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THE CHANGING GEOGRAPHY AND OWNERSHIP OF VALUE CREATION:

EVIDENCE FROM MOBILE TELECOMMUNICATIONS

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THE CHANGING GEOGRAPHY AND OWNERSHIP OF VALUE CREATION: EVIDENCE FROM MOBILE TELECOMMUNICATIONS

Abstract: Through an innovative trade-in-task case study, we explore how Nokia, which is historically one of the most important mobile phone manufacturers in the world, offshored the development and production of three distinct mobile phones at three different points in time. Adjacent to these processes, we find that the value creation in areas such as design and manufacturing knowledge has rapidly shifted away from advanced economies to emerging economies. Moreover, we find that the value added captured by Nokia decreased dramatically over the studied time period. Based on our results, we discuss more generally the challenge of multinational corporation (MNC) to preserve value and how the realization of the benefits of offshoring must be assessed with respect to the altered requirements for controlling value-adding activities.

Keywords: Offshoring, outsourcing, value creation, Nokia, trade-in-task case study.

1. INTRODUCTION

As firms relocate business tasks and activities across geographical and organizational boundaries (i.e., engage in offshoring (Massini et al., 2010)), a key challenge relates to the act of balancing the value provided by accessing locational advantages and the costs of disintegrating and dispersing organizational activities (Asmussen et al., 2016; Baldwin and Venables, 2013). On the one hand, firms can create value through offshoring by relocating disaggregated activities to locations with favorable factor endowments, including access to low-cost labor and new knowledge (Lewin et al., 2009; Farrell, 2005). On the other hand, recent research has focused on the costs of offshoring and the global distribution of work. For example, Aron and Singh (2005: 135) argue that firms are often caught up by the "*harsh realities of offshoring*". They fail to adopt the correct processes and calculate the operational and structural risks to live up to their initial expectations of offshoring activities (Larsen et al., 2013).

Recent research has focused on these value-creating tensions spurred by offshoring. For example, studies have found that the distribution of value creation across global supply chains in a variety of industries is increasingly skewed (e.g., Ali-Yrkkö, 2010; Dedrick et al., 2010; Linden et al., 2009). In a case study on the global value chain of the iPod, a product that has been largely offshored to China and assembled from several hundred components and parts that are sourced from around the world, Dedrick et al. (2010) find that Apple captures only approximately one-third of the retail price, whereas companies such as Toshiba from Japan and Samsung from South Korea capture another major part as profit from the manufacture of high-value components such as the hard-disk drive, display and memory. Other studies show that recipient emerging economy firms are increasingly "catching up" with lead firms in terms of value creation as a result of the spillovers created by offshoring (Mudambi, 2008).

Our study seeks to contribute to this stream of research by exploring a firm's ability to create value in the face of extensive offshoring. Value creation can be seen as the ability to appropriate rents of resources owned by the firm (Peteraf, 1994) and has been emphasized as a major source of competitive advantage (Barney, 1991). In this respect, we stress that the process of offshoring encapsulates the important decisions of the location of firm activities (i.e., where; Dunning 1998) and the organization (i.e., by whom; cf. Buckley and Casson, 1976) that both may affect firms' ability to create value. First, reliance on external suppliers may, for reasons such as coordination and exchange hazards, jeopardize the target firm's ability to fully control its value-creating activities (Williamson, 1975). Second, operations in foreign locations may subject firms to "liabilities of foreignness" (Zaheer, 1995), wherein unfamiliar business practices and uncertain institutions potentially undermine the firm's ability to control its value-adding activities (Gatignon and Anderson, 1988). However, in contrast to research focusing on the performance consequences of these offshoring decisions (e.g., Massini et al., 2010) or studies that focus on single points in time (Linden et al., 2009; Dedrick et al., 2010), we explore how these effects unfold over time (see Mudambi, 2008, for a similar approach). Therefore, the research question that guides our study is the following: How do the organization and geography of firms' value creation change as firms engage in offshoring?

We explore this question through an exploratory trade-in-task[1] case study of the geographical and organizational value creation of three comparable mobile phones that were developed and introduced at different points in time by Nokia, which is historically one of the most important mobile phone manufacturers in the world. Specifically, by using "teardown"

[1] Specialization or division of labor is becoming an important source of economic growth for any national economy. Trade-in-task method represents a way to understand the deepening specialization in division of labor. It also provides the tools to understand the expansion of the market and its productivity growth across national economies (Lanz et al., 2011).

reports of the phones' component compositions and other financial data, we study the value creation of the specific type of actual tasks at the product level at three different points in time (Grossman and Rossi-Hansberg, 2008; Sturgeon and Gereffi, 2014).

Our analyses reveal a number of interesting insights into the relationship between offshoring and value creation in the face of economic globalization in the mobile phone industry. First, we find strong evidence of the forces that encourage geographic dispersion, which has clearly prevailed over the time period in our case study. Over the course of the three products, we can clearly document a rapid shift from value being created in the home country to value predominantly being created abroad in the emerging economies. We find that tasks such as technology and product development, prototyping, component manufacturing and final assembly are increasingly conducted in emerging economies, particularly China. Specifically, the value added that is created in Asia (China) increased from 55% in 2003 to 66% in 2007, whereas the value added created in the home country (Finland) decreased from 24% to 11% over the same period. At the same time, we find that the value added captured by Nokia dropped dramatically over the studied time period. Nokia's value added share decreased from 38% in 2003 to 19% in 2007, whereas the value added captured by the vendor of vendors increased from 22% to 34%. Further, our results imply that the shift in value creation includes tangibles and manufacturing in addition to intangibles and design knowledge. Although the management of most valuable intangibles, such as patents and similar intellectual property, continued to be located in advanced economies, market knowledge was increasingly relocated to the emerging economies. For example, whereas Nokia's Beijing R&D site had previously focused on products for the Chinese market, the Beijing site increasingly designed products for the global market.

More generally, our case study reveals a process of excessive value redistribution across national and organizational boundaries, which has important theoretical contributions to research on an MNC's ability to control its value creation activities and competency upgrading in global value chains. Although we can only speculate on the reasons for the value redistribution, including the challenges of managing offshoring, increasing competition, commoditization, and deteriorating bargaining power, we discuss how they pose new requirements for contemporary MNCs that are managing global production networks. In particular, whereas the extant research has focused on offshoring consequences such as 'unbundling costs' (Baldwin and Venables, 2013), reconfiguration costs (Larsen, 2016), and disrupted learning capabilities (Reitzig and Wagner, 2010), we emphasize how the processes of relying more on foreign locations and external suppliers place the MNC in a more vulnerable position as its ability to create and retain value is challenged. Consequently, as value creation is increasingly subsumed at the level of geographically distant subsidiaries (internal and external), offshoring firms need, to a larger extent, to assume the responsibility of systems integrators to lead and coordinate geographically dispersed networks of value-creating units (cf. Brusoni et al., 2001). Finally, we demonstrate how bottom-up, product-level research on tangible products may reveal several important insights into how firms actually offshore relocate firm activities and the consequences of this action. Although there are a few other examples of this methodology (e.g., Linden et al., 2009; Dedrick et al. 2011; Ali-Yrkkö et al., 2011; Seppälä et. al. 2014), we contribute by exploring the changes in the organization over the course of introducing three distinct mobile phones.

The article proceeds as follows. Section 2 describes the data, data sources and methods used to explore the relationship between offshoring and value creation. Section 3 provides the empirical analysis and the results, and section 4 discusses the implications of this study and provides suggestions for further research.

2. DATA AND METHODS

2.1 Empirical context

To explore how the organization and geography of firms' value creation change as firms engage in offshoring, we use an innovative trade-in-task case study of Nokia. The company was founded in 1865 by Fredrik Idestam, a mining engineer, as a ground wood pulp mill to manufacture paper in the town of Nokia in Finland. In the early 1990s, the mobile telecommunications market began to grow rapidly. During the late 1990s and early 2000s, Nokia emerged as one of the world's largest manufacturers of mobile devices and networks. The Finnish telecommunications cluster was by far the fastest-growing industrial sector, and Nokia was the fastest-growing major company in Finland.

At the peak of Nokia's success in the mid-2000s, the company produced more than 400 million mobile devices, had net sales of more than €40 billion and an operating profit of €2 billion, and represented an estimated 31% of the global market share. Furthermore, the firm accounted for 1% of total employment and 4% of the Finnish GDP. The company was responsible for more than 40% of corporate R&D in Finland. Before being acquired by Microsoft in 2013 after a long period of declining sales, Nokia had a global workforce of 130,000 employees in 120 countries worldwide.

Given our single focus on Nokia, this research can be characterized as an exploratory case study (Eisenhardt, 1989; Yin, 2003), which is appropriate for studying firm processes in depth and is especially suitable for complex processes such as knowledge transfer and innovation across country borders (Birkinshaw, Brannen, and Tung, 2011). Specifically, we follow similar product-level research (e.g., Linden et al., 2009; Dedrick et al., 2010) to explore where value is created over time in a single company. Moreover, as we study the value creation and location of tasks, a case study of a single company is more appropriate than, for example, a large-n survey. We analyze three candy-bar-form factor handset models with small monochrome displays and no cameras that were launched by Nokia: the 3310 (in 2000), the 1100 (in 2003), and the 1200 (in 2007). These three models are among the world's bestselling handset models, with the 3310 as the fifth bestselling mobile phone of all time, the 1100 the bestselling mobile phone of all time, and the 1200 the third bestselling mobile phone of all time. Each has sold more than 100 million units.[2] All three handset models had similar functionalities but different industrial designs; that is, the looks and mechanical designs of the handset models were different.

