

# Part I

## Changing features of global value chains



# 1 Global supply chains: why they emerged, why they matter, and where they are going

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## 1.1. Introduction

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Global supply chains have transformed the world. They revolutionized development options facing poor nations; now they can join supply chains rather than having to invest decades in building their own. The offshoring of labour-intensive manufacturing stages and the attendant international mobility of technology launched era-defining growth in emerging markets, a change that fosters and is fostered by domestic policy reform (Cattaneo et al., 2010 and Baldwin, 2011b). This reversal of fortunes constitutes perhaps the most momentous global economic change in the last 100 years.

Global supply chains, however, are themselves rapidly evolving. The change is in part due to their own impact (income and wage convergence) and in part due to rapid technological innovations in communication technology, computer integrated manufacturing and 3D printing.

This paper looks at why global supply chains (GSCs) matter, the economics of their unbundling and their implications for policy. It finishes with a discussion of factors affecting the future of global supply chains. The paper begins by putting global supply chains into historical perspective.

## 1.2. Three centuries of globalization: GSCs in perspective

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Globalization is often viewed as driven by the gradual lowering of natural and man-made trade costs. This is a serious misunderstanding.

Advances have driven globalization in two very different types of “connective” technologies: transportation and transmission. These have dramatically different implications, but understanding why requires some background.

### ***First unbundling: steam made it possible, scale economies made it profitable***

In the pre-globalization world, each village made most of what it consumed. Production and consumption were forced together by poor transportation technology. The steam revolution, especially railroads and steamships, made it feasible to spatially separate production and consumption with this starting from the 1830s and accelerating in the 1870s (the Trans-America line was completed in 1869). Once feasible, scale economies and comparative advantage made separation profitable. This transformed the world.

Globalization’s first unbundling was marked by five top-line facts:

#### ***North industrialization and South de-industrialization***

The “North” (Europe, North America and Japan) industrialized while the South de-industrialized, especially India and China (Table 1.1).

#### ***Growth take-off***

While the Industrial Revolution commenced in the United Kingdom before the first unbundling, steam power’s dramatic impact on trade costs made it profitable to produce

**TABLE 1.1: Per capita industrialization levels, 1750–1913 (United Kingdom in 1900 = 100)**

	1750	1800	1830	1860	1880	1900	1913
France	9	9	12	20	28	39	59
Germany	8	8	9	15	25	52	85
Italy	8	8	8	10	12	17	26
Russian Federation	6	6	7	8	10	15	20
United Kingdom	10	16	25	64	87	100	115
Canada		5	6	7	10	24	46
United States	4	9	14	21	38	69	126
Japan	7	7	8	7	9	12	20
China	8	6	6	4	4	3	3
India-Pakistan	7	6	6	3	2	1	2
Brazil	–	–	–	4	4	5	7
Mexico	–	–	–	5	4	5	7

Source: table 9, Bairoch (1982); UK in 1900 = 100.

at vast scales. This triggered modern growth, characterized by a self-sustaining cycle of production, innovation and income gains that made further innovation profitable. This spread to continental Europe and the United States around the middle of the 19<sup>th</sup> century.<sup>2</sup>

“Big time” international income divergence/convergence

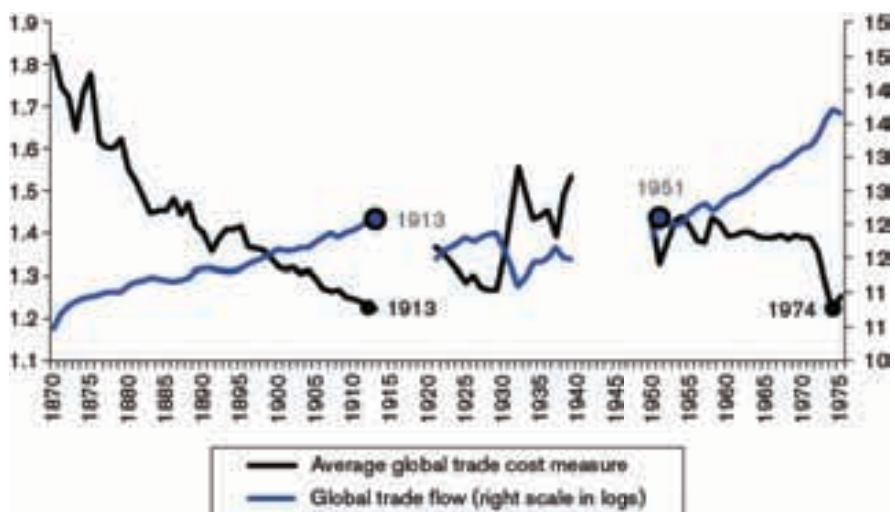
The first unbundling saw the North's and South's incomes diverge massively. Innovation, scale and specialization gave Northern industry a powerful cost-advantage over industry in the South. In addition to favouring the location of more manufacturing in the North, the shift also destroyed incentives for innovation in the South. The higher Northern growth – which persisted up till the early 1990s – produced what Pritchett (1997) calls income divergence “big time”.<sup>3</sup>

International trade and labour migration boomed

International trade in goods and labour migration exploded during the first unbundling. After being shut down by two world wars, a surge of protectionism and the Great Depression, trade returned, by 1951, to Victorian levels; trade costs (including protection) returned to pre-WWI levels by 1974. Mass international migration never resumed.

Figure 1.1 shows the strong association between trade costs and globalization up to the 1980s. From the mid-19<sup>th</sup> century to WWI, trade costs fell rapidly due mostly

**FIGURE 1.1: Global trade flows and estimated trade costs, 1870–1975**



Source: David, Meissner, and Novy (2011).

to lower transportation costs. From 1914 to 1950, trade costs rose erratically but substantially due mostly to man-made trade barriers such as the Smoot-Hawley tariff and the retaliation it provoked. Finally, during the post-war period, trade costs have fallen steadily due mainly to tariff liberalization and better organization of transportation (such as containerization).

### *Production clustered locally as it dispersed globally*

The first unbundling did not make the world flat. Indeed, it produced the first globalization paradox: freer trade led production to cluster locally in factories and industrial districts. The world's economic geography went from homogenous (subsistence agriculture everywhere but a few cities) to "spiky" (Florida, 2005). The flat-world musings of economists-without-economics-training, like Thomas Friedman and William Greider, are about as wrong as can be.

Globalization's paradox is resolved with three points: i) cheap transport favours large-scale production, ii) such production is complex; and iii) extreme proximity lowers the cost of coordinating the complexity. By removing one constraint (transport costs), the first unbundling brought forward another – coordination costs. Proximity became more important in many ways, not fewer.

### ***Second unbundling: ICT made it possible, wage differences made it profitable***

To think about the microclustering of economic activity, consider a stylized factory with three production stages (Figure 1.2 middle panel). Coordinating production requires a complex exchange among stages of goods, technology, people, training, investment and information (see double-headed arrows). For reasons that are easy to list but hard to study, bundling all stages in a single factory reduces costs and risk.

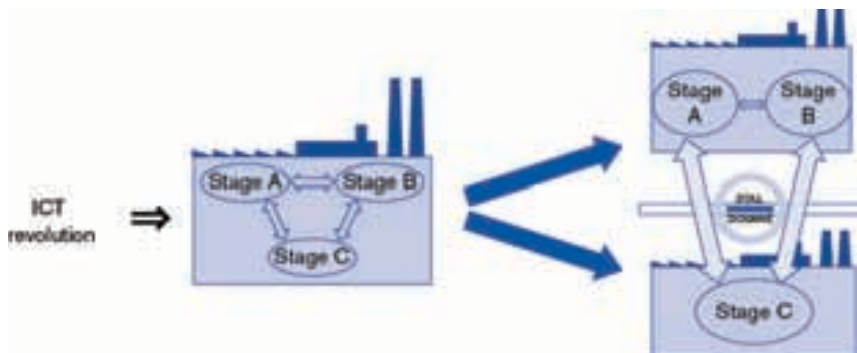
Some of the coordination costs are related to communication, so the "coordination glue" began to melt from the mid-1980s with ICT's melding of telecommunications, computers and organizational software. In short:

- The ICT revolution made it possible to coordinate complexity at distance
- The vast wage differences between developed and developing nations made separation profitable

This was globalization's second unbundling – some production stages previously performed in close proximity were dispersed geographically (Figure 1.2 right panel).

Importantly, most technology is firm specific, so internationalizing supply chains often involves offshoring know-how. While technology transfer is an ancient story (gunpowder), ICT facilitated control that reduced the costs and risks of combining developed-economy technology with developing-nation labour.<sup>4</sup> For this reason, technology became more internationally mobile.

**FIGURE 1.2: Schematic illustration of coordination costs and the second unbundling**



Source: Derived from Baldwin (2011a).

### Indicators of global supply chains

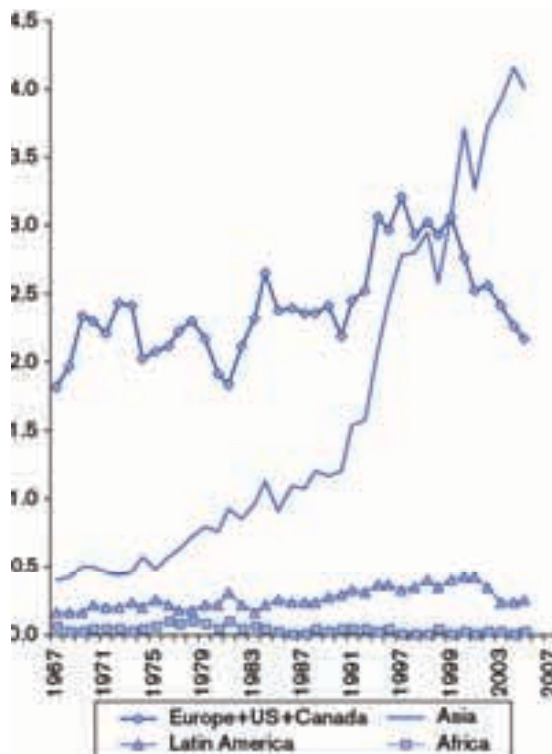
Directly measuring the “nexus” or the rise of 21<sup>st</sup> century trade is difficult; existing statistical categories were designed to quantify the first unbundling.

One measure of supply chain internationalization focuses on products where nations are exporting and importing an extraordinary amount. This makes little sense from a first unbundling perspective; nations seem to have both a comparative advantage (extraordinarily large exports relative to other nations) and a comparative disadvantage (extraordinarily large imports relative to other nations). From a second unbundling perspective, the extent of such overlapping comparative advantage and disadvantage provides a proxy for global supply chains.

Thus the sum of such overlapping trade as a fraction of world manufacturing trade provides a conservative measure of supply chain trade (Amador and Cabral, 2009). The evolution of this measure by region and by sector is shown in Figure 1.3 and Figure 1.4.

These charts show that there is nothing new about supply chain trade. However, before the ICT revolution, most of the international sourcing was done among mature economies, such as the United States and Canada in the auto industry or as in intra-EU trade in machinery. Figure 1.4 shows that starting in the late 1970s, Asia's participation in GSCs started to boom, with a sudden take-off timed with the ICT revolution around 1990. By the late 1990s, Asia had surpassed the North Atlantic economies.

**FIGURE 1.3: Regional measures of 21<sup>st</sup> century trade, 1967–2007**



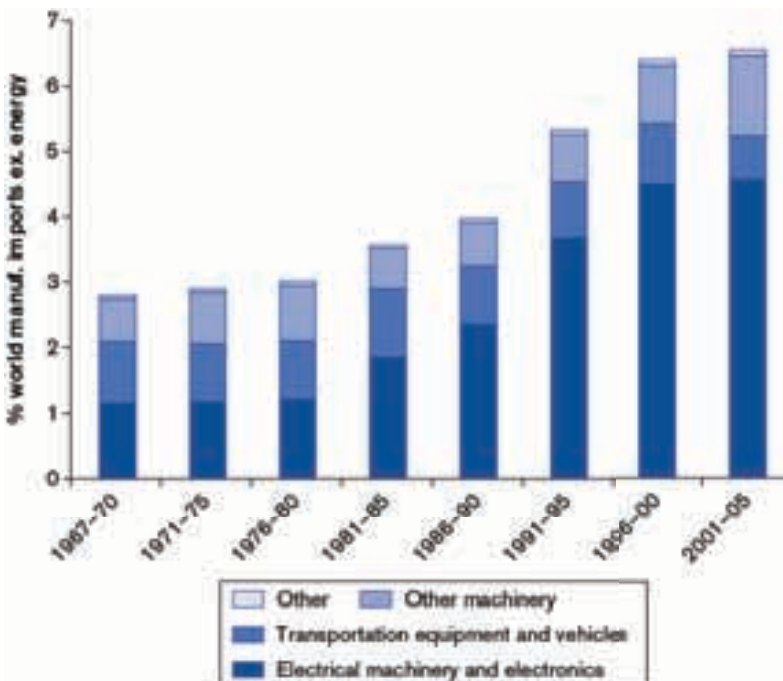
Source: Author.



As it turns out, 21<sup>st</sup> century trade is concentrated in relatively few sectors (Figure 1.4). Electrical machinery and electronics take the lion's share of the level and the growth in the 1990s.

A different measure of global supply chain activity uses nations' input-output matrices to identify which goods are inputs into which industries. This family of measures uses this information to identify which imports are used as intermediate inputs and sums them up to get a measure of supply chain trade.<sup>5</sup> Lopez-González (2012) uses this method to estimate the share of a nation's exports made up of value added from intermediate inputs from its trade partners. For example, about 37 per cent of the gross value of Mexican exports consists of US intermediate inputs, while only two per cent of US exports consist of Mexican intermediate inputs.

**FIGURE 1.4: Sector measures of 21<sup>st</sup> century trade, 1967–2005**



Source: Author.

The matrix of these “backward linkages” (Figure 1.5) reveals stark asymmetries in the global supply chain.

- There are “headquarter” economies (whose exports contain relatively little imported intermediates) and “factory” economies (whose exports contain a large share of imported intermediates)

The bottom row of the table shows the column sums and thus each nation's overall dependence on intermediates from the listed nations. Japan and Germany have quite low shares, but all the advanced technology nations have shares under 20 per cent; the figures for Indonesia and Brazil are low since they are important exporters of natural resources that use few intermediates.

- The global supply chain is really not very global – it's regional

Most of the large numbers – which indicate a strong supply chain relationship – are in the regional blocks, what I call Factory Asia, Factory North America, and Factory Europe.<sup>6</sup>

- There is a hub-and-spoke asymmetry in the dependence of factory economies on headquarter economy's intermediate exports

For example, the US column shows little dependency on imports from Canada and Mexico, but the Mexican and Canadian columns show strong dependence on the United States and very little dependency on each other. The same can be seen in Factory Asia where Japan is the technology leader, although the asymmetries are far less stark than they are in NAFTA. Germany is the hub in Factory Europe.

### *The second unbundling's impact*

Many economists think of the second unbundling as just like the first, only applied to parts and components rather than to final goods (Grossman and Rossi-Hansberg, 2008). This is wrong. The second unbundling transformed the world economy and continues to do so today.

Table 1.2: Backward linkage matrix for major supply chain traders, 2007

Partner	Reporter															
	United States	Canada	Mexico	Japan	China	India	Indonesia	Korea, Rep. of	Germany	United Kingdom	Italy	France	Spain	Poland	Portugal	Brazil
US		18%	37%	1%	2%	2%	3%	3%	1%	2%	1%	2%	2%	1%	1%	5%
Canada	4%		2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mexico	2%	1%		0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	1%
Japan	1%	1%	5%		5%	1%	5%	6%	1%	1%	0%	1%	1%	1%	1%	1%
China	3%	3%	9%	2%		5%	6%	7%	2%	2%	2%	2%	3%	3%	1%	3%
India	0%	0%	0%	0%			1%	1%	0%	0%	0%	0%	0%	0%	0%	1%
Indonesia	0%	0%	0%	2%	1%	1%		1%	0%	0%	0%	0%	0%	0%	0%	0%
Korea, Rep. of	1%	0%	4%	1%	4%	1%	2%		0%	0%	0%	0%	1%	1%	0%	1%
Germany	1%	1%	3%	0%	1%	2%	2%	1%	2%	4%	5%	5%	7%	12%	7%	2%
UK	1%	1%	1%	0%	0%	1%	0%	0%	2%		1%	2%	2%	1%	2%	1%
Italy	0%	0%	1%	0%	0%	1%	1%	0%	1%	1%		3%	4%	3%	3%	1%
France	0%	0%	1%	0%	0%	0%	1%	0%	2%	2%	3%	5%	5%	2%	4%	1%
Spain	0%	0%	1%	0%	0%	0%	0%	0%	1%	1%	1%	2%		1%	15%	0%
Poland	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%		0%	0%
Portugal	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%
Brazil	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%
Total	15%	27%	65%	8%	16%	16%	20%	21%	11%	13%	16%	17%	29%	26%	35%	16%

Source: Author's manipulation of Lopez-González (2012) data.

Note: The columns show the intermediate inputs intensity from each row nation, e.g., five per cent of the gross value of China's exports consists of intermediates bought from Japan, while two per cent of Japan's gross exports consist of intermediates bought from China.

