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2013
Industry Studies Association
Working Papers

WP-2013-1
http://isapapers.pitt.edu/

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July 4, 2013

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Acknowledgements: The authors thank Jyrki Ali-Yrkkö and Nitin Joglekar for their helpful comments when reviewing the paper. This research is a part of the ongoing research project "Value Creation and Capture – The Impact of Recycling and Global Dispersion of Intangible Capital" (2012-2014), funded by the European Funding Agency for Technology and Innovation.

Abstract

This paper explores the role of product innovation in creating and capturing value added throughout the manufacturing and service life of a product. We explore the empirical roots of the concept of profiting from product innovation in the industrial and commercial machinery and equipment industry, offer a global value chain analysis of how an EU-27 headquartered firm has employed an effective business model for capturing value added from product innovation. In essence, we analyze how organizational and financial architectures reflect the realization of economic value in product innovations in the context of contemporary globalization. We present two different value creation and capture patterns for the same product innovation; one process describes the case of manufacturing, and one describes the case of services. We then show how these two different patterns of value creation and capture are reflected in different supply chain participants and national geographies. The key insights of this paper are twofold. First, we find that the concept of profiting from product innovation is significant at both the firm and nationwide levels. Second, we observe the disaggregation of the value chain of product innovation into two separate value chains: manufacturing and servitization. This observation provides novel insights into the governance of global value chains.

Introduction

Decades of increased productivity, partly resulting from offshoring and outsourcing activity, has left many advanced economies without substantial investments in next-generation manufacturing platforms. Such investments are essential to rebuilding these national economies in the long term (Olsen, 2006; Pisano and Shih, 2009). Although the offshoring and outsourcing phenomena have developed and the value chain activities of firms continue to be disaggregated, productivity in many advanced economies has begun to show signs of struggle (see Figure 1). This problem is a recent phenomenon because in many advanced economies, gross domestic product (GDP) has grown primarily through increases in productivity i.e. value added per work hour (see Figure 1). Therefore, it is clearly in the interest of any national economy to understand who creates and captures value added from technology, product, and service innovations during the life of products in the current global value chain (GVC) economy (Baldwin and Evenett, 2012; Gereffi and Lee, 2012).

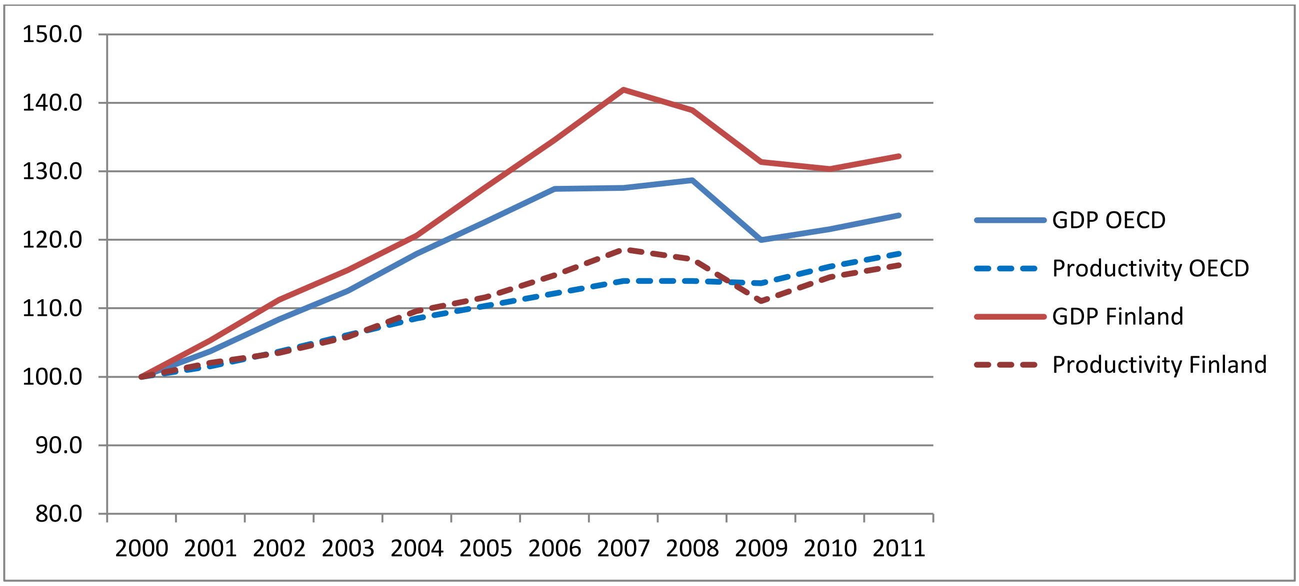

Figure 1. The developments of gross domestic manufacturing and productivity (Source: OECD)

The period of stagnant productivity growth in advanced economies has also led many nations to reconsider their positions in GVCs; in particular, the role of the manufacturing sector has been under serious consideration (Pisano and Shih, 2012; Baldwin and Evenett, 2012; Roper and Arvanitis, 2012; Seppälä and Kenney, 2013). In this context, the international relocation of firms and the disaggregation of firms knowledge and value chain activities within global supply chains are important factors in analyzing and understanding contemporary globalization from the perspective of firms and nations (Pedersen et al. 2013). The product-level GVC concept and its respective methodology is an approach that facilitates financial analysis of the global and geographical distribution of value added between national economies and between supply chain participants throughout the life of a product innovation (for the origins of this methodology, see Dedrick et al., 2009; Ali-Yrkkö et al. 2011).

The existing conceptualization of GVC concept lacks depth. Despite the current and anticipated future growth of this value chain activity, it has not received adequate systematic research attention at the micro level (Baldwin and Evenett, 2012). In particular, although we have a significant amount of knowledge regarding the phenomenon in general, less is known about how value added at the firm level can be translated into value added at the national level and, further, to the global level. However, many of the most important international organizations concerned about economic development have adopted the GVC concept and its related descriptions of the economic developments of contemporary globalization (Gereffi and Lee, 2012). On the national level, specific public policies are explicitly or implicitly employed to support economic growth. In essence, national policies articulate the logic of how a nation attracts value added and foreign direct investment (FDI) and how it profits from GVCs.