We maintain that these three mobile devices are a representative sample of a larger portfolio of products and can help explain what was occurring on a large scale within a mobile device supply chain. In particular, the 1100 and 1200 were basic models targeted at first-time users in entry markets and did not have any significant new features compared to older models, such as the 3310 and the 3210. Moreover, it is important to recognize that the added value from research and development for each mobile phone model was practically equal (i.e., Nokia 3300 – 2,2 % of total added value; Nokia 1200 – 2,7 % of total added value; and Nokia 1100 – 2,9 % of total added value).[3] Furthermore, Nokia was capable of keeping the model-level program cost relatively stable over the lifecycle of these models, at an estimated level of ten million Euros. Accordingly, the similarity among the handset models offers the opportunity to consider the commoditization of technology, task-level knowledge transfer and globalization, and

[2] http://www.telegraph.co.uk/technology/picture-galleries/9818080/The-20-bestselling-mobile-phones-of-all-time.html?frame=2458860 (information retrieved 26.5.2015).

[3] This added value includes all direct research and development contributions for developing one mobile phone model, as in this study.

geographical and organizational value creation at the product level. An ideal setting for a dynamic examination of product-level value creation allows us to analyze the same product over multiple years. However, in the mobile phone industry, the life cycle of single products is too short for this approach. Therefore, we used several comparable models (see the methods chapter below).

2.2 Data description

Typically, companies will not provide information about the pricing of components or manufacturing costs. The same is true for distributors and retailers. For this reason, we used four different information sources to estimate the distribution of the value added that was created by different participants and regions.

First, in October 2010, we physically disassembled the Nokia 3310, 1100 and 1200 phones and, in collaboration with electrical engineers, examined each of their hundreds of components. Second, we used "teardown" reports of the component compositions that are published by industry analysts. These reports (see, e.g., Portelligent, 2007) include estimates of factory prices and vendors. Third, using the knowledge gathered in the previous steps, we collected further qualitative and quantitative information by interviewing 12 industry experts who were either currently working or had previously worked in various roles in the mobile handset supply chain. The interviews were conducted between April 2009 and May 2011.[4] The data, especially the component and production cost data, that were collected as part of the first and second steps of the research process were augmented and adjusted to more correct levels by these interviews. Finally, we examined the financial reports, including financial statements and balance sheets, and press releases of the companies involved and those of their direct

[4] Because of the topic's sensitivity, we had to ensure full anonymity to our interviewees. The interviews were semi-structured, and the questions varied among interviewees depending on their positions in the supply chain and financials.

competitors. In particular, we exploited the differences in reporting in various geographical locations and examined officially required additional information, such as Securities and Exchange Commission 20-F reports in the US and the ORBIS database from Bureau van Dijk Electronic Publishing (DvDEP).

2.3 Methods

To explore our research question, we conduct three sub-analyses. First, we explore the dynamics in the location of the tasks of the three different mobile phones. This analysis enables us to investigate the extent to which the forces that encourage geographic dispersion actually prevail. Second, we investigate the direct costs of manufacturing the three phone models and use this as a basis for analyzing the value creation by different supply chain participants. This approach allows us to understand the dynamics of value creation across the three different models. Finally, we examine the location of the value creation using the same logic as the second analysis but focusing on the geographical dimension.

To facilitate these three analyses, we need to map the supply chain underlying the development and production of the three mobile phones. In this respect, we are interested in the global flows of intermediate goods and services, including those provided in-house (captive) and those purchased from unaffiliated companies (outsourced), that are involved in providing a good or service for final consumption (Figure 1).

**** Figure 1 about here ****

Generally speaking, the flow in Figure 1 is as follows. The outputs of miners/refiners are turned into sheets of metal and other elementary processed goods that are traded to parts and components vendors. The 3310, 1100 and 1200 consist of approximately 250 to 400 components, and their vendors deliver the great majority of these components to sub-assemblers (who may, in turn, deliver the same components to other sub-assemblers). In the final assembly, the assembly to-order phase (ATO), Nokia itself combines these sub-assemblies and certain separate components. Some of the intangibles, to the extent that they are not embedded in and bundled with physical components, are licensed. Standalone software is purchased from third parties, as necessary. Furthermore, many of the intangibles are provided in-house or by vendors compensated at a billable hourly rate. Depending on the market, in the case of mobile phones, Nokia's immediate customers are typically distributors (e.g., Brightpoint Inc.) who, in turn, supply wholesalers and retailers or operators (e.g., Vodafone).

In each step, each organization conducts its own value-creating activities (Y_c) and sells its output, c, to the other participants in the supply chain. The sum of all value-creating activities equals the final retail price (Y) before any applicable taxes (equation 1):

$$Y = \sum_{c=1}^{N} Y_c \ . \quad (1)$$

For each company in the supply chain of the three phones, we calculate the value creation as the difference between the cost of the inputs purchased by an organization and the price for which it sells the output. Accordingly, we apply a strict definition of value creation, focusing on "either the monetary amount realized at a certain point in time, when the exchange of the new task, good, service, or product takes place, or the amount paid by the user to the seller for the use value of the focal task, job, product, or service" (Lepak et al., 2007: 181). For the retailer, the wholesaler, and Nokia, we were able to calculate accurate product-level value creation. For most of the other companies, i, in the supply chain, we derived the ratio of the value creation to net sales (what we call the value-added margin) at the firm level (equation 2).[5]

[5] For the companies that conform to US GAAP accounting principles, labor costs are unavailable. For these firms, we assume the value-added margin to be identical to that of its nearest competitor(s). For example, in the case of

$$VA\_MARGIN^i = \frac{Operating\_profit^i + Depreciation^i + labor\_costs^i}{Net\_sales^i} \text{. (2)}$$

We then approximated the component-level value creation (Y_c) by multiplying the firm-level value-added margin by the component price ($PRICE_c^i$):

$$Y_c = VA\_MARGIN^i \, PRICE_c^i \text{. (3)}$$

In addition to the value creation of each participant, we analyzed its geographical breakdown. It should be noted that companies themselves do not typically provide product-level information regarding their locations for manufacturing and other operations. With further research from financial statements, balance sheets and interviews, we could nevertheless estimate this information fairly accurately, at least as far as broader regions are concerned.

The value capture of in-house indirect inputs, such as the role of general management, the corporate brand and image, and reusable tangible and intangible assets (including design and technical aspects copied from previous products or that contribute to future models), is difficult to allocate in general and is particularly difficult across geographical locations. Thus, we follow Ali-Yrkkö et al. (2011) and the estimation method developed therein (see Appendix 1). In the case of each participant, 10% of the value creation occurs at the headquarters location, and 90% is attributed according to the actual location(s) of participants' production factors (we also attempt to correct for regional productivity differences by using multi-factor productivity differences between regions (see equation (A6) in Appendix 1)). The preferred method considers

the charger included in the sales package of the Nokia 1200, the factory price of the charger is approximately €0.8, and Astec supplied a part of the chargers to this phone model. Astec (US) is a part of the Emerson Network Power group that adheres to US GAAP. Its direct competitor, Salcomp Oy (Finland), the leading global mobile phone charger vendor, follows IFRS. In its 2007 financial statement, Salcomp's value-added margin was 23.3%. Thus, we estimated Astec's value added to be approximately €0.19. Similarly, in the case of Texas Instruments (US), we employed the average of the value-added margins of three competitors it identified in its 2007 Form 10-K report (pp. 3–4) required by the US Securities and Exchange Commission, i.e., *NXP* (the Netherlands), Infineon Technologies AG (Germany) and STMicroelectronics (Switzerland). For the other models (i.e., the Nokia 3310 and Nokia 1100), we use year 2003 and 2004 Form 10-K reports.

that there are many multinational companies that have production factors in different regions; that is, the value added of each component is distributed among geographical regions. Second, the method takes into account the location of the multinational companies' headquarters (i.e., the value-added contribution of management teams). Furthermore, the method considers that intellectual property rights are owned by company headquarters. Based on these two facts, the location management team and intellectual property, the preferred method allocates an extra share to the headquarters location.

3. ANALYSIS

3.1 Location of tasks

Where does the production of three mobile models occur? To understand whether Nokia has increasingly offshored the development and production of the mobile phones, we need to investigate the changes in the location of the tangible activities. Perhaps unsurprisingly, our data reveal that Nokia increasingly offshored the development and production of the mobile phones to Asia over the studied time period. During the 2000s, Nokia and its supplier network actively increased both their affiliated and unaffiliated operations in Asia. As part of this development, Nokia also offshored technology and other types of knowledge from Europe and the U.S. to China. Instead of being a sudden change, this process was gradual and occurred over almost a decade.

**** Table 1 about here ****

Table 1 considers the transformation and locations of the following functions: 1) concept design and product management; 2) hardware and software platform design; 3) product-specific design tasks and prototyping; and 4) component, subassembly, and product manufacturing. The information in Table 1 enables us to understand the evolution of the strategies of the firm and helps us comprehend the intra- and cross-functional dependencies between different tasks from a longitudinal transformation perspective.

The 3310 was one of Nokia's first global products. Although the prototype manufacturing was located in Finland, the mass manufacturing was distributed across three continents. Nonetheless, the model was mainly developed and managed in Europe. Tasks such as product program management, hardware platform design, software platform design, concept design and product test design were all located in Europe. Nokia's R&D site in Denmark was a particularly important site for the 3310. Furthermore, Nokia's Finnish suppliers (such as Aspocomp, Perlos, Protopaja, and Elcoteq) played an important role in assembly, component design, industrialization, and manufacturing. Figure 2 describes the increasing involvement of Asian suppliers (such as Foxconn, BYD, and LiteOn). To illustrate, in 1999 Foxconn was audited; later that same year, Foxconn received its first plastics component orders from Nokia (Seppälä, 2010, 2013a). Foxconn subsequently became the largest supplier of technology and electronics manufacturing services for Nokia.