Globalization's second unbundling was marked by five top-line facts:

Reversal of the big income divergence

After rising since the steam revolution, the G7 nations' share of world income reached its peak in 1988 at two-thirds (Figure 1.5). The second unbundling reversed this. The offshoring of labour-intensive stages of manufacturing and heightened international mobility of technology produced spectacular growth in emerging markets whose economic reforms fostered and were fostered by rapid industrialization.

The reversal has been remarkably fast. By 2010, the G7's share is down to half (Figure 1.5). This share is likely to continue to sag for decades; the G7 is home to only a tenth of the world's people.

**FIGURE 1.5: Reversal of the big divergence**



Source: World Databank from 1960; Maddison pre-1960; pre-1960, G7 = Western Europe, United States, Canada, Australia and New Zealand.

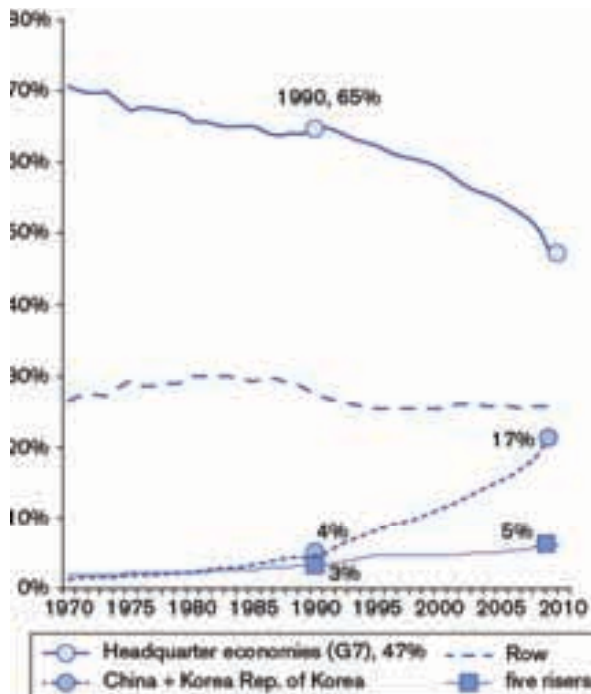
This reversal of fortunes is perhaps the most momentous change in the last one hundred years. It is reshaping every aspect of international relations. The “rocket engine” is the rapid industrialization in emerging economies.

### South industrialization and North de-industrialization

The second unbundling reversed the 19<sup>th</sup> and 20<sup>th</sup> century industrialization/de-industrialization trend. Since the early 1970s, with a significant pick up in the 1990s, the North has de-industrialized and the South industrialized (Figure 1.6).

De-industrialization is a pervasive trend among developed nations but the South's rapid industrialization has been driven by the excellent performance of just a dozen nations – all of them heavily involved in international supply chains and most of them in Asia. The performance of Chinese manufacturing alone accounts for much of the reversal.

**FIGURE 1.6: Reversal of industrialization/de-industrialization trend**



Source: Author.

*Rise of 21<sup>st</sup> century trade: the trade-investment-services-IP nexus*

20<sup>th</sup> century trade meant goods crossing borders. 21<sup>st</sup> century trade is radically more complex for a very simple reason. Internationalizing supply chains also internationalized the complex two-way flows that used to take place only within factories.

This is why it is misleading to view the second unbundling from the perspective of the first unbundling. The rise of global supply chains is much more than extra trade in parts and components. The heart of 21<sup>st</sup> century trade is an intertwining of:

- Trade in goods, especially parts and components
- International investment in production facilities, training, technology and long-term business relationships
- The use of infrastructure services to coordinate the dispersed production, especially services such as telecoms, internet, express parcel delivery, air cargo, trade-related finance and customs clearance services
- Cross-border flows of know-how such as formal intellectual property and more tacit forms such as managerial and marketing know-how.

To stress its interconnectedness, I call this the trade-investment-services-IP nexus.<sup>7</sup>

*New industrialization path: joining rather than building industrial supply chains*

The second unbundling revolutionized development options faced by poor nations. Before the rise of global supply chains, nations had to build a deep and wide industrial base before becoming competitive. This is the way the United States, Germany and Japan did it. After the second unbundling, nations could industrialize by joining international supply chains (Baldwin, 2011b). Joining supply chains is drastically faster and surer than the old import-substitution route. The developing nations that adopted this new strategy are called “emerging market economies”.

The new join-instead-of-build development paradigm also transformed the political economy of policy reform.

*New political economy of liberalization*

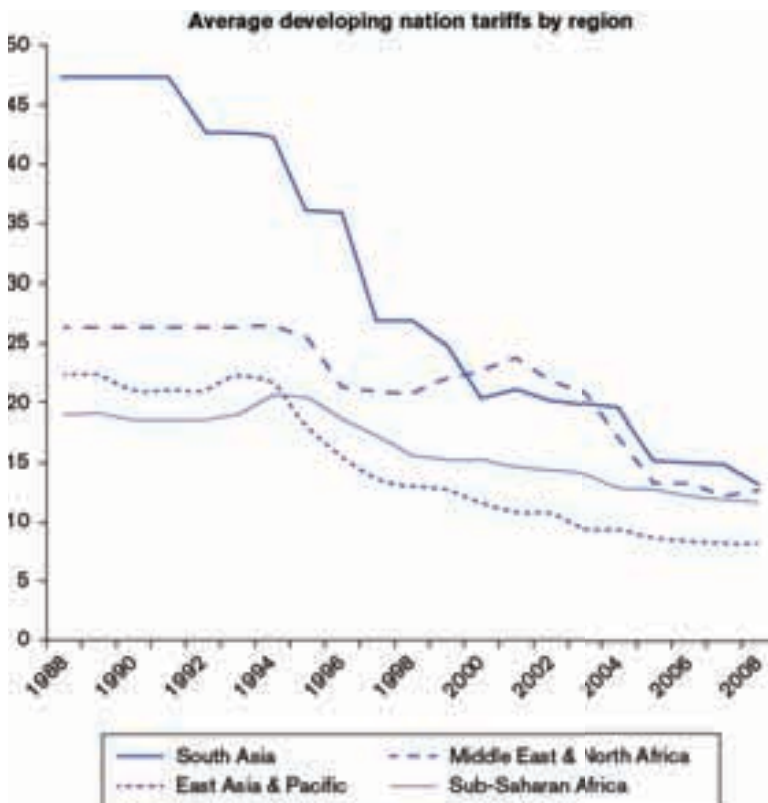
Many pro-industrialization policies from the pre-ICT era – import substitution policies, FDI and local-content restrictions, state-owned enterprises, etc. – turned out to be

hindrances to joining supply chains. Many developing nations dropped the old policies to attract offshored manufacturing jobs and investment. This revolutionized the world of trade and investment policy.

Before the second unbundling, the political economy of trade liberalization was “I’ll open my market if you open yours”.<sup>8</sup> After the second unbundling, the political economy was mostly unilateral: “I’ll open my borders and adopt pro-nexus reforms to attract factories and jobs”. Many emerging economies unilaterally liberalized tariffs, embraced pro-business and pro-investor policies.

The *volte-face* in the political economy of trade liberalization is most obvious in the developing nation’s marked unilateral reduction of tariffs (Figure 1.7).<sup>9</sup> The

**FIGURE 1.7: Unilateral tariff cutting by developing nations, 1988–2009**

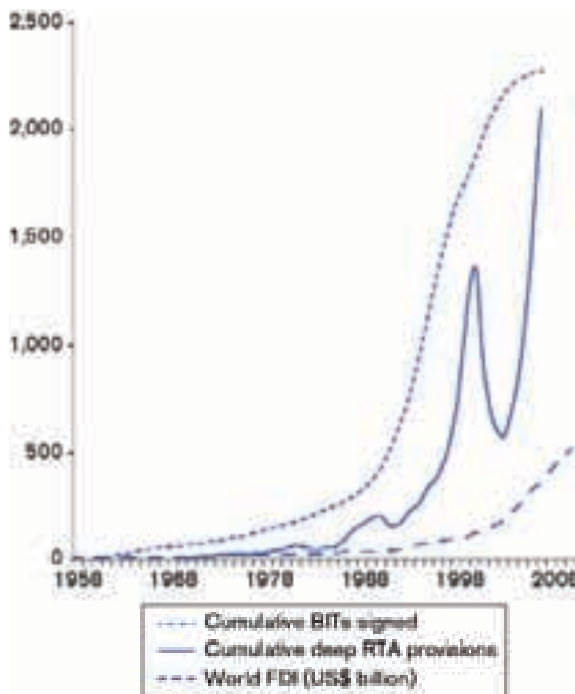


Source: World Databank.

new pro-trade, pro-investment attitude can also be seen in a nations' willingness to embrace disciplines on “beyond the border barriers” (BBBs) in “deep” trade agreements with their key supply chain partners.<sup>10</sup>

Starting in the mid-1980s and accelerating sharply in the 1990s, nations signed agreements with new disciplines to underpin the trade-investment-services-IP nexus.<sup>11</sup> Important multilateral progress on these issues was made with the Uruguay Round's inclusion of intellectual property, investment and services, but the multilateral route was shut when the Doha Round focused firmly on 20<sup>th</sup> century trade issues. As can be seen in Figure 1.8, the number of 21<sup>st</sup> century disciplines in RTAs exploded in the 2000s.<sup>12</sup>

**FIGURE 1.8: Indicators of FDI and 21<sup>st</sup> century trade disciplines, 1957–2009**



Source: UNCTAD and ICSID.

### 1.3. Economics of supply chain unbundling

Supply chains are as old as industry. Automobiles require tyres that require rubber; steel requires iron that requires iron ore. The supply chain is the sequence of plants



that provide these inputs. The value chain is a broader concept popularized by Michael Porter.

Porter thought that firms spent too much time and money performing stages and support activities where they had no competitive advantage (Porter, 1985). This is why Porter squeezed the supply chain into a single stage, “operations”, while breaking out pre- and post-fabrication stages, and support activities. Porter’s main thought was to apply the Ricardian principle of comparative advantage to firm’s value chains. He told firms to focus on what they do best and to outsource for the rest. Porter is not the right framework for thinking about value chains in 2012 – largely because most firms followed Porter’s advice.

Globalization’s second unbundling shifted the locus of globalization from sectors to stages of production. This requires an analytic focus on supply chains. The economics of this change is best looked at by decomposing it into two phenomena: fractionalization and dispersion.

- Fractionalization concerns the unbundling of supply of chains into finer stages of production
- Dispersion concerns the geographic unbundling of stages

### ***Supply chain unbundling: the functional dimension***

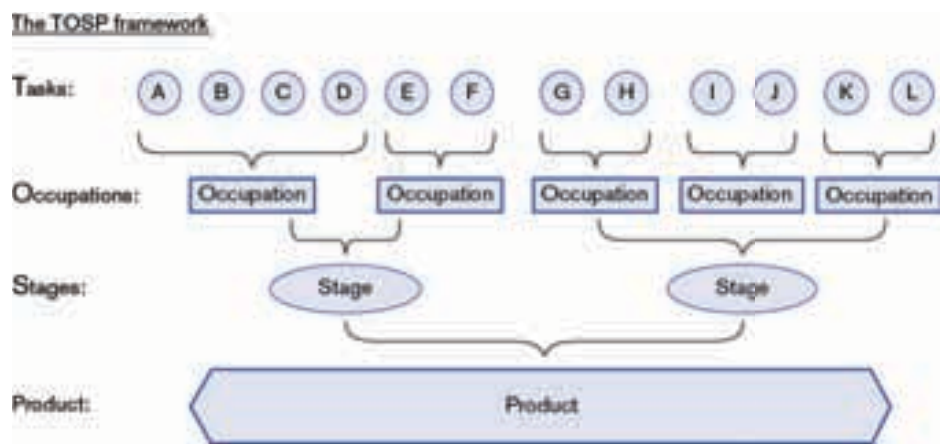
To consider why ICT improvements lead to the unbundling of production, it is useful to view the supply chain at four levels of aggregation: products, stages, occupations, and tasks (Figure 1.9). At the bottom is the product, which is conceived of as including after sales services. At the top are tasks – the full list of everything that must be done to get the product into consumers’ hands and provide them with associated after-sales services.

One natural intermediate aggregation is “occupation” – the group of tasks performed by an individual worker. Stages – defined as a collection of occupations that are performed in close proximity due to the need for face-to-face interaction and the fragility of the partially processed goods – are the critical level of aggregation since supply chain internationalization typically involves the offshoring of stages rather than individual occupations or individual tasks.

With this in hand, consider the economics of the optimal:

- 1) Tasks per occupation; and
- 2) Occupations per stage.

**FIGURE 1.9: Tasks, occupations, stages and product – the TOSP framework**



*Note:* The circles represent individual tasks, the rectangles represent individual occupations and the ovals represent individual stages of production.

*Source:* Author.

*Functional unbundling: specialization versus coordination and risk*

Adam Smith had it right – specialization pays – or as he described it in his famous pin factory example, a finer division of labour boosts productivity. Rather than hiring dozens of workers each of which performs all the tasks of making a pin, 18<sup>th</sup> century pin makers allocated individual tasks to individual workers (although Smith called them “operations”, not “tasks”).

The downside of splitting up tasks is the difficulty of coordinating the whole process. Moreover, a long supply chain also tends to be risky – given the famous weakest-link property. In a nutshell, the optimal allocation of tasks to occupations is governed by the trade-off between specialization and coordination.

As the ICT revolution rolls on, this fundamental trade-off is shifting towards more stages. The effects, however, are not straightforward, as Bloom et al., (2006) show. Some ICT improvements reduce the benefits of specialization while others reduce the costs of specialization.

ICT affects the optimal division of labour via two channels:

- Communication and organizational technologies – call them coordination technologies for short – facilitate transmission of ideas, instructions and information

Good coordination technology favours fewer tasks per occupation and fewer occupations per stage.

- Information technology makes it easier for individual workers to master more tasks

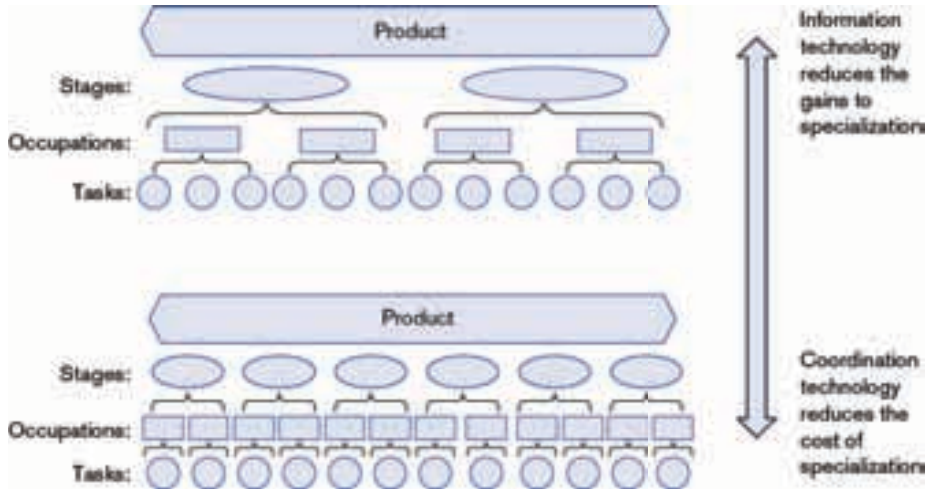
This happens in several ways. Computerizing tasks and embedding them in machinery is one. Numerically controlled machines, robots and computer-aided manufacturing embed information in capital in a way that allows a single worker to perform a wider range of tasks. A single worker operating the machine can do tasks that used to be done by a team of specialized workers.

This basic communication-technology versus information-technology trade-off is illustrated schematically in Figure 1.10. In a nutshell:

- Better coordination technology reduces the cost of specialization and thus fosters functional unbundling
- Better information technology reduces the benefits of specialization and thus disfavours functional unbundling

This insight has recently received some empirical support from Lanz et al., (2012) which find that offshoring of business services complements manufacturing activities, in the sense that increased import penetration in business services is associated with a shift in local task content from information and communication-related tasks towards tasks related to handling machinery and equipment. Offshoring of other services complements local information-intensive tasks in that it shifts local task composition towards ICT-related tasks.

FIGURE 1.10: Supply chain unbundling: coordination versus information technology



Source: Author.

### ***Geographic unbundling: balancing dispersion and agglomeration forces***

Locational decisions have been studied for centuries. The touchstone principle is that firms seek to put each stage in the lowest cost location. The cost calculation involves a trade-off between direct factor costs and “separation” costs.

- The direct costs include wages, capital costs and implicit or explicit subsidies
- The separation costs should be broadly interpreted to include both transmission and transportation costs, increased risk and managerial time

The location decision may also be influenced by local spillovers of various types. In some sectors and stages, say fashion clothing, proximity between designers and consumers may be critical. In others, product development stages may be made cheaper, faster and more effective by co-location with certain fabrication stages. Yet other stages and sectors are marked by strong technological spillovers that make clustering of producers the natural outcome.

