Chapter 8
Intangible Investment and Technical Efficiency: The Case of Software-Intensive Manufacturing Firms in Turkey

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ABSTRACT
This chapter analyzes the effect of intangible investment on firm efficiency with an emphasis on its software component. Stochastic production frontier approach is used to simultaneously estimate the production function and the determinants of technical efficiency in the software intensive manufacturing firms in Turkey for the period 2003-2007. Firms are classified based on the technology group. High technology and low technology firms are estimated separately in order to reveal differentials in their firm efficiency. The results show that the effect of software investment on firm efficiency is larger in high technology firms which operate in areas such as chemicals, electricity, and machinery as compared to that of the low technology firms which operate in areas such as textiles, food, paper, and unclassified manufacturing. Further, among the high technology firms, the effect of the software investment is smaller than the effect of research and development personnel expenditure. This result shows that the presence of R&D personnel is more important than the software investment for software intensive manufacturing firms in Turkey.

INTRODUCTION
In recent years, the share of investment in intangible assets of the firms in manufacturing industries increased in most of the EU countries while the share of investment in tangible capital has decreased (Corrado, Haskel, Jona-Lasinio, & Iommi, 2013). Intangible investment is defined as “the claims on future benefits that do not have a physical or financial embodiment” (Lev, 2000). Many authors proposed different ways of classifying the intangible assets (van Ark & Piatkowski,
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2004; Young, 1998; Vosselman, 1998; MERITUM, 2002; Oliner, Sichel & Stiroh, 2008; Hulten & Hao, 2008; Cummins, 2005). A more recent classification is proposed by Corrado, Hulten & Sichel (2009). According to him, there are three main components of intangibles. These are computerized information, scientific and creative property, and economic competencies. The computer software and computerized databases are in the first group. The second group includes science and engineering R&D, mineral exploration, copyrights and license costs, and other activities for product development such as design and research. The third group emphasizes the “soft” part of the intangible assets, such as brand equity, firm specific human capital, and organizational structure.

Studies that focus on the link between intangible investments and productivity found that intangible investments increase the productivity (Oliner et al. 2008; Corrado et al. 2009, Bosworth & Triplet, 2000; van Ark, Hao, Corrado & Hulten, 2009; Park & Ginarte, 1997). However, there is little evidence on the effect of intangible investments on firm efficiency (Becchetti, Bedoya & Paganetto, 2003). In this chapter, we analyze the effects of software investment and R&D personnel expenditure which are components of intangible investment on firm efficiency in Turkey. We consider the software intensive manufacturing firms in Turkey for the period 2003-2007. We observed two main trends. First, the number of firms making software investment decreased during the period investigated. Second, firms which already make software investment became more software-intensive. The main question asked is the increase in the intensity of software investment results in efficiency gains for the Turkish manufacturing firms. We also included R&D personnel expenditure as another component of intangible investment in this chapter.

This chapter is organized as follows: Background section provides the review of literature on intangible investment of the firms. Model section explains the specifications of the production function and the technical efficiency. In this chapter, we also provide an extant review of literature on determinants of technical efficiency. The other section is devoted to data and methodology. We, then discuss empirical results. The last section introduces concluding remarks.

BACKGROUND

The 1970s marks the beginning of a period referred to as post-Fordist Era. This period is characterized with a transition from manufacturing based economy to services based economy. This change has resulted in a shift from tangible assets such as physical, financial, and human to the intangible ones in the production process (Shapiro & Varian, 2013). The history of the concept of intangible investment dates back to Machlup (1962). He conceived the knowledge as an intangible asset and emphasized the difficulties in isolating the effects of intangible investment on the knowledge producing industries. Therefore, the much of the concern with the intangible asset is related to their identification and the measurement.

Intangible investment refers to investment in human capital such as education and socialization activities (Webster, 1999). Adams & Oleksak (2010) consider the intangible assets such as the personal networks, reputation, or innovation capability and refer to them as “invisible assets”. More recently, the definition of intangible assets is broadened to include software and databases, research and development activities, intellectual property rights, human capital, and organizational structure.

Empirical studies that use intangible investment as a production factor increased since the 2000s. Jalava & Pohjola (2008) found the positive effect of intangible investment on Finnish economy by using non-financial business sector data and emphasized the increasing role of the quality of the investment rather than the quantity in the economic growth. The positive effect of intangible