Understanding Cross-Level Interactions of Firm-Level Information Technology and Industry Environment:
A Multilevel Model of Business Value

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ABSTRACT

This article contends that although much research on the business value of IT focuses on firm-level impacts, studies have begun incorporating industry-level variables as explanatory factors of interest to offer better contextualized explanations for the differences in value firms obtained from their IT across different industries. The authors present a multi-level model of IT value where industry-level and firm-level factors jointly determine the value a firm obtains from its IT. By using a nested model to examine industry to firm interactions, they are able to control for problematic violations of statistical assumptions that are likely to bias estimates from conventional methods. Their analysis shows that all of the industry factors we examined had significant interaction effects. Specifically, industry concentration, industry growth, industry capital intensity, industry outsourcing, and presence in service sector significantly impact firm-level IT value. More interestingly, the authors find these impacts manifest not as mean differences between industries, but rather as interactions with firm-level effects.

INTRODUCTION

Information technology (IT) is the single largest category of capital investment in the United States (Stiroh, 2002). Much research has examined the impact of this investment on various measures of firm performance, such as labor productivity, and market valuation, (e.g. Jorgenson, 2001; Triplett and Bosworth, 2002; Bharadwaj et al., 1999; Brynjolfsson and Hitt, 1996; Hitt and Brynjolfsson, 1996; Morrison, 1997; Anderson, Banker and Ravindran, 2006; Aral & Weill, 2007; Stiroh, 2002; Pilat, 2004). Most investigation of IT impacts have, understandably, focused at the locus of decision-making: the firm-level (Rai et al., 2006; Barua et al., 2004; Banker et al., 2006; Paulo and Sawy, 2006).

However, more recently, information systems (IS) researchers have pointed out the importance of the investigatory context (Luke, 2004; Hong et al., 2013). In the context of firm-level investigations, contextual understanding connotes firm decisions within an industry (Chiasson and Davidson, 2005). Despite seemingly widespread acknowledgement of the importance of industry context, such investigations are largely under-explored.

While IT value research has begun to take notice of this issue, it has not been adequately addressed in the extant literature. Melville et al. (2004) conducted an extensive review of the field and proposed a number of potentially fruitful avenues for future research on IT value. We attempt to answer their call by addressing one of the questions they propose: "What is the role of industry characteristics in shaping IT business value?" They also specifically mentioned that the use of industry controls was not a viable means of answering that question because the use of such controls ultimately ignores the investigatory context. Despite this, researchers, while moving away from using simpler industry dummies to control for industry heterogeneity, have persisted in using industry attributes as controls to measure industry impacts. For example, Chari, et al. (2008) controlled for industry capital intensity, uncertainty, concentration, and growth in their study of the impact of firm diversification on the returns from IT investments. Similarly, Melville, et al. (2007) inserted industry dynamism and competitiveness into their firm-level production functions. Also, Xue et al. (2012) demonstrated how industry environments moderate the type of performance gains firms are likely to realize through IT. Nevertheless, none of these studies used an explicitly contextualized modelling approach such as multilevel modelling. Multilevel or hierarchical models allow firm-level effects to vary across industries. This approach enables researchers to assess both the impact and magnitude of a variety of contextual factors and is a major source of this paper's expected contribution. Since most phenomena that scholars study is fundamentally multilevel in nature, the use of multilevel analytic techniques becomes extremely important (Luke, 2004).

The critical role of industry characteristics is beginning to be recognized, and a burgeoning number of studies in the IS and strategy literature suggest that industries do differ in the extent of IT use and adoption (e.g. Farrell, 2003; Forman et al. 2003). Nevertheless, no formal analysis has been conducted to identify either how these differences interact with industry-specific attributes to affect firm performance, or by how much. If this was known, researchers would be better able to ascribe reasons for the differences in IT value found across firms. Without this knowledge, the measurement and establishment of performance-related goals from IT investments may be biased. Thus, our research question is:

How do the characteristics of the industry environment impact firm IT value?

The inability of existing research to provide a basis to differentiate firm-level IT impacts according to the nature and types of industry characteristics hinders improvements in the efficient management of IT resources, as well as the achievement of greater accuracy in the measurement of IT impacts, as various questions remain unanswered. This research study explores some of these issues using hierarchical linear modelling (Raudenbush & Bryk, 2002), a robust analytic method that is expressly designed to estimate models with nested data structures. We then present the details of our model, followed by the description of the data, the analysis procedures and the results. The paper concludes after a discussion of the implications of the initial results.

LITERATURE REVIEW

The purpose of this study is to conduct an initial analysis to examine the role industry factors play in the link between IT and firm performance, and to determine if a multilevel model can prove a useful lens through which to examine this link. The strategy literature informs us that a firm's industry has a significant and sustained impact on its performance (Brush et al., 1999; Chang and Singh, 2000; McGahan and Porter, 2003). Building on prior studies of firm performance in the IS and strategy literature (e.g. Chang and Singh, 2000; McGahan and Porter, 2003), a range of both firm and industry-level factors were selected for inclusion in our model. Anecdotal evidence and practitioner studies indicate that industries do differ in the extent to which they adopt and use information technology

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