**** Figure 2 about here ****

In the case of the 1100 and 1200, China had a substantially more important role as a location for parts of the production process. Although the main responsibility for hardware platform design, software design and industrial design remained in Denmark, Nokia's Beijing R&D site participated in development. Furthermore, the Chinese and Taiwanese part suppliers began to contribute to the parts' design. As part of this involvement, certain employees of Beijing's site visited Denmark to increase their knowledge about hardware platform design and product software design. During the 2000s, Nokia's Denmark R&D further increased its cooperation with the Taiwan-based Foxconn to include product test design and prototype manufacturing (Larsen and Pedersen, 2011).

Notably, although Nokia was able to significantly reduce its product development time with knowledge gained from Foxconn, the process of relocating activities to Foxconn and China did not come without substantial costs and challenges (Asmussen et al., 2016). Specifically, although Nokia had expected that Foxconn would be largely self-managed and require minimum intervention, the management recognized that substantial investments in coordination were required to safeguard against misinterpretations and misbehavior. For example, after relocating the activities to China, the Nokia management realized the necessity of transferring substantially more technological information to China than originally expected. To achieve this, the management established frequent physical meetings, weekly video conferences to discuss the status of each project, and monitoring practices even for standardized activities to ensure that the products were developed according to plan. Moreover, eight full-time Nokia Denmark employees were assigned to follow and monitor the 30 to 50 engineers working in Foxconn in China. The partners also met in either Denmark or China every six to eight weeks.

China's role substantially increased to encompass tasks other than pure mass manufacturing. Whereas Nokia's Beijing R&D site had previously localized products to the Chinese market, the Beijing operation evolved to design products for the global market. In addition to technical knowledge transfer, this process included training programs to encourage initiatives by local R&D employees. As such, Nokia began to relocate more technical responsibilities to China. Whereas the original intention had been to relocate more standardized activities to China while retaining the more knowledge-intensive activities closer to headquarters, the management realized that this was far too costly in terms of coordinating the interfaces between the geographically dispersed activities. Therefore, the management decided to also relocate parts of these activities to China.

Accordingly, our data imply that Nokia has offshored larger responsibilities to China. This rise of China's role required the systematic development of resources and knowledge transfers. Consequently, in the spring of 2011, Nokia decided to downsize its Danish R&D site. Furthermore, Nokia's Finnish supplier network was replaced by Taiwanese and Chinese multinationals capable of providing lower unit and assembly costs (Seppälä 2010, 2013a).

3.2 Who creates value?

Having established that Nokia increasingly offshored its tasks to Asia over the course of the three mobile phones, our next task is to investigate how this activity influenced the value creation of the mobile phones. We commence this investigation by analyzing value creation by type of actor in the supply chain. In the next analysis, we consider value creation in terms of geography. We first consider the direct costs of components, parts, sub-assemblies, software, and licenses with respect to the three phone models (Table 2). We begin by considering the actual sales prices (the gross value), and then we consider the first-tier suppliers on a value-added basis.

**** Table 2 about here ****

Based on our calculations, the direct bill-of-materials (BOM) was approximately €31.2, €23.7 and €14.6 for the 3310, 1100 and 1200 models, respectively. Thus, between 2003 and 2007, the BOM per phone was more than halved. One of the main drivers of price decline is technology commoditization. As part of the process of technology commoditization, knowledge essential for the production of components spread to developing countries. In addition to MNC's units in developing countries, local companies also became suppliers. For instance, the displays of the 3310 and 1100 came from Samsung (South Korea), whereas the displays for the 1200 were provided by Taiwanese vendors such as Wintek.

According to Seppälä (2013a, b), Nokia actively searched for and systematically developed local suppliers in developing countries at the end of the 1990s and during the 2000s. By lowering the unit cost of components and assembly internally and externally, the company was able to lower sales prices, which in turn enabled low-income customers to purchase handsets. This development indirectly served Nokia's strategy of increasing mobile phone penetration and its market share in developing countries. In addition to the five participant categories presented in Figure 1, we separated the value creation by logistics and warranty operations. Because Nokia used both its in-house facilities and unaffiliated companies' facilities to manufacture mobile phone engines, we also separated engine manufacturing into its own category.[6]

Table 3 shows the value creation breakdown of the three models' pre-tax retail prices. The pre-tax retail price for the Nokia 3310 was €79 in 2003, for the Nokia 1100 was €63 in 2004, and for the Nokia 1200 was €27 in 2007, which represents a total decrease of 66%.

**** Table 3 about here ****

For distributors, wholesalers, and retailers, the value-added margin and the sales margin were effectively identical. In the case of the 3310, 1100 and 1200 models, retailers' margins ranged from 10.2% to 13.6% of the final sales price,[7] whereas the margins for the

[6] The sum of the bill of materials related to the engine's final assembly for the Nokia 3310, the Nokia 1100, and the Nokia 1200 varies from 80% to 90% of the total bill of materials cost, depending on the phone model.

[7] Mobile phone sales margins are difficult to estimate because of various types of tie-ins and bundlings with subscriptions and/or other services, in which case the initial transaction is often undertaken at a loss. We consider margins without any bundlings. However, retailers themselves decide how much to charge for the product or service; therefore, their sales margins vary.

distributors/wholesalers were between 4% and 4.7%. These percentages also represent their share of the total product value.

In all of these cases, Nokia generated a large share of the total value. However, Nokia's contribution to the value creation was substantially lower in the case of the 1200 than in the previous models. In value terms, the estimated value creation generated by Nokia for the 3310, 1100 and 1200 was €34, €26.7 and €5.7, respectively. This was partly because Nokia's BOM decline was unable to keep up with the drop in pre-tax sales price for this technology. These amounts were ascribed to direct and indirect in-house[8] labor costs, including final assembly (including the ATO phase), R&D, marketing, sales, sourcing, management, the depreciation of tangible and intangible assets, investments, and operating profit.

Careful study of industry sources and the information contained in our interviews suggests that the final assembly/manufacturing costs, including both engine assembly and the ATO, for the Nokia 3310, 1100 and 1200 were €7.4, €5.6 and €1, respectively. These amounts account for 3.7% to 9.4% of the pre-tax final sales prices. Thus, although final assembly is an essential part of the supply chain, the value creation (supplied by final assembly) declined and was surprisingly low.

With respect to the final assembly/manufacturing costs, first-tier hardware vendors were responsible for 17%-19%, first-tier (external, non-cross-licensed) intangible vendors were responsible for 0.5%-0.8%, and second- and higher-tier vendors (vendors-of-vendors) in both categories were responsible for 21%-34% of this amount.

3.3 Where has the value been created?

[8] This includes some outsourced work that was purchased as billable hours. However, because of the lack of data, we were not able to allocate this to other companies.

In addition to understanding value creation by supply chain participants, we want to understand the location of value creation.[9] It should be noted that the geographical allocations of the country of final sales and final assembly are case specific. For instance, in the case of a Nokia 3310 that was assembled (engine and ATO assemblies) in Salo (Finland) for the UK market, an extra 9.4% of total value creation accrues to Finland and an extra 14.5% to the UK (Other EU area). In the case of an assembly in Beijing (China) for the US market, the accrual is different. In Table 4, we consider five potential combinations (see Table 7 for details) and calculate the average of these results.

**** Table 4 about here ****

Based on our estimates (Table 4), the geography of value creation changed drastically during the 2000s. In the case of the 3310, overall, 33% of the value added was captured in Finland. When we consider the entire EU-27 area, the share was as high as 56%. These shares are quite different compared to those of the 1200, which was launched in 2007. In the case of the 1200, the corresponding shares for Finland and the entire EU area were 15% and 36%, respectively.

The data presented in Table 5 show the impact of structural changes caused by offshoring and sales locations. Although the Nokia 3310 was manufactured and sold in Finland, the Nokia 1200 was never manufactured or ever sold in Finland. Because of these differences among the models, the data presented in Table 3 must be used cautiously. To control for bias, we fixed the locations and considered the case in which both manufacturing and final sales were located in Asia (Table 5). In Table 6, we considered all five potential combinations (see Table 7 for details) and calculated the averages of these results.

[9] These findings should not be confused with the results in Chapter 3.1, which discusses the location of the physical tasks and intangible knowledge (i.e., the direct evidence of offshoring). However, we obviously expect a strong correlation between the two analyses.

**** Table 5 about here ****

Although the exact data in Tables 4 and 5 differ, the overall trend is similar. The share of Asia increased, which correlates to an increased amount of value added. In Tables 6 and 7, we consider the details of five alternatives in constructing the geographical breakdown, similar to Ali-Yrkkö et al. (2011). Our baseline method, in Column A, allocates the value added to the headquarters location of each participant in the supply chain. This approach tends to over-estimate the role of developed countries and regions. Our second method, in Column B (see Eq. 4 in Appendix 1), assigns the value capture solely on the basis of the locations of the production factors (physical capital, labor, and R&D). This implicitly assumes that the general management or corporate brand has no specific role in the value capture and tends to under-estimate the role of developed countries and regions. The third alternative, in Column C, is an intermediate method between A and B in which it is assumed that in the case of each participant, 10% of the value capture occurs at the headquarters location and 90% occurs at the actual location(s) of the participant's factors of production. Individuals and organizations in various locations have different productivities. Thus, their abilities to create value may vary. Column D replicates Column B, but it attempts to correct for this fact by using multifactor productivity differences among regions (see Eq. 6 in Appendix 1).