Previous product-level studies involving GVC analyses have focused on the value added of a product at a single point in time. The basis of these studies has been a product-level supply chain[1] that defines the flow of value added from the suppliers of the components to the distribution channel and how those supply chain participants interact. Moreover, these product-level supply chains characterize how firms operate in GVCs. However, this study expands the horizon relative to past GVC analyses: we analyze which participants create and capture value during the product life and thus attempt to understand which participants profit from product innovation (see Figure 3 for an illustration of the case firm's global supply chain at a manufacturing level). The global value and supply chain perspective that is used in this study is comparable to the previous studies conducted by Linden et al. (2009), Dedrick et al. (2009, 2011), Ali-Yrkkö (2010), Ali-Yrkkö et al. (2011), and Seppälä and Kenney, 2013.

[1] We define a supply chain as a physical flow of goods from raw materials to the distribution and sale of a final product and after-sales services.

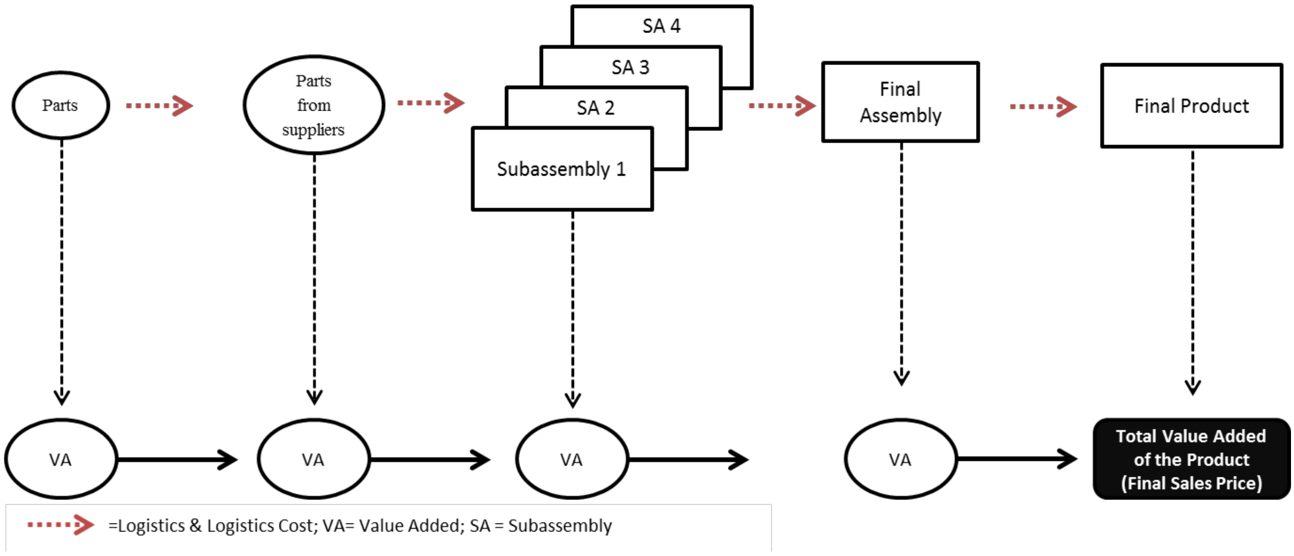

Figure 2. Supply chain versus value chain

The approach in this paper is grounded in the seminal work of Teece (1986), who established the theory of profiting from innovation (PFI). Furthermore, we frame our approach based on the theories of GVCs, business models, and servitization. These theories are then used to frame our data analyses. In particular, business models become key determinants of understanding differences in the distribution of value added during the economic life of a product. Furthermore, we examine the case firm's complementary assets position from the perspective of its business model based on the criteria that are identified by these theories.

This paper offers an economic analysis of value added that encompasses 36 years of the product life. The analysis identifies and explains the factors that determine which participants add value in global supply chains for product innovation over the product life. Furthermore, the study examines how the added value is distributed among national economies and among supply chain participants in two separate value chains: manufacturing and service value chains. This paper addresses the following research question: "Which participants create and capture the value added during the economic life of a product innovation in contemporary GVCs?"

The case firm profits from product innovation and possesses the capabilities that are needed to succeed in the present competitive market environment. The framework of economic analysis and its associated methodology appears to have value for highlighting the role of the different value-adding stages of product life, such as manufacturing and services (see Figure 3 for an illustration of product and service volumes).

This methodology and our case study technique permit a highly granular examination of a single industrial machinery product from which we draw larger observations regarding the nature of profiting from product innovation (Ali-Yrkkö, 2010; Ali-Yrkkö et al., 2011; Kalm and Seppälä, 2012; Seppälä & Kenney, 2013). Our unique and detailed data were provided by the case firm and enable us to examine value creation, value capture, and economic geography at the product level from both the manufacturing life and service life perspectives.

