

Overseas factories, domestic employment, and technological hollowing out: a case study of Samsung's mobile phone business

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Abstract Analysing the case of Samsung Electronics' mobile phone business, this paper examines the effects of establishing factories abroad on domestic jobs and the issue of technological hollowing out. The offshoring of mobile phone assembly to China, India, Brazil and Vietnam did not result in a reduction of domestic jobs. On the contrary, Samsung's domestic employment increased from 5960 persons in 2002 to 20,500 in 2012. This increase mainly reflects a net increase in high-paying jobs (R&D, engineering, design, marketing) while the number of low-paying jobs (assembly) remained stagnant. To cope with possible technological hollowing out, Samsung kept its core engineers/technicians in a special unit, instead of firing them, whenever domestic assembly lines were reduced or foreign lines were established. They were kept inside the so-called "global manufacturing technology center," with the number of its employees increasing from 80 in 2006 to more than 1103 in 2011. These employees visit overseas factories to conduct activities such as maintenance, monitoring, re-modeling of assembly lines, and automation. In terms of strategy, Samsung engages in offshoring, but not outsourcing. This is in contrast to Apple which does both offshoring and outsourcing by contracting with Foxconn.

Keywords Overseas factories · Employment · Hollowing out · Internationalization · Outsourcing · Offshoring · Samsung

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1 Introduction

Internationalization of production has been an important topic since the works of Hymer (1976) and a series of works by Dunning (1981, 1988, 2000). The so-called eclectic theory of internationalization of Dunning posits that for a firm to internationalize its production, three conditions should be satisfied: ownership advantage, location advantage, and internalization advantages. In particular, a key concept is ownership advantage, which indicates that a firm should have a unique or differentiating competence in its technology or brand power; otherwise, internationalization will fail.

Interestingly, in the Korean context, the internationalization of Korean firms was conducted at a large scale (in terms of the number of firms) by small and medium enterprises (SMEs) rather than by big businesses in the mid-1980s, as domestic wages increased rapidly to the detriment of price competitiveness of the products made by the SMEs; thus, the firms started to relocate their factories to lower-wage-rate countries in Southeast Asia (Jun 1987; Lee 1994). Jun (1987) called this phenomenon “premature internationalization,” as these firms went abroad without strong ownership advantage. Instead, this phenomenon is more consistent with another theoretical perspective, the so-called “macroeconomic theory of internationalization” proposed by Kojima (1973, 1982), which focuses on a changing comparative advantage of a nation in accordance with the changes in wage rates over time (Kojima 1973, 1982). In particular, he observed that Japan had been losing comparative advantage in labor-intensive sectors because of increased domestic wage rates, and thus had to move factories to other neighboring countries with lower wage rates. Based on this perspective, Korean firms have been following a similar pattern as Japanese firms.

Most big businesses from Korea, with their specialization in more capital-intensive sectors, started internationalization only since the mid-1990s (Lee et al. 2012). The so-called “Chaebols” set up overseas factories, which were of mixed nature, comprising both cases of substitution of the domestic factories and new expansions of production facilities abroad. Since this period, these overseas factories by big businesses have become a public concern in terms of the possible hollowing out of the Korean industry.

The internationalization of production and other activities reflects the optimization of resources at the firm level, but it has country-level consequence in terms of possible losses of domestic jobs, value added, and tax revenues in the home country. This issue has persisted in typical advanced countries that experienced “de-industrialization.” However, some degree of internationalization is considered natural or inevitable as an economy matures with the increase in income levels, and its main sector shifts from manufacturing to services (Baumol et al. 1989). Manufacturing industries have been prioritized because of backward and forward linkages (EMCC 2006). Detailed studies on this issue have been conducted by Hijzen and Swaim (2007, 2010), Besson et al. (2013), and Becker et al. (2008). A study by Harrison and McMillan (2011), using US enterprise data, finds that the employment effects of overseas investment are diverse, depending on the nature of the investment. The employment effects are not always worrisome because simple

unskilled labor is replaced with overseas labor, while jobs of higher quality are created in the domestic country. Therefore, recent literature has focused on where and which jobs are created, and whether the labor share of total value added increases or decreases (Besson et al. 2013).

