Value Creation and Structural Change during the Third industrial Revolution. The Swedish Economy from a Vertical Perspective.

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Value Creation and Structural Change during the Third Industrial Revolution

The Swedish Economy from a Vertical Perspective

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Stockholm, January 2014

Daniel Lind

1. Introduction

1.1 General aim

With its foundations established by classical economists such as Smith, Ricardo and Marx, the analysis of structural change and its role in the growth process is a heterogeneous research tradition. Consequently, economic structures and structural change are terms widely used in economic research, but often with different meanings and interpretations. Despite this vagueness, in economic historical research the analysis of economic structures usually refers to the distribution of factors of production among various sectors of the economy, and structural change denotes, accordingly, how the composition of economic activity changes over time (Syrquin 2010).

Within the Swedish economic historical research tradition, the use of this definition of structural change is prevalent. In this strand of research, the conventional approach to the analysis of growth and structural change has been to apply a horizontal perspective on the economy. Among other things, this means that individual sectors, such as manufacturing and services, are studied in isolation, and no particular interest is directed towards their interdependencies – how purchases and sales of intermediates make them dependent on each other in order to finalize production.

Using this perspective, some well-established notions, or stylized facts, about the contemporary Swedish economy have been identified. These constitute important parts of the general understanding of how the structure of the economy has evolved over time. One of these notions is the claim that production processes have become more vertically disintegrated, due to outsourcing and new services intermediates needed in manufacturing production. Another well-established notion claims that the economy has been deindustrialized in terms of production and employment, supporting the emergence of a post-industrial, knowledge intensive and services dominated economy. Closely related to this is the stylized fact that the business services sector has emerged as an important node of knowledge creation and knowledge diffusion, to the benefit of aggregate efficiency, but especially for the manufacturing sector. This notion is often based on the argument that less productive service sectors contribute to the efficiency gains of a highly productive manufacturing sector. The difference in competitiveness underlying

this argument also has strong global connotations. Following the claimed process of deindustrialization, it is argued that the competitive position of the Swedish economy has deteriorated, as the emerging economies have become more integrated in the world economy.

The general aim of this thesis is to investigate to what extent these emphasized notions – (1) more vertically disintegrated production processes, (2) a deindustrialized economy, (3) the growing importance of the business services sector as a distributor and generator of growth enhancing knowledge, (4) the distinction between a low productivity service sector and a high productivity manufacturing sector and (5) reduced competitiveness – remain valid when a vertical perspective is applied on the contemporary Swedish economy. Are the notions dependent on the particular perspective applied? To what extent will the vertical perspective gradate the general understanding of value creation and structural change? Although highly disparate at a first glance, the notions are closely related, and the common denominator is how companies choose to organize their production and how it affects the growth process.

1.2 The vertical perspective on the economy

The starting point of the vertical perspective is that companies, sectors and countries are interdependent. This interaction means that changes in one part of the economy are spread to all other parts along the supply chains. Obviously, if final demand improves in one sector, this will affect its supplying sectors. The intermediate demand directed towards these sectors generates further demand along their supply chains, maybe also from the initiating sector, and so forth. Economic interdependencies of this kind show that a market economy can be characterized as a circular process, in which a complex network of inter-industry transactions is a necessary ingredient. Stated in a different way, if productivity improves in one part of the economy, some of these efficiency gains are spread to other parts of the economy.

If new production processes alter the depth and character of these transactions, this will have repercussions on the functioning of the economy and how and where economic values are generated. The structure of the economy and how it evolves over time are therefore closely related to the way production processes are organized. Accordingly, if changes in the organization

of production are neglected, analyses of value creation and structural change are running the risk of misinterpreting the contemporary growth process.

In a comparison with the horizontal perspective, this thesis represents an attempt to analyse the economy using methods which more closely resemble the functioning of actual production processes and the nature of value creation in real world economies. The decision on the organization of production is, however, determined by an intricate web of interacting and sometimes opposing forces. Already Smith (1776) argued that the division of labour relates to the whole production process – from the first stage of intermediate production to the final product. This means that specialization creates mutual dependencies, within companies and between sectors, and within and between countries.[1] Smith (1776, p 18-19) states about the production of a woollen coat that it: "…is the produce of the joint labour of a great multitude of workmen. The shepherd, the sorter of the wool, the wool-comber or carder, the dyer, the scribbler, the spinner, the weaver, the fuller, the dresser, with many others, must all join their different arts in order to complete even this homely production."[2]

Another determining factor on how companies choose to organize their production is the costs associated with market transactions. Coase (1937) asked the question: if markets are efficient, why is a large part of the transactions in the economy contained within hierarchical and centrally planned companies? With the market clearing price mechanism, would it not be more efficient to buy the intermediate goods and services used in the production process through the market? The answer of Coase was that it is costly to rely on market transactions.[3] These transaction costs imply that in an efficient economy there are both markets and centrally planned organizations. Williamson (1971, 2002, 2010) identified which factors that determine the choice between bureaucratic planning and market transactions. According to Williamson, transaction costs are determined by information collection,

1 Lundvall (2005) argues that specialization within companies can be defined as internal specialization, and specialization among companies, sectors and countries can be defined as external specialization. If nothing else is explicitly stated, in this thesis specialization refers to external specialization.

2 According to Smith, division of labour among the different stages of a production process is limited by the extent of the market. With an example from his home country, the level of specialization is lower in the central highlands of Scotland, where the farmer has to be a butcher, baker and brewer, than in more densely populated areas.

3 In 1991, Coase was awarded the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel. The award was given: "For his discovery and clarification of the significance of transaction costs and property rights for the institutional structure and functioning of the economy." See http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/. Coase (1937) argues that the most obvious cost related to the use of the price mechanism is associated with the discovery of relevant prices.

contract agreements and governance.[4] If the decision is to outsource instead of producing in-house, the former entails costs for contracting out, but the latter would have entailed costs related to contracting within.

A third aspect of the organization of production is related to innovation and technology. Since the breakthrough of industrialization in the late 18th century, periodic waves of major innovations, such as the steam engine, electricity, the combustion engine and microelectronics, and their gradual diffusion have altered the structure of production, how businesses are organized and, consequently, how companies interact (Schön 2006a, 2010a). Rosenberg and Birdzell Jr (2005) argue that one main reason behind the remarkable growth of the industrialized world over the last 200 years is this flexible and decentralized way of production, in which market transactions between independent actors constitute an indispensable part, and where this mutual coexistence has been adjusted to new technological opportunities.

1.3 The vertical perspective in the literature

Early contributions

The classical economists recognized the interdependent aspect of economies. Apart from Smith, Quesnay (1758), for example, studied the structure of the economy through the exploration of interdependencies between horizontally represented sectors. Crucial to this analysis is that natural proportions between sectors can be identified. A similar idea is found in Marx (1885) and his accumulation and reproduction of capital. By a distinction between constant and variable capital, where the former represents the circular aspect of the economy, it is argued that the ratio between the two types of capital increases over time. This transformation means that the proportion between different types of products evolves in a regular pattern, and that the structure of the economy is related to the circular dimension of production processes (Silva and Teixeira 2008). Accordingly, products are not only produced by primary factors of production, such as capital and labour, but also from each other.

However, the interest in the analysis of long-term growth and its association with technology and structural change lost ground when the marginalist

4 In 2009, Williamson was awarded the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel. The award was given: "For his analysis of economic governance, especially the boundaries of the firm." See http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/.

revolution, with its emphasis on rationality, optimal resource allocation, perfect information and efficient markets, emerged as the dominant way of economic thinking in the late 19th century. This lack of interest prevailed until the appearance of Joseph Schumpeter's work in the 1940s and 1950s.[5] Along the lines of the classical economists, Schumpeter argued that structural changes were a prerequisite for a continuous rise in the material well-being of countries (Fagerberg 2003). The main force behind such changes is innovations. These arise from technological competition among companies and generate high profits during an initial period.[6] With the goal of getting part of these profits, new innovations are generated at the same time as they are diffused throughout economies.[7] The positive effects of the innovations eventually fade off and the economy enters a period of weaker growth. This suggests that the innovation process is non-linear, with innovations clustering not only among certain sectors but also in time periods, indicating that the growth process is discontinuous.

Neo-Schumpetarian economics

Following the legacy of Schumpeter's work, a new strand of research on structural change and its association with economic growth has emerged since the latter parts of the 1970s (Fagerberg 2003). This is known as neo-Schumpetarian or evolutionary economics, and it is the main reason behind the revival of research on economic structures and structural change. In contrast to neoclassical economics, important notions are bounded rationality, non-complete information, path-dependency, out-of-equilibrium processes, intermediate interaction and continuous learning. Instead of using a production function approach, the emphasis is directed towards explicit analyses of the connection between changes at the micro level and its overall effects on the macroeconomic dynamics. This stresses the importance of interdependencies among different levels of analysis, not the least in terms of technology and its effect on the structure of production (Nelson and Winter 1982).

The evolutionary oriented research has opened up the black box and studies the functioning of actual processes of innovation among companies, sectors and countries (Freeman 1994). It stresses the importance of the diffusion of new technologies and how it affects the structure and functioning of

5 Swedberg (1994) is an often recommended biography of Schumpeter's life and work.

6 According to Schumpeter, competition in terms of prices is only of secondary importance. The competition that matters comes from new technologies, new products, new supply structures and new ways of organizing businesses.

7 Schumpeter used a rather broad definition of innovation and included, for example, new production processes. He called the diffusion of new innovations the swarming process.

economies. One early proponent of this research tradition is Rosenberg (1982). From a detailed perspective of technology and its diffusion, it is stated that stronger technology-generated interdependencies between sectors outdate the conventional representation of sectors. Rosenberg even argues that analyses applying a horizontal perspective become artificial and treat structural changes in a less appropriate way; sectors should instead be defined on the basis of their vertical, or inter-linked, production processes. Rosenberg (1996, p 345) argues that: "…much of the impact of new technologies is realized through intersectoral flows." This perspective is also a main component of the notion of development blocks, developed by Dahmén (1950, 1988) and inspired by the clustering of innovations in the work of Schumpeter. Dahmén argues that strong interdependencies are a necessary component of a growth-enhancing development block; a development block is identified through the depth of its intermediate interaction within itself and in relation to the outside economy.[8]

Lundvall (1985, 1988, 2005, 2007) has conceptualized the national innovation systems approach, based on user-producer relations. Within this framework, the interaction between users and producers of knowledge and innovation is of paramount importance for the outcomes of the innovation process.[9] The starting point is that there will always be a separation between the innovation unit and the users, either between departments within companies or when the user and producer need the market to interact. This interaction is in an ongoing state, as the innovation process is gradual and cumulative.[10] Based on this integrative approach, Lundvall argues that the conventional perspective in economics is to analyse the economy from a horizontal perspective, consisting of isolated sectors of activity. The user-producer perspective instead focuses on the vertical way of organizing the economy, with attention directed towards the importance of interactions between sectors and how these affect the structure of economies. In this respect, the user-producer perspective cuts across conventional sectoral boundaries. These vertical linkages are crucial for the overall economy and for the competitive position of nations.[11]

8 In a similar way, Freeman and Perez (1988) argue that the most successful sectors within a techno-economic paradigm are those that use the intermediates containing the new technology in the most efficient way. See also Dosi (1982) who uses the term scientific paradigm for a similar interpretation.

9 See also Freeman and Clark et al (1982) for an evolutionary contribution to the analysis of technology diffusion as an interactive and creative process. See Malerba (2005) for a discussion of sectoral systems of innovation.

10 Lundvall (2007) prefers to define the contemporary economy not as a knowledge economy but as a learning economy. The latter is preferred as it more directly resembles the importance of knowledge interactions and joint efforts, often with an inter-industry character.

11 In neoclassical economics, spillovers are often seen as a bad thing, as the profits from an investment are partially shared with actors not financing the investment. Lundvall argues

With these evolutionary oriented perspectives, there are indispensable connections between technology, structural change and economic growth. For the new technology to affect the macroeconomic performance, the profound importance of the diffusion process cannot be neglected. While many orthodox economists have focused on primary factors of production, economic historians and evolutionary economists often emphasize technology and its diffusion as the main engine of growth. With this focus, it comes as no surprise that the limitations of the horizontal perspective on the economy are often highlighted. The interest in the vertical perspective has, however, also increased quite recently within non-evolutionary strands of economic thinking.

Non-evolutionary economics

The revival of interest in evolutionary economics has spurred the conceptualization of general purpose technologies (GPT) among mainstream economists (Enflo 2008). With the support of the absent productivity effects of the growing computer usage in the 1980s, Breshnahan and Trajtenberg (1995) argue that long periods of growth are caused by a few radical technologies, and it takes time to diffuse these growth forces throughout economies. Consequently, for a technology to be defined as a GPT, it must be widely used as an intermediate; GPTs typically emerge in one sector and are gradually diffused to other parts of the economy – and improved and adjusted along the way, supported by complementary technologies and innovations. A second criterion is that the innovation process in the downstream sectors must benefit from the innovations in the GPT. These innovational complementarities emphasize the interactive perspective of learning and innovation processes, they magnify the growth effects of the GPT and they stimulate innovation propagation.[12] Helpman and Trajtenberg (1998) argue that the speed and extent of the technology diffusion are crucial aspects of the dynamic processes associated with a GPT and, hence, important determinants of the rate of growth induced by them.

The intangible character of information and communication technologies (ICTs) as the current GPT further emphasizes the diffusion aspect of technology and innovation through the intermediate structure. With attention directed towards process innovations and knowledge creation, intermediates such as

that in a learning economy, inter-industry related spillovers are a natural and beneficial aspect of productivity enhancing interactions.

12 Lipsey et al (1998) define this interaction as vertical complementarities. They also argue that inter-industry linkages constitute an important component of the overall technological system of an economy, where output in one sector is used as an intermediate in another.

R&D, vocational training, design, marketing, advertisement and financial services are becoming more important in advanced production processes and, consequently, in aggregate growth.[13] For example, Corrado et al (2009, p 662) show that the inclusion of this type of intermediates in the capital stock has significantly changed the pattern of growth and productivity in the US economy since the 1990s, and they state that: "The exclusion of intangibles obscures the role of many factors at the centre of the innovation process that have…played an important role in economic growth."[14] Accordingly, capital not included in the GDP measure has become a more important determinant of the GDP growth (OECD 2013c).

Another related reason for the emphasis on the diffusion process through the intermediate structure is the strong growth of the business services sector and its role as a bridge for knowledge creation and knowledge diffusion. There is a strong interrelatedness between the emergence of the ICT based knowledge economy and the strong growth of knowledge intensive services. First, some parts of the business services sector belong to the ICT producing sectors and thus constitute the very centre of the ICT revolution. Second, new innovations in this area have increased the tradability, separability and transportability of information. This has increased the intermediate demand for knowledge intensive services. As argued by Antonelli (2000), knowledge creation is strongly influenced by networks of companies and their interdependencies. This is the reason why the strong growth of the business services sector cannot be properly understood without close attention to its role within the intermediate structure (Kox 2001). Den Hertog and Bilderbeek (2000) argue that the competitiveness of companies, sectors and countries to a larger extent than before depends on the ability to receive, apply and translate knowledge within vertically organized production processes.

For historical reasons, the manufacturing sector has been seen as the locus of innovation and productivity generation. With a broader use of ICT and other intangibles, this is not necessarily an accurate description of the functioning of advanced contemporary economies. It can thus be argued that the productivity

13 Edquist (2001) argues that a useful taxonomy is to divide innovations into either product innovations or process innovations. The former is a matter of what is being produced. The latter concerns how goods and services are produced. Process – or organizational – innovations thus concern how companies organize inter-industry transactions and govern inter-industry relationships.

14 Based on the global trend towards an intensified use of intangibles, Edquist (2011) shows that 30 percent of the labour productivity growth of the Swedish business sector between 1995 and 2007 are explained by a strong growth in the intermediate use of intangibles. OECD (2013c) shows that business outlays on intangibles have increased in all OECD countries since the 1990s, and exceed the investments in physical capital in several countries.

enhancing processes have become more widespread. The distinction between a highly innovative and highly productive manufacturing sector and a laggard service sector seems to have lost some of its appeal. Not the least, the intersection between the manufacturing sector and the service sector constitutes a central aspect of the current growth process. This has not only stimulated employment in the latter, but has also intensified the need to properly understand the role of services in the process of productivity generation and productivity diffusion (Baumol 2001). From a similar perspective, Bryson and Daniels (2010) argue that services have become more important intermediates in the production of manufactured products. The reason is that the ICT revolution has changed the boundaries of companies, with the effect that employment has been reallocated from the manufacturing sector to the service sector. This is defined as a manuservice economy, in which economic values are created through the blending of manufacturing and service functions. Bryson and Daniels (2010) argue that this change outdates the horizontal representation of the economy.

The vertical perspective on the economy has been addressed since the classical economists, but it has seen a revival over the last couple of decades. With its strong focus on technology diffusion, how it affects the structure of the economy, and how it contributes to the improvement of the material well-being of countries, this is strongly related to the emergence of the neo-Schumpetarian strand of economic thinking. Supported by the current trend towards outsourcing and globalization, the acknowledgement of the vertical perspective has also grown stronger among orthodox economists. Consequently, several literatures have rather recently identified the need of a new, vertically oriented empiricism to further understand value creation and structural change in advanced contemporary economies.[15]

Through the five notions presented in section 1.1, this thesis adjoins the analysis of the Swedish economy to some of these literatures. Although a perspective often recognized at a general level in the Swedish economic historical literature, no comprehensive macroeconomic investigation has been performed which explicitly applies it to value creation and structural change.

15 Apart from those already mentioned, see Boden and Miles (2001), McCarthy and Anagnostou (2004), Jacobides and Winter (2005), Schettkat and Yocarini (2006), Rubalcaba and Kox (2007), Montresor and Vittucci Marzetti (2010, 2011), Grossman and Rossi-Hansberg (2008), Timmer et al (2012a, 2012b, 2013), Johnson and Noguera (2012a, 2012b) and OECD (2013a).

1.4 The Third industrial revolution

The main characteristic of an industrial revolution is fundamental changes in how production processes are organized (Magnusson 1999). With close links to the diffusion aspect of technology and the work of Schumpeter, such changes explain why many economic historians argue that the process of industrialization since the late 18th century follows a regular pattern (Schön 2006a, 2010a).[16] Although no consensus has been reached, one typology states that the dynamics of capitalist economies since the dawn of industrialization can be understood through three industrial revolutions, all of which have their roots in new technologies and their repercussions on production processes and how businesses are organized. The First industrial revolution occurred in the late 18th century and was strongly associated with the steam engine and its gradual diffusion in society. A hundred years later, the Second industrial revolution emerged, with its strong emphasis on electricity and the combustion engine as the core technologies. Not the least, this set the stage for the assembly line, the Fordist way of production and vertically integrated companies. The main ideas were to impose control, reduce uncertainty, and rationalize through internal specialization. Production processes were integrated backwards through the acquisition of raw materials and transportation. This gave the opportunity not only to supply and market control, but also to take advantage from economies of scale (McCarthy and Anagnostou 2004). Apart from scale economies, Mowery and Rosenberg (1989) and Chandler (1990) have shown that mass production and vertically integrated manufacturing companies were made possible by reduced transport costs. The innovations underlying this change in production were new energy sources, such as coal, electricity and oil, and better materials, such as iron and steel. A second reason was the advances in specialized mechanical, chemical and electrical knowledge. This created new possibilities for product innovations along the chains of production. In order to develop these products, however, it was necessary to integrate knowledge from several areas inside and outside the companies.

After the golden age of industrialism, the global economic crisis of the 1970s was also the beginning of a new era – the Third industrial revolution, or the end of the dominance of the industrial society (Schön 2006a, 2010a). The core technology and the main growth force in this phase of history are microelectronics and its effects on business boundaries and the wider society. Particularly, the ICT revolution has shifted the balance between in-house production and outsourcing; internal hierarchies are substituted for

16 See also Freeman and Soete (1997).

market transactions, a trend caused by the possibilities of more efficient coordination of production processes and easier ways of communication. Production processes have therefore become more automated, integrated and decentralized, both within companies and between sectors. This is the reason why Crafts (2006) argues that the ICT revolution reduces the benefits of vertical integration. More specifically, Eliasson (2002) argues that within the manufacturing sector, the new core technology has greatly changed the possibilities of decentralization of production. Companies have become more specialized and outsource more of their production, at the same time as the scale effects are reached through the intermediate linkages within global production networks. Productivity enhancing specialization can thus be reached without the benefits from large scale production. The Fordist way of production has given way to lean production, with its strong emphasis on cooperation, networks and supply chain management. With this tendency to an increased use of externally purchased knowledge intensive services, Pavitt (2003, p 20) argues about these services that: "They are…the prolongation of the industrial system into a period of growing specialization and complexity..."

Schön (2006a, 2010a) argues that the cycles of around 100 years between the revolutions can be divided into two parts: a first part dominated by the effects of the new and dominating technology on production processes, and a second phase that is more focused on infrastructure and institutional change in a wider sense. Each of these phases can, in turn, be separated into a cycle of structural crisis-renewal-rationalization-structural crisis. The crisis in the mid-1970s is a period which turned a strong emphasis on rationalization and efficiency of current structures into a phase dominated by the renewal and transformation of old structures. Among other things, the transformation period is characterized by a pronounced diffusion of the new core technology, new production processes and the emergence of new sectors.

Through an evolutionary lens and with focus directed towards the technology side of transformation, this thesis addresses notions and stylized facts related to the development of the Swedish economy during the period 1975-2005. As the first part of the first phase of the Third industrial revolution, with its emphasis on diffusion of knowledge and technology, new production processes, outsourcing and fast growing service sectors, these general characteristics particularly warrant a vertical perspective on value creation and structural change.