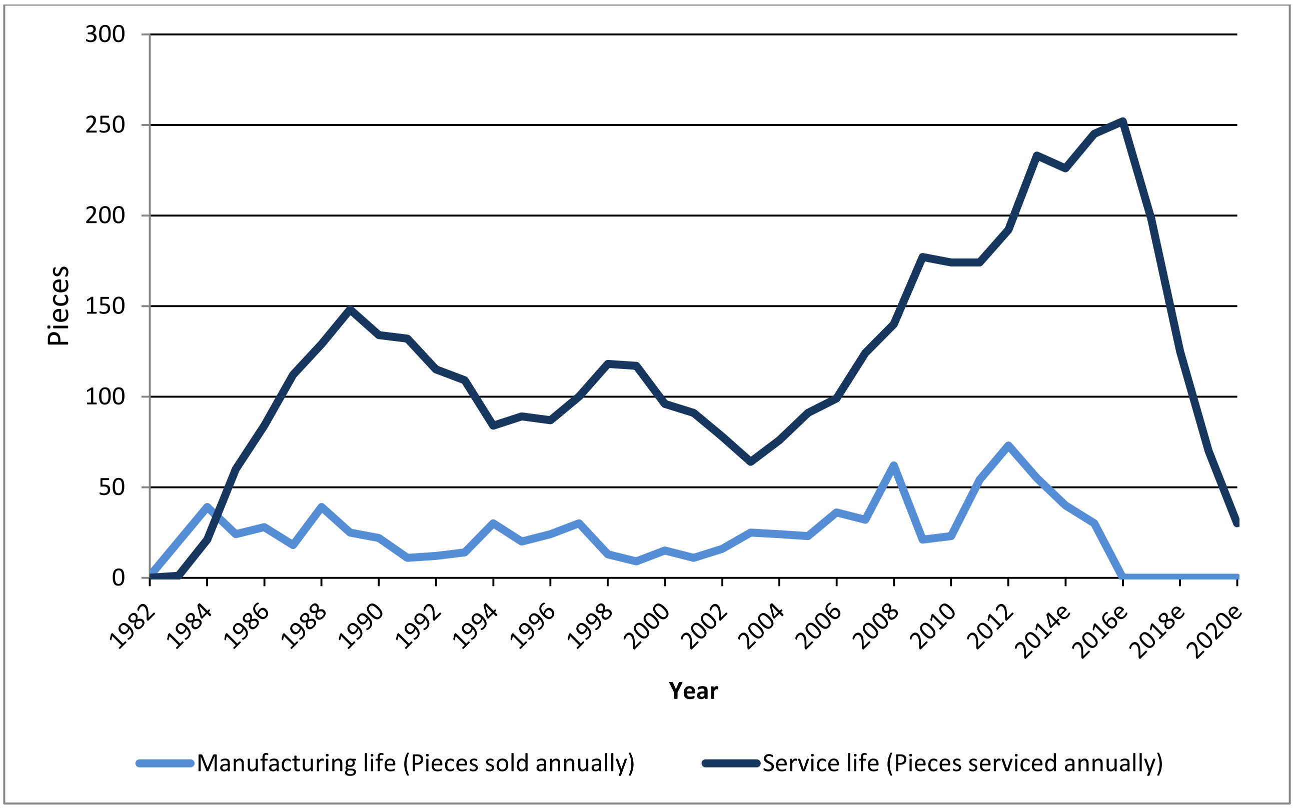

Figure 3. The manufacturing and service volumes of product innovation during the manufacturing and service life

Our analyses show that 46% of the economic value of product innovations arises from the manufacturing value chain, and 54% arises from the service value chain. The total value added is approximately 500M€. As a single case study, there are distinct limitations to this paper; however, the main benefit is the more granular analysis that aggregate studies cannot provide (see Figure 4). Furthermore, our analysis addresses the general lack of knowledge as to where value is created and captured during the economic life of a product innovation. The findings of this paper suggest that these segregated rents of the created and captured value added are crucial for understanding the long-term causes and consequences of profiting from product innovation and related public policies at the national and global levels.

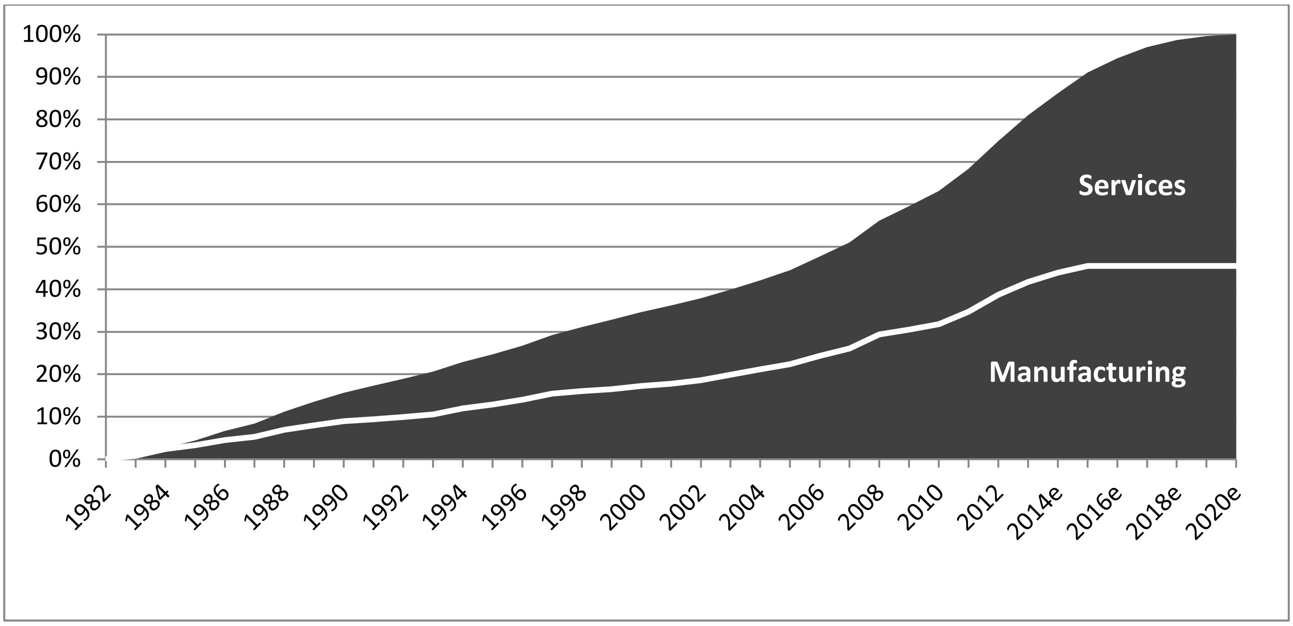

Figure 4. The economic added value of manufacturing versus services

Next, we discuss the concepts of GVCs and PFI. We begin in section 2 by explaining the theories of PFI, business models, and servitization. Section 3 describes the relevant industry, the case firm, and the chosen methodology. Section 4 explains the results from our case study, and section 5 concludes the paper by providing brief managerial, theory, and policy implications.

Theories of PFI, business models, and servitization

A GVC can be dispersed among a number of different national economies. A product, manufacturing, and service innovation can take many forms. Servitization can vary from product-related services to more demanding services. We have challenged ourselves to revisit the seminal Teece (1986) article and have considered arguments to reframe Teece's question in the context of our qualitative case study. Who profits from innovations during the product life in today's GVC economy?

One of the greatest changes in the supply chain and manufacturing strategies of firms has been the manufacturing unbundling that accelerated in the 1980s; This process has since caused the internationalization and gradual upgrading of technological, manufacturing, and supply chain competencies in offshore subsidiaries throughout the product cycle (Vernon 1966; Cantwell, 1995; Fukao et al., 2003; Baldwin, 2006; Mudambi, 2008; Hobday and Rush, 2007; Seppälä, 2013a, b). Furthermore, this unbundling implies that the stages of the product life are increasingly disaggregated and that the activities of firms are based on a complex set of strategic and operative decision variables: labor, transportation, and inventory costs; quality considerations; workforce capabilities; and proximity to appropriate suppliers and end customers (Tan et al. 2002; Kenney and Florida 2003; Buckley & Ghauri, 2004; Mudambi, 2008).

