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An empirical investigation of advanced manufacturing technology investment patterns: Evidence from a developing country

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ABSTRACT

Advanced manufacturing technology (AMT) investment patterns in developing countries is in need of further investigation, particularly in the light of the conflicting evidence from the literature. This paper provides new evidence on AMT investment patterns from the Turkish automotive industry and develops a taxonomy by exploring the relationships between AMT investment patterns, ownership structure, firm size and performance. Analysis of industry survey data suggests the existence of three groups with different AMT investment strategies. Results suggest that AMT investment patterns are not only significantly correlated with firm performance or ownership, but also reveals significant differences in manufacturing performance across investment patterns.

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Introduction

Changing and increasing customer expectations and the inefficiency of conventional manufacturing have led manufacturers to consider new manufacturing approaches such as advanced manufacturing technology (AMT), which allows higher quality and flexibility at lower cost. AMT applies a range of technologies that utilize computers to control or monitor the manufacturing process (Boyer et al., 1996; Jonsson, 2000). It involves manufacturing techniques and machines combined with

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information technology, microelectronics and new practices in the manufacturing process (Boyer et al., 1996; Small and Chen, 1997; Burgess and Gules, 1998; Beaumont et al., 2002).

Diaz et al. (2003, p. 579) state that the “relevant literature dealing with an analysis of AMT investment patterns is fairly recent and still relatively scarce”. In their pioneering study, Boyer et al. (1996) proposed a taxonomy of AMTs used in the North American metal-working industries based on relative investment in design, manufacturing and administrative technologies. Following the work of Boyer et al. (1996), Jonsson (2000) and Diaz et al. (2003) present similar taxonomies based on the Swedish metal industry and the Spanish aeronautical industry, respectively. A common characteristic of the studies by Boyer et al. (1996), Jonsson (2000) and Diaz et al. (2003) is their focus on developed countries as far as the analysis of investment patterns in AMT is concerned. However, macro- and micro-economical factors are just important in AMT adoption (Alcorta, 1999), and developing countries face more challenges than developed countries in this respect. For example, firms in developing countries have a less educated workforce, more limited capital and resources, and a less organized economic system relative to firms in developed countries (Prasad et al., 2005). Furthermore, each industry has its own process structure while the type of industry affects the associated manufacturing activities (Hayes and Wheelwright, 1979; Swamidass and Newell, 1987). For this reason, AMT investments may change from one country and one industry to another, and the technological strategies identified in the previous studies may not be relevant to firms in developing countries.

There are three main motivations for this research: (i) the contradictory findings of previous studies empirically exploring the impact of AMT investment strategies on firm performance necessitates further evidence, (ii) the lack of studies exploring AMT investment patterns in developing countries, and (iii) the suggestion repeatedly echoed in the literature to study taxonomies over time and in different contexts (Miller and Roth, 1994; Kathuria, 2000; Frohlich and Dixon, 2001), which is taken up in this research.

The main aim of this study is to identify whether firms can be differentiated in their investments in AMT and to explore manufacturing and firm performances in the automotive industry of an emerging and developing economy, in this case Turkey¹. The study aims to contribute to the operations management literature by (i) providing new evidence from the automotive sector of a developing country in which the use of AMT is highly relevant, which, to our knowledge is a first, and (ii) to provide a taxonomy of AMT investments in this sector and to identify differences and similarities from previous studies. The results are also of use for managers to understand the characteristics of each pattern, and the relationship between the patterns, performance, size, and ownership structure in this context.

The rest of the paper is structured as follows. In Literature review and working hypotheses, we present a review of the relevant literature including the existing taxonomies proposed on AMT investments, and describe the working hypotheses. The methodological approach taken in this paper is presented in Methodology, followed by an analysis of the data and presentation of the results in Analysis and results. Conclusions are given in section conclusions.

Literature review and working hypotheses

There are numerous studies which show the potential benefits of using AMT in aiding manufacturers to gain competitive advantage by improving their technological prowess and ability to manufacture a wide range of products at low volumes without a significant increase in costs or penalties (Adler, 1988; Gerwin and Kolodny, 1992; Dean and Snell, 1996; Kotha and Swamidass, 2000), increasing productivity (Swamidass and Kotha, 1998), reducing direct labor costs, rework costs, and work-in-progress inventories (Zammuto and O'Connor, 1992; Zairi, 1993; Ghani and Jayabalan, 2000; Lewis and Boyer, 2002), and establishing closer and more responsive links to markets without increasing costs (Gupta et al., 1997). Swink and Nair (2007), however, stated that the existing

¹ See the lists by The World Bank <http://data.worldbank.org/about/country-classifications/country-and-lending-groups> and International Monetary Fund (IMF) <http://www.imf.org/external/pubs/ft/weo/2012/01/pdf/text.pdf> (both accessed 12 January 2013) for a list of developing countries, which Turkey appears as one in the Central and Eastern Europe region.

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