Global supply chains and transfer pricing
Insights from a case study

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Abstract

Purpose – The purpose of this paper is to integrate the issue of transfer pricing and logistics costs to understand trade statistics and the operation of supply chains by using invoice-level data for a single globally sourced product of a multinational firm. Supply chains are central to understanding wealth creation and capture in an increasingly globalized production system. The increasing disaggregation and dispersal of supply chains is profoundly affecting the geographical distribution of value added, input costs and profits of multinational firms. This suggests that understanding supply chains and where the activities and accounting for these activities take place is crucial for understanding the causes and consequences of contemporary globalization.

Design/methodology/approach – By using a case study of a single product and invoice-level data, it was possible to capture the actual costs incurred by a firm using a relatively simple global supply chain. The authors show how corporate intra-firm transfer pricing determines which business unit and location captures profits. A single firm provided the core data in this paper, including product- and firm-level information on intermediate product prices and input costs for all internal transfers.

Findings – This paper advances interesting insights into trade in value added and shows that, though not often considered significant, transfer pricing is a critical issue for understanding the geographical distribution of value added. The authors conclude with some observations about the nature of global supply chains, the value of international trade statistics and a hidden advantage of an integrated firm operating on a global scale the ability to somewhat arbitrarily select the activities to which profits should be allocated. For nation states, as supply chains become more international and complex, critical measures, such as gross domestic product, worker productivity, etc., are becoming ever more imprecise. The economic geography of cost of inputs and profits continue to separate as multinational enterprises drive the disaggregation of value creation and value capture.

Research limitations/implications – The case study facilitates an understanding of complex supply chain issues, thereby extending and deepening findings from previous research. This case study of transfer pricing in supply chains will assist other scholars in better formulating testable propositions for their studies and sensitize them to the internal complexities corporate managers face when making operationalizing decisions.

Originality/value – The case study suggests that understanding the configuration of and accounting in supply chains is vital for accurately measuring any national economic statistics. This case study provides some bottom-up evidence that national accounts and international trade economics undertaken without a deep understanding of supply chain organization is likely to generate misleading results. The methodology of using invoice-level data can provide a more granular understanding of how supply chains are organized and where the value is added and captured. For practitioners, the data suggest that firms should think very carefully about which of their activities generate the most value, and value those accordingly.

Keywords International trade, Globalization, Value added, Transfer pricing, Value chain, Manufacturing industries, Global supply chain management, Global division of labor

Paper type Research paper

Introduction

Less expensive transportation, real-time communications and reduced trade barriers have loosened the "coordination glue" anchoring many job tasks in close proximity (Baldwin and Venables, 2010; Baldwin, 2011). This development has meant the dispersion of job tasks and presumably value-adding and supply chain activities and their resultant profits

internationally and across firm boundaries (Ernst and Kim, 2002; Kenney and Florida 2003; Mudambi, 2008; Ali-Yrkkö, 2010; Ali-Yrkkö *et al.*, 2011). While international trade traditionally consisted mainly of the trade of finished goods and extracted raw materials, trade is increasingly a trade of goods-in-process (Grossman and Rossi-Hansberg, 2008). There has been a concomitant increase in international trade of goods-in-process internal to individual firms (Clausing, 2000).

Stages of supply chains are increasingly distributed internationally as activities are situated according to a complex set of decision variables, including labor availability and cost, transportation and inventory costs, quality considerations and proximity to appropriate suppliers and end customers (Tan *et al.* 2002; Kenney and Florida 2003; Buckley and Ghauri, 2004; Gereffi *et al.*, 2005; Creazza *et al.*, 2010). And yet, aside from a few electronics products, such as mobile phones and personal computers (Dedrick *et al.* 2009, 2011; Ali-Yrkkö *et al.*, 2011), little is known about how accounting decisions that determine where single firms capture their profits along the supply chain[1].

The foundation of this paper is that the accounting decisions, supply chain designs and respective transfer pricing mechanisms of a multinational enterprise (MNE) play a role when considering international trade in value added and the geographical distribution of the value added in global supply chains. Hence, our key motivation is to discuss and to address the differences in the economic geography of input costs and profits by answering the research question "How important is profit as a variable that can be used to measure value added?"

To address the general lack of knowledge about where value is created and where profits are captured, we report, on an invoice level, a global supply chain analysis for a single precision machinery product. This product is manufactured internally in six separate modules and is then assembled for the final delivery to the customer by an enterprise with assembly facilities and customers in three macro regions: Northern Europe (Finland), Asia (China) and North America (USA).

