研究論文

Hollowing Out or Sustaining? Taiwan's SME Network-based Production System Reconsidered, 1996-2011

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The dominant view of Taiwan's industrial transformation suggests scaling up and growing concentration as the strategies for surviving global competition, thus implying the demise of the SME system. Through a detailed sectoral analysis of Taiwan's manufacturing industries during the 1996-2011 period, using industrial and commerce census data, this article examines two competing questions (1) whether a SME network-based production system is still viable in Taiwan, and (2) whether Taiwan's industrial structure is headed towards the modern industrial capitalism associated with increasing concentration and dominance by large corporations.

The detailed breakdown by sectoral analysis suggests the following. (1) The Information Technology (IT) sector may have skewed our understanding of the overall performance of Taiwan's manufacturing sector. The growth-driven approach, which centers on the performance of individual firms making the final product, has overlooked the value-added by independent parts makers. (2) The contribution of the machinery and metal sector (mostly SMEs) to Taiwan's economy, measured by value-added, is similar to that of the IT sector (with the exception of the semiconductor industry) on which current generalizations on the rise of large firms draw. (3) Lastly, contrary to the claim of the hollowing out of SMEs with the rise of the IT sector and that Chandlerian modern large corporations prevail, the findings reveal that the decentralized production system in which a system of SMEs and the networks among them for coordinating economic activities continues to thrive.

The article then discusses the mechanisms that drive the SME system, namely, the overlooked role of parts makers and their cross-sectoral, skills-

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based learning, and the role of para-public institutions in coordinating a decentralized industrial system. It concludes with a reconceptualization of the paths to prosperity and policy implications.

Keywords: SME network production, decentralized industrial structure, flexible specialization, innovation, industrial transformation

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台灣奇蹟的幻滅？重探台灣中小企業的網絡式生產體系，1996-2011

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關於台灣的產業轉型，目前的主流論述是：台灣產業結構正轉向以集中化與大公司支配為特徵的現代資本主義形式，過去創造台灣奇蹟的中小企業網絡生產體系將式微。為檢驗上述命題，本文使用1996年到2011年的工商普查資料檔，分析製造業各部門後發現：(1)大企業主宰台灣產業的命題是根據資訊工業的發展經驗所提出，其關注生產最終產品的廠商，卻忽略了對附加價值有相當貢獻的各式零件廠商。(2)以附加價值而論，以中小企業網絡生產模式為主的機械與金屬部門對台灣經濟的貢獻，實際上與資訊產業部門（扣除半導體產業）相去無幾。(3)中小企業並沒有因為資訊產業（高科技產業）的興起而空洞化。

本文接著討論驅動中小企業體系的機制，包括零件廠商跨部門的技術交流與學習；公共研發機構在分散化生產體系中扮演協調的角色。最後，本文修正產業發展模式的概念，並討論相關政策意涵。

關鍵字：網絡式生產組織、經濟發展、附加價值、代工、產業升級

This article is motivated by the question of what is driving Taiwan's current industrial transformation. A distinctive feature of Taiwan's post-war economic development has been decentralized industrialization, consisting of a system of small and medium enterprises (SMEs). These SMEs are clustered in geographical locales where numerous small firms, each specializing in one phrase of production, complement each other in the production process. Together, they laid the foundation of the so-called Taiwan miracle (Chen 1994; Shieh 1992). In their dynamism, SMEs served as a showcase for network perspective theories in the 1990s, which contended that alternative forms of organizations can compete equally with hierarchical organizations (Powell 1990), and they also were associated with the flexible specialization theories in understanding the post-Fordist transition (Piore and Sabel 1984). This view, however, has receded in the face of globalization and financial liberalization. Instead, concentration and polarization dominate the current debate on the global economy's structural transformation. This holds true for understanding the transformation for latecomers, like Taiwan. A growing number of studies suggest that Taiwan is going through a major transformation in which Chandlerian large modern corporations are prevailing in the country's quest for industrial ascent, and that it is thus converging with the global trend of modern industrial capitalism (Amsden and Chu 2003; Chen 2005). Empirical evidence seems to support the demise of the SME thesis: For instance, in Taiwan, 79.6% of total export outputs in the manufacturing sector in 2011 were handled by large firms employing over 500 people.

This article aims to revisit the old debate by examining the competing questions of whether the SME-based economy is hollowing out and whether Taiwan has converged at the homogenizing thesis that large corporations dictate the economy. It does so through a detailed sectoral analysis using industrial and commerce census data from 1996 to 2011, a period when Taiwan's economy was considered to have gone through a major transformation to high-tech industrialization led by IT industries.

This article reveals that the decentralized production system of SMEs and the networks among them for coordinating economic activities have continued to persist and thrive. Conventional celebrated stories based on the rise of large, scaling-up, Chandlerian types of modern organizations in the information-technology (IT) sector are derived from studies of the exceptions rather than the norm. I draw on the performance of three industries in the less celebrated machinery sector (bicycle, auto parts, and machine tool) in addition to my long-term fieldwork data to examine the continuity thesis of the persisting organizational principles of the decentralized system and contrast them with the semiconductor industry, an important industry in the IT sector.

Motivated by the findings about resilient SMEs, I then discuss the two key mechanisms that drive the system of SMEs, namely, the overlooked roles of parts makers, who focus on intermediate inputs, and para-public institutions in coordinating a decentralized industrial structure by disseminating information and resources among various stakeholders and connecting firms from different production networks for learning and innovation. These multiple connected networks function to their advantage in the quest for skills and technology learning. I will conclude with a discussion of both the theoretical and policy implications of the study findings for understanding Taiwan's current transformation.

AN SME-BASED ECONOMY IN TRANSITION

In what follows, I first outline the distinguishable features of Taiwan's post-war industrialization so as to set forth debates on the agents of industrial transformation. Taiwan's decentralized industrial system consists of the following features. First, the SME-based production system encompasses an extensive division of labor, in which firms complement each other in the production process. They cluster in geographical locales where numerous firms compete and cooperate in the same industry (Chen 1994). Extensive subcontracting is also exercised within the parts sector. The various components within a part are subcontracted to small factories that specialize in manufacturing that particular part. Second, the SME production network consists of numerous independent parts makers and processing specialists that focus on intermediate inputs and do not make the final product. Third, production networks are decentralized, in that they are open and non-dependent networks in which suppliers and specialist firms are usually not tied to particular assemblers or suppliers; they can supply to several firms within the industry or sell to other industries. Lastly, what distinguishes Taiwan's SMEs from their counterparts in other countries, such as Japan, Korea, the United States, and France, is that Taiwan SMEs are in charge of export activities. In particular, parts makers and specialist firms are incorporated into the global production network and compete directly in the world market, rather than being completely dependent on domestic assemblers.

Nonetheless, despite competing successfully in light (maturing) industries, the decentralized industrial system is believed to have difficulty in shifting to high-technology industrialization because it lacks R&D research and marketing. Instead, the dominant view postulates that the current transformation and upgrading in Taiwan's economy involves a disruption or discontinuities in the existing network form of organizations and calls for scaling up as a solution to the bottleneck of the original equipment manufacturing (OEM)-based export-led industrialization upon which Taiwan's initial success was built. This implies conforming to the conventional view of large corporation-cum-modern industrial economy, as exemplified in the latecomer catch-up literature (e.g., Amsden and Chu 2003). In this article, this view is referred to as the "celebrated model," which emphasizes scale and scope and the mechanisms associated with these particular catch-up/growth strategies.

The emphasis on scale and scope came from the theory of the growth of the firm. Conventional narratives favoring large corporations as the driving force for modern economies follow the neoclassical assumption that hierarchy reduces transaction costs, enhance efficiency, and minimize opportunism (Williamson 1985). At the same time, Chandler's (1977) line of thought emphasizes scale, and thus larger-scale economies that reduce production costs encourage firms to internalize production. Moreover, industrial transformation involves technological innovation in situations where scale is key to staying ahead in innovations (Schumpeter 1950). This is because innovations bring technological rent so that firms can invest more in production equipment and R&D. Scale economies in turn create entry barriers for others.[1]

In the case of Taiwan, the emphasis on large firms and debates on industrial transformation derive from two sets of literature: (1) the latecomer catch-up thesis, and (2) the global value chains (GVC) literature.[2] In what follows, I outline the key assumptions of the literature and their applications to Taiwan.

1 The emphasis on scale dominates current analyses of modern capitalism. Scaling up leads to an over-production crisis, drives down profits, and results in the creative destructions that are essential to the Schumpeterian view of business cycles and capitalist development, as well as to various Marxist approaches to over-production crises.

2 The other strand of the latecomer literature focuses on the state's role in facilitating industrial transformation. I am aware of the debate but have put it in the background, as patterns of state intervention are also influenced by the assumptions in the two literatures discussed here.

The emphasis on ramping up production as a latecomer catching-up strategy is best exemplified in Amsden and Chu's work in understanding Taiwan's upgrading policies (2003). Amsden and Chu argue that latecomers compete at a more mature stage of the product cycle and thus on lower cost; therefore, they have what are known as second-mover advantages, which are based on efficiency and capacities (volume). Thus, there is a need to enlarge the scale and output in a short time by exploiting scale economies and manufacturing in large volume to lower production costs and reap profits, as in the case of OEM manufacturing.