According to Hanson et al. (2005) and Yamashita and Fukao (2010), employment effects of the internationalization of production can be considered in terms of two effects: The substitution effect refers to the substitution of domestic labor by foreign low-wage labor and the respective reduction in domestic employment. The scale effect refers to factories' foreign expansion and the associated increase of domestic jobs, which accompanies increased production volumes and sales. Hanson et al. (2005) suggested that the total effect of foreign expansion on US firms may be positive or negative depending on the magnitude of the substitution and scale effects. Yamashita and Fukao (2010) studied Japanese multinational enterprises and found that the scale effect is greater than the substitution effect. The present study also addresses the relative magnitude of the substitution and scale effects. Given that this study is a one-firm case study, our unique contribution would be to determine how the scale effect is produced by increasing the profitability of products through the establishment of foreign assembly factories. Furthermore, this study analyses the change in the workforce across diverse job categories, such as the high value added jobs of R&D or marketing, compared with the possible decrease in low-end or assembly jobs.

Another focus of this study, which is unique compared with the literature, is the issue of "technological hollowing out or disconnection," that is, the issue of whether overseas expansion of manufacturing facilities will lead to the hollowing out or weakening of manufacturing competence of the company. In other words, when the manufacturing process is moved out of the home country, the home base may lose the opportunity and context to absorb and accumulate site-specific tacit knowledge involved in the production process, affecting not only the manufacturing competence but also research and development (R&D) capabilities. A question along this line of thought is whether the practice of keeping only R&D at home while the production site is moved abroad will affect, in the long run, the manufacturing competence of a company. This issue is important because a typical company in an advanced country, for instance Apple, conducts most of its production overseas while conducting its R&D only in the United States, as the famous phrase "Designed in California, Assembled in China" suggests. Determining how Samsung, a rival of Apple, is doing in this respect and how Samsung is handling this challenge of technological hollowing out, aside from production hollowing out, would be interesting. No literature has so far considered the job relocation effect together with the possible technological hollowing out effect.

Based on interviews with the Samsung employees, we find that technological hollowing out has been a special concern of this company. We find that the company has its own specific definition of "technological hollowing out" (*gisul gongdonghwa*) and "technological disconnection" (*gisul danjeol*), and tries to reduce or overcome these possibilities. For the employees, technological hollowing out is defined as the situation in which specific technologies or manpower that constitutes a part or a chain of the whole production process is not available inside the home/domestic territory. "Technological disconnection" refers to a situation in

which specific technology or manpower is still available inside the home territory but there is no successor to that knowledge, which means that that process will not be domestically executed in the future. The management of Samsung considered both concepts to be important for the long-term competitiveness of the company. If such hollowing out or disconnection affects firm competitiveness, then the phenomenon will certainly have an implication for employment because firm competitiveness, sales, and the size of workforce are directly related to each other. Besson et al. (2013) find that is not whether a firm goes abroad but whether it maintains competitiveness that ultimately determines the workforce size of a firm.

The present case study of Samsung Electronics became feasible through a special arrangement with Samsung Electronics. The details of on-site visits and interviews are noted in the “Appendix”. In early 2013, the firm arranged and allowed interviews with its staff and visits to its mobile phone factory in Gumi, Korea (January 15 and 16, 2013), its mobile phone factory in Vietnam (January 21–23, 2013), its sub-contracting or supplier companies in and out of Korea, the Global Manufacturing Technology Center (GMTC) in Suwon City, Korea (February 5, 2013), and the Samsung Economic Research Institute (January 4, 19, and other dates in 2013).

This paper proceeds as follows. Section 2 gives a brief introduction on the beginning of Samsung’s telecommunication equipment business, its internationalization, and the effects on costs. Section 3 analyzes the effects on domestic employment and its composition. Section 4 analyzes the issue of technological hollowing out. Section 5 summarizes and concludes the paper.