Because this analysis is based on invoice-level internal data, it contributes to a new understanding of transfer pricing and the location of profits in global value and supply chains. In this context, how multinational firms implement their transfer pricing plays a significant role. Recently, bottom-up methodologies based on an examination of the costs and geographical sources of specific products have received increasing attention (Linden *et al.*, 2009; Dedrick *et al.*, 2009, 2011, Ali-Yrkkö, 2010; 2011; Shih *et al.*, 2012). This study follows this tradition by focusing on a single product. Our research extends previous studies in four ways: first, our data, which are based on the actual invoices for inputs, allow for the division of a firm's value added into two parts, input costs (labor cost and supplies, both tangible and intangible) and profits. Using the MNE's cost, accounting and transfer pricing data, the firm's value added, input costs and profits at each step of the global value and supply chain are calculated. Second, with these data, it is possible to establish the geographical location of both the inputs and the profits. Third, due to the granularity of the data, it is possible to understand how transfer pricing is manifested. Finally, we conclude that MNEs have multiple ways of accounting for the activities that generate their profits, which can result in a wide variety of transfer-pricing schemes. This fact inherently limits the generalizability of this case study; however, in exchange for the lack of generalizability, we provide insights resulting from the granularity of the data and the methodology.

The paper proceeds as follows. Section 2 examines previous research on global value and supply chain design and transfer pricing in MNEs. Section 3 describes the industrial setting, and Section 4 describes the data. In Section 5, we analyze the data and present the empirical analysis. The concluding section discusses the results and suggests further research opportunities.

Intra-firm trade, transfer pricing and supply-chain design

Global supply chains are composed of trade in goods and trade in tasks because flows of content, knowledge-intensive work are separate from the flows of physical components, intermediates, and final goods (Baldwin, 2006, Baldwin, 2009; Grossman and Rossi-Hansberg, 2008). Value added is important because the condition of a national economy is measured by the gross domestic product (GDP), which is the sum of the value added by all organizations in a national economy. And yet, the nature of global supply chains is making GDP ever more difficult to measure because value added is defined as gross output minus intermediate consumption; therefore, it is important to know where the value added is created. Value added is divided into the input costs and profits for both intangible and tangible assets (Mudambi 2008). However, the dynamics of goods and task dispersion and their impact on value added and profit disaggregation vary between industries and even MNEs (Hirshleifer, 1956; Christopher and Ryals, 1999; Vidal and Goetschalckx, 1999).

When considering the geography of production and the respective supply chains, it is possible to distinguish between vertical production networks, in which a firm exports inputs from its home nation to be assembled in an affiliate factory abroad and then reexported to multiple destinations and horizontal production networks, in which a firm establishes a plant in a nation to produce and process inputs for that nation. In the traditional vertical production network, a common corporate strategy has been to build capital-intensive inputs in the home country and perform the labor-intensive work in the host nation (Hanson *et al.* 2005). Using aggregate US Government data, Hanson *et al.* (2005)found that the:

> [. . .] demand for imported inputs is higher when affiliates face lower trade costs, lower wages for less-skilled labor (both in absolute terms and relative to wages for more-skilled labor), and lower corporate income tax rates.

These results are intuitive, but at an aggregate level and cannot provide insight into issues such as the role of transfer pricing that can shape multinational firms' supply-chain decisions and where value added, input costs and profits occur. Analyzing not only where activities are undertaken but also where the firm accounts for costs and profits, facilitates a more complete picture of the strategies firms use in managing their supply chains. Shedding light on this issue is important because firms have considerable freedom, within certain limits (such as having a presence to which the profit can be

attributed), in choosing where to book profits (Vidal and Goetschalckx, 1999; Shelanski, 2004).

The supply-chain literature has focused more on the operationalization aspects of supply chains (for supply chain management literature see Mentzer, *et al.*, 2001; Sacham and Datta, 2005; Frankel *et al.*, 2008; Mentzer *et al.*, 2008; Stock *et al.*, 2010). Another parallel literature that we draw on conceptualizes the supply chain as a "value chain". These scholars use the terminology of value added (which is the sum of the input costs and profits at any node in the value chain) and value capture (which is profits at any node in the value chain) rather than costs (all input costs) and profits (which are the sales price minus all costs) because they have been concerned with determining which nations undertake which activities (for global value chain literature, see Gereffi, 1994; Gereffi, 1999; Henderson *et al.*, 2002; Gereffi *et al.*, 2005; Gibbon *et al.* 2008; Dedrick *et al.* 2009; Gereffi and Lee, 2012). For firms, the issue is supply-chain design and profits, which can only be realized when the goods or service being produced is sold to a customer. Value is added at different stages in the process by different firms and in different nations; however, the profits of all internal activities are only realized on final sale. If all the steps in a supply chain were entirely separate entities, transfer pricing would not be feasible because a payment would be made at each step. To explore these issues, we use input costs, including transfer prices and overall profits. More importantly, we shed light on how a firm actually creates value and exerts power in the supply chain.