In turn, the latecomers' globalization drive focuses on expanding production capacities and shifting production to low-wage countries to cut manufacturing cost (Amsden and Chu 2003: 12). Thus, to keep up with the race, latecomers need to scale up and invest heavily in managerial and technological capabilities, and in enlarging scale and scope, which involves the growth of big businesses. Korean *Chaebols* serve as a model for latecomers (Amsden 1989; Evans 1995).

This line of argument, with its focus on the growth of large firms and building organizational capabilities, has been followed by current research on Taiwan's transition, despite its coming from different traditions. For instance, Chen (2002, 2008) states that the SME network of production based on trust, kinship, and interpersonal relationships that contributed to the initial success of Taiwan's export-led industrialization is not capable of meeting the challenges of upgrading. For one, trust and interpersonal relations alone cannot explain technology learning and all of the other aspects of learning needed to meet global competition. Instead, transformation would require constructing firms' organizational capabilities and transforming the organization of production. For instance, instead of mobilizing resources from existing personal networks and kinships, firms need to leverage resources (such as financial capital to facilitate growth in scale and scope) from constructing global networks (Chen 2002, 2008). Implicitly and explicitly, this implies a discontinuity from the existing network form of governance as firms head towards institutionalized modern corporations with rationalized production and management. In other words, the central thrust of the transformation literature on Taiwan, as seen in Amsden and Chu (2003) and Chen (2005, 2008), is about building Chandlerian types of organizational capabilities of modern large corporations. Existing social relations that contribute to the firm's growth would give way to developing the firm's internal organizational capabilities.

The emphasis on large firms as drivers for catching up is also influenced by the literature on global value chains analysis (GVCs). The concepts of OEM vs. own brand name manufacturing (OBM) were introduced to capture the international division of labor, in which late industrializers were incorporated into global production as OEM manufacturers, focusing on manufacturing and assembling according to blueprints, technical specs, and technical assistance disseminated by multinational corporations (MNCs), while the final product carried the brand name of the buyers in charge of the product's design and distribution (Chu 2006; Gereffi 1994). Yet, the GVC literature postulates that most profits are captured by firms that either design the product (product innovators) or market/brand the product and control distribution (Gereffi 1994). Thus, upgrading for latecomers means moving up the hierarchical ladder of GVCs and ultimately becoming leading product innovators or controlling the distribution and moving away from being OEM manufacturers (Gereffi et al. 2005; Humphrey and Schmitz 2002). Following this line of thought, larger firms are better positioned (reinforced by their organizational and technological skills and greater access to capital) than are SMEs to reap technology rent or marketing premiums to survive global competition.

The need to capture technology rent and engage in OBM has dominated the discourse on the prospects for Taiwan's future. Wang (2010) forcefully argues that Taiwan has been successful in becoming a fast follower in the IT sector with scale and greater efficiency by upgrading network-based production. Nevertheless, this path of upgrading based on OEM manufacturing and supply-chain management has reached its limit. Breaking through the current impasse of the OEM model would require a shift to OBM. Wang (2010) differs from Chen (2002, 2005) and Amsden and Chu (2003) in suggesting the persistence of the network form of organization in the high-tech transition to the IT sector and the role of institutional arrangements in accounting for the upgrading of the network system, whereas the latter two emphasize developing individuals firms' organizational capabilities. Yet, in prescribing strategies for future ascent, Wang attributes the importance to OBM and thus leading/large firms in making radical breakthroughs. Radical innovations are preferred (as opposed to incremental innovation), because they are related to the capability to engage in OBM (e.g., Apple Inc.). The underlying idea is that the rents generated from OBM will enable firms to invest in large-scale R&D to stay ahead, following a Schumpeterian view of modern capitalist development.

These predispositions in turn affect how industrial transformation is understood and how latecomer states (e.g., Taiwan) formulate industrial policies, namely, by picking winners and promoting strategic industries. The indicators of industrial transformation are thus based on sectoral transformation, moving from light industries to high-technology industries, from shoes and toy manufacturing to computers, IT chips, and bio-tech (Amsden and Chu 2003; Evans 1995; Mathews and Cho, 2000; Wang, 2010; Wong 2011). Indicators based on product type emphasize downstream large/leading firms that make the final products and radical breakthroughs that can capture technology rent. The finished product approach also connects industrial ascent with imperatives of “brand name building” (OBM) in the context of impasses of OEM-based growth.

The direct implications for latecomers’ upscaling and convergence to Chandlerian modern industrial corporations means an increasing concentration at the industry level, as smaller firms are driven out of the intense price competition with the rise of large capitalists (Amsden and Chu 2003: 9). Industrial and census data support the thesis of increasing concentration. For instance, firms with over 500 employees constituted 65.9% of the total revenue generated in the manufacturing sector in 2011, a jump from 43% in 1996. At the same time, the total revenue generated by SMEs (defined as firms with fewer than 200 employees) decreased from 44.8% in 1996 to 25% in 2011 and SMEs’ share of export output decreased from 31.6% to 12.5% from 1996 to 2011.[3] Consequently, emerging research centers on the social consequences accompanying the rise of large capitalists, such as increasing inequality in terms of income distribution and large capitalists capturing a developmental state (e.g., Lin 2009, 2013). Growth with equity and the role of SMEs are no longer an understood story. That important elements of the Taiwan miracle, such as “manufacturing bosses/boss islands” or “workers turned bosses” (Shieh 1989), are becoming passé seems to dominate the headlines and public discussions.

3 The data of the aggregated manufacturing sector in Table 1 in the Appendix illustrate well the currently understood story of industrial transformation.

SECTORAL TRANSFORMATION RECONSIDERED: THE LESS-CELEBRATED STORIES

As discussed, the conventionally understood kind of transformation relies on ramped-up production, market expansion, and monopolistic/oligopolistic competition, in which leading large firms and OBM are drivers. Yet, the aforementioned linear approach—with its emphasis on downstream lead firms and the IT sector—overlooks the possibility that many intermediate firms and specialist firms that do not make the final product could be connected to different production chains. It also overlooks the possible contributions these firms could make. This gives rise to the research questions: Is Taiwan's industrial structure headed on the path of modern industrial capitalism associated with increasing concentration and dominance by large corporations? Or does an SME-based economy still hold in Taiwan (in the manufacturing sector)? Using industrial and commerce census data, I examine these two competing questions through a detailed sectoral analysis from 1996 to 2011. The transition during this period was associated with the dominance of IT export replacing light industries to become the key driver in Taiwan's economy, increasing offshore production for labor-intensive industries, internationalization of production of local SMEs, and rising large corporations and Taiwanese MNCs in the manufacturing sector.

The following three indicators are examined in the data analysis and are derived from assumptions in the scaling-up thesis. (1) *Revenue vs. value added*. Revenue is conventionally used as an indicator to measure the scale and growth of a firm. Yet, if upgrading is about creating value added, it is relevant to examine the agents contributing to the value added in the manufacturing sector. Therefore, the data analysis performs a detailed breakdown of the value added of sub-industries within major manufacturing sectors in addition to an analysis based on revenue and sales across industries. (2) *Who is hollowing out?* The demise of the SME thesis and increasing production outsourcing to low-wage countries raise the question of whether SMEs are hollowing out. The data analysis tackles this question by generating a breakdown of the total gross output (total value of production output) and its relationship to the total revenue generated within the sub-industries of manufacturing sectors. (3) *Concentration measures*. The call for ramping up production and increasing scale and scope postulates industrial concentration. The analysis tackles the question by examining various dimensions of concentration measures, such as concentration ratios of the top 10 firms within the subsectors of various manufacturing industries by revenue, value added, and firm size.

Revenue vs. value added. A detailed sectoral analysis of industries' breakdown may suggest a less celebrated truth. The detailed breakdown by sectoral analysis based on two- to four-digit clarification suggests that the IT sector may have skewed our understanding of the overall performance of Taiwan's manufacturing sector. For instance, the IT sector as a whole generated 49.7% of the total revenue of the manufacturing sector in 2011, up from 21.7% in 1996, whereas the value added of the IT industry increased from 17.8% to 40% of the total value added of the manufacturing sector from 1996 to 2011. Yet, if we look at the detailed breakdown within the IT sector, the story looks slightly uneven when taking into account the sub-industries within the sector by examining the composition of industries based on the three-digit classifications. For instance, the semiconductor industry constituted 6.2% of the total revenue of the manufacturing sector in 2011 but generated 17% of the manufacturing sector's total value added. In contrast, the computer and computer peripheral equipment industries captured 26.5% of the total revenue in the manufacturing sector but created only 5.6% of the manufacturing sector's total value added. This is in sharp contrast to the aggregated metal and machinery sector（金屬機械）, which comprised 22.1% of the manufacturing sector's total revenue but generated 26.9% of the total value added in the manufacturing sector in 2011(see Table 2).