2 The rise of Samsung’s mobile phone business and its foreign factories

2.1 Growth of the mobile phone business

The initial main business areas of the Samsung Group (conglomerate), since its establishment in the pre-war period, have been general trading, textile, and sugar refinery (Samsung Group 1998). Only in the early 1970s did the Samsung Group enter the electronics industry by establishing a television set factory in Suwon, a city 1 h south of Seoul (Lee and He 2009). In 1985, Samsung entered the telecommunication equipment sector first by producing fixed-line telephone switching systems in its factory in Gumi, which is located in the east-central part of South Korea. However, this telephone switch-making business was not satisfactory because of the limited size of the domestic market and the difficulty in entering foreign markets.¹ Thus, Samsung decided to enter mobile phone production, although it did not have any prior experience in that specific field.

The Korean firms and the government authorities considered the development of the cellular phone system in the 1990s. At that time, the analog system was dominant in the United States, and the time division multiple access-based global system for mobile communication (GSM) was the dominant system in Europe.

¹ Information is based on the interview with the director at the Gumi Factory in Korea. See “Appendix” for details of the interview.

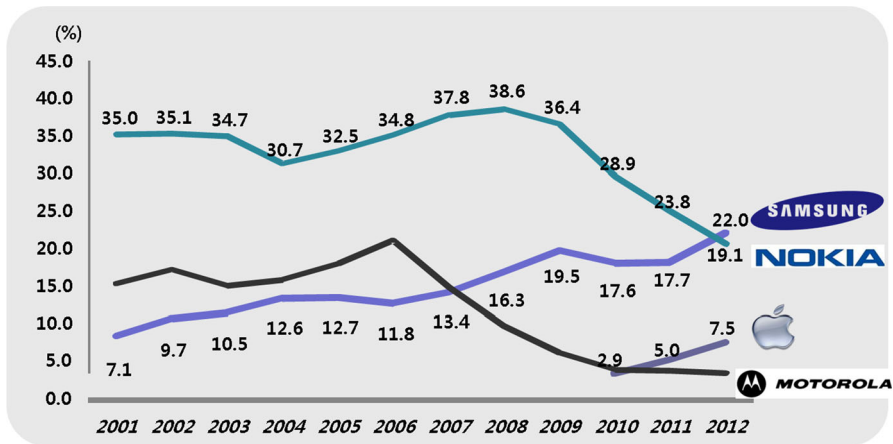


Fig. 1 Global market share by mobile phone maker. *Source:* Gartner presentation (<http://www.gartner.com/newsroom/archive/>)

However, the Korean authorities (i.e., the Ministry of Information and Communication, MIC) paid attention to the emerging code division multiple access (CDMA) technology, which has higher efficiency in frequency utilization and higher quality and security in voice transmission than the other technologies (Lee and Lim 2001). In 1991, the contract to introduce the core technology from, and to develop the system together with, the US-based Qualcomm was forged. In 1993, MIC declared CDMA to be the national standard in telecommunication. As a key player in this public/private consortium to develop mobile phone handsets, Samsung soon took the lead in actually producing this new product first for the domestic market in the mid-1990s and later for foreign markets with diverse standards, including GSM. However, Samsung was always behind the market leader, Nokia, until the emergence of smartphones initiated by Apple.

By quickly embracing the Google-made Android operating system (OS), Samsung gradually caught up with Nokia who stuck to its own OS (Giachetti and Marchi 2010; Giachetti 2013). Finally, in 2012, Samsung occupied the largest share of the mobile phone market (25.2 %) in the world, as shown in Fig. 1. Samsung overtook Nokia by selling 400 million mobile phones in 2012. Samsung also made a remarkable achievement by selling more units of high-end mobile phones or smartphones (215.8 million units) than Apple to occupy the largest share (39.6 %) of the smartphone market.

The rise of Samsung's mobile phone business has diverse explanations, as discussed by Giachetti and Marchi (2010) and Giachetti (2013). The internationalization of production bases worldwide is one of the explanations, as it has led to the substantial reduction of production costs, higher price competitiveness, and large and stable profits margins required for the next round of investment.