The mainstream framework for studying the impact of market size on industrial location is the so-called New Economic Geography literature launched by Paul

Krugman in the 1990s (Krugman, 1991; Fujita et al., 1999). The New Economic Geography perspective views the locational outcome as balancing dispersion forces and agglomeration forces.

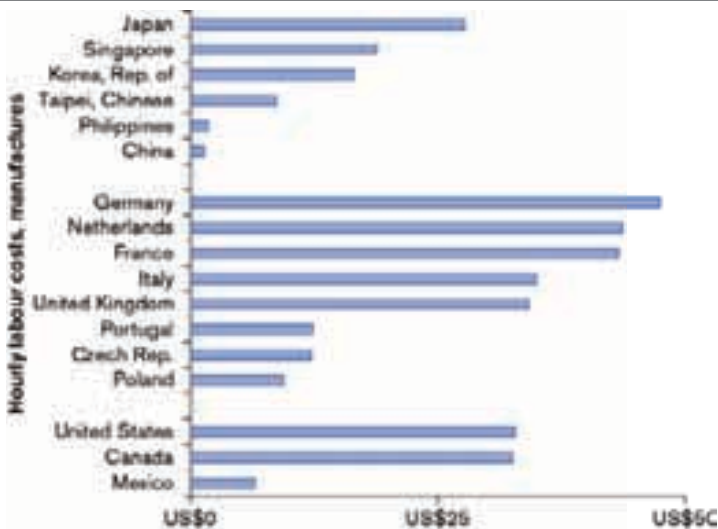
### Dispersion forces

Dispersion forces favour the geographic dispersion of stages. There are two prominent dispersion forces in the supply chain context:

- Skilled and unskilled labour wages gaps determine “vertical specialization”

The offshoring of labour-intensive stages from Japan, the United States and Germany to their nearby low-wage neighbours is driven by two wage gaps. Low-skill labour is much dearer in the “headquarter” economies such as the United States, Germany and Japan than it is in the nearby “factory” economies (Figure 1.11). High-skill labour, however, remains relatively abundant and thus relatively cheap in headquarter economies (Figure 1.12). The result is a spatial sorting of skill-intensive stages to high-wage nations and labour-intensive stages to low-wage nations. This is the key to North-to-South offshoring.

**FIGURE 1.11: Wage differences in Factory Asia, Factory North America and Factory Europe, 2008**



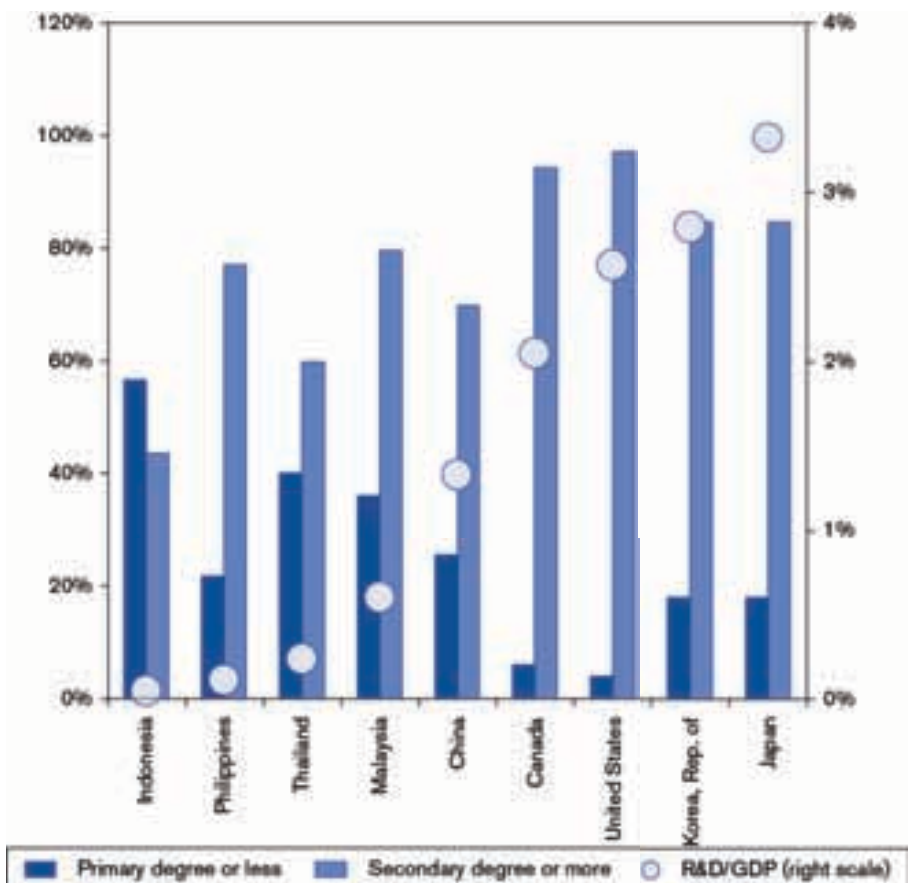
Source: US Bureau of Labor Statistics, International Labor Comparisons.

- Firm-level specialization and excellence determine “horizontal specialization”.

Factor prices are not the only consideration; as Figure 1.12 shows, international supply chains have long existed among high-wage economies. The dispersion here is driven by a much more micro gain from specialization.

For example, when it comes to automobile air conditioners, the Japanese company Denso and the French company Valeo dominate their markets through excellence, not through low wages. While each could in principle make their own auto air conditioners, scale economies mean that it is cheaper for Swedish and German auto firms to source them from France.

**FIGURE 1.12: Education and R&D: ASEANs, China, Republic of Korea, United States, Japan and Canada, 2005**



Source: World Databank online.

Given the systemic importance of learning-by-doing and the growing role of scale economies in an ever more fractionalized supply chain, it is natural that regional champions will emerge in particular parts and components. This is the key to the “horizontal” internationalization of supply chains among high-wage nations.

### Agglomeration forces

Agglomeration forces are the opposite of dispersion forces – they encourage geographical clustering. Technically, an agglomeration force is said to exist when the spatial concentration of economic activity creates forces that encourage further spatial concentration.

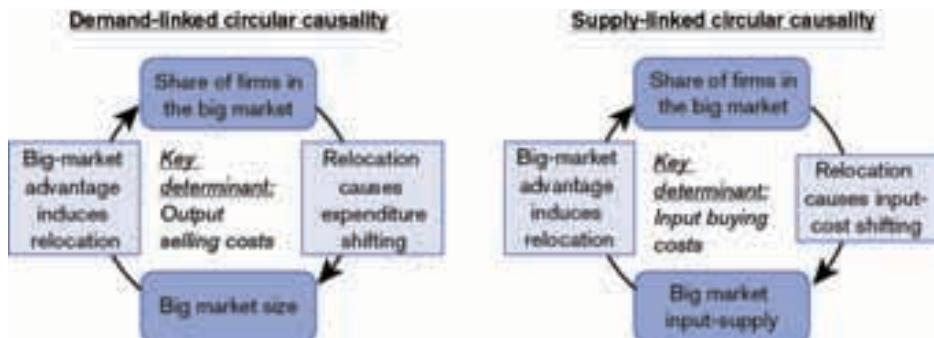
There are many agglomeration forces, but some of them only operate on a very local scale. These local agglomeration forces, such as knowledge spillovers, help explain why firms in the same line of business so often cluster. When it comes to locational unbundling of supply chains – a phenomenon that spans the globe in some cases – these are too local to provide much explanatory leverage. The most important agglomeration forces for global supply chains are supply-side and demand-side linkages.<sup>13</sup>

These are subject to what might be called “circular causality” (Figure 1.13):

- Demand-linked circular causality rests on market-size/demand issues

If an economy already enjoys the presence of a great deal of economic activity (GDP), then doing business in the economy will, all else being equal, be attractive to firms seeking to be near their customers. As this attraction draws more firms and more economic activity, the cycle continues. Were it not for dispersion forces,

FIGURE 1.13: Circular causality and agglomeration forces



Source: Author.

extreme location outcomes would be observed. Indeed in the case of some cities such as Tokyo, demand-links have resulted in a truly astounding share of activity concentrated spatially. This is one key reason why manufacturers continue to produce in high-wage nations. Customers attract suppliers whose workers become new customers.

- Supply-linked circular causality rests on cost-of-inputs issues

Since firms source intermediate inputs from other firms, the presence of many firms in a given location tends to make that location attractive to new firms from the input-cost perspective. This is one key reason why China is such an attractive location for the production of new goods, especially in electronics. Suppliers attract more suppliers.

Generally speaking, demand-links operate on an economy-wide basis, while supply links operate more on a sectoral basis.<sup>14</sup>

In this framework, the location of industry shifts to balance agglomeration and dispersion forces (Figure 1.14). Extreme solutions are occasionally observed, but interior solutions are the more common outcome.

### Trade costs and hump-shaped agglomeration

While the interplay of agglomeration and dispersion forces determines the equilibrium location of industry, changes in trade costs can have unexpected effects.

**FIGURE 1.14: Equilibrium location balances agglomeration and dispersion forces**



Source: Author.



Lower trade and transportation costs makes distance less of an issue and thus weaken both agglomeration and dispersion forces. If the agglomeration forces weaken more than the dispersion forces, clustering weakens; if the opposite happens, clustering gets more pronounced.

This logic explains why clustering tends to follow a “hump shaped” pattern as trade costs fall. Consider the polar examples:

- When trade is highly restricted, it is very unprofitable for firms in one region to sell to other regions; each region makes their own
- At the other extreme of perfectly costless trade, location region is immaterial

In short, agglomeration is not necessary when trade costs are zero; it is not possible when trade costs are very high. In between these two extremes, being in a cluster is both possible and rewarding.

This widely known feature of the New Economic Geography logic leads to the seemingly contradictory conclusion that lowering trade costs when they are high tends to produce a concentration of economic activity (in the North, as history would have it). However beyond some threshold level, further trade cost reductions leads to dispersion away from the North. This explains how globalization’s first and second unbundlings could have diametrically opposed effects on the agglomeration of industry and overall economic activity.

This hump-shaped outcome in global economic activity is shown in Figure 1.15.<sup>15</sup> The first unbundling fostered agglomeration in the North while the second unbundling fosters dispersion. The salient point is that the world today is beyond the crest;

**FIGURE 1.15: Schematic illustration of function and location unbundling interactions**



Source: Author.

lower trade costs will almost surely foster greater dispersion of economic activity to the South.

### *Agglomeration economies and supply chain location*

New economic geography is useful in thinking about the micro, or firm-level, determinants of location, but it was originally designed to study the emergence of large-scale economic structures spanning regions and nations. The baseline here is the observation that economic activity tends to become more concentrated as economic integration proceeds (Niepmann and Felbermayr, 2010).

The obvious application here is China. The vast agglomeration of manufacturing capacity that has assembled in China since 1990 will, by itself, continue to attract manufacturing activity. As China's low-wage advantage erodes the new economic geography framework predicts a dispersion of activity beyond China – not a disappearance. The key work here is Paul Krugman, Tony Venables and their students; particularly relevant is the “island hopping” framework introduced by Puga and Venables (1996). Starting from a situation where all industry is in one nation, they show how productivity/wage growth induces firms to move offshore to a second location once a threshold wage is reached.

The key point is that the spread is not even: the departing industry does not spread out evenly, it concentrates in just one new location to benefit from agglomeration rents. Moreover, the relocation does not empty out the first location/nation but rather slows the growth of new manufacturing activity. As the second location's wages are driven up, a third location/nation emerges for offshoring. This is, in essence, the geographical dimension of the “flying geese” pattern whereby one East Asian nation after the other benefits from a cluster of industrial activity.

### *GSCs and the second unbundling*

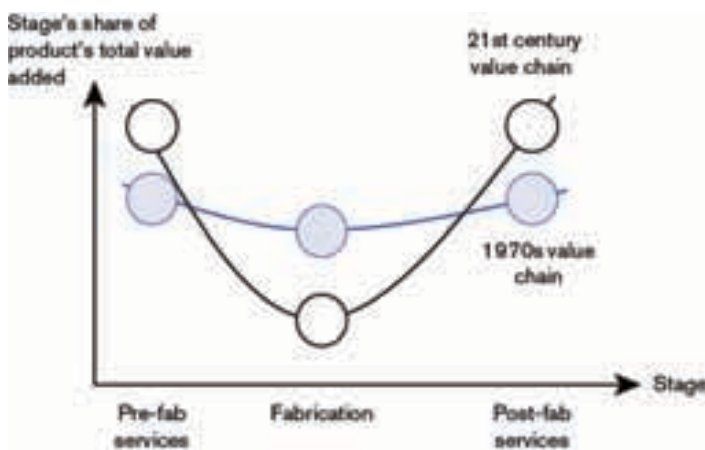
Treating the functional and geographical dimensions of unbundling separately is convenient analytically but it misses one important interaction. Functionally unbundling the supply chain can be done in a way that results in stages that have more homogenous skill/technology demands. This is advantageous given the vast wage differences (Figure 1.11). In other words, supply chain fractionalization may be driven in part by the possibility of offshoring low-skilled stages to low-wage nations. This is illustrated in Figure 1.15; a single stage, initially located in Japan, is unbundled into two stages so the low-skill tasks – marked by an

“L” in the circles – can be clustered and offshored to China. The relatively skill-intensive stage stays in Japan (the “H” in the circle indicates a high-skilled task).

### Smile curve economics

The second unbundling made it feasible to offshore stages of production; some stages moved, others did not. Curiously, value added along the value chain seemed to shift away from the offshored stages. This observation is known as the “smile curve” which shows the value added at each stage of production (Figure 1.16). This curve asserts that fabrication – especially final assembly – involves less value creation today than it did before the second unbundling – the smile deepened, so to speak.

FIGURE 1.16: The smile curve: good and bad stages in the value chain

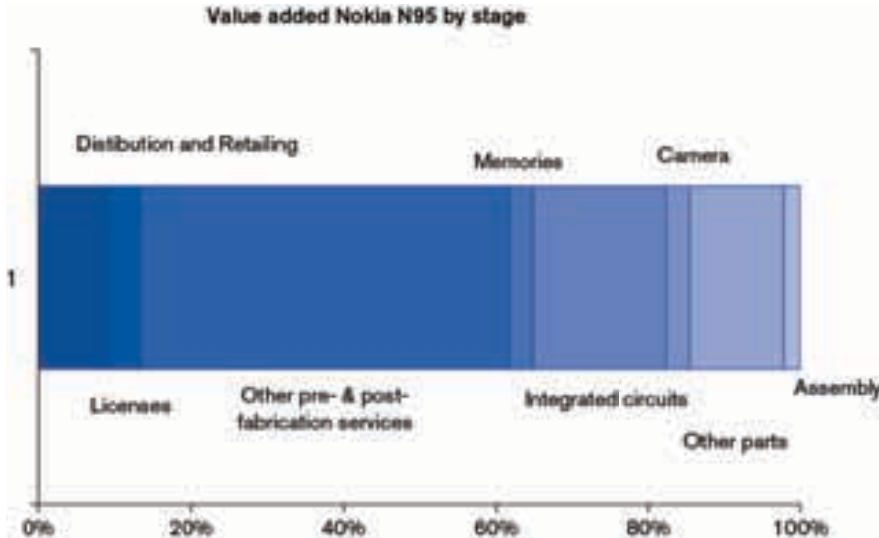


Source: Author.

### Nokia N95 example

The allocation of value added along a value chain can be seen in the decomposition of the total retail sales price of the Nokia N95 phone (Ali-Yrkkö et al., 2011). Although the phone is mostly “made” in Asia, Figure 1.17 shows that most of the value added accrues in Europe. The total value added in Europe depends on where the phone is sold (retail margin) and assembled (China or Finland). In the worst of cases – an N95 assembled in China and sold in the EU – more than half the value added is in Europe; the high-end figure is 68 per cent.

FIGURE 1.17: Breakdown of the phone's EUR 546 pre-tax retail price circa 2007



Source: Author's own compilation.

Note: \* includes protocols, the operating system, pre-installed software, etc.: \*\* Nokia outsources only 20 per cent of assembly. N95 was assembled in Beijing (China) and Salo (Finland) by Nokia employees.

### Why did the smile deepen?

A definitive answer to this question will require a great deal more empirical research, but simple economics suggests an obvious explanation – cost accounting. When a stage's cost is reduced by offshoring, its share in value added falls since a stage's value added is based on costs. Even if the cost saving is fully passed on to consumers, the offshored stage's share of value added will fall. This basic cost-accounting effect can be amplified by:

- Relative market power

Offshored tasks tend to be things that can be done in many emerging nations, given that most of them are eager to attract such stages. The non-offshored stages, by contrast, tend to involve things where firms naturally have market power due to product differentiation and branding. In short, offshored tasks become commoditized; the onshore tasks do not.

- Internationally mobile technology

If the offshoring firm moves its advanced technology to the offshore location, it drives down the cost of the offshored task even more. As before, this automatically shifts value to the non-offshored tasks.