Moreover, if we examine the total revenue of the IT sector excluding the semiconductor industry in 2011, it had 43.5% of manufacturing's total revenue but generated only 23% of the manufacturing sector's value added. By contrast, the metal and machinery sector constituted only 22.1% of total manufacturing revenue but created 26.9% of the value added of the total manufacturing sector for that year. This implies that the sector contributed to the overall manufacturing value added in a way similar to the aggregated performances of the IT sector (excluding the semiconductor industry).

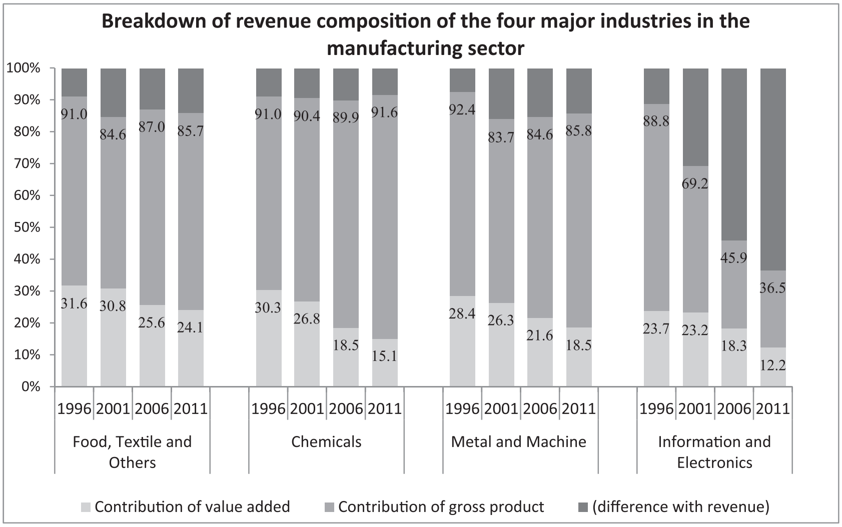
Who is hollowing out? The 2006 Industrial and Commerce Census Report indicates that almost one fourth (24.38%) of the total revenue in the manufacturing sector came from triangle manufacturing, meaning that transactions were made between the Taiwanese parent companies and foreign buyers, while the goods were produced in and exported from another country. Moreover, over 48.31% of the IT sector's total production output came from overseas production, compared with 4.68% of the non-IT sector (2006 report, p.18). If we examine the composition of the revenue of the four sectors (see Figure 1), the total gross product (total value of production output)[4] of the IT sector constituted only 36.5% of the sector's total revenue, a huge drop from 88.8% in 1996, while over the past decade, the total gross product of the machinery sector consistently constituted about 85% of the sector's total revenue , as had the chemical industries (over 90%) and other light industries (over 85%). This implies that the growth of the IT sector's revenue (especially in the computer and peripheral-equipment industries) came from internationalization of production, from triangle manufacturing or overseas production; and the bulk of the revenue went to purchasing intermediate inputs and finished products, thus creating much less gross product output (therefore not many manufacturing activities in Taiwan) or value added, compared to the other sectors. This explains the disproportionate discrepancy between revenue growth and the lower value added in the IT industry's contribution to the overall economic activities in Taiwan. This is contrary to the conventional view that the traditional manufacturing sector would hollow out and the high-technology sector would remain. What has been happening is exactly the opposite.

Concentration measures. How does increasing concentration measure up? The data reveal that the top 10 firms in the metal and machinery sector constituted 15.1% of the sector's total revenue and that the top 10 firms (by value added) generated 12.5% of the sector's total value added in 2011, compared with the top 10 firms of the IT sector that captured 56.5% of the sector's total revenue and generated 40.6% of the total value added in 2011.[5] The concentration ratio of the top 10 firms by revenue was relatively consistent for the metal and machinery sector, while the ratio of the top 10 firms by revenue in the IT sector more than doubled between 1996 and 2011 (Table 3). In other words, the metal and machinery industries seem to indicate a relatively decentralized structure in their overall economic activities, but they contributed as much to value-added production as the

4 According to the industrial census data, gross product output = value of sales of goods and services (revenue) + value of annual inventory change - purchase expenses. Total value added = total gross output - intermediate input consumption.

5 In fact, the IT sector reveals a much higher concentration, with the top five firms capturing over 41.5% of the sector's total revenue, compared to 10% of the top five firms in the metal and machinery industries.

Figure 1



Source: Directorate-General of Budget, Accounting and Statistics. Industry, commerce and service census Taiwan-Fukien area, the Republic of China.

more-often-emphasized IT sector (excluding the semiconductor industry). Thus, the argument of increasing concentration is merely based on the experience of the IT sector.

If we look at the breakdown of revenue and value added by firm size (defined by number of employees), the data suggest that over 50% of the revenue and value added of the metal and machinery sector was generated by SMEs (with fewer than 200 employees) from 1996 to 2011. This is in contrast to the increasing concentration of the IT sector, where 7.7% of total revenue and 11.8% of the total value added were generated by SMEs and 85.8% of total revenue and 62.2% of total value added by large corporations with over 500 employees in 2011 (Table 1).

If one examines the average number of employees in the manufacturing sector and compares it with the average number in the IT and metal and machinery sectors, the latter project a relatively fragmented and decentralized situation in terms of both the number of employees per firm and the numbers of firms within the manufacturing sector. For instance, the average number of employees per firm in the metal and machinery sector was consistently 70% (about 12 people) below the average number of employees per firm in the manufacturing sector (17-18 people) between

1996 and 2011, whereas the IT sector showed an upward trend, from over 2.7 times in 1996 to 4.6 times more than the average number of firms in the manufacturing sector in 2011. At the same time, the metal and machinery sector has been the main source of jobs, employing over 36% of all employees since 1996 in the manufacturing sector, in contrast to 16.3% in 1996 to 28.3% in 2011 employed by the IT sector. In terms of the number of firms in the manufacturing sector, the metal and machinery sector constituted over 50 % of all registered manufacturing firms during the past decade, compared to approximately 6% in the IT sector (Table 4).

In short, the statistics suggest that claims about the increasing concentration and dominance of large firms are based on the experience of the IT sector. Yet, the other, less-known reality revolves around the numerous SMEs continuing to operate in a decentralized industrial system, as can be seen in the analysis of the metal and machinery sectors. In other words, the distinctive feature that created the "Taiwan miracle"—the system of SMEs in a decentralized industrial structure—has also continued to drive Taiwan's industrial transformation in the past decade, even though it is being less celebrated and studied.

THE PERSISTING ORGANIZATIONAL PRINCIPLE IN THE CURRENT TRANSFORMATION: PARTS MAKERS AND SPECIALIST FIRMS IN TAIWAN'S DECEMTRALIZED INDUSTRIAL SYSTEM

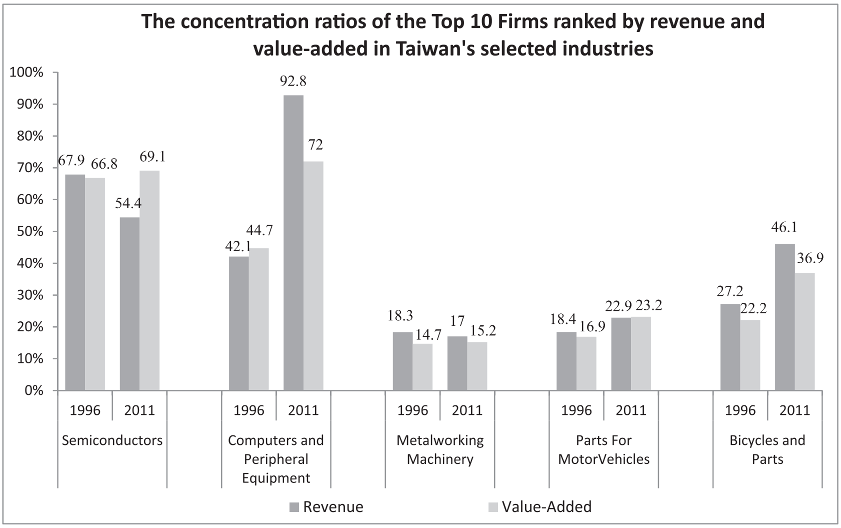
So far, I have demonstrated that the less celebrated sector has done equally well compared to the well-studied IT sector and that the claim about the dominance of large firms is based on the experience of the IT sector. In what follows, I examine the continuity thesis, which postulates that the organizational principles of Taiwan's decentralized industrial system that originally accounted for Taiwan's success continue to be present in the current transformation. First, network-based production, in which independent parts makers are connected to different supply networks with each focusing on one segment of the production chain, has continued to prevail in the high- and medium-technology sectors. Second, the prevalent role of parts makers and their ability to export and to participate in different global production networks as independent specialist subcontractors (especially among those that do not make final products) has continued. Third, instead of hollowing out, clusters remain. Drawing on the findings from industrial and commerce census data, industry statistics, and long-term fieldwork, I use the analysis of industrial performances in (1) the bicycle industry, (2) the auto-parts industry, and (3) the machine-tool industry to test the aforementioned claims. I then contrast these findings with (4) the semiconductor industry, an important IT industry (the celebrated model) on which the claims about the high-technology transition were based.

