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Exploring benchmark corporations in the semiconductor industry based on efficiency

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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 envelope 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.

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 economic (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; Chareonsuk & Chansa-ngavej, 2010; Lin & Tang, 2009; Randhawa, Kirca, Talay, & Akdeniz, 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 Nassir bin Shaari, & Hassan Md. Isa, 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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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, administrated 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 view points 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 defined key stakeholders (Ferreira & Franco, 2017; Inkinen et al., 2017; Marr, Schiuma, & Neely, 2004) and as a hierarchy of nested concepts with synonymous terms often being used across studies (Beattie & Thomson, 2007). Generally, it can be defined as the economic value, intangible assets, holistic or meta-level capability of an organization to coordinate, orchestrate, and deploy its knowledge resources towards creating value in pursuit of its future vision (Kaufmann & Schneider, 2004; Petty & Guthrie, 2002; Restage, 2003).

Owing to its multi-dimensional concept nature, IC encompasses countless corporate values (Sáenz, Aramburu, Buenechea, Vanhala, & Ritala, 2017), such as employee knowledge, customer confidence, company infrastructure, information technology, intellectual property, experience (Stewart, 1997), the efficiency of the business process (Mouritsen, Larsen, & Bukh, 2001).

In light of these corporate values, as advocated by practitioners and academics, IC is helpful in describing a company's stock of knowledge assets and how these have changed, or are expected to change, over time (Huang, Luther, & Tayles, 2007; Sáenz et al., 2017); thus producing value to enterprises that can be reflected as final income in financial statements (Lu et al., 2010). Needless to say, IC is one of the important competitive advantages to firms and has become a crucial measure for every corporation (Inkinen et al., 2017; Lu et al., 2010).

Nevertheless, resulting from its lack of clear definition, there is a pervasive lack of explanation in previous studies of the detailed coding rules used to precisely categorize IC (Beattie & Thomson, 2007; Inkinen et al., 2017). To date, IC is categorized into structural capital, relational capital, human capital (Cabrita et al., 2017; Campbell & Rahman, 2010; Kaasa, 2009; Wexler, 2002), organizational capital, external capital, innovation capital (Joia, 2008), employee competence (Secundo, Perez, Martinaitis, & Leitner, 2017; Sveiby, 2002), market assets, human centered assets, intellectual property, and infrastructure assets (Brooking, 1996; Hashim, Osman, & Alhabshi, 2017). However, others make the distinction between internal and external elements (McPhail, 2009).

Empirically, IC has been tested with variables that include company size (Bozzolan, Favotto, & Recceri, 2003; Bukh, Nielsen, Gormsen, & Mouritsen, 2005; Chareonsuk & Chansa-ngavej, 2010; Cuozzo et al., 2017), industry membership (Abdolmohammadi, 2005; Bozzolan et al., 2003), ownership (Bukh et al., 2005; White, Lee, & Tower, 2007), company ages (Bukh et al., 2005; Chareonsuk & Chansa-ngavej, 2010; Cordazzo, 2007; White et al., 2007), nationalities (Bozzolan, O'Regan, & Ricceri, 2006), and business sector. Most findings indicated that IC has a positive effect on the firms' performance (Ferreira & Franco, 2017; Lu et al., 2010; Yang & Kang, 2008), market value, and financial performance (Chen, Cheng, & Hwang, 2005; Razafindrambinina & Anggreni, 2017).