### *Smiles and good jobs*

Smile curve economics suggests that the fabrication stages in manufacturing may not be the development panacea as they once were. Global supply chains made industrialization faster and easier (the supply chain made industry less lumpy). Industrialization became less meaningful for the same reasons. For example, that the Republic of Korea could export domestically designed car engines was testimony to its rich-nation status. Now, exporting sophisticated manufactured goods is no longer the hallmark of having arrived. It may simply reflect a nation's position in a global supply chain.

This observation calls for a good deal more thinking on the role of manufacturing in development strategies (Baldwin, 2011b). After all, the originator of the smile-curve concept used it to argue for a need to diversify away from fabrication.

As far as the evolution of GSCs is concerned, it is important to note that the pre- and post-fabrication stages consist primarily of services rather than goods. As such, shifting the location of such stages will have a first-order impact on the pattern of transmission, not transportation. Of course a second order impact (location of fabrication influenced by location of design) is likely, but determinants of comparative advantage in pre- and post-fabrication service are quite different from fabrication, and the cost of transmitting these services is quite low. This suggests that shifts in the pre- and post-fabrication stages will not have a major impact on supply chain trade patterns when it comes to goods.

## **1.4. What it means for policy**

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As mentioned above, 21<sup>st</sup> century trade – or more precisely 21<sup>st</sup> century international commerce – is a richer, more complex, more interconnected set of cross-border flows of goods, investment, technology, services, technicians, managers and capital. This transformed policy making globally, first by creating new supply and new demand for deeper disciplines, and second by creating a bond among various strands of policymaking, some of which were always viewed as international but many are traditionally viewed as domestic policy issues.

This section considers the implications of global supply chains for global economic policy; it draws on Baldwin (2012) and Gereffi et al., (2005).

### *The nexus: more interconnected policy*

The quantum leap in complexity and interconnectedness has had momentous implications for world trade governance – shifting it sharply towards regionalism and eroding WTO centrality. Before turning to these points, it is worth pointing out that there is nothing really new here. The basic challenge of supply chain trade and the basic response of deeper, regional disciplines has been a feature of global governance for a half century.

Before the second unbundling really got going in the late 1980s, most trade was simple. It could be governed by simple regulations like the GATT 1947 (less than 100 pages long). The GATT rules, however, were not sufficient for the cross-border relations where supply chains were an issue in the 1960s and 1970s. As Figure 1.13 shows, some trade relations back then were marked by supply chain trade and so was the need for deeper-than-GATT disciplines. In response, North Atlantic nations set up deeper disciplines. Since the trade was regional rather than multilateral, the deeper disciplines were placed in regional trade agreements. The 1965 US-Canada Auto Pact, which regulated trade and investment in the auto sector, is a classic example.

The Auto Pact was a clear violation of GATT rules (Article XXIV) but US officials argued that the Pact “was designed to promote trade and economic efficiency within this single industry by bringing about such reallocation of production between the two countries as would permit Canada to achieve substantial economies of scale on some components and some models, while abandoning others.”<sup>16</sup> It is hard to think of a clearer statement of the goals of the North-North trade-investment nexus.

The European Economic Community, as the EU was known at the time, similarly sought much deeper disciplines. This, however, was not aimed at underpinning existing, complex cross-border activity. It was aimed at creating it. The European founders viewed an ever-closer economic integration as the only sure-fire means of avoiding another European war.<sup>17</sup> As Figure 1.15 shows, it worked.

The history lesson here is simple. Complex cross-border flows demand complex rules. Since most complex trade is regional, there is a strong tendency to establish

the necessary complex rules at a regional rather than multilateral level. Multilateral rules would almost surely have been more efficient, but negotiating them in the GATT would have been too cumbersome and slow; most GATT members were not involved in this type of international commerce.

### *Which new disciplines are needed?*

The trade-investment-services-IP nexus creates a need for two new types of disciplines. These correspond to the two new elements of the associated international commerce.

- First, supply chain trade often involves producing abroad, either directly or via long-term relationships with independent suppliers

This is basically the investment and intellectual property part – setting up business abroad is an essential part of 21<sup>st</sup> century trade. This means that barriers to doing business abroad are now trade barriers. Likewise, much of the internationalization of supply chains involves overseas application of a firm's advanced know-how. A lack of intellectual property (IP) protection therefore becomes a barrier to trade.

- Second, production among the facilities must be coordinated and this involves the two-way flow of goods, services, people, capital, and training

Barriers to these flows are now barriers to trade. Note that traditional trade barriers are part of this, but the list is much longer as the cross-border flows are more complex (express mail, air cargo, trade financing and insurance, business mobility).

One good source of the necessary disciplines is the deep regional trade agreements that have been signed among nations where the trade-investment-services-IP nexus trade is important. Following a procedure established by Horn et al., (2009), the WTO recently created a database of deeper disciplines in all the RTAs announced to the WTO by 2010. While the data covers over 50 measures, few of these occur frequently enough to be important. Table 1.3 shows a selection of deeper-than-GATT disciplines that appear frequently in modern trade agreements. The term "WTO-plus" applies to issues that are covered by WTO discipline but where the RTA involves commitments that go further. The "WTO-X" term applies to disciplines that are not mentioned in WTO agreements, so the RTA provisions are creating new rules rather than extending or deepening existing disciplines.

**TABLE 1.3: Selected deeper than GATT provision in RTAs**

WTO-plus areas	
Technical barriers to trade	Affirmation of rights and obligations under WTO agreement on TBT; provision of information; harmonization of regulations; mutual recognition agreements
State trading enterprises	Establishment or maintenance of an independent competition authority; non-discrimination regarding production and marketing condition; provision of information; affirmation of Art XVII GATT provision
Trade-related investment measures	Provisions concerning requirements for local content and export performance of FDI
Services	Liberalization of trade in services
WTO-X areas	
Competition policy	Maintenance of measures to proscribe anticompetitive business conduct; harmonization of competition laws; establishment or maintenance of an independent competition authority
Intellectual Property (IP)	Accession to international treaties not referenced in the TRIPS Agreement
Investment	Information exchange; development of legal frameworks; harmonization and simplification of procedures; national treatment; establishment of mechanism for the settlement of disputes
Movement of capital	Liberalization of capital movement; prohibition of new restrictions
Regional cooperation	Promotion of regional cooperation; technical assistance programmes

Source: WTO's Anatomy of PTAs database, <http://www.wto.org>.

## **21<sup>st</sup> century regionalism and the WTO's erosion**

Globalization's second unbundling created a new type of win-win situation in international commerce. The old type was "my market for yours"; the new type is "my factories for your reform". This spawned massive demand for new disciplines from "headquarter economy" firms and a massive supply of new disciplines from "factory economy" governments.

As the WTO was occupied with the Doha Round and its emphasis on 20<sup>th</sup> century issues (tariffs and agriculture), supply met demand in regional trade agreements – just as it did in the 1960s. More precisely, the supply chain governance gap was filled by uncoordinated developments in deep regional trade agreements, bilateral investment treaties, and autonomous reforms in emerging economies. The resulting package of deeper disciplines is what I have called 21<sup>st</sup> century regionalism (Baldwin, 2011a) – a theme taken up in the WTO's *2011 World Trade Report* (WTO 2011).

21<sup>st</sup> century regionalism is a threat to the WTO's centrality in multilateral trade governance, but not in the way that 20<sup>th</sup> century bilateralism was. It is not useful to think of 21<sup>st</sup> century regionalism using the analytic frameworks established by last-century



thinkers like Jagdish Bhagwati when regionalism was mostly about tariff preferences. In fact, 21<sup>st</sup> century regionalism is not primarily about preferential market access as WTO (2011 Chapter B) demonstrates convincingly. Instead, 21<sup>st</sup> century regionalism is about disciplines that underpin the trade-investment-service-IP nexus. Because of this, 21<sup>st</sup> century regionalism is a threat to the WTO's role as a rule writer, not as a tariff cutter.

Stepping from “what is” towards “what should be”, it is absolutely clear that the optimal governance solution for global supply chains would be global, not regional. Indeed the firms conducting much of this 21<sup>st</sup> century trade find themselves faced with a spaghetti bowl of disciplines – although this is tamed by the fact that the United States, Japan and the EU have established a system of hub-and-spoke bilateral agreements that tends to reduce conflicts for firms located in a hub. The real problem concerns the spokes such as Mexico that have deep agreements with the EU, Japan and the United States.

## 1.5. Future of GSCs

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The future of global supply chains will be moulded by the answers to three questions:

- Will supply chains become more fractionalized?
- Will stages of production become more polarized in terms of skill, capital and technology intensity?
- Will stages of production be further dispersed and interconnected internationally?

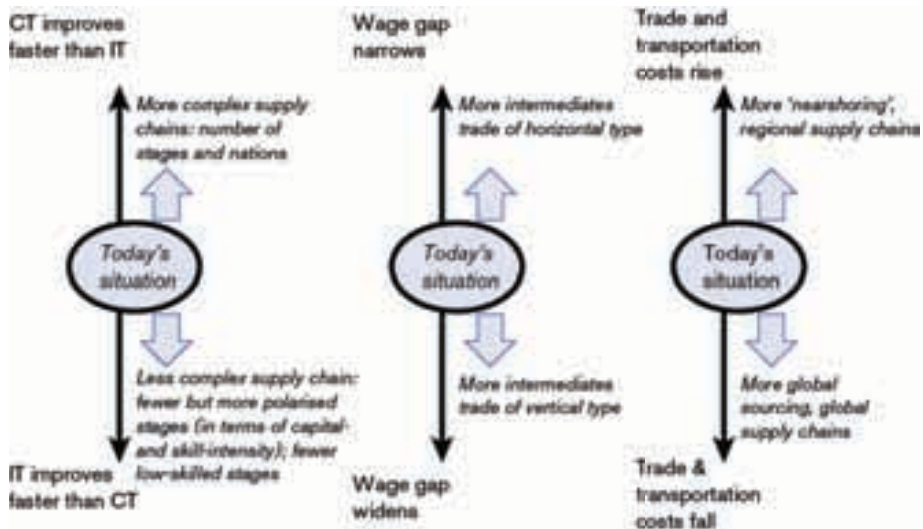
Fractionalization of the supply chain is determined by the interplay between the gains from specialization and cost of coordination and risk (see Section 1.3). The specialization gains come from scale economies and learning-by-doing as well as from a heightened ability to place each stage in a nation with the most appropriate wage structure. Coordination and risk costs come from the extra difficulty and expense of managing spatially distributed stages. Unbundling along the functional dimension will be directed by changes in these costs and benefits of fractionalization.

Polarization of stages is determined by the costs and benefits of computerization and robotization of manufacturing. Broad advances in information technology will largely govern the future course on this issue.

The geographic spread and international complexity of supply chain stages are determined by the costs and benefits of scattering stages of production. The cost of dispersion falls as coordination technology improves and transportation and travel costs fall. The gain from dispersion rises with the diversity of production conditions in various nations, most notably the size of wage gaps. Unbundling along the geographic dimension will be directed by changes in these costs and benefits of dispersion.

It is impossible to know what the future path will be for these four determinants. This section considers various combinations and their likely impact on GSCs. Figure 1.18 helps organize ideas.

FIGURE 1.18: Future of international supply chains



Source: Author.

### Information versus coordination technology

Rapid improvement in coordination/communication technology – such as important advances in telepresence technology, workflow organization and communications software – favours supply chain unbundling functionally and geographically (Section 3). The resulting finer division of labour will allow firms to sort stages geographically according to the cost of the relevant productivity factors (labour, capital, technology, etc.). Other things being equal, this will result in more, and longer-distance, trade in parts and components. Thus rapid advances in coordination and communication technology will lead to more complex supply chains. This is illustrated in the top of the leftmost panel

of Figure 1.18. Box 1.1 discusses a number of radical technological breakthroughs that might have important implications for the future of global supply chains.

Better information technology, by contrast, favours the bundling of many tasks into the ambit of individual workers. This will typically result in broader occupations and few separate stages of production. Other things being equal, this would tend to reduce international trade in parts and components.

Better information technology also tends to polarize stages of production. As routine, low-skill, and repetitive tasks are easier to computerize and robotize, the information-technology-led bundling will typically eliminate occupations that involve such tasks. At the same time, the more intensive use of sophisticated production machines will make the remaining jobs more skill-, capital- and technology-intensive. This leads to a polarization of stages in terms of skill-content. Routine low-skill tasks are bundled into high-skill occupations while the remaining low-skill tasks will typically be highly labour-intensive but less routine. The resulting, broader stages will involve more capital-intensive, more technology-intensive and more skill-intensive processes. This tends to favour production in high-wage nations (see the bottom of the leftmost panel in the figure).

### **Box 1.1: Extreme CT: telepresence, remote surgery and the death of meetings**

Another revolutionary development would radically reduce the need for technicians and managers to travel to remote factories. Products such as Cisco's Telepresence already reduce the need for face-to-face meetings in the service sector. If such technology were combined with human controlled robots of the type used today in operating rooms (e.g., Intuitive Surgical's da Vinci Surgical System), technicians could conduct inspections or undertake repairs from remote locations.

This is not science fiction. The US military already operates many of its drone aircraft in West Asia from bases in the United States. A company called Remote Presences does underwater survey, inspection and recovery using Remotely Operated Vehicles. And some US hospitals are using remote presence robots to leverage the time of doctors across hospitals (see video <http://www.youtube.com/watch?v=qRx7CdseGsQ>).

The implications of this would be to de-regionalize supply chains, at least to the extent that the time-cost of travel was a significant consideration in offshoring locations.

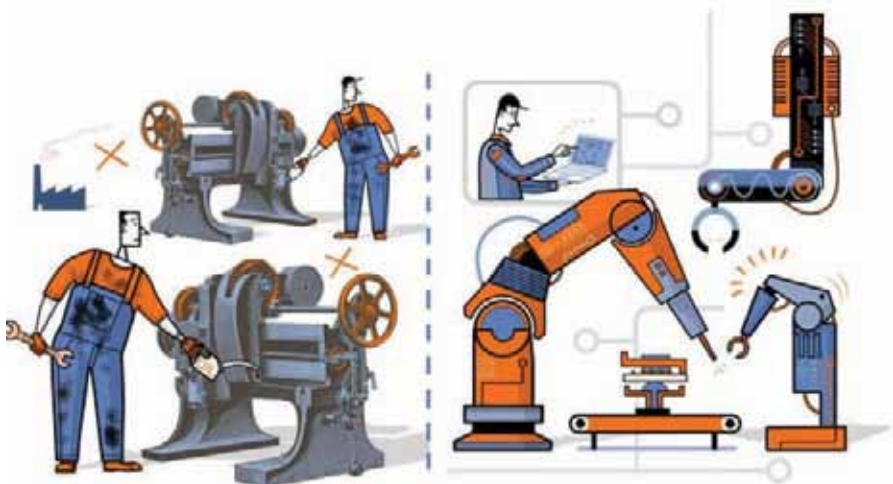
Box 1.2 discusses some futuristic IT developments that might have a large impact on supply chains.

### **Box 1.2: Extreme IT: “comufacturing” or taking the man out of manufacturing**

When thinking about the future of global supply chains, it is worth speculating on truly revolutionary technological developments. One such possible development concerns Computer Integrated Manufacturing (CIM). This has already produced a tectonic shift in manufacturing in high-wage nations – moving from a situation where machines helped workers make things to a situation where workers help machines make things. Perhaps manufacturing will be called “comufacturing” in the future.

The integration and automation of tasks, however, does not stop at the factory gate. Many design, engineering, and management tasks have been computerised (Alavudeen and Venkateshwaran, 2010). Computers have greatly boosted the productivity and speed of product design as well as greatly reduced the need for prototyping. Once designed, the production process

**FIGURE 1.19: Schematic illustration of computer integrated manufacturing**



Source: Author.

can be outlined using computer-aided process planning systems and design programmes can create instructions for numerical-control machines. Models of the manufacturing system can be simulated before they are built. The basic manufacturing functions – machining, forming, joining, assembly and inspection – are supported and integrated by computer-aided manufacturing systems and automated materials-handling systems. Inventory control is automated, tracking inventory movement, forecasting requirements and even initiating procurement orders.

The key economic effects of CIM are:

- A radical reduction in the fixed cost and time delays associated with new models and new products
- A shift away from mass production of identical goods to mass production of customized goods
- A heightened possibility for spatial unbundling of certain segments of the value chain as digitized information makes coordination at distance less complicated
- A bundling of many tasks previously undertaken by individual workers of varying skill levels into advanced machinery and computers
- A polarization of the shop floor

The polarization, as Autor et al., (2003) pointed out, stemmed from the fact that computers were substitutes for some workers but complements for others. Demand for routine, low-skill tasks declined as they were easy to computerize and robotize. By contrast, computers boosted labour productivity in tasks demanding flexibility, creativity, generalized problem-solving capabilities, and complex communications. Cheaper computers and robots lowered demand for low-skill labour and raised demand for high-skill workers.<sup>18</sup>

A special report by the Economist magazine extrapolates these trends even further. It notes that manufacturing may be going through a new industrial revolution due to the advent of “3D printing” or additive manufacturing. This bundles virtually all stages of manufacturing into a single machine. Combined with the virtual designing made possible by computer-aided design systems, this would take manufacturing very close to the Star Trek replicators.