Over the past 30 years, our understanding of GVCs and value capture from innovations has dramatically expanded at the national, industry, and firm levels (Pisano & Teece, 2007; Pisano & Shih, 2009; Gereffi & Lee, 2012; Baldwin & Evenett, 2012). As Pisano and Teece (2007) noted, *"aspects of economic organization, business strategy, technology and innovation must all be understood"* to fully comprehend national-, industry-, and firm-level outcomes of product, manufacturing, and service innovations. However, the existing theoretical and empirical work only marginally explains contemporary globalization, especially the links and dependencies between economic analyses and the different stages of the product life. One of the major deficiencies in understanding contemporary globalization has been the lack of rich micro-level data (Baldwin and Evenett, 2012). Hence, this paper combines these aspects into a product-level economic analysis of value added and economic geography. The analysis further enables us to understand the role of profiting from product innovation over the life of a product in contemporary globalization. We obtain insights from the product sale and servitization perspectives.

Profiting from Product Innovation

Teece (1986; 2010) and Pisano and Teece (2007) provided a multidisciplinary framework and approach to study profiting from product innovations in GVCs and the associated production networks. The authors of those studies combined economic analyses with an organizational model, business models with technology, and markets for appropriability regimes and complementary assets[2]. This approach serves as an ideal theoretical framework for explaining and predicting a) how product innovators are creating value added and b) how they are capturing profits from their innovations in contemporary global supply chains (Pisano, 2006; Dedrick et al., 2009).

An economic analysis in conjunction with an organizational model serves as a means of understanding the ever-changing GVC environments of a single nation and a multinational firm (Rumelt et al. 1991; Teece, 1994; 1996). However, many other theories (approaches) and concepts are involved in these analyses (Barney and Hesterly, 2006). Our idea of combining economic analyses with organizational models is an effort to understand both the multinational firm's competitive position in its GVCs and the firm's business model at single or at multiple points in time as well as during the product life. The results of the analyses have constructive implications for various policies at the national level and in the strategies of multinational firms.

Firms employ either an explicit or implicit appropriability regime and/or complementary assets to support their product innovation and a business model that is aligned with their current business strategy (Teece, 1986; Pisano and Teece, 2009). Furthermore, the business model itself describes firms' value creation and value capture mechanisms (Teece, 2010). In essence, firms' business models and product-level value creation and value capture mechanisms articulate the internal logic of these organizations and demonstrate how they can profits from their innovations during the product life.

Teece (1986) distinguished between industries and technologies for which patents are effective and those for which patents are not effective (Winter, 2006). As Winter (2006) noted, "*Teece developed a detailed conceptual analyses of what firms needed to do in order to profit from their innovation when patent protection was not effective".* Furthermore, Pisano (2006) extended the core concept of appropriability in view of recent developments in the business environment.

[2] See Research Policy 35 (2006) p. 1091-1099.

Numerous business models have been adopted by firms that have created economic value and profits from their product innovation without intellectual property protection. Additionally, when a product innovation does not include any appropriability mechanism, the imitation of the product is easy, and complementary assets are important.

In the context of our case, the success of the product innovation of the case firm is not contingent on its appropriability regime. Moreover, in our case, the lack of patent protection combined with complementary assets is an important feature. We argue that our case product value chain primarily consists of characteristics related to complementary assets. Today, the value created and captured by the product innovation and the related portfolio of complementary assets are typically shared among the different participants in GVCs and distributed among the various national economies (Dedrick et al. 2009, Ali-Yrkkö et al. 2011).

Manufacturing and Service Value Chains and Business Models

The GVC is a phenomenon that has received considerable attention in various multinational firm, industry, and general global contexts (Gereffi and Lee, 2012). From the perspective of a national economy, these value chains primarily entail contributions to gross domestic product, and at the firm level, the analogous concept is value added. Furthermore, from an industry perspective, these chains are important to the global organization of industry, and how they are governed. Meanwhile from a multinational firm perspective, these chains primarily involve the value capture and bargaining power of firms (Dedrick et al., 2009).

In GVCs, a multinational firm(s) bears the primary responsibility of making strategic and operative decisions regarding where to locate different stages of production and the related supply networks. Furthermore, at a GVC level, the lead multinational firm bears the primary responsibility of maximizing value added, which is then divided among its stakeholders (Dedrick et al. 2009); that is, the fraction of value added that accrues to each stakeholder depends on the relative bargaining power of each firm (Porter, 1980; Bowman and Ambrosini, 2000; Dedrick et al. 2009).

The growing importance of services to national economies was identified by Chandler (1977). Potts (1988), and Vandermerwe and Rada (1988), who recognized the increasing importance of the servitization of manufacturing in corporate strategy. Today, a growing number of firms have adopted service-centric strategies to support a largely product-centric businesses and business models (Oliva and Kallenberg, 2003). This process of creating value by adding services to products is increasingly being recognized (Oliva and Kallenberg, 2003; Baines et al., 2009).Furthermore, in terms of the service life of a product, we recognize the importance of the discussion of the product/service interface (for an introduction, see Mathe and Shapiro, 1993; Oliva and Kallenberg, 2003) and the role of the installed base of manufactured products (for an introduction, see Wise and Baumgartner, 1999; Patton and Bleuel, 2000)). Moreover, the business role of services (in our case, industrial services) continues to be an area of growing interest among economic and management researchers (Baines et al., 2009).

The ability of any nation or firm to maximize value added from product and service innovation is essential for the competitiveness of such a nation or firm. On a national level, specific explicit or implicit policies must be employed to capture FDI. At the firm level, a particular business model must be employed to profit from product innovations (Teece, 2010). In essence, a firm's business model articulates the logic of how the firm creates value and captures profits in GVCs. Furthermore, a firm's business model embodies information and other details related to the organizational and financial architecture of the firm (Chesbrough and Rosenbloom, 2002). The model outlines firms' architecture of the revenues, costs, and profits that are associated with the product or service that is creating and delivering value (Teece, 2010).

The research on the economic value added of services that are linked to the manufactured base of a product is surprisingly limited. Existing models analyzing GVCs tend to focus on the products themselves and largely overlook the role of services in the value creation process of firms. However, the distinction between the manufacturing and servitization of a manufactured good appears to be blurring because firms are bundling manufacturing and services as integrated value-added solutions (Wise and Baumgartner, 1999).

