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Relationships among information technology, inventory, and profitability: An investigation of level invariance using sector level data

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Abstract

Researchers studying multi-level theories use homologous models to represent parallel nomological networks among similar constructs across different levels of analysis. We use the logic underlying homologous models to examine whether relationships established at the firm level of data aggregation are also evident at the economic sector level. Specifically, we investigate the process-model which posits that the relationship between IT investment and financial performance is mediated by operational performance, albeit in the manufacturing sector using firm level data. We examine the process-model using publicly available sector level data from 1960 to 1999 in the manufacturing, retail and wholesale sectors of the U.S. economy. Our results provide strong support for the process-model and highlight inter-sector variations, suggesting that different contextual factors may be at play in the three sectors. Finally, examining the process-model at a higher level of aggregation contributes to the scant multi-level empirical research.

Keywords: IT investment; Inventory; Profitability; Cross-level longitudinal analysis

1. Introduction

"Inventory management" and "investment in information technology" have generated great interest in the academic and business press in recent years because of the substantial monetary expenditures involved. In October 2006, the total adjusted inventory in the United States (U.S.) was $481 billion for all manufacturers, $492 billion for retailers, and $393 billion for wholesalers.[2] Similarly, investments in information technology (IT) increasingly account for a larger proportion of capital expenditures in U.S. companies, exceeding 50% in 2000 and amounting to more than $400 billion (Carr, 2003). In the present study, we examine two important questions associated with IT investment's impact. We first analyze whether increased IT investment has led to improved inventory performance. Then, we study the role of inventory performance between information technology and financial performance.

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[2] 2006 Monthly Trade Survey of the U.S. Census Bureau.

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Our research is motivated by the following observations. First, while IT investment's impact on a firm's inventory and/or financial performance has been extensively studied in several academic disciplines, few studies have linked all the three variables (i.e. IT investment, inventory, and financial performance) simultaneously. We fill this gap by holistically examining the empirical associations among these three constructs, using longitudinal data that span four decades.

Second, the empirical evidence supporting the effect of IT investment on financial performance is mixed (Kohli and Devaraj, 2003), prompting researchers to coin it the ''profitability paradox'' (Dedrick et al., 2003). Carr (2003) argues that large investments in IT do not result in higher performance and are not a source of competitive advantage because IT is not a rent yielding resource in a ''resource-based view'' sense, but it is an infrastructure that is easily imitable and, at best, provides only a rapidly eroding advantage to firms. Other IT researchers note that instead of directly affecting a firm's financial performance, IT investment's impact is indirect through intermediate operational performance related to inventory turnover, product quality, and plant productivity (Banker et al., 1990; Barua et al., 1995; Melville et al., 2004). The mediating role of operational measures between IT investment and financial performance is formalized as the ''process-model'' in the IT literature. The process-model explicitly specifies that IT investment leads to better financial performance indirectly through improving operational performance. From a theoretical perspective also, the process-model is consistent with the industrial organization paradigm proposed by Scherer and Ross (1990) that operational excellence in inventory performance is essential to appropriate financial benefits from implementing structural decisions such as IT investments. In linking IT investment, inventory and financial performance, we aim to examine the process-model beyond its manufacturing origins into the retail and wholesale sectors.

Third, previous studies have examined relationships among IT investment, inventory and financial performance with firm level data. In their meta-analysis of the IT literature, Kohli and Devaraj (2003) concluded that the impact of IT investment is most likely to be detected in manufacturing industries. Further, they noted that IT investment's impact is easier to observe with primary data at the firm level than with secondary data at higher levels of aggregation. In contrast, organization systems scholars suggest that similar relationships may exist at multiple levels of an organizational system (Duncan, 1972). Multi-level organization system researchers use homologous models to represent parallel nomological networks among similar constructs across different levels of analysis (Chen et al., 2005a). Identifying such cross-level relationships is of considerable importance to theory building (Rousseau, 1985; Barney, 1992; Hackman, 2003) because they signal a boundary condition; however, empirical analysis of such relationships remains scarce (Chen et al., 2005a).

To resolve these issues in the existing literature, we examine whether relationships established at lower levels of data aggregation (e.g. firms) are also evident at higher levels of aggregation in the three main sectors (manufacturing, wholesale and retail sectors) of the U.S. economy. We examine our research questions using econometric data publicly available from the Bureau of Economic Analysis (BEA) and hierarchical regression analysis.

The remainder of the paper is organized as follows: a brief review of the relevant literature and research hypotheses are presented in Section 2. Data sources and variables are discussed in Section 3. The statistical methods used to examine the hypotheses and results are described in Section 4, followed by a discussion of the findings and their implications in Section 5.

2. Theoretical foundation, literature and research hypotheses

To build the theoretical foundation for the present study, we reviewed three literature streams. These are operations management (OM), supply chain management (SCM), and information systems/information technology (IS/IT). We conducted an extensive review of the relevant OM, SCM, and IS/IT literature focusing on studies that examined IT investment and its impact on inventory performance and/or financial performance. We classified these studies by the type and level of data and the analysis method used. The type of data used in the studies range from cross-sectional to longitudinal, and the level of aggregation at which the analysis is conducted includes dyadic interactions, multiple firms in one or more industries, and industry sub-groups aggregated by strategic business units (SBU) or standard industrial code (SIC) in the manufacturing, retail, or wholesale sectors. Data sources include survey or case-based data and publicly available data. Rather than a complete list of extant literature, we present a summary of the most relevant literature in Table 1.

Not surprisingly, we find that each research stream has developed with a distinct focus. One of the primary themes in OM research has been on examining the