Supply chain unbundling is driven by a fundamental trade-off between the gains from specialization and the costs of dispersal. This would be seriously undermined by radical advances in the direction of mass customization and 3D printing by sophisticated machines. Whether these machines end up in high-wage, high-skill nations, or they are distributed to be near every large customer base, the impact would be a very substantial reduction in supply chain trade.

To put it sharply, transmission of data would substitute for transportation of goods.

### *Wage gap convergence may increase supply chain trade*

One of the most remarkable trends in recent years has been a narrowing of wage differences between developed and developing nations. The implications for this trend are illustrated in the middle panel of Figure 1.18. This trend is having, and will continue to have, two distinct effects on international supply chains.

- First, wage convergence changes the nature of trade between the converging nations

Specifically, developing nations such as China are producing sophisticated intermediate goods that previously were imported.

- Second, as wages rise in China, Mexico, Poland and other countries, the geographical extent of supply chains widens to include new low-wage nations like Viet Nam.

The view that global supply chains are driven mainly by large wage gaps is highly misleading. The perfect illustration is the US auto industry where there is more US offshoring to high-wage Canada than there is to low-wage Mexico.

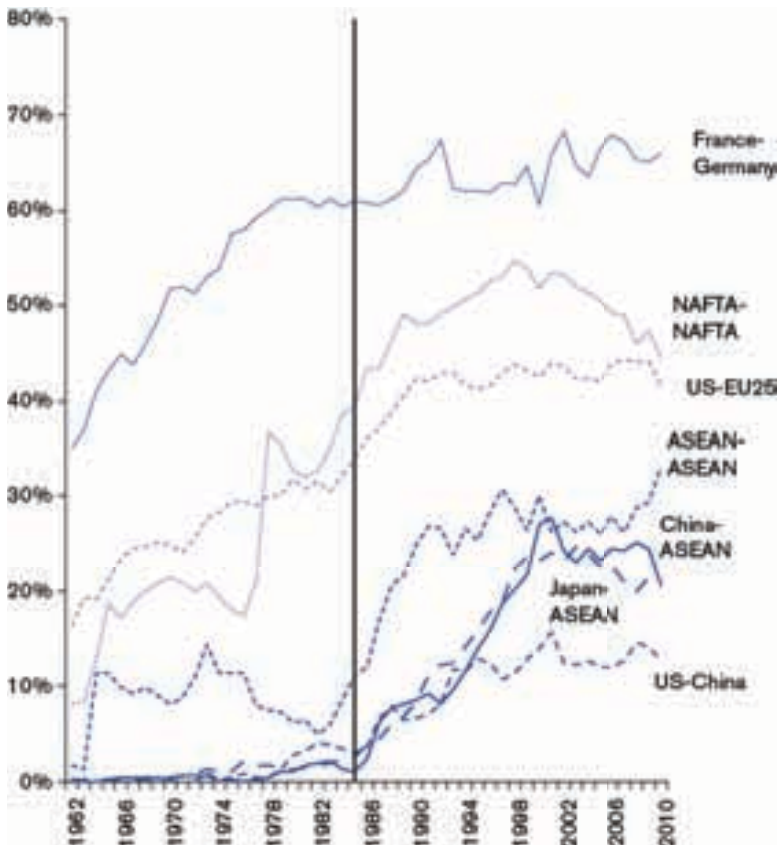
As Figure 1.4 shows, supply chain trade was prevalent among nearby high-wage nations like Canada and the United States and within Western Europe even before the second unbundling and it is still very high today. This is the “horizontal” specialization type discussed above – specialization that is based on firm-level excellence rather than wage gaps. As such specialization is not generally subject to local clustering effects, the result is massive two-way flows in similar goods.

Figure 1.20 shows a different measure of supply chain trade that is more easily calculated for specific bilateral trade flows. The measure – intra-industry trade – gauges the overall relationship between imports and exports at a finely defined sectoral level, for instance with electrical machinery. This is an imperfect proxy since some of the intra-industry trade is in final goods, but a great deal is in intermediate goods.

The clear messages from these figures are:

- Despite the second unbundling and the rise of North-South supply chain trade, such trade is substantially more prevalent among high-income nations
- North-South supply chain trade does not seem to be substituting for North-North supply chain trade (Japan is an exception as it assembles so much of its final goods in China)

**FIGURE 1.20: Indicator of supply chain trade North-North versus North-South**



Source: Author.

Both points suggest that income convergence will boost supply chain trade in that the extra horizontal specialization will more than compensate any reduction in wage-driven, vertical specialization.

As nations like China experience rapid income growth, the volume of supply chain trade may rise to a level more like the level observed between the United States and the EU. One of the best-known tenets of the “new trade theory” is that countries trade more as they get larger and more similar in size. This suggests that the rapid growth of emerging markets will create more trade than it displaces. US-China intra-industry trade would have to increase six fold to match the intensity of French-German trade.

The second trend is nothing new. In East Asia, it is known as the flying geese pattern. The industrialization of first Japan and then the Republic of Korea; Chinese Taipei; Hong Kong, China and Singapore raised local wages that in turn triggered offshoring to Thailand, the Philippines, Indonesia, Malaysia and, after 1990, China. As wages have begun to rise in this new set of “tigers”, low-skill jobs are increasingly offshored to nations such as Bangladesh and Viet Nam. Throughout this process, supply chain trade volumes rose rapidly.

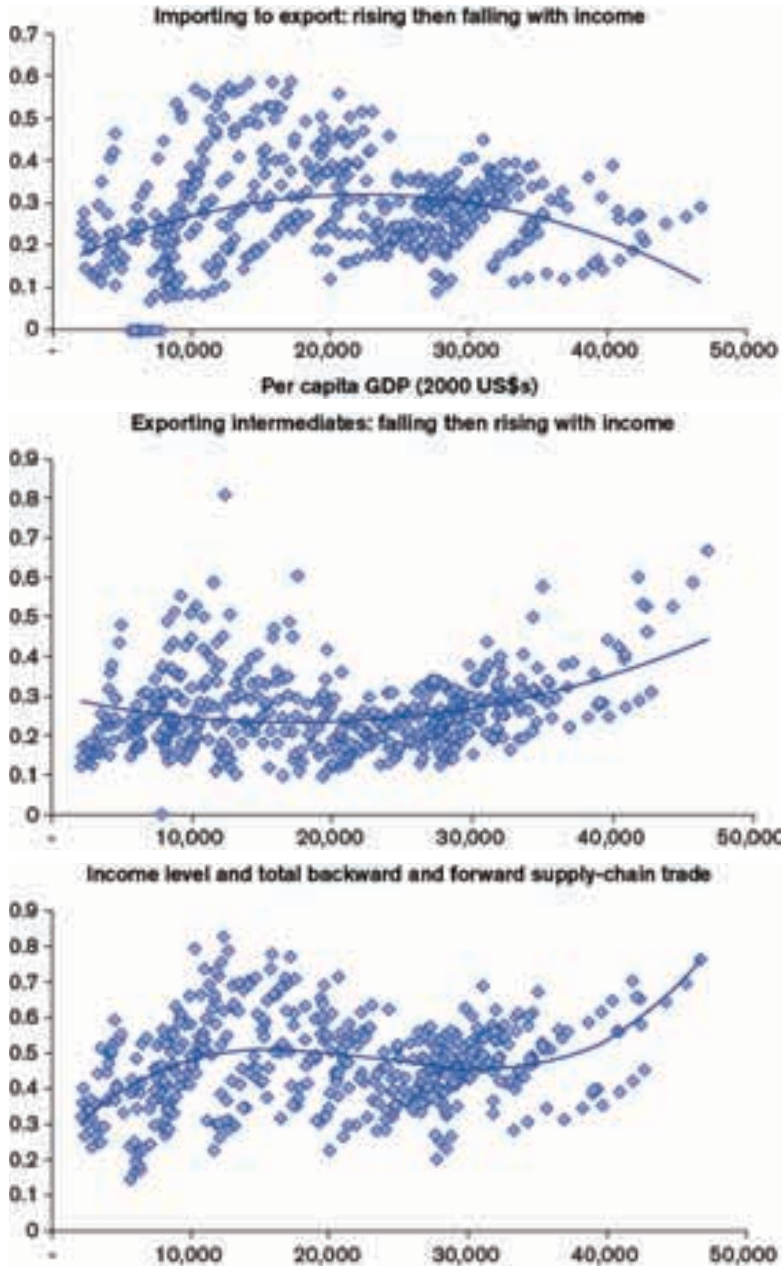
### *Per capita income and supply chain trade*

The discussion so far has put aside the issue of direction of trade. In a supply chain, however, direction matters. Importing intermediates in order to export is quite different from exporting parts that help other nations export. Lopez-González (2012) calls the former “backward” supply chain trade (buying intermediates from GSCs) and the latter “forward” supply chain trade (selling intermediates into GSCs).<sup>19</sup> As it turns out, there are some clear empirical regularities linking a nation's level of development – as measured by per capita income – and its backwards and forwards supply chain trade.

- As nations get richer, up to a point, they use imported intermediates more intensively in their exports. Beyond a threshold – about US\$ 25,000 per year per person – the intensity then diminishes (Figure 1.21 top panel)
- For forward supply chain trade – i.e. the supply of intermediates to others – the relationship is flipped. It falls for lower income levels but rises beyond a point near US\$ 15,000 (Figure 1.21 middle panel)



FIGURE 1.21: How backward, forward and total supply-chain trade vary with income



Note: The Lopez-González (2012) measures indicate the share of gross exports accounted for by intermediate imports from a particular partner (backwards), and the share of exports used as inputs into other nations' exports (forwards). The measures are bilateral and direction-specific, so each point in the graph corresponds to a single bilateral measure of supply chain trade for each year from 1995 to 2007.

Source: Author.

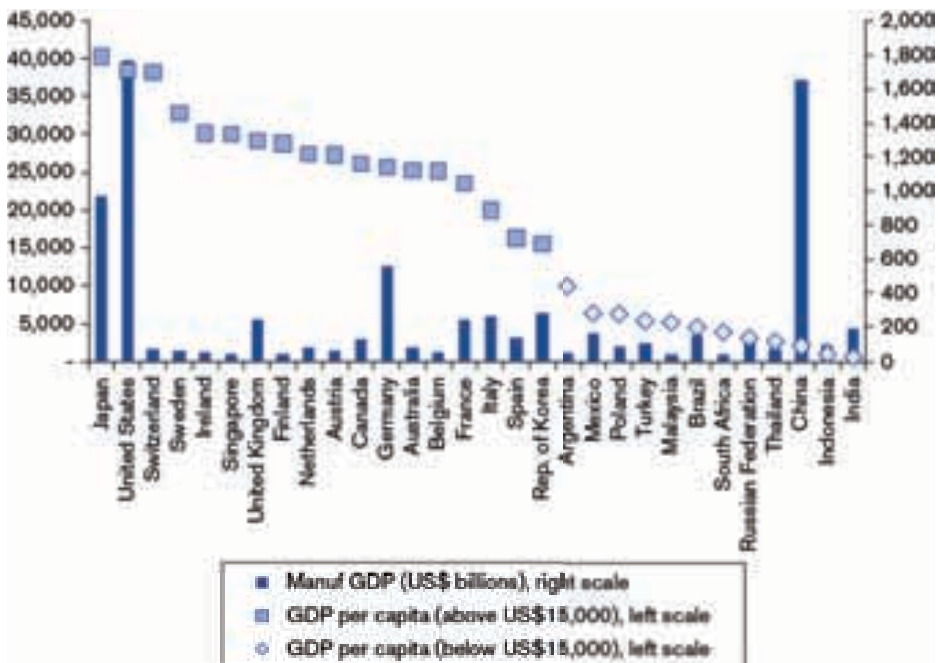
Combining the two measures, we get a nation's total involvement in the supply chain (Figure 1.21 bottom panel)

While this research is very recent and thus not yet part of economists' received wisdom, the top-line message is very much in line with the general view presented above. As China moved up from textiles and apparel to assembling electronics and machinery, the import content of its exports rose. At the other extreme, a nation like Finland has all but exited from the fabrication end of manufacturing, so the domestic value-added content of its exports tends to be higher. In some ways the top panel of Figure 1.21 can be thought of as a shadow of the smile curve.

Likewise, it is commonly known that advanced technology nations such as Japan and Germany are increasingly focusing on sophisticated components that are exported for assembly elsewhere – an observation that is consistent with the middle panel of Figure 1.21.

Taking the fitted curves at face value gives an idea of how global supply chain trade will develop as emerging market incomes rise. Figure 1.22 shows, for the nations

**FIGURE 1.22: Manufacturing GDP and incomes levels – nations below the turning point**



Source: Author.

that account for 90 per cent of global manufacturing GDP, the size of manufacturing and the per capita income level. According to Lopez-González (2012), the backwards supply chain trade intensity should increase for the nations below the threshold of US\$ 25,000. The forward trade should decrease for nations below US\$ 15,000. The numbers show that many important manufacturing nations are below US\$ 15,000, so further income growth in China and other factory economies will draw them more deeply into global supply chains.

While such calculations are conjectures at best, they suggest that supply chain trade is likely to increase at least for China both on the import and export sides.

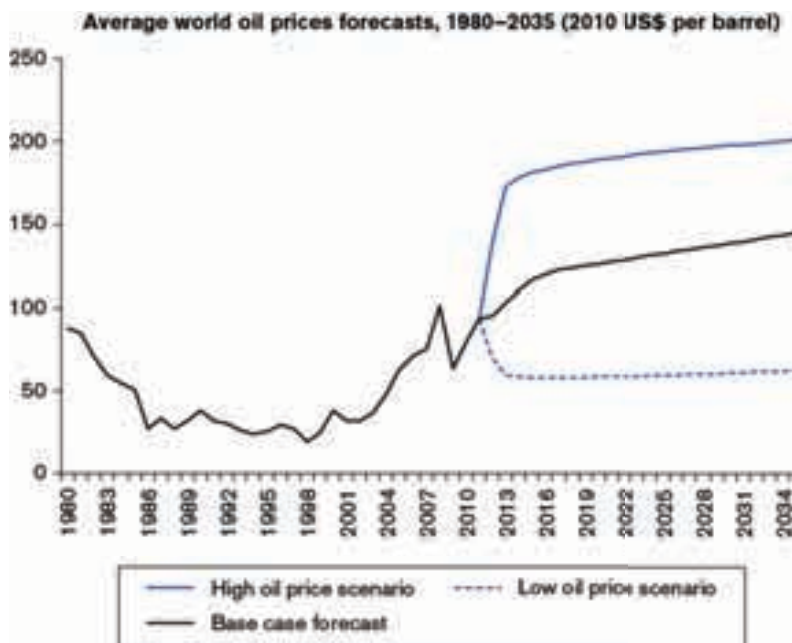
### *Trade barriers and transportation costs*

The last trend to be considered is the cost of moving goods across borders. The second unbundling has been accompanied by a remarkable reduction in policy barriers to trade in goods such as tariffs, port delays and red tape. This trend is likely to continue given the political economy that has driven it (see Section 1.4). Trade costs, however, could still rise with oil prices.

The future course of the price of oil is not known, but many forecasters view oil prices rising along with the rise of emerging market incomes, and with those of China, India and Brazil in particular. Figure 1.23 shows one mainstream forecast that incorporates three scenarios. The first aspect to note is that much of the boom in supply chain trade that came with the ICT revolution was aided by a drop in the price of oil as well as by a drop in tariffs (Figure 1.23). As tariffs have a lower bound of zero, the latter boost will not be repeated going forward. Nor does it seem that oil prices will provide as permissive an environment as they did in the past decades. Even the low oil price scenarios foresee prices remaining relatively high. The pessimistic scenario sees them doubling.

If oil prices do rise substantially, the geography of supply chains will be affected. The nature of the impact is quite obvious – it would favour “nearshoring” or even “reshoring” of geographically dispersed production stages. Supply chains would be less global and more regional. The actual magnitude of the shift is thought to be large by experts in the case of the high-price scenario.<sup>20</sup> It is worth pointing out, however, that the experts’ calculations see wage and income gaps as unaffected by the oil price changes, and so their analyses are rough guesses at best.

FIGURE 1.23: Historical and forecast oil prices



Source: US Annual Energy Outlook 2012.

## 1.6. Concluding remarks

Globalization's second unbundling and the global supply chains it spawned have produced and continue to produce changes that alter all aspects of international relations – economic, political and even military. The spearhead of these changes has been the extraordinary economic growth accompanying emerging markets' integration into global markets at an unprecedented speed and scale – an accomplishment that is largely due to the development of global supply chains and heightened international mobility of capital.

This paper is an economist's view on supply chains – why they are significant, what future directions they are likely to take and what they mean for policy. After putting global supply chains into an historical perspective, the paper presents an economic framework for understanding the functional and geographical unbundling of production processes – focusing on manufacturing.

Supply chain fractionalization – the functional unbundling of production processes – is governed by a fundamental trade-off between specialization and coordination costs. Supply

chain dispersion – the geographical unbundling of stages of production – is governed by a balance between dispersion forces and agglomeration forces. Agglomeration forces create attraction to clusters that discourages offshoring – mostly the tendency to co-locate with customers and intermediate good supplies. The dispersion forces that encourage geographic unbundling include wage gaps (fostering North-South offshoring) and firm-level excellence (fostering North-North and South-South offshoring).