An MNE transfer-pricing mechanism is typically determined by the headquarters and actualized in accounting (Eccles, 1985; Kaplan and Atkinson, 1989; Edlin and Reichelstein, 1995; Shelanski, 2004). As Shelanski (2004) indicates, transfer pricing is one of the key components of how MNEs manage and structure all intra-firm transactions and how the costs of resources and profits are allocated among different business units and different geographies. Classically, the transfer price set by the headquarters reflects a globally agreed upon standard cost of the specific activity related to the product at that step. The transfer price, based on the standard cost, can express either profits or losses in a particular node in the overall internal supply chain. Typically, if the transfer price is determined by the profit center, it includes profits. Cost-based supply chain analyses cannot capture transfer pricing and are unable to determine where firm profits are generated and/or allocated. Ultimately, the transfer price mechanism is dependent on an MNE's strategy and structure. For MNEs, value-added and profit mechanisms are planned and executed under the rules and regulations set by the Organisation for Economic Cooperation and Development (OECD) and a local nation's taxation authorities[2]. In practice, the execution of these rules and regulations offers enormous scope for interpretation. By understanding the global supply chain and MNEs' transfer pricing mechanisms (i.e. the way multinationals control and execute their business operations and organize their supplier relationships and the locations of production and where profits are captured), it is possible to better understand the inner workings of corporate supply chains.

The exact amount of value added is determined at every point of sale, both internal and external, in a global supply chain (Shelanski, 2004; Lepak *et al.* 2007). Utilizing transfer pricing mechanisms Bowman and Ambrosini (2000) and Shelanski (2004) explain how the value-added and profit processes, respectively, are organized in global supply chains. However, the previous mainstream literature[3] in supply chains, as indicated by Power, (2005), Sacham and Datta (2005) and Joyce (2006), does not use these types of concepts, definitions, theories, rules and principles from other research disciplines. In contrast, the supply chain management literature extensively discusses transfer pricing (Hirshleifer, 1956; Stevens, 1989; Christopher and Ryals, 1999; Vidal and Goetschalckx, 1999; Sacham and Datta, 2005). This paper contributes to the extant literature on global supply chains by focusing on the specifics of value-added analytics from the perspective of transfer pricing in supply chain management. Moreover, this paper defines the economic geographies of added value, input costs and profits; in contrast, earlier literature and empirics have focused on the international trade in value added and the corresponding statistics.

Industrial setting – the precision machinery industry

The global value and supply chain literature have examined a wide variety of industries, ranging from textiles and electronics to food processing (Gereffi, 1994; Bridge, 2008; Kenney, 2012). Far less attention has been given to producers' goods such as precision machinery, which includes a wide variety of capital goods. As a capital good, precision machinery is not generally mass-produced in enormous quantities, and technologically it evolves more slowly than products such as garments and electronics (Fine, 1998, 2000; Sturgeon *et al.* 2008). Typically, precision machinery reflects deep technological expertise in terms of hardware, embedded software and other product-specific knowledge that comes from different individuals including engineers, technicians and, frequently, skilled crafts persons.

Geographically, developed nations are the most significant exporters of precision machinery, while developing nations, such as China, typically have been large importers of precision machinery (Kenney, 2012). More recently, due to cost pressures and the enormous size of the Chinese market, precision machinery firms have begun manufacturing in China, although their Chinese factories usually produce lower-end, mass production machines that are sold in price-competitive market segments or lower value-added modules. In contrast, newer higher value-added machines and key modules containing significant intellectual property and know-how continue to be designed and produced in Finland. In this way, the highest value-added activities are retained in advanced economies. In this case study, while the highest value-added activities are retained in the advanced economy, the profits are not attributed to this particular segment of the supply chain.

Historically, precision machinery firms, such as ours, operated from and manufactured their products within a single nation, though sales were often global. Further, most suppliers were located in close proximity to their national manufacturing units. More recently, the globalization of markets has pressured firms in this sector to globalize their production. In this particular case, while production

globalized, the firm's accounting system did not change and no longer reflects where the value added and respective key intellectual property are created[4].

