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Positioning and shifting of technology focus for integrated device manufacturers by patent perspectives

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ABSTRACT

The relationship between integrated device manufacturers (IDMs) and contract chip makers (foundries) in the semiconductor industry has changed over the past three decades. An increasing number of IDM companies have diversified or branched off as foundry companies, whether officially or privately. This paper explores the technology focus of IDM companies and the shifting of that focus by examining the shifts in focus of productivity, quality, and integrated measurement of selected IDM companies between 1981 and 2010 by patent perspective. The results of this research reveal that AMD, one of the more notable companies to have established a pure foundry company from an IDM company, is located in the foundry-oriented area. Additionally it shows that, although Micron and TI have not officially announced their intentions to diversify or branch off as foundry companies, the two are located in the foundry-oriented area as a means of showing their competitive positions with regard to joining the foundry business.

1. Introduction

The semiconductor industry has been one of the most important industries over the past three decades. Due to the wide use of semiconductors in telecommunications, computers, and consumer electronics, the semiconductor industry has all but become a core upstream element in every part of electronics industries. Much research regarding the semiconductor industry has been conducted. Appleyard [1] examined inter-firm information flows in the knowledge-intensive semiconductor industry. Appleyard and Kalsow [2] built a framework for the degree of similarity in organizations' technical prowess. Chang and Tsai [3] studied strategies adopted by Taiwan's semiconductor industry at different stages in its technology development, specifically focusing on the research consortium strategy and industry consortia. The knowledge-based view applied to firm boundary decisions and the implications of the performance of those decisions have also been examined [4]. In general, there are three major characters in the semiconductor value chain: Design Houses, which only design and sell devices (such as Qualcomm, Broadcom, and Nvidia); Foundries, which manufacture devices under contract with other companies and do not design them (such as TSMC, UMC, and GlobalFoundry); and IDMs, which engage in manufacturing and selling integrators as well as designing devices (such as Intel, Samsung, and IBM), as shown in Fig. 1. Generally speaking, IDMs play an integrational role—designing, manufacturing, and selling—in the semiconductor industry and Foundries provide IDM and Design Houses with manufacturing capacity. In the early stages of the development history of the semiconductor industry, IDMs dominated the entirety of the industry's development of technological capability and manufacturing capacity. Due to IDMs' integrational role in the semiconductor value chain, they can diversify or shift their character in the semiconductor value chain toward either Foundries or Design Houses. In short, IDMs may, to some extent, be competitors of Design Houses or Foundries. In fact, over the past decade, an increasing number of IDM companies

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have claimed positions in the foundry business or taken the "Fab-Lite" strategy to ease financial burdens. Compared with IDMs, Foundries and Design Houses have retained their current roles in the semiconductor value chain. There are many reasons for IDM companies to shift their technology focus, such as financial problems, manufacturing capacity, and geographical clusters. With regard to development trends in the semiconductor industry, Ernst [5] discussed the growing geographic mobility of chip design and its dispersion in Asia. He argued that, to cope with such demanding requirements, firms must have a strong incentive to concentrate on innovation in their home countries. For capacity planning, many IDM companies or Design Houses commonly suffer from foundry capacity shortages when the industry is prosperous. A method that accepts this uncertainty of demand and uses stochastic integer programming to find a tool set responsive to shifts in demand was presented by Hood et al. [6], who considered a set of possible discrete demand scenarios with associated probabilities, determined the tools to be purchased, and minimized the weighted average unmet demand under a budget constraint. The semiconductor industry is highly capital-intensive, so it would be natural to apply the strategic alliance approach to the technology development. To provide value-added directions and information to semiconductor companies that want to select partners for R&D cooperation among different characters and technology fields, character shifting is one of the most important factors to consider. Character shifting may also attract researchers to explore semiconductor technology shifts within roles. Most research into the shifting of or relationship among these roles has focused on economics [7], manufacturing capacity [8], and strategy management [9]. Regarding technology position, Debackere et al. [10] explored regional technological capabilities, linked technological position to economic growth, and found a competitive advantage in European patent data. Research into corporate technology strategy that secures competitive positions by patent analysis was also discussed in this research [11]. Patent data are a valuable source of information for technological development. Because they contain standardized data relating to new ideas and technological developments and are available to all, patents have been treated as the most important output indicators of innovative activities [12] and patent data have become the focus of many tools and techniques used to measure innovation [13–15]. Patent analysis is widely applied to the exploration of competitive advantages among companies or industries. Henderson and Cockburn [16] attempted to measure heterogeneous organizational competence using patent data in pharmaceutical research. Fleming and Sorenson [17] demonstrated that technology should be considered a complex adaptive system based on patent data. Several researchers, such as DeCarolis and Deeds [18] and Gittelman and Kogut [19], conducted empirical studies using patent and financial data from biotechnology firms. Long [20] regarded patents as a signaling mechanism by which technology firms can credibly publicize information. Daim et al. [21] explored forecasts in three emerging technology areas by integrating the use of bibliometrics and patent analysis into well-known technology forecasting tools such as scenario planning, growth curves, and analogies. The aforementioned literature measured innovation activities or explored the technology development in various industries. However, little research focuses on the detection of position and the position shifting of technology focus in a specific industry. In addition to previous applications, we applied the framework to detect messages delivered by selected IDM companies concerning the shifting of technology focus. Much research has explored companies' technology positions as a means of monitoring and understanding their technological strength. This information will usually be provided to the decision makers of a company as a means of internally managing their technology. On the other hand, company stakeholders, such as shareholders and analysts, have an increasing interest in assessing a company's technological competence because of its strong impact on a company's future competitiveness [22,23]. Position and the shifting of technology focus of specific companies or industries are important strategic information for decision makers of companies, and could be used to detect their relative technology levels in the industry. In addition to industry practitioners, industry researchers could also apply the information as a means of grasping the technology evolution in specific industries. This study aims to provide decision makers of companies with the overall position of technology focus for specific IDMs. By using the position map created from this study, decision makers can detect their relative technology levels within the industry. This study also aims to explore the shifting of technology focus for specific IDMs. The decision makers of companies or industry researchers could apply the shifting map created in this study to detect the character evolution for specific companies or industries while still in the early stages.

The positioning and position shifting of technology focus help monitor the overall competitiveness or cooperation possibilities for decision makers of R&D or management teams in the IDMs. Moreover, decision makers could apply the information gleaned to monitor the shifting of targeted companies or industry while still in the early stage. Hence, we apply a patent analysis for the detection of positions and position shifting of technology focus for IDM companies.

The paper is organized as follows. Section 2 presents research data and methods. Section 3 describes the research results. Section 4 presents our conclusion and considerations for future research.

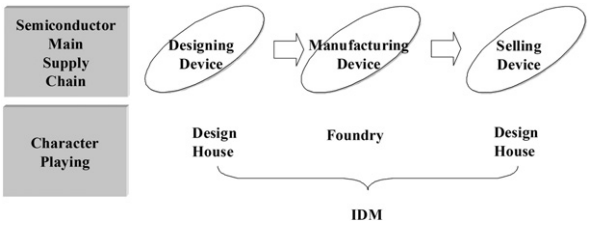

Fig. 1. Major value chain of a semiconductor industry.

2. Data and methods

2.1. Selecting IDM companies

Because the semiconductor industry is a cross-field industry, we searched related patents of other technology fields and queried the patent data. Because business diversification has