In practice, multinational firms are globally disaggregated, and information technology is hastening the communication pressure related to increased transferring of services from advanced economies to emerging economies (Fukao et al., 2003; Baldwin, 2006; Mudambi, 2008; Baldwin and Evenett, 2012; Seppälä, 2013a, b).

The GVC of the product innovation of the case firm has only recently (after 2009) followed this trend of manufacturing unbundling, followed by supply network localization. However, the value creation and capture associated with product innovation has largely remained the same, as the units in emerging economies are used as internal suppliers to the units in advanced economies in different portfolios of value creation and capture (Dedrick et al. 2009, Ali-Yrkkö et al. 2011).

Next, we introduce the relevant industry, case firm, and methodology and explain how we apply our analytical approach to understand PFI during a product life cycle. The rich empirical data provided by the case firm and the “screwdriver economics” methodology enable us to perform economic analyses on the national and firm levels in a GVC and production network context for a specific product innovation.

Industry, the Case Firm and Methodology

To analyze the case firm and the structure of its value chain, it is important to understand the industry in which the value chain operates, as the industry defines and characterizes the specialization and structure of the industry players (Pisano & Teece, 2007).

The industry

The case firm operates in a horizontally integrated industry in which actors strive to provide integrated solutions for customers[3]. The firm operates in industry which manufactures industrial and commercial machinery equipment (SIC 35)[4] and it produces machinery products and provides services for these products. The case product is part of a wider product range. This product range includes products meeting a variety of customer needs, and the operating principles are consistent over this range. The product ranges of the different manufacturers within the industry are quite similar. This similarity arises because the application environment defines the dimensions of the products, which constitute the key differentiating factor among products within product ranges. In general, the industry and its products are not protected through strong legal mechanisms or natural barriers that could enhance appropriability. However, the industry actors are protected through complementary assets, which substitute for the protection provided by legal mechanisms or natural barriers. In addition, the products from competing manufacturers are differentiated based on these complementary assets (e.g., brands, services, manufacturing quality and efficiency, distribution, and specific technologies).

Furthermore, the industry is similar to car manufacturing in that it has become characterized by a high degree of modularity, as the products consist of several modules produced by highly specialized suppliers. Furthermore, one supplier may provide modules for several industry actors at any given time. Therefore, unlike car manufacturing, the design and development processes are not highly coordinated and integrated. As in the studied industry, the components that are

[3] In return for the participation of the firm and as a result of the sensitivity of the data, anonymity was granted for the firm and the interviewees.

[4] This SIC group includes establishments engaged in manufacturing industrial and commercial machinery and equipment and computers. Included are the manufacture of engines and turbines; farm and garden machinery; construction, mining, and oil field machinery; elevators and conveying equipment; hoists, cranes, monorails, and industrial trucks and tractors; metalworking machinery; special industry machinery; general industrial machinery; computer and peripheral equipment and office machinery; and refrigeration and service industry machinery. Source: http://www.census.gov/epcd/ec97sic/def/D35.TXT (information retrieved 4.7.2013)

sourced from suppliers are protected by complementary assets, such as manufacturing quality, rather than formal appropriability regimes.

Historically, the industry has been quite product driven, but the importance of value-adding services (excluding spare parts, which have been important for decades) has increased and continues to increase. Two major reasons for this change are the increasing threat of Asian competitors and the desire to provide a more stable revenue source in a cyclical industry. The rapid and reliable delivery of spare parts and value-adding services to remote locations is one of the key success factors in the studied industry.

The case firm

The case firm is a Finnish subsidiary of a multinational enterprise (MNE) from the EU-27. Industrial machinery products are its main outputs. The MNE operates in global supply and production chains, and it is one of the leaders in its sector. The subsidiary has been manufacturing these products in Finland for nearly 50 years, and the parent company has been in machinery production for more than 150 years. However, the case firm was one of the later entrants to the market for the original product innovation. Since the early 2000s, the subsidiary's products have also been manufactured at the parent company's plant in China. In the value chain, the case firm and its parent's other subsidiaries are integrators that provide solutions for customers; hence, the MNE is at the top of the value chain. The solutions relate to both the end products and the services that are linked to the end products. The firm has an EU-27-centric supplier network from which it sources the key components for its products. The explanation for this arrangement is two-fold. First, most of the EU-27 suppliers have well-known brands. Second, suppliers outside of the region, such as those based in Asia, do not have components of comparable quality and raw materials to offer. The components are primarily standard products, but in some cases, the suppliers also develop components for the end products.

According to the interviewees in this study, the case firm's customers have several criteria that they consider when choosing a product. However, the sales price is not one of these criteria. The customers' key selection criteria are reliability, efficiency, delivery time, the availability of spare parts, the unit cost of customers' final output, and safety. In this industry, environmental issues are also becoming increasingly important. Hence, the above criteria have been considered during the product design process. The service offerings of the case firm are also designed to provide services that are specifically needed by the end customers. Historically, the case firm has not offered onsite maintenance services, but this policy has changed recently. Daily maintenance and major overhauls are examples of the maintenance services that are provided. However, the largest manufacturers offer maintenance services only for their own products; only third-party maintenance service firms provide maintenance for multiple brands. Nevertheless, because of the simplicity of the case product, an ordinary mechanic employed by the end user can provide any maintenance services needed by the product. Therefore, the case firm does not offer maintenance services for case product, but it does provide maintenance manuals and training for mechanics working with the case product. In this case study, the value added that is created through the maintenance services provided by end users or third parties are not significant; hence, the exclusion of these services from the study does not significantly affect the distribution of value added in terms of either geography or participants.

The services for the case firm's products are provided through local area-specific subsidiaries of the parent company. Such services include both spare parts and maintenance services. The subsidiaries also occasionally operate as importers for the end products. The spare parts business falls under two separate organizations. An EU-27-based subsidiary manages global spare parts sales to area-specific subsidiaries and procures the components from suppliers. The actual transportation and warehousing of the spare parts are outsourced to a global logistics company. In practice, the spare parts are stored at five different warehouses around the globe. The key offering of the spare part operations is the rapid and reliable delivery of the components to customers around the globe.