Data description

The core data in this study were provided by the firm and included product- and firm-level information on intermediate product prices when transferred within the firm. The data were collected during six in-depth interviews at the firm headquarters between January 2011 and December 2011. Each interview/workshop lasted two to five hours and included one to six participants and two research team members. The interviews were followed up with telephone calls and emails to complete the data collection. The primary sources of financial information were the chief financial officer and the business unit controller; however, purchasing directors and managers also participated in the majority of the interview sessions. These semi-structured interviews were used to gather product-specific financial data, including:

- sales pricing and intra-firm transfer pricing data (e.g. invoicing data between corporate headquarters and manufacturing units and invoicing data between different manufacturing units);
- the firm- and plant-level income statements and balance sheets; and
- the bill of materials, including each component's price, the name of the supplier and the country of design, manufacture and distribution. In contrast to nearly all other studies, the firm also provided transportation and inventory carrying costs. In return for the firm's participation, both the firm and the respondents were granted anonymity.

The firm also provided information on the costs of all inputs purchased from its external suppliers, distributors and retailers as well as material breakdown estimates of all components. Because the firm had limited information concerning upstream suppliers and their suppliers and components, the research team used the suppliers' financial statement data and balance sheets, as reported in the ORBIS database by Bureau van Dijk Electronic Publishing (DvDEP). All financial statements, balance sheets and press releases available for each firm that was identified as a direct supplier or direct competitor were examined.

These data allow calculation of the value added, input costs and firm profits for the product (for the calculation methodology, see the Appendix 1). This particular product is composed of six separate modules that are produced internally. There is a distinct division of labor, with five of these modules produced exclusively in China and one produced exclusively in Finland. The modules are shipped to assembly facilities located in Finland, the USA and China. The total number of components for the entire product is approximately 500.

The firm is approximately 100 years old (see Table I for a summary of the firm's characteristics) and produces multiple products that are sold globally. For each product, the firm has manufacturing units on at least two continents. Each plant has local and international customers. Using Gereffi *et al.* (2005)'s

Table I Firm overview

Supply chain stakeholders	The case firm
Headquarters	Finland
Founded	Early 1900s
Industry classification	Industrial machinery
Annual revenues	> 1,000 M€
Off-shoring activity	High and internal
Manufacturing locations	Finland, China, USA; each handles regional distribution
	Finnish and Chinese factories are equal in size, US factory is smaller
Internal and external supply chain	Asia-centric supply chain
Production capacity	10 per day. Within each factory, this product represents a medium share of the total factory production capacity
Price per item	10,000€ (indexed)
Outsourcing activity	Purchased inputs are a low percentage of the total cost and are governed by manufacturing partnerships

model of supplier relationships, our firm operates using hierarchical (internal), relational and market relationships.

Empirical analysis and results

Our detailed product-level and firm-level data enable us to analyze value added, input costs and profits for a significant portion of the supply chain and to examine how the value added is divided between different participants and locations in the global supply chains. First, we examine how the value added in the global supply chain is divided between input costs and profits for each manufacturing location. Second, we illustrate how the value added, input costs and profits differ among manufacturing locations. Third, we present the geographical distribution of the value added, the input costs and the profits in each of the three nations within which the firm operates.

Input costs versus value capture

The product is standardized, and a significant part of its production and other activities are located outside of Finland. The final customer price is the same in Europe, Asia and the USA. The suppliers are mainly located in China, from where they serve Finland-, China- and USA-based manufacturing units. As mentioned earlier, the final product consists of six sub-assemblies that are assembled at a factory in each of the three global macro regions. Figure 1 demonstrates that there is a simple division of labor, with five sub-assemblies produced solely in China and one sub-assembly produced solely in Finland. These two factories supply the three regional final assembly facilities.

Final assembly – Finland

In Table II, the total sum of the value added equals the product sales price of the firm (e.g. 10.000€ (indexed) = 100 per cent of value added). The final product sales price is without taxes. The sales price of the product is then divided

