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Capability and efficiency of intellectual capital: The case of fabless companies in Taiwan

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ABSTRACT

It is important to increase their value by managing intellectual capital (IC), since fabless firms face an intensely competitive environment. The aim of this paper is develops a two-stage production process including IC capability and IC efficiency to characterize the IC performance of the fabless firms using a non-parametric frontier method – data envelopment analysis (DEA). The IC performance rating should be considered as a key element for achieving greater innovation and competitive advantages. The results show that IC efficiency is better than IC capability for these fabless firms; 15.8% of fabless firms perform well in both models and these firms can be treated as benchmarks for others; most firms operate at decreasing returns to scale, indicating that firms are facing a highly competitive environment; further mergers and acquisitions among firms should be considered so as to achieve economies of scale; the critical input/output measures will also help firms improve their performance and identify the key factors that impact a firm's performance.

1. Introduction

The fabless production value was merely 36 billion dollars in 1994 according to the statistical data took by the global Fabless Semiconductor Association (FSA). However, production value has since expanded to 500 billion dollars in 2006. Amazingly, the production value and growth of fabless business have sharply increased fourteen times during these 10 years. In addition, fabless industries play an important role in the global semiconductor industry. From the data, we can see that the operating revenue of fabless industries was only 3.5% in the semiconductor industry but had increased to 20% in 2006. Therefore, the data shows that fabless industries have become more and more important. According to statistics, the Industrial Technology Research Institute of Taiwan indicates that the production value of fabless industries in Taiwan is 20% of the world production. This production value is only second to the production value of the U.S.

Fabless is a brain intensive industry, with fabless firms placing the most value in "people". In other words, engineers and support staff are the greatest assets of fabless firms. In addition, the main profit of fabless firms comes from "innovation". Through innovation, fabless firms develop new products that have high market value to the firm. Due to the results, we can indicate that intellectual capital(IC) plays an important role in fabless firms. Many studies have conferred upon the importance and content of intellectual capital (Bontis, 2001; Edvinsson & Malone, 1997; Stewart, 1997; Sullivan, 2000). Van Buren (1999) further discusses how to transform intellectual capital into competitive advantage but from a more conceptual aspect. To enhance competitive advantage, the fabless firms require a detailed performance benchmark analysis to improve its IC management and to assist its resource allocation.

However, since a firm's IC performance management is a complex phenomenon requiring more than a single criterion to characterize it, traditional performance measurement techniques have often been criticized for being inadequate. To overcome the drawbacks mentioned above, DEA has been used extensively for benchmarking analysis ever since its introduction by Charnes, Cooper, and Rhodes (1978). DEA has many desirable features, which may explain why researchers are interested in using it to investigate the efficiency of converting multiple inputs into multiple outputs. One major advantage is that DEA has emerged as the leading method for efficiency evaluation in terms of both the number of research papers published and the number of applications to real world problems (Gattoufi, Oral, & Reisman, 2004; Seiford, 1997), such as banking (Halkos & Salamouris, 2004; Luo, 2003; Mukherjee, Ray, & Miller, 2001; Sturm & Williams, 2004), semiconductor industries (Chen & Chen, 2007; Kozmetsky & Yue, 1998; Liu & Wang, 2008; Leachman, Ding, & Chien, 2007), education (Guan & Wang, 2004; Leitner, Michaela, Stowasser, & Wagner, 2005) and

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medical treatment (Marathe, Wan, Zhangand, & Sherin, 2007; Pilyavsky et al., 2006; Rouse & Swales, 2006).

First of all, this study developed a two-stage production model to access the capability of creating IC and the efficiency of IC increasing a firms' value. DEA is particularly useful for practitioners to adopt benchmarking, as firms can easily identify the efforts required to catch up with benchmarking partners by examining their performance to find out which firm most efficiently utilizes its IC to maximize the firms' value. The advantage of the two-stage model is not only to measure the relationship between inputs and outputs but also to consider the whole production process. This can create a more complete explanation for the analysis results.

Secondly, this paper examines the relation between the capability and the efficiency of IC. This study discusses whether the efficiency of creating firms' value is affected by the capability of creating IC. A cross-tabulation is employed to illustrate the difference between the capability and the efficiency of IC in order to discover the common point in firms which perform highly capable and efficient IC.

