The Development of the Taiwan's Semiconductor Industry sine 1960s: The Rise of Silicon Island

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Abstract

This study attempts to revisit the successful development of the Taiwan's semiconductor industry since 1960s from the 'OING' (organizational, industrial, national, and global) contexts. Prior research has largely documented the role of the government and national innovation system on the success of the Taiwan's semiconductor industry. However, the successful development of an industry relies on various factors and the interlocks among these factors. Although the traditional economic development approach helps us understand the institutional effects in terms of industrial level and national level on an industry's development, the neglect of taking the organizational, regional or global factors into consideration may undermine our understanding on the complete picture of the development and growth of an industry. Thus, this study integrates four different levels of contexts into an analytical framework, the 'OING', to analyze the development of an industry. Moreover, this study provides the updated development of the Taiwan's semiconductor industry which prior research had investigated only until the earlier 2000. Finally, using the integrated analytical framework of this study, this study attempts to re-classify the phases of the Taiwan's semiconductor industry development with the attributes of the 'OING'.

Keywords:

Introduction

Since the government's supports in the early 1970s by establishing the Electronics Research and Service Organization of the Industrial Technology Research Institute (ERSO/ITRI) for technology leverage and by Development Fund for enhancing financial or capital leverage (Mathews, 1997), the Taiwan's semiconductor industry has been growing at a very fast pace. By the end of 2011, the Taiwan's semiconductor industry accounts for approximately 70.2% of worldwide IC foundry sales, 55.1% of worldwide package and testing sales, around 20.1% of worldwide design sales (TSIA, 2012). As for the individual firm, Taiwan Semiconductor Manufacturing Corporation (TSMC), the largest foundry in the world, was the third largest semiconductor sale leader, accounted for 6.5% worldwide market shares in 2011, following its rivals, Intel (22.4) and Samsung (15.3%). The outstanding performance from the both industry and firm levels suggests that the success of the Taiwan's semiconductor industry plays an important role in the global semiconductor industry.

A number of prior studies have addressed the success of emerge of the Taiwan's semiconductor industry (Chang and Hsu, 1998; Chang and Tsai, 2000; Hung and Chu, 2006; Liu, 1993; Mathews, 1997; Tung, 2001). Particularly, these studies mostly emphasize the governmental role on the success of the industrial development. However, the successful development of an industry relies on various factors and the interlocks among these factors. Although the traditional economic development approach helps us to understand the institutional effects in terms of industrial level, such as industrial structure and competition

intensity (Bain, 1959), and national level, such as national innovation system (Nelson, 1993) or the government intervention (Evans, 1995; North, 1981), on an industry's development, the emphasis on the organizational, regional or global factors may complement to our understanding on the complete picture of the development and growth of an industry.

Organizational structures, capabilities as well as cultures, and their linkages with external actors in the industry will affect the rate and direction of innovation (Teece, 1996). Firms in particular types of structures should fit specific types of governance modes, which are facilitated by corresponding industrial structures. This implies that the technological advance of firms relies on the match between organizational context and institutional context. Moreover, foreign direct investment (FDI) has been regarded as a critical inflow source of knowledge and capital. With the increased globalization, Narula and Dunning (2000) suggest that the nations needs to provide unique and non-replicable assets to maintain a successful FDI-assisted development strategy, which in turn to attract investments by multinational corporations (MNCs) and then nurture the industrial development. More importantly, increased global competition, technological change, fast-changing market situations, and continuous customer/client demand for quality services may also punctuate the direction of an industry's development, such as the impact of tablets' emergence on the personal computer industry. Finally, global production network also provide the different landscapes of regional or global industrial development (Saxenian, 2002). Thus, the global (or regional) context may

also influence an industry's development in addition to the organizational, industrial, and national contexts.

In addition to the individual impacts of different levels of contexts on the industrial development, interacted effects among different levels of contexts should be also taken into account for the development of an industry. For instance, capabilities or structures of organizations for flexible production may change the governance modes among firms' interactions, which in turn influence the regional development (Scott, 1988; Storper and Harrison, 1991). Such the regional development enhanced by the transition of particular organizational capabilities and governance mode may together affect the development direction of an industry. Thus, an integrated multi-level analytical framework may provide insights for our understanding on the success of an industrial development.