Table 1. Firm overview

	The case firm
Type	A Finnish subsidiary of a MNE from the EU-27
Founded	1960s (subsidiary), 1800s (parent)
Industry classification	Industrial and Commercial Machinery and Equipment (SIC 35)
Annual revenues	>1,000M€
Manufacturing	Finland and China (since late 2000s)
Internal and external supply chain	Finland and EU-27 centric
Price per item	100-300k€
Aftermarket sales per	100-300k€

item	
Outsourcing activity	Most of the key components are manufactured by the suppliers

The case product

The researched product is a Finnish industrial machinery product. The design process of the product began in the 1970s, and the first machine was delivered to a customer in the early 1980s from a Finnish production plant. Hence, the product innovation is more than 30 years old. The innovation was conceptualized and industrialized and is now manufactured by the Finnish case firm. During the design process, the designers consulted potential customers and chose technologies that were considered reliable and simple. Although the firm had previously manufactured a similar product, the new design was not based on that former product innovation. The design and development process was rather straightforward, as the design team included only the main product engineer and a few other workers who assisted with some minor aspects, such as electronics planning. Since the initial innovation, there have been minor changes in design because of component upgrades. The product has been so successful that despite occasional plans to redesign the product in the past decade, other projects have been perceived as more important. Hence, the company has bypassed this redesign. Specifically, the product is not yet fully digitized into two- (2D) or three- (3D) dimensional computer-aided design (CAD) programs, although the case firm has used these programs since the 1990s. Meanwhile, the actual design process of the new products has changed, as the designers have specialized in specific technologies.

The manufacturing process had remained quite static until the late 2000s, when the firm opened a second production plant in China. Since the plant opening, production has been divided almost evenly between Finland and China. This change highlighted the need for more precise product design plans and guides for Chinese workers. Since the end of 2012, all manufacturing of the case product has been centralized in the Chinese factory, and the manufacturing of the product is intended to be phased out completely by the end of 2015. The service offering for the case product is estimated to operate for five more years after the end of the product life. The current sales price of the product is between 100,000 and 300,000 euros depending on the sales area and the equipment standard. However, the sales price does not depend on the production location.

The company estimates that the average value of aftermarket sales is between 100,000 and 300,000 euros, and these sales are typically spread over a five-year period.

During the lifetime of the product, the major component suppliers have been largely unchanged. However, major changes have been considered in our calculations. As a whole, the design has been unaltered since the 1980s; however, certain components have been upgraded as environmental regulations have been tightened or as the efficiency of the product has improved. However, in most cases, the supplier has remained the same.

Methodology and Data Description

This paper uses a case study methodology to empirically analyze the value chains at a MNE level (Eisenhardt, 1989; Yin, 1994; Voss et al. 2002). The analysis is based on the data provided by the studied firm and includes both product- and firm-level information on intermediate product prices within the firm. The case data were collected in six workshops and five in-depth interviews, which occurred during two distinct periods. The first three workshops and three interviews were conducted between January 2011 and December 2011. The remainder of the workshops and interviews were conducted between October 2012 and May 2013. The duration of these interviews was approximately one and a half hours each. Two research team members and three to five persons from the firm were in attendance at each workshop. The data that were collected during the interviews and workshops were augmented with email and telephone inquiries. In the first stage, the chief financial officer, the SVP of supply chain management, and the business unit controller were the most important sources of financial information. Additionally, purchasing directors and managers were in attendance during the interviews and workshops to provide data for the analysis. The three interviews were conducted during a visit to the factory in China. The interviewees were responsible for production, sourcing, and human resources at the Chinese unit. In the second stage, the business unit controller and the assistant controller were the key information sources; however, the product engineer who designed the product and the person who is responsible for services at the case firm were also interviewed.

During the first stage of the semi-structured interviews and workshops, product-specific financial data were collected. These data included 1) sales pricing and intra-firm transfer pricing data; 2) the income statements and balance sheets of the plant and the firm; 3) the bill of materials (BOM); and 4) historical sales data, which included the country information for each end user. The BOM included the buying price of each component as well as the name and country of the supplier and the manufacturer. During the second stage, the semi-structured interviews and workshops provided comprehensive information about the sales of the product over its life cycle. These interactions also provided product-specific service sales data, which included 1) sales pricing and intra-firm transfer pricing of the spare parts and the maintenance services, 2) the distribution of sales between spare parts and maintenance, 3) a list of components that are sold as spare parts, and 4) the name and country of the maintenance providers. In addition, the firm provided information regarding the logistical costs. In return for the participation of the firm and as a result of the sensitivity of the data, anonymity was granted for the firm and the interviewees.

In addition to the BOM, the firm supplied additional information concerning the manufacturers of certain products that it purchased through distributors. However, the research team needed to turn to alternative information sources to research the financial information of the upstream suppliers of the firm and, in turn, their suppliers. These additional information sources were necessary because the firm had limited knowledge of this information. Additional financial reporting data, including financial statements and balance sheets, were accessed through the ORBIS database from Bureau van Dijk Electronic Publishing (DvDEP).

Value added

In this paper, the analysis of value added created by the product over its life is conducted in three stages. In the first stage, the value added of the manufacturing of the product is calculated. In the second stage, the value added created by the services is analyzed. These analyses are calculated for a single point in time. In both cases, this point was the year 2011. In the third stage, the shared value is calculated by utilizing the results of the first two stages and sales data provided by the case firm. The following method is used to calculate the value added. The value added that is created during the manufacture of a product by organization *i* can be calculated by summing the value (Y_c^i) that is created at each value-adding step, *c*. This value is the difference between the selling price of the product and the cost of purchased inputs at value-adding step *c*. This difference can be divided into two factors, as the value added that is created at each step can be expressed as a combination of the step's internal expenses (E_c^i) and operating profits (P_c^i) (equation 1):

$$Y_c^i = E_c^i + P_c^i \tag{1}$$

To calculate the total value added of the finished product (Y_M), all of the value-adding steps (Y_c^i) must be summed (equation 2). This total equals the final price of the product before any applicable taxes.

$$Y_M = \sum_{i=1}^{J} \sum_{c=1}^{N} Y_c^i, \quad in\ which \tag{2}$$

$Y_M =$ The sum of value-adding activities, which equals with the final price of the product
$Y_c^i =$ Value-adding activity

To calculate the added value of the researched product, the value-adding steps are calculated. The data provided by the case firm enable us to accurately calculate the product-level value added. This analysis can be repeated for suppliers, for whom the product-level value added is estimated based on company-level information. In total, we recognized six major activity groups into which the value added of the product can be divided: suppliers of material inputs, first-tier suppliers, manufacturing, headquarters, logistics, and distribution. Logistics includes both incoming logistics to the factory and outgoing logistics to the end customer. The value added can be divided further into internal expenses (E_c^i) and operating profits (P_c^i) in both cases.

