



Partnership ecosystem of IC design service companies: The case of Taiwan



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ABSTRACT

The continuously evolving IC industry has driven IC design service companies to become the niche players in the semiconductor value chain. These emerging companies, mostly SMEs, manage the entire chip development manufacturing process and apply third party's resources when and where its customers need them. To keep the customer as their main focus and deliver what the customer truly needs, a strong and committed partnership ecosystem is more important than ever.

The objective of this paper is to provide a better understanding of the partnership ecosystem of Taiwan's IC design service companies. A co-evolutionary theory in the business ecosystem is used as a theoretical background to explain the relationship in the investigated partnership networks. The partnership networks of the IC design service companies were analyzed together with the corporate data such as revenues and milestones. The findings show that the firms have accumulated and created their competitive advantage by forming strategic alliances with various leading foundries, IP vendors, and EDA tool providers to leverage their technological capabilities. While the production ecosystem was localized in Taiwan based on the benefit of the complete value chain, the IP ecosystem was more internationalized.

The existing networks provide a new insight into opportunities for new entrants even in the highly competitive environment like the semiconductor industry. This study contributes to the understanding of the characteristics of the niche players. It will be useful as policy implications for the industry stakeholders and governments to setup direction for further support and investment in the IC design service business.

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1. Introduction

High competitive pressure resulting from the rising costs of fabrication and design, technology uncertainty, and consumer price squeeze has led to the semiconductor industry undergoing structural change [1]. As the IC manufacturing process has evolved into sub-wavelength technology nodes, the manufacturing technology has become very complicated and requires detailed knowledge to integrate the complex process technologies in each IC production step along the entire supply chain. It is difficult for most companies to conduct independent technology development and innovation. As a result, many outsourcing tasks originated from the IC companies creating opportunities not only for manufacturing, packaging and testing but also for the design business.

The continuously evolving character of the semiconductor industry has driven the IC design service company in becoming an emerging niche player in the semiconductor value chain. The business model of an IC design service company is the fabless ASIC (Application-Specific Integrated Circuit) model that is a logical progression of the trend to outsourcing in the semiconductor industry [2–4]. It offers a complete line of IC design services based on the customers' needs and provides services through foundry manufacturing. Unlike fabless IC design houses, IC design service companies, mostly SMEs, do not have their own chips. The major function of IC design service company is to act as an intermediary between design and manufacturing, providing IC designers with an IP library, IP integration and customized modification, and IC manufacturing process technique to reduce not only the development cost but also design time. It also provides turnkey solutions to produce ASICs and/or handle the production process in the comprehensive supply chain. Thus, the customers can focus their technical capability on a specialty area and utilize an increased

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amount of company resources for market development [5,6].

The semiconductor industry has been researched extensively; however, most of the previous studies focus on the semiconductor value chain [7–9] and leading players in the industries including foundries and fabless companies [10–15]. We argue that few studies focus on the IC design service companies and their partnership ecosystem. As emerging business in the highly competitive industries, the case study of the IC design service companies should provide an insight into the characteristics of niche players and how the niche players interact and utilize the existing ecosystem. In other word, it should demonstrate the utilization of the mature ecosystem in practice. According to Lin et al. [5], the core competencies of a successful IC design service company could have been similar to that of a fabless IC design house. However, due to their different functionalities, the core competence and key success factors between them may vary; thus further study will be required. IC design service company business model is to provide services to their customer by managing its resources and third party's resources [2–4]. Therefore, the partnership ecosystem should be one of the key success factors providing a competitive advantage. If companies are going to continue to keep customers as their main focus and deliver what the customers truly needs, a strong and committed partnership ecosystem is more important than ever. Therefore, the objective of this study is to explore the partnership network of Taiwan's IC design service companies. The research question is “what are the characteristics of the IC design service companies and their partnership ecosystems?”.

This study would provide the characteristics of the IC design service companies and their partnership networks in the semiconductor industry. It may be utilized as a reference not only to a government but also to the industry, investors and academics for better understanding about the opportunities of new entrants in the semiconductor industry. It should provide policy implications for governments in developed and developing countries that plan to encourage local start-ups or existing SMEs firms to engage in highly competitive IC industry value chain. To introduce the key stakeholders of the partnership network, an overview of the semiconductor value chain will be explained in the next section. Sections 3–6 illustrate the theoretical backgrounds, the methodology and data, main findings, and conclusions and implications, respectively.