Figure 1 Supply chain with final assembly

----> Logistics Cost; VA = Value Added; SA = Sub-Assembly
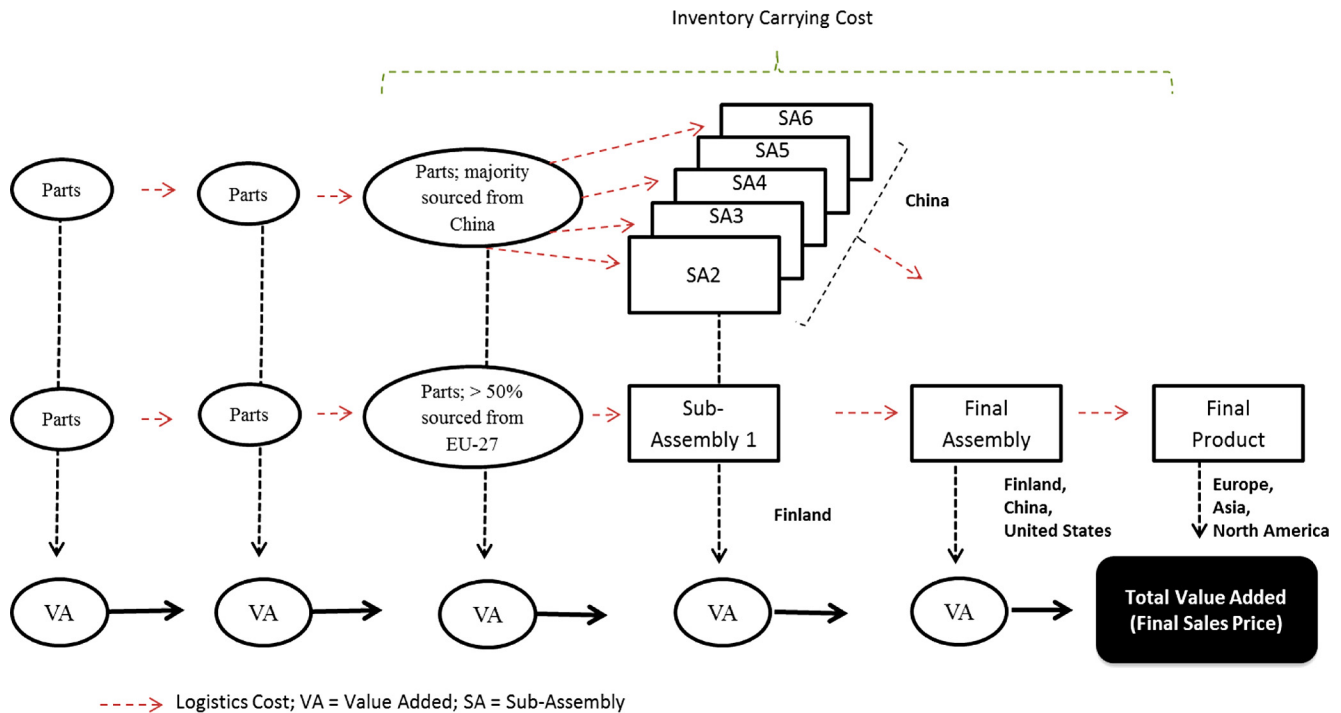
between the different participants in a global supply chain according to the data received from the focal firm and data inferred regarding suppliers (see value added column in Table II). In the case of the firm, when the product is manufactured in Finland and distributed to the European market, manufacturing is the largest contributor of value added. There are two separate operations: the production of sub-assembly one (sourced in Finland) and the final assembly. In this case, the five other sub-assemblies are imported from the firm's Chinese factories as are the parts necessary for the final assembly. Nearly all of the Asia-sourced components are low-technology standard inputs.

As Table II indicates, when the product is manufactured in Finland and distributed to European markets, the inputs are 65 per cent (6.500€ indexed) of the total cost of the finished product, while profits comprise 35 per cent (3.500€ indexed) of the total cost. The actual input costs and profits are then

Table II Distribution of input costs and operating profit in Finland

Supply chain stakeholders	Total cost (in per cent) (10.000€)	Input costs (in per cent) (6.500€)	Profits (in per cent) (3.500€)
Sales and distribution	10	16	−1
Outbound logistics	4	6	1
Headquarters	3	5	0
Manufacturing (module and final assembly)	49	26	90
Inventory carrying cost	1	1	0
Inbound logistics	7	9	1
Tier one suppliers	9	12	5
Lower-tier suppliers	17	24	4

distributed among the global supply chain participants according to the data received from the case companies (see input costs and profit columns in Table II). In the accounting system, because the final assembly is treated as the profit center, it appears to produce the bulk of the profits. Because all of these operations are internal, through using invoices that attribute profits to various operations, we cannot ascertain the location of the highest value-added activities. Because there is no market for the various sub-assemblies, there is no external market comparison.

Final assembly – China
The firm's operations in China differ from those in Finland. China produces five of the modules and undertakes the final assembly for the Asian market (depicted in Figure 1). Sub-assembly 1 is exported from Finland to China to be included in the final product. When the product is manufactured in China and distributed to the Asian market, manufacturing is the largest contributor of value added, at 54 per cent (see Table III). The actual share of the input costs is 42 per cent (4.200€ indexed) of the total value added, and profits are 58 per cent (5.800€ indexed) of the total value added. Manufacturing continues to be the largest input cost. Given its low input costs and the ability to sell the product for roughly the same price in Asia as elsewhere in the world, the Chinese assembly operation appears to have excellent profits.