In cases for which product-level data were not available, the company-level data are used to calculate the operating margin to estimate the component-level operating profit (P_c^i).

$$P\_Margin^i = \frac{Operating\_profit^i}{Net\_sales^i} \tag{3}$$

When the operating margin is known, we are able to estimate the operating profit (P_c^i) by multiplying the operating margin (P_Margin^i) by the component price ($Price_c^i$) at which the focal firm buys the component.

$$P_c^i = Price_c^i * P\_Margin^i \tag{4}$$

Next, the internal expenses (E_c^i) are calculated by subtracting the above profit (P_c^i) from the component-level value added (equation 5).

$$E_c^i = Y_c^i - P_c^i \tag{5}$$

In addition to the above analysis of value added, the value created at each value-adding step can be geographically allocated by region as follows (equation 6):

$$Y_c^i = Y_{c,F}^i + Y_{c,E}^i + Y_{c,N}^i + Y_{c,A}^i + Y_{c,O}^i \qquad (6)$$

where

F = Finland

E = Other EU-27

N = North America

A = Asia

O = Others

The allocation of the case firms' value added is based on the data provided by the company. These data include the allotment of company-generated value added among manufacturing, sales, and other support functions as well as the geographical allotment for these functions. Additionally, most of the manufacturing and R&D locations of the parts have been co-located. Therefore, the geographical allotment of the value added is quite straightforward. If the location information is unknown, then the value added is allocated equally to the regions in which the firm's headquarters and manufacturing facilities are located. In case of the suppliers' suppliers, the value added is equally distributed over the regions.

We utilized a method similar to that described above to calculate the value added of the maintenance and spare part sales. In particular, the analysis of spare part sales uses the information gathered during the analysis of the added value of the product. As the first two stages of the value added analysis are calculated using 2011 data and the product is sold over a 30-year period, inflation must be considered, in addition to changes in the price of the product and services.

The data provided by the company include both sales prices and the direct costs of the product since 2001. Furthermore, a close examination of the data shows that although the average sales price has fluctuated substantially over time, the direct costs have increased almost linearly during the time period (adjusted R^2=0.95 and F-test $p<0.01$). Therefore, in this study, the yearly sales prices are calculated in relation to the direct costs, which have been estimated with regression analysis. The service earnings are also calculated similarly. The value added of each product sold is divided among the different actors and geographic regions according to the calculations described earlier in this section. To account for price inflation, GDP deflators are applied. Furthermore, from 2012 to 2020, the deflators are based on the five-year average from 2007 to 2011. The above treatment of the data enables us to use 2011 price level consistently in our calculations over the product life.

Explaining the results

Analyzing how the value added of the case product is spread through the supply chain allows us to identify exactly which players add value in the supply chain during the product life of a product innovation. In addition, the analysis reveals the geographic distribution of the value added. Finally, we present these distributions separately for the manufacturing and service value chains to explain how they differ.

Table 2 presents the distribution of total value added by each participant over the product life. The data are indexed; hence, the total sum of total value added (100%) equals the sum of sales and after-sales revenue over the lifecycle of the product expressed at the 2011 price level. The prices do not include any taxes. Distribution, which is provided by the area-specific subsidiaries, is the largest creator of value added; this component generates 30% of the total value added. The first-tier suppliers are the second largest contributor of value added (27%) and a larger creator of value added than manufacturing (17%); this difference arises because the case product includes several key components that are sourced from outside providers. Among the six participants, logistics contributes the least value added (5%).

Table 2. Distribution of total value added by the participants

Suppliers of material inputs	First-tier Suppliers	Manufacturing	Headquarters	Logistics	Distribution
14%	27%	17%	7%	5%	30%

Table 3 presents the geographic distribution of the total value added, which is equal to the total value added presented in Table 2. Finland captures the largest share of total value added (31%). The second largest capturer of value added is the category of “Others”, which captures 28% of the value added during the product life. Interestingly, only 4% of the value added is captured in Asia.

Table 3. Geographic distribution of total value added

Finland	EU-27	North America	Asia	Others
31%	21%	16%	4%	28%

Tables 2 and 3 clearly show that although the case product is a Finnish product innovation, neither the case firm nor Finland as a country creates significantly more value than the other geographic areas and actors. There are two important reasons for this outcome. First, 30% of the total value added is created by the distributors i.e. by the sales subsidiaries of the parent company, which are located throughout the world; many of these firms are located in the category of "Others". Second, some of the key first-tier suppliers, which provide components with high value added, and the subsidiary operating the spare parts business are EU-27 firms. Hence, the share of value added from the EU-27 is quite high, although the EU-27 is not an important market area for the case firm. Asia's low share of value added can be explained by these two factors: the case firm does not source key components from Asia, and Asia is not an important market for the case product compared to other geographic areas.

The analysis above has provided a general overview of how value added is distributed. Next, we raise the analysis to another level of detail by separately analyzing the manufacturing value chain and the service value chain. Table 4 shows the distribution of total value added between these two value chains. The manufacturing value chain generates 46% of the total value added of the case product during the product life cycle, and the service value chain generates the remaining 54%.

Table 4. Distribution of total value added – manufacturing versus after-sales services

Total Value Added: Manufacturing	Total Value Added: Services
46%	54%

Table 5 presents the distribution of value added from manufacturing operations across value chain participants. The sum of manufacturing value added is 46% of the total value added. The largest value creator is assembly operations, accounting for 37% of the total, followed by first-tier suppliers and distribution; each of which contributes 21% of the value added. Headquarters contributes only 1% of the value added in manufacturing.

Table 5. Distribution of added value of manufacturing by the participants

Suppliers of material inputs	First-tier Suppliers	Assembly	Headquarters	Logistics	Distribution
17%	21%	37%	1%	3%	21%

Table 6 provides the geographic distribution of the value added from manufacturing operations. This sum is equal to the value added from manufacturing presented in the previous table. Manufacturing is Finland-centric: 53% of the value added from manufacturing is contributed by the Finnish firms. The “Others” category is the second largest contributor with 23%, and the remaining areas each contribute 10% or less.

Table 6. Geographic distribution of the value added from manufacturing

Finland	EU-27	North America	Asia	Others
53%	10%	9%	5%	23%

Tables 5 and 6 demonstrate that although manufacturing creates 37% of the value added from manufacturing operations, more than 50% of the value added is generated in Finland. As the market for the case product is small in Finland, the product innovation contributes to the Finnish economy through suppliers but only marginally through distribution. Despite the rise of Chinese manufacturing, only 5% of the value added from manufacturing operations is generated in China. The reason for this small share is that the assembly of foreign components does not contribute a large amount of added value, and only a small number of case products are assembled in Asia over its product life. The high contribution of the distribution phase can also contribute to explaining why the other countries contribute more than one-fifth of the value added from manufacturing operations.