2. Research setting: semiconductor value chain

The IC industry started a disruptive structural change from integration towards disintegration with the emergence of the foundry business in the mid-1980s. Before then, IC industry was dominated by IDM (Integrated Design Manufacture), which does not only design but also manufacture its own chips. IDM is an integrated firm conducting chip design, production, marketing, supply chain management and after-sale support. Nowadays, several IDMs have changed their business characters to fabless. Some have adopted a fab-lite approach of using foundries for leading edge process and continuing to manufacture internally anything that does not require a leading-edge fab [16,17]. Firms in the semiconductor value chain can be divided into two groups, design and manufacturing. Those industries with main activities dealing with designing chips are Silicon IP (Intellectual Property) provider, EDA (Electronic Design Automation) tool vendor, and fabless. Foundry and packaging & testing are industries involved in manufacturing the chip.

The diagram explaining the overview of semiconductor industry's disintegration is shown in Fig. 1. Foundry refers to a company that processes and manufactures of silicon wafers. Fabless is a company that designs chips but contracts out their production

rather than owning its own factory. EDA tool vendor is a company that designs and develops software tools for designing electronic systems such as printed circuit boards and integrated circuits. The tools work together in a design flow that chip designers use to design and analyze entire semiconductor chips. IP provider refers to a fabless (chipless) firm that does not provide physical chips to its customers but merely facilitate the customer's development of chips by offering certain functional blocks such as a Microprocessor.

An IC design service company refers to a service firm that manages the entire chip development manufacturing process and applies the third party's resources when and where its customer needs them. Their customers, which usually are IC design houses or system companies, can focus their technical capability on a specialty area and utilize the increased amount of company resources for market development [18]. The availability of a full semiconductor value chain enables the emerging IC design service companies to provide solutions covering design, wafer manufacturing, packaging, and testing, which are very labor and time-consuming processes [19,20].

Taiwan IC industry has distinguished itself from its complete industry value chain from fabless (including IC design houses, IC design services, IP providers and EDA tool vendors), manufacturing to packaging & testing companies. The world-leading IC Foundries and IC Packaging & Testing companies together offer the best deal of one-stop shopping model. In 2012, the Taiwan semiconductor industry consisted of 260 fabless, 15 IC manufacturing companies, 37 packaging and testing houses, 7 substrate suppliers, 11 wafer suppliers, 3 mask makers, and 4 lead-frame companies [21]. Most of the world's leading IC design services companies are based in Taiwan. They may gain benefits from the complete Taiwanese IC industry infrastructures. There were around ten design services companies in Taiwan creating total revenue of NT\$22 billion in 2012. Apart from the partnership with local companies, Taiwanese IC design service companies have also formed international partnerships.

From time to time, firms in the semiconductor industry are redesigning their business model not only within the company itself but also at the collaborative interaction between the firms and their partner [7,9]. In the next section, we would like to explain briefly about the co-evolutionary theory in a business ecosystem and strategic alliances that we used as theoretical backgrounds to explain the partnership network of Taiwan IC design service companies.

3. Theoretical backgrounds

An innovation often does not stand-alone; rather, it depends on accompanying changes in the firm's environment for its own success. These external changes, which require innovation from other actors, embed the focal firm within an ecosystem of interdependent innovations [22]. Co-evolutionary perspective considers organizations, their populations, and their environments as the interdependent outcome of managerial actions, institutional influences, and extra-institutional changes [23]. It refers to the simultaneous development of organisations and their environment, independently as well as interactively. For co-evolution to occur, the population should consist of heterogeneous firms that have learning capabilities and can mutually influence each other [24]. The use of co-evolution as an explanatory factor appears to stem from the simultaneous change between the macro, micro and meso level environments around the focal organization. The notion of the focus of co-evolution at a level between the micro (firm level) and meso (industry level) also occurs [25]. Applying the theory of co-evolution to understand changes in firms and their strategic alliances assumes that the changes may occur in either the dyad of

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