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The effect of lean production on financial performance: The mediating role of inventory leanness

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ABSTRACT

The purpose of this paper is to empirically investigate the relationship between lean production implementation and financial performance. Particular emphasis is placed on the mediating role of inventory leanness in deriving the financial performance benefits commonly associated with lean production. Moreover, the interaction among different lean practice bundles in affecting financial and inventory performance is assessed. Based on an analysis of a combination of survey and secondary data, the effect of lean production on financial performance is found to be partially mediated by inventory leanness. In addition, there is strong evidence that the concurrent implementation of internally-focused and externally-focused lean practices yields greater performance benefits than selective lean production implementation. Thus, this study contributes to the theory of lean production by providing insights into the mediated and moderated effects of lean production on inventory leanness and financial performance.

1. Introduction

Lean production is often regarded as the gold standard of modern operations and supply chain management (e.g., Guinipero et al., 2005; Goldsby et al., 2006). Numerous studies have investigated the relationship between lean production and financial performance (e.g., Fullerton et al., 2003; Jayaram et al., 2008). Yet, the exact mechanism(s) through which lean production affects financial performance remain underresearched. Conventional wisdom holds that, as a manufacturing strategy, lean production strives to minimize waste and thereby increase efficiency (Womack et al., 1990), and by extension, financial performance.

Given the multiplicity of lean production practices such as kanban, JIT, and TQM, for example, it is apparent that the relationship between lean production and financial performance may be complex and multi-faceted. Indeed, one factor that is often implicitly considered as a mediator of this relationship is inventory efficiency. For example, several studies have examined the effects of lean production implementation on inventories (e.g., Huson and Nanda, 1995; Balakrishnan et al., 1996). Likewise, analytical research has examined the linkage between production and inventory (e.g., Miyazaki, 1996; Dobos, 2007). In a separate literature stream, prior research has investigated the performance implications of efficient inventory management (e.g., Capkun et al., 2009; Eroglu and Hofer, 2011). Moreover, Fullerton and Wempe (2009) contend that the effects of lean production implementation on financial performance are mediated by various operational performance measures, such as delivery performance, manufacturing cycle times, and labor productivity. However, these authors do not consider inventories as a mediating factor. Yet, inventory costs are of great significance in the context of logistics and supply chain management (Stock and Broadus, 2006).

Thus, the purpose of this study is to add to our understanding of lean production by examining the relationship between lean production and financial performance, with an emphasis on the mediating role of inventories. In addition, and consistent with the notion that lean production is a system of lean practices (Womack et al., 1990), interactions among various facets of lean production and their effects on inventories and performance are investigated.

This research contributes to the existing literature in multiple ways: First, it provides a richer, more nuanced conceptualization of the relationships among lean production, inventory leanness, and financial performance. Specifically, we draw on existing lean production and inventory literature to develop a research model that examines the mediating role of inventory in delivering the commonly expected financial performance benefits of lean production implementation. This model is tested using a data sample with firm-level observations from a diverse set of US manufacturing industries which is compiled from two distinct sources: survey data and matched secondary financial data. Beyond conventional

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mediation analysis, we also test for potential reverse causality and, thus, gain a better understanding of the interplay of lean production, inventory leanness, and financial performance.

Second, this study explores interactions among lean practices. Existing literature suggests that when lean practices are implemented concurrently, the total performance effect will exceed the sum of performance effects of individual lean practices (Shah and Ward, 2003). While some recent studies (e.g., Furlan et al., 2011a) have empirically tested the complementarity (synergy) among lean practice bundles, these analyses were restricted to specific aspects of lean production and focused on plant-level performance. In this study, we conceptualize lean production as two lean practice bundles (internal and external) that collectively encompass all lean practices, and we test the synergy between these lean practice bundles at the firm-level instead of at the plant level. In addition, this research addresses concerns of potential common methods bias (Podsakoff et al., 2003) that may arise when lean production and performance data are provided by the same survey respondent by using secondary inventory and financial performance metrics along with primary survey data on lean production implementation.

Third, the two main constructs of this study, i.e., lean production and inventory leanness, are operationalized using measures proposed in recent research. More specifically, lean production is assessed using a survey instrument developed by Shah and Ward (2007) which consists of a set of 10 distinct lean practices: supplier feedback, supplier JIT, supplier development, customer involvement, pull manufacturing, continuous flow manufacturing, setup time reduction, statistical process control, employee involvement, and total productive maintenance. Inventory leanness, in turn, is measured using the Empirical Leanness Indicator (*ELI*) developed by Eroglu and Hofer (2011). The *ELI* measures a firm's inventory leanness as the deviation of a firm's inventory levels from size-adjusted within-industry average inventory levels. As such, the study extends operations management literature by providing independent empirical evidence for the validity of these instruments.