As of early 2013, the wireless communications division that manages the mobile phone business of Samsung runs eight production bases in five countries (Table 1), including the so-called 'mother factory' in Gumi, Korea, and others, such as three in

Table 1 Samsung's telecommunication equipment factories around the world (as of February 2013)

	Founded year	Production volume (million, 2012)	Number of employees (thousand, 2012)
Gumi (Korea)	1988	38	3.5
Huizhou (China)	1992	125	8.7
Manaus (Brazil)	1995	8	2.5
Tianjin (China)	2001	82	8
Shenzhen (China)	2002	6	0.6
Kambinas (Brazil)	2007	13	2.3
Noida (India)	2007	32	2.9
Parkning (Vietnam)	2008	119	25.9
Sum		420	54.4

In the early days, some of these factories produced other products, but now they all produce mobile phones

Source: Information provided by the company during the on-site visit and interview in January 2013. See the “[Appendix](#)”

China (Chen-jin, Hui-zhou, and Shenzhen), one in India (Noida), two in Brazil (Kambinas and Manaus), and one in Vietnam (Parknin area).

Samsung's overseas expansion of the fixed line or mobile phone production began as early as 1992 by establishing an assembly factory in Huizhou, China, followed by a factory in Brazil and another large-scale assembly line in China (Tianjin) near Beijing in 2001. Another great leap in its series of overseas expansion is the establishment of Samsung's largest scale assembly line in Vietnam. As noted in Table 1, the Vietnam factory has the largest capacity of about 120 million units per year, almost 25 % of the total global production volume in 2012, and the largest workforce size. Therefore, this study considers the year 2008 as an important turning point in Samsung's overseas expansion of production sites and focuses on the Vietnam factory for deeper analysis.²

2.2 Cost and productivity impacts of internationalization of production

One of the most important reasons for setting up a new factory in Vietnam was to benefit from lower costs in the assembly stage of production using local labor.

The comparison in Table 2 shows that Vietnam's processing cost per unit in 2012 is only 29 % of that of Gumi, with the difference in processing cost per unit amounting to USD 5.7. We are allowed to reveal only this relative difference because the company does not wish to release the exact figures of costs in absolute terms. Considering that Samsung produces about 120 million units of mobile phones in Vietnam each year, running the factory in Vietnam gives Samsung a cost

² We were told during the interview that overseas factories were constructed for slightly different purposes. The factories in China produce goods for China's local market, and the factories in Brazil are aimed at producing local goods and avoiding tariffs. The purpose of the business expansion in India is to target the market for low-price phones in India and its surrounding countries by producing the goods locally. The production base in Vietnam is the core production base that exports goods to the global market.

Table 2 Comparison of production cost (Vietnam vs. Gumi, Korea)

	Korea	Vietnam
Production volume (million)	39	119
Processing cost per unit (with Gumi as 100 %) ^a	100 %	29 %
Labor cost per unit (with Gumi as 100 %) ^a	100 %	16 %
Share of labor costs in total value added (%)	41.7 %	6.8 %
Share of labor costs in factory-level sales revenue (%)	4.6 %	0.76 %

Source: Information given by the company during the on-site visit and interview in January 2013

^a Processing cost includes the costs of labor, depreciation of equipment, and basic supporting and administrative functions (excluding marketing) but does not include the costs of raw materials, parts, and development. The company does not wish to disclose the exact dollar figures for processing and labor costs for each factory and instead reveals the gap in dollar terms (which is USD 5.7 per unit) between the two factories

advantage in the amount of USD 682 million per year. This amount is the basis for profits and re-investment. The difference in labor costs per unit is larger in Gumi, as the costs per unit in Vietnam is only 16 % of that in Gumi, as shown in Table 2. The reason is that labor costs are part of the overall processing cost that includes not only the costs of labor but those of the depreciation of equipment and of the basic supporting and administrative functions (excluding marketing). However, processing costs do not include the costs of raw materials, parts, and development. Note that the above cost differences are inclusive of the costs of hiring not only local Vietnamese workers but also Korean employees conducting various supportive functions, including administration.