Thirdly, the critical input/output measure is discussed. For an efficient firm, the performance of IC is determined and characterized by the best practice status. For an inefficient firm, the performance of IC is determined and characterized by the distance to the frontier. Thus, an important measure of IC performance should be characterized by whether or not it is the best practice used to measure firm efficiency for both efficient and inefficient firms.

There are three more sections aside from this introductory section. Following this section, the relationship literature is reviewed. We introduce the research design and data selection in the next section. In the ensuing section, this study presents the empirical results and analysis. Finally, conclusions are given in the last section.

2. Literature review

2.1. Intellectual capital

Stewart (1991, 1997) indicated that IC means anything an enterprise can use to increase its competitive advantage in the market place, including knowledge, information, intellectual property rights and experience. In other words, IC is presented as intangible assets and it produces value to enterprises that can be reflected as final income in financial statements, but it cannot be expressed as an accounting title in financial statements. Therefore, if an enterprise can quantify, evaluate as well as analyze those intangible assets, it will increase its competitiveness in the industry. According to the measurement of IC, Sveiby (2001) suggests four main measuring approaches: (1) direct intellectual capital methods (DIC), (2) market capitalization methods (MCM), (3) return on assets (ROA) methods, and (4) scorecard methods (SC). Up to now there is no single best solution because each method has its pros and cons. ROA and MCM methods can quantify data and use historical financial data audited by CPA during computation. ROA and MCM methods are beneficial to the comparability of the firm with firms in the same business. We choose MCM and ROA method to measure IC, since the objective of research is to utilize financial data between same industry in order to begin efficiency evaluation.

2.2. The relationship between IC and financial performance

In terms of managers and academics, IC is one of the important competitive advantages to firms (Edvinsson & Malone, 1997; Stewart, 1997; Sveiby, 1997). It has become more and more crucial to measure and assess IC.

There is sufficient evidence to suggest that IC has a positive effect on the firms' performance. Chen, Cheng, and Hwang (2005) indicated that firms' IC has a positive impact on market value and financial performance, and may be an indicator for future financial performance. In addition, they found that investors may place different values on the three components of value creation efficiency (physical capital, human capital, and structural capital). Finally, evidence is presented that R&D expenditure may capture additional information on structural capital and has a positive effect on firm value and profitability.

Tan, Plowman, and Hancock (2007) found that IC and firm performance are positively related; IC is correlated to future firm performance; in the sense that the rate of growth of a firm's IC is positively related to the firm's performance. Huang and Liu (2005) investigated the interaction between innovation capital and IT capital synergy effects on firm performance. The main finding of the study is that after considering the interaction between innovation capital and IT capital, there is a positive effect on firms' performance. Firms should coordinate different perspectives of IC to improve firm performance.

Consequently, the greater efforts firms devote to managing IC, the greater performance and competitive advantage they may receive in return.

2.3. DEA and semiconductor

Some of the applications related are to the semiconductor. Chen and Chen (2007) found that the efficiency of every domestic semiconductor manufacturer is generally good. Considering the four perspectives of the balanced scorecard, the most important for the domestic firm is the financial perspective, second is the internal process perspective, third the learning and innovation perspective, and lastly the customer perspective. Leachman et al. (2007) employs data envelopment analysis (DEA) to determine relative efficiencies among fabrication plants over time on the basis of empirical data, whereby cycle time performance is transformed into monetary value according to an estimated price decline rate. The results show that cycle time and yield follow increasing returns to scale, just as cost and resource utilization does. Statistical analyses are performed to investigate the DEA results, leading to specific improvement directions and opportunities for relatively inefficient fabrication plants.

Following previous studies, we know that besides the importance of IC, there is also a relationship between IC and firms' performance. A few studies have researched the capability and efficiency of IC in fabless firms in Taiwan by using DEA. Moreover,, IC is important to fabless firms since fables firms are based on knowledge, which is the reason why we choose to assess the capability and efficiency of IC in fabless firms.

3. Research design

3.1. Two-stage value-creating process of fabless companies

Since a firm's performance is a complex phenomenon requiring more than a single criterion to characterize it, a number of studies have argued that a multi-factor performance measurement model should be used. Seiford and Zhu (1999), Zhu (2000), and Luo (2003) developed a multi-factor performance measure model for US companies. This study developed two-stage transformation process (Fig. 1) to design two performance models for intellectual capital, namely, IC capability and IC efficiency.

From Fig. 1, the IC capability model (stage-1) measuring a fabless firm's capability to create IC consists of two inputs (liability, stockholders' equity) and four outputs (human capital, process