The policy implications stem from the second unbundling's transformation of international commerce. The internationalization of production stages has internationalized the complex flows of goods, information, investment, training, technology and people that used to occur inside individual factories. The heightened complexity of cross-border flows demands deeper disciplines. As the WTO has been occupied with 20<sup>th</sup> century trade issues since its inception in the 1990s, the new disciplines have arisen outside the multilateral system. This development threatens the WTO's centrality, but not on the tariff-cutting front as suggested by 20<sup>th</sup> century thinking on regionalism by Jagdish Bhagwati and others. Rather, 21<sup>st</sup> century regionalism threatens to undermine the WTO's role as the world's rule writer and rule keeper.

The future of global supply chains will be influenced by four key determinants: 1) improvements in coordination technology that lower the cost of functional and geographical unbundling; 2) improvements in computer integrated manufacturing that lower the benefits of specialization and shifts stages toward greater skill-, capital-, and technology-intensity; 3) narrowing of wage gaps that reduces the benefit of North-South offshoring to nations like China; and 4) the price of oil that raises the cost of unbundling.

Two key messages emerge from the analysis. First, convergent wages and income level between “factory economies” and “headquarter economies” need not reduce the extent of supply chain trade among them. Indeed, the intensity of such trade among developed nations exceeds that between developed and emerging nations since the gains from specialization driven by firm-level excellence is even more important than the gains from specialization due to large wage gaps. A foundational tenet of trade theory is that nations trade more – not less – as their economies become larger and more similar. Second, narrowing wage gaps between China and developed nations are likely to produce a continuation of the old “flying geese” pattern whereby early developers move up the value chain and thereby encourage the next low-wage nation to step on to the development ladder.

## Endnotes

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**2** The dates suggested by Rostow (1960) are UK 1783–1802, France 1830–60, Belgium 1833–60, US 1843–60, Germany 1850–73, Sweden 1868–90, Japan 1878–1900, Russia 1890–1914 and Canada 1896–1914.

**3** On the theory connecting agglomeration, innovation, growth and income divergence, see Baldwin et al., (2001).

**4** This is not the “technology transfer” of yesteryear. Firms make elaborate efforts to avoid such transfers.

**5** See Hummels et al., (1999); Johnson and Noguera (2011); Koopman et al., (2008), and González (2012).

**6** See Baldwin (2008) for an analysis of Factory Asia.

**7** See Baldwin (2011a) for details.

**8** It was a game played mostly by rich nations. Developing nations were not required to reciprocate under the GATT's “Special and Differential Treatment” principle.

**9** See Baldwin (2010) for analysis of unilateral tariff liberalization.

**10** Asymmetric in the sense that the agreements required the developing nation to change large swaths of laws and regulation but require almost no regulatory reform of the developed nation partner.

**11** These include provisions on investment, capital flows, intellectual property protection, competition policy, services trade, and industrial standards and regulations; see WTO (2011) for detailed analysis.

**12** See Baldwin (2011a) and WTO (2011) for an in depth analyses of 21<sup>st</sup> century regionalism.

**13** Called, respectively, forward and backward linkages by 20<sup>th</sup> century writers such as Albert Hirschman.

**14** The reason is that a clustering of firms means a clustering of workers and thus a clustering of purchasing power. However, the purchasing power tends to get spent on the whole range of goods.

- 15** This data, from the economic historian Angus Maddison, differs in the peak year from the more modern data series used in Figure 1.7.
- 16** Patterson (1966), page 356.
- 17** See Chapter 1 of Baldwin and Wyplosz (2012).
- 18** Of course, this is not the first time automation has polarized the factory jobs. In the 19<sup>th</sup> century, mechanized looms replaced medium-skilled textile workers with low-skilled, low-wage workers. A process immortalized by the machine-wrecking tactics of Luddites.
- 19** His actual terminology is “vertical specialization” following a long tradition in this literature.
- 20** See Simchi-Levi (2010) and Simchi-Levi et al., (2011).

## References

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- Alavudeen, A.; Venkateshwaran, N. 2010. “*Computer Integrated Manufacturing*”, (New Delhi, India, PHI Learning).
- Ali-Yrkkö, J.; Rouvinen, P.; Seppälä, T.; Ylä-Anttila, P. 2011. “Who Captures Value in Global Supply Chains? Case Nokia N95 Smartphone” in *Journal of Industry, Competition and Trade*, 11(3): 263–278.
- Amador, J.; Cabral, S. 2009. “Vertical Specialization Across the World: A Relative Measure”, in *The North American Journal of Economics and Finance*, Volume 20, Issue 3, December: 267–280.
- Autor, D.H.; Levy, F.; Murnane, R.J. 2003. “The Skill Content of Recent Technological Change: An Empirical Exploration” in *Quarterly Journal of Economics*, 118(4): 1279–333.
- Baldwin, R.E.; Martin, P.; Ottaviano, G.I.P. 2001. “Global Income Divergence, Trade, and Industrialization: The Geography of Growth Take-Offs,” in *Journal of Economic Growth*, Springer, 6(1): 5-37.
- Baldwin, R. 2008. “Managing the Noodle Bowl: The Fragility of East Asian Regionalism”, in *Singapore Economic Review*, 53:(3): 449-478.
- Baldwin, R. 2010. “Unilateral Tariff Liberalisation,” NBER Working Paper 16600 (Cambridge MA, National Bureau of Economic Research).
- Baldwin, R. 2011a. “21<sup>st</sup> Century Regionalism: Filling the Gap between 21<sup>st</sup> Century Trade and 20<sup>th</sup> Century Trade Rules”, CEPR Policy Insight No. 56 (London, UK, Center for Economic Policy Research).

Baldwin, R. 2011b. "Trade and Industrialization after Globalization's 2<sup>nd</sup> Unbundling: How Building and Joining a Supply Chain are Different and Why it Matters", NBER Working Paper 17716 (Cambridge MA, National Bureau of Economic Research).

Baldwin, R. 2012. "WTO 2.0: Global Governance of Supply-Chain Trade", in CEPR Policy Insight No.64, December (London, UK, Centre for Economic Policy Research).

Baldwin, R.; Wyplosz, C. 2012. "The *Economics of European Integration, 4<sup>th</sup> Edition*", (London, UK, McGraw-Hill).

Bloom, N.; Garicano, L.; Sadun, R.; van Reenen, J.M. 2009. "The Distinct Effects of Information Technology and Communication Technology on Firm Organization", NBER Working Paper No. 14975 (Cambridge, MA, National Bureau of Economic Research).

Brühlhart, M. 2001. "Evolving Geographical Concentration of European Manufacturing Industries", in *Weltwirtschaftliches Archiv*, 137(2): 215–243.

Cattaneo, O.; Gereffi, G.; Staritz, C. 2010. "*Global Value Chains in a Post-crisis World: A Development Perspective*" (Washington, DC, World Bank)

Economist, The. 2012 "A third industrial revolution", Economist Magazine Special Report, 21 April 2012. Available at: <http://www.economist.com/node/21552901>

Florida, R. 2005. "The World is Spiky" in *The Atlantic Monthly*, 296 (3):48–51

Fujita, M.; Krugman, P.; Venables, A. J. 1999 "*The Spatial Economy: Cities, Regions and International Trade*" (Cambridge MA, MIT Press).

Gereffi, G.; Humphrey, J.; Timothy Sturgeon, T. 2005. "The Governance of Global Value Chains", in *Review of International Political Economy*, 12: 1.

Horn, H.; Mavroidis, P. C.; Sapir, A. 2009. "Beyond the WTO? An Anatomy of EU and US Preferential Trade Agreements", CEPR Discussion Paper No. DP7317 (London, UK, Center for Economic Policy Research).

Hummels, D.; Ishii, J.; and Yi K-M. 1999. "The Nature and Growth of Vertical Specialization in World Trade", Staff Reports 72, Federal Reserve Bank of New York. Available at: <http://ideas.repec.org/p/fip/fednsr/72.html>

Johnson, R.C.; Noguera, G. 2011. "Accounting for Intermediates: Production Sharing and Trade in Value Added", in *Journal of International Economics*, forthcoming.

Johnson, R. C.; Noguera, G. 2012. "Fragmentation and Trade in Value Added over Four Decades". Available at: [www.colorado.edu/Economics/seminars/johnson.pdf](http://www.colorado.edu/Economics/seminars/johnson.pdf)



Koopman, R.; Wang, Z.; Wei, S.-J. 2008 "Give Credit where Credit is Due: Tracing Value Added in Global Production Chains", NBER Working Paper 16426 (Cambridge MA, National Bureau of Economic Research).

Krugman, P. 1991 "Increasing Returns and Economic Geography", in *Journal of Political Economy*, 99: 483–99.

Lanz, R.; Miroudot, S.; Nordås, H.K. 2012. "Does Fragmentation of Production Imply Fragmentation of Jobs?", OECD Trade and Agriculture Directorate working paper. Available at: <https://www.gtap.agecon.purdue.edu/resources/download/5841.pdf>

Lopez-González, J. 2012. "Vertical Specialisation and New Regionalism", Thesis PhD, University of Sussex, April.

Niepmann, F.; Felbermayr, G. 2010. "Globalization and the Spatial Concentration of Production", in *World Economy*, 33(5): 680–709.

Patterson, G. 1966. "*Discrimination in international trade: The policy issues 1945–1965*" (Princeton NJ, Princeton University Press).

Porter, M.E. 1985. "*Competitive Advantage*" (New York, Free Press).

Pritchett, L. 1997. "Divergence, Big Time", in *Journal of Economic Perspectives*, 11: 3.

Puga, D.; Venables, A.J. 1996. "The Spread of Industry: Spatial Agglomeration in Economic Development", in *Journal of the Japanese and International Economies*. 10(4): 440–464.

Simchi-Levi, D. 2010. "Impact of Crude Oil Volatility on Network Design", online powerpoint. Available at: [www.scdigest.com/assets/refs/Impact\\_Oil\\_Prices\\_on\\_Supply\\_Chain\\_Network\\_Design.pdf](http://www.scdigest.com/assets/refs/Impact_Oil_Prices_on_Supply_Chain_Network_Design.pdf)

Simchi-Levi, D.; Peruvankal, J.P.; Mulani, N.; Read, B.; Ferreira, J. 2011. "Made in America: Rethinking the Future of US Manufacturing", Available at: [www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Made-in-America.pdf](http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Made-in-America.pdf).

Spitz, A. 2004. "Are Skill Requirements in the Workplace Rising? Stylized Facts and Evidence on Skill-Biased Technological Change", ZEW Discussion Paper 04-33. Available at: <ftp://ftp.zew.de/pub/zew-docs/dp/dp0433.pdf>

WTO. 2011. "The WTO and Reciprocal Preferential Trading Agreements", World Trade Report 2011 (Geneva, Switzerland, World Trade Organization).



# 2 The role of services in global value chains

Patrick Low<sup>1</sup>

## 2.1. Introduction

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The intangibility of services makes them analytically and statistically elusive. Systematic efforts to deepen our understanding of the economic role played by services – particularly at the international level – have only occurred in the last thirty years. These efforts have intensified recently with the increased presence of global value chains, where services fulfill a vital and complex role.

Services have occupied a dominant place in most economies for a long time. According to the World Bank's World Development Indicators (2012), the share of services value-added in world gross domestic product (GDP) was 70 per cent in 2010, rising fairly steadily from 53 per cent in 1970, 57 per cent in 1990 and 68 per cent in 2000. Besides reflecting the shift towards service economies in advanced countries, the growth in these shares over time will almost certainly have been influenced by improvements in statistical methods and techniques. The services share has also risen as a result of structural changes in economies that have led to greater segmentation and more arms-length transactions, allowing the separate identification of services transactions. Notwithstanding national variations in the shares of GDP attributable to services, manufacturing, agriculture and mining, in most economies the services share is greater than that of the other three components of economic activity combined.

The story of the share of services in international trade is even more interesting, reflecting data limitations that the international community has only just begun to address. For many years we have been estimating the share of cross-border services transactions in international trade at just over one-fifth of total trade (WTO International Trade Statistics, 2012). The recent OECD/WTO work on measuring trade in terms of the value added to products by different countries along supply chains, rather than

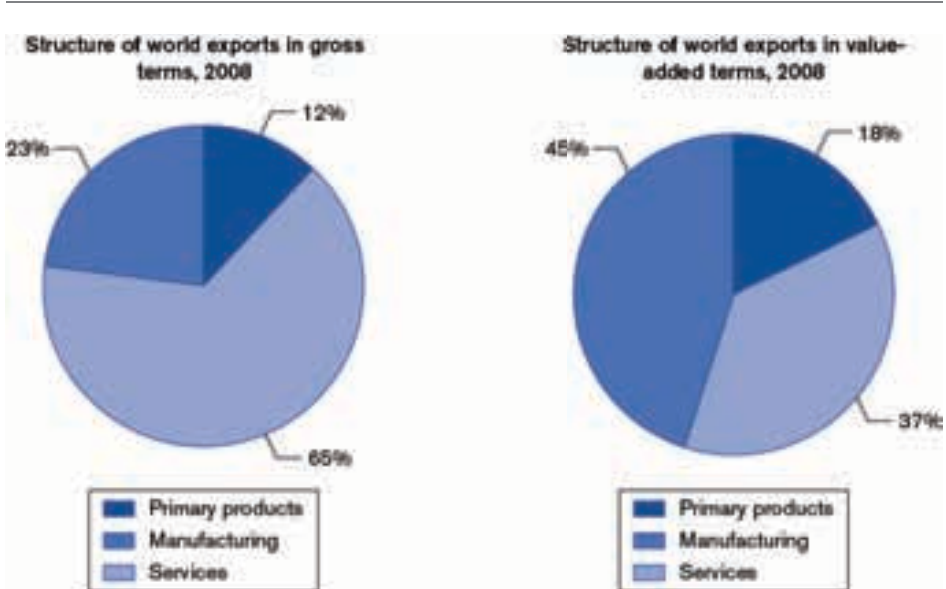
in gross terms, has yielded a dramatically different picture. In 2008, for example, the share of commercial services in world trade was estimated at 23 per cent in gross terms and 45 per cent in value-added terms (Figure 2.1).<sup>2</sup>

In what follows, Section 2.2 of the paper explores a range of issues relating to the role of services on supply chains. The analytical challenges associated with complementarity among multiple markets are discussed. Emphasis is placed on the ubiquity of services in supply chain production. The concepts of servicification, service science and invisible assets are considered in terms of supply chain operations. Section 2.3 looks very briefly at the complex issues associated with upgrading and value-added attribution along supply chains, and considers where services might fit into this debate. Section 2.4 covers data issues relating to the identification, classification and measurement of services. Section 2.5 concludes.

## 2.2. The role of services along global supply chains

Services figure in almost every activity in an economy. This is particularly true of what are often referred to as producer services – transport, communications,

Figure 2.1: Sectoral contribution to total trade, gross and value-added measures, 2008



Source: WTO Secretariat estimates based on OECD-WTO data.

finance, distribution and business services. This pervasiveness makes services key determinants of competitiveness and the productivity of capital and labour. But this is only part of the picture, since numerous other services are involved in the production and sale of products, whether the final product is a good or a service.

Services have sometimes been referred to as the glue that holds supply chains together and ensures that they function in a fluid manner. This is only one aspect of what services do. They are also part of many production and sales processes, as we will see below. Modern communication and transport technologies have enhanced the tradability of services. This has facilitated their incorporation in supply chain production as traded inputs. In addition, what business literature calls “modularization”<sup>3</sup> has led to the incorporation or bundling of services into composite products. This phenomenon is not unlike what the economics literature refers to as trade in tasks<sup>4</sup>, where inputs do not break down readily into the product classification and nomenclature systems with which we are more familiar. A typical example of this would be “business functions”.

While in the past productivity growth has been greater in manufacturing than in services, emerging literature on the extent of unidentified service activities in production raises questions about the accuracy of relative productivity measures. Even if the data reflect reality, services may be a growing source of competitiveness. This conclusion follows from a new appreciation of how the service economy works and of different ways of producing and delivering services as elements of aggregated value propositions.

As discussed below, much of the analysis does not necessarily refer directly to services, but rather to invisibles. However, since invisibles are intangible, and the one defining feature distinguishing services from goods is intangibility, there is no doubt that invisibles include services.

### ***The consequences of complementary markets***

In terms of their operation, supply chains can be thought of as a series of linked markets for goods and services. These markets are interdependent in the sense that something happening in one market affects many other markets. This complementarity, sometimes referred to as joint demand or derived demand, is associated with negative cross-elasticities of demand. This means that if the price of product A increases in

one market, the demand for product B in another will fall. The result is that demand for both A and B falls.

This complementarity links goods and services markets with no distinction in terms of economic effects as to whether the products in question are tangible or intangible.<sup>5</sup> Under these multiple-market relationships, changes in conditions in one market – including because of a policy intervention – provoke ripple effects in others along the whole supply chain, both upstream and downstream. The same logic holds in situations where there is modularization or bundling, and inputs are composites of at least two products that in principle could be supplied separately.