If we add the costs of intermediate inputs (i.e., raw and semi-processed materials and various parts and supplies) and some factory-level profit margin to the processing costs, then we will have the sale revenues of the factory. Table 2 shows that the share of labor costs in the total sale revenue of a factory is only 4.6 % in the Gumi factory and 0.76 % in the Vietnam factory. One may think that this share of labor costs is very small and thus wonder how this can be the main reason for setting up the overseas factory. However, a more important figure is the share of labor in total value added, which emerges after taking out the costs for intermediate inputs from the total sales revenue. Table 2 shows that the share of labor costs in the total value added is not small or as high as 42 % in the Gumi factory but is still very low at 6.8 % in the Vietnam factory. This huge difference may justify the setting up of overseas factories in locations with low wage rates. Labor cost difference is an important source for reducing costs and thus generates profits because the costs of intermediate inputs are not much different between a domestic and a foreign factory.

The low wage rates in Vietnam convert into cost advantage simply because the productivity of Vietnamese workers is not that much lower compared with that of Korean workers in Gumi. The productivity of the Vietnam factory has quickly improved since its operation. As shown in Table 3, a worker in the assembly line of the Gumi factory produced 104.1 units each month on average in 2012, whereas this worker's counterpart in the Vietnam factory produced 89.4 units, reaching 86 % of the former. Productivity increased by 24 % a year from 2011 to 2012 in Vietnam,

Table 3 Productivity (units produced per month by a comparable labor/post) in cell phone factories

Years	Korea	Vietnam	Vietnam/Korea
2011	98.2	72.1	84 %
2012	104.1	89.4	86 %
Rate of change	6 %↑	24 %↑	–

Table 4 Failure rates in factories in Korea and Vietnam

Failure rate (PPM)	2010			2012		
	Gumi	Vietnam	Vietnam/ Gumi	Gumi	Vietnam	Vietnam/ Gumi
Failure rates of final products for shipping	6066	12,032	1.98	5629	10,174	1.81
Failure rate of parts and materials	256	798	3.12	385	360	0.94
Failure rate at PBA	8598	6600	0.77	9145	8099	0.89

Source: Information given to the authors during the visit and interviews in January 2013. See “[Appendix](#)” *PPM* (no. of) part per million units, *PBA* printed board assembly

whereas it increased only 6 % in Gumi during the same period. Failure rates are also an important indicator of productivity. In Samsung’s mobile phone factories, the three indicators shown in Table 4 are generally used as the failure rates. If we look at the changes in the 2010–2012 period, the failure rate of the Vietnam factory is relatively high in the beginning but quickly declines. Furthermore, although the failure rate of the final products of the Vietnam factory is 1.8 times higher than that of the Gumi factory, the failure rate of printed board assemblies (PBA) and parts and materials of the Vietnam factory is lower than that of the Gumi factory.

3 Impacts on domestic employment and its composition

This section investigates the effects of Samsung’s internationalization of production on the size and composition of domestic employment.

Table 5 shows that the aggregate size of domestic employment increased from 5950 in 2002 to 14,435 in 2008 and further to 20,491 in 2012. However, if we focus on assembly jobs, the trend reflects the waves of the internationalization of production. The number of domestic assembly jobs is 3098 in 2002, and it slightly increases to 3601 in 2008, but decreases to 3444 in 2012. Therefore, a substitution effect seems to exist, but this effect is more than an offset by scale effects in other job categories, such as R&D, design, and marketing. Table 5 shows that all these non-assembly jobs increase throughout the period, including the period of 2008–2012; these jobs increase from 10,834 in 2008 to 17,047 in 2012. Overall, the increase in high-paying jobs follows the trend of sales growth over the period.

Table 5 Employment by job category in the mobile phone division of Samsung, 2002–2012

		2002	2008	2012	Change from 2002 (%)
Sales (trillion KRW, %)	Total	11	24	93	715
	Domestic	3		11	221
	Abroad	8		83	934
Domestic employment (person, %)	Total	5950	14,435	20,491	244
	Supporting etc.	492	1197	1879	282
	Marketing	234	586	1289	451
	Design	59	311	522	785
	R&D	1497	6895	9627	543
	Technician/Engineer	570	1845	3730	554
	Non-assembly total	2852	10,834	17,047	498
	Assembly	3098	3601	3444	11
Employment abroad (person, %)	Total	983	13,831	50,704	5058
	Vietnam		237	26,115	
	Non-Vietnam	983	13,594	24,589	2401

Overseas employment in this table refers to assembly jobs

Source: Calculations using the data given by the company to the authors during a visit in January 2013. See “[Appendix](#)”

Sales increase by 715 % in 2002–2012, and the number of designs, technicians, and R&D workers increases by 785, 554, and 543 %, respectively.