1.5 Main research questions

This thesis contains seven chapters. The current chapter serves as an introduction to the thesis. Chapters two to six contain empirical analyses of different aspects of how changes in the organization of production have affected the structure of the Swedish economy and how and where economic values are generated. Chapters two to five are mainly concerned with the domestic economy, while chapter six is devoted to the integration of the Swedish economy into the global value chains. Following the general aim, each empirical chapter has been attributed a main research question. These questions give a clear indication of the general direction and contribution of the chapter at hand. Chapter seven summarizes and discusses the main themes of the thesis.

Chapter 2: Inter-industry linkages and key sectors

The main research question is: have the production processes of the Swedish economy become more vertically disintegrated?

In terms of the organization of production, the defining feature of the Third industrial revolution is the transition from a Fordist way of production to integrated production systems. As mentioned, driven by the ICT revolution and its effect on the transaction costs, it has become easier to coordinate production processes among independent suppliers. Consequently, the positive aspects of being a large company have been reduced, which suggests that internal hierarchies are substituted for intermediate market transactions (Ottosson and Isacsson 2002; Magnusson 2006; Lundquist et al 2008; Schön 2010a). Another effect of the ICT revolution is the improved possibilities to organize production chains over long distances, not the least within the manufacturing sector. Some parts of many production processes have therefore moved to emerging economies, and the global trade in intermediates has grown fast (Schön 2010b; Baldwin 2006, 2011). The other side of this is that the relative use of domestic suppliers may have been reduced, indicating weaker inter-industry linkages within the domestic economy.

These two forces – the manuservice economy and the emergence of global value chains – point in different directions concerning the domestic use of intermediates. However, the net effect of these forces of structural change has not been identified. With an introductory character, this chapter represents an attempt to stretch the analysis a bit further.

Chapter 3: Outsourcing, servitization and deindustrialization

The main research question is: has the Swedish economy been deindustrialized?

Magnusson (1999, 2006) argues that the main indication of the transition from the Second to the Third industrial revolution is a shrinking manufacturing sector, in Sweden and elsewhere in the most advanced countries. This reduction is absolute in terms of employment, and relative in terms of production and employment. The flip side of this is a fast growing service sector, paving the way for terms such as the post-industrial society and an emerging knowledge economy. Schön (2010a) argues that the industrial society reached its peak in the mid-1970s, and has since then been replaced by a service economy, with service employment accounting for more than 70 per cent of economy-wide employment.

Several possible explanations for this horizontally addressed structural change have been suggested. These are concerned with changes in relative demand, productivity differences, and increased competition from emerging economies. A fourth hypothesis addresses changes in the vertical structure of production. With a shift away from vertically integrated companies to outsourcing and the use of new service intermediates, it is likely that the indirect employment and production generated throughout the economy by the manufacturing sector have increased, thus suggesting that the process of deindustrialization is overestimated if the manufacturing sector is studied from a horizontal perspective. This argument is well-established in the Swedish economic historical literature,[17] but it has not been empirically investigated with appropriate methods; earlier vertical attempts have been too crude.[18] Accordingly, this chapter investigates to what extent the general understanding concerning the magnitude and dynamics of the process of deindustrialization during the Third industrial revolution is altered when a vertical perspective is applied, including the indirect employment and production generated through the intermediate structure.

Chapter 4: Business services as bridges for innovation

The main research question is: what role does the business services sector play in the national innovation system?

The growth of knowledge intensive business services has been quite remarkable since the 1980s, in Sweden and elsewhere in the most advanced countries. Schön (2010a) argues that the main reason behind this strong

17 See, for example, Magnusson (1999, 2006), Ottosson and Isacson (2002), Ekstedt (2002), Göransson (2002), Andersson-Skog (2002) and Schön (2006a, 2010a).

18 See Eliasson (1993, 2002) and Lundquist et al (2008).

performance is changes in production processes brought about by the ICT revolution. At the same time as increased vertical specialization within the manufacturing sector has shifted intermediate transactions to the market, manufacturing production has become more knowledge intensive (Ejermo et al 2011). The combined effect has been a strong growth in knowledge intensive intermediate deliveries to the manufacturing sector (Lundquist et al 2006, 2008). These intensified interdependencies are often seen as crucial for the overall functioning of the national innovation system (Lundvall 2007).

Despite the importance of the argument, the Swedish economic historical literature lacks a proper macroeconomic analysis of the reasons behind the strong growth of the knowledge intensive business services sector, its knowledge content and its interaction with the manufacturing sector. This chapter represents an attempt to shed some further light on these issues.

Chapter 5: Vertical distribution of productivity

The main research question is: is the service sector a productivity laggard?

In order to explain the gradual reallocation of resources towards technology stagnant sectors, Baumol (1967) distinguishes between a high productivity manufacturing sector and a low productivity service sector. In the former, production can be standardized and mechanized on a large scale, while production in the latter is highly personal and, consequently, less possible to mechanize and standardize. The implication is that aggregate productivity growth is unbalanced, due to differences in the general characteristics of the two main aggregates of the economy. Applying a horizontal perspective, Schön (2010a) argues that the dynamics of the Swedish economy since the 1970s supports Baumol's distinction.[19] With the strong productivity pick-up in the manufacturing sector since the economic crisis at the beginning of the 1990s, this argument seems to have become even more valid.

However, this research does not take into account any difference in the use of intermediates between the manufacturing sector and the service sector; it is focused on horizontally isolated sectors of activity.[20] If all labour needed throughout the economy in order to finalize production is included in the productivity estimates, Baumol's distinction may lose some of its validity. With a perspective including all stages of the production process, this chapter

19 Kander (2005) uses a horizontal approach to show that the effect of an unbalanced productivity performance is that the Swedish service sector's share in inflation adjusted GDP has not increased during the Third industrial revolution.

20 See, for example, Schön (1998, 2000, 2004, 2006b), Josephson (2005) and Andersson and Lindmark (2008).

contributes with new insights into the productivity performance of the Swedish economy during the Third industrial revolution.

Chapter 6: Global value chains and competitiveness

The main research question is: has the competitive position of the Swedish economy deteriorated?

Apart from the effects of new technologies on the organization of production within domestic economies, one main characteristic of the Third industrial revolution is a new global division of labour. One indication of this change is that the share of emerging economies in world manufacturing production and exports has grown fast, indicating a fall in competitiveness of the most advanced countries (Magnusson 1999, 2006; OECD 2013a). Along similar lines, Schön (2010a) argues that one reason behind the process of deindustrialization in the most advanced economies is a weakened global competitive position of manufacturing production.

The new global division of labour, with vertically more disintegrated global production processes, means that the cross-border flows of intermediates need to increase in order to finalize production. Consequently, global trade is today dominated by products-in-progress. When the value of the exported products is counted at each border crossing, this means that the well-known problem with double counting has grown (Schön 2010b). This suggests that the gross value of exports has grown faster than the value added embedded in the traded products. This widening gap indicates that measures of competitiveness based on gross exports may have become less reliable. This chapter adjoins the Swedish economy to the fast growing literature using a vertical perspective on global manufacturing production and the competitive position of nations.

1.6 Empirical methods and statistical issues

The empirical study of interdependencies between sectors

Despite a period characterized by a general lack of interest in analyses of structural change, several formal models relating structural change to economic growth were developed from the 1940s and onwards. Along the lines of Quesnay (1758), the interest concerned how horizontally represented sectors were interlinked – how they are dependent on each other to finalize production (Silva and Teixeira 2008). Two of these models were invented

by von Neumann (1945) and Sraffa (1960), respectively, both perceiving production as a circular process – products are used to produce products. Leontief (1941, 1953, 1991) also investigates the intermediate linkages among horizontally represented sectors. This is done on the basis of a theory of production and detailed investigations of production structures using input-output relations.

Sraffa (1960) showed that it is possible to transform the recognition of the circular dimension to the actual measurement of vertically integrated sectors. With the vocabulary used in this thesis, the vertical perspective could be operationalized and used as an empirical approach in the analysis of value creation and structural change. From the perspective that the research on structural change required new tools, Pasinetti (1973) further developed the vertical representation of the economy, and showed that Leontief's input-output relations can be transformed into a set of vertically integrated sectors.[21] Consequently, sectors are not organized around specific activities, but how these activities are interlinked through actual production processes.

Input-output analysis

With its vertical perspective, input-output (IO) analysis has become an influential part of the evolutionary oriented empirical research on growth and structural change (Silva and Teixeira 2008), and will be used throughout this thesis. More specifically, the suitability of this methodology is based on its capacity to analyse technology driven changes at the micro level and how these affect the structure of the macro economy. This applied technique was invented by Wassily Leontief and gained importance in the Keynesian era and the development of national accounting after the Second World War.[22] With a background in mathematics, Leontief believed in the usefulness of formal theory, but only if it had anything to say about real world problems. With this position, his aim was to develop a theory of production which would enable detailed empirical analyses of the functioning of economies and how different parts are interrelated. From this perspective, Baumol (2000a, p 151) states about IO analysis: "...it shows how theory can be constructed in a way that provides

21 The concept of vertically integrated sectors is an integral part of a Keynesian oriented theory of growth and structural change, developed by Pasinetti (1981, 1993).

22 In 1973, Wassily Leontief was awarded the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel for the invention of the IO method and its application to important economic problems. According to the committee, this empirically-useful method particularly highlights the interdependence in production systems and provides tools for systematic analyses of the complicated network of inter-industry transactions. See http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1973/press.html

a window to reality and that permits applications that really can contribute to the well-being of society." Among evolutionary economists, Rosenberg (1982) argues that one of the merits of IO analysis is that it opens up the black box and displays a wealth of information contained in inter-industry flows of intermediates. Rosenberg also argues that many aspects of technical change are only visible at this level of analysis; when directly moving from primary factors to final production, large amounts of information are neglected.

However, when neoclassical economics became the dominant way of thinking, IO analysis lost some of its appeal and disappeared from the most prestigious journals. Nevertheless, it continued to attract academic interest within several sub-disciplines, such as growth, productivity, trade, development, regional science and national accounting. Over the last decade or so, there has been a renewed interest in IO analysis among orthodox economists. The reason for this is the awareness that it provides applied methods which can improve the understanding of some of the most pressing contemporary economic and political issues, such as environmental depletion, deindustrialization, knowledge creation and globalization. Put differently, at a time when outsourcing and offshoring are claimed to be dominant notions of production processes, the partially regained fame is closely related to the need to appropriately understand changes in the verticality of production and interdependencies between sectors and countries. Economic interdependencies and the circular aspect of economies have thus become a perspective gradually attracting more researchers, and IO analysis provides useful empirical techniques to investigate different aspects of this roundaboutness. Consequently, Baumol (2000b) argues that IO analysis is one of the major contributions to economics in the 20th century. Miller and Lahr (2009) argue that IO analysis is one of the most widely used empirical methods in economics.

Although some important attempts have been made, IO analysis has never become an established applied macroeconomic methodology among Swedish social scientists. Despite the arguments put forward by Dahmén, Rosenberg and Lundvall among others, even within the economic historical research tradition, with its focus on technology diffusion and its association with growth and structural change, it is almost completely absent. Following the trend in recent years, however, there seems as if the general interest has grown somewhat. Despite that, the lack of IO research means that there are many unexplored issues concerning distinctive and fundamental features of the contemporary Swedish economy. With the general aim, this thesis represents an attempt to reduce some of these knowledge gaps. The perspectives

applied and the methods used are well-established in different strands of the international literature.

The input-output model

The main source of information in IO analysis is the IO tables. They are based on the idea that inter-industry transactions can be registered in a matrix divided between origin and destination. IO tables thus show from where sectors buy there intermediates and to where they deliver their production. Products are produced and they are used. Some of the products are delivered as intermediates to the production of other products, some go as final products to final demand, such as household consumption, government consumption, investments, exports or inventories. With n sectors in the economy, and with total production, or gross output, in sector i denoted by x_i and final demand by f_i, equation 1.1 shows how sector i distributes its production between intermediate sales and final demand:

$$x_i = z_{i1} + \cdots + z_{ij} + \cdots + z_{in} + f_i = \sum_{j=1}^{n} z_{ij} + f_i \qquad (1.1)$$

where the z terms represent inter-industry sales by sector i.[23] From the IO based production theory, it is assumed that the inter-industry transactions from sector i to sector j for a given period depend on the total production of sector j in this period. This is expressed as a ratio between the value of the intermediate deliveries from sector i to sector j and the total production of sector j. This ratio, $a_{ij} = z_{ij}/x_j$, is called the technical coefficient, or the direct input coefficient, and expresses the value of the intermediate deliveries from sector i per unit of production in sector j.[24] With $z_{ij} = a_{ij}x_j$, for sector i equation 1.1 can be rewritten as:

$$x_i = a_{i1}x_1 + \cdots + a_{ii}x_i + \cdots + a_{in}x_n + f_i = \sum_{j=1}^{n} a_{ij}x_i + f_i \qquad (1.2)$$

23 The presentation of the IO model in this section is based on Miller and Lahr (2009). See also ten Raa (2005).

24 As will be clear later on, IO tables can be domestic or include imports of intermediates. From a theoretical point of view, when the domestic tables are used, the results are not based on the Leontief production function, as the use of imported intermediates is excluded. In a strict sense, these coefficients should therefore be defined as transaction, or flow, coefficients, but due to simplicity the term technical coefficients will be used throughout the thesis.

With total production expressed in this way for all n sectors, the matrix representation of equation (1.2) is:[25]

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{f} \quad . \tag{1.3}$$

This can also be expressed as:

$$(\mathbf{I} - \mathbf{A})\mathbf{x} = \mathbf{f} \tag{1.4}$$

and refers to a set of n linear equations with n unknowns, $x_1, x_2 \ldots, x_n$, and $\mathbf{I}$ refers to the identity matrix, with ones on the main diagonal and zeros elsewhere. This system of equations has a unique solution if $|\mathbf{I} - \mathbf{A}| \neq 0$.[26] If this holds, $(\mathbf{I} - \mathbf{A})^{-1}$ can be found and the unique solution is given by the IO model:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} = \mathbf{L}\mathbf{f} \tag{1.5}$$

where $(\mathbf{I} - \mathbf{A})^{-1} = \mathbf{L} = \left[l_{ij}\right]$ is the Leontief inverse, or the total requirements matrix. l_{ij} is a partial derivative and expresses the total effect on production in sector i from a unit change in final demand in sector $j (l_{ij} = \partial x_i / \partial f_j)$, including all subsequent rounds of indirect intermediate demand. The Leontief inverse therefore describes how a change in final demand is transmitted throughout the economy in wider and wider circles. Accordingly, each column sum of the Leontief inverse measures the total output effect of the economy from a unit change in final demand in the particular sector (output multiplier).[27] The Leontief inverse is the main building block in applied IO research and will be the empirical cornerstone throughout this thesis.

25 Lower-case bold letters refer to vectors and upper case bold letters refer to matrices.

26 In words, a unique solution exists if the determinant of $\mathbf{A}$ is non-zero, implying that the columns are linearly independent.

27 The model presented in this section assumes that household consumption, as part of final demand, is exogenous to the technically interrelated sectors in matrix $\mathbf{A}$. This means that the model is said to be open. However, households earn their incomes as labour inputs, and changes in labour demand will affect the level of consumption. For this reason, it is not unusual to transform the household sector from a final demand component to an interrelated sector within matrix $\mathbf{A}$, making the sector endogenous. This is known as closing the model with respect to households. Multipliers based on households treated exogenously (simple multipliers) are smaller than those derived with households treated endogenously (induced multipliers). Simple multipliers will be used in this thesis.

Statistics used in the thesis

The starting point of the empirical analyses in this thesis is IO tables for the years 1975, 1980, 1985, 1991, 1995, 2000 and 2005. IO tables are derived from supply and use tables. These are integral parts of the system of national accounts, and they have the dimension of products along the rows and sectors along the columns. In order to compile a symmetric IO table, it has to be decided whether the rows and columns should contain products or sectors. Both methods are used, although the product-by-product tables are preferred by the UN and Eurostat (Eurostat 2008). The Swedish IO tables are of this type and are constructed under the assumption of industry technology. The difference between the two methods concerns the existence of secondary production. Supply tables show that most sectors also produce other products than their primary production. Except for motor vehicles, for example, the motor vehicle sector also produces some engineering products and transport services. The question is how this production should be distributed in an IO table. In a product-by-product table, this secondary production is distributed to the product group where it belongs. The use of product-by-product tables therefore means that the empirical analysis is not analysing sectors of activity in their conventional meaning. Instead, the intermediate transactions measure the value of the intermediate products used in the production of each product. Expressed in another way, each column in the IO table represents the input structure needed to produce the particular product. If nothing else is explicitly stated, the term sector thus refers to a product group.

The IO tables for the period 1975-91 have been provided by Statistics Sweden, and the tables for 1995-2005 are available on their homepage. There are several important differences between the tables covering these two periods. First, they are constructed using different manuals of the System of National Accounts (SNA). This means that software is treated as an intermediate in the former manual, but as a capital investment in the latter. Second, the classification of sectors and products differs between the two groups of tables. However, this problem becomes less severe as the level of aggregation increases.[28] Many sub-sectors of the manufacturing sector are also rather homogenous and changes in the classification do not change the structure of the sector in any important way. Third, in the tables of the first period, the production of the public sector is only delivered to final demand. Analyses using the same construction for the IO tables of the second period have been performed, however, and the difference for the manufacturing

28 Johnson and Noguera (2012b, 2012c) are recent examples of influential IO based research using different manuals to track main aggregates over long periods.

sector and its sub-sectors is almost negligible; the public sector is rather isolated in the domestic production system. Nevertheless, the overall message is that comparisons between the IO tables of 1975-91 and 1995-2005 should be made with caution, although the qualitative conclusions should not differ in any substantial way.

Another issue concerning IO tables is the question about current or constant prices. IO tables are most often compiled and expressed in nominal terms. This is also the case for the tables produced by Statistics Sweden.[29] The main reason for this is the tedious task of finding price indices for each cell in the IO tables. Large amounts of research are therefore performed on IO tables in current prices.[30] This will also be the general case in this thesis. In certain contexts, however, IO tables in constant prices are used. Although the distinction is important, research indicates that the results do not differ to any significant degree at the more aggregate levels of the economy (Dietzenbacher and Temurshoev 2012). In some individual sectors, the differences can be more pronounced.

Important assumptions

All empirical methods have their limitations. These should be acknowledged and borne in mind when analysing value creation and structural change within an IO framework. The strong connection between theory and applied research in IO analysis implies some bold assumptions. One of the most important assumptions follows from the fact that the standard IO model used in this thesis is a fixed price equilibrium model, in which prices are unchanged while the quantity of production changes when the economy is affected by changes in final demand. Another important assumption is the fixed relation between a sector's output and its inputs, formalized in the technical coefficients. Consequently, production in the IO model operates under constant returns to scale – a proportional change in inputs will lead to a proportional change in output. Another assumption is that each sector also uses intermediates in fixed proportions. This follows from the fixed technical coefficients. As mentioned, it is assumed that each sector only produces one product, despite the real world observation of the multi-product characteristics of sectors. Finally, it is assumed that it is always possible to satisfy an increase in final demand. This means that there are no supply restrictions.

29 These tables are expressed in current basic prices. The basic price is the amount receivable by the producer from the purchaser minus any tax payable, plus any subsidy receivable.

30 Two recent examples are the construction of the World Input-Output Database (WIOD) and the WTO-OECD project on trade in value added.

Using static methods analysing dynamic phenomenon

In economic historical research, neoclassical production theory and growth accounting techniques are often used to empirically investigate historical patterns of growth and structural change.[31] This approach is also well established within the Swedish economic historical research tradition.[32] This means that dynamic processes are analysed with a static empirical methodology. Analogously, in this thesis an IO based production theory and IO techniques are used to empirically investigate changes in the production structure and some of their repercussions on the Swedish economy since the 1970s. Although prevalent in the international literature on technology and its association with growth and structural change, it means that dynamic processes are analysed with a static empirical method; the dynamics are considered through the time dimension.

31 See, for example, van Ark and Crafts (1996), Crafts (2000), Broadberry (2006) and Eichengreen (2007).

32 See, for example, Schön (2004, 2009), Josephson (2005) and Lobell and Schön et al (2008).

2. Inter-industry linkages and key sectors

2.1 Introduction

The perspective substantiating this thesis is that the analysis of value creation and structural change benefits from applying a vertical perspective on the economy. This production perspective of the structure of the Swedish macro economy is, however, underdeveloped, although it is commonplace in many other countries, and despite the fact that this type of inter-industry interactions is often acknowledged in the Swedish economic historical literature in general terms, implicitly or more explicitly.[33] The depth and character of these intermediate interdependencies are determined by the way companies choose to organize their production. This decision is, in turn, affected by several interacting and sometimes opposing forces, related to specialization, transaction costs and technology. Pavitt (2003) argues that modern economic history is characterized by new production processes swinging the pendulum between vertical integration and vertical disintegration.

One of the main characteristics of the Second industrial revolution, with its dependency on core technologies such as electricity and the combustion engine, was the assembly line and large, vertically integrated companies. As mentioned in the previous chapter, the Third industrial revolution is instead characterized by the ICT revolution and its effect on the boundaries of companies. Not the least, this core technology enables companies to outsource parts of the production process, at the same time as the scale effects are reached through intermediate linkages within global production networks. Antonelli (2000) argues that such vertical linkages between companies and sectors are crucial for knowledge creation in a knowledge economy, and Den Hertog and

33 Jones (2011) argues that such inter-industry linkages are the core of the misallocation argument, used to explain the large, and in many cases increased, differences in economic prosperity between countries; inefficiencies are spread in the economy through this diffusional aspect of economic growth. Another recent issue concerning linkages between sectors is found in IMF (2012). The question is whether the effects of the ongoing fiscal cutbacks in many developed countries have had larger negative effects on GDP than expected. Using forecasts from OECD, EU and IMF, the authors show that the fiscal multipliers have been substantially underestimated, leading to overoptimistic statements of the speed of the global recovery after the financial crisis in 2008-09.