While the complementary nature of markets is intuitively obvious and doubtless taken into account in many decisions of market agents, this reality does not always seem to be fully factored into the expectations of policy-makers in terms of the consequences of their actions. A possible explanation for this could be myopia, given that until very recently adequate data were unavailable. Policy interventions will affect relative prices across different interdependent markets, possibly with unintended consequences.<sup>6</sup> This suggests that policy-making should be an integrated process.

There are two aspects to this, at the level of measures and policies. When governments take measures pursuant upon a policy, they should take into account market complementarities and knock-on effects in the particular market situation at hand. The impact of such reverberations can be particularly pronounced where policies affecting components (goods or services inputs) have a multiplicative or magnification effect as they cross more than one frontier along the supply chain.<sup>7</sup>

At the policy level, this is about the design of different policies with varying objectives and contexts, which in the end come together to affect outcomes beyond the initial focus of attention and the objectives of individual policies. Outcome linkages and spill-overs call for a holistic approach to policy formulation. Policies formulated internationally that also aim to shape outcomes in areas like trade in goods, trade in services, investment, intellectual property protection, and competition will affect many activities in many markets. Getting policy right in each of these areas is therefore essential to the effective overall operation of supply chains. The current approach that relies on “silo” agreements in these different areas is short on appreciation of the consequences of complementarity. The pattern observed internationally is a reflection of how policy is made domestically, suggesting that any new approach must begin at home.

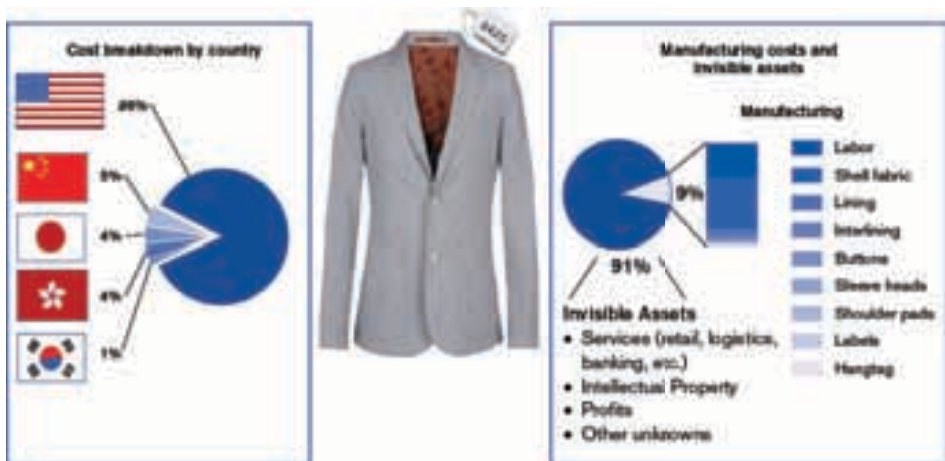
### Identifying services along the supply chain

In practice it is no easy matter to identify separately all the individual service components that make up the full value of a product, not least because of the bundling phenomenon. The detailed product breakdown in Figure 2.2, depicting the value chain for a coat, is a useful illustration of the difficulties encountered in trying to disaggregate a range of different services.

Of the US\$ 425 price tag for the jacket, only 9 per cent of this initial retail price is associated with making the jacket, with the remainder attributable to “invisible” assets.<sup>8</sup> This is the identification problem: what is contained in the invisible assets? There will be elements both on the pre-manufacturing upstream part of the process, as well as on the post-manufacturing downstream. Upstream sources of value are likely to include design, intellectual property, branding, and so on. Downstream elements include advertising, marketing and retailing. Disentangling the sources of value, the individual services involved, and the implication of policy for these segments of the supply chain are formidable tasks.

One of the most thorough efforts at achieving this is the case study of the Nokia95 phone undertaken by Ali-Yrkkö et al. (2011). Through meticulous sleuthing, the authors managed to produce a detailed breakdown of the value chain for the product.

FIGURE 2.2: A suit made in China and sold in the United States



Source: Fung Global Institute Li & Fung case study.

The parts (including processors, memories, integrated circuits, display and camera) accounted for 33 per cent of the product. Assembly only accounted for 2 per cent. The remaining two-thirds of the product was accounted for by Nokia's internal support services (31 per cent), licenses (4 per cent), distribution (4 per cent), retailing (11 per cent) and operating profit (16 per cent). Despite the relatively fine detail of the breakdown of invisibles in this case study, a good deal is still missing in terms of the different services that went into production. The missing services problem also applies in the case of the manufacturing part of the operation, notwithstanding its small share.

### *The notion of “servicification”*

The Swedish National Board of Trade has undertaken some useful work in a number of studies in recent years on the servicification of the Swedish economy and of Swedish firms operating internationally (Kommerskollegium, 2010a, 2010b, 2012). Related work based on the same idea of servicification makes reference to servicing (Reisken et al., 2000) and the “manuservice” economy (Bryson and Daniels, 2010). As discussed in Ryu et al. (2012), the term servitization was first used by Vandermerwe and Rada (1988). The definition of servification and similar derivatives of the word service used to denote the same phenomenon is not very precise but they capture important ideas about how the role of services has evolved in recent years. Essentially, servicification refers to the increased use of services in manufacturing, both in terms of production processes and sales. This phenomenon may in part reflect the separation of services functions in manufacturing from core production functions. In Sweden's case (and no doubt elsewhere) this is linked to the development of enterprise groups, where manufacturing enterprises comprise different firms, some of which are dedicated to service production. Higher productivity growth in manufacturing than services and shifting demand and production patterns underlie the decline in the share of manufacturing and the rise of services in economies like that of Sweden (Kommerskollegium, 2010a).

A significant feature of servicification is the opportunity it offers for strategic firm behaviour designed to move up the value chain. While some of the bundling or modularization occurring along supply chains as a result of servicification may be occasioned by the exigencies of locational dispersion in production and consumption, or by regulatory requirements, these tendencies are also likely to be fed by strategic motivations internal to firms (Sundin et al., 2009; Kommerskollegium, 2012). Firms may seek to customize their offerings so as to differentiate them in the marketplace and earn higher returns or to spread risk by diversifying the output mix.



A case study of the Swedish multinational Sandvik Tooling (Kommerskollegium, 2010b) revealed that in order to manage the supply chain and deliver goods, the firm had recourse to 40 discrete services. A further twelve services were required to handle customer delivery (Table 2.1). The study does not specify whether these services were separately supplied even if they could be separately identified, or whether they were packaged (modularized) into composite offerings.

This wide array of services includes high value-added and low value-added activities. Some of the services are tradable, others are not. Some may be produced in-house, others at arms-length. Arms-length services could be outsourced or offshored. Amongst this large set of services associated with the production of machine tools, there would doubtless be opportunities for product differentiation and higher average value-added packages – in other words, for repositioning on the supply chain. Some of these services could even be provided to customers of rival manufacturing firms in the same market, or to rival firms themselves.

Finally, depending on the product in question, significant scope may exist for the provision of after-sales services as an additional source of product differentiation and profit. These services can take many forms, including technical assistance and training, maintenance, provision of spare parts and repair services, and a range of other customer care services (Saccani et al., 2007). The means of delivery of after-sales services by a lead firm will vary from direct supply, sub-contracting arrangements, agency relationships and franchising.

**TABLE 2.1: Services necessary to the Sandvik Tools supply chain**

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*Services for operating the supply chain*

Legal services; Accounting, book-keeping etc.; Taxation services; Medical services; Computer services; Research and development; Rental/Leasing; Advertising; Market research; Services incidental to manufacturing; Placement of personnel; Maintenance and repair; Security services; Packaging; Printing; Publishing; Design; Building-cleaning services; Photographic services; Courier services; Logistic services; Postal services; Telecommunications; Audio-Visual services; Educational services; Environmental services; Banking services; Insurances; Health related services; Hotels and restaurants; Travel agency services; Maritime transport – freight; Inland waterways – freight; Inland waterways – freight; Air transport – freight/passenger; Road transport – freight/passenger; Cargo-handling services; Storage and warehouse services; Freight transport agency services; Feeder services; Energy services.

*Services for customer delivery*

Computer services; Research and development; Rental/leasing; Maintenance and repair; Management consulting; Technical testing and analysis services; Services incidental to manufacturing; Design; Environmental services; Financial services; Logistics; Warehouse services.

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Source: Authors.

## *Services, networks and value analysis*

In a similar vein to the analysis of complementary markets, joint production and trade in tasks discussed above, a new literature is emerging that goes under the broad rubric of “service science”. The literature is yet to become mainstream but it strives to explain how networks, technology, entrepreneurship and consumers interact to generate innovation and create value. The recently published volumes by Maglio et al., (2010) and Demirkan et al., (2011) are examples of a burgeoning literature around service science.

A “service-dominant” logic of value creation and exchange (Vargo and Lusch, 2004) underpins much of the analysis, which focuses on service systems. Production is seen more as a dynamic and collaborative interactive process among people than as the combination of readily definable fixed and variable inputs of capital, labour and components into units of output. The analysis that goes under the name of service science bears a resemblance to the notion of innovation systems.

Service science aspires to a high degree of inter-disciplinary or even trans-disciplinary thinking. Spohrer (2009) has argued for “an integrated approach that spans not only existing discipline-based silos within academic organizations (i.e. marketing, operations, and human resource management within a business school) but also across academic organizations (i.e. business, engineering and liberal arts).”<sup>99</sup> Ng et al., (2011) suggest that service science should combine what they describe as a prevailing reductionist analytical perspective with a systems perspective as a means of establishing a disciplinary base for service science.

A useful bridge between service science and more conventional analytical approaches is provided by Allee (2008) who examines the relationship between value and tangible and intangible assets. Intangible assets may be unpriced in the market and non-contractual, but nevertheless embody value. Such intangibles could include human knowledge, internal structures, working methods, reputation, business relationships, trust, social citizenship, environmental responsibility, and business values. These intangibles can sometimes command explicit value in the market, such as through consultancy contracts or explicit price premia. Allee (2008) argues, however, that trying to price these assets in terms of units of input is a fool’s errand. Some idea of the worth of the assets can be gleaned from the difference between the value of a firm’s assets and its sale value.

An imperfect and approximate indicator of this value could be captured by the goodwill recorded on a firm's balance sheet. Some of the value emerges as barter relationships among parties to transactions. For the rest, the argument seems to be that value analysis requires an understanding of how roles and relationships create value. Even unpriced assets can be rendered into negotiable value and a systematic analysis of roles, transactions and deliverables must be undertaken in value creation analysis.

### *The OECD new sources of growth project*

If the Allee (2008) analysis assists in bridging the gap between service science and more traditional analytical approaches to understanding markets, the OECD's work (OECD, 2011, 2012) on intangible assets as new sources of growth is a further contribution in this direction. The OECD refers to a three-fold definitional distinction among the components of invisible assets. These include computerized information (software and data), innovation property (R&D, intellectual property), and economic competencies (brand equity, human capital specific to firms, networks joining people and institutions, organizational know-how, and advertising and marketing strategies).

The economic competencies category is strikingly similar to the essential focus of service science. The OECD's use of terminology has varied over time. Earlier references were to intellectual assets, knowledge assets and intellectual capital, while in later work the term used has been knowledge-based capital (KBC). All these terms refer to invisibles, which are to be contrasted with tangible assets such as plant, machinery and buildings. The OECD argues that countries investing proportionately more in KBC are doing better via enhanced productivity than those investing proportionately less.

A further useful addition to the OECD's work in this field is an analysis of the implications of policy on investment in, and production of, KBC. Relevant policies include tax and regulatory regimes, intellectual property, competition policy, investment policy, protection of data, data privacy and policies affecting corporate governance. This discussion reinforces the growing conviction that the segregation of policies into separately constructed regimes is inimical to coherence at the interface of policy and supply chain operations. An integrated approach to policy appears increasingly necessary.

### 2.3. Services and progression up the value chain

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The emphasis so far has been upon understanding both the ubiquity of services in supply chain production and the interdependent nature of markets across the goods and services spectrum. This focus calls for a brief consideration of a current issue for many governments – namely, how to build a more diversified, prosperous and dynamic economy through participating in supply chains. In practical terms this amounts to the separate but connected questions of how to position a country in terms of supply chain participation, and how to acquire higher value-added segments of supply chains in which a country is involved or broaden the scope of participation. The paper by Gereffi and Sturgeon (2013) in this volume addresses these issues in more detail, particularly in relation to emerging economies. While emerging economies with large and dynamic domestic markets may have more degrees of freedom in terms of their policy options, this matter is no less pressing for other developing countries.

The core emphasis here is on the scope for thinking about invisibles as a vehicle for new entry and upgrading. This requires firms to look beyond their core competencies to other, less visible competencies such as networks with suppliers and the capability to perform specific tasks that can be replicated. An extensive listing of services that might be supplied to a lead firm on a supply chain has been undertaken by Gereffi and Fernandez-Stark (2010). The authors have divided services into information technology, knowledge processes and business processes. Each of these categories is further divided into multiple activities similar to the breakdown laid out above in the case of the Sandvik Tools supply chain (Kommerskollegium, 2010b). In addition, they have approximately ranked the services in terms of value-added, with knowledge processes and some information technology services embodying high value-added, and business processes tending to involve lower value-added content.

The analysis by Gereffi and Fernandez-Stark (2010) is in fact based on a discussion of off-shored services. This suggests the option of plugging into a supply chain with activities located elsewhere, relying on cost and skill advantages that allow participation in relatively high value-added activities from a distant location. But the provision of such services does not have to be on an off-shored basis. They could also have been outsourced domestically. Moreover, we often tend to think of off-shored and outsourced services being supplied at arms-length by independent entities. This is not necessarily the case. Such services could be provided on an

in-house basis by the lead firm itself. In both cases the key point is location, as what we are interested in here is progression up the value chain from a national perspective.

### ***The process of upgrading***

A wide literature has developed over the last decade or so on the ingredients of successful upgrading by firms.<sup>10</sup> The essence of successful upgrading resides in the capacity to segment markets. It means establishing a competitive position with an offering that cannot be replicated, at least in the short-term. This is clearly easier for a lead firm to achieve than a secondary supplier. The sources of this market advantage could be a technology, a technique, a bottleneck of some description or a modularized product.

Kaplinsky and Morris (2001) distinguish among four kinds of upgrading – process, product, functional and chain. Process upgrading involves efficiency gains that allow the capture of a part of the chain unreachable at lower levels of competence. Product upgrading involves the acquisition of technological capability that permits the introduction of a new product or improving an existing one. Functional upgrading occurs when a producer manages to move to a different segment of the supply chain with higher value-added characteristics. Finally, chain upgrading means participating on a different, higher value-added supply chain.

The extent to which service provision can benefit from upgrading within this framework depends in part on how the service is supplied. If services are supplied as individual products, the changes in the product itself or its production processes will be the sole source of any upgrading gains. If, on the other hand, services are provided as part of a modularized task embodying more than one product as inputs, then the services components of such a task may play a greater or lesser role in the shift to higher value-added activities.

### ***The role of policy in upgrading: relationships between firms and governments***

Part of the upgrading literature is particularly concerned with the question of what role governments should play in fostering upgrading.<sup>11</sup> The interest of governments in this is essentially about social upgrading, which means improving workers' conditions and environmental standards. Industrial upgrading is the

proximate consequence of this objective. The discussion is rooted in the post-war industrialization debate. From the earliest versions of industrial development policy in developing countries, including import substitution and export-oriented industrialization, the debate has moved on to consider the kind of industrial policy needed to participate in supply chain operations in a manner that will serve national development priorities. The role of the domestic market for final output is attenuated for large economies and non-existent for small ones where successful participation in a supply chain relies on transforming domestic and imported inputs into further elaborated inputs or final goods for export markets. The picture is a little different if the supply chain ends in the domestic market. The requisite policy mix will be conditioned by the nature of involvement and the source of competitiveness, including in the context of upgrading.

A broad distinction can be made between those policies that aim to create the right economy-wide environment for competitiveness and those that seek directly to alter the structure of production through sector-specific interventions. The first of these approaches focuses on such matters as infrastructure, connectivity, a business-friendly and cost-minimizing operating environment, access to credit, innovation and macroeconomic stability. The more directed, sector- or activity-specific interventions generally involve tariffs, other trade restrictions, fiscal incentives and other subsidies, a range of possible regulations such as local content or export performance requirements, and exchange restrictions.

Views differ as to the relative merits of narrow- versus broad-based approaches, although they are not mutually exclusive. Much depends on the specific circumstances, including the nature of the supply chain, the quality of governance, and various aspects of domestic supply conditions. Where do services fit into this picture? The relative neglect that services tend to receive in both policy and analysis would suggest that this is an obvious place to look for possible upgrading opportunities. As illustrated in Gereffi and Fernandez-Stark (2010), scope for participating remotely in supply chains exists in a range of services. What is significant about services in this context is that the physical infrastructure requirements are less onerous than those required for participation in the goods sector, allowing economies and firms to do some leapfrogging. On the other hand, good telecommunication connectivity is essential. Finally, there is also the question of the role of services in upgrading through modularization or servicification/servitization, and how policy can facilitate such opportunities.