**** Tables 6 and 7 about here ****

Our preferred estimation method (Column E) combines Columns C and D. Thus, in the case of each participant, 10% of the productivity-adjusted value creation occurs at the headquarters location, and 90% occurs at the actual location of the production factors. In Tables 6 and 7, A and B constitute the lower and upper bounds for Europe, C and D refine certain aspects of the model, and E provides our preferred estimate of the geography of value creation. It should be noted that different models were manufactured and sold in various regions. For instance, the Nokia 3310 was manufactured and sold in Finland, but the Nokia 1200 was never manufactured or sold in Finland. Because both the location of assembly and the country of final sale have consequences for the geographical distribution of value creation, the above calculations reflect the arithmetic mean of the following four combinations (and are thus comparable across models/time): (1) assembled and sold in the EU, (2) assembled in Mexico and sold in the US, (3) assembled and sold in Asia, and (4) assembled in Asia and sold in the EU.

The majority of unaccounted inputs are low-cost inputs, such as resistors, capacitors and screws, which are mostly manufactured and designed in Asia. In the geographical breakdown, we assume that 80% of the total value added of these inputs is created in Asia, 10% in EU-27 countries and 10% in the United States. Based on our firm-level data, approximately one-third of this value is created in the new member states of the EU. Thus, we attribute this amount to the EU-27 and the remaining two-thirds to other countries (i.e., countries outside the EU-27, Asia and North America). We consider the vendors of material supplies and immaterial supplies separately. We divide the value creation that is created by vendors of material suppliers to all regions equally (EU-27, North America, Asia and other countries). In terms of the value created by immaterial suppliers' vendors, we assume that 90% of the value created by vendors of immaterial suppliers was created in these three regions and divide this 90% equally among the EU-27, North America and Asia. The remaining 10% is attributed to other countries.

4. DISCUSSION AND CONCLUSION

4.1 Summary of findings

In this article, we have explored offshoring and the dynamics of value creation in the context of bottom-up, product-level research on three basic mobile phones introduced by Nokia between

1999 and 2007. We find that most of the tasks related to technology and product development, prototyping, component manufacturing and final assembly were offshored to emerging economies, particularly China, whereas the management of most valuable intangibles, such as patents and similar intellectual property, continues to be located in advanced economies. More interestingly, our results suggest that the value added by Nokia decreased drastically over the studied time period. For example, Nokia's value added share decreased from 38% in 2003 to 19% in 2007, whereas that of vendors increased from 22% to 34%.

Moreover, because the emerging economies execute most of the tasks related to technology and product development, prototyping, component manufacturing and final assembly, the share of value added attributable to the developing countries in which the value added was created increased. In the case of the Nokia 3310, which was launched in 1999, Asia captured an average of 28% of the total value, and the EU-27 captured an average of 56% of the total value. These shares changed dramatically with the Nokia 1200, which was launched in 2007. In the case of the 1200, Asia captured an average of 45% of the total value, and the EU-27 captured an average of 37% of the total value. Finally, the increase in the number of demanding tasks in developing countries required a transfer in competencies from developed countries. Instead of a sudden change, this process occurred gradually over several years. Previously, product creation units in developing countries only localized products; in 2007, some of these units, such as the Nokia Beijing product creation center, were able to take full responsibility for developing products for global markets.

4.2 Implications for global distribution of value creation

At the outset of this article, we noted that the strategy of offshoring presents firms with a trade-off between accessing locational advantages, such as low-cost labor and talent, and co-location and agglomeration advantages that can be used to economize coordination and knowledge transfer costs (cf. Asmussen et al., 2016; Baldwin and Venables, 2013). Our analysis adds nuance to this tension. The comparative locational advantages seem to create a strong incentive to unbundle and relocate firm activities to foreign sites. For example, Nokia relocated not only production activities to Asia but also intangible, more knowledge-intensive activities. One explanation may be that Nokia sought both locational advantages and agglomeration advantages by allocating the bulk of the development and production to Asia. However, our analyses also suggest that this transition did not come without additional complexities. Specifically, we demonstrate how the processes of offshoring may alter firms' ability to control and appropriate the value created at other locations and outside the firms' boundaries. In this respect, existing research has emphasized how the costs of disaggregating and relocating value adding activities, including "unbundling costs" (Baldwin and Venables, 2013), disrupted learning capabilities (Reitzig and Wagner, 2010), and "hidden costs" (Larsen et al., 2013), may explain why firms often struggle to realize the full benefits of offshoring.

Building these insights, we propose that the changing distribution of value creation in Nokia's global production network paves the way for an enhanced understanding of the dynamics of offshoring and the global distribution of work (e.g., Dibbern et al., 2008; Larsen et al., 2013; Stringfellow et al., 2008). We argue that it does so with respect to an MNC's ability to control its value creation activities and competency upgrading in global value chains. First, in the tradition of the resource-based view, which considers value creation as being key to firm competitiveness (Barney, 1991), a major task of the MNC is to control its value creation activities, especially as foreign locations and external partners become involved in the production network (Cantwell and Santangelo, 1999). However, our results suggest that the ability to preserve value creation is challenged as firms increasingly engage in offshoring and outsourcing. Although we can only speculate about the exact antecedents of this value redistribution (see discussion below), we maintain that it underscores the potential vulnerability of MNCs that rely extensively on foreign locations and external partners.

In this respect, Mudambi (2008: 699) argues that firms can protect their value-creating mandates by exploiting either "linkage economies" (i.e., vertically integrating all geographically dispersed value-adding activities) or specialization advantages (i.e., outsourcing peripheral activities to foreign third-party vendors). Relatedly, research on competency upgrading in global value chains has established that when subsidiaries upgrade their competencies, their role and area of responsibility potentially change (e.g., Cantwell, 1995; Rugman and Verbeke, 2001; Hobday and Rush 2007). According to Cantwell and Mudambi (2005), competence upgrading as part of subsidiary evolution is determined by several factors, including group-, subsidiary- and location-specific factors. However, the competence upgrading of vendors and subsidiaries should not be understood as an ultimate goal of any subsidiary or parent company. Pananond (2013) argues that subsidiaries upgrade their capabilities because they strive to move up the value chain. If subsidiaries do not have certain capabilities, they are not able to undertake such moves (see also Rasiah, Nolintha and Songvilay, 2011). In general, when a subsidiary upgrades its competence, it is able to either better perform its current activities or extend its activities to new functions. Either result may lead to increased valued creation at the level of the host organization, which is consistent with the definition of a foreign subsidiary as a value-adding entity, as noted by Birkinshaw and Hood (1998).

Importantly, our study provides an important insight into how the parallel forces of offshoring and competency upgrading in global value chains may challenge an MNC's ability to maintain its value-creating mandate. Whether as a result of the non-negligible costs of accessing local complimentary assets or internal and external subsidiaries with more power and capabilities, we emphasize that the realization of the benefits of offshoring must be assessed with respect to the altered requirements for controlling value-adding activities. We summarize this discussion as follows:

Theoretical proposition: MNCs' increasing global distribution of work challenges their ability to preserve value creation at home and within organizational boundaries.

On a methodological note, our study demonstrates how bottom-up, product-level research on tangible products may reveal several important insights into firms' global organizations. To our knowledge, only a few studies examine the effects of this movement toward trade-in tasks on value creation and its geographical distribution. For example, Linden et al. (2009) and Dedrick et al. (2009, 2011) examined Apple's iPod to understand how value is distributed across supply chain participants and concluded that firms in the U.S. capture most of the value. Ali-Yrkkö (2010) and Ali-Yrkkö et al. (2011) analyzed the geography of value creation in a Nokia N95 smartphone and found that even when the final assembly was located in China and the final sales occurred in the U.S., Finland captured 39% of the value created. We extend these previous studies in two important ways. First, instead of using a single point in time, our examination of three models introduced at different times enables a dynamic approach that allows us to analyze how the location of value creation has changed as the technology inside products has been commoditized. Second, we analyze which types of tasks have been offshored to emerging economies and which types have been retained in advanced economies. As a result, we are able to analyze the changes in value creation as a result of offshoring over time.

It is important to stress that value creation in offshoring should not be considered a 'zero-sum game' in which value created abroad or with suppliers equates value lost at home or internally. Much research suggests how the process of offshoring can produce more value for the entire firm and not necessarily at the expense of other geographical and organizational units in the MNC network (Bertrand, 2011; Nieto and Rodríguez, 2011). For example, Nieto and Rodríguez (2011) find that MNCs can enhance their general innovation performance by offshoring knowledge-intensive R&D tasks. Relatedly, Bertrant (2011) discusses how strategies of offshore outsourcing may assist firms to reduce production costs, enhance flexibility, access new resources and market knowledge, and eventually increase export performance.

Equally, we recognize that there may be more than one explanation behind our results. Arguably, an important part of these changes relates to patterns such as increasing commoditization, falling ICT prices, growing competition and decreasing bargaining power (Lepak et al., 2007). For example, extant research has long noticed the consequences of economic development in emerging economies for accumulating physical, human and social capital in tangible and intangible assets (see, e.g., Balassa 1979; Balassa and Noland 1989; Anderson 1990; Antras et al., 2005; Hausmann and Klinger. 2006). Similarly, because of the decreasing costs of unbundling and transportation, the necessity of making goods close to the point of consumption and the communication and coordination costs have decreased. Furthermore, as product processes mature and product architectures become increasingly modular, it becomes easier and less risky to unbundle different types of activities (see, e.g., Hobbs, 1996; Ernst and Kim, 2002; Antras et al., 2005; Baldwin, 2006; Lorentz et al., 2012). Over time, the overall production processes of mobile phone products gradually become more labor intensive, thus shifting the distribution of value added away from capital-intensive activities and toward labor-intensive tasks (see, e.g., Cantwell, 1995; Jacobs et. al., 1997; Mudambi and Navarra, 2004; Cantwell and Mudambi, 2005; Antras et al., 2005; Hobday and Rush, 2007; Mudambi, 2008).