Final assembly – North America
The US operation differs from those in Finland and China in that it only undertakes the final assembly. Five modules are imported from China, and the remaining one is imported from Finland. When the product is final-assembled in the USA and distributed to the North American market, manufacturing

Table III Distribution of input costs and operating profit in China

Supply chain stakeholders	Value added (in per cent) (10.000€)	Input costs (in per cent) (4.200€)	Profits (in per cent) (5.800€)
Sales and distribution	14	8	19
Outbound logistics	3	7	0
Headquarters	3	6	0
Manufacturing (excluding headquarters)	54	23	77
Inventory carrying cost	3	7	0
Inbound logistics	2	5	0
First-tier suppliers	7	16	2
Lower-tier suppliers	12	28	2

contributes the greatest proportion of value added, at 35 per cent (see Table IV). The actual share of the input costs is 82 per cent (8,200€ indexed) of the total value added, and profits are 18 per cent (1,800€ indexed) of the total value added. Manufacturing and inbound logistics are the largest input costs. The US assembly operation has higher logistics and inventory carrying costs compared with Finnish and Chinese assembly operations because all subassemblies and components are imported, and therefore, it reports far lower profits.

National distribution of value added and input costs

When we shift our perspective from that of the firm to that of the nation, a different pattern is observed (see Table V). If the final assembly is undertaken in Finland, then 64 per cent of the total value added occurs there. In the case of final assembly in China, 77 per cent of the total value added occurs there, and if final assembly occurs in the USA, 50 per cent of the value added occurs there. Because suppliers are small and, for the most part, provide standardized parts and because profits are allocated to the assembly factory, the location of the final assembly has a significant impact on the perceived location of the value added. To illustrate this point, the Finnish share of value added drops from 64 to 15 per cent if the location of the final assembly is China and to 18 per cent when the final assembly is in the USA. In China, this result is due to the large number of modules and other components sourced from

Table IV Distribution of input costs and operating profit in the USA

Supply chain stakeholders	Value added (in per cent) (10.000€)	Input costs (in per cent) (8.200€)	Profits (in per cent) (1.800€)
Sales and distribution	8	13	−14
Outbound logistics	3	3	1
Headquarters	3	4	0
Manufacturing (excluding headquarters)	35	24	84
Inventory carrying cost	3	3	0
Inbound logistics	13	14	6
First-tier suppliers	12	14	12
Lower-tier suppliers	22	26	11

China. In the case of the US assembly, this result is due to the fact that there are few local suppliers. From this perspective, Finland and China have a similar share of the total value added: 18 per cent. This result is paradoxical because the assembly factory undertakes the simplest functions and requires fewer trained personnel, particularly when compared with the Finnish sub-assembly factory.

From an overall perspective, the high value added attributed to Chinese operations is the result of two processes. First, the transfer of sub-assembly manufacturing operations to China means that an increasing portion of the entire product is produced there. Second, because the profits are assigned to the final assembly facility, it appears as though China has high value added. While the US operation appears to have high value added, a significant portion of this value added consists of logistics and inventory costs, which, of course, are not value added in the normal sense of the term (for a discussion of the costs of logistics, see Lorentz *et al.*, 2012). In summation, if the product is assembled in Finland, the product's value added is 65 per cent of its total inputs and 35 per cent of its value capture. When the product is manufactured in China, the product's value added is 42 per cent of its total cost of resources and 58 per cent of its value capture. Finally, if the product is assembled in the USA, the value added of the product consists of 82 per cent of its total cost of resources and 18 per cent of its value capture.

The differences between the three final assembly locations and how the input costs are distributed internationally are shown in Table VI. If the final assembly is located in Finland, then 48 per cent of the total input costs are derived from Finland. In the case of China, 48 per cent of the total input costs are national. For the USA, this percentage declines to 47 per cent. This result indicates that the location of the final

Table V Geographical distribution of value added (Finland versus China versus USA)

For product assembled in:	Value added–Finland (in per cent) (10.000€)	Value added–China (in per cent) (10.000€)	Value added–USA (in per cent) (10.000€)
Finland	64	15	18
China	11	77	18
Americas	2	0	50
EU-27	19	6	8
Other	4	3	5

Table VI Geographical distribution of input costs (Finland versus China versus USA)

For product assembled in:	Costs of inputs from Finland (in per cent) (6.500€)	Costs of inputs from China (in per cent) (4.200€)	Costs of inputs from the USA (in per cent) (8.200€)
Finland	48	32	20
China	14	48	19
Americas	3	0	47
EU-27	28	13	8
Other	6	6	6

assembly has a significant impact on input costs, which is most evident in the case of the final assembly in the USA, where inventory carrying and logistics costs are significant.