These high-quality jobs would not have been created if competitiveness had not been improved and production had not expanded by moving factories abroad. Particularly, the increased demand for technicians for production and engineering is interesting and reflects the global expansion of factories around the world and the concern of Samsung to cope with the possible hollowing out of technology, which will be discussed in the following sections.

4 Coping with the possibility of technological hollowing out

The preceding sections show that Samsung’s internationalization of production has brought a substantial cost reduction and thus larger profits available for re-investment. These sections also show that the total size of domestic jobs has increased. Nonetheless, a remaining concern, especially for Samsung, is the possible long-term adverse effects, such as loss of manufacturing know-how and competence, of having more factories abroad than in the home country. In fact, Samsung has gone through a series of overseas relocations of production lines for several consumer electronic items. Its first overseas factory is a TV factory in Mexico in 1988, followed by a camera factory in China in 1994, a printer factory in China in 1996, a refrigerator factory in Thailand in 1997, and a series of phone factories around the world. At present, the degree of the internationalization of production or the share of foreign production varies by item, with an average of 80 % in the mid-

Table 6 Number of GMTC workers in Korea by year

Years	2006	2007	2008	2009	2010	2011
Number of workers (person)	82	202	172	325	847	1103

Table 7 Number of workers who are GMTC members in Suwon on business trips

	Those on business trip	Overseas trip					Domestic trip
		Total	China	Southeast Asia	EU&CIS	America	
Number of workers	256	147	32	46	30	39	109
% of the total number of workers of GMTC in Suwon ^a	45.0	25.8	5.6	8.1	5.3	6.8	19.1

^a The percentage is an estimate on a daily average basis in a typical week in February 2013. % values are estimated not by the total number of GMTC members but by that of the members in Suwon; workers in the “factor technology” team whose work is closer to R&D than manufacturing technology are excluded. The figures are given by the company to the authors during a visit with prior arrangement

2000s.³ With these relocations, Samsung has recognized the possibility of technological hollowing out as a consequence of the weakening domestic production and has tried to find preventive measures.

To prevent technological hollowing out, Samsung established a unit called the Global Manufacturing Technology Center, GMTC in Suwon City in 2006. Whenever a factory is relocated or established overseas, Samsung does not fire all of the workers in the affected factory. Instead, the company keeps the core technicians at the GMTC. Over time, the number of GMTC employees has increased, as shown in Table 6. GMTC had 82 workers in 2006, and the number increased to 1103 by 2011. GMTC employees are based not only in Suwon but also in Gumi. They are dispatched globally, that is, wherever the factories of Samsung are operating.

The size and spatial expansion also means that roles and functions of workers also expand to serve as global hub for manufacturing innovation, automation, process reorganization, and productivity improvement, as well as to spread these to factories around the globe. This unit covers all product varieties, including TVs, refrigerators, microwave ovens, washing machines, mobile phones, and other consumer items. As shown in Table 7, on average, about half of the GMTC employees in Suwon are on business trips domestically or globally. The staff manages and supports 30 production bases in 27 countries through these trips.

In the case of the mobile phone production plant in Vietnam, only 37 Korean employees have long-term affiliations and are on the payroll of this local subsidiary in Vietnam in 2013. However, on average, about 150 Korean employees are working in the Vietnam factory on business trips, sent either by the GMTC or the

³ Information provided by the SERI during a meeting in January 2013. See “Appendix”.