(1) Bicycle Industry

The bicycle industry is an important empirical case to understand alternative possibilities: It was one of the first group of industries, regarded as sunset industries, moving production offshore to cheap labor production sites like China. One might expect that the industry would eventually hollow out, following the fate of other labor-intensive light industries, such as shoes and apparel. Yet, contrary to predictions, the industry made a transition to high value-added production and retained its production base in Taiwan, in addition to increasing internationalization of production. For instance, the number of bicycles exported from Taiwan reached 10 million in 1998, dropped to 4 million in 2003, and reached over 5 million in 2010. Despite the decline in total volume, the total value of bicycle exports has risen significantly. For instance, the average free-on-board (FOB) price of an exported bicycle rose from US$109 to over US$400 from 2000 to 2012 (see Table 5). Moreover, the transition to high value-added production is supported by a vibrant, indigenous parts sector, with over 70% local content for a high-end bicycle, thus indicating a genuine upgrading, as opposed to its being merely an assembling industry with foreign imports. This is also supported by the fact that one half of the total revenue generated in the bicycle industry has derived from the parts sector since 1996 and that the parts sector has captured over 60% of the total value added in the bicycle industry (industrial and commerce census data, calculated by the author). The cluster remains active in central Taiwan, and firms have made collective efforts to move to high-end production.

Decentralized structure. The industry's initial success shared similar features with other SME-based industries, tapping into the decentralized industrial system to compete in the global market. In 1991, there were 1,215 parts producers to supply over 92 bicycle assemblers in Taiwan, and the trend remained consistent through the 2000s, with over 1,000 parts firms

Figure 2



Source: Directorate-General of Budget, Accounting and Statistics. Industry, commerce and service census Taiwan-Fukien area, the Republic of China.

supplying over 80 assemblers. The industry has continued to be SME dominated, with over 90% of firms having fewer than 200 employees. The top ten firms (by value added) generated about 37% the total value added of the industry in 2011 (see Figure 2).

Export-driven and a diversified export market. The industry has been incorporated into global bicycle production since the 1970s, with over 90% of its total production for export, and it continues to be export driven, with over 95% of the production for export. The European market is the main export destination, and the exports there constitute 51% of total exports (value), compared with 25.8% for the North American market (22.4% for the US) and 6.6% for Japan.[6] In other words, the export market continues to be diversified.

The ability of parts makers to export directly. The export of parts accounted for 42.3% of the total output of bicycle parts in 1986, and it has remained at over 50% since 2000 (Shih et al. 2006). In 2012, the total export value of bicycle parts made up one third of the total export value of the

6 Figures are calculated from the 2012 export statistics published by the Taiwan Bicycle Exporters' Association.

bicycle industry (about US $0.9 billion out of US $2.7 billion). The increasing capacity of parts firms as strong exporters and the fact that they have dealt directly with foreign buyers have further reduced their dependence on assembly firms.

(2) Auto-Parts Industry

The auto-parts industry also has demonstrated its strong growth over the past decade. Yet, growth in the auto-parts industry presents a puzzle, because the auto industry is conventionally considered a strategic industry that would be used to create backward linkages and be conducive to national development. The emphasis is on the assembling sector to develop trickle-down effects to the parts sector and other industries. The decentralized industrial structure, however, did not favor an industry that requires scale economies and a formation of large, indigenous assembling firms without state intervention. The literature attributes the failure of Taiwan's attempt to develop an indigenous assembling sector to failed state intervention (Arnold 1989; Chang and Wu 1997); nevertheless, Taiwan has developed a vibrant auto-parts industry deriving from the decentralized SME network (Biggart and Guillen 1999). This is notwithstanding the experience of auto-parts makers in the developing world being dependent on large assemblers (mostly MNCs) with little indigenous technology (Doner 2009). Cheng's work (2006) on Taiwan's auto industry, while acknowledging the continuous growth of the auto-parts industry in Taiwan, retains an analytical focus on the learning of the leading assembling firm to insert itself into the global market. Thus, Taiwan's vibrant auto-parts industry remains a major puzzle with respect to how the industry developed and sustained itself, as well as how it developed its technological capacities.

Decentralized structure. In 2011, the auto parts industry generated about 1.1% of the manufacturing sector's total revenue and over 1.8% of the total value added of the manufacturing sector (Table 2). The auto-parts industry also revealed a relatively decentralized structure, despite the conventional assumption that scale economies are needed for the auto industries. For instance, about one half of the total revenue and value added in the auto-parts industry is generated by firms with fewer than 200 employees (Table 1). The top 10 auto-parts firms (by revenue) consisted of 18.4% to 22.9% of the total revenue between 1996 and 2011, and the top 10 firms (by value added) generated approximately 22% (on average) of the total value added from 2001 to 2011 (Figure 2). The auto-parts sector has over 3,000 firms, and these firms exercise extensive network production. Over one third of auto-parts firms are clustered in central Taiwan (Taichung and Chunghwa) and another 20% in northern Taiwan (industrial and commerce census data, calculated by the author).[7]

Export driven. Despite the lack of strong auto assemblers in Taiwan, auto-parts makers have been actively seeking export outlets. Most exports are in the aftermarket (AM) category, with replacement parts and accessories. The industry has occupied this niche market (the AM market) in which firms produce a wide range of products in small batches with lots of variety. This is in direct contrast to the scale economies and mass production of OEM manufacturers for auto parts. For instance, between 2000 and 2012, the total export value almost tripled, from approximately US $2.65 billion to about US $6.58 billion (Table 5). The industry findings reveal a diversified export market with the main export destinations being the US (36.7%), Japan (6.9%), China (4.8%), Germany (3.1 %), and Australia (3.0%) in 2010, while during the last decade, over 45% of total exports went consistently to destinations outside the top 5 countries (Song et al. 2011).

(3) Machine-Tool Industry

Broadly speaking, the machine-tool industry comprises two types, metal-cutting machines （金屬切削工具機）and metal-forming machines （金屬成型工具機）. This industry was chosen for analysis because it is often referred to as the mother industry that is vital to the production of other industries, such as the automobile and aerospace industries. Thus, the level of the machine-tool industry's development is considered the benchmark for a country's industrial development. In the case of Taiwan, despite lacking support from the auto-assembling industries, machine tools were indispensable for processing and repairing in the manufacturing industries and for manufacturing spare parts in the earlier period, and thus they were conduc-

7 According to the 2011 Vehicle Year Book (Song et al. 2011: 2-227), the auto-parts cluster in northern Taiwan constitutes about 42% of the firms, and the cluster in central Taiwan about 28%. One possible explanation for the discrepancy would be that the cluster in northern Taiwan is related to the assembling sector (meant for domestic production), whereas if one takes into consideration makers of accessories parts (which are export oriented), the bigger cluster would be in central Taiwan, as revealed by the industrial census data.

ive to the development of a flourishing component sector. In turn, the availability of these local parts producers reduced dependence on imports. The literature attributes the industry's success to the decentralized subcontracting system, clustered in central Taiwan and subsequently inserting itself into global production networks, typical of Taiwan's SME miracle (Amsden 1985; Chen 2009; Liu and Brookfield 2000; Wang 2010).

SME-based and decentralized structure. The machine-tool industry constituted about 1% of the total revenue of the manufacturing sector and 1.4% of value added in the manufacturing sector in 2011 (Table 2). The industry's transformation has continued to be congruent with the existing decentralized SME system instead of ramping up production or increasing concentration. For instance, among the over 5,900 firms classified as being in the machine-tool industry in the census data, over 99% employ fewer than 200 people. Moreover, the industry demonstrates a highly decentralized industrial structure, with the top 10 firms (ranked by revenue) accounting for approximately 18% (on average) of the industry's total revenue between 1996 and 2011 (Figure 2). Over 75% of the industry's total revenue was generated by firms with fewer than 200 people (Table 1). Central Taiwan (Taichung and Chunghwa) has continued to be the hub of the machine-tool industry.

International comparison lends support to the decentralization thesis. Despite being ranked as the number-four exporter in the machine-tool industry globally, none of the Taiwanese firms have made it to rank among the top 50 global machine-tool firms, measured by revenue. For instance, the total revenue of the number-one machine tool maker in Taiwan was only 22% of that of Korean Doosan Infracote in 2007 (Wang 2010: 63).[8] In my field research, representatives from many of these independent SME specialist firms mentioned that their equivalent counterparts in other countries like Japan are often a subdivision of a large corporation like Hitachi, and thus their competition in the global market is like David competing with Goliath (interviews 20131007YW; 20110617CHC).[9]

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8 The total output value of Taiwan's machine-tool industry is slightly less than that of its Korean counterparts.

9 The qualitative data comprise fieldwork with various industries and interviews with relevant industry representatives, including owners, engineers (both at private companies and government-funded research institutes), and managers during the 2003-2014 period. Whenever references are taken from the interviewees, they are indicated with a name code, where the first letter refers to the company initial and the second/third letters refer to the last name. Numerical numbers refer to the date/year on which the interview was conducted.