4.3 Concluding remarks

We propose that the processes of offshoring pose new requirements for firms (such as Nokia) that are managing global production networks. As distant subsidiaries (internal and external) presume a growing share of an MNC's value creation, we argue that the role of the MNC needs to change to preserve its value-creating mandates. In this respect, future research could examine the topic of systems integration, which can be defined as units that "lead and coordinate from a technological and organizational viewpoint the work of suppliers involved in the network" (Brusoni et al., 2001: 613). In essence, system integration becomes an important strategic mechanism in response to an increasingly complex organization. Thus, in an organizational system consisting of a number of offshored components and entities in which value creation is largely located in the realms of the subsidiaries, the system integrator becomes the architect who integrates and coordinates the different value-creating components of the different actors into a final output. A fully systems-integrated organization would therefore understand the interactions and dynamics of the entire organization (Hobday et al., 2005). Obviously, there are other ways of integrating an organizational system that comprises a globally dispersed and disaggregated supply chain. For instance, the surge of information technology has provided grounds for integrating and coordinating virtual organizations whose members and subunits are globally separate (Boudreau, Loch, Robey, and Straud, 1998; Wiesenfeld, Raghuram, and Garud, 1999). Moreover, Ernst and Kim (2002) describe the prevalence of global production networks in which "network flagships" (lead firms) integrate different activities through their higher network status.

In conclusion, MNCs such as Nokia need capabilities to respond to the new realities facing contemporary organizations. It is increasingly clear that traditional MNCs, because of increasing competition, lower costs of communication, and new competencies offered in new locations, can no longer withhold value-creating mandates within their headquarters locations. Therefore, our case study allows us to suggest that capabilities such as systems integration increasingly seem to be at the core of the successful management of disaggregated and geographically dispersed MNCs. The emergence of the "*harsh realities of offshoring*" (Aron and Singh, 2005) and the unforeseen costs and difficulties of managing offshoring that undercut anticipated benefits (Larsen et al., 2013) may thus be related to firms' ability to control and appropriate the value created at other locations and outside the firms' boundaries. We hope that future research will continue to investigate the consequences of MNCs' changing geographical and organizational landscapes.

REFERENCES

Ali-Yrkkö, J. 2010. The Value Creation of Mobile Phones – The Case of Nokia N95. In Ali-Yrkkö (Ed.): *Nokia and Finland in a Sea of Change.* Taloustieto Oy, Helsinki.

Ali-Yrkkö, J., Rouvinen, P., Seppälä, T. & Ylä-Anttila, P. 2011. The Value Creation of Mobile Phones – The Case of Nokia N95; *Journal of Industry, Competition and Trade*, 11(3): 263-278.

Anderson, K. 1990. Changing comparative advantages in China: effects on food, feed and fibre markets. Changing comparative advantages in China: effects on food, feed and fibre markets. http://www.cabdirect.org/abstracts/19921892831.html;jsessionid=78D088D52BD730FE05376 17F01E89B36

Antras, P., Garricano, L., and Rossi-Hansberg, E. 2005. Offshoring in the Knowledge Economy *NBER Working Paper* No.. 11094.

Asmussen, C.G, Larsen, M.M., and Pedersen, T. 2016. Organizational adaptation in offshoring: The relative performance of home- and host-based learning strategies. *Forthcoming in Organization Science*.

Aron, R., Singh, J. 2005. Getting offshoring right. *Harvard Business Review*, *83*(12): 135–143.

Balassa, B. 1979. The changing pattern of comparative advantage in manufactured goods. *The Review of Economics and statistics*, 259-266.

Balassa, B. and Noland, M., 1989. The changing comparative advantage of Japan and the United States. *Journal of the Japanese and International Economies*, 3(2), pp.174-188.

Baldwin R., & Venables, A. 2013. Spiders and Snakes: Offshoring and Agglomeration in the Global Economy. *Journal of International Economics*, 90(2) 245-254.

Barney, J. 1991. Firm resources and sustained competitive advantage. *Journal of Management*, 17: 99-120.

Bertrand, O. 2011. What goes around, comes around: Effects of offshore outsourcing on the export performance of firms. *Journal of International Business Studies*, 42(2): 334-344.

Birkinshaw, J., & Hood, N. 1998. Multinational subsidiary evolution: Capability and charter change in foreign-owned subsidiary companies. *Academy of Management Review*, 23(4): 773-795.

Birkinshaw, J., Brannen, M. Y., & Tung, R. L. 2011. From a distance and generalizable to up close and grounded: Reclaiming a place for qualitative methods in international business research. *Journal of International Business Studies*, 42(5): 573–581.

Boudreau, M., Loch, K.D., Robey, D., & Straud, D. 1998. Going global: Using information technology to advance the competitiveness of the virtual transnational organization. *The Academy of Management Executive*, 12(4): 120–128.

Brusoni, S., Prencipe, A., & Pavitt, K. 2001. Knowledge specialization, organizational coupling, and the boundaries of the firm: Why do firms know more than they make? *Administrative Science Quarterly*, 46(4): 597–621.

Buckley, P.J., Casson, M.C. 1976. *The Future of the Multinational Enterprise*. Homes and Meier, London, .K.

Cantwell, J. 1995. The globalisation of technology: what remains of the product cycle model. *Cambridge Journal of Economics*, 19: 155-174.

Cantwell, J. & Mudambi, R. 2005. MNE competence –creating subsidiary mandates. *Strategic Management Journal*. 26, p. 1109-1128

Cantwell, J. A. & Santangelo, G. D. (1999) The frontier of international technology networks: sourcing abroad the most highly tacit capabilities. Information Economics & Policy, 11(1): 101–123.

Contractor, F.J., Kumar, V., Kundu, S.K., & Pedersen, T. 2010. Reconceptualizing the firm in a world of outsourcing and offshoring: The organizational and geographical relocation of high-value company functions. *Journal of Management Studies*, 47(8): 1417–1433.

Dedrick, J., Kraemer, K.Linden, G. 2009. Who Profits from Innovation in Global Value Chains?: A Study of the iPod and Notebook PCs. *Industrial & Corporate Change*, 19(1): 81–116.

Dedrick, J., Kraemer, K.L. & Linden, G. 2011. The Distribution of Value in the Mobile Phone Supply Chain. *Telecommunications Policy*. 35(6): p. 505-52.

Dibbern, J., Winkler, J., & Heinzl, A. 2008. Explaining variations in client extra costs between software projects offshored to India. *MIS Quarterly*, 32(2): 333–366.

Dunning, J.H. 1998. Location and the multinational enterprise: A neglected factor?.*Journal of International Business Studies*. *29*(1): 45-66.

Eisenhardt, K. M. 1989. Building theories from case study research. *Academy of Management Review*, 14(4): 532–550.

Ernst, D. & Kim, L. 2002. Global production networks, knowledge diffusion, and local capability formation. *Research Policy*. 31(8-9): 1417-1429.

Farrell, D. 2005. Offshoring: Value creation through economic change. *Journal of Management Studies*, 42(3): 675-683.

Gatignon, H., & Anderson, E. 1988. The multinational corporation's degree of control over foreign subsidiaries: An empirical test of a transaction cost explanation. *Journal of Law, Economics, & Organization*, *4*(2), 305-336.

Grossman, G. M., & Rossi-Hansberg, E. 2008. Trading Tasks: A Simple Theory of Offshoring. *American Economic Review*, 98(5): 1978-1997.

Hausmann, R. and Klinger, B. 2006. Structural transformation and patterns of comparative advantage in the product space. *KSG Working Paper No. RWP06-041 CID Working Paper No. 128*

Hobday, M. & Rush, H., 2007. Upgrading the technological capabilities of foreign transnational subsidiaries in developing countries: The case of electronics in Thailand. *Research Policy*, 36(9): 1335-1356.

Hobday, M., Davies, A., & Prencipe, A. 2005. Systems integration: A core capability of the modern corporation. *Industrial and Corporate Change*, 14(6): 1109–1143.

Hobbs, J.E. 1996. A transaction cost approach to supply chain management. *Supply Chain Management: An International Journal*, 1(2), pp.15-27.

Jacobs, L.W., Wills, J.R., Coskun Samli, A. and Bullard, W.R. 1997. Internationalization of domestic product life cycles: An exploration of causality. *International Marketing Review*, 14(1), pp.75-87.

Larsen M.M., Manning, S. & Pedersen, T. 2013. Uncovering the hidden costs of offshoring: The interplay of complexity, organizational design, and experience. *Strategic Management Journal*. 34(5): 533-552.

Lanz, R., S. Miroudot and H. K. Nordås (2011), "Trade in Tasks", OECD Trade Policy Working Papers, No. 117, OECD Publishing.

Larsen MM. 2016. Failing to estimate the costs of offshoring: A study on process performance. *International Business Review*, 25(1): 307-318..

Lepak D.P., Smith, K. G., & Taylor, M.S. 2007. Introduction to Special Topic Forum: Value Creation and Value Capture: A Multilevel Perspective. *Academy of Management Review*. 32(1): 180-194.