Gumi factory, which is the so-called mother factory. The length of their stay ranges from several weeks to several months, depending on the tasks. These employees have important functions, including enhancing productivity on the shop floors, product engineering, solving ad hoc problems, constructing and changing assembly lines, and spreading innovations, including process automation. These workers fulfill these duties not only for the Samsung factory but also for the small- and medium-sized suppliers that are located at the Parkning Industrial Park or nearby areas. We were told that Samsung tries to minimize the number of Korean employees because of the higher costs of keeping these workers in Vietnam and the unwillingness of the family members of these workers to live in Vietnam. Thus, making the most of the key technicians or engineers in many factories around the world even for several weeks turned out to be a viable option for everyone. However, this short-term, global rotation of key technicians in overseas factories can cause a misleading result for any quantitative analysis if they are counted simply as employees of the parent company.

The global utilization of key technical personnel is supported by the Global Supply Chain Management (GSCM), which is a computerized system developed and run by Samsung. GSCM is a system that performs real-time management of the global production system of Samsung not only to conduct a 24-h monitoring of factories around the world and handle any ad hoc situations, but also to economize physical and human resources. The GMTC is the organization in charge of the GSCM and the Samsung Production System (SPS), which is the global production system of Samsung. More than 1100 workers are divided into the following teams: manufacturing technology, automation technology, factor technology, mold technology, manufacturing innovation, support/human resource, and overseas production corporation. In particular, the overseas production corporation team directly controls the factories in Brazil and India.

The GMTC headquarter is located in Suwon but its staff is also heavily present in Gumi with 350 employees. The employees are distributed around the world. A typical practice is that when Samsung launches new models, they are tested in the assembly lines in the Gumi factory; upon the stabilization of production, the new models are mass-produced in foreign factories. Therefore, the Gumi factory is known as the mother factory.

The role of the GMTC in the technological hollowing out can be discussed with regard to how Samsung still produces molds for phone cases (outside covers) in-house instead of outsourcing the task. Apple outsources the manufacturing of molds for mobile phone cases to Foxconn, whereas Samsung, particularly the mold technology team of the GMTC, does it internally. Molding is not a simple technology but a key and high-end technology. The technical requirement is to be able to produce cases for more than tens of thousands of units out of the same mold with the same quality. Having a high-quality case is critical because it determines the surface and external appearance of mobile phones, and it is very important from the point of view of consumers. Samsung makes mobile phone cases both internally and by outsourcing. However, the molds used by supplier firms to which the manufacturing of cases were outsourced are also made and supplied by the GMTC of Samsung, as confirmed by a visit we made to a supplier that makes mobile phone

cases for Samsung. This supplier company has its headquarter and factory near the Gumi factory of Samsung and has its subsidiary factories near the overseas factories of Samsung, such as in Vietnam and China.

Samsung can introduce more new models with new designs in a very short time because of this in-house mold making. By contrast, Apple requires more time to make new molds by outsourcing before new models can be introduced. In this sense, Samsung is offshoring its factories but not outsourcing the manufacturing, whereas Apple is both offshoring and outsourcing. Samsung has mechanized and automated the design and manufacturing of molds and can make a mold for a mobile phone within 5 days. In fact, we were told that the Design for Excellence (DfX) Manufacturing develops various designs quickly through the efficient fusion of design and manufacturing, which is one of the key features of SPS. This advantage of Samsung is consistent with some literature (Jacobides and Billinger 2006; Teece 1996) on the benefit of vertical integration in reducing time to market and fostering rapid new product introductions. However, in principle the relative advantage of this sort of vertical integration depends upon several factors such as the nature and scope of technological change in the industry and on the effects of various demand and product life-cycle patterns (Langlois and Robertson 1989; Robertson and Langlois 1995). For instance, in-house or networked supplies might incur higher costs than some other independent suppliers, and the impacts of such costs gaps might be felt heavier during business downturn. Actually, this seems to be the case and regarded as one source of Samsung's lower profit margins than that of Apple which gives its production orders to the qualified suppliers which can offer the globally lowest prices.⁴

Another example of innovation introduced by the GMTC is the success in reducing the number of bolts and nuts used for every unit of mobile phone. The number of bolts and nuts is critical in determining the productivity of the assembly stage in making mobile phones. The higher the number is, the more time and people are required to assemble; the probability of errors is also higher with a higher number of bolts and nuts. For instance, if assembling each bolt and nut takes 3 s, then the reduction of the number of bolts and nuts by 10 means 30 s less from the assembly time. This condition translates to saving 3 billion seconds per 100 million units, which is the actual production volume in the Vietnam factory. A typical Samsung mobile phone uses only 13 sets of bolts and nuts, whereas an Apple iPhone uses about 50.

