Exploring benchmark corporations in the semiconductor industry based on efficiency

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\textbf{ARTICLE INFO}

\textbf{Keywords:}
- Intellectual capital
- Corporate governance
- Firm value
- Efficiency
- Semiconductor industry
- Data envelopment analysis (DEA)

\textbf{ABSTRACT}

The aim of this study is to explore benchmark corporations in the semiconductor industry based on efficiency. In this study, perspectives of intellectual capital and corporate governance are taken into account for the input data, whereas firm value is considered as the output data. Data envelopment analysis (DEA), including CCR and BCC models, is utilized to ensure that the benchmark standards are precisely selected. Based on the result, suggestions for both semiconductor corporations and future research are provided at the end of this article.

\textbf{1. Introduction}

In today’s 21st century, where innovation, a knowledge-based economy and the value of knowledge management are strongly advocated, competition with globalization and fierceness is becoming a trend (Chen & Chen, 2013; Gao & Jefferson, 2007; Pardo & Nam, 2016). Such a phenomenon directly fuels the increasing importance of high-tech industry, especially the semiconductor industry, an industry using technology as its core competitive advantage, along with the continuous enhancement of technology during recent years. One reason for this is that the semiconductor industry is one of the most profitable industries, and can directly affect the growth of a nation’s economy (Chen & Chen, 2009; Hsu, 2017; Rasiah & Xiao Shan, 2016; Shin, Kraemer, & Dedrick, 2016).

To improve the performance of a knowledge-based industry, such as the semiconductor industry, a growing body of studies strongly advocates the importance of intangible assets (Avellaneda, 2016; Hsu, 2017; Joia, 2008). This is because intangible assets have been perceived to play a critical role in not only improving operation performance, but also creating firm values, no matter the kind of organization (Bontis & Serenko, 2009; Charoeun & Chansa-ngavej, 2010; Lin & Tang, 2009; Randhawa, Kirca, Talay, & Aldeniz, 2017; Rose, Kunar, & Ibrahim, 2008; Vomberg, Homburg, & Bornemann, 2015). Among numerous intangible assets, intellectual capital and corporate governance are two crucial assets that have been drawn tremendous focus from researchers and practitioners (Liu, 2017; Mangena & Chamisa, 2008; Petty & Guthrie, 2002; Striukova, Unerman, & Guthrie, 2008).

Intellectual capital (IC), the knowledge-based resources of an organization (Soo, Tian, Teo, & Cordery, 2017; Striukova et al., 2008), has been found to have strong and positive relationship with strong firm performance (Ferreira & Franco, 2017; Khalique, Bontis, Abdul Nasir bin Shaari, & Hassan Md. Is, 2015; Lu, Wang, Tung, & Lin, 2010; Tan, Plowman, & Hancock, 2007). In recent years, more and more studies have attempted to realize the content of IC (Inkinen et al., 2017; Lu et al., 2010) and deem it as a key driver of value within knowledge-based organization (Inkinen et al., 2017; McPhail, 2009).

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http://dx.doi.org/10.1016/j.hitech.2017.10.007

Available online 06 November 2017
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Similar to IC, an increasing number of developed, developing and emerging market countries today put equal emphasis on corporate governance (CG) (Mangena & Chamisa, 2008; Rodrigues, Tejedo-Romero, & Craig, 2017). CG refers to an amalgam of processes, customs, policies, laws, and institutions by which companies are directed, administered and controlled (Guillet & Mattila, 2010). Evidence has shown a positive association of CG with a firm’s operating efficiency and effectiveness (Anderson, Kadous, & Koonce, 2004; Ararat, Black, & Yurtoglu, 2017; Bushman & Smith, 2001; Daily & Dalton, 2015; La Porta, Lopez-De-Silanes, Shleifer, & Vishny, 2002; Yadav, Jain, & Singh, 2017); and additional investment from outside (Lin & Liu, 2010; Rajagopalan & Zhang, 2008).

However, the improvement of both IC and CG is difficult for the semiconductor industry because R & D is quite long-term, with a high rate of failure, although the successes can lead to a large profit (Millet-Reyes, 2004; Prester, 2016). In addition, current research indicates that most outside directors, independent of industry, were often appointed to improve inadequate corporate performance (Sueyoshi, Goto, & Omi, 2010). Hence, improving IC and CG has become the top priority for hi-tech industry to significantly benefit a nation's economy. Due to the viewpoint that R & D expenditure has a positive effect on firm value and profitability (Lu et al., 2010; Ruiqi, Wang, Xu, & Yuan, 2017) and that technology-based innovation is shaped by firms in the private sector responding to market forces (Hout, 2006), the aim of this study is to explore the benchmark corporate of the semiconductor industry in terms of efficiency, from the perspectives of IC and CG. An analysis of the top 21 corporations of the semiconductor industry using data envelopment analysis (DEA), including BCC and CCR models, is presented.

Today, DEA has become the leading method in both operation research and management science for efficiency evaluation, and been utilized to real world problems, such as criminal superior court, school districts, national parks, hospitals, transport, banking, microelectronics, telecommunications, manufacturing, education, and medical treatment (Ali, 2016; Bai, Ma, & Xia, 2011; Chang, 2011; Chi, Yeh, & Lai, 2011; Cricelli & Gastaldi, 2002; Huang & Kao, 2008; Kao, Hsu, & Huang, 2010; Lee, Ryu, Bae, & Park, 2011; Li & Zheng, 2010; Lu et al., 2010; Silva, 2017; Tseng, Lee, & Wu, 2010).

The rest of this paper is organized as follows. Literature review for IC and CG is discussed in Section 2. The Semiconductor Industry overview is presented in Section 3. DEA is introduced in Section 4. An empirical study is conducted in Section 5. Conclusions and Remarks are in the last section.

2. Literature review

Prior studies have confirmed the positive relationships of IC (Boedker, Guthrie, & Cuganesan, 2005; Ferreira & Franco, 2017; Petty & Guthrie, 2002), CG (Ajinkya, Bhojraj, & Sengupta, 2005; Ho & Williams, 2003; Kato, Li, & Skinner, 2017; Weir, Laing, & McKnight, 2002), and high organization performance and value (Kim, Eppler-Kim, Kim, & Byun, 2010; Lin & Liu, 2010; Mangena & Chamisa, 2008) as well as efficiency (Lin & Liu, 2010). In this section, IC and CG are discussed in detailed.

2.1. Intellectual capital (IC)

Intellectual capital, known as IC, has been widely used in the private sector but without a certain definition (Joia, 2008). IC can be defined as the knowledge-based resources of an organization (Soo et al., 2017; Striukova et al., 2008), as a collection of knowledge assets that are attributable to an organization and create improved competitive positioning by adding value to de-
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