micro factors that affect productivity at the firm-level. The results of our analysis reveals that changing decision rights increases the productivity effects of IT in Japanese firms, and that interfirm collaboration using SCM systems increases the operational efficiency of firms leading to a higher TFP of Japanese firms. The results of these firm-level studies reveal how IT could be used effectively to increase performance of Japanese firms and gives some insights into how Japan could improve its macroeconomic performance by effectively utilizing IT.