## 2.4. Data challenges

### *The implications of the smile curve for services in global value chains*

One of the most commonly reproduced diagrams in discussions on supply chains is the smile curve articulated by the founder of Acer, Stan Shih. The smile curve illustrates the opportunities that exist on a value chain to produce higher value-added components upstream and downstream of manufacturing and assembly (Figure 2.3). This was the strategy from which Acer was born, upgrading from assembly to the high value-added invisibles on the supply chain for computers.

Unless interpreted with care, the smile curve can be misleading in terms of understanding the role of services on the supply chain. The problem arises from the interpretation of what exactly the smile curve depicts. The vertical axis does not show what share of value-added each identified activity represents of the total price of the product – in other words the identified sources of value are not additive. Even the implied relative share of value-added among activities is not established because the position of each activity on the curve is determined by the production sequence depicted on the horizontal axis. We do not know, for example, whether value-added per unit of output on branding is less than the same measure for design.

FIGURE 2.3: Stan Shih's Smile Curve



Source: Adapted from Business Week Online Extra, May 16, 2005.

Another interpretative pitfall relates to whether we think of the smile curve as a product, a sector, or an entire economy. This can become particularly troublesome if the assumption is made that manufacturing is where the jobs are, in contrast to the high-return, capital intensive segments of the production process. If taken to represent the whole economy, it is easy to assume there is an inevitable trade-off between jobs and higher value-added – in other words that reliance on services destroys jobs. In fact, some parts of the upstream or downstream value chain may be labour-intensive (such as retailing). Be that as it may, assuming greater capital-intensity in higher value-added activities does not necessarily mean a job shortage for the economy because the composition of available jobs for the production of a single good is not the same as the job requirements for the economy as a whole. The job consequences of upgrading depend on the structure of the entire economy. It may well be that moving to higher value-added segments on a supply chain implies fewer employment opportunities on that chain. But many other factors, such as skill levels in the workforce and the functioning of the labour market, will determine the employment consequences of upgrading on the economy as a whole.

### ***The imperfect statistical identification of services on supply chains***

The only decisive difference between services and goods is tangibility. The intangibility of services makes them harder to identify and measure. The difficulty is compounded by the heterogeneous (customized) nature of many services transactions and the lack of a properly developed and generally accepted nomenclature for services. Other challenges arise for the reasons discussed above – services may not be supplied separately from one another, or from goods, and they may not even be contracted for and priced.

From a statistical point of view, it also matters whether transactions are arms-length. On a supply chain producing goods, any services produced “in-house” – without any recorded arms-length transaction – may well appear as goods in both output and trade data.<sup>12</sup> While this creates no discrepancy between output and trade data, it still misrepresents services as goods.<sup>13</sup> The degree to which this occurs depends on the structure of the economy. As firms grow, and agglomeration effects create external economies of scale, the outsourcing or offshoring services previously produced internally is likely to increase. This will lessen the degree of statistical confusion between goods and services.



Another classification issue, however, further militates against precision and predictability in distinguishing between goods and services in production. This results from reliance on ownership as a criterion for determining whether output counts as goods or services. Contract manufacturing arrangements result in manufactured output being classified as services output. This is the treatment prescribed by the 6<sup>th</sup> revision of balance of payments statistics and the 2008 revision of the system of national accounts. As Adlung and Zhang (2012) point out, this is not only an accounting matter. In a world where policies applying to goods and services are not uniform, different policy treatment can affect investment and ownership decisions in the real economy. This means that policy can inadvertently distort economic structures.

### ***Definitional redundancy further complicates analysis***

The concepts of “embodied” and “embedded” services have been widely used to describe the role of services in production.<sup>14</sup> Embodied services are generally defined as a service whose product constitutes an input into the manufacture of a good. Examples of embodied services include transport, telecommunications, financial services and business services. Embedded services are those that constitute an input into the sale of a good, such as retail, after-sales support, and inventory management.

One problem with the distinction is that it creates a discrete definitional break in processes along a supply chain that does not seem to serve any useful analytical purpose. From a policy perspective the distinction is not precise enough – the relevant policy mix is likely to be very different among services categorized within each group. Moreover, the distinction cuts across key service sectors and does not match fully with certain kinds of services such as management, administration and back-office functions or information technology systems, which might be embodied or embedded. The categories therefore overlap.

Perhaps the most serious drawback is that these categories do not distinguish clearly between arms-length and non-arms-length transactions. It is this distinction that determines whether services are incorporated in goods (and vice-versa) for statistical purposes. The two categories do not, therefore, help us distinguish between statistical (informational) shortcomings and structural/organizational factors, both of which are associated with identification challenges relating to the contribution of services to supply chain production and trade. In short, the key issue for statistical recording is the contractual nature of the supply relationship, not embodiment or embedment.

## 2.5. Summary and conclusions

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Services matter more than one might judge from the paucity of analytical attention they have received. They dominate many national economies in terms of their share of GDP. They are also a prominent and increasingly important component of international trade. They play a crucial role in value chains – a role that is often underestimated and poorly understood.

Part of the challenge of acquiring a clear understanding of services on value chains relates to the intangible nature of services, their heterogeneity (even within narrowly defined service categories) and the absence of a fully developed and commonly agreed product nomenclature. Case study work has revealed how numerous and multi-faceted service inputs can be on product-specific supply chains. Case study work has also shown how difficult it is in practice to identify the true content of the frequently significant share of total value to be accounted for between manufacturing costs and the final price of a product. This margin contains upstream and downstream inputs along the supply chain, typically of the kind identified by the smile curve analysis (plus profits). Another area of complexity relates to post-sales services in the case of certain kinds of supply chains.

Complementarity relationships among markets along supply chains, involving both goods and services, also complicate analysis. This is particularly relevant when thinking about policy, since the traditional tendency to think about policies and regulate markets in unconnected silos can lead to unintended and undesirable results. In addition to the complementary nature of discrete markets, in many cases goods and services may be bundled or modularized into composite offerings. Reasons for this vary, and may include considerations of technical efficiency, responses to the regulatory environment, strategic market segmentation, or a policy of upgrading to acquire a larger share of value-added. Whatever the motivation, disentangling the outcomes with precision is a challenge.

Recent work, some of it under the rubric of “service science”, seeks to understand services networks and the importance of these networks for generating value along supply chains. They combine production, technology, entrepreneurship, and consumers into a virtuous circle of innovation. Outcomes are complex, and the resulting creation of value is not always fully captured in explicit market transactions or prices. This branch of analysis is relatively new and in some respects still under development.

It is linked to the OECD-driven work on knowledge-based capital, which seeks to understand opportunities for generating value through invisible assets.

This paper contains a very brief discussion of upgrading aspirations – often articulated at the national or regional level – that aim to acquire a larger share of value-added along supply chains. The emphasis in this paper is on where services might fit in this context. The capture of value-added may take the form of breaking into supply chains that begin and end elsewhere, or of building a greater source of domestic value on commodity-based chains that begin at home. The policy mix pursued for this purpose is a subject of debate, and depends on questions such as the size of the domestic market, the state of domestic infrastructure, and the quality of governance.

A key distinction in thinking about policy is whether the focus is on enabling competitive production at greater levels of sophistication or seeking to alter the economic structure by applying policies more narrowly to particular sectors or activities. Broadly, the first approach is akin to a horizontal orientation, while the latter is industrial policy proper. They are not mutually exclusive. Opportunities for upgrading through services have arguably been neglected. They include the possibility of limiting the need for infrastructure to good information and communications networks, and a range of possibilities through modularization.

In light of the nature and potential complexity of engaging in supply chain production through services, not to mention the challenges of mastering the intrinsically elusive nature of services, it is unsurprising that complete services data are difficult to acquire. Important issues are how services are counted in terms of ownership relationships and whether transactions are arms-length. Where services are clustered or modularized into composite offerings, measurement complications also arise. The paper argues that from a statistical and conceptual perspective, one should be careful about how the smile curve is interpreted. It was also argued that the notions of embodied and embedded services, as frequently used in the literature, are not very helpful in analytical terms.

In sum, the paper has attempted to identify some of the major issues and challenges confronting efforts to understand the role of services in supply chains. An obvious take-away is that more research is required in order to understand the nature of services that form part of supply chains, and to forge optimal policies accordingly. A less obvious one is that armed with an adequate appreciation of the realities, pragmatic ways should be found for dealing with them, rather than exerting efforts in pursuit of spurious precision that will ultimately be subject to challenge.

## Endnotes

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- 1** The author is a member of the staff of the WTO Secretariat, a Senior Fellow at the Fung Global Institute and an Adjunct Professor at the Graduate Institute of International and Development Studies. The views expressed in this paper are those of the author and should not be attributed in any way to the institutions with which he is associated or to the membership of the WTO. The author is grateful for comments from Hubert Escaith, Gaurav Nayyar, Albert Park, Julia Tijaja and Rocky Tung on an earlier draft. None of them bear responsibility for any remaining errors.
- 2** See also Francois and Manchin (2011) for calculations of the services value-added content of trade.
- 3** Modularization arises from arrangements whereby the offering of a value chain supplier is a packaged combination of products, be they goods and/or services. Such offerings may reflect cost minimization considerations or they may be strategically put together as a means of market segmentation (customization) that provides higher returns for the supplier.
- 4** For the seminal economics paper on this that brings together a previous literature on offshoring and the workings of supply chains, see Grossman and Rossi-Hansburg (2008).
- 5** In practice, however, the fact that goods, unlike services, are storable and can be held as inventory may influence the complementarity relationships between goods and services.
- 6** The possibly apocryphal tale of Victorian rat catchers who raised more rats than they killed in order to increase their incomes as rat exterminators is a simple example of how policies taken in isolation of any thought of their knock-on effects can have unintended consequences.
- 7** See, for example, Ferrantino (2012) for an explanation of how this works. The magnification effect is not unlike the bullwhip effect discussed in the business literature on supply chains.
- 8** Since this is a product from the fashion industry, it is likely that the initial retail price would be discounted in order to avoid the problem of managing inventories in an industry where fashions change quickly. Nevertheless, the invisible assets still represent a major part of the product's value.
- 9** Cited in Ng et al. (2011). P.15
- 10** Among the major early contributions to this literature are Gereffi and Kaplinsky (2001), Kaplinsky and Morris (2001) and Gereffi (2002).
- 11** The main lines of argument in this debate is summarized in Gereffi and Sturgeon (2013). Another recent contribution is Milberg et al. (2013).
- 12** Modern national accounting survey techniques attempt to adjust for this.
- 13** The same can happen with respect to goods on a services supply chain, but probably occurs less frequently.
- 14** See, for example, Drake-Brockman and Stephenson (2012).

## References

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Adlung, R.; Zhang, W. 2012. "Trade disciplines with a trapdoor: contract manufacturing", *WTO Working Paper*, ERSD-2012-11. Electronic access: [http://www.wto.org/english/res\\_e/reser\\_e/ersd201211\\_e.pdf](http://www.wto.org/english/res_e/reser_e/ersd201211_e.pdf)

Ali-Yrkkö, J., Rouvinen, P., Seppälä, T.; Ylä-Anttila, P. 2011. "Who Captures Value in Global Supply Chains? Case Nokia N95 Smartphone", in *Journal of Industry, Competition and Trade*, September, Volume 11:3, 263–278.

Allee, V. 2008 "Value Network Analysis and value conversion of tangible and intangible assets", *Journal of Intellectual Capital*, 9(1): 5–24.

Bryson, J.R.; Daniels, P. W. 2010. "Service Worlds: The 'Services Duality' and the Rise of the 'Manuservice' Economy" in Maglio, P.P., Kieliszewski, C. A. and Spohrer, J.C. (eds.) *Handbook of Service Science*, Springer, New York.

Demirkan, H.; Spohrer, J.C.; Krishna, V. (eds). 2011. *The Science of Service Systems*, Springer, New York.

Drake-Brockman, J.; Stephenson, S. 2012. "Implications for 21<sup>st</sup> Century Trade and Development of the Emergence of Services Value Chains", Electronic access: <http://ictsd.org/downloads/2012/11/implications-for-21st-century-trade-and-development-of-the-emergence-of-services-value-chains.pdf>

Ferrantino, M. J. 2102. "Using Supply Chain Analysis to Examine the Costs of Non-Tariff Measures (NTMs) and the Benefits of Trade Facilitation", *WTO Working Paper*, ERSD-2012-02. Electronic access: [http://www.wto.org/english/res\\_e/reser\\_e/ersd201202\\_e.pdf](http://www.wto.org/english/res_e/reser_e/ersd201202_e.pdf)

Francois, J.; Manchin, M. 2011. "Services Linkages and the Value Added Content of Trade". Electronic access: [http://siteresources.worldbank.org/INTRANETTRADE/Resources/Internal-Training/287823-1256848879189/6526508-1283456658475/7370147-1308070299728/7997263-1308070314933/PAPER\\_7\\_Francois\\_Manchin.pdf](http://siteresources.worldbank.org/INTRANETTRADE/Resources/Internal-Training/287823-1256848879189/6526508-1283456658475/7370147-1308070299728/7997263-1308070314933/PAPER_7_Francois_Manchin.pdf)

Gereffi, G.; Kaplinsky, R. (eds.). 2001. "The Value of Value Chains: Spreading the Gains from Globalisation", *IDS Bulletin* 32(3).

Gereffi, G. (ed). 2002. *Who Gets Ahead in the Global Economy? Industrial Upgrading, Theory and Practice*, New York: Johns Hopkins Press.

Gereffi, G.; Fernandez-Stark, K. 2010. "The Offshore Services Global Value Chain", Mimeo, (Center on Globalization, Governance and Competitiveness, Duke University).

- Gereffi, G.; Sturgeon, T. 2013. "Global Value Chain-Oriented Industrial Policy: The Role of Emerging Economies", in D. Elms and P. Low (eds): *Global Value Chains in a Changing World* (Geneva, World Trade Organization).
- Grossman, G. M. and Rossi-Hansburg, E. (2008) "Trading Tasks: A Simple Theory of Offshoring", in *American Economic Review*, 98(5): 1978–1997.
- Kaplinsky, R.; Morris, M. 2001. *A Handbook for Value Chain Research*. Electronic access: <http://www.srp-guinee.org/download/valuechain-handbook.pdf>
- Kommerskollegium 2010a. *Servicification of Swedish Manufacturing*, Stockholm.
- Kommerskollegium. 2010b. *At Your Service: The Importance of Services for Manufacturing Companies and Possible Trade Policy Implications*, Stockholm.
- Kommerskollegium. 2012. *Everybody is in Services – The Impact of Servicification in Manufacturing on Trade and Trade Policy*, Stockholm.
- Maglio, P.P.; Kieliszewski, C. A.; Spohrer, J.C. (eds): 2010. *Handbook of Service Science*, Springer, New York.
- Milberg, W.; Xiao, J.; Gereffi, G. 2013. "Industrial Policy in the Era of Vertically Specialized Industrialization", Mimeo.
- Ng, I.; Maull, R.; Smith, L. 2011. "Embedding the New Discipline of Service Science" in Demirkan, H., Spohrer, J.C. and Krishna, V. (eds.) *The Science of Service Systems*, Springer, New York.
- OECD. 2011. "New sources of growth: intangible assets". Electronic access: <http://www.oecd.org/sti/inno/46349020.pdf>
- OECD. 2012. "New Sources of Growth: Knowledge-Based Capital Driving Investment and Productivity in the 21<sup>st</sup> Century", Interim Project Findings. Electronic access: <http://www.oecd.org/sti/50498841.pdf>
- Reisken, E.D.; Johnson, J.K.; Votta, T. J. 2000. "Servicizing the Chemical Supply Chain", *Journal of Industrial Ecology*, 3(2) & 3(3): 19–3.
- Ryu, J.; Hosun, R.; Park, K.; Kim, H. 2012. "A Framework for Servitization of Manufacturing Companies" in Mangal, V.; Karmakar, U. (eds.) 2012. *The UCLA Anderson Business and Information Technologies (BIT) Project: A Global Study of Business Practice*, Singapore: World Scientific Publishing Company.
- Saccani, N.; Johansson, P.; Perona, M. (2007) "Configuring the after-sales service supply chain: A multiple case study", *International Journal of Production Economics*, 110: 52–69.

Spohrer, J. C. 2009. "Welcome to our declaration of interdependence", *Service Science*, IBM.

Sundin, E., Lindahl, M., Comstock, M., Sakao, T.; Shimomura, Y. 2009. "Achieving mass customization through servicification", *Journal of Internet Manufacturing and Services*, 2: 56–75.

Vandermerwe, S.; Rada, J. 1988. "Servitization of Business: Adding Value by Adding Services", in *European Management Journal* 6(4): 314–324.

Vargo, S. L.; Lusch, R. L. 2004. "Evolving to a new dominant logic for marketing", *Journal of Marketing*, 68: 1–17.

World Bank. 2012. *World Development Indicators*, (Washington DC, World Bank).

WTO 2012. *International Trade Statistics*, (Geneva, World Trade Organization).