Export oriented. Despite the lack of strong end-user industries, such as the auto and aerospace industries, Taiwan's machine-tool industry has demonstrated its capacity to compete internationally. Its outstanding export performance over the past decade surprised the policy pundits, and the industry became the "hidden champion." The total export value has increased three times, from approximately US$1.46 billion in 2000 to US $2.65 billion in 2005, and to approximately US$4.23 billion in 2012 (Table 5). The industry has become the world's fourth-largest machine-tool exporter and the sixth-largest producer, measured by total output (Liu et al. 2007; Yeh et al. 2013), after Japan, Germany, and Italy. The export ratio of the machine-tool industry has been consistently over 70% and has steadily increased to over 78% since 2008, compared to 30% of the export ratio for the Korean machine-tool industry. Taiwan's machine-tool industry shows a diversified export structure, with the top five export destinations being China (32.8% of total export value), the United States (12.8%), Thailand (6.3%), Turkey (4.9%), and Germany (3%) in 2012, and over 40.2% of total export value going to countries outside the top five export destinations (Liu et al. 2013).

In addition to being a major exporter of machine tools, many component makers or specialist firms related to machine tools have been actively connecting to global production outlets. For instance, wood-mold makers (of 30-40 employees) for casting pieces stated that their ability to export/supply to multiple customers helped them weather the 2008 financial crisis that hit the industry worldwide (interview 20131007YZH). In other cases, casting firms not only supply local final assembling machine builders but also have direct relationships with Japanese and European customers (interviews 20131007YW; 20131008SC; 20131008BCH).

(4) Semiconductor Industry

By including the semiconductor industry in the comparison, I do not intend to equate the mechanisms of development of the semiconductor industry with those of the machinery sector. Nor do I attribute the causes of the former's success to the subcontracting system that led to light industries' export success in the 1980s, as discussed by Shieh (1991). The semiconductor industry and the machinery sector differ in many respects, such as sources of financial capital, levels of technology, sources of learning and knowledge flow, and the division of labor in organizing production. The point here is that the ways in which specific patterns of Taiwan's semiconductor industry have evolved correspond to the underlying logic of Taiwan's decentralized industrial structure, in which firms are connected to different production networks; these inter-firm dynamics have not been overhauled, nor have they converged to anything similar to a vertically integrated system. In fact, Taiwan's foundry manufacturing has been considered the organizational innovation that breaks up the organizational principle of vertical integration and leads to vertical disintegration in the IT industry globally (Chen 2003). An example of a way in which the semiconductor industry has continued to tap into Taiwan's decentralized network structure for upgrading is that firms have focused on manufacturing application-specific integrated circuits (ASIC) as opposed to mass producing Dynamic Random-Access Memory (DRAM), in which Korea has prevailed.[10] The presence of Taiwan Semiconductor Manufacturing Corporation（TSMC, 台積電）and other specialized foundry manufacturing firms has allowed many integrated circuit (IC) chip-design companies to enter the value chains and focus mainly on upstream design. They have tapped into the highly specialized network in the Hsinchu high-tech cluster and work closely with engineers of IC manufacturing firms to ensure proper design. The growth in ASIC chip design and manufacturing has been an important element in the growth of Taiwan' s IT industry, especially in the component sector. ASIC semiconductor chip manufacturing accounts for the diverse range of electronic and IT components/products coming out of Taiwan, since most IT components require ASIC chips.

Despite the conventional view that Taiwan's semiconductor industry is capital and scale intensive, it has demonstrated a relatively diversified organizational/industrial structure when compared to its international counterparts and other industries in the IT sector. For instance, if one uses patents as a proxy for innovations and technological capacities and examines the patents filed at the US Patent and Trademark Office (USPTO), the semiconductor industry has been the key patent generator among all the industries in Taiwan and South Korea. Yet, at the individual-firm level, the TSMC contributed 7% of Taiwan's total patents compared to Samsung

10 For instance, ASIC and IC foundry manufacturing constituted 47.7% of the total output value of Taiwan's semiconductor industry, whereas DRAM manufacturing constituted 12.8% during 2000-2012. Downstream packaging and testing (mostly related to ASIC and IC foundry manufacturing) constituted 31.5% of the total output of the semiconductor industry (Yearbooks of Industrial Production Statistics, Taiwan, Ministry of Economic Affairs).

Electronics, which contributed over 53% of Korea's patents in 2007 (Wang 2010: 308). Although the IT industry has driven innovation in both countries, the patent analysis reveals major differences in industrial structure and industry concentration. For instance, in Taiwan, the top 10 patent holders by organizations are from the IT sector, and half of them are semiconductor firms, but they constituted only 41% of patents within the IT sector and about 24 % of Taiwan's total patents for the 2000-2007 period. In contrast, the top 10 patent holders in Korea constituted 87% of patents within the IT sector and over 65% of Korea's total patents during the same period (Wang 2010: 308).

When one compares Taiwan's computer and peripheral-equipment industries, the top 10 firms (by revenue) in the semiconductor industry generated 54.4% of the total revenue of the industry in 2011, a decrease from 67.9% in 1996. This is in contrast to the increasing concentration of the computer and peripheral-equipment industry in which the top 10 firms constituted 92.8% of the industry's total revenue in 2011, a huge jump from 42.1% in 1996 (Figure 2).

To conclude, the industrial performance of the less celebrated truth and that of the important industry in the IT model suggest that the industries have not experienced a major disruption in the current transformation in terms of the level of concentration or the organizational principles of a network-based production system. Figure 2 captures well the claim that increasing concentration is derived merely from the experience of the IT sector, especially in the computer and peripheral-equipment industries, when the findings are juxtaposed with the aforementioned metal and machinery sub-industries. Moreover, despite increasing internalization of production and offshore production in countries with low-wage labor, such as China and Vietnam, Central Taiwan has continued to be the hub for the machine-tool industry, as well as the bicycle industry and related machinery parts; Hsinchu（新竹）has continued to be the hub for the IT industry and the semiconductor industry and IT-related industries; and Southern Taiwan has continued to be the hub for steel and metal-related industries. Entrepreneurship remains vibrant at the industry level, especially among parts makers, contrary to the hollowing-out thesis. Lastly, SMEs, especially parts makers, continue to prevail in the current quest of high-technology industrialization. Even if one invokes the conventional proxy (i.e., patents), to measure innovation or technological capacity, Wang's (2010) patent analysis reaffirms the relative importance of the machinery sector in driving

Taiwan's transformation over the past decade. Wang's analysis suggests that three sub-industries in the machinery sector (machine tools, transportation equipment, and sports equipment) also made it into the top 10 patent-holding industries in Taiwan, whereas in Korea, 9 out of the top 10 patent-holding industries were within the IT sector (Wang 2010: 301).[11] The fact that one half of patent holders in the machinery sector in Taiwan were registered as individuals as opposed to organizations suggests that SMEs have continued to be sources of innovation.

SOCIAL FOUNDATIONS OF THE DECENTRALIZED INDUSTRIAL SYSTEM

I have demonstrated that the claim for the increasing concentration and dominance of large corporations in Taiwan's quest for high-technology industrialization is based on the study of the exception rather than the norm, that is, the current understanding of the high-technology industrial transformation in Taiwan centers on the experience of the IT industries and individual lead firms. Organizational principles of decentralized production have persisted in the less celebrated sectors, such as machinery. How could the "putative periphery"[12] (such as parts makers in Taiwan's machinery sector) continue to do so well? Put differently, how are these SMEs able to learn, and how do they manage to export or insert themselves into global production networks, given their small-scale R&D expenditures and size?

The adaptation experiences of Taiwanese SMEs share similarities to the flexible specialization production that Piore and Sable (1984) characterize as a historically alternative capitalism, in contrast to the mass production associated with modern industrial capitalism. This kind of production shares the properties of flexible specialization of the production system, or small lot production, in which a system of SMEs competes in differentiated product markets or niche markets that emphasize quality over price, as opposed to markets that focus on the price-sensitive standardized

11 In terms of the actual number of patents, Taiwan's industries in the machinery sector (e.g., material processing, metal working and motors, parts, and transportation) outnumbered those of Korea (7915 vs. 4853) from 2000 to 2007 (Wang 2010: 301).

12 I borrow the term from Scranton (1997), who described the less discovered SME systems in the United States from the 1870s to the 1930s during the second industrial revolution, a period conventionally understood as one of increasing consolidation of modern mass-production capitalism.

products associated with the mass-production paradigm (Sabel and Zeitlin 1997; Zeitlin 2008).

The alternative model calls for the quality aspects of technological learning and competition, as opposed to competition based on scales, efficiency, and price. In turn, it involves completely different conceptualizations in organizing the production and relationships among firms. These emergent governing relations in understanding inter-firm collaboration in the alternative model are referred to as "pragmatic disciplines," in which firms collaborate to explore each other's potential and acquire skills that could be reapplied in other ventures. Such concepts as learning by monitoring, flexible specialization, and diversified quality production are often applied to describe these emergent production principles (Helper et al. 2000; Sable 1994, 2006).

In what follows, I discuss two key mechanisms that drive the system in Taiwan's less celebrated model: the role of parts makers and specialist firms and the role of support institutions in coordinating a decentralized structure.