Bilderbeek (2000) argue that the competitiveness of companies, sectors and countries to a larger extent than before depends on the ability to receive, apply and translate knowledge within vertically organized production processes. The growing importance of intangible capital and vertical linkages within national systems of innovation also highlights the qualitative dimension of economic interdependencies between sectors.

These changes suggest that the pendulum has swung towards vertical disintegration during the Third industrial revolution, indicating that more inter-industry transactions are needed in order to finalize production. The cooperation between independent actors through the market has thus changed, along the lines of the new technological opportunities. Despite the general lack of research, in a recent book about the Swedish service sector, the editor argues that today, a change in final demand will have larger repercussions on the overall economy, not the least through stronger intermediate linkages between the manufacturing sector and the service sector (Jordahl 2012).[34] If this is correct, it indicates that production processes have become more vertically disintegrated. Without any robust empirical confirmation, and with the stronger presence of global value chains likely to push the production structure of the economy in the opposite direction, the main research question in this chapter is the following: have the production processes of the Swedish economy become more vertically disintegrated? In support of this main question, the following questions will also be addressed. In terms of size-independent output and input multipliers, how has the production structure of the main sectors changed over time? Using these estimates, which are the new key sectors in the economy? Finally, how does the keyness of sectors change when the size of intermediate and final demand is considered?

This chapter has an introductory character, as it applies perspectives and empirical methods used in the following chapters. This is done through the introduction of some well-established IO techniques. The fundamental purpose of IO analysis is to estimate and understand inter-industry linkages.[35] Since its inception, this research tradition has served as a basis for inter-temporal and international analyses of production structures. In this respect, IO analysis is deeply rooted in the tradition of analysing economic structures and structural changes (Silva and Teixeira 2008). Cai and Leung (2004, p 65) argue that: "Information on sector's linkages is essential to understanding the structure of an economy, which in turn is important to formulating industry

34 See Lundquist et al (2008) for a similar argument.

35 Economic research has often used IO techniques to analyse vertical integration and vertical disintegration. Some recent examples are Fan and Lang (2000), Acemoglu et al (2005), Acemoglu et al (2010), Atalay et al (2013) and Alfaro et al (2013).

policies." Inter-industry linkages and key sectors have been studied since the 1950s and still constitute a lively field of research. After a period of less attention, Sonis et al (2007) argue that this research is once again attracting a great deal of academic and policy interest. Due to its long history, however, there is a tremendous amount of theoretical and applied research. This lengthy body of literature is diverse. Several fundamentally different methodological approaches have been suggested, and within each of them there are different interpretations and technical solutions.

As argued by Sonis et al (1995) and Dietzenbacher (2005), different methodologies and techniques should be seen as complementary and case specific, addressing different, but related, questions. In this chapter, two of the most influential and most widely used methods to measure inter-industry linkages and to identify key sectors are applied (Andreosso-O'Callaghan and Yue 2004; Guerra and Sancho 2010). These are: (1) classical multiplier methods (CMM) and (2) hypothetical extraction methods (HEM). CMM represent the first attempts at measuring inter-industry linkages and key sectors, and are still frequently used in applied research. HEM were established in the 1960s and 1970s and are by many considered to be a methodological improvement in relation to the CMM. Miller and Lahr (2001) and Temurshoev (2009) thus argue that the HEM have become increasingly popular. CMM and HEM should, however, be seen as complementary, as the former estimate linkages which do not consider the size of sectors (size-independent/dimensionless), while the latter take into account the size of both intermediate and final demand.

The outline of this chapter is the following. The next section is rather formal, and presents the theories and methodologies used in the empirical analysis. Section 2.3 presents the empirical results based on the CMM, domestically and with the inclusion of imported intermediates. Using the domestic estimates, key sectors are also identified. The results from the HEM analysis are presented in section 2.4. A final section concludes the chapter.

2.2 Theory and measurement

2.2.1 Classical multiplier methods

Within an IO framework, output in one sector affects the economy in two ways. First, an increase in output in sector j increases its demand for intermediates (as a purchaser) for sector j to produce its products. This

initial increase in intermediate demand will, in turn, force the intermediate producers to increase their intermediate demand in order to satisfy the demand for their intermediate products. These upstream, or backward, relations are the direction of causation in most settings where inter-industry linkages are discussed, as they concern each sector's use of its supply chains in order to produce its output. Apart from these backward linkages, however, increased output in sector j also means that more products produced in sector j will (as a seller) be available as intermediates in other sectors' production processes. These forward, or downstream, linkages increase the available supply and utilize more production in the economy.

In order to capture higher order effects, including all indirect linkages throughout the economy, Rasmussen (1957) suggested the column (row) sum of the Leontief inverse, $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$, as a measure of backward (forward) linkages.[36] As mentioned in chapter one, each element in $\mathbf{L}$, l_{ij} , expresses total output in sector i per unit of final demand in sector j. The column sum of $\mathbf{L}$, often referred to as the output multiplier, or the backward linkage, is for sector j defined as $BL_j = \sum_{i=1}^{n} l_{ij}$ and measures the direct and indirect output in all sectors of the economy necessary to produce one unit of final demand in sector j. The row sums of $\mathbf{L}$, defined as the input multiplier, or the forward linkage, $FL_i = \sum_{j=1}^{n} l_{ij}$, express the total deliveries of intermediates from sector i to all sectors of the economy when final demand simultaneously increases by one unit in all sectors in the economy.[37]

Cai and Leung (2004) argue that the output multiplier is widely used and rather uncontroversial as a standard measure of backward linkages. However, the forward linkage has been much more discussed in the literature. The main issue is, according to Oosterhaven (2008) and Miller and Blair (2009), that it is based on an unrealistic stimulus – a simultaneous unit increase in final demand in all sectors of the economy. Moreover, Dietzenbacher (1997) argues that this forward measure should be defined as a backward linkage, as it is a

36 This suggestion followed from Chenary and Watanabe (1958), in which the column and row sums of matrix $\mathbf{A}$ were suggested as measures of direct backward and forward linkages, respectively. Moreover, Ghosh (1958) presents an alternative IO model. Instead of focusing on the demand dimension, it is constructed from the supply-side perspective. This means that the model focuses on primary inputs entering the production process. The analogue equation to the Leontief inverse is the Ghosh output inverse matrix, defined as $\mathbf{G} = (\mathbf{I} - \mathbf{B})^{-1}$. Each element in $\mathbf{G}$, g_{ij} , measures the total production in sector j per unit of primary input in sector i. For example, if g_{ij} = 0,7, this is interpreted as the output increase in sector j from a unit increase in primary inputs available in sector i.

37 The corresponding row vector of backward linkages for each sector can in matrix form be expressed as $\mathbf{b} = \mathbf{i}'\mathbf{L}$, $\mathbf{i}'$ where is a (row) summation vector containing n ones. The corresponding column vector of forward linkages for each sector can be expressed as $\mathbf{c} = \mathbf{L}\mathbf{i}$, with i representing a column summation vector.

function of the intermediates needed when final demand increases by one unit in all sectors; the causation seems to go from final demand to intermediate demand, and not vice versa.

Based on these arguments, the use of the row sums of the Leontief inverse as a measure of forward linkages has been reduced over time. Nevertheless, it is still used and they have a structure suitable for the diffusional aspects of technology and innovation, not the least in relation to the role of the business services sector in the contemporary growth process (Guo and Planting 2000; Cai and Leung 2004; Rubalcaba and Kox 2007; Lundvall 2007; OECD 2007). This forward dimension on inter-industry linkages is also important within the notion of development blocks, established by Dahmén (1950, 1988), and to understand the position of economies in the world economy (OECD 2013a). These downstream measures from a backward perspective will therefore be used in several settings in this thesis.

Rasmussen indices

In order to compare backward linkages in the individual sector with the average backward linkage in the economy, Rasmussen (1957) suggested the use of an 'index of the power of dispersion'.[38] This index measures the relative strength of a sector's backward linkage and is defined as:

$$\overline{BL_j} = \frac{\sum_{i=1}^{n} l_{ij}}{\left(\frac{1}{n}\right) \sum_{i=1}^{n} l_{ij} \sum_{j=1}^{n} l_{ij}} \qquad (2.1)$$

where n is the number of sectors, the numerator is sector $j's$ backward linkage, and the denominator is the average of all backward linkages.[39] This means that this index relates the backward linkage to the average of all backward linkages. If the ratio is larger (smaller) than one, the backward linkage is stronger (weaker) than the average backward linkage of the economy.

Rasmussen (1957) also suggested an 'index of sensitivity of dispersion', in order to compare the individual forward linkages with the economy-wide average. This index is defined as:

$$\overline{FL_i} = \frac{\sum_{j=1}^{n} l_{ij}}{\left(\frac{1}{n}\right) \sum_{i=1}^{n} l_{ij} \sum_{j=1}^{n} l_{ij}} . \qquad (2.2)$$

38 The notation in this section follows Miller and Lahr (2009).

39 The overbar indicates normalization.

The only difference in relation to the power of dispersion index is that this measure contains the row sums of the Leontief inverse. If $\overline{FL_i}$ is larger (smaller) than one, the intermediate output increase in sector i from a simultaneous unit change in final demand in all sectors of the economy will be larger (smaller) than the average forward linkage of the economy.[40]

Key sectors

Using Rasmussen indices, and from the perspective of economic development in less developed countries, Hirschman (1958) introduced the notion of key sectors. The purpose was to identify sectors in the economy that would generate the largest aggregate output effect if stimulated by active fiscal policy. A sector is considered as a key sector, or generally dependent, if both the normalized BL_j and FL_j are larger than one. The opposite situation, with both multipliers smaller than one, indicates a sector which is generally independent, or relatively less integrated within the production system. If $BL_j > 1$ and $FL_j < 1$, it is an upstream oriented sector and dependent on inter-industry supply; it creates strong demand for intermediate products along its supply chains when there is an increase in its own final demand, but it is not as important as a supplier of intermediates when final demand changes in other sectors. If $BL_j < 1$ and $FL_j > 1$, it is a downstream oriented sector dependent on inter-industry demand; it generates a strong growth in intermediate production when there is an increase in final demand in other sectors, but the demand for intermediates is smaller when there is an increase in its own final demand.

Apart from using normalized backward and forward linkages and the four-way classification scheme to analyse the importance and role of sectors, the distribution of linkages throughout the economy should be considered. This can be done using the coefficients of variation (CV) for the backward and forward linkages, respectively, defined as the ratio between the standard deviation of the individual linkage and the economy-wide linkage average. A small CV thus implies an even distribution of the multipliers, and output effects will be spread more evenly among the sectors in the economy. Therefore, a sector is defined as a key sector if $BL_j > 1$, $FL_j > 1$, $CV_j^{BL} < 1$ and $CV_j^{FL} < 1$.

40 The corresponding vector of the normalized backward linkages is in matrix form defined as $\mathbf{b} = n\mathbf{i}'\mathbf{L}/\mathbf{i}'\mathbf{L}\mathbf{i}$, and for the normalized forward linkages as $\bar{\mathbf{c}} = n\mathbf{L}\mathbf{i}/\mathbf{i}'\mathbf{L}\mathbf{i}$.

2.2.2 Hypothetical extraction methods

The starting point of and the fundamental idea in HEM is the question: how much would the size of the economy be reduced if sector j $(j = 1,2 \ldots n)$ ceased to exist? This is thus an opposite approach to the CMM, in which the question is how much the economy will expand from an initial change in final demand. In an IO framework, the HEM question is answered by nullifying the columns and rows in the matrix **A** and, hence, in the Leontief inverse.[41] Since sector j ceases to exist, it is also necessary to nullify sector $j's$ final demand. To keep the properties of the production function, it is assumed that these output losses are satisfied through imports.

This measure means that the value of all connections between sector j and the rest of the economy disappears. Solving the adjusted IO model with sector j excluded, $\mathbf{x}^{\mathbf{HEM}} = \left(\mathbf{I} - \mathbf{A}^{\mathbf{HEM}}\right)^{-1}\mathbf{f}^{\mathbf{HEM}}$, therefore implies that the endogenous vector of gross outputs, $\mathbf{x}^{\mathbf{HEM}}$, will be reduced. The difference between the pre-extracted gross output, found by solving the standard IO model, and the gross output generated with sector j excluded, is an absolute quantitative measure of a sector's importance, or total linkage, to the rest of the economy. This linkage is the combined effect of the level of purchasers and deliveries of intermediates, respectively, and the level of final demand. Accordingly, large sectors in terms of final demand and sectors which are strongly interrelated with other sectors through the intermediate structure are those that are found to be the most important in the economy. Normalization is usually performed by relating the absolute output reduction to the total economy pre-extracted gross output level.

Apart from these total HEM linkages, Dietzenbacher and van der Linden (1997) suggest that the HEM can also be used to measure backward and forward linkages separately. In terms of backward linkages, this non-complete extraction is performed by nullifying the column of sector j in matrix **A**, keeping forward intermediate deliveries and final demand unchanged. This means that sector j is assumed to buy all its intermediates from outside the domestic economy. If the IO model is solved without sector $j's$ domestic purchases of intermediates and compares the extracted output with the pre-extracted gross output of the economy, this generates the normalized backward linkage in an HEM setting. Analogously, and under the assumption that sector j domestic sales of intermediates are imported by the purchasing sectors, nullifying the row of sector j in matrix **A** leads to a measure of sector $j's$ forward linkage in an HEM setting.

41 See, for example, Miller and Lahr (2001) and Dietzenbacher and Lahr (2013).

2.3 Classical multiplier analysis

Domestic inter-industry linkages

Let us now turn to the empirical analysis of the inter-industry linkages, using the methodologies defined in the previous section.[42] The results for the CMM measures are presented in table 2.1 for the main aggregates of the domestic economy between 1975 and 2005.[43] The first (output) multiplier, defined as the column sums of the Leontief inverse, measures the total, direct and indirect, production needed throughout the domestic economy in order to produce one additional unit of final demand.[44] The backward linkage in the total economy was 1.62 in 1975.[45] This means that in that year, an increase in final demand by one krona, for example by growing private consumption or additional investment activities, on average generated a total output expansion in the domestic economy of 1.62 krona.[46] This total expansion is caused by the indirect, round-by-round, effects on the intermediates used throughout the economy to produce one unit of final demand. Over the period until 1991, the backward linkage decreased, indicating a reduction in the overall repercussions on production from an initial change in final demand. This reduction has also continued since 1995, with an output multiplier of 1.57 in 2005. Although structural changes of this kind are slow and un-dramatic processes by nature, the conclusion is that the backward inter-industry linkages have gradually been reduced in a rather linear fashion since the mid-1970s.

Underneath this aggregate backward measure, however, the patterns are non-linear. In the case of the manufacturing sector, the development was U-shaped between 1975 and 1991, with an average output multiplier of 1.72 in 1975, with weaker linkages in 1980 and 1985, and then returns to a slightly higher level in 1991 than in 1975. Since the 1990s, the overall pattern is instead a gradual and substantial reduction of the average backward linkage

42 Examples of related research are found in Gowdy (1991), Dietzenbacher (1992, 2002), Drejer (1999, 2003), Guo and Planting (2000), Claus (2003), West and Brown (2003), Andreosso-O'Callaghan and Yue (2004), EU Commission (2007), Dietzenbacher and Lahr (2008), Reis and Rua (2009), Guerra and Sancho (2010) and López González (2012).

43 Once again, the reader should be reminded that comparisons between the period 1975-91 and 1995-2005 should be done with the awareness of the differences between the IO tables for the two periods.

44 The estimates are weighted with final demand.

45 In tables 2.4 and 2.5 in the appendix of this chapter, these backward and forward linkages are presented for all sectors of the economy for the period 1975-2005.

46 In general terms, domestic inter-industry linkages are, on average, larger in small countries and smaller in large countries. Francois and Woerz (2008) show that the dynamics of the average inter-industry linkage in 78 countries follows an inverted U-shaped pattern in relation to GDP per capita.

– each unit of manufacturing final demand generates a smaller total output effect in 2005 than in 1995 and 1975. In this respect, the manufacturing sector has become less integrated with the domestic structure of production.

When it comes to the service sector, the pattern of backward linkages had an inverted U-shape between 1975 and 1991. This means that the domestic supply chains on average had to deliver more intermediates in 1980 and 1985 than in 1975 in order to satisfy an additional unit of services final demand. With a clear reduction between 1985 and 1991, the linkage had, however, returned to a level slightly below the 1975 figure at the beginning of the 1990s. Over the period 1995-2005, the average service sector output multiplier has remained almost unchanged, and it has actually increased among market services. This means that it is difficult to detect any systematic reduction in the average services backward linkage between 1975 and 2005. The difference between market services and the manufacturing sector is somewhat striking during the period 1995-2005.

Table 2.1. Backward and forward linkages, main aggregates, domestic economy, 1975-2005. Sources: Statistics Sweden and own calculations.

Backward linkages							
	1975	**1980**	**1985**	**1991**	**1995**	**2000**	**2005**
Total economy	1.62	1.57	1.61	1.58	1.59	1.58	1.57
Manufacturing	1.72	1.60	1.67	1.74	1.72	1.67	1.66
Service sector	1.49	1.52	1.55	1.47	1.53	1.53	1.52
Market services					1.56	1.59	1.59
Forward linkages							
	1975	**1980**	**1985**	**1991**	**1995**	**2000**	**2005**
Total economy	1.90	1.92	1.94	2.07	2.02	1.99	2.04
Manufacturing	1.61	1.55	1.53	1.57	1.50	1.44	1.44
Service sector	2.09	2.28	2.36	2.39	2.27	2.31	2.36
Market services					3.08	3.07	3.14

For the total economy, the lower part of table 2.1 shows that the average downstream interaction within the domestic economy gradually increased between 1975 and 1991 – from 1.9 to 2.07. In the period between 1995 and 2005, the increase continued, although at a slower pace. Clearly, this indicates that the downstream interaction in the economy has increased since the mid-1970s.[47] This is the result of a two-way dynamic. First, the average forward linkage within the manufacturing sector has, in a rather linear fashion, been reduced between 1975 and 2005 – from 1.61 to 1.44. This shows that the manufacturing sector has become a less important provider of intermediates

47 Due to the construction of the Leontief inverse, the unweighted backward and forward linkages of the total economy have to be the same.

to production processes in the domestic economy. Second, the opposite is true for the service sector. In this case, the forward linkage has gradually increased from 2.09 to 2.36 between 1975 and 2005. This indicates that each unit of final demand, on average, generates a larger amount of services intermediate deliveries in 2005 than in 1995 and 1975. The last row of the table suggests that market services are an important reason behind the high services forward linkage level and why it has grown fast since the mid-1990s. The prime role of market services, with knowledge intensive business services as an indispensable part, seems to be to deliver large amounts of intermediates to production processes throughout the economy.

To sum up, through the estimation of output and input multipliers, table 2.1 has introduced a way of analysing the dimensionless domestic production structure, and how it has evolved over time. At the level of the total economy, the trends of the backward and forward linkages look very different; the former indicate gradually weakened upstream interaction, while the latter indicate gradually stronger downstream interaction. The reason for this difference is that large services sectors also have large and often growing forward linkages, not the least within the business services sector. Underneath the aggregate trends, the role of the manufacturing sector has been reduced in the domestic production system, both in terms of backward and forward linkages. After a non-linear development during the 1970s and 1980s, the backward linkage has been substantially reduced at least since the beginning of the 1990s. This indicates that each unit of manufacturing final demand generates less indirect output effects along its domestic supply chains. Despite this reduction, the average backward linkage is still considerably larger in the manufacturing sector than in the service sector. The weakened role of the manufacturing sector in the domestic production system also emerges with the estimates of the forward linkages. In this case, however, the downward sloping trend is more linear and more pronounced over the whole period 1975-2005. This indicates that the manufacturing sector has become a less important provider of intermediates to production processes in the domestic economy. With the manufacturing sector buying a large share of its intermediates from itself, the reductions of the backward and forward linkages are strongly interrelated; when the upstream demand for intermediates is relatively reduced, this implies that the downstream manufacturing deliveries caused by final demand for manufactured products are weakened.

The trends are quite different for the service sector. In terms of backward linkages, the average use of intermediates has not been reduced, and it actually increased in the late part of the 1970s and in the first part of the 1980s. On the other hand, the service sector's position as a downstream provider of

intermediates has increased substantially since the mid-1970s. This is a strong indication of production processes becoming more dependent on service intermediates, not the least within the manufacturing sector.

The reasons behind these trends, both in the aggregate economy and within the main sectors, are of course complex to identify. Forces of technical change and increased specialization may push the production structure in one direction, while other forces, such as productivity, globalization and agglomeration, may push it in another direction. In the forthcoming chapters, these forces are further analysed, among other things as to how they have affected value creation and structural change. Before continuing along that road, however, the issue of global production processes will be briefly scrutinized.

Inter-industry linkages including imports

One obvious reason behind the divergent trend between the manufacturing sector and the service sector in terms of upstream linkages is the global fragmentation of production processes. This suggests that intermediates are to a larger extent than before purchased from foreign suppliers, especially in the manufacturing sector. Table 2.2 gives a first indication of this process of structural change. Using IO tables including imports of intermediates, size-independent backward linkages have been estimated. This means that the world economy is seen as one production system and no distinction is made between the domestic economy and the intermediate interaction with Sweden's trading partners. From this perspective, the average total economy output multiplier has gradually increased between 1975 and 2005. This indicates that the use of imported intermediates has increased in the domestic production processes since the mid-1970s.[48] In 2005, each unit of final demand on average generated a total output increase in the world economy of 2.12.