The geographical distribution of the profits reflects the firm's decision to allocate profits to the final assembly. This fact is illustrated in Table VII. For example, if the final assembly occurs in Finland, then Finland appears to generate 92 per cent of the total profits. When the assembly occurs in China, China appears as though 98 per cent of the total profits are generated in China, despite the fact that the single most valuable module is produced in Finland. In many respects, the most remarkable result is the case of the US assembly, which is shown to be responsible for 63 per cent of the profits, even though it only performs the final assembly. The details of the geographical distribution of the profits are explained in Table VII. The operation's US profits appear high, even though its logistics and inventory costs are large and the USA performs only simple assembly. This example is an artifact of the firm's decision to account for profits at the assembly operation.

Discussion

In this paper, we have identified and illustrated the need for new measures of trade statistics in the industrial era of the second unbundling: trade-in-added-value measures can be further subdivided into trade-in input costs and trade-in profits to understand the manner in which MNEs actually operate in global supply chains. Furthermore, we have identified and illustrated the role of transfer pricing by parsing added value into input costs and profits in the different stages of global manufacturing networks and their locations. By examining the ways in which a corporation accounts for and reports its costs and profit, we contribute to both supply chain analysis and international trade theory. By considering added value, input costs and profits, a more realistic picture of the operation and accounting in a global supply chain emerges. For those analyzing global supply chains, we show that it is important to identify and include the effect of transfer pricing in separating added value into input costs and profits among the different nodes in a global manufacturing network.

The single most surprising finding is that the MNE's accounting system and transfer pricing mechanism do not necessarily represent where the most valuable assets of the MNE are located. This is due to the fact that our firm previously had manufactured its products in one single nation and had only recently globalized its operations and supply chain. One explanation for this finding would be that the firm's accounting system and transfer pricing mechanisms are simply lagging

Table VII Geographical distribution of profits (Finland versus China versus USA)

For product assembled in:	Profits–Finland (in per cent) (3.500€)	Profits–China (in per cent) (5.800€)	Profits–USA (in per cent) (1.800€)
Finland	92	2	12
China	5	98	17
Americas	0	0	63
EU-27	2	1	7
Other	1	0	1

behind reality. However, this suggests that, given the significant number of firms that have built global supply chains and the many more that will do so in the future, today's trade statistics may be seriously misleading and in the future, they may become even more misleading. One bold assumption by top-down trade economists might assert that this is not a problem because, given the variety of firms, the discrepancies will cancel each other out. However, it may be equally true that the data are skewed in significant ways. Moreover, such data skewing could be industry-specific, thereby further disturbing analyses and leading to erroneous conclusions.

As a case study, our results have significant limitations. First, this is a case study of a single product built in multi-product factories; thus, in these factories, managers may have more and less profitable products. However, in our case, this product was one of their most profitable. While this firm allocates nearly all profits to the final assembly, other firms may have entirely different strategies, such as allocating profits to headquarters and R&D, to offshore tax havens, or to the marketing and distribution functions. Therefore, the generalizability of our results may be quite limited. Yet, the results show that the share of profits is a significant variable when considering value added; therefore, the current methods of measuring trade in value added can easily mislead decisions and policy makers.

Based on the interviews and invoice-level component data, we know that the Finnish module has the highest value-added components and software and is the focus of corporate R&D. This finding suggests that the allocation of the "profits" to the assembly facilities provides an unrealistic impression of where the greatest value is added and where the firm's profits are generated. This fact disguises the true role of the Finnish module not only in generating the overall profit but also in ensuring that the firm retains control over the supply chain. Further, from the perspective of the supply base, the production of the key module in Finland provides markets for European suppliers.

There are also national and regional implications. First, while some scholars suggest that developed nations should be the location of higher value-added activities, the US factory is a kit assembly operation that shows high profits. With the low-cost modules produced in China and the high-cost module built in Finland, the US factory appears to have little potential for upgrading. This finding suggests that industrial recruitment campaigns to increase "manufacturing" employment should be careful in regard to what specific nodes in the supply chain are being courted. With regard to China, the Chinese operations appear to have a limited ability to upgrade their production due to the centralization of the value added in the Finnish module.

The appearance of profitability is interesting in its own right. Due to transfer pricing, the Chinese operations appear to be the most profitable ones because five modules are produced domestically and thus have small inventory and shipping costs. From an accounting perspective, China appears to be the most successful and important operation. This result is a creation of the accounting system, not the reality of where the true value is created.

Supply chain managers have long known that inventory and logistics costs are real and have a significant impact on overall profitability. Despite this fact, in nearly all previous studies, these costs have been either imputed or simply included in residual

costs. Locational decisions affect these costs. At the risk of repetition, the US assembly operation was the most dramatic example. Because it received all modules from China and Finland, this operation had the highest input costs. Most striking were its inventory and logistics costs of €2,050; in comparison, these costs were nearly half of those in Finland (€1,040) and less than half of those in China (€798).