The importance of the parts sector and specialist firms (multiple horizontal linkages). The emphasis on quality and skills attributes greater importance to parts makers and specialist firms in the production process, as opposed to treating them as powerless subcontractors supported by large leading firms. This argument affirms that firms' decision to outsource is not simply a matter of seeking cheap labor, but requires tapping into the ideas and core competencies of these independent parts makers, which also work in other industries (Helper et al. 2000; Whitford and Zeiltin 2004). From the perspective of suppliers, doing OEM became a way to seek more market information and to gain additional skills, as information was shared in ways that were unthinkable in the old hierarchical paradigm. For instance, these SMEs enter the global supply chain for companies seeking niche products, as opposed to being tied to a few giant MNCs. It follows that parts makers and specialist firms are key drivers in the decentralized industrial system, contrary to the conventional emphasis on leading large firms. Consequently, the pragmatic turn has impacted how we make sense of the role of these SME-based specialist firms and parts makers as agents of value creation in the less celebrated model in the following ways:

(1) *Distinctions in sources of innovation/learning*. The quality emphasis of the less celebrated model distinguishes it from the existing approach of theoretical, top-down, and science-based in-house R&D by

focusing more on the non-codified aspect of technology learning. Distinctions between science-based/codified technology learning and "art-based" /non-codified learning are relevant, because they might affect the understanding of by whom and how innovation/learning occurs and why certain industries remain territorially rooted when facing globalization (Chen 2009; Malerba 2005). For instance, science-based electronic or IT industries, in which East Asian latecomers claim distinction, emphasize internal R&D and patents as sources of technology transfer. IT hardware manufacturers modularize and standardize products that highlight efficiency and volume, as opposed to quality and precision. In contrast, in sectors like machinery equipment, sources of innovation center on performance improvement, reliability, and customization. These industries rely on tacit knowledge and what Amsden called "art-based" learning of a "cookbook variety" that features the hands-on and shop-floor experiences of skilled personnel and engineers (Amsden 1985: 279).[13] Thus, R&D in the context of pragmatic principles is often linked to troubleshooting, problem solving, learning by monitoring, quality control, capability building, and incremental improvement (Herrigel 2010; Sabel 1994; Whitford and Zeitlin 2004). In the machinery sector, for example, production experience impacts quality, as technological competence is acquired through shop floor and manufacturing experiences (Chen 2009: 529).[14]

(2) *Shop-floor dynamics and an emphasis on skilled labor*. The emphasis on quality and precision leads to a very different labor/management relationship between production workers and managers/owners on the shop floor. Skilled workers are in demand, and their feedback is greatly valued in production processes, in contrast with semi-skilled and unskilled workers on the assembly line who tend the machines in the electronic and IT sector. Existing work suggests that shop-floor dynamics in the machinery-parts sector are less a combat zone between managers and workers and more a

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13 Interestingly, many of my interviewees often used cooking and the art of the master chef as analogies to explain technical processes. For instance, iron-casting processes for machine-tool components resonate with the notion of art-based technology of the cookbook variety (interviews 20131008SC; 20110526PL; 20140306AL).

14 Despite increasing digitalization and IT applications being applied to machinery equipment, empirical findings suggest that hands-on experience matters a great deal for problem solving in the machinery industry.

site for experimentation between foremen and workers.[15] The informality of management that facilitates communication between engineers in operations (those on the shop floor) and those in design (or R&D) has been regarded as the key to the success of Taiwan's machinery industry (Amsden 1985: 280-281).

Production processes break down new routines to identify problems that were not discovered in earlier rounds, for constant readjustment and problem solving.[16] Moreover, in these non-codified sectors, design capacities or modifications of design often require shop-floor manufacturing experience. Thus, constant communication and feedback loops between experienced engineers/designers and shop-floor builders and machinists for "simultaneous engineering" are required. The emphasis on shop-floor experience means that parts makers and specialist firms become important to leading firms, because their hands-on experience is conducive to incremental innovation, problem solving, and cost-down engineering (i.e., reducing the number of steps in manufacturing processes).

(3) *Horizontal/cross-sectoral inter-firm learning.* Learning and skills come not only from the shop floor; they also emerge from working with others. In Taiwan's decentralized production system, the fact that parts makers are connected to multiple production networks means that learning does not come from a top-down direction from leading firms to suppliers; rather, learning takes place from multiple directions. Moreover, learning is not confined to the industry itself; instead, information flows among different industries from which parts makers benefit. Moreover, parts makers' ability to engage directly in the export market illustrates the importance of having access to novel information flows by connecting to different clusters (this was a recurrent theme in my fieldwork surveys). The director of the R&D division of an aluminium materials supplier shared the importance of connecting to different overseas customers: "Foreign buyers provide us market information and other information. This may not necessarily be one regarding technology, but it gives us the idea that there is such a product in the market. It widens our vision and imagination and

15 Interviewees concurred that the small lot production system (the just-in-time system) gave more autonomy and recognition to workers at the work station. Thus, the shop floor is less a combat zone where people fight over whom to blame for errors (interviews 20100617SK; 20100610WCH; 2004TCH).

16 This was referred to as system root-cause detection in the pragmatic principle (Helper et al. 2000: 466).

inspires our product development" (interview 2004AT). The engineer of a component company defined the company as a specialist manufacturer that works with different industries: "We focus on the specialization of the manufacturing and applications of composite materials as opposed to a final product. So even though we started with tennis racquets, we are not confined to sports equipment. At the same time, diversifying into manufacturing different products [via OEM] allowed us to expand our manufacturing knowledge" (interview 2004TKL). Consequently, parts makers have developed more specialized skills and knowledge, which has enabled them to negotiate with domestic assemblers or larger firms for better treatment on a more equal footing.

An immediate outcome of the free flow of information among industries permits the parts sector to pursue improvement and innovations at the intermediate input level, which can be applied to many situations, not just at the end-product stage. In turn, cross-industry learning often leads to the adaptation of new materials and new manufacturing technologies through recombining ideas. The strength of material innovations is supported by the patent analysis, where material processing and handling patents constituted one fourth of the total patents in Taiwan's machinery sector during the 2000-2007 period (Wang 2010: 301).

Many parts makers emphasize that focusing on intermediate inputs allows firms to be more general and apply their skills to different situations (interviewees A1, P1, P2, A2, A3). The point here is that a decentralized and horizontal structure embedded in the clusters is conducive to learning, especially among parts makers. The open and decentralized networks in an egalitarian context makes it easy for firms from other fields to enter the industry. Case studies show that more IT component makers are entering the field of electronic automobile components by collaborating with auto parts makers (interview 20130718ARW). Decentralized production networks facilitate this kind of cross-industry fertilization, make new entries easier, and account for growing entrepreneurship.

Support institutions for export and technology learning (non-market forms of coordination of learning). As illustrated, the underlying mechanism of the alternative decentralized system at work develops industries instead of growing individual firms. Yet, the network-based system is not independent of the state. Public support institutions are connected to the decentralized industrial system by addressing collective needs and help parts makers insert themselves into global production networks and succeed in the global market. This includes efforts to sustain networks that are neither conventionally acknowledged nor understood: encouraging skill formation; introducing new manufacturing technologies and disseminating information, thus lowering the entry barriers for SMEs; and matchmaking different production chains for recombining ideas to construct cross-sectoral ties. Case studies have revealed that policies that do not try to pick winners work best to preserve horizontal inter-firm cooperation, especially in the parts sector, because they enable information and learning to spread throughout the population and form a broader base for entrepreneurship (Hsieh 2015).

Industry associations and industry-specific R&D centers that work with the parts sector have been crucial in sustaining the capabilities of these parts makers. For instance, industry-specific R&D centers have been instrumental in building internationally accredited testing facilities for the auto-parts, machine-tool, and bicycle industries. In the case of the auto-parts industry, to be accepted as AM suppliers, they need to pass the testing requirement for entering the EU and US markets. In other cases, changes in EU regulations and EU industrial standards have affected the manufacturing methods of machine tools and components. Yet an individual SME is not likely to meet these requirements on its own. Hence, testing facilities have been important for product development for SMEs and for troubleshooting (interviews 20130718ARW; 20110610PMC; 20130902ML; 20131008 MPF; 20110617BRL). The supporting industry R&D centers disseminate information on changing regulations in the export markets and the respective implications for changes in manufacturing and possible solutions. Common problems that the industry confronts are often discussed at meetings of industry associations, especially among the export-oriented industries. Business (industry) associations for the SMEs in this context are not political lobby groups; instead, they focus on overcoming export hurdles and disseminating market information. These collective services may seem subtle but have been effective in assisting SMEs, especially within the parts sector, by shortening the learning curves and overcoming barriers for export and product development. In short, public-support institutions enhance firms' capability by providing external economies applicable to all firms.