Lewin A.Y., & Couto, V. 2007. *Next Generation Offshoring: The Globalization of Innovation*.: Duke University CIBER/Booz Allen Hamilton Report, Durham NC.

Lewin, A.Y., & Peeters, C. 2006. Offshoring work: Business hype or the onset of fundamental transformation? *Long Range Planning*, 39(3): 221–239.

Lewin, A.Y., Massini, S. Peeters, C. 2009. Why are companies offshoring innovation? The emerging global race for talent. *Journal of International Business Studies*. 40(8): 1406-1406.

Linden, G., Kraemer, K. L., & Dedrick, J. 2009. Who Captures Value in a Global Innovation Network? The Case of Apple's iPod. *Communications of the ACM*, 52(3): 140-144

Lorentz, H., Töyli, J., Solakivi, T., Hälinen, H.M. and Ojala, L. (2012), "Effects of geographic dispersion on intra-firm supply chain performance", *Supply Chain Management: An International Journal*, 17 (6), 611-626.

Massini S., Pern-Ajchariyawong, N., & Lewin, A.Y. 2010. Role of corporate-wide offshoring strategy on offshoring drivers, risks and performance. *Industry & Innovation*. 17(4): 337-371.

Mudambi, R. 2008. Location, control and innovation in knowledge-intensive industries. *Journal of Economic Geography*. 8(5): 699 – 725.

Mudambi, R. and Navarra, P. 2004. Is knowledge power? Knowledge flows, subsidiary power and rent-seeking within MNCs. *Journal of International Business Studies*, 35(5), pp.385-406

Nieto, M. J., & Rodríguez, A. 2011. Offshoring of R&D: Looking abroad to improve innovation performance. *Journal of International Business Studies*, 42(3): 345-361.

Pananond, P. 2013. Where do we go from here? Globalizing subsidiaries moving up the value chain. *Journal of International Management*. 19(3): 207-219.

Peteraf, M. A. 1993. The cornerstones of competitive advantage: a resource‐based view. *Strategic Management Journal*, 14(3), 179-191.

Portelligent 2007. *Nokia 1200, GSM 900/1800 MHz Cellular Phone*. Austin, Texas, Portelligent.

Rasiah R, Nolintha V, & Songvilay L. 2011 Garment manufacturing in Laos: Clustering and technological capabilities. *Asia Pacific Business Review*. 17(2): 193-207.

Reitzig, M., & Wagner, S. 2010. The hidden costs of outsourcing: Evidence from patent data. *Strategic Management Journal*, 31(11): 1183-1201.

Rugman, A.M., & Verbeke, A. 2001. Subsidiary‐specific advantages in multinational enterprises. *Strategic Management Journal*, 22(3): 237-250.

Seppälä, T. 2010. Transformations of Nokia's Finnish Supplier Networks from 2000 to 2008. In Ali-Yrkkö (Ed.): *Nokia and Finland in a Sea of Change*. Taloustieto Oy, Helsinki

Seppälä, T. 2013a. Transformations in Mobile Telecommunication Industry Supply Chains. In Pedersen, T., Jensen, P. & Larsen, M. (Ed.); *The Offshoring Challenge: Strategic Design and Innovation for Tomorrow's Organization*;, Springer Engineering Series

Seppälä, T. 2013b. Tracking Offshoring and Outsourcing Strategies in Global Supply Chains. In Pedersen, T., Jensen, P. & Larsen, M. (Ed.); *The Offshoring Challenge: Strategic Design and Innovation for Tomorrow's Organization*, Springer Engineering Series

Seppälä, T., Kenney, M., & Ali-Yrkkö, J. 2014. Global supply chains and transfer pricing: insights from a case study. *Supply Chain Management: An International Journal*, 19:445–454

Tanriverdi, H., Konana, P., & Ge, L. 2007. The choice of sourcing mechanisms for business processes. *Information Systems Research*, 18(3): 280–299.

Van Assche, A. 2008. Modularity and the organization of international production. *Japan.and the World Economy*, 20(3): 353-368.

Wiesenfeld, B.M., Raghuram, S., & Garud, R. 1999. Communication patterns as determinants of organizational identification in a virtual organization. *Organization Science*, 10(6): 777–790.

Williamson, O.E. 1975. Markets and Hierarchies. Free Press: New York.
Yin, R. K. 2003. *Case study research*. London: Sage.
Zaheer, S. 1995. Overcoming the liability of foreignness. Academy of Management Journal 38(2), 341–363.

APPENDIX 1

To estimate the geographical breakdown of the product's value, we proceed as follows. The total value of the product Y is composed of the value added of all activities of the product's value chain or

$$Y = \sum_{c=1}^{N} Y_c \quad , \qquad \text{(A1)}$$

where

Y = The total value of the product

Y_c = The value added of value chain's value-adding activity, c.

The value added of each activity (Y_c) can be created globally. We assume that this total value added of each activity is created in an area covering home country (Finland), other Europe, North America and Asia; thus,

$$Y_c = Y_{c,D} + Y_{c,E} + Y_{c,N} + Y_{c,A} + Y_{c,O} \quad , \qquad \text{(A2)}$$

where

D = Domestic (Finland)
E = Europe (Other EU-15)
N = North-America
A = Asia
0 = Others

Our data include the value added of each part (Y_c), but we do not have information about how this value added is created in different areas. To estimate the value added of activity c created in each region ($Y_{c,D}, Y_{c,E}, Y_{c,N}, Y_{c,A}, Y_{c,O}$), we have proceeded as follows.

We assume that the value added of activity c captured in each region is created by means of the factors of production. As is common in the economic literature, we consider three factors of production: physical capital stock (C), the size of the labor force (L) and knowledge capital stock (K). We assume that the impact of each production factor is identical to its elasticity of output. The previous empirical literature (including a number of studies) has estimated a Cobb-Douglas style of production function:

$$Q = AC^{\alpha} L^{\beta} K^{\gamma} \quad , \qquad \text{(A3)}$$

where A= multiplicative technology parameter

Equation (3) is typically estimated in logarithm form; thus, the parameters α, β and γ are the elasticity of output (Q) with respect to physical capital stock, labor and knowledge, respectively. In the majority of empirical studies, the estimated production function has included only two factors of production: physical capital and labor. Typically, the results of empirical studies show that the physical capital elasticity is approximately 0.4 and that the labor elasticity is approximately 0.6.

In studies in which knowledge capital is approximated by using R&D stock, the estimated knowledge capital elasticity varies typically between 0.05 and 0.25 (e.g., Hall 1993, Mairesse & Hall 1994, Harhoff 1998, Capron & Cincera 1998). Based on these studies, our calculations assume that this elasticity is 0.15. However, most studies have not considered the double counting related to R&D. R&D investment also consists of investment in physical capital and labor, and these components are included in the regular production factors (see, e.g., Schankerman 1981, Hall & Mairesse 1996). Based on earlier literature, we know that approximately 50 % of the R&D expenditures are labor costs (Hall 2009, NSF 1995). By taking this into account, we modify the capital elasticity (0.6) and labor elasticity (0.4) as follows.

$$\hat{\alpha} = \alpha - 0.5\gamma$$

$$\hat{\beta} = \beta - 0.5\gamma$$

Thus, our double-counting-corrected elasticities for capital, labor and R&D are 0.325, 0.525 and 0.15, respectively. We use these elasticities as the multipliers of production factors.

We continue by calculating the share of each production factor that is located in each region *R* and multiply each share by the elasticity of output. Next, we sum these values by region and obtain each region's share of value added (related to part *c*). Finally, we multiply this share by the value added of part *c* (Y_c). The value added of part *c* created in region R is calculated as follows:

$$Y_{c,R} = \left(\frac{C_R}{C}\hat{\alpha} + \frac{L_R}{L}\hat{\beta} + \frac{K_R}{K}\gamma \right) Y_c, \qquad \text{(A4)}$$

where

C_R is the firm's physical capital stock in region *R*,

C is the sum of the firm's physical capital in all regions,

L_R is the firm's employment in region *R*,

L is the sum of the firm's employment in all regions,

K_R is the firm's knowledge capital in region *R*, and

K is the sum of the firm's knowledge capital in all regions.

Thus, for instance, the domestically created value added is calculated as follows:

$$Y_{c,D} = \left(\frac{C_D}{C}\hat{\alpha} + \frac{L_D}{L}\hat{\beta} + \frac{K_D}{K}\gamma \right) Y_c \qquad \text{(A5)}$$

Equations (A4) and (A5) implicitly assume that total productivity is equal in each region. To account for regional productivity differences, we calculate the productivity corrected value added of part *c* that is created in region R as follows:

$$\hat{Y}_{c,R} = \frac{MFP_R\left(\frac{C_R}{C}\hat{\alpha} + \frac{L_R}{L}\hat{\beta} + \frac{K_R}{K}\gamma \right)}{\sum MFP_R\left(\frac{C_R}{C}\hat{\alpha} + \frac{L_R}{L}\hat{\beta} + \frac{K_R}{K}\gamma \right)} Y_c \qquad R \in (D, E, N, A, O), \quad \text{(A6)}$$

where MFP_R is multi-factor productivity in region *R*.

Thus, for instance, the domestically created value added is calculated as follows:

$$\hat{Y}_{c,D} = \frac{MFP_D\left(\frac{C_D}{C}\hat{\alpha} + \frac{L_D}{L}\hat{\beta} + \frac{K_D}{K}\gamma \right)}{\sum MFP_R\left(\frac{C_R}{C}\hat{\alpha} + \frac{L_R}{L}\hat{\beta} + \frac{K_R}{K}\gamma \right)} Y_c \qquad R \in (D, E, N, A, O) \quad \text{(A7)}$$

Operationalization of production factors

If component-level factors and factor shares are unavailable, we use firm-level information on the location of different factors. Firm-level data are based on the annual reports and websites of each vendor. We have the following operationalized variables:

C = Non-current assets or long-lived assets, depending on which one was reported in 2007.