The remainder of this paper is structured as follows: The relevant literature is reviewed and hypotheses are proposed in Section 2. Data and measurement issues are discussed in Section 3. In Section 4, mediation and interaction hypotheses are tested and empirical estimation results are presented. Section 5 presents a discussion of the findings, research and managerial implications, limitations, and future research opportunities.

2. Literature review and hypothesis development

Lean production is a strategy or philosophy that promotes the use of practices, such as kanban, total quality management (TQM) and just-in-time (JIT), to minimize waste and enhance firm performance (Womack et al., 1990). Thus, the implementation of lean production practices is expected to result in improved operational outcomes, such as lower inventories, higher quality, and shorter throughput times, which, in turn, should improve financial performance. This description of lean production clearly indicates a number of mediating factors between lean production and financial performance. This notion is consistent with the "new inventory paradigm" (Chikán, 2011, 2009) which emphasizes the connectedness to other processes and functions within firms and to firm profitability.

In this study, we focus on inventory leanness as the mediator of interest and suggest that inventory leanness mediates the effect of lean production implementation on financial performance. Inventory leanness is defined by comparing a firm's inventory levels to the size-adjusted average inventory level within the firm's industry (Eroglu and Hofer, 2011). It is expected that lean production implementation not only carries direct financial benefits, but also results in greater inventory leanness which, in turn, contributes to improved financial performance.

In accordance with the proposed research model, relevant literature is grouped in three distinct streams as shown in Fig. 1 adapted from Fullerton and Wempe (2009). The first stream consists of studies exploring the relationship between lean production and financial performance. The second stream examines the effect of lean production on inventory leanness and other operational outcomes as potential mediators. The third stream focuses on the analysis of the relationship between inventory leanness and financial performance. All three streams are reviewed below, followed by the presentation of research hypotheses on the mediating role of inventory leanness in the lean production-financial performance relationship and the interaction effects among lean production practice bundles.

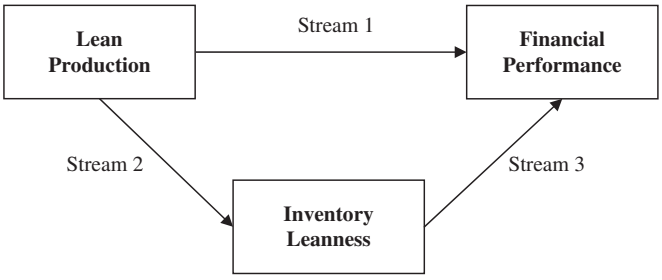

Fig. 1. Research streams on lean production and firm performance.

2.1. Stream 1: Relationship between lean production and financial performance

The first stream of research explores the direct effects of lean production practices on financial performance (Table 1). Most of these studies employ a survey methodology to assess the degree of implementation of lean production practices and to measure financial performance. The measures of lean production are typically narrowly focused on JIT (e.g., Inman and Mehra, 1993; Fullerton and McWatters, 2001) which is part of but not synonymous with lean production. Other studies identify companies that have adopted JIT practices via a search of news articles and company reports (Biggart, 1997; Kinney and Wempe, 2002). Firm financial performance, in turn, is estimated using metrics such as *ROS*, *ROA*, and *ROI* in most studies.

The studies' findings are largely consistent: Evidence of positive effects of lean production implementation on at least some financial performance indicators is presented by Inman and Mehra (1993), Callen et al. (2000), Fullerton and McWatters (2001), Germain et al. (1996), Kinney and Wempe (2002), Fullerton et al. (2003), Fullerton and Wempe (2009), and Yang et al. (2011). Only Biggart (1997) and Jayaram et al. (2008) find no statistically significant relationships between lean production practices and firm profitability.

2.2. Stream 2: Relationship between lean production and inventory leanness

The second stream of research explores the effects of lean production implementation on inventory leanness and other operational performance measures (Table 2). Most of the studies in this literature stream are based on surveys of manufacturing executives (e.g., White, 1993; Norris et al., 1994; Droge and Germain, 1998; Shah and Ward, 2003). These studies typically employ multi-item scales to measure the degree of implementation of lean production. Inventory and operational performance,