These institutions are also crucial for sustaining the SME clusters and preventing network failures. Here, the state coordinates decentralized networks by developing supply chains and matchmaking different production networks. Hence, the focus is on extending technologies to industries and to ensure local spill-over effects, as opposed to growing individual firms' capacities, upon which rests the existing understanding of a top-down approach of acquiring and transferring crucial technology to individual leading firms. For instance, Taiwan used to be the top exporter of fasteners, an industry clustered in southern Taiwan. Despite losing advantages to other lower-wage countries, the cluster has survived, and many companies have moved from low-end standardized fasteners for construction to a higher grade for auto-parts suppliers and the aerospace industry. The transition involves working with the whole supply chain for fasteners and tapping into the decentralized network for collective upgrading. The metal industries R&D center was central in coordinating the upgrading process by introducing new technologies and working with machine-tool firms and fastener-parts makers to develop the required equipment for the new precision manufacturing technology (interviews 20130902ML; 20130903MC). In turn, the technology has become widely extended as the equipment can be built domestically (interviews 20130902MK; 20130903MC). The upgrading has cascaded not just among the fastener manufacturers but also to a wide range of auxiliary specialists and equipment manufacturers.

In addition to disseminating information and new technologies, public technology support agencies have played an orchestrating role in bridging different networks and resources, which has reduced the barrier for new entries and alleviated the R&D burden on individual SMEs. As discussed, some IT firms are actively entering the automobile component industry by focusing on electronic applications of auto parts (interview 20130718 ARW). The automobile R&D center has been coordinating the connections among industries for the joint products. The orchestrator coordinates the decentralized network by bridging and connecting firms/actors from different production networks, and this is conducive to new breakthroughs, as innovation often occurs through recombination of existing means (interviews 20110610CHC; 201106017BRL; 20110414MCH; 20130903 MH). Thus, the role of orchestrator, which differs from the conventional view of the state agency as leader, should not be dismissed, for it carries important implications for understanding how innovation and learning come about.

The decentralized system requires a state that creates a level playing field, as opposed to one that is concerned with picking winners. These partnerships between the lower-rank R&D centers and SMEs affect the subsequent form of technological learning on the SMEs where each actor (including state agencies) is connected in multiple directions. There, the actors' concerns have been to develop industries that will tap into external economies, as opposed to facilitating growth within individual firms.

The aforementioned two mechanisms differ from existing accounts of Taiwan's industrial transformation concerning the roles of institutions and firms in two fundamental assumptions: First, by bringing the collection of parts makers to the fore, the alternative model highlights the relevance of a decentralized network of firms in driving the changes, as opposed to individual leading firms. Moreover, existing studies treat clusters of firms, thus geographical agglomeration, as means to increase efficiencies and reduce transaction cost. Thus, inter-firm relations are considered to improve efficiencies and strengthen the growth of individual firms and, ultimately, draw attention to the leading firm that produces the final product. In other words, the inter-firm network is an independent variable used to explain the growth of firm/market competition. Social relationships (e.g., trust) here are merely an extension of the neoclassical analysis to improve individual firms' performance. Yet, as illustrated, inter-firm collaborations and social relations in the alternative model rest upon the assumption of problem solving and learning instead of enhancing the efficiencies of individual firms in the market.[17]

Second, the role of the state in the existing firm-centered, final product approach is about preventing market failure. For instance, the work on Taiwan's public research institutions focuses on how institutional incentives affect individual firm behavior (Wang 2010). Alternatively, the accounts assume that the state prevents market failure and mitigates risks by playing a leadership role in technological learning and creating new industries to induce entrepreneurs into new investments that they otherwise would not take, but that the state is expected to withdraw once the market has been created. In turn, this approach emphasizes the centrality of elite research institutions, such as Industrial Technology Research Institute

17 A classic example is the formation of A-team, an alliance established by two leading assemblers and parts suppliers in the bicycle industry since 2002 in their attempt for joint upgrading. When inquiring if the initiatives were about supply-chain integration by bringing the suppliers into the orbit of leading assemblers, the leading assembler quickly asserted that it was about learning, not about supply-chain integration (interview 20100618MT). In reevaluating his claim and accessing the actual operation of the alliance, I concurred with the interviewee's foresight.

(ITRI), and formal elite higher education (Chen 2003). In contrast, the less celebrated model depends upon the assumption of decentralized network coordination, in which the state mitigates learning by connecting different programs with various production networks to explore manufacturing and innovation possibilities. The state is loosely connected to the systems, as with a hidden developmental state (Block 2008). Its involvement is decentralized and resonates with the idea of letting a hundred flowers bloom. The concern at stake is to strengthen the system of the network of firms and prevent network failure by enhancing collaboration and learning, not about reducing transaction costs (prices) or producing hierarchy/picking winners to improve efficiency (Whitford and Schrank 2011).

FINAL REMARKS

The specifics of the Taiwan experience contribute to the discussion on the "pragmatic turn." This literature examines the restructuring processes of advanced countries like the United States, Germany and Japan in the face of expanding transnational production networks with a shift to decentralized networks of production, along with associated changes in organizing the economy (Block and Keller 2009; Herrigel 2010; Whitford 2005; Whitford and Zeitlin 2004). Taiwan is an interesting and important case to examine because its integration into the global economy and global production networks since the 1970s has specifically contributed to the shift. This article contributes to the discussion by highlighting the ways in which the decentralized system facilitates learning by constructing cross-cutting ties (i.e., cross industry networks) and the overlooked role of parts makers in creating value added. The cases illustrate the conditions in which some clusters/SMEs could remain resilient and globally connected in face of globalization. It also adds empirical nuances in understanding the sources of innovation and learning in a decentralized system. The emphasis here is not size per se in accounting for the SMEs' resilience; rather, the analysis provides a structural foundation wherein resilience draws on the decentralized network system of learning and cross-sectoral linkages.

If this argument for the less celebrated story holds, we will have very different understandings of the path to prosperity; strategies for latecomer catch-up, such as technology learning and the notion of OEM vs. OBM; how economies are organized; and the role of the state in regard to Taiwan's future transformation. In the celebrated model, which is mostly derived from studies of individual large firms, the unit of analysis is those firms, and the model tends to generalize from their experience of industrial or sectoral performance. Moreover, the celebrated model places great emphasis on size and scale because growth strategy is based on assumptions of market expansion and monopolistic or oligopolistic competition. The focus on scale economies means that the conventional literature uses revenue as an indicator for market share and growth to understand success or failure in industrial development. Innovation and learning capacities in this context are often associated with R&D inside research labs and firms, and not from the shop floor and external economies. This then affects how innovations are understood, for they are measured by the number of patents and the amount of R&D expenditures. Yet, the analysis of Taiwan's IT industry suggests that this indicator could be misleading and over-exaggerate the contribution and value added generated by these revenue-driven activities, thus distorting what actually happens in the economy. A linear process of upgrading by moving up the value chain from OEM to OBM is assumed to be the only solution to bypass low value-added subcontracting activities by capturing the market or technology rent. In turn, it is assumed that large leading firms that make the final product are the value creators in contemporary capitalism. In the celebrated model, the state's solution to industrial ascent is to identify strategic industries and incubate new industries; and firm-specific support is expected when the role of the state in economic development is evaluated. Thus, the debate centers on the state vs. the market or the state vs. the hierarchy. Consequently, scholars and policy pundits have devoted attention to studying the social consequences related to these predispositions, such as increasing concentration and inequalities, identifying the next strategic industries, and providing solutions to move from OEM to OBM.

The experience of the less celebrated truth paints a very different picture of how an economy operates, with such features as inter-firm relations, sources of innovation and learning, and agents of value-added creation. The unit of analysis is a system that comprises a network of firms complementing each other and tapping into external economies. Generalizations are made not from the experience of the individual firm but from the network of firms driving the system. Therefore, the indicator of success/failure is not size or market growth, but the system's viability. As the Taiwan experience demonstrates, breakthroughs come not only from large lead firms but also in waves from component makers and specialist firms that do not make final products. Contrary to the conventional view of powerless subcontractors being dictated by large leading firms, independent specialists and parts makers have more power to manoeuvre in a decentralized structure. The values are distributed more equally among these specialist firms, yet their contribution is not captured in the current large firm-centered, revenue-driven/market expansion analysis. Consequently, the less celebrated model poses the question of the relevance of the ascent strategy based on a linear movement from OEM to OBM that dominates the current debate, since the drivers of the less celebrated model are specialists who do not make finished products and who are connected to different production networks.

In the less celebrated model, R&D and innovation/learning come not only from research labs but from shop-floor experience and working with various industries. The less celebrated model places a premium on the skilled labor force, especially shop floor training, as opposed to codified knowledge from the research labs applied to unskilled labor on the shop floor. The emphasis on skill formation and craft-based skills raises the question of the necessity of vocational training for developing the so-called quality regime, in contrast to scaling up and ramping up production in the mass-production regime.

Lastly, the state-firm relationship in the alternative model involves nurturing the whole system instead of picking national champions, by extending local supply chains and recombining and connecting different networks. This is done to prevent network failure, as opposed to preventing market failure or hierarchical failure. In short, the empirical evidence suggests that the less celebrated and studied model of the machinery sector illuminates the alternative possibilities of a territorial-rooted production that is also able to compete and adapt well globally.