This firm, as we believe is the case with many other firms in the producer goods' industries, took a quite different road than firms in electronics and garments that long ago outsourced a large part or nearly all of their assembly activities. While our firm has relocated the production of the five less technically sophisticated modules to China, it continues to produce them in a subsidiary. Despite retaining the most important module in Finland, the accounting system and transfer-pricing mechanisms have not allocated profits to Finland, where the firm's most valuable assets and greatest apparent value addition are located. Interestingly, the firm did not choose to create a tax haven subsidiary in a nation such as Singapore for tax-reduction purposes. Because our firm has globalized relatively recently, our paper suggests that its accounting systems may lag or misrepresent where value is created and where value is recognized. This fact may not have been important when both the assembly and the key module assembly were centralized in Europe; however, with global operations, this decision may be causing a greater mismatch with reality. This case study suggests that top-down national income accountants or international trade economists that do not consider the learning from supply chain researchers are likely to mis-specify their models and misunderstand the reality of the global economics. With global supply chains becoming ever more complex and dispersed, transfer pricing will only become more important for firms and nations.

Notes

1 For example, it is common knowledge that many US firms have booked enormous amounts of profit offshore to avoid US taxes; however, there is little known about the internal accounting that makes this possible (US Senate 2012).

2 See, for example, the OECD Transfer Pricing Guidelines for Multinational Enterprises and Tax Administrations (22 July 2010).

3 On the supply chain management literature, see Ellram and Cooper, 1990; Cooper and Ellram, 1993; Harland 1996; Houlihan, 1987, 1988; Mentzer *et al.* 2001; Tan, 2001; Burgess *et al.*,2006; Kanda and Deshmukh 2008; Christopher *et al.* 2006; Christopher, 2010; Creazza *et al.*, 2010.

4 Until the early 2000s, this firm undertook all production in Finland, and then exported the finished product.

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Appendix 1

Value added, input costs and profit calculation methodology

At each value-adding step c, an organization i purchases inputs, conducts its own value-adding activities (Y_c^i) and sells its output to the next node in the supply chain. The value added of each step equation (A1) is the combination of the step's input costs E_c^i and its operating profits π_c^i:

$$Y_c^i = E_c^i + \pi_c^i \qquad (A1)$$

The sum of all value-adding steps equals the final price (Y) before any applicable taxes equation (A2):

$$Y = \sum_{i=1}^{J} \sum_{c=1}^{N} Y_c^i \qquad (A2)$$

For each firm in the supply chain, we calculate the value added, which is the difference between the input costs (i.e. the costs of inputs purchased by an organization) and the price for which it sells the output (for suppliers, this cost is imputed). For the case product, we are able to calculate accurate product-level value added (Y_c^i) as well as its two components (E_c^i) and (π_c^i). For suppliers, our data allow USA to impute the product-level value added (Y_c^i), but not its division into (E_c^i) and (π_c^i). To approximate these product-level figures, we use firm-level data as follows. First, we calculate the operating margin at the firm-level equation (A3):

$$\pi\_MARGIN^i = \frac{operating\_profit^i}{Net\_sales^i} \qquad (A3)$$

Second, we approximate the component-level operating profit (π_c^i) by multiplying the firm-level operating margin (π_MARGIN^i) by the component price ($PRICE_c^i$) at which our focal firm purchases the input:

$$\pi_c^i = \pi\_MARGIN^i x PRICE_c^i \qquad (A4)$$

Then, we subtract this product-level profit from the component-level value added to obtain the internal expenses at the component level equation (A5):

$$E_c^i = Y_c^i - \pi_c^i \qquad (A5)$$

To estimate the geographical breakdown of the product's value, we allocate the value added, internal expenses and profits in step Y_c to each region equation (A6):

$$Y_c^i = Y_{c,D}^i + Y_{c,E}^i + Y_{c,N}^i + Y_{c,A}^i + Y_{c,O}^i, \qquad (A6)$$

where

D = Finland
E = Other EU-27
N = North America
A = Asia
O = Others.

The data include invoice information concerning the firm's generated value added in its manufacturing, sales and other support functions in each region and the transfer price for all intra-firm transactions. The data also include the manufacturing and R&D locations for nearly every component used in the final assembly and locational information for the majority of the parts used in the sub-assemblies. The great majority of these components are simple metal components, such as flanges and metal plates. Thus, their allocation to various regions is straightforward. In cases without detailed locational information, we allocate the inputs and profits of that component or value-adding step equally to a region where the component manufacturer's headquarters and manufacturing units are located.

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