Although the import adjusted output multiplier has grown larger in the service sector, the main reason behind this change is found in the manufacturing sector. Recall that the domestic backward linkage has been gradually reduced since the beginning of the 1990s, but if the imported intermediates used in domestic manufacturing production processes are considered, the output multiplier has increased rather dramatically since the mid-1970s – from 2.32 to 2.69. In a world of complex and multidimensional forces affecting the structure of the economy in different ways, this should be considered as a major change. The conclusion is that the vertical integration seems to have increased

48 Using a similar approach, Östblom (1986) shows that an increased use of imported intermediates was a defining feature of the Swedish economy already between 1957 and 1980. See also Norén (2010).

in manufacturing production processes within the domestic economy, but this is more than compensated for by an increased use of imported intermediates. From the perspective of the world economy as one production system, the vertical disintegration has instead increased substantially, and seems to be a defining feature of the Third industrial revolution. Expressed in a slightly different way, the supply networks of the manufacturing sector have become less dense in the domestic economy, but much more so if the emerged global value chains are considered.

Table 2.2. Backward linkages including imports of intermediates, main aggregates, 1975-2005. Sources: Statistics Sweden and own calculations.

Backward linkages including imports							
	1975	**1980**	**1985**	**1991**	**1995**	**2000**	**2005**
Total economy	2.05	2.08	2.18	1.96	2.04	2.12	2.12
Manufacturing	2.32	2.36	2.50	2.43	2.52	2.63	2.69
Service sector	1.71	1.78	1.85	1.64	1.79	1.83	1.83
Market services					1.86	1.95	1.97
Domestic/including imports							
	1975	**1980**	**1985**	**1991**	**1995**	**2000**	**2005**
Total economy	0.79	0.76	0.74	0.80	0.78	0.75	0.74
Manufacturing	0.74	0.68	0.67	0.72	0.68	0.64	0.62
Service sector	0.87	0.85	0.84	0.89	0.86	0.84	0.83
Market services					0.84	0.82	0.81

This aspect of the globalization process is identified in the lower part of table 2.2. The presented measure expresses the share of domestic backward linkages, identified in table 2.1, in backward linkages including imports of intermediates, identified in the upper part of table 2.2. These ratios can be seen as an indication of the level of interaction with the global economy; it shows the increased use of imported intermediates in domestic production processes. As can be seen, in 2005 the level of imported intermediates in the total economy reached the same level as in the manufacturing sector 30 years earlier. The use of imported intermediates in the service sector is today still considerably lower than the use of imported intermediates in the manufacturing sector in the mid-1970s.

Key sector analysis using classical multiplier methods

One way of structuring the information concerning backward and forward linkages in the individual sectors is to identify key sectors – sectors with production processes that cause strong overall output effects in the domestic

economy. As stated in section 2.2.1, a sector is defined as a key sector if the normalized, size-independent forward and backward linkages are larger than one, meaning that the growth effects are above the economy-wide average. If this is the case, a krona worth of expansion in these sectors will stimulate more productive activities throughout the economy, both in terms of upstream and downstream interaction, than an equal expansion in another, non-key sector. These generally dependent sectors should also spread their growth impulses evenly. Accordingly, in order to be defined as a 'pure' key sector, the coefficient of variation (CV) should be smaller than one. The typology used therefore gives the following categories: (1) KSW: key sector widely spread. These are the sectors with above average linkages in terms of both backward and forward linkages, and these linkages are evenly spread throughout the economy; (2) KSC: key sector concentrated. These are the sectors with above average linkages in both cases, but at least one of the CVs is above one, indicating a relatively uneven distribution in the economy; (3) BO: backward oriented. These are the sectors with an above average backward linkage and with a forward linkage below average; (4) FO: forward oriented: these are the sectors with an above average forward linkage and a backward linkage below average; (5) WO: weakly oriented. These are the sectors with both linkages below average.

Using the multipliers of the individual sectors, tables 2.6 and 2.7 in the appendix of this chapter present the results of the key sector analysis. Some general conclusions are mentioned in the following. In 1975, ten out of 43 sectors could be defined as key sectors, as they strongly stimulate the economy per unit of final demand, both in terms of intermediate demands in their own production processes and as providers of intermediates to production processes in other sectors. In that sense, they are positioned in the centre of the economy, sending strong growth impulses both upstream and downstream in the production system. Of the ten key sectors in 1975, two of them, printing and publishing and bank and insurance, respectively, had at least one multiplier that was unevenly distributed in the economy. Their role as key sectors is therefore somewhat weaker. In 1975, six out of the ten key sectors belonged to the manufacturing sector, and two belonged to the service sector.

Thirty years later, eleven out of 51 sectors could be defined as key sectors. Five of them belonged to the manufacturing sector, although none of them belonged to the group of high-tech or medium high-tech manufacturing sub-sectors, according to the classification by OECD (2011); these sub-sectors are in general highly integrated within global production networks. Some clear patterns can be identified between 1975 and 2005. Most importantly, a new group of key sectors has emerged around knowledge intensive business

services.[49] This part of the economy is highly forward oriented, with a large amount of intermediate deliveries to other parts of the economy per unit of final demand. This position has gradually strengthened, and their weighted forward linkage has been the highest of all sectors since the mid-1990s; business services intermediates have become the most intensively used intermediates in production processes throughout the domestic economy. This improved forward position has emerged alongside a slight increase in the backward linkages. The combined effect of the intensified size-independent upstream and downstream interaction is that the business services sector has become a key sector.

Some other key features are:

- A new group of key sectors has emerged around transportation and telecommunication. In transportation, with a strong and continuously growing forward position, this is caused by stronger backward linkages. In telecommunication, it is a matter of higher levels of both backward and forward linkages. Obviously, this change is related to the ICT revolution and a growing use of ICT intermediates.
- Agriculture and food production have had large upstream and downstream multipliers over the whole period, despite the relative decline of these sectors in terms of final demand. This shows that the size-independent production structure can be rather unchanged despite major changes in relative demand patterns. From this dimensionless perspective, these two sectors are still defined as key sectors.
- Due to weakened downstream linkages, production related to wood and paper seems to have lost some of its central role in the economy during the 1980s, but they have retained its central position in the economy since the mid-1990s. The reason for this is regained levels of the downstream linkages.
- Both printed matter and steel production have kept their key positions over the whole period.
- Due to weaker upstream linkages, construction lost its role as a key sector in the 1980s, but kept its forward orientation until 2005.
- The figures for the period 1995-2005 show that the public sector is not very integrated with the domestic production system. This is especially the case in terms of weak downstream provision of intermediates to the market sectors.

49 Since the1990s, the business services sector is defined as renting of machinery, computer services, R&D and other business services.

As have been stated, the inter-industry linkages analysed in this section identify the production structure of the economy without any consideration about the actual size of sectors. In order to reach a broader understanding of the structure of the economy, this type of analysis should be complemented with an approach which also includes to what extent sectors meet actual levels of intermediate and final demand. This is done in the following section.

2.4 Inter-industry linkages using hypothetical extraction methods

The HEM approach gives a comprehensive picture of how important a sector is in terms of intermediate use, intermediate deliveries and final output for the aggregate economy. In this respect, these measures give a clear indication of sectoral structural changes since the mid-1970s. Let us focus on the main aggregates of manufacturing and services, respectively. The next chapter will in more detail analyse the hypothesis that Sweden has been deindustrialized since the 1970s. This will be done using the Leontief inverse and to translate sectoral gross output to levels of – direct and indirect – employment and value added. Figure 2.1 therefore addresses perspectives more thoroughly analysed later on in the thesis.

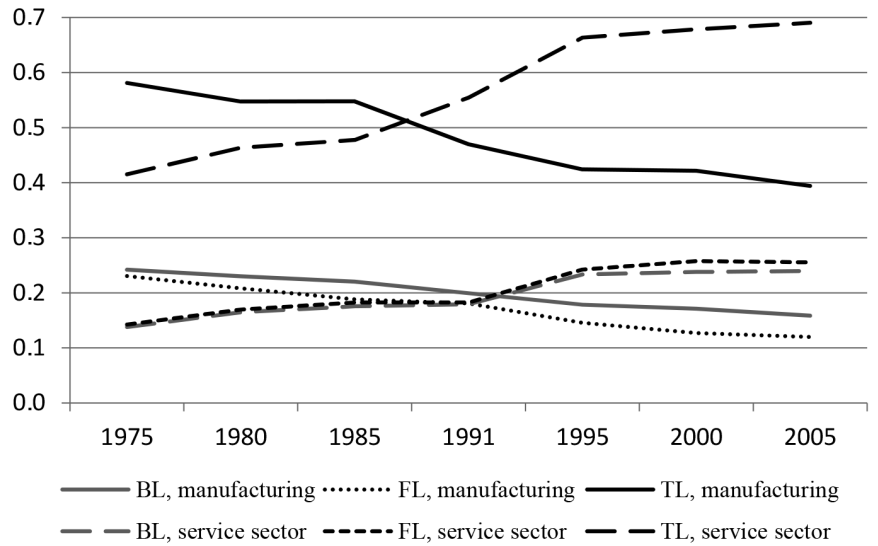
The figure contains six graphs, all of them describing the ratio between the extracted value and the economy-wide pre-extracted gross output level.[50] For example, when the manufacturing sector's columns are nullified in matrix **A**, the extracted value represented 24 per cent of the economy-wide gross output level in 1975 (BL, manufacturing). This means that the size of the economy would have shrunk by 24 per cent if the domestic upstream purchases of intermediates by the manufacturing sector ceased to exist. A rather linear decline thereafter resulted in an extracted share of 16 per cent in 2005. Clearly, this shows that the level of upstream interactions of the manufacturing sector with the overall domestic economy has been reduced by around 34 per cent since the mid-1970s; the supply chains of the manufacturing sector generate much less relative production in the domestic economy today than 35 years ago.

The same pattern seems to apply for the downstream interaction of the manufacturing sector, although the level has been somewhat lower over the

50 In tables 2.8 and 2.9 in the appendix of this chapter, the HEM estimates are presented for all sectors for the period 1975-2005.

whole period. This indicates that the extracted share of gross output, based on the value of the intermediate deliveries from the manufacturing sector to the national production system (including itself), has been reduced by 48 per cent since the mid-1970s. Finally, if both directions of intermediate transactions and final demand are extracted, the economy shrunk by 58 per cent in 1975 but only by 39 per cent in 2005 – a reduction of around one third. However, this process of structural change has not been linear. In the first part of the 1980s and the latter part of the 1990s, the share in gross output was unchanged. In the latter part of the 1970s and at the beginning of the 2000s, the role of the manufacturing sector was only slightly reduced. Consequently, the main reduction occurred from the mid-1980s to the mid-1990s. Although the deep crisis at the beginning of the 1990s substantially affected the manufacturing sector, the reduction seems to have been even more pronounced in the latter parts of the 1980s. In terms of total linkages, this is also the period in which the service sector grows larger than the manufacturing sector. This means that the role of the manufacturing sector in the domestic economy has been reduced along all three dimensions: upstream, downstream and total linkages, with the first two being strongly interrelated.

Figure 2.1. Hypothetically extracted values as shares of unextracted total economy gross output, manufacturing and services, 1975-2005. Sources: Statistics Sweden and own calculations.



The other side of the coin is, of course, the growing role of the service sector. This concerns both an increased importance of intermediates used in production

processes throughout the economy, and larger amounts of intermediates needed in the own production processes. From the downstream perspective, the increase amounts to 73 per cent between 1975 and 2005, and it is slightly larger than the provision of intermediates in the upstream dimension. Combined with a strong increase in final demand, it means that the total extracted service sector share of economy-wide gross output has increased from 42 to 69 per cent during the period 1975-2005. However, the speed of divergence between the manufacturing sector and the service sector has been reduced since the mid-1990s, a conclusion supported by all three dimensions.

How do these HEM results compare with conventional analyses of nominal value added shares, a measure often used to address issues related to the process of deindustrialization?[51] From a methodological perspective, using the conventional approach, no distinction is made between intermediate and final production. From this follows that no distinction can be made between upstream and downstream oriented sectors. Accordingly, it can be argued that the HEM approach to structural change is more closely related to the production structure of the economy and the positioning of sectors within this system, characterized by an intricate web of inter-industry interdependencies. Due to methodological differences, direct level comparisons between the HEM based results and the conventional approach for the manufacturing and the service sector are not appropriate. Changes in the relative shares are, however, possible to compare. This is done in table 2.3.[52] Clearly, the results differ quite considerably between the HEM total linkages and nominal value added shares. For the manufacturing sector, the reduced share between 1975 and 2005 is twice as large in terms of HEM total linkages as compared to the value added approach. For the service sector, the picture is the opposite, although even more pronounced. When the values of the three HEM dimensions of the role in the production system are included, the relative position of the service sector is considerably strengthened in comparison to the value added approach. Accordingly, with the HEM approach, the process of deindustrialization has been more pronounced than what is commonly acknowledged – and the keyness of the manufacturing sector is further reduced. The main reason for this is the inclusion of the upstream perspective, or the value of the purchased intermediates.

51 See, for example, Wölfl (2005), Houpt et al (2007) and Schön (2010a).

52 Note, however, that the HEM estimates are based on product-by-product IO tables and the value added shares are based on the SNI structure of the national accounts. This means that small differences between the two approaches should be treated carefully.

Table 2.3. Percentage change in HEM total linkage shares and nominal value added shares, 1975-2005. Sources: Statistics Sweden, EU Klems and own calculations.

	1975-2005
Manufacturing, VA	-16.8
Manufacturing, HEM TL	-32.2
Services, VA	19.6
Services, HEM TL	66.2

Another way of comparing the HEM estimates with the nominal value added shares is to use Spearman rank correlations. Using this method, the general result is that the rank of a sector in terms of value added correlates rather strongly with the rank in terms of the three HEM measures, although important exceptions exist. The rank correlations are the strongest in terms of total linkages, with a figure of around 0.9 over time. The weakest relationship is found between the forward linkage and the value added shares. In this case, the rank correlation is found to be around 0.7. When it comes to the total linkage, financial intermediation and electricity and gas, respectively, are found to have a much higher rank position in terms of value added than with the HEM linkage in 2005. The opposite is true for motor vehicles and food and beverage, respectively. In the HEM case, motor vehicles are ranked sixth, but only in 17th place in terms of value added. Accordingly, when all dimensions are included – upstream, downstream and final demand – the position of the motor vehicle sector improves.

When it comes to the HEM backward linkage, the general pattern is that the rank of many manufacturing sectors improves in comparison with the rank in terms of value added shares. Apart from motor vehicles and food and beverage, this is also the case for machinery and equipment, basic metals and pulp and paper. The reason for this improved rank is the abundant use of intermediates in their production processes. Finally, in a rank comparison between value added and the HEM forward linkage, the striking result concerns the role of the public sectors. They generate high levels of value added at the same time as their production is only to a small extent used as an intermediate in the production processes of other sectors. This means that the rank deteriorates in terms of HEM forward linkages. For example, health and social work is ranked second in terms of value added but only 38th in terms of the HEM forward linkage. Two high-tech manufacturing sub-sectors are also included in this group. Both chemicals and electrical machinery generate a substantially better rank position in terms of value added than in terms of HEM forward linkages. The reason for this is their rather weak forward position in the economy: being globally oriented high-tech sub-sectors, a relatively small share of output is used as intermediates in domestic production processes.

The estimates presented in this section show that the position of sectors within the domestic production system varies considerably, which is an issue not possible to address with conventional value added shares. The HEM approach also contributes to the understanding of the process of deindustrialization, in the sense that it is amplified when studying the economy from this production perspective. In several cases, the importance of individual sectors in terms of their size is also altered when using this approach.

2.5 Concluding discussion

This chapter has tested the hypothesis that production processes in the domestic Swedish economy have become more vertically disintegrated. In the literature, it is assumed that this is caused by a growing use of outsourcing and new services intermediates in the manufacturing sector. In turn, this is caused by a growing use of ICTs and their effect on the transaction costs; internal hierarchies are substituted for market transactions. If this is the case, the demand for services intermediates per unit of final demand needs to increase to finalize production. On the other hand, the fragmentation of manufacturing production processes along the global value chains suggests that a growing use of imported intermediates reduces domestic intermediate demand per unit of final demand. The net effect of these structural changes is that the economy, if anything, has become slightly more vertically integrated, as indicated by an almost gradual reduction of the output multiplier since the 1970s. It can thus be argued that the forces of globalization have been somewhat stronger than the forces pushing for a closer interaction between different parts of the domestic economy, mainly between the manufacturing sector and the service sector.

Behind this aggregate trend, it is clear that the development in the manufacturing sector has been non-linear. In a comparison with the mid-1970s, the output multiplier was lower in the 1980s and did not reach the same level again until the beginning of the 1990s. Since then, however, there has been a rather substantial increase in the level of vertical integration; the need for domestic intermediates per unit of final demand has decreased. On the other hand, when the world is seen as one production system, the period since the mid-1970s is characterized by manufacturing production processes becoming substantially more vertically disintegrated, as shown by a growing need of intermediates to finalize production. The global presence of the service sector is still clearly below the global presence of the manufacturing sector in

the mid-1970s. The emergence of global value chains, and its consequences for the understanding of global production and the competitive position of nations, will be further scrutinized in chapter six.

With the manufacturing sector delivering much of its intermediate production to itself, its forward linkage is likely to be closely related to its backward linkage; when less domestic upstream intermediates are needed, the amount of forward deliveries will decrease. The importance of the global value chains is therefore also present in terms of input multipliers. On the other hand, the use of service intermediates within the domestic production system has gradually increased since the mid-1970s. This is a strong indication of an emerging manuservice economy, with the blending of manufacturing and services functions as its main characteristic. This aspect of structural change will be analysed in the next chapter.

Using size-independent backward and forward linkages, the key sector analysis has shown that several substantial structural changes have occurred since the mid-1970s. Most importantly, the business services sector has emerged as a key sector. As a downstream oriented sector, gradually stronger upstream linkages have qualified this part of the economy as a key sector. At the same time, the forward position has grown considerably stronger and the use of its products as intermediates has become more spread among sectors. Since the mid-1990s, the business service sector is the part of the economy with the strongest and most widely used forward linkages; it has emerged as the most important provider of intermediates to production processes throughout the economy. This perspective of the business services sector is analysed in chapter four.

Finally, the HEM approach to key sector analysis and structural change concerns the level of both intermediate and final demand. The intermediate perspective includes upstream purchases and downstream deliveries. Accordingly, the HEM represents a perspective which includes several dimensions in terms of structural change and the position of sectors within the production system. This chapter has shown that the process of deindustrialization is considerably more pronounced using the HEM approach than if a nominal value added approach is used. The reason for this is the relative reduction in the use of domestic manufacturing intermediates, at the same time as a strong growth in services final demand has generated larger volumes of intermediate demand, especially from itself. The keyness of the service sector has therefore grown much faster than what the value added approach indicates, and the opposite is true for the manufacturing sector. Among other things, this means that the choice of method affects the interpretation of the importance of the

growing knowledge based service economy, and the extent to which Sweden has been deindustrialized.

Although the general patterns are quite similar, at the level of individual sectors there are some significant differences between the HEM approach and the value added shares; Spearman rank correlations show that the latter is not always a good predictor of the rank in terms of the former. This seems to be the case along all three dimensions, but mostly in terms of forward linkages. Accordingly, both in terms of aggregate structural change and the importance of individual sectors, the HEM approach adds new knowledge to the production structure and how it has evolved over time, not the least in terms of the keyness among several manufacturing sub-sectors with strong output multipliers; their contribution to the economy is underestimated when excluding their intermediate purchases.

From tables 2.8 and 2.9 in the appendix of this chapter, the HEM estimates show the gradual growth of the business services sector since the mid-1970s. This concerns all three dimensions, and means that this part of the economy has become the largest sector in terms of both forward and total linkages. Consequently, this part of the economy has emerged as a key sector also in terms of its size. The size-independent linkages and the HEM approach thus point in the same direction: increased levels of intermediate and final demand have emerged alongside production processes becoming more dependent on business services intermediates.

Appendix

Table 2.4. Size-independent backward and forward linkages, individual sectors, domestic economy, 1975-91. Sources: Statistics Sweden and own calculations.