If we accept the truth of these other less celebrated stories, future research questions will move observations beyond the existing firm-centred analysis to a unit of analysis based on a system of networks of firms. This will involve different conceptualizations in understanding how the economy operates. In turn, research questions will not evolve around how to scale up, how to become a fast follower, or how to move up the value chain to become brand name building manufacturers; rather, the questions will be about skill formation, for example, "How can we construct a regime that seeks to reach goals based on humanistic, skill intensive, and quality effective standards?"

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APPENDIX

Table 1

The contribution in percentages of the revenue, value-added, and export values by firm size (numbers of employees) in Taiwan's four major manufacturing sectors and selected sub-industries.

Sector and Industry Classification (2011 R.O.C. Classification System Code)	Revenue(%)						Value-Added(%)						Export(%)					
	1996			2011			1996			2011			1996			2011		
	≧501	201~500	≦200	≧501	201~500	≦200	≧501	201~500	≦200	≧501	201~500	≦200	≧501	201~500	≦200	≧501	201~500	≦200
Information and Electronics	63.6	12.7	23.7	85.8	6.5	7.7	62.2	12.3	25.5	78.5	9.7	11.8	73.8	11.5	14.7	89.6	5.4	5
Metal and Machine	33	9.8	57.2	33.1	13.7	53.2	33.2	7.8	59	30.7	12.8	56.5	30.2	16.2	53.6	41.5	16.9	41.6
Metalworking Machinery (291)	8.6	13.8	77.6	7.4	17.2	75.4	7.3	9.6	83.1	7.4	14.6	78	13.7	25.7	60.6	9.5	25.3	65.2
Parts for Motor Vehicles (303)	15.7	19.4	64.9	25.5	25.6	48.9	15.7	17.8	66.5	26.4	25.3	48.3	20.2	30	49.8	41.5	23.9	34.6
Bicycles and Parts (313)	9.4	18.2	72.4	34.2	26.2	39.6	9.5	13.4	77.1	26.6	26.1	47.3	14.9	28.2	56.9	47.7	28.9	23
Bicycle Parts (3132)	3.5	9.2	87.4	17.4	25.2	57.4	3.7	6.6	89.7	14.9	25.6	59.5	9.8	16	74.2	31.9	23.7	44.4
Food, Textile, and Others	31.6	16.2	52.2	35.2	14.7	50.1	41.7	12.5	45.8	45.9	12.3	41.8	27.5	25.1	47.4	31.4	20.9	47.7
Chemicals	49.5	10	40.5	65.4	8.2	26.4	52.9	8.3	38.8	54.7	9.2	36.1	54.7	11.2	34.1	70.4	10.1	19.5
Aggregated Manufacturing Sector	43.3	11.9	44.8	65.9	9.1	25	45.4	9.8	44.8	56.6	10.8	32.6	53.7	14.7	31.6	79.6	7.9	12.5

Source: Directorate-General of Budget, Accounting and Statistics. Industry, commerce and service census Taiwan-Fukien area, Republic of China.

Table 2

The contribution in percentages of revenue and value-added of the four major sectors and selected sub-industries to Taiwan's manufacturing sector

Sector and Industry Classification (2011 R.O.C. Classification System Code)	Contribution to Manufacturing Sector							
	Revenue (%)				Value-Added (%)			
	1996	2001	2006	2011	1996	2001	2006	2011
Information and Electronics	21.7	36	47.2	49.7	17.8	31.9	43.7	40
Semiconductors (261)	4	7.6	8.6	6.2	4.3	10.4	18.5	17
Computers and Peripheral Equipment (271)	8.9	13.3	17.2	26.5	4.9	8	5.8	5.6
Metal and Machine	32.3	26.3	23.7	22.1	32.1	26.6	25.9	26.9
Metalworking Machinery (291)	1.2	1.1	0.9	1	1.2	1.2	1.1	1.4
Parts For Motor Vehicles (303)*	2.1	1.6	1.2	1.1	1.6	1.8	1.5	1.8
Bicycles and Parts (313)	0.8	0.6	0.4	0.6	0.8	0.6	0.5	0.7
Food, Textile, and Others	21.8	15.7	8.9	8.4	24.2	18.6	11.5	13.4
Chemicals	24.2	22	20.2	19.8	25.7	22.6	18.9	19.8

Note: *1996 and 2001 data include manufacturers of body shells of motor vehicles, subsequently classified as an independent sub-industry

Source: Directorate-General of Budget, Accounting and Statistics. Industry, commerce and service census Taiwan-Fukien area, Republic of China.

Table 3

The top 10 firms' concentration ratio ranked by revenue and value-added in Taiwan's four major manufacturing sectors.

Sector	Shareholding of Top 1-10 Firms							
	Revenue (%)				Value-Added (%)			
	1996	2001	2006	2011	1996	2001	2006	2011
Information and Electronics	23.5	24.5	37.8	56.5	25.6	27.6	35.3	40.6
Metal and Machine	14.2	13.1	14.4	15.1	16.8	14.4	14.7	12.5
Food, Textile, and Others	15.5	17.2	16.1	20.2	27.2	30	22.7	31.1
Chemicals	35.2	40	51.9	51.7	40	42.3	42.9	38.3

Source: Directorate-General of Budget, Accounting and Statistics. Industry, commerce and service census Taiwan-Fukien area, Republic of China.

Table 4

The contribution in percentages of firm numbers, employee numbers, and average employee numbers of the four major manufacturing sectors in Taiwan's industries.

Sector	1996			2001			2006			2011		
	Firm Numbers (%)	Employee Numbers (%)	Average Employee Numbers per Firm	Firm Numbers (%)	Employee Numbers (%)	Average Employee Numbers per Firm	Firm Numbers (%)	Employee Numbers (%)	Average Employee Numbers per Firm	Firm Numbers (%)	Employee Numbers (%)	Average Employee Numbers per Firm
Information and Electronic	5.9	16.3	45.3	6.7	23.2	59.7	6.2	27.6	81.5	6.1	28.3	82.6
Metal and Machine	48.8	36.5	12.2	50.5	34.9	11.9	51.9	36.5	12.8	53.7	37.0	12.2
Food, Textile and Others	23.5	26.0	18.0	21.3	22.0	17.8	20.8	18.1	15.8	19.8	17.6	15.8
Chemicals	21.8	21.2	15.9	21.6	19.8	15.8	21.1	17.8	15.4	20.5	17.2	14.8
Aggregated Manufacturing Sector	100 (154753)*	100 (2522474)**	16.3	100 (140613)*	100 (2418544)**	17.2	100 (148017)*	100 (2693909)**	18.2	100 (157284)*	100 (2783927)**	17.7

Note: * The figures in parentheses refer to the total number of firms in Taiwan's manufacturing sector for the respective years.

** The figures in parentheses refer to the total number of employees in Taiwan's manufacturing sector for the respective years.

Source: Directorate-General of Budget, Accounting and Statistics. Industry, commerce and service census Taiwan-Fukien area, Republic of China.

Table 5

Export Performance of Selected Industries

Year	Bicycle (3131)			Parts for Motor Vehicles (303)	Metalworking Machinery (291)
	Export Value (million U.S. dollars)	Export Quantity (million sets)	Average Export Price per Bicycle (U.S. dollars)	Export Value (million U.S. dollars)	Export Value (million U.S. dollars)
2000	821.4	7.53	109.0	2653.8	1456.9
2001	536.2	4.80	111.8	2337.3	1357.1
2002	523.8	4.22	124.2	2637.4	1444.7
2003	583.0	3.88	150.1	3131.9	1674.3
2004	720.7	4.35	165.8	3812.1	2250.7
2005	918.7	4.59	199.9	3978.9	2653.5
2006	839.4	4.06	206.6	4085.5	2961.3
2007	1054.5	4.75	221.9	4503.7	3464.8
2008	1387.9	5.40	256.9	4841.8	3705.2
2009	1249.7	4.30	290.6	4227.1	1740.8
2010	1502.7	5.07	296.4	5413.7	2946.6
2011	1662.8	4.38	380.0	6272.1	3982.3
2012	1807.1	4.33	417.5	6578.0	4228.7

Sources: Huang, Jung-Fen. 2006. *2006 Machinery Industry Yearbook*. Hsinchu: Industrial Technology Research Institute. (in Chinese); Shih, Yu-Hsien et al. 2006. *Vehicle Industry Yearbook*. Hsinchu: Industrial Technology Research Institute. (in Chinese); Bureau of Foreign Trade. *Statistics of Import and Export of Republic of China*. Retrieved Nov 5, 2014 (http://cus93.trade.gov.tw/fsci/)(in Chinese); Taiwan Machine Tool and Accessory Builders' Association. *2001~2013 Taiwan Metalworking Machinery Production, Export, Import, and Demand Analysis*. Retrieved Nov 5, 2014 (http://www.tami.org.tw/statistics/week2.htm) (in Chinese); Taiwan Transportation Vehicle Manufacturers Association. *Statistical Table of Taiwan Bicycle Production and Sales*. Retrieved Nov 5, 2014 (http://www.ttvma.org.tw/cht/industrial-survey.php) (in Chinese).

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