IT Productivity Impacts in Manufacturing Contexts

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INTRODUCTION

The fundamental questions of whether and how information technology (IT) contributes to firm performance have been answered in different ways. IT value research findings have been equivocal, with some studies finding negative performance impacts (Berndt & Morrison, 1995; Johansen, Karmarkar, Nanda & Seidmann, 1996), some finding no overall effect (Barua, Kriebel & Mukhopadhyay, 1995; Dos Santos, Peffers & Mauer, 1993; Loveman, 1994; Strassman, 1985, 1990), and some finding positive impacts (Brynjolfsson & Hitt, 1996; Brynjolfsson & Yang, 1997; Hitt & Brynjolfsson, 1996; Mukhopadhyay, Kekre & Kalathur, 1995).

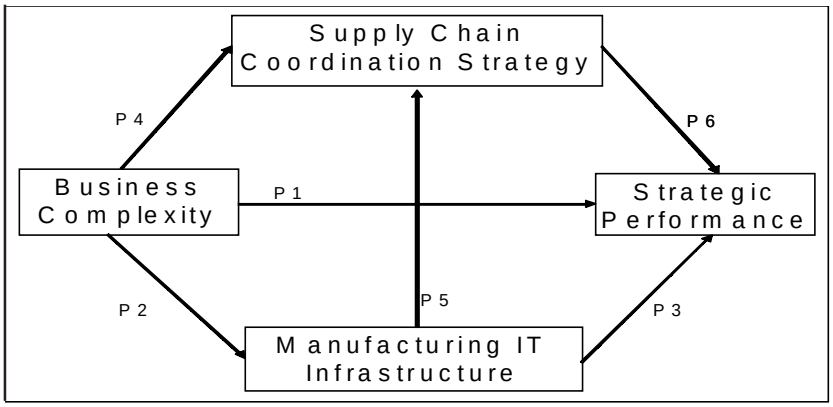
To reconcile these findings, several studies suggest that contextual factors associated with the firm and/or its environment mediate IT's performance effects (c.f., Banker, Kauffman & Morey, 1990; Brynjolfsson & Yang, 1997; Scott-Morton, 1991; Venkatraman, 1991; Weill, 1992). Brynjolfsson and Hitt find that "firm effects" accounted for roughly half the productivity benefits attributed to IT. Firm capabilities leverage investments in IT. They suggest:

"…an interesting extension would be to identify common characteristics of the highly productive firms and thereby examine some of the conventional wisdom regarding management best-practice" (1995, p. 12).

BACKGROUND

This project explores how business complexity, supply chain coordination strategy, and manufacturing IT infrastructure interact to impact inventory productivity. The research model is represented in Figure 1, where theoretical constructs are represented by rectangles, and proposed associations between them are represented by numbers.

Figure 1. Research model



Business complexity describes the degree of coordination difficulty associated with a firm's supplier- and customer-facing processes due to volatility and diversity of its product-market (Holland, 1995). This reflects the transactions cost perspective in which uncertainty results from imperfect foresight and difficulty in solving problems containing multiple variables.

Business complexity has become a crucial consideration, as global competition has pressured firms to diversify their product offerings into markets with which they have little experience, and at the same time, to compete on cost, quality, reliability, and responsiveness. They are attempting to maximize performance on all dimensions, while struggling to cope with product proliferation and heightened customer expectations in unfamiliar product markets.

Manufacturing IT infrastructure describes the extent of IT deployment for manufacturing planning and control (MPC) functions. It is defined as the enabling base of shared IT capabilities which "provides common services to a range of applications" (Broadbent, Weill, O'Brien & Neo, 1997, p. 175), including "…information to efficiently manage the flow of materials…coordinate internal activities with those of suppliers, and communicate with customers about market requirements" (Vollmann, Berry & Whybark, 1992, p. 2). It is hypothesized to mediate business complexity's impact on inventory turnover.

As companies struggle to expand margins and improve operational excellence within their own organizational boundaries, their efforts often earn diminishing marginal returns. Accordingly, organizations have begun to focus on performance optimization across organizational boundaries in the supply chain. IT presents opportunities to streamline and integrate key operations and processes by coordinating distributed activities within and across a firm's boundaries. Consequently, as firms within a supply chain coordinate product designs, demand forecasts, and production among themselves, schedules become more stable and coordination simpler.

Schedule stability improves output efficiency by reducing inventory buffers and their attendant physical costs throughout the supply chain. This confers competitive advantage, in that capital invested in inventory becomes available for other differentiating opportunities. Market mediation costs are also reduced. These include costs associated with lost sales and customer dissatisfaction due to stock outs, as well as lower profits due to product markdowns on unsold goods. In volatile industries, these costs can exceed the manufacturing cost (Fisher, 1997).

Brynjolfsson and Yang (1997) found that firms investing in complementary intangibles such as business process adjustments, training, and interorganizational relationships reap four times the return from their investment in IT as those not making these investments. To the extent that firms leverage IT to improve interorganizational relationships, and to coordinate and integrate their marketing, planning, and production decisions, their inventory productivity and other measures of performance should improve.

The *supply chain coordination strategy* describes the firm's approach to process coordination across firm boundaries. The goal is to improve performance across the entire supply chain. It measures the extent to which the firm has integrated its activities with those in the larger business network so that efficiencies are maximized across the whole business network—not just the individual function or firm (Venkatraman, 1991). This construct is measured on a continuum anchored by transaction on one end and partnership on the other (c.f., Henderson, 1990; Malone, Yates & Benjamin, 1987).

Inventory productivity is the dependent variable, calculated as annual sales revenue/value of average total inventory (Vollmann et al., 1992). This is consistent with Brynjolfsson and Yang's (1997) calculation of productivity, and is regarded as a useful measure of the physical efficiency of a firm's supply chain (Fisher, 1997). This key measure addresses the physical movement of goods and the efficiency of this process. Inventory productivity also reflects firms' effectiveness in responding to market context. Whether the market dictates responsiveness, or low-cost strategies, or both, annual sales revenue reflects success in meeting market demands.

The reduction of physical costs associated with production, transportation, and inventory, and of market mediation costs associated with stock-outs and markdowns, has become a strategic necessity. To the extent that IT can be used to accurately forecast demand; efficiently plan, schedule, and accomplish production; and purchase and manage inventory in the supply chain, it can support improved performance.

MEDIATION EFFECTS OF SUPPLY CHAIN COORDINATION STRATEGY AND MANUFACTURING IT

Our research question asks, "How do manufacturing IT infrastructure and supply chain coordination strategy mediate the relationship between business complexity and inventory productivity?"

Previous empirical studies have generally attempted to measure generic IT dollar investments and their relationships to productivity, profitability, or firm valuation. These rely on aggregated data regarding multiple applications from a variety of industries. We're aware of none that include both complexity and supply chain coordina-