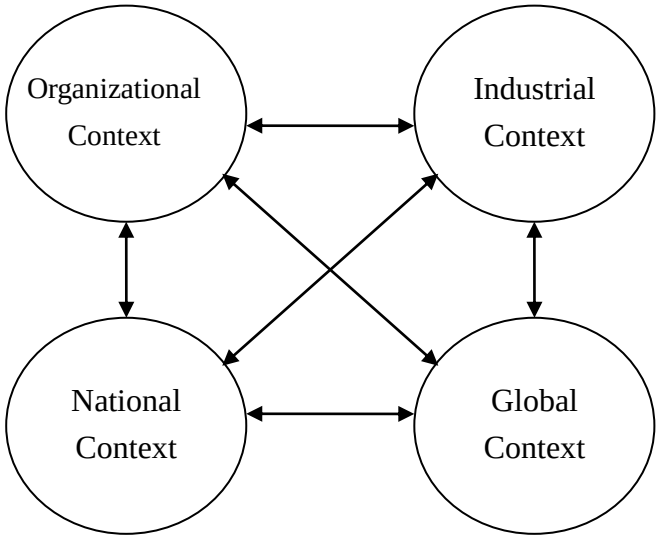


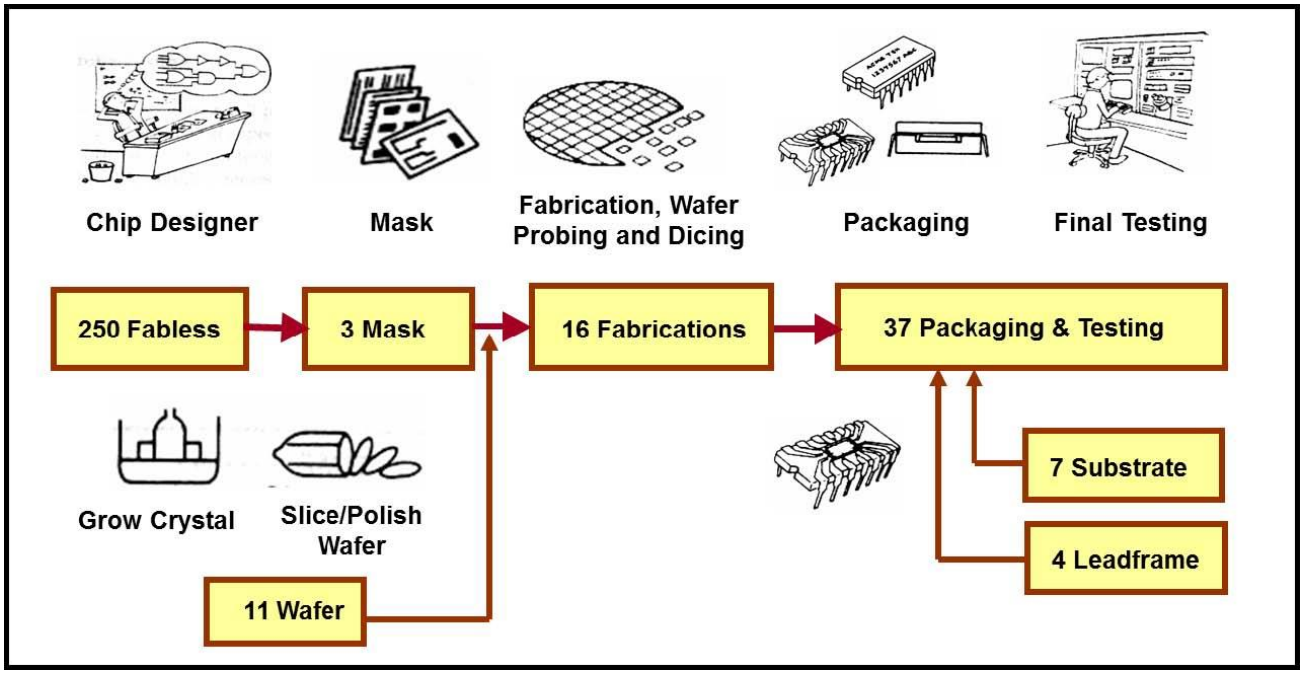
Figure 1. Analytical Framework- The OING

Figure 1 provides such a framework, the 'OING' (organizational, industrial, national, and

global/regional contexts), to meet the purpose of this study. The *organizational context* may include governance modes, resources and capabilities, entrepreneurship, and organizational structure. The *industrial context* consists of the Porter's (1980) systematic and comprehensive economic tools for analyzing an industry in depth, a five force framework, including threats from new entrants, internal rivalry, bargaining power by suppliers, bargaining power by buyers, threats from substitutions. The *national context* may include factors suggested by the Porter's (1990) diamond framework, such as factor markets, demand markets, related and supported industries, competitive rivalry, state and government, and chance. Finally, the global context will consider factors such as FDI, global competition, technological change, fast-changing market situations and continuous customer/client demand for quality services. Our framework echoes the Andrews' (1971) proposition that economic, technical, physical, political, and social community, national and global environments have major impacts on corporate decisions, while a company's capability (including financial, managerial, functional, and organizational), reputation, and history determine its internal competence. A fit is obtained by matching these external and internal factors together.

Most prior studies regard the rise and success of the Taiwan's semiconductor industry as the uniqueness of the de-integrated industry structure (Chang and Hsu, 1998; Hung and Yang, 2003; Tung, 2001) and the contribution of business model innovation (Tung, 2001). Unlike an integrated device manufacturing (IDM) company, which includes integrated circuit (IC)

design, fabrication, packaging, and testing, all in one company, Taiwan has developed the unique industrial structure of vertically specialization, which consists of independent production in each following sub-sectors: IC fabless, wafer fabrication, mask generation and fabrication, IC packaging, and testing. As shown in Figure 2, in 2011, there were total 328 firms in the Taiwan's semiconductor industry, which made Taiwan the fourth largest semiconductor production country in the world. Several studies have documented this unique development and deem it as the contribution of the different phases of industrial development (Chang and Tsai, 2000; Liu, 1993; Mathews, 1997; Tung, 2001). However, most of the above research had documented the development of the Taiwan's semiconductor industry until the late 1990s or early 2000s. The global semiconductor industry has changed dramatically since the 2000s. The economic depression in Japan and the Western countries and the rise of the emerging counties, such as China, India, Russia, and Brazil, urge the necessity to investigate the latest development of the Taiwan's semiconductor industry. Most important of all, by documenting the industrial development from the 1960s to the early 2010s with the attributes of the 'OING' framework, this study adds the organizational and regional/global factors to interpret the development and growth of the Taiwan's semiconductor industry, which has received less attention in prior studies. .



*Numbers inside the frame are the number of Taiwanese firms in each sub-sector of the semiconductor industry in 2011.

Source：IEK-ITRI, TSIA (2012: 5).

Figure 2. The unique Disintegrated Infrastructure in Taiwan

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