5 Summary and concluding remarks

The main findings of this research can be summarized as follows:

First, the mobile phone division of Samsung increased its number of domestic jobs, despite the establishment of factories overseas, from 5950 employees in 2002 to 20,500 in 2012. This increase in particular reflects a rise in the number of non-

⁴ This point was raised by one senior manager of the Samsung Economic Research Institute (SERI) during discussion.

assembly jobs (R&D, marketing, design and technicians/engineers), while the number of workers in the assembly lines was stagnant.

Second, by outsourcing assembly to a factory in Vietnam, Samsung achieved substantial cost reduction. The weight of labor cost in the total value added is about 42 % in the Gumi factor in Korea but only 6.8 % in the Vietnam factory. The difference in wage rates in the two factories translate into a difference of USD 5.7 per unit of handset, which then translates to a saving USD 682 million in the substantial cost for 120 million units produced per year. Such cost saving from overseas factories is important for the stability and large profits of Samsung Electronics and has been the financial source for the next round of investment and for launching new models with more innovative functions. Some segments of value chains were relocated abroad, but the higher-value segments, such as R&D and marketing, remained inside Korea. As a result, the mobile phone business of Samsung has formed a virtuous cycle of a global value chain system from local R&D and global production to greater profits and re-investment for the next round, which is a critical element for success in short-cycle items, such as mobile phones.

Third, for Samsung's mobile phone business the scale effects of job increases associated with volume increases were larger than the substitution effects of foreign workers. While the number of workers in the domestic assembly lines was reduced by about 150 between 2008 and 2012, the number of R&D workers and technicians combined increased by more than 4600. In other words, the substitution of foreign workers in overseas factories for domestic assembly jobs is accompanied by a net increase of higher-paying jobs, such as R&D and technicians. These higher-paying jobs may not have been created domestically, had the overall competitiveness not been improved through cost reduction by setting up factories abroad. This result is consistent with that of Hijzen and Swaim (2007), who used an industry data survey of 17 OECD countries and found that establishing factories abroad decreases the labor-capital ratio of its industry in their home countries, whereas the total domestic employment of the industry does not decrease or increase.

Fourth, to cope with possible technological hollowing out, Samsung kept its core engineers/technicians in a special unit, instead of firing them, whenever domestic assembly lines were reduced or foreign lines were established. They were kept in the "Global Manufacturing Technology Center". These employees seem to be the core of the manufacturing excellence of Samsung. Most technicians and engineers are always on short-term, specific task assignment in factories across the world, although they are registered as staff of units in Korea, either in the Gumi factory or at the GMTC in Suwon. Therefore, using the conventional data for the number of workers in and outside the home country cannot capture the full reality of the global functions of this specific workforce. Specifically, the GMTC and the mother factory in Gumi seem an interesting device of Samsung to cope with the challenge of internationalizing the production and the associated possibility of technological hollowing out.

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Appendix: Information about the on-site visits and interviews

Places and dates	Gumi, Korea (5 units) January 15–16, 2013	Seoul, Korea (1 unit) January 4 and 9, 2013	Vietnam (8 units) January 21–23, 2013	Suwon, Korea February 5, 2013
Units of Samsung	Gumi Factory Meeting with 12 employees including Director General Jeon	Samsung Economic Research Institute Series of meetings with five employees including Director General Chung and research fellow Dr. Tae	Parking Factory of Samsung Five employees including the head of subsidiary Mr. Y. Ryu	Global Manufacturing Technology Center 10 employees, including Director General H. Kim
Supplier companies	A company B company		Vietnam subsidiary of Company A Company D, Company E	
Governmental units etc.	Local Chamber of Commerce (Mr. JB Kim) Employment Promotion Agency (Head, Mr. Lee)		Local Investment Promotion Agency Administration of the Parking Industrial Park Local KOTRA office	

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