An Empirical Analysis of Technical Efficiency: The Role of IT Intensity and Competition

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We analyze the impact of information technology (IT) on the technical efficiency of firms in the context of their observed competitive settings. Because competition can be a driver of efficiency and industries display varying degrees of competitiveness, firm-level efficiency is likely to display considerable heterogeneity. To shed light on these questions, we analyze the economic impact of IT on technical efficiency, a key component of efficiency, in heterogeneous competitive settings. Our study employs a number of econometric techniques, including a stochastic frontier and a generalized method of moments approach, on data from firms in a wide cross-section of industries. We find, after controlling for firm-level heterogeneity and potential endogeneity, that IT is positively associated with gains in technical efficiency but its impact is moderated by the degree of competition. Firms display large variation in their levels of technical efficiency partly because of the heterogeneous market competitiveness conditions they face. In more competitive industries, firms tend to deploy IT more intensively and use it more efficiently. Our study makes a distinct contribution relative to prior studies that have focused on the productivity impacts of IT while assuming perfect competition and not allowing for potential heterogeneity in firm-level efficiency. Overall, our results demonstrate that IT and competition are significant determinants of gains in technical efficiency and provide insight into how competition affects the returns to IT investment.

Key words: technical efficiency; competition; productivity; economics of IS; business value of IT

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1. Introduction
Expenditures on information technology (IT) by U.S. firms have grown rapidly over the last 50 years, peaking at almost half of new capital investment in the late 1990s, although recent growth has slowed in the current economic downturn (Computerworld 2010). Not surprisingly, U.S. non-farm business sectors achieved rapid productivity improvement in the late 1990s with the average growth rate rising to 2.7% (Jorgenson and Stiroh 2000, Stiroh 2002). Because IT constitutes a significant and increasing share of total capital, there has been widespread examination of the relationship between IT investment and productivity growth. The consensus view now is that IT contributes significantly to productivity and to output growth (Jorgenson and Stiroh 2000, Brynjolfsson and Hitt 2003, Dedrick et al. 2003).

Productivity growth results from both technical progress and efficiency improvement (Fare et al. 1994, Banker et al. 2005). Technical progress shifts the production possibility frontier outwards and can be achieved by employing new technologies or by introducing product and process innovations. An example of technical progress is the migration to a new business model or a reengineered process enabled by solutions based on the complementary set of mobile and cloud technologies. In contrast, efficiency gains are achieved when firms move up the production possibility frontier by extracting more output from any given set of inputs and extant technology. For instance, firms can improve the quality of decision making, and as a result the performance of operating processes such as supply chain or customer acquisition, through the use of business intelligence software that enables the application of sophisticated analytics on existing data.

Moreover, multiple firms can achieve efficiency gains when superior management practices diffuse from one firm to others (Basker 2005, Nishimizu and Page 1982, Barros 2008). Increases in the intensity of IT capital, competition, and their interaction can accelerate this process. For instance, increases in IT