L = Number of employees (in 2007).

K = R&D expenditure. We are unable to calculate R&D stock for each region; thus, we used R&D expenditure in 2007.

In some cases, the reported regional breakdown of some factors is imperfect. In those cases, we read the entire annual report carefully and searched for necessary information on the Internet to approximate the regional breakdown. For instance, National Semiconductor (a US company) reports the regional breakdown of long-lived assets (annual report, p. 104) and employees (annual report, p. 12) but does not report the exact geographical breakdown of R&D expenditures. However, on p. 21, the company reports that their principal research facilities are located in Santa Clara (California, US) and that they also operate small design facilities in 13 different locations in the U.S. and 11 different locations outside the United States. Of those 11 overseas R&D units, approximately half are located in Asia, and half are in the EU-15 area. Based on these facts and the number of facilities per region, we estimate that approximately 70% of R&D is conducted in the U.S., and we divide the rest of the 30% fifty-fifty for Europe (15%) and Asia (15%).

Operationalization of multi-factor productivity (*MFP*):

We used value-added-based *MFP* figures of the electrical and optical equipment and postal and telecommunications industries reported by Inklaar and Timmer (2008). These data are downloadable at www.ggdc.net/databases/levels.htm. Based on this database, the regional MFPs used in our estimations are as follows:

$MFP_D = 1.24$ (Finland);

$MFP_E = 0.81$ (the average of EU-15 countries, excluding Finland);

$MFP_N = 1$ (United States);

$MFP_A = 0.52$ (the average of Japan, China, South Korea and Taiwan). The *MFP*s of China, South Korea and Taiwan are based on Motohashi (2008), who uses Japan as a reference country (Japan = 1.00), and

$MFP_O = 0.37$ (the average of Australia, the Czech Republic, Hungary, and Slovenia).

APPENDIX 2

Robustness test 1:

To test to what extent our results depend on our assumptions related to the value added created by material suppliers' vendors, we recalculate the geographical breakdown of value added by changing these assumptions. It might be argued that Asia's role in these upstream activities is more significant than we assumed in our basic calculations. Moreover, Australia, Russia and Africa are important raw material providers, and in this sense, our basic assumptions potentially under-estimate the role of these regions. Because of these two reasons, we raise the share of Asia to 50% and that of Other countries (including, e.g., Australia, Russia and Africa) to 30% of the value added created by vendors of vendors, and we lower the share of EU-27 to 10% and that of North-America to 10%. Next, we re-calculate all potential combinations related to the final assembly location and the countries of final sale. The results of this re-calculation show that our basic results hold (See Appendix 3).

APPENDIX 3

Robustness test 1 results by a value-added regional breakdown (different combinations of manufacturing and sales locations).

3310

	Average.	Manufactured in EU (excluding Finland) and sold in EU.	Manufactured in North America and sold in North America.	Manufactured in Asia and sold in Asia	Manufactured in Asia and sold in EU (excluding Finland).
Finland	26.2 %	26.2 %	26.2 %	26.2 %	26.2 %
Other EU area	22.4 %	42.7 %	8.8 %	8.8 %	29.4 %
North America	13.0 %	4.5 %	38.4 %	4.5 %	4.5 %
Asia	31.3 %	19.5 %	19.5 %	53.4 %	32.7 %
Other countries	7.1 %	7.1 %	7.1 %	7.1 %	7.1 %
	100 %	**100 %**	**100 %**	**100 %**	**100 %**

1100

	Average.	Manufactured in EU (excluding Finland) and sold in EU.	Manufactured in North America and sold in North America.	Manufactured in Asia and sold in Asia.	Manufactured in Asia and sold in EU (excluding Finland).
Finland	20.9 %	20.9 %	20.9 %	20.9 %	20.9 %
Other EU area	23.7 %	45.9 %	9.9 %	9.9 %	29.4 %
North America	13.2 %	4.2 %	40.3 %	4.2 %	4.2 %
Asia	35.5 %	22.3 %	22.3 %	58.4 %	38.8 %
Other countries	6.7 %	6.7 %	6.7 %	6.7 %	6.7 %
	100 %	**100 %**	**100 %**	**100 %**	**100 %**

1200

	Average.	Manufactured in EU (excluding Finland) and sold in EU.	Manufactured in North America and sold in North America.	Manufactured in Asia and sold in Asia.	Manufactured in Asia and sold in EU (excluding Finland).
Finland	8.1 %	8.1 %	8.1 %	8.1 %	8.1 %
Other EU area	21.9 %	41.3 %	7.3 %	7.3 %	31.8 %
North America	13.8 %	5.3 %	39.3 %	5.3 %	5.3 %
Asia	45.8 %	34.9 %	34.9 %	69.0 %	44.4 %
Other countries	10.4 %	10.4 %	10.4 %	10.4 %	10.4 %
	100 %	**100 %**	**100 %**	**100 %**	**100 %**

Figure 1. Stylized supply chain of the Nokia 3310, 1100 and 1200 models[10].

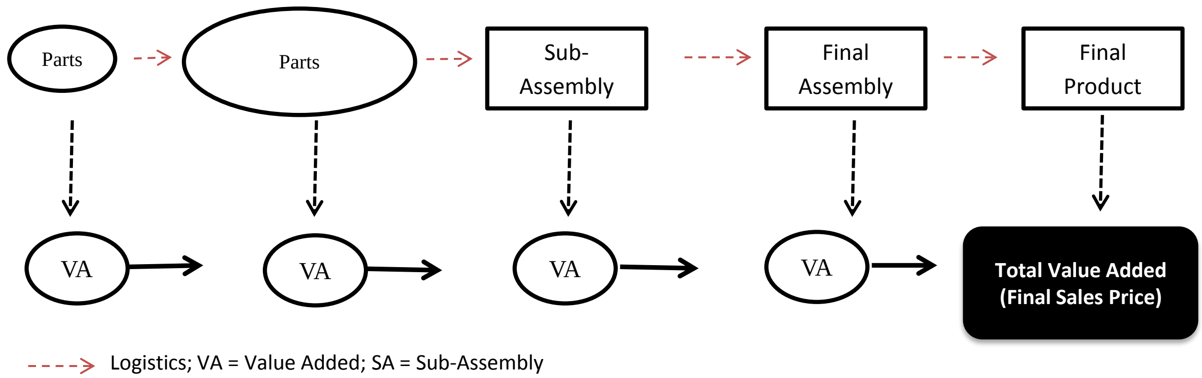
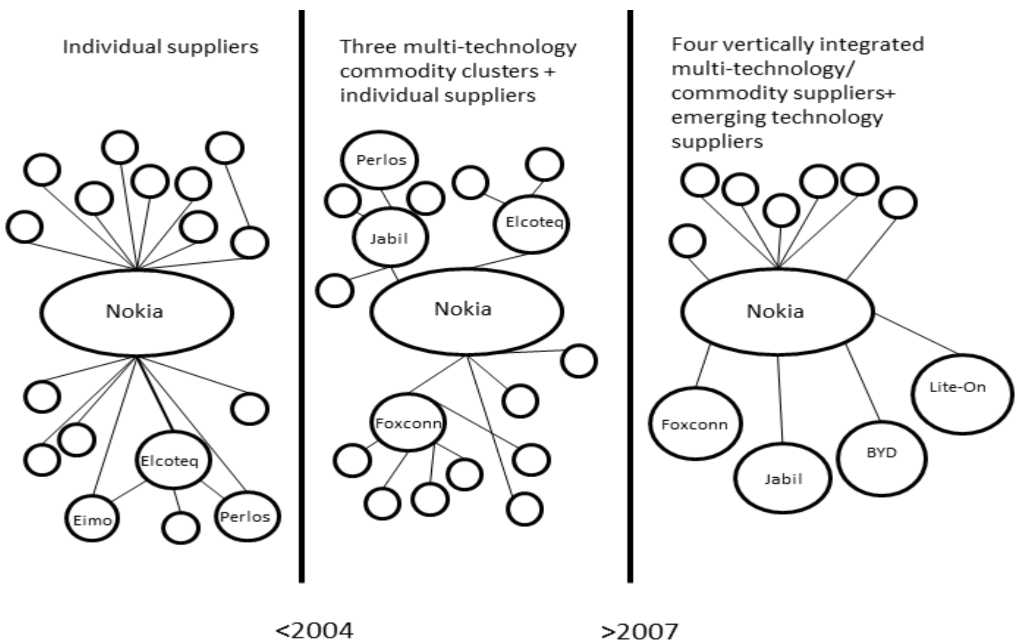


Figure 2. Changes in Nokia's supply chain network (Seppälä 2013a).



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10 Definitions: A-cover is the front cover of the mobile phone; B-cover is the bottom cover of the mobile phone; D-cover is the middle cover of the mobile phone; Engine is the printed circuit board assembly; Engine's final assembly is the assembly of display, D-cover and printed circuit board assembly; Assembly to order is the final assembly of A-cover, B-cover and an engine assembly, including software and sales packing. See Linden et al. (2009) for similarities.