The distribution of value added from service operations by participants over the product life is presented in Table 7. The sum accounts for a 54% share of the total value added presented in Tables 2 and 3. The distribution participants are the largest value creators; they account for a total of 38%. First-tier suppliers, which supply the spare parts, are the second largest contributors (33%). Manufacturing, which includes the case firm itself, contributes less than 1% of the value added because the service operations occur through the parent company. In addition, the case firm manufactures only those components that normally withstand the full life cycle of the case product.

Table 7. Distribution of the value added of services by the participants

Suppliers of material inputs	First-tier Suppliers	Assembly	Headquarters	Logistics	Distribution
11%	33%	0%	12%	6%	38%

The geographic distribution of the value added from service operations is presented in Table 8. The overall level of value added accounted for is equal to that in Table 7. The largest contributors of value added are the other countries (33%). The EU-27 is the second largest contributor of value added (30%). Only 2% of service value added is generated in Asia, and 13% is generated in Finland.

Table 8. Geographic distribution of the value added from services

Finland	EU-27	North America	Asia	Others
13%	30%	22%	2%	33%

Tables 7 and 8 demonstrate that the manufacturing unit, which designed the product, does not benefit from the service operations because these operations are provided by other entities. Furthermore, most of the value added from service operations is contributed in locations that have strong markets for the case product or that house the suppliers or the parent company. Therefore, only a small share of the value added of service operations is generated in Finland relative to that generated in other geographic areas (e.g., EU-27, North America, or other countries).

Our analyses have shown that the manufacturing firm (i.e., the case firm) contributes value added only through manufacturing operations. The value added from service operations is notable, but it is channeled directly through the case firm's parent company. Hence, in Finland, value added is contributed only by the case firm through manufacturing operations and the suppliers through both manufacturing and service operations. The other geographic areas, except for Asia, generate more value added through services than through manufacturing operations. Distribution activities explain a significant portion of this difference.

Conclusions

The key lessons of this paper highlight the significance of profiting from product innovation from the perspectives of firms and nations. In particular, our granular analysis explains the differences in the division of value added among supply chain participants and in the economic geographies of these two value chains. In addition, the analysis reveals and quantifies the role of services in firm value creation. Furthermore, the described MNE's business models for manufacturing and servitization value chains explain why the added value created by research and development and by manufacturing is limited to the sale of the product. These differences in business models also explain why other affiliates of MNEs capture value related to servitization. Moreover, the above shows that there are further opportunities to investigate the role of manufacturing and servization in value chains, reverting to data from MNE's and a reasonable methodology. Additionally, identifying the profiting from product innovation outcomes in other industries is a great opportunity for future studies.

This article has applied a novel methodology for estimating and analyzing the value added from the manufacturing and servitization aspects of an MNE in a global value and supply chain. This study considered the current physical configuration of manufacturing and servitization value chains and the organizational structure of the MNE. Transfer pricing and accounting practices served as prerequisites to our economic analyses of the case product, which then explored and explained the causal effect of manufacturing and servitization on the value creation of the firm. Furthermore, we found that the value added of the product innovation is not contingent on its appropriability regimes; rather, its complementary assets are more important. In this context, our findings have direct managerial, theoretical, and policy implications.

First, the separate manufacturing and servitization value chain analyses reveal how an MNE leverages two different business models: one model focuses on the sale of a final product, and the other focuses on the servitization of that product. This observation is confirmed by understanding the economic geography of the manufacturing and service value chains. Furthermore, it is important to note the short five-year life of the services after the sale of the final product. Because the service life varies across products, firms, and industries, this implication may be limited in its generalizability. However, we found evidence that these vertically integrated models may provide greater value for firms but do not provide such value for nations. MNE's have multiple opportunities choosing parts of the organization that will serve as a cost and/or profit center(s).

Second, manufactured products serve as complementary assets to a product's service operations. This finding reveals the MNE's motivations for manufacturing and selling products to the end customers. The case firm maintains its role as a manufacturer of the product and provides related services. This specific product innovation has increased value added for the firm and for different nations for more than 40 years. The limitation of this implication is that the appropriability regimes and the relevance of complementary assets vary across products, firms, and industries. Nevertheless, we partly disagree with the observation of Dedrick et al. (2009), who claimed that the lead multinational firm bears the primary responsibility for maximizing value added, which it then shares with its stakeholders. For the service life of a product, this claim might not be applicable; that is, during the service life, the division of value added to each stakeholder does not depend on the relative bargaining power of each firm.

Third, country-specific policies can affect the decisions of MNEs and thus influence the division of value added among participants and geographic areas. The division of value added across geographic areas can be significantly altered by changing the country in which the ownership of the global service operations is located. Currently, there are neither national- nor global-level policies in place to dictate how such a change should be executed. Furthermore, the division of value capture among participants (e.g., global sales organizations and distributors) is dependent on each particular MNE's policies regarding the value capture mechanism. This finding partly confirms the observation of Seppälä and Kenney (2012) with regard to the multiple opportunities that an MNE encounters when choosing parts of the organization that will serve as a cost or profit center. Moreover the results of the analyses indicate that the MNE's appear to be ahead of the game, and national and global policies are lagging behind. Hence, there are many possibilities and individual countries, but also international organizations can influence these decisions with their policies.

Finally, our analysis has a broader policy implication. Our findings highlight the irrelevance of the lingering discussion distinguishing manufacturing from service. The value added that is accounted for by manufacturing has a significant business service component. Similarly, the value added that is accounted for by services has a significant tangible component. From that perspective, international commodity trade statistics continue to be highly misleading from economic analysis perspectives. Indeed, concerted international efforts should be made to develop trade statistics based on the trade of goods and of services. Although complementing the goods trade statistics with service trade statistics and the balance of payment information should be helpful in principle, this practice does not currently appear to be common.

In general, we have demonstrated that understanding value chains at the micro level provides insights into the globalization process and related trade statistics. Furthermore more granular value chain analyses and considerations bring out may be more valuable details about the contemporary globalization. Moreover, the empirics related to MNE business models and general modes of operation are crucial for understanding the phenomenon of PFI at both the national and global levels.

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