	Backward linkages				Forward linkages			
	1975	**1980**	**1985**	**1991**	**1975**	**1980**	**1985**	**1991**
Agriculture	1.74	1.73	1.67	1.72	2.02	1.53	1.88	1.72
Forestry	1.25	1.21	1.20	1.23	2.47	2.34	2.45	2.46
Fishing	1.37	1.34	1.34	1.34	1.01	1.01	1.02	1.03
Iron ore mining	1.60	1.69	1.44	1.76	1.20	1.17	1.11	1.12
Non-ferrous ore mining	1.67	1.51	1.51	1.85	1.07	1.16	1.12	1.07
Quarrying and other mining	1.33	1.61	1.58	1.72	1.18	1.16	1.15	1.22
Protected food	2.48	1.45	2.29	2.32	1.91	1.52	1.75	1.69
Import-competing food	1.84	1.81	1.82	1.89	1.36	1.32	1.38	1.44
Beverage and tobacco	1.65	1.67	1.63	1.69	1.10	1.07	1.09	1.12
Textile, wearing apparel and leather	1.42	1.46	1.44	1.50	1.36	1.33	1.26	1.27
Saw mills	1.88	1.87	1.99	2.02	1.60	1.67	1.51	1.52
Wooden building materials	1.75	1.79	1.71	1.82	1.63	1.53	1.43	1.56
Pulp	1.78	1.92	1.89	2.10	1.35	1.32	1.24	1.21
Paper and paperboard	1.81	1.94	1.85	1.89	1.52	1.65	1.68	1.60
Fibreboards and other paper	1.84	2.01	1.95	1.92	1.64	1.42	1.42	1.43
Printing and publishing	2.11	2.00	2.12	1.98	2.51	2.02	2.18	1.99
Industrial chemicals and fertilizers	1.55	1.60	1.58	1.56	2.09	1.91	1.78	1.74
Other chemicals	1.57	1.59	1.62	1.58	1.40	1.35	1.34	1.29
Petroleum refining	1.12	1.08	1.10	1.12	1.58	1.87	1.91	1.42
Rubber	1.40	1.43	1.41	1.50	1.16	1.15	1.13	1.12
Plastics	1.50	1.44	1.43	1.47	1.17	1.17	1.16	1.19
Non-metallic mineral	1.56	1.70	1.65	1.73	1.53	1.47	1.40	1.47
Iron and steel	1.67	1.74	1.80	1.89	1.81	1.74	1.67	1.66
Non-ferrous metal	1.65	1.74	1.76	1.77	1.51	1.50	1.48	1.43
Fabricated metals	1.55	1.60	1.61	1.69	2.01	1.94	1.90	2.24
Machinery and equipment	1.53	1.55	1.53	1.61	1.71	1.76	1.71	2.01
Electrical machinery	1.46	1.48	1.44	1.56	1.38	1.29	1.25	1.39
Ship building and repairing	1.66	1.78	1.70	1.68	1.14	1.14	1.07	1.07
Transport equipment	1.64	1.62	1.53	1.65	1.44	1.34	1.21	1.34
Instruments	1.36	1.40	1.34	1.46	1.05	1.03	1.02	1.05
Other manufacturing	1.57	1.69	1.62	1.77	1.02	1.04	1.03	1.02
Electricity and gas	1.28	1.32	1.35	1.35	1.91	2.15	2.08	2.17
Water	1.52	1.49	1.48	1.54	1.08	1.22	1.20	1.24
Construction	1.70	1.68	1.65	1.63	2.43	2.06	2.12	2.22
Wholesale and retail trade	1.46	1.48	1.50	1.47	2.72	3.08	3.06	2.99
Hotels and restaurants	1.83	1.63	1.66	1.60	1.12	1.43	1.46	1.42
Transportation and storage	1.54	1.58	1.64	1.60	2.52	2.88	2.89	3.83
Post and telecommunication	1.70	1.43	1.54	1.48	1.33	1.62	1.70	1.61
Financial institutions	1.62	3.34	4.68	1.39	1.92	4.27	5.50	1.89
Dwelling and real estate	1.37	1.46	1.41	1.39	1.85	1.55	1.74	1.69
Business services	1.68	1.50	1.66	1.68	2.24	2.27	2.61	3.58
Reparation	1.38	1.47	1.42	1.40	1.37	1.29	1.32	1.43
Other private services	1.43	1.46	1.43	1.41	1.38	1.57	1.57	1.77

Table 2.5. Size-independent backward and forward linkages, individual sectors, domestic economy, 1995-2005. Sources: Statistics Sweden and own calculations.

	Backward linkages			Forward linkages		
	1995	**2000**	**2005**	**1995**	**2000**	**2005**
Agriculture, hunting	1.76	1.75	1.83	1.75	1.68	1.67
Forestry, logging	1.15	1.17	1.38	1.64	1.62	1.58
Fishing	1.51	1.56	1.51	1.01	1.01	1.01
Coal and lignite	1.90	2.18	2.07	1.04	1.35	1.21
Petroleum and natural gas, uranium	1.99	2.20	2.00	1.00	1.00	1.00
Metal ores	1.64	1.70	1.54	1.27	1.20	1.26
Food, beverage and tobacco	2.16	2.01	1.99	2.18	1.96	1.74
Textiles	1.49	1.54	1.53	1.25	1.17	1.13
Wearing apparel	1.48	1.60	1.58	1.01	1.01	1.01
Leather	1.86	1.65	1.61	1.05	1.06	1.04
Wood	1.85	1.97	1.96	1.68	2.18	2.11
Pulp and paper	1.77	1.72	1.85	1.88	1.55	1.51
Printed matter and recorded media	1.89	1.90	1.92	2.31	2.05	1.88
Coke, refined petroleum	1.27	1.13	1.08	1.35	1.43	1.40
Chemicals	1.53	1.45	1.44	1.47	1.33	1.25
Rubber and plastic	1.58	1.54	1.47	1.34	1.31	1.26
Non-metallic mineral	1.70	1.75	1.71	1.32	1.32	1.27
Basic metal	1.76	1.78	1.73	2.00	1.59	1.62
Fabricated metal	1.70	1.66	1.64	2.14	2.09	2.04
Machinery and equipment	1.64	1.64	1.67	1.64	1.44	1.48
Office machinery and computers	1.58	1.40	1.55	1.01	1.00	1.00
Electrical machinery, radio and telecom	1.67	1.67	1.54	1.26	1.16	1.16
Medical and precision instruments	1.56	1.46	1.46	1.10	1.05	1.09
Motor vehicles	1.69	1.70	1.75	1.30	1.30	1.33
Other transport	1.59	1.55	1.60	1.31	1.33	1.32
Furniture	1.79	1.77	1.73	1.11	1.15	1.13
Secondary raw materials	1.77	1.85	1.57	1.03	1.10	1.12
Electricity, gas and steam	1.30	1.41	1.40	2.00	1.79	1.97
Water	1.50	1.58	1.55	1.16	1.13	1.12
Construction	1.60	1.62	1.60	2.01	1.97	2.00
Retail and wholesale trade	1.49	1.51	1.51	3.58	3.37	3.35
Hotels and restaurants	1.77	1.74	1.73	1.71	1.46	1.46
Land transport	1.67	1.69	1.67	3.26	3.01	3.00
Water transport	1.53	1.89	1.74	1.14	1.15	1.16
Air transport	1.64	1.58	1.60	1.31	1.33	1.21
Transport services	1.66	1.85	1.79	2.24	3.46	3.35
Post and telecom	1.60	1.76	1.80	2.08	2.30	2.11
Financial intermediation	1.43	1.47	1.40	2.13	2.01	1.83
Insurance and pension	1.45	1.37	1.30	1.20	1.17	1.17
Services financial intermediation	1.70	1.58	1.57	1.14	1.20	1.21
Real estate	1.52	1.52	1.59	3.35	3.01	3.20
Renting of machinery and equipment	1.65	1.56	1.54	1.41	1.56	1.53
Computer services	1.72	1.65	1.60	1.96	2.15	2.17
R&D and other business services	1.76	1.65	1.59	4.71	5.33	5.34
Public administration and defence	1.55	1.53	1.55	1.32	1.35	1.31
Education	1.46	1.43	1.42	1.14	1.20	1.15
Health and social work	1.43	1.31	1.31	1.17	1.11	1.14
Sewage and refuse disposal	1.70	1.71	1.70	1.14	1.19	1.22
Membership organisations	1.50	1.49	1.46	1.20	1.16	1.14
Recreation, culture and sports	1.71	1.72	1.74	1.34	1.39	1.47
Other services	1.61	1.42	1.40	1.06	1.06	1.06

Table 2.6. Typology of key sectors using size-independent backward and forward linkages, 1975-91. Sources: Statistics Sweden and own calculations.

	1975	1980	1985	1991
Agriculture	**KSW**	BO	**KSW**	**KSW**
Forestry	FO	FO	FO	FO
Fishing	WO	WO	WO	WO
Iron ore mining	BO	BO	WO	BO
Non-ferrous ore mining	BO	WO	WO	BO
Quarrying and other mining	WO	WO	BO	WO
Protected food	**KSW**	WO	**KSC**	**KSC**
Import-competing food	BO	BO	BO	BO
Beverage and tobacco	BO	BO	WO	BO
Textile, wearing apparel and leather	WO	WO	WO	WO
Saw mills	**KSW**	**KSW**	BO	BO
Wooden building materials	**KSW**	BO	BO	BO
Pulp	BO	BO	BO	BO
Paper and paperboard	BO	**KSW**	**KSW**	BO
Fibreboards and other paper	**KSW**	BO	BO	BO
Printing and publishing	**KSC**	**KSW**	**KSW**	**KSW**
Industrial chemicals and fertilizers	FO	FO	FO	FO
Other chemicals	WO	WO	WO	WO
Petroleum refining	WO	FO	FO	WO
Rubber	WO	WO	WO	WO
Plastics	WO	WO	WO	WO
Non-metallic mineral	WO	BO	WO	BO
Iron and steel	**KSW**	**KSW**	**KSW**	**KSC**
Non-ferrous metal	BO	BO	BO	BO
Fabricated metals	FO	FO	FO	**KSC**
Machinery and equipment	FO	FO	FO	FO
Electrical machinery	WO	WO	WO	WO
Ship building and repairing	BO	BO	BO	BO
Transport equipment	BO	WO	WO	BO
Instruments	WO	WO	WO	WO
Other manufacturing	WO	BO	WO	BO
Electricity and gas	FO	FO	FO	FO
Water	WO	WO	WO	WO
Construction	**KSW**	**KSW**	FO	FO
Wholesale and retail trade	FO	FO	FO	FO
Hotels and restaurants	BO	BO	WO	WO
Transportation and storage	FO	FO	FO	FO
Post and telecommunication	BO	WO	FO	WO
Financial institutions	**KSC**	**KSC**	**KSC**	FO
Dwelling and real estate	FO	WO	FO	FO
Business services	**KSW**	FO	FO	**KSC**
Reparation	WO	WO	WO	WO
Other private services	WO	WO	WO	FO

Table 2.7. Typology of key sectors using size-independent backward and forward linkages, 1995-2005. Sources: Statistics Sweden and own calculations.

	1995	2000	2005
Agriculture, hunting	**KSW**	**KSW**	**KSW**
Forestry, logging	FO	WO	WO
Fishing	WO	WO	WO
Coal and lignite	BO	BO	BO
Petroleum and natural gas, uranium	BO	BO	BO
Metal ores	BO	BO	WO
Food, beverage and tobacco	**KSW**	**KSW**	**KSW**
Textiles	WO	WO	WO
Wearing apparel	WO	WO	WO
Leather	BO	BO	BO
Wood	**KSW**	**KSW**	**KSW**
Pulp and paper	**KSW**	BO	BO
Printed matter and recorded media	**KSW**	**KSW**	**KSW**
Coke, refined petroleum	WO	WO	WO
Chemicals	WO	WO	WO
Rubber and plastic	WO	WO	WO
Non-metallic mineral	BO	BO	BO
Basic metal	**KSC**	BO	**KSW**
Fabricated metal	**KSC**	**KSC**	**KSC**
Machinery and equipment	**KSW**	BO	BO
Office machinery and computers	WO	WO	WO
Electrical machinery, radio and telecom	BO	BO	WO
Medical and precision instruments	WO	WO	WO
Motor vehicles	BO	BO	BO
Other transport	WO	WO	WO
Furniture	BO	BO	BO
Secondary raw materials	BO	BO	WO
Electricity, gas and steam	FO	FO	FO
Water	WO	WO	WO
Construction	FO	FO	FO
Retail and wholesale trade	FO	FO	FO
Hotel and restaurant	**KSW**	BO	BO
Land transport	**KSC**	**KSC**	**KSC**
Water transport	WO	BO	BO
Air transport	BO	WO	WO
Transport services	**KSW**	**KSW**	**KSW**
Post and telecom	FO	**KSC**	**KSW**
Financial intermediation	FO	FO	FO
Insurance and pension	WO	WO	WO
Services financial intermediation	BO	WO	WO
Real estate	FO	FO	FO
Renting of machinery and equipment	BO	WO	WO
Computer services	**KSW**	**KSC**	**KSC**
R&D and other business services	**KSC**	**KSC**	**KSC**
Public administration and defence	WO	WO	WO
Education	WO	WO	WO
Health and social work	WO	WO	WO
Sewage and refuse disposal	BO	BO	BO
Membership organisations	WO	WO	WO
Recreation, culture and sports	BO	BO	BO
Other services	WO	WO	WO

Table 2.8. Hypothetically extracted values as shares of unextracted total economy gross output, individual sectors, 1975-91. Sources: Statistics Sweden and own calculations.

	HEM, backward linkages				HEM, forward linkages				HEM, total linkages			
	1975	1980	1985	1991	1975	1980	1985	1991	1975	1980	1985	1991
Agriculture	2.0	1.9	1.5	1.0	3.1	2.4	2.2	1.6	4.7	4.3	3.8	2.4
Forestry	0.4	0.3	0.3	0.3	2.7	2.2	1.7	1.8	2.2	1.6	1.7	1.4
Fishing	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.1	0.1	0.1	0.1
Iron ore mining	0.4	0.2	0.1	0.1	0.3	0.2	0.1	0.1	1.0	0.4	0.4	0.3
Non-ferrous ore mining	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.3	0.3	0.2
Quarrying and other mining	0.1	0.1	0.1	0.2	0.4	0.2	0.2	0.2	0.3	0.3	0.3	0.4
Protected food	5.4	5.2	4.5	3.0	2.1	0.6	1.4	1.2	9.1	8.6	8.0	3.4
Import-competing food	0.6	0.8	0.7	1.0	0.9	0.8	0.8	0.7	1.4	1.5	1.4	2.2
Beverage and tobacco	0.3	0.3	0.3	0.4	0.1	0.1	0.1	0.2	0.8	0.8	0.8	0.9
Textile, wearing apparel and leather	0.6	0.5	0.4	0.3	0.5	0.4	0.3	0.3	2.2	1.6	1.4	0.8
Saw mills	1.3	1.3	1.2	1.0	1.2	1.3	0.7	0.8	2.7	2.8	2.4	1.9
Wooden building materials	1.4	1.4	1.1	1.2	1.8	1.6	1.0	1.4	3.3	3.2	2.6	2.6
Pulp	1.4	1.1	0.9	0.7	0.6	0.5	0.4	0.3	3.3	2.2	1.9	1.3
Paper and paperboard	1.3	1.8	1.8	1.7	1.0	1.1	1.0	1.0	2.9	3.6	3.9	3.5
Fibreboards and other paper	0.8	0.8	0.8	0.7	1.2	0.8	0.7	0.7	1.8	1.6	1.6	1.4
Printing and publishing	2.1	1.5	1.7	1.6	2.6	1.9	2.0	2.0	4.0	3.0	3.3	3.3
Industrial chemicals and fertilizers	0.7	0.8	0.8	0.7	1.6	1.3	0.9	0.9	2.0	2.2	2.3	1.9
Other chemicals	0.6	0.7	0.7	0.8	0.7	0.6	0.5	0.5	1.7	1.8	1.9	2.1
Petroleum refining	0.2	0.2	0.3	0.1	1.2	2.0	1.6	0.9	1.4	2.9	3.0	1.4
Rubber	0.2	0.1	0.1	0.1	0.3	0.3	0.2	0.2	0.5	0.4	0.5	0.3
Plastics	0.2	0.2	0.2	0.2	0.4	0.4	0.3	0.4	0.6	0.6	0.6	0.7
Non-metallic mineral	0.6	0.8	0.6	0.7	1.4	1.3	0.9	1.2	1.7	1.9	1.6	1.6
Iron and steel	1.7	1.4	1.6	1.2	2.0	1.6	1.2	1.2	4.2	3.4	3.6	2.5
Non-ferrous metal	0.5	0.7	0.6	0.4	0.8	0.7	0.6	0.5	1.2	1.5	1.4	1.0
Fabricated metals	1.8	1.7	1.6	1.7	2.5	2.2	1.7	2.4	5.0	4.5	4.3	4.3
Machinery and equipment	2.6	2.5	2.4	2.4	1.6	1.5	1.3	1.7	7.7	7.1	6.9	6.3
Electrical machinery	1.3	1.1	1.1	1.4	1.0	0.7	0.6	0.9	4.2	3.5	3.7	3.8
Ship building and repairing	1.1	0.5	0.4	0.2	0.2	0.1	0.1	0.1	2.7	1.2	0.9	0.4
Transport equipment	2.3	2.2	2.3	2.3	1.1	0.9	0.6	1.0	6.0	5.6	6.6	5.9
Instruments	0.1	0.2	0.2	0.3	0.0	0.0	0.0	0.1	0.5	0.5	0.6	0.8
Other manufacturing	0.1	0.2	0.2	0.1	0.0	0.1	0.1	0.0	0.4	0.4	0.5	0.3
Electricity and gas	0.5	0.8	1.0	0.9	1.7	2.1	1.5	2.0	2.4	3.4	3.7	3.6
Water	0.1	0.2	0.4	0.2	0.2	0.5	0.5	0.5	0.3	0.6	0.6	0.7
Construction	7.0	6.6	5.2	6.0	3.5	3.1	3.0	3.7	17.0	16.3	13.2	15.4
Wholesale and retail trade	4.3	5.1	4.9	4.5	4.0	4.3	3.8	3.6	13.6	15.4	14.7	14.1
Hotels and restaurants	1.2	1.3	1.2	1.1	0.3	1.0	1.1	1.0	2.5	3.0	3.0	3.1
Transportation and storage	2.5	3.2	3.6	3.4	3.6	4.9	5.1	5.3	7.0	8.6	9.2	9.1
Post and telecommunication	1.0	0.7	1.0	0.9	0.9	1.6	1.7	1.6	2.5	2.5	2.8	2.7
Financial institutions	1.2	2.8	3.8	1.8	1.7	3.2	10.1	1.8	3.1	4.0	4.8	6.2
Dwelling and real estate	2.8	3.8	3.5	4.3	2.4	1.5	2.4	1.9	10.3	12.0	12.1	15.2
Business services	1.9	1.8	2.5	3.7	2.8	2.9	3.4	5.3	4.7	5.2	6.3	9.2
Reparation	0.5	0.6	0.6	0.7	1.0	0.9	0.8	1.1	1.7	1.9	1.9	2.4
Other private services	1.2	1.1	1.1	1.2	1.2	1.6	1.7	1.9	4.0	3.5	3.6	4.2

Table 2.9. Hypothetically extracted values as shares of unextracted total economy gross output, individual sectors, 1995-2005. Sources: Statistics Sweden and own calculations.

	HEM, backward linkages			HEM, forward linkages			HEM, total linkages		
	1995	2000	2005	1995	2000	2005	1995	2000	2005
Agriculture, hunting	0.8	0.6	0.5	1.4	1.0	0.8	1.9	1.5	1.2
Forestry, logging	0.1	0.1	0.2	1.1	0.9	0.7	1.1	0.8	0.5
Fishing	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Coal and lignite	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
Petroleum and natural gas, uranium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Metal ores	0.2	0.2	0.2	0.3	0.3	0.5	0.6	0.5	0.7
Food, beverage and tobacco	3.0	2.3	2.1	1.7	1.3	1.0	5.7	4.5	4.1
Textiles	0.1	0.1	0.1	0.1	0.1	0.0	0.4	0.3	0.2
Wearing apparel	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
Leather	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
Wood	1.2	1.2	1.2	1.1	1.2	1.2	2.6	2.5	2.5
Pulp and paper	2.1	1.7	1.6	1.6	1.0	0.7	4.8	4.0	3.5
Printed matter and recorded media	1.4	1.2	1.0	2.4	2.0	1.6	3.0	2.6	1.8
Coke, refined petroleum	0.2	0.1	0.1	0.4	0.6	0.5	0.9	1.3	0.4
Chemicals	1.0	0.9	0.9	0.7	0.5	0.4	3.0	2.9	3.1
Rubber and plastic	0.5	0.4	0.3	0.6	0.5	0.4	1.3	1.2	1.0
Non-metallic mineral	0.4	0.4	0.3	0.7	0.5	0.5	1.0	0.8	0.8
Basic metal	1.5	1.3	1.5	1.6	1.0	1.1	3.5	2.9	3.5
Fabricated metal	1.2	1.2	1.2	1.8	1.9	1.9	3.0	3.0	3.0
Machinery and equipment	2.2	1.9	2.1	1.0	0.8	0.8	4.0	5.0	5.3
Office machinery and computers	0.1	0.0	0.1	0.0	0.0	0.0	0.2	0.2	0.2
Electrical machinery, radio and telecom	1.8	2.9	1.3	0.6	0.4	0.3	4.4	7.1	3.7
Medical and precision instruments	0.4	0.3	0.4	0.2	0.2	0.2	1.2	1.2	1.2
Motor vehicles	2.2	2.3	2.7	0.7	0.9	1.0	5.4	5.6	6.2
Other transport	0.4	0.3	0.4	0.3	0.3	0.4	1.0	0.9	1.0
Furniture	0.6	0.5	0.4	0.2	0.2	0.2	1.3	1.2	1.0
Secondary raw materials	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2
Electricity, gas and steam	0.6	0.6	0.7	1.6	1.2	1.5	2.4	1.9	2.4
Water	0.2	0.2	0.1	0.5	0.4	0.4	3.6	0.4	0.4
Construction	2.5	2.3	2.6	2.7	2.5	2.7	6.8	6.0	6.8
Retail and wholesale trade	4.1	4.3	4.4	4.4	4.1	4.0	12.4	12.6	13.2
Hotels and restaurants	1.4	1.3	1.2	1.4	1.0	0.9	3.1	2.9	1.8
Land transport	1.6	1.5	1.5	3.0	3.1	3.1	4.0	3.7	3.9
Water transport	0.4	0.5	0.5	0.1	0.2	0.2	1.2	1.2	1.1
Air transport	0.3	0.3	0.2	0.6	0.6	0.4	0.9	0.9	0.6
Transport services	1.4	2.8	2.7	1.6	2.9	2.9	3.4	6.1	6.1
Post and telecom	1.0	1.4	1.4	2.0	2.3	1.9	2.6	3.3	3.3
Financial intermediation	1.0	1.0	0.8	2.4	1.8	1.7	3.5	3.0	2.8
Insurance and pension	0.3	0.3	0.2	0.4	0.3	0.3	0.9	0.9	0.9
Services financial intermediation	0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.4	0.4
Real estate	5.0	4.4	5.0	4.8	4.6	4.9	11.9	13.0	13.6
Renting of machinery and equipment	0.5	0.5	0.5	0.7	0.9	0.9	1.2	1.5	1.4
Computer services	1.2	1.6	1.6	1.8	2.2	2.2	2.9	4.1	4.3
R&D and other business services	4.0	4.5	4.3	6.3	7.8	7.8	9.3	11.4	11.7
Public administration and defence	2.5	2.3	2.0	0.7	0.7	0.6	7.1	6.5	5.7
Education	1.7	1.5	1.6	0.3	0.4	0.3	5.4	5.0	5.4
Health and social work	2.8	2.0	2.1	0.5	0.2	0.3	9.3	8.4	9.0
Sewage and refuse disposal	0.2	0.2	0.3	0.4	0.5	0.7	0.5	0.6	0.7
Membership organisations	0.6	0.5	0.5	0.3	0.2	0.2	1.7	1.5	1.5
Recreation, culture and sports	1.0	1.1	1.2	0.7	0.8	0.9	2.5	2.6	2.7
Other services	0.2	0.1	0.2	0.1	0.1	0.1	0.5	0.5	0.5

3. Outsourcing, servitization and deindustrialization

3.1 Introduction

In the economic historical literature, research on structural change is often directed towards the shares of value added and employment and how they evolve over time. With the purpose of finding empirical regularities on this issue and, hence, to understand the process of structural change, Kuznets (1971, p 348) argues that: "structural changes…are required without which modern growth would be impossible." As a central component of economic development, this type of structural change was at an early stage centred round the relative reduction of the agricultural sector. Indeed, in Sweden, in 1900, agriculture constituted 28 per cent of nominal GDP, and 52 per cent of employment.[53] A hundred years later, the shares were as low as 1.2 and 3.0 per cent and a completely different society had emerged.[54]

These changes were accompanied by a fast growing manufacturing sector. This was the driving force behind the golden age of economic growth until the beginning of the 1970s. This long phase of industrialization gradually lost momentum, however, and the process of deindustrialization started, in Sweden and elsewhere in the industrialized world.[55] The flip side of this was a fast growing service sector, leading to terms such as the postindustrial society, network society, knowledge economy, learning economy, servicification, tertiarization, quarternarization and servitization, often related to knowledge as an increasingly important factor of production, new and growing uses of ICT and a stronger presence of business related services.[56]

53 Calculations based on Schön and Krantz, Swedish Historical National Accounts 1560-2010.

54 As a forerunner, Sweden was, of course, part of a general process of industrialization in the Western World. See Houpt et al (2007) for a review of sectoral developments in Europe since the Second World War.