Table 1. Location of major tasks related to the handsets

Product life cycle	**1999 - 2003**	**2003 – 2007**	**2006 -**
Product Model	Nokia 3310	Nokia 1100	Nokia 1200
	Including: 3310 (Europe), Chinese variant[11] (China), American variant [12] (USA)	Including: 1100 (Asia & Europe), American variant[13] (USA)	
Product management	Denmark	Denmark	Denmark
Hardware platform design and development	Denmark, Finland	Denmark, Japan	Denmark, China
Software platform design and development	Denmark	Denmark	Denmark
User interface design and development	Denmark	Denmark	Denmark
Product software design	Denmark, China (Asia's software variant)	Denmark, Finland (America's software variant)	Denmark, (active participation from China)
Concept mapping and design	Finland, Denmark	Finland, Denmark	Finland, Denmark, China
Product design (hardware)	Denmark (3310), Finland (American variant)	Denmark (1100), Finland, USA (American variant)	China
Product test design	Finland	Finland	China
Proto manufacturing	Finland, USA	Finland, USA	China
Assembly to order manufacturing (ATO) (Nokia)	USA, Finland, Germany, Hungary, China, South Korea	USA, Hungary, China, South Korea, Brazil	China, India, Romania, Hungary, Mexico, South Korea
Engine assembly, if not in ATO location (Nokia)		Mexico	
Engine assembly (outsourced)	Estonia, Hungary	Estonia, Hungary, Mexico	China
Mechanical component manufacturing and sub-assemblies	USA, Finland, Germany, Hungary, China, South Korea, Mexico, China, USA	USA, Hungary, China, South Korea, Hungary, China, Mexico	China, India
Electro mechanical component manufacturing and sub-assemblies	Japan, China	Japan, China	China, India

Source: ETLA database

11 Software variant to Asian market.

12 American variant required a close collaboration with American operators (both hardware and software).

13 American variant required a close collaboration with American operators (both hardware and software).

Table 2. Bill of materials (BOM) of Nokia 3310 in 2003 prices, Nokia 1100 in 2004 prices and Nokia 1200 in 2007 prices.

	2003 Nokia 3310		**2004 Nokia 1100**		**2007 Nokia 1200**	
Description	Eur	%	Eur	%	Eur	%
Processor(s)	2.2	7.0 %	2.2	9.3 %	1.8	12.5 %
Display	3.8	12.1 %	3.3	13.7 %	0.6	4.4 %
Memories	2.7	8.6 %	1.1	4.4 %	0.6	4.3 %
Battery pack	1.37	4.4 %	1.37	5.8 %	1.05	7.2 %
Other integrated circuits (excluding processors and memory)	8.46	27.1 %	6.74	28.4 %	2.86	19.6 %
Mechanics	3.79	12.2 %	3.05	12.9 %	1.85	12.6 %
All other hardware inputs	7.39	23.7 %	4.71	19.8 %	4.86	33.2 %
BOM (excluding supporting material, license fees and manufacturing)	29.7	95.2 %	22.4	94.3 %	13.7	93.8 %
Supporting material	0.95	3.1 %	0.93	3.9 %	0.70	4.8 %
BOM (excluding license fees and manufacturing)	30.6	98.2 %	23.3	98.2 %	14.4	98.5 %
License fees	0.56	1.8 %	0.43	1.8 %	0.22	1.5 %
BOM (excluding manufacturing)	31.2	100 %	23.7	100 %	14.6	100 %

Data source: Authors/ETLA database
Note A: For the Nokia 3310, 1100 and 1200 models, the values are presented in 2003 prices, in 2004 prices and in 2007 prices, respectively.
Note B: Costs related to warranty and outbound logistics are not included.

Table 3. Value added breakdown in the supply chain by participant.

	2003 Nokia 3310	2004 Nokia 1100	2007 Nokia 1200
Vendors of vendors	22 %	21 %	34 %
Suppliers of material inputs	17 %	17 %	19 %
Licensors	0.5 %	0.5 %	0.8 %
Engine manufacturing	5 %	3 %	2 %
Nokia, excluding engine manufacturing	38 %	39 %	19 %
Logistics and warranty	2.5 %	4.9 %	6.4 %
Distributor	4.0 %	4.4 %	4.7 %
Retailer	10.6 %	10.2 %	13.6 %
Total	100 %	100 %	100 %

Source: Authors/ETLA database

Table 4. Value added breakdown by regions after taking into account the value added created in the country of final sales

	2003 Nokia 3310	2004 Nokia 1100	2007 Nokia 1200
Finland	33 %	30 %	15 %
Other EU area	23 %	26 %	21 %
North America	9 %	9 %	12 %
Asia	28 %	28 %	45 %
Other countries	7 %	7 %	7 %
	100 %	100 %	100 %

Source: Authors' calculations

Table 5. Value added breakdown by region (manufacturing and final sales in Asia).

	2003 Nokia 3310	2004 Nokia 1100	2007 Nokia 1200
Finland	24 %	27 %	11 %
Other EU areas	10 %	12 %	10 %
North America	6 %	6 %	8 %
Asia	55 %	52 %	66 %
Other countries	4 %	4 %	6 %
	100 %	100 %	100 %

Source: Authors' calculations

Table 6. Breakdown of value added by region (different combinations of manufacturing and sales locations).

Nokia 3310	(a) Based on headquarters.	(b) Based on the locations of production factors.	(c) 10 % to the headquarter country and 90 % based on the locations of production factors.	(d) Based on the locations of the production factors, corrected for productivity.	(e) 10 % to the headquarter. country and 90 % based on the locations of production factors, corrected for productivity.
Finland	46.7 %	25.8 %	26.1 %	26.3 %	26.2 %
Other EU area	11.6 %	23.4 %	22.9 %	23.7 %	23.9 %
North America	13.4 %	18.7	18.8 %	19.1 %	14.5 %
Asia	18.4 %	26.4 %	26.1 %	25.3 %	31.3 %
Other countries	9.9 %	5.7 %	6.1 %	5.6 %	4.2 %
	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %

Nokia 1100	(a) Based on headquarters.	(b) Based on the locations of production factors.	(c) 10 % to the headquarter country and 90 % based on the locations of production factors.	(d) Based on the locations of the production factors, corrected for productivity.	(e) 10 % to the headquarter country and 90 % based on the locations of production factors, corrected for productivity.
Finland	40.5 %	21.7 %	21.7 %	24.8 %	20.9 %
Other EU area	21.5 %	24.6 %	24.7 %	24.4 %	25.1 %
North America	13.4 %	19.0 %	19.0 %	19.1 %	14.6 %
Asia	15.8 %	29.3 %	28.8 %	26.4 %	35.5 %
Other countries	8.7 %	5.4 %	5.7 %	5.3 %	4.0 %
	40.5 %	21.7 %	21.7 %	24.8 %	100.0 %

Nokia 1200	(a) Based on headquarters.	(b) Based on the locations of production factors.	(c) 10 % to the headquarter country and 90 % based on the locations of production factors.	(d) Based on the locations of the production factors, corrected for productivity.	(e) 10 % to the headquarter country and 90 % based on the locations of production factors, corrected for productivity.
Finland	21.0 %	8.1 %	8.1 %	10.5 %	8.1 %
Other EU area	22.1 %	23.0 %	23.3 %	23.0 %	24.2 %
North America	21.0 %	21.2 %	21.5 %	21.4 %	16.1 %
Asia	26.3 %	39.1 %	38.4 %	36.6 %	45.8 %
Other countries	9.6 %	8.6 %	8.7 %	8.5 %	5.8 %
	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %

Table 7. Value added breakdown by regions (different combinations of manufacturing and sales locations).

3310	Average.	Manufactured in EU (excluding Finland) and sold in EU.	Manufactured in North America and sold in North America.	Manufactured in Asia and sold in Asia.	Manufactured in Asia and sold in EU (excluding Finland).
Finland	26.2 %	26.2 %	26.2 %	26.2 %	26.2 %
Other EU area	23.9 %	44.1 %	10.2 %	10.2 %	30.9 %
North America	14.5 %	6.0 %	39.9 %	6.0 %	6.0 %
Asia	31.3 %	19.5 %	19.5 %	53.4 %	32.7 %
Other countries	4.2 %	4.2 %	4.2 %	4.2 %	4.2 %
	100 %	**100 %**	**100 %**	**100 %**	**100 %**

1100	Average.	Manufactured in EU (excluding Finland) and sold in EU.	Manufactured in North America and sold in North America.	Manufactured in Asia and sold in Asia.	Manufactured in Asia and sold in EU (excluding Finland).
Finland	20.9 %	20.9 %	20.9 %	20.9 %	20.9 %
Other EU area	25.1 %	47.3 %	11.2 %	11.2 %	30.8 %
North America	14.6 %	5.6 %	41.6 %	5.6 %	5.6 %
Asia	35.5 %	22.3 %	22.3 %	58.4 %	38.8 %
Other countries	4.0 %	4.0 %	4.0 %	4.0 %	4.0 %
	100 %	**100 %**	**100 %**	**100 %**	**100 %**

1200	Average.	Manufactured in EU (excluding Finland) and sold in EU.	Manufactured in North America and sold in North America.	Manufactured in Asia and sold in Asia.	Manufactured in Asia and sold in EU (excluding Finland).
Finland	8.1 %	8.1 %	8.1 %	8.1 %	8.1 %
Other EU area	24.2 %	43.6 %	9.5 %	9.5 %	34.1 %
North America	16.1 %	7.6 %	41.6 %	7.6 %	7.6 %
Asia	45.8 %	34.9 %	34.9 %	69.0 %	44.4 %
Other countries	5.8 %	5.8 %	5.8 %	5.8 %	5.8 %
	100 %	**100 %**	**100 %**	**100 %**	**100 %**

Note: 10 % to the headquarter country and 90 % based on the locations of production factors, corrected for productivity.