55 UN statistics show that the manufacturing share in nominal world GDP was reduced from 28 to 17 percent between 1970 and 2007.

56 Based on the Clark-Fisher hypothesis, a growing share of services in GDP was discussed already in the 1930s. See Hortlund (2010) and Tillväxtanalys (2010, 2011a) for recent reports on the Swedish service sector.

Although this process of structural change is a well-known phenomenon and has been debated all along, knowledge about its causes is still relatively limited. For example, Russo and Schettkat (2001) argue that there is a surprising disagreement about the nature of this change and a full understanding of its causes is still lacking. In a similar vein, Nickell et al (2008) state that the economic forces behind the process of deindustrialization are not well understood, and therefore no consensus has been reached. Montresor and Vittucci Marzetti (2010, 2011) argue that the empirical research on the deindustrialization process in the most advanced countries is far from conclusive.

In the literature, however, several possible explanations behind this structural change have been suggested. Following Rowthorn and Ramaswamy (1997, 1999), Feinstein (1999), Rowthorn and Coutts (2004), Palma (2005), Wölfl (2005) and Schettkat and Yocarini (2006) among others, four of the main, non-rival hypotheses are: (1) the relative demand for manufactured products decreases as countries grow richer in terms of GDP per capita; (2) differences in labour productivity between the manufacturing sector and the service sector lead to relative price movements, labour reallocations from the former to the latter and to a growing service share in nominal value added; (3) manufacturing companies have been focusing on their core activities and, consequently, have deepened their intermediate interaction with the service sector; and (4) increased North-South trade.

With its emphasis on the boundaries of companies, hypothesis three is strongly related to the vertical structure of production and how companies interact to finalize production. By explicitly considering this hypothesis, the main research question in this chapter is: has the Swedish economy been deindustrialized? In support of this main question, the following questions will also be addressed. To what extent has manufacturing production become more service intensive? How many employees are working with manufacturing production when the vertical interdependencies are accounted for?

The hypothesis under scrutiny has attracted a great deal of academic attention over the last couple of decades. In a Swedish context, Schön (2010a, p 397) argues about the manufacturing related employment that: "Deindustrialization in the sense of lower employment in the manufacturing sector is partly due to the new symbiosis between industry and services. Some of the service sector's rapid growth at the expense of the manufacturing sector since the 1970s is a statistical optical illusion."[57] Lundquist et al (2006) follow the same line of reasoning and argue that stronger intermediate interaction blurs the

57 Similar arguments are found in Magnusson (1999, 2006), Ottosson and Isacson (2002), Ekstedt (2002), Göransson (2002) and Andersson-Skog (2002).

boundaries between sectors and makes it difficult to understand changes in the manufacturing sector without considering the service sector. The inter-industry transactions between the manufacturing sector and the service sector have therefore become more important in order to properly understand the contemporary process of value creation and structural change.[58] This change in the vertical structure of the economy is, however, not thoroughly analysed in the Swedish economic historical literature; the argument of an intensified interaction between the two main sectors has not been analysed with empirical methods which in an appropriate way consider the growing use of service intermediates in manufacturing production processes. Due to the widespread use of the argument, this is somewhat surprising.

With its purpose and construction, IO analysis is an adequate empirical technique when addressing these issues. More specifically, size-independent manufacturing backward linkages towards the service sector will be estimated. This approach answers the following question: what amount of service intermediates is needed to produce one unit of manufacturing final demand? A distinction will be made between direct and indirect employment, and between direct and indirect value added. Making use of this, measures of vertically integrated manufacturing employment and value added will be presented, including all indirect linkages in the domestic production system. Moving down from the level of manufacturing and services, manufacturing sub-sectors will be analysed, and comparisons with horizontally oriented statistics will be performed. This latter aspect is used in a discussion of the content and dynamics of the process of deindustrialization.

The structure of the chapter is the following. The next section outlines the notion of an emerging manuservice economy, with the blurring of the boundaries between the manufacturing sector and the service sector as its main characteristic. As a background, section 3.3 addresses the deindustrialization process from a horizontal perspective, while section 3.4, the core part of the chapter, applies a vertical perspective on the manufacturing production process. A final section concludes the chapter.

58 The hypothesis concerning differences in labour productivity between the manufacturing sector and the service sector, the core of Baumol's so-called cost disease, has been shown to be valid in Sweden in terms of shares in value added. This means that the manufacturing share in real value added has not decreased since the 1970s. See Kander (2002, 2005), Henriques and Kander (2010) and Schön (2010a).

3.2 The manuservice economy

Outsourcing and the role of the service sector as a provider of intermediates were discussed already at the beginning of the 1950s (Stigler 1951). Levitt (1972, 1976) argue that there is no such thing as a service sector. All parts of the economy are to different extents service dependent, and the more technically advanced the manufactured product becomes, the more dependent will it be on services for its quality and sales. Due to increased specialization within and between companies, Levitt argues that the service share of the economy is not restricted to the service sector, but should include all product-related services supplied by manufacturing companies. It is also argued that the increased use of service intermediates and sales of product-related services outdates conventional sectoral classifications. A more recent example of a similar argument is found in Bryson and Daniels (2010). They argue that technical innovations and changes in the boundaries of companies have shifted employment away from the manufacturing sector to the service sector. According to the authors and due to a continuing evolution of the division of labour, this change should not be equated with a structural transformation away from a manufacturing based economy to a service based economy. Increased specialization has instead infused new intangible services functions into manufacturing production processes. When outsourcing of in-house functions is included, the activity based distinction between the manufacturing sector and the service sector is blurred. Bryson and Daniels (2010) define this as the manuservice economy, in which economic values are created through the blending of manufacturing and service functions.[59] Services have a dual role in this process.

First, the growing role of services as intermediates in production processes throughout the economy, not the least within the manufacturing sector, as outsourcing shifts intermediate transactions to the market. The second role is related to the tendency to add services to products. Manufacturing companies have become more dedicated to sell integrated products and solutions to customer problems. This servitization represents an innovation in manufacturing companies' capacity and processes to generate value through the sales of service intensive products (Baines et al 2009). In their literature review, they find that there are three main reasons behind servitization.[60] First, integrated products are often less exposed to price-based competition.

59 Bryson (2010) argues that these hybrid production systems and hybrid products is a radical, although not completely new, innovation in the production process.

60 Although the term was coined in the late 1980s, Schmenner (2009) argues that the blurring distinction between the manufacturing sector and the services sector, due to sales agents,

This means that higher profits and stable revenues can be achieved through servitization. Second, a comparative advantage is more likely to be sustained when selling integrated products, as they are more difficult to imitate. Third, integrated manufacturing products tend to increase sales. Among other things, this is related to customer loyalty and tailored products. Using a large scale survey, Lay et al (2010) show that a vast majority of European manufacturing companies offer services and service sales. The revenues from these sales are, however, still low and the servitization strategies are not fully developed.

As mentioned, already Levitt (1972, 1976) recognized the problems associated with the conventional taxonomy used to classify sectors. The manuservice perspective, based on the service duality, further emphasizes this problem. With changes in the vertical structure of the economy towards stronger interdependencies between the manufacturing sector and the service sector, the conventional sectoral classification has become less appropriate for understanding the contemporary growth process, and how and where economic values are created. Although difficult in practice, this is the reason why Bryson and Daniels (2010) support an empirical perspective based on vertical production processes and value creation. Following a similar line of reasoning, Montresor and Vittucci Marzetti (2010, 2011) argue that analyses based on the conventional sectoral classification suffer from a methodological flaw. The reason is that they do not consider the indirect effects on employment and value added caused by the use of services intermediates in the manufacturing sector. From the effects of outsourcing on the vertical structure of the economy, McCarthy and Anagnostou (2004) argue that to correctly understand and measure the economic value of the manufacturing sector in GDP, it is necessary to recognize the highly inter-industry related manufacturing production processes. With almost all products being composite products in advanced economies, Schettkat and Yocarini (2006) argue that an analysis of sectoral employment structures requires a vertically integrated perspective, including the indirect employment embedded in the purchased intermediates. Jacobides and Winter (2005) call for a new empiricism transcending conventional sectoral classifications, focusing on inter-industry interactions and value creation.

Different, but related, literatures point in the same direction – the need to properly estimate the size and role of sectors from a production perspective. Already Carter (1970) used IO analysis to show that the use of service intermediates in the US manufacturing sector increased between 1947 and 1967. With a continuous stream of research thereafter, over the last decade or

reparations, demonstrators, credit specialists and retail stores, has existed during the last 150 years.

so, the IO based analysis of outsourcing, servitization and deindustrialization has grown considerably.[61] This chapter adjoins the analysis of the Swedish economy to this literature.

3.3 Industrialization and deindustrialization

In the literature, three indicators are most often used to identify and analyse the process of deindustrialization. These are: (1) the share of manufacturing employment in total employment, (2) the absolute number of manufacturing employment and (3) the share of the manufacturing sector in nominal GDP.[62] On the basis of these indicators, the Swedish industrialization and deindustrialization process is presented in figure 3.1.

Industrialization in Sweden became increasingly intense in the latter part of the 19th century and continued over the World Wars until the 1950s, but then reached a plateau. The phase of deindustrialization then started. With 39.1 per cent, the manufacturing share in nominal GDP reached its highest level already in 1951. In terms of both relative and absolute employment, the highest level was reached in 1960 – 36.2 per cent and 1 171 000 employees, respectively.[63] There has been a gradual decrease after that and in 2007 manufacturing employment amounted to 723 000. This means that the number of employed has returned to the same level as in the mid-1930s. The employment reduction is even more pronounced in relative terms – we have to return to the years around 1900 to find an equally low level of relative manufacturing employment. Despite this considerable structural change, Palma (2005) argues that the development in Sweden between 1960 and 1998 follows an average pattern of deindustrialization which many other developed countries have also experienced.[64]

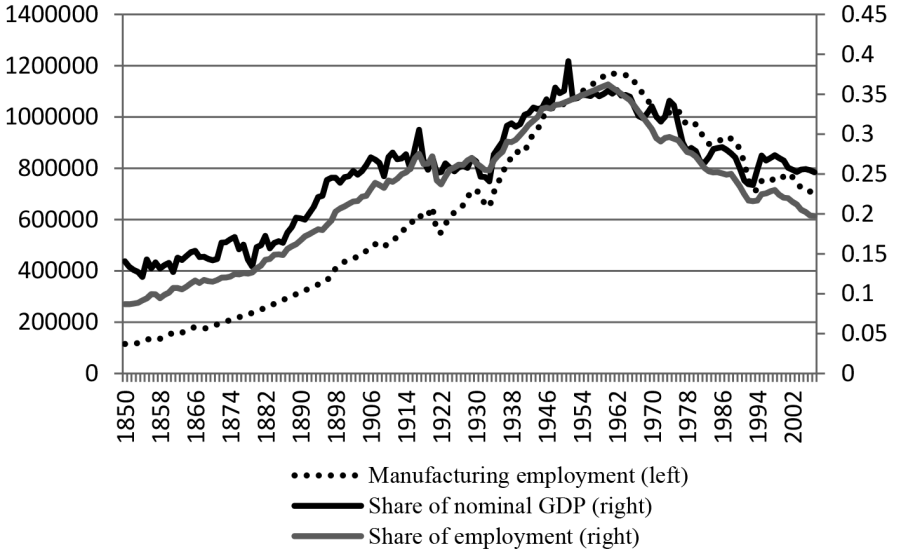
61 Some examples are Dietrich (1999), Greenhalgh and Gregory (2001), McCarthy and Anagnostou (2004), Pilat and Wölfl (2005), Wölfl (2006), Gregory and Russo (2006), Schettkat and Yocarini (2006), Falk and Jarocinska (2010), Montresor and Vittucci Marzetti (2010, 2011), Timmer et al (2012a, 2012b) and OECD (2013a).

62 See, for example, Feinstein (1999), Rowthorn and Coutts (2004), Palma (2004), Nickell et al (2008) and Memedovic and Iapadre (2010).

63 According to Feinstein (1999), the Swedish manufacturing share in civilian employment reached its peak with 42.8 per cent in 1965. United Kingdom, Belgium, Switzerland and Australia reached their peaks earlier than Sweden.

64 Palma (2005) also shows that the inverted U-relation is not constant over time; countries industrialized at a later stage than the Western World have reached their inflection point at an increasingly lower level of GDP per capita. See Haraguchi and Rezonja (2010) for a similar analysis of the manufacturing sub-sectors.

Figure 3.1. The Swedish manufacturing sector, 1850-2007. Sources: Schön and Krantz, Swedish Historical National Accounts 1560-2010 and own calculations.



Using the conventional indicators, deindustrialization in Sweden is a fact. From the peak year until 2007, the share of manufacturing employment has been reduced by 45 per cent, and the nominal share in GDP by 36 per cent. The reduction in manufacturing employment amounts to almost 450 000. With several possible, and non-rival, hypotheses behind this structural change, the rest of this chapter tries to understand to what extent outsourcing and an intensified use of new service intermediates can explain these patterns of deindustrialization.

3.4 The manuservice economy and the deindustrialization process

3.4.1 Earlier Swedish research

In a Swedish context, a few attempts have been made to systematically analyse the interrelatedness between the manufacturing sector, outsourcing and deindustrialization. Pousette and Lindberg (1985) use panel survey data, based on 270 large Swedish companies, to analyse the service content within

the manufacturing sector – both the internal use and purchased services from subcontractors along the supply chains. Their starting point is a general lack of knowledge and an increased awareness of the blurred intersection between the manufacturing sector and the service sector in the national accounts. The authors conclude that conventional value added measures of the manufacturing sector are becoming less meaningful and that the deindustrialization process is less severe if business related services are added to the manufacturing sector's production and employment. According to the survey, in 1981, the purchased external services including transports amounted to little more than six per cent of total sales.[65] There were major differences among sub-sectors. For example, in the production of consumption products, the share was only 2.9 per cent, but as high as 8.9 per cent in the production of building materials.

Using a comprehensive survey, Pousette and Lindberg (1987) compare Sweden with seven European countries. They show that between 1975 and 1980, the share of purchased services in total manufacturing production increased in most countries. The Swedish share was below the country group average. The conclusion drawn is that the service content of the manufacturing sector varies a great deal among countries and that measurement issues can be one explanation. Other possible explanations are tested – such as sectoral structure, technical level, company size and labour market institutions – but no clear answers emerge. However, the authors argue that the high concentration of large Swedish manufacturing companies possibly indicates that the external purchases of services are smaller than what would otherwise have been the case.

In a report to the Lindbeck Commission, Eliasson (1993) argues that the conventional sectoral classifications are outdated. However, using them, the author shows that the manufacturing share in nominal GDP decreased from 30 per cent in 1950 to slightly above 20 per cent in 1990. This has caused concerns and a debate about the deindustrialization process has followed, based on the idea that the manufacturing sector is too small. Following Pousette and Lindberg (1985, 1987), Eliasson argues that the service content in manufacturing production is on the rise, and researchers should correct for the blurred intersection between the two sectors in general and in relation to business related services in particular. Eliasson does this by adding the nominal value added of manufacturing related business services to the manufacturing value added. With this vertically oriented measure, related to but cruder than an IO analysis, it is argued that this extended manufacturing share in nominal GDP increased slightly between 1950 and 1985 and remained constant between

65 This is in accordance with Ek (1985). Ek uses IO analysis to show that the share of externally purchased services in relation to manufacturing production increased from 5.6 to 6.5 percent between 1976 and 1982.

1970 and 1985.[66] If value added generated by manufacturing subsidiaries outside Sweden is included, it is argued that the manufacturing share in nominal GDP has increased rather substantially since the 1950s. Based on this observation, the author argues for a broader definition of the manufacturing sector and concludes by saying that the Swedish macroeconomic problems at the beginning of the 1990s have other causes than a too small manufacturing sector; the only way in which Sweden has been deindustrialized is in terms of a shrinking share of blue-collar workers. Eliasson (2002) updates these estimates and shows that the manufacturing share in nominal GDP amounted to 55 per cent in the mid-1990s – the highest level since 1950.

Lundquist et al (2008) represent a recent attempt using a similar approach as Eliasson (1993, 2002). With the starting point in a discussion of the fast growing producer services, the authors add two categories of producer services to the manufacturing share in nominal value added, and define this as the manufacturing related economy. With this approach, the share of the economy-wide value added increased from 53 per cent in 1985 to 56 per cent in 2004. In terms of employment, manufacturing related employment increased by 100 000 employees during the same period – from one million in 1985 to 1.1 million 29 years later – and had never been larger than at the end of the period.

The interaction between the manufacturing sector and the service sector is a topic that has attracted academic attention in Sweden. One drawback of this research is, however, that no appropriate method has been used to estimate the level of indirect employment and value added generated throughout the economy by the manufacturing sector; the full and more precise effects of the circular character of the economy have not been accounted for. More specifically, in earlier research it is assumed that whole sectors, such as business/producer services, are only delivering intermediates to the manufacturing sector. A substantial part of the production in these sectors is, however, delivered to final demand, and a considerable part of the intermediate demand comes from the non-manufacturing parts of the economy. On the other hand, other non-manufacturing sectors than business/producer services sell intermediates used in manufacturing production processes. The net effect of these opposing interactions has not been identified.

66 Statistics and arguments on this issue are also found in Eliasson et al (1990), Sjöholm (1993) and Eliasson (1994).

3.4.2 The use of services intermediates in manufacturing production

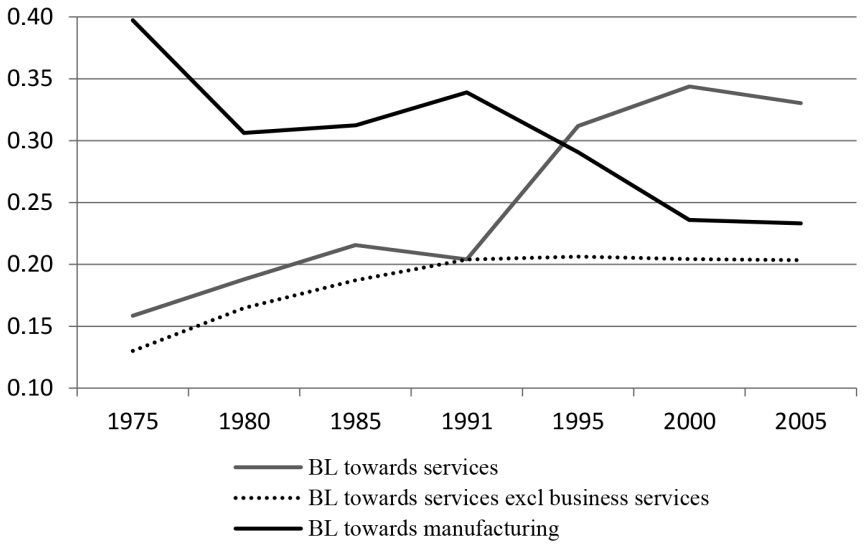
Following Carter (1970), one appropriate method to study the intermediate interaction between the manufacturing sector and the domestic private service sector is to use the coefficients in the Leontief inverse, defined in chapter one and used in chapter two. With this size-independent perspective on structural change, the following question can be answered: how much will intermediate demand for private services increase when manufacturing final demand increases by one unit? To answer this question, each column of the manufacturing sub-sectors in the Leontief inverse is summed among the private service sectors. This gives the total effect, including all indirect repercussions, on the intermediate service demand per unit of manufacturing final demand, and gives a clear indication of how the production structure has evolved over time. Figure 3.2 presents the estimates of these manufacturing backward linkages towards the private service sectors during the period 1975-2005.[67] At the beginning of the period, each unit of manufacturing final demand generated an increase in indirect services demand with 16 öre throughout the economy (BL towards services). Over the coming decade, the service content of manufacturing production increased considerably – by almost four öre, or 36 per cent. After a weak period in the latter part of the 1980s, the service intensity of manufacturing production leaped upwards again. After a peak level in 2000, each unit of manufacturing final demand generated intermediate service demand worth 33 öre in 2005. This shows that the service intensity of manufacturing production processes has approximately doubled since the mid-1970s, if all subsequent rounds of intermediate services demand are accounted for.

However, figure 3.2 also indicates that the development of the business services sector differs considerably in comparison with the other service sectors (BL towards services excl business services). Until 1991, the growth of the services linkage excluding business services was twice as high as the growth including business services. Consequently, the difference between the two measures vanished. Since the 1990s, the time profile is rather different. The manufacturing use of domestic business services intermediates started to growth faster while the use of the products of the other service sectors remained flat. Accordingly, the period since the 1990s is characterized by an intensified use of business services intermediates in manufacturing production

67 Final demand has been used as weights to aggregate the sub-sectors to a manufacturing aggregate.

processes, while the use of other services has been unchanged.[68] Between 1975 and 1991, the intermediate service use increased in 23 out of 25 manufacturing sub-sectors, with pulp and petroleum as the only exceptions, and in 15 of 21 sub-sectors between 1995 and 2005.[69]

Figure 3.2. Intermediate demand per unit of manufacturing final demand, domestic economy, 1975-2005. Sources: Statistics Sweden and own calculations.



How does the use of service intermediates compare with the total use of domestic intermediates in manufacturing production? If the statistics presented in figure 3.2 are compared to the total manufacturing backward linkages, the service sector share amounted to 22 per cent in 1975, but to 52 per cent in 2005. Accordingly, over the whole period, the service sector share has grown by more than 130 per cent, with a clear bias towards high-tech sub-sectors being the relatively most intensive users of service intermediates, not the least in terms of business services.

The development of the interaction with the service sector starkly contrasts with the reduced average manufacturing backward linkage towards

68 One reason behind the unchanged use of other services than business services can be an increased use of imported intermediates. Using IO tables including imports, this does not seem to be the case. Although it has some effects, the general pattern holds. In tables 3.1 and 3.2 in the appendix of this chapter, the average manufacturing sector backward linkage towards all private service sectors is presented for the period 1975-2005.

69 In tables 3.3 and 3.4 in the appendix of this chapter, the indirect average service sector linkage among the manufacturing sub-sectors between 1975 and 2005 is presented.

the aggregate domestic economy, presented in chapter two, and indicates a reduction in the use of domestic manufacturing intermediates. This is confirmed by figure 3.2, where it is shown that the decrease amounts to more than 40 per cent between 1975 and 2005, and where this change occurred in the late 1970s and continued from the 1990s and onwards (BL towards manufacturing); the use of domestic manufacturing intermediates per unit of manufacturing final demand actually increased in the 1980s. Since the mid-1990s, however, it has been lower than for the service sector, indicating that the service sector has become a more important provider of domestic intermediates to the manufacturing sector than the manufacturing sector itself.

Focusing on the underlying structure of production, these measures are important in their own right but they should be complemented with measures considering the actual size of sectors and the level of intermediates that they purchase and sell. With this perspective included, the total amount of employment and value added generated throughout the economy from manufacturing final demand can be estimated.

3.4.3 Vertically integrated manufacturing employment

The VIS approach

Pasinetti (1973, 1981) developed the concept of vertically integrated sectors (VIS) based on a theory of economic growth. Starting with the notion that almost all products in modern economies are neither pure goods nor pure services, this means that changes in final demand and their effect on the structure of the economy benefit from being analysed within a framework where both direct and indirect effects can be identified – where all stages along the supply chains are included. Obviously, if final demand increases, strong upstream linkages generate high levels of indirect employment and value added in other sectors.

The VIS approach can be transformed into a useful empirical tool by the use of IO techniques. Let **PL** be labour requirements per unit of gross output and **F** final demand, both represented by diagonal matrices, with zeros in all cells except on the main diagonal.[70] First, post-multiplication of the Leontief inverse by the final demand matrix gives the gross output matrix, where each cell measures the gross output generated in sector i caused by final demand in sector j. Second, pre-multiplication of this matrix by the matrix of inverted labour productivity levels gives the matrix **E**:

70 The **PL** matrix expresses the inverse of the labour productivity level when measured by gross output.

$$\mathbf{E} = \mathbf{PL}\,(\mathbf{I} - \mathbf{A})^{-\mathbf{1}}\mathbf{F}. \qquad (3.1)$$

E is a matrix where each element, e_{ij}, expresses the employment in sector i generated by final demand in sector j. Each row sum of this matrix measures the employment in each sector needed to supply its products for both intermediate and final demand. Accordingly, this is the conventional measure of employment in the national accounts. However, the matrix **E** can also be read vertically. In this case, each column sum expresses total – direct and indirect – employment generated along the supply chains needed to satisfy final demand in the particular sector. This is the VIS allocation of employment, independent of where in the economy it is generated.

These estimates are presented in figure 3.3. In 1975, 1 250 000 employees were employed in the business sector in order to satisfy final demand for manufactured products.[71] This number was almost unchanged until the mid-1980s, but then fell fast until the beginning of the 1990s. Since then, the numbers have continued to fall, but only at a moderst rate; the VIS manufacturing employment decreased by 50 000 people between 1995 and 2005. This means that the VIS employment has been reduced by slightly less than 300 000 employees since the mid-1970s.

Figure 3.3 also shows that one reason behind the modest reduction since the 1990s is that the number of indirect employees within the private service sector has increased by 45 per cent since the mid-1970s; in 1975, this number was 205 000 and 30 years later it was almost 300 000. However, this development is mainly explained from the beginning of the 1990s and onwards – as shown, a period characterized by a strong growth in the business services related backward linkages. Between the beginning of the 1990s and until 2005, employment in the private service sector generated by manufacturing production increased by 30 percent, or almost 70 000 employees.[72]

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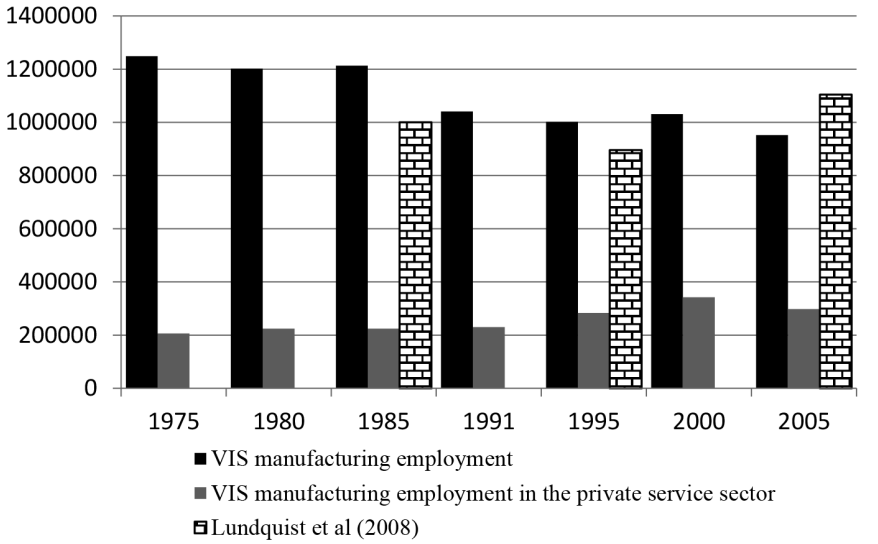
71 Note that this is not the total number of employees in the production of manufactured products. The reason is that some employees within the manufacturing sector are, outside this VIS approach, employed due to final demand for other than manufactured products. For example, when final demand for farming vehicles increases or when business services buy new hardware, this will generate some indirect employment in the manufacturing sector. Due to data limitations, this category is not included in figure 3.3.

72 The ratio between direct and indirect employment can be expressed in terms of employment multipliers. For the manufacturing sector, this multiplier has increased by 22 per cent since the mid-1980s. This shows that each directly employed generates more indirect employment today than a couple of decades ago, and this is especially the case in relation to the indirect employment generated in the private services sector. In 1975, each manufacturing employee generated 0.34 indirectly employed in this part of the economy, but in 2005 this amount had doubled, to 0.67.

Figure 3.3. Direct and indirect employment generated by final demand for manufactured products, domestic economy, 1975-2005. Sources: Statistics Sweden and own calculations.



By the addition of two types of producer services to the horizontal manufacturing employment level, Lundquist et al (2008) estimate manufacturing related employment in 1985, 1994 and 2004. They find that this employment measure amounted to 1 002 000 in 1985, and to 1 104 000 in 2004 – an increase of slightly more than 100 000 employees. In a comparison with the VIS estimates, in 1985 the authors underestimate the level of employment related to manufacturing production with around 200 000 employees. Ten years later, the underestimation has been reduced to slightly more than 100 000 employees. In 2005, the authors instead overestimate manufacturing related employment by 150 000 employees. Consequently, over the whole period, the difference in employment growth amounts to more than 350 000. This difference is substantial and gives a very different picture of the size of manufacturing related employment and the dynamics of the process of structural change since the mid-1980s. Based on a method which more accurately addresses the issue of inter-industry transactions, I argue that Lundquist et al (2008) underestimate the process of deindustrialization, and misinterpret its time profile. The reason is that they exaggerate the importance of the intermediate linkages between the manufacturing sector and the producer services sectors. Before the strong growth of producer services, manufacturing related employment is therefore underestimated, and the opposite is the case when a much larger producer services sector is added to the manufacturing sector 20 years later. Figure

3.7 in the appendix of this chapter shows that the differences between the estimates in Lundquist et al (2008) and the VIS measures in this section also hold in terms of relative employment.

The enlarged VIS approach

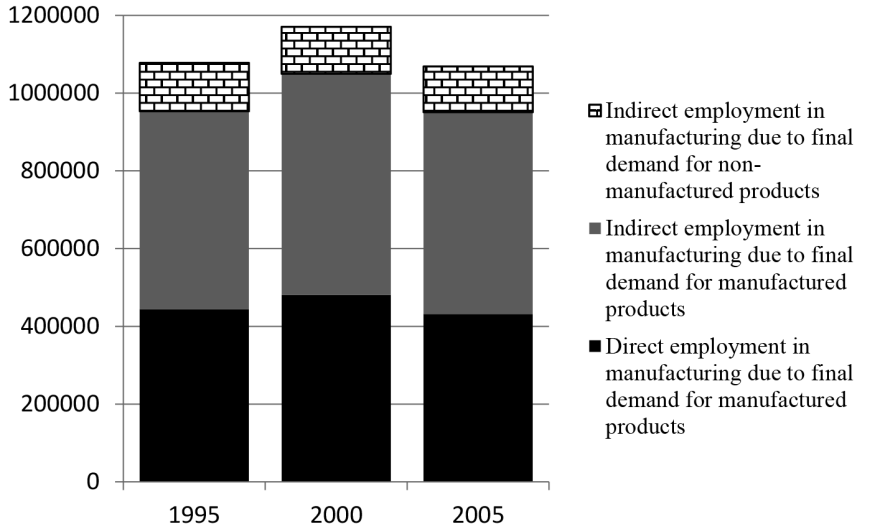
As mentioned, some employees in the manufacturing sector produce intermediates used in the production of final products in the non-manufacturing part of the economy. Accordingly, if both the upstream and the downstream dimensions are considered, the number of employees in the economy who either directly or indirectly work with manufacturing production can be estimated by adding three categories of employment. First, those who are directly employed in the manufacturing sector by final demand for manufactured products. Second, those who at all subcontracting levels are indirectly employed throughout the economy by final demand for manufactured products (also in the own sector). Third, those who are indirectly employed in the manufacturing sector due to final demand for non-manufactured products.

If these three categories are added together, which is the most appropriate measure of the number of employees related to manufacturing production, figure 3.4 shows that this enlarged VIS manufacturing employment has almost remained unchanged between 1995 and 2005 – the decrease only amounts to 9 200 employees, or 0.9 per cent. With this method, a total of 1 068 000 employees were in 2005 employed in the production of manufactured products, and they constituted 25 per cent of the economy-wide employment – a decrease by less than two percentage points since 1995.[73] These estimates can be compared to the conventional sectoral statistics from the OECD. In this case, manufacturing employment was reduced by almost 68 000 employees, or 8.6 per cent.[74] Conventional employment statistics thus overestimate the process of deindustrialization in terms of employment by more than seven times between 1995 and 2005.

73 In the business sector, the enlarged VIS manufacturing employment shrinks to 1 049 000 in 2005. This constituted 36 percent of the business sector employment.

74 Figures from Statistics Sweden indicate a reduction of 65 000 employees, or 8.7 percent.

Figure 3.4. Numbers of employed in the economy working with production of manufactured products, domestic economy, 1995-2005. Statistics Sweden and own calculations.



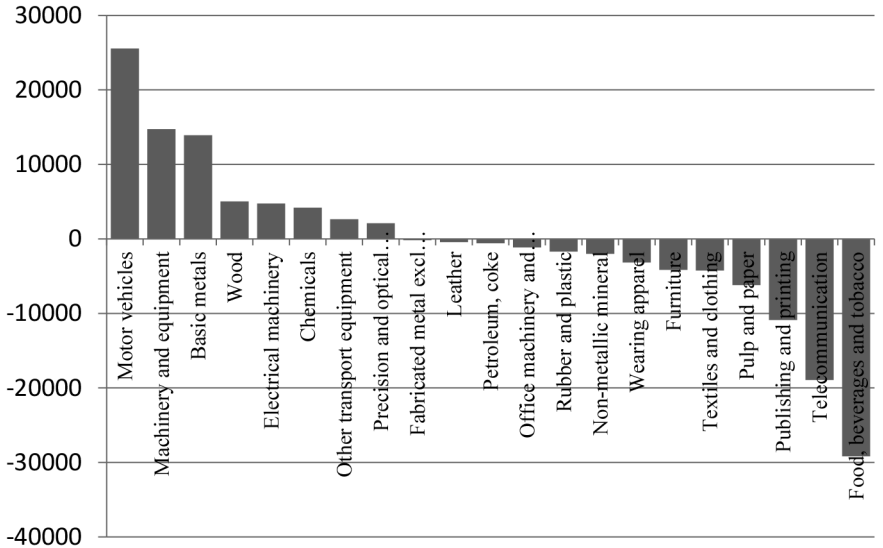
3.4.4 Enlarged VIS employment in the manufacturing sub-sectors

With only a small reduction in the enlarged manufacturing VIS employment, let us continue with an analysis of the employment performance of the manufacturing sub-sectors during the period 1995-2005. Figure 3.5 presents the change in the enlarged VIS employment in the manufacturing sub-sectors.[75] As can be seen, manufacturing employment increased in eight out of the 21 sub-sectors during the period. Six of those are defined as high-tech or medium high-tech by OECD (2011). Among this group, employment increased by almost 60 000, indicating an absolute and relative shift towards high-tech manufacturing production. If all high-tech and medium high-tech sub-sectors are considered, the enlarged VIS employment increased by 23 000 employees, or four per cent, during the period. Consequently, these sub-sectors increased their share of the enlarged VIS manufacturing employment from 51 to 54 per cent between 1995 and 2005. If instead conventional statistics had been used, the high-tech and medium high-tech sub-sectors would have lost 31 000 employees, or 7.8 per cent, and their share in conventional manufacturing

75 Tables 3.5 and 3.6 in the appendix of this chapter present direct employment, indirect employment, enlarged VIS employment and employment multipliers for all manufacturing sub-sectors for the years 1995 and 2005.

employment would have been unchanged. The vertical perspective thus strengthens the position of the most technology oriented sub-sectors in the manufacturing sector, both in absolute and relative terms. The reason for this is that these sub-sectors are highly specialized and use a large and growing amount of services intermediates in their production processes.While the amount of direct employment was unchanged between 1995 and 2005, the enlarged VIS employment increased by more than 25 000 employees within the production of motor vehicles. This constituted an increase of 18 per cent, but the conventional increase only reached around half of that. The increase of 15 000 employees in machinery and equipment corresponds to an enlarged VIS employment increase of 9.2 per cent, while the conventional measure decreased by four per cent. With 24 per cent, the strongest relative increase was, however, found in basic metals.[76] At the other end of the figure, employment in the production of food and beverage was reduced by more than 29 000 employees, or 25 per cent, between 1995 and 2005.

Figure 3.5. Change in the enlarged VIS employment between 1995 and 2005, manufacturing sub-sectors, domestic economy. Sources: Statistics Sweden and own calculations.



These changes altered the ranking of the sub-sectors in terms of enlarged VIS employment. With almost 161 000 employees, food and beverages was the largest manufacturing sub-sector in 1995, with machinery (142 000) and motor vehicles (118 000) as the second and the third largest sub-sectors, respectively.

76 The conventional reduction was instead three per cent.

Also in 2005, these sub-sectors dominated the manufacturing production system; they constituted more than 40 per cent of the enlarged manufacturing VIS employment. However, due to the strong absolute reduction, food and beverage lost the position as the largest manufacturing sub-sector (132 000). Instead, machinery with 157 000 employees and motor vehicles with 143 000 employees were found to be the largest sub-sectors.

3.4.5 Vertically integrated manufacturing value added

One of the main arguments used by Lindberg and Pousette (1985, 1987) and Eliasson (1993, 2002) is that the horizontally based manufacturing share of the economy-wide value added has become a less credible indicator of structural change. The reason is, once again, that it excludes the intensified indirect manufacturing interaction with the service sector in general and within the business services sector in particular. If this is the case, and in accordance with the perspective supporting the VIS employment estimates, the conventional value added approach excludes the growing share of indirect value added generated in other parts of economy by manufacturing production. As argued by Montresor and Vittucci Marzetti (2010), the VIS approach can more accurately estimate value added shares.

Keeping the Leontief inverse and the final demand vector as they were defined in equation 3.1, but instead of pre-multiplying the product of these two matrices with labour requirements, it is multiplied by a diagonal matrix of nominal value added shares in gross output. This gives the matrix **V**:

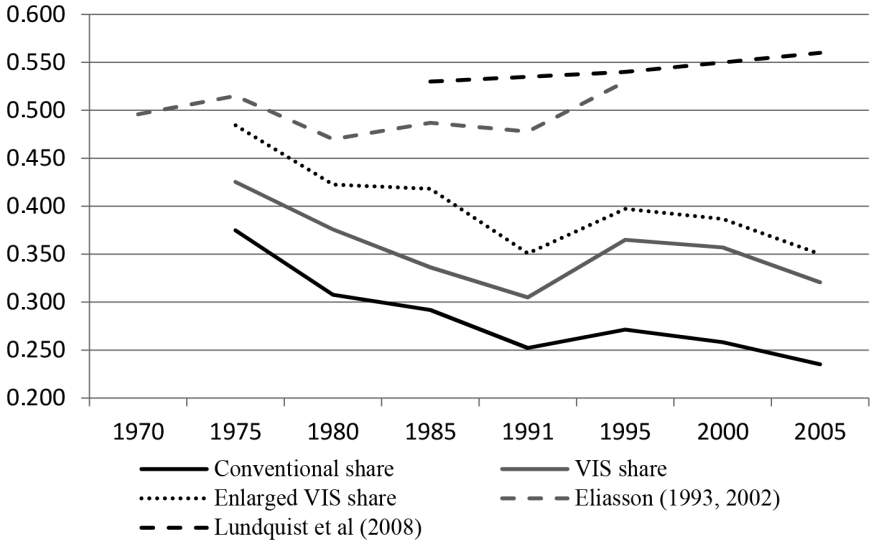
$$\mathbf{V} = \frac{\mathbf{VA}}{\mathbf{GO}} (\mathbf{I} - \mathbf{A})^{-1}\mathbf{F}. \qquad (3.2)$$

V is a matrix where each element, v_{ij}, expresses the value added in sector i generated by final demand for products in sector j. Analogously, each row sum gives the conventional value added in each sector needed to supply its products for both intermediate and final demand. However, the more interesting part of matrix **V** is the vertical relations and the column sums; each column sum expresses the total value added generated throughout the economy in order to satisfy final demand for the products produced in each sector. This is the VIS allocation of value added, independent of where in the economy it is generated.

If the column sums of the manufacturing sub-sectors are added together and related to the total value added in the business sector, the result will be the manufacturing related VIS based nominal value added share during the period

1975 to 2005. These figures are presented in figure 3.6. In the figure, the VIS based value added share is compared with the conventional – or horizontal – value added share, and also with the share that includes the downstream relations. As can be seen, the VIS share gradually decreased from 43 to 30 per cent between 1975 and 1991, and the indirectly generated value added, defined as the difference between the conventional share and the VIS share, was more or less constant. From the beginning of the 1990s, there is, however, a growing difference between the two measures; the increase in the VIS share is more pronounced in the mid-1990s and that difference persisted over the following decade. This means that the relative indirect value added generated by final demand for manufactured products has increased. Consequently, the usefulness of the conventional measure has been reduced, in the sense that it excludes a larger share of the manufacturing related value added.

Figure 3.6. Manufacturing shares of business sector nominal value added, domestic economy, 1970-2005. Sources: Statistics Sweden and own calculations.



The overall picture of the conventional share is that the speed of the decline has been reduced since the beginning of the 1990s, but the share in 2005 is still lower than in 1991. Although the VIS share has also decreased since the mid-1990s, the share in 2005 is still larger than in 1991. In 2005, 32 per cent of the business sector value added was generated – directly or indirectly – by the manufacturing sector. If the downstream linkages are included, the enlarged VIS share was 35 per cent in the same year. This was almost a five percentage point decrease since the mid-1990s, but it was unchanged if compared with

1991. The conventional share only reached 23 per cent in 2005. This indicates that the conventional value added share underestimates the manufacturing related share in business sector value added by around 50 per cent.

The figures presented in Eliasson (1993, 2002) show that the manufacturing related share of total economy nominal value added has been more or less constant between 1950 and 1985, and also between 1975 and 1995.[77] In general, these figures are larger than those presented in this section. For example, Eliasson's estimates show that in 1985, 49 per cent of aggregate valued added could be derived from manufacturing production and related services and ten years later, the share had increase to around 53 per cent. The VIS measure shows that the manufacturing share was 34 and 37 per cent in those years, respectively. These substantially lower figures show that the research performed at the beginning of the 1990s overestimated the manufacturing related level of value added. This is also the case with the estimates presented in Lundquist et al (2008). Consequently, the process of deindustrialization has been underestimated by earlier research applying a vertical perspective, and this underestimation has gradually grown, the reason being the exaggeration of the importance of the upstream linkages between the manufacturing sector and the business/producer services sectors.

3.5 Concluding discussion

There are several hypotheses proposed in the literature explaining the process of deindustrialization in the most advanced economies during the Third industrial revolution. One of these is concerned with outsourcing and vertical disintegration. This chapter has shown that the Swedish economy has been deindustrialized, although the extent of this process of structural change is considerably less pronounced than what the horizontally oriented research has suggested. The reason for this is that manufacturing production processes have become more service intensive; the use of domestic service intermediates has approximately doubled since the 1970s, and this has particularly been the case since the beginning of the 1990s. During this latter period, this is solely explained by a growing use of business services intermediates.

These changes contrast with the pronounced reduction in the use of domestic manufacturing intermediates in manufacturing production processes, especially

77 The figures in Eliasson (1993, 2002) refer to shares in GDP. This is one reason why these shares are lower than in Lundquist et al (2008).

since the 1990s. This confirms that these changes have altered the economy-wide production structure in two main directions. First, a growing use of service intermediates has pushed the economy towards vertical disintegration, as the interaction between the manufacturing sector and the service sector has been intensified. Second, the emergence of global value chains and a growing use of imported manufacturing intermediates have reduced the vertical linkages within the domestic manufacturing sector, pushing the economy in the direction of vertical integration. The conclusion is that manufacturing production processes have become more vertically disintegrated, along both their services related domestic and manufacturing related foreign supply chains, but the latter dimension has neutralized the tendency towards vertical disintegration in the aggregate domestic economy. This is particularly the case for high-tech and medium high-tech manufacturing sub-sectors. Due to the dependence of often knowledge intensive service intermediates, the absolute and relative employment performance of these sub-sectors is improved when a vertical perspective is applied.

Accordingly, a manuservice economy has emerged, with manufacturing companies focusing on its core competencies. At the same time, new services are added to the manufactured products. This servitization creates further demand for service intermediates in order to finalize the integrated products. The employment effects of the manuservice economy are considerable. Not the least, the employment multiplier towards the private service sector has doubled. As a consequence, the number of indirectly employed by manufacturing production in the private service sector has increased. This suggests that the overestimation of the deindustrialization process by the horizontal perspective has gradually become more severe. The horizontal perspective also leads to questionable conclusions about the time profile of the deindustrialization process. Despite a substantial reduction in horizontally represented employment between 1975 and 1985, the VIS approach shows that manufacturing related employment remained almost constant during this period – with a crisis driven relative shift towards the use of domestic manufacturing intermediates as one main explanation. At odds with conventional interpretations, the deindustrialization hypothesis is therefore not supported by the VIS approach, neither in terms of absolute nor relative employment, during the first part of the Third industrial revolution. Furthermore, instead of a reduction amounting to around eight per cent, the enlarged manufacturing related employment only decreased by 0.9 per cent between 1995 and 2005 – a period characterized by globalization entering a new and more intensive phase, not the least in terms of global value chains. The approach used in this chapter thus shows that the late 1980s is the only

period since the mid-1970s during which manufacturing related employment decreased in any significant way.

On the other hand, this chapter has shown that earlier research applying a vertical perspective has underestimated the deindustrialization process, and has misinterpreted its time profile. The reason for this underestimation is that the empirical methods have been too crude, as they have exaggerated the intermediate deliveries from the business/producer services sector to the manufacturing sector. With this approach, the evolution of manufacturing related employment and value added has therefore been too dependent on the strong growth of the business/producer services sector. This means that the underestimation has grown over time. With the dependency on the business/producer services sector, the time profile of the deindustrialization process in terms of employment is misinterpreted; the reduction of manufacturing related employment is overestimated from the mid-1980s to the mid-1990s, and the strong manufacturing performance since then has been overestimated. As will be further scrutinized in the next chapter, the strong growth of the business/producer services sector during this latter period is to a lesser extent than often believed explained by the manufacturing sector.

Through the use of a more appropriate empirical method, based on the call for a new empiricism, the conclusion is that this chapter has identified a middle way between earlier horizontally and earlier vertically oriented research on the process of deindustrialization. The Swedish economy has been deindustrialized, but to a much lesser extent than what is often believed, and this structural change has not been linear; it can be argued that this process started as late as in the latter part of the 1980s, but almost came to a halt a decade later.

During the Second industrial revolution, conglomeration and vertical integration were often seen as the optimal way of organizing businesses. This strategy meant risk diversification, economies of scale and market power. However, manufacturing companies are complex organizations which have to respond to changes in demand, competition and innovation; the boundaries of the companies are a key part of their competitiveness. With the ICT revolution, many of the benefits from vertical integration can be reached in more vertically disintegrated production processes, relying on intermediate market transactions. Today, the dominant way of thinking is that a competitive advantage can be created through the externalization of internal processes to independent services suppliers. The benefits of this strategy are often related to increased efficiency, higher quality, more innovation and greater flexibility. This does not only mean that the distinction between the manufacturing sector and the service sector has become blurred, it also means that value creation and

productivity to a greater extent have become a matter of interactions within and between sectors, and within and between countries. In a manuservice economy, co-operation and mutual interests are a common feature. With its central role in the knowledge economy, this is especially the case for the business services sector. This is the topic investigated in the next chapter.

Appendix

Table 3.1. Intermediate demand per unit of manufacturing final demand, domestic economy, 1975-91. Sources: Statistics Sweden and own calculations.

	1975	**1989**	**1985**	**1991**
Wholesale and retail trade	0.050	0.062	0.063	0.061
Hotels and restaurants	0.002	0.008	0.008	0.010
Transportation	0.027	0.038	0.040	0.065
Post and telecommunication	0.007	0.013	0.014	0.014
Bank and insurance	0.014	0.036	0.043	0.021
Real estate	0.012	0.007	0.010	0.012
Business services	0.029	0.026	0.030	0.056
Reparation	0.006	0.004	0.005	0.007
Other private services	0.007	0.012	0.012	0.019

Table 3.2. Intermediate demand per unit of manufacturing final demand, domestic economy, 1995-2005. Sources: Statistics Sweden and own calculations.

	1995	**2000**	**2005**
Retail and wholesale trade	0.064	0.053	0.051
Hotels and restaurants	0.010	0.007	0.007
Land transport	0.048	0.034	0.034
Water transport	0.002	0.002	0.001
Air transport	0.004	0.005	0.003
Transport services	0.019	0.052	0.051
Post and telecom	0.018	0.020	0.017
Financial intermediation	0.018	0.014	0.012
Insurance and pension	0.002	0.002	0.002
Services to financial intermediation	0.003	0.005	0.005
Real estate	0.022	0.024	0.029
Renting of machinery	0.006	0.010	0.009
Computer services	0.017	0.021	0.022
R&D and other business services	0.073	0.089	0.087

Table 3.3. Intermediate demand for private services per unit of manufacturing sub-sectors final demand, domestic economy, 1975-1991. Sources: Statistics Sweden and own calculations.

	Intermediate demand per unit of FD				Share of domestic intermediate demand			
	1975	**1980**	**1985**	**1991**	**1975**	**1980**	**1985**	**1991**
Protected food	0.19	0.08	0.25	0.23	0.13	0.19	0.20	0.17
Import-competing food	0.16	0.21	0.22	0.21	0.19	0.26	0.26	0.24
Beverage and tobacco	0.16	0.27	0.25	0.19	0.25	0.40	0.40	0.28
Textile, wearing apparel and leather	0.13	0.15	0.16	0.16	0.31	0.32	0.36	0.31
Saw mills	0.17	0.22	0.26	0.24	0.20	0.25	0.26	0.23
Wooden building materials	0.16	0.23	0.23	0.22	0.22	0.29	0.32	0.26
Pulp	0.24	0.21	0.21	0.21	0.30	0.23	0.23	0.19
Paper and paperboard	0.14	0.24	0.22	0.20	0.17	0.25	0.26	0.23
Fibreboards and other paper	0.14	0.27	0.28	0.25	0.16	0.27	0.30	0.27
Printing and publishing	0.22	0.28	0.33	0.25	0.20	0.28	0.30	0.26
Industrial chemicals and fertilizers	0.12	0.20	0.20	0.19	0.23	0.33	0.35	0.34
Other chemicals	0.15	0.27	0.30	0.20	0.26	0.46	0.49	0.34
Petroleum refining	0.04	0.03	0.03	0.03	0.34	0.32	0.29	0.30
Rubber	0.13	0.16	0.16	0.16	0.32	0.37	0.40	0.33
Plastics	0.13	0.15	0.16	0.17	0.27	0.34	0.38	0.36
Non-metallic mineral	0.15	0.27	0.27	0.27	0.28	0.39	0.41	0.37
Iron and steel	0.20	0.22	0.31	0.27	0.30	0.30	0.39	0.31
Non-ferrous metal	0.20	0.28	0.29	0.28	0.32	0.37	0.38	0.36
Fabricated metals	0.15	0.19	0.21	0.19	0.27	0.33	0.35	0.28
Machinery and equipment	0.14	0.20	0.21	0.20	0.26	0.36	0.39	0.33
Electrical machinery	0.17	0.22	0.22	0.23	0.37	0.45	0.50	0.41
Ship building and repairing	0.12	0.25	0.26	0.22	0.19	0.32	0.37	0.32
Transport equipment	0.14	0.19	0.19	0.19	0.21	0.31	0.36	0.30
Instruments	0.12	0.18	0.18	0.17	0.33	0.47	0.53	0.36
Other manufacturing	0.15	0.22	0.21	0.27	0.26	0.32	0.33	0.35

Table 3.4. Intermediate demand for private services per unit of manufacturing sub-sectors final demand, domestic economy, 1995-2005. Sources: Statistics Sweden and own calculations.

	Intermediate demand per unit of FD			Share of domestic intermediate demand		
	1995	2000	2005	1995	2000	2005
Food, beverages and tobacco	0.33	0.36	0.39	0.29	0.37	0.40
Textiles	0.23	0.34	0.34	0.48	0.67	0.68
Wearing apparel	0.20	0.38	0.38	0.44	0.68	0.71
Leather	0.29	0.24	0.26	0.35	0.39	0.44
Wood	0.29	0.38	0.39	0.35	0.39	0.41
Pulp and paper	0.31	0.34	0.43	0.41	0.48	0.53
Printed matter and recorded media	0.39	0.46	0.45	0.46	0.55	0.54
Petroleum and coke	0.13	0.06	0.04	0.50	0.52	0.56
Chemicals	0.31	0.28	0.28	0.60	0.65	0.66
Rubber and plastic	0.30	0.34	0.27	0.54	0.65	0.60
Other non-metallic mineral	0.38	0.44	0.43	0.56	0.61	0.62
Basic metals	0.29	0.38	0.32	0.39	0.49	0.45
Fabricated metal	0.27	0.32	0.30	0.40	0.50	0.48
Machinery and equipment	0.32	0.33	0.33	0.51	0.53	0.52
Office machinery and computers	0.29	0.25	0.35	0.51	0.63	0.66
Electrical machinery and telecom	0.38	0.44	0.36	0.58	0.68	0.68
Medical, precision and optical instruments	0.31	0.28	0.26	0.57	0.62	0.60
Motor vehicles	0.30	0.34	0.35	0.45	0.50	0.48
Other transport equipment	0.25	0.25	0.27	0.45	0.46	0.47
Furniture	0.32	0.37	0.36	0.42	0.51	0.52
Secondary raw materials	0.52	0.56	0.36	0.69	0.69	0.66

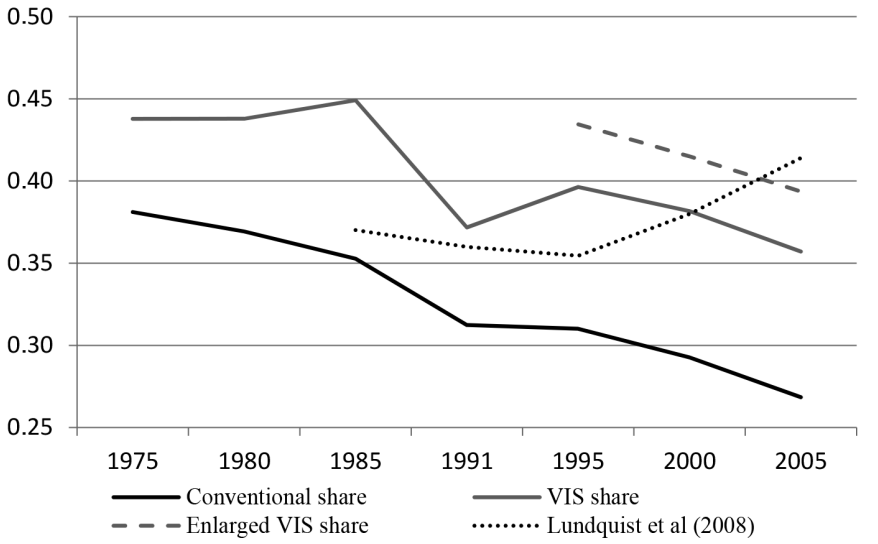
Table 3.5. Enlarged VIS employment and employment multipliers, manufacturing sub-sectors, domestic economy, 1995. Sub-sectors are ranked according to the enlarged VIS employment. Sources: Statistics Sweden and own calculations.

			Ind empl from other sectors FD	Enlarged VIS empl	E-multi
	Dir empl	Ind empl			
Food, beverages and tobacco	43208	107678	9869	160754	2.49
Machinery and equipment	74302	59556	8149	142007	0.80
Motor vehicles	50372	65260	2124	117756	1.30
Pulp and paper	28397	49789	6490	84675	1.75
Telecommunication	31391	41434	2033	74857	1.32
Fabricated metal	27017	17362	18666	63045	0.64
Chemicals	26095	29463	2675	58234	1.13
Printed matter and recorded media	11972	13399	32623	57995	1.12
Wood	18386	26085	10554	55025	1.42
Basic metals	19057	23716	2914	45688	1.24
Furniture	22287	14403	3215	39905	0.65
Medical, precision and optical instruments	19166	12476	2878	34520	0.65
Electrical machinery	18857	12424	1983	33265	0.66
Rubber and plastic	13909	9869	3994	27772	0.71
Other transport equipment	13095	7925	5023	26044	0.61
Non-metallic mineral	6545	4863	8761	20169	0.74
Textiles	8533	3819	1191	13542	0.45
Petroleum and coke	2073	3936	678	6686	1.90
Office machinery and computers	3974	2587	119	6680	0.65
Wearing apparel	4569	1722	139	6430	0.38
Leather	1139	1167	88	2394	1.02

Table 3.6. Enlarged VIS employment and employment multipliers, manufacturing sub-sectors, domestic economy, 2005. Sub-sectors are ranked according to the enlarged VIS employment. Sources: Statistics Sweden and own calculations.

			Ind empl				% change in
			from other	Enlarged		Change in	enlarged VIS
	Dir empl	Ind empl	sectors FD	VIS empl	E-multi	enlarged VIS	1995-2005
Machinery and equipment	77620	73466	5657	156743	0.95	14737	0.09
Motor vehicles	49690	89401	4216	143307	1.80	25552	0.18
Food, beverages and tobacco	43675	77856	10043	131574	1.78	-29180	-0.25
Pulp and paper	25804	49435	3236	78476	1.92	-6199	-0.07
Fabricated metal	25209	17228	20439	62876	0.68	-169	0.00
Chemicals	28707	31969	1749	62425	1.11	4192	0.07
Wood	15414	28225	16426	60066	1.83	5040	0.09
Basic metals	21718	35379	2507	59604	1.63	13916	0.24
Telecommunication	24066	31329	523	55917	1.30	-18940	-0.34
Printed matter and recorded media	9886	11747	25482	47114	1.19	-10881	-0.24
Electrical machinery	20734	16182	1098	38014	0.78	4750	0.12
Medical, precision and optical instruments	19920	12209	4503	36632	0.61	2111	0.06
Furniture	20421	13745	1579	35745	0.67	-4160	-0.13
Other transport equipment	12832	8898	6956	28686	0.69	2643	0.10
Rubber and plastic	14433	8008	3627	26069	0.55	-1704	-0.07
Non-metallic mineral	6311	4360	7493	18165	0.69	-2004	-0.10
Textiles and clothing	6180	2689	436	9306	0.44	-4237	-0.31
Petroleum and coke	2822	2830	457	6110	1.00	-577	-0.09
Office machinery and computers	3176	2344	13	5532	0.74	-1148	-0.17
Wearing apparel	1964	1244	66	3274	0.63	-3157	-0.49
Leather	1179	762	19	1960	0.65	-434	-0.18

Figure 3.7. Manufacturing shares of business sector employment, domestic economy, 1975-2005. Sources: Statistics Sweden, OECD and own calculations. These shares differ somewhat from the ones presented in the main text. The reason is that another denominator has been used in order to stretch the analysis back to 1975.



4. Business services as bridges for innovation

4.1 Introduction

The strong growth of the business services sector (BSS) can to a large extent explain the increase in the service sector's share of nominal GDP and employment in the OECD countries over the last 40 years or so.[78] In the literature, it is often argued that the main reason behind this structural change is that the BSS has emerged as an important provider of knowledge intensive intermediates throughout advanced economies; many BSS companies function as nodes in the innovation system and facilitate transfers of knowledge and support innovative processes in clients' businesses, not the least within the manufacturing sector. Consequently, in order to understand the process of value creation and structural change during the Third industrial revolution, attention should be directed towards the BSS and its inter-industry relations (Kox 2001). From a similar point of view, Montresor and Vittucci Marzetti (2011) and Ciriaci and Palma (2012) argue that analyses not considering the intermediate interaction are running the risk of misinterpreting the size and role of the BSS in the contemporary growth process.

This interactive perspective of the innovation process is found in Rosenberg (1982). It is argued that a full account of the benefits from innovation should include vertical inter-industry linkages. With new innovations altering the patterns of integration among companies and sectors, the effects of these innovations cannot be properly understood within the framework of conventional sectoral boundaries. Freeman and Soete (1997) argue along similar lines that the interactive aspect of learning and innovation has become increasingly influential in determining the rate of diffusion and the productivity gains associated with it. Following the Schumpetarian idea

78 Eichengreen and Gupta (2009) argue that the positive association between the services share of output and GDP per capita is one of the best-known regularities in the growth literature. They show that producer services are a main reason behind the strong growth of the services share of GDP in the most advanced economies. When it comes to knowledge intensive business services, such as computer services and technical consultancies, their share of GDP takes off at a higher level of GDP per capita than the average producer service.

that the diffusion process has a strong systemic character, Lundvall (2005, 2007) argues that successful product innovation requires interactive learning in general and user-producer interaction in particular. It is argued that one important aspect of such a system is the vertical linkages between users and producers of knowledge, and how these linkages contribute to specialization and value creation. To understand how learning takes place in the innovation process, it is therefore necessary to study vertically integrated production processes. Lundvall also argues that one useful way of learning more about the overall functioning of an innovation system is to analyse inter-industry knowledge flows. From a similar perspective, Ejermo et al (2011) argue that if the intermediate transactions between specialized R&D companies and the manufacturing sector have increased, a new understanding of the innovation process and where the payoffs are captured is needed.

This vertical perspective of innovation has often been applied to the inter-industry linkages between the manufacturing sector and the BSS. The reason for this is, of course, the perception that the manufacturing sector is the main engine behind innovation and productivity. If the BSS, through the sales of knowledge intensive intermediates, spreads growth enhancing spillovers along the supply chains of the manufacturing sector, this benefits the whole economy and improves the competitiveness of nations. Therefore, it is critical for policy makers to understand the role that the BSS plays in manufacturing production processes (OECD 2006). Lundquist et al (2008, p 474) argue along similar lines that: "…analyzing the manufacturing sector or the producer services separately could lead to erroneous conclusions about the characteristics of contemporary economies."

Given its central role in the contemporary growth process, the BSS and its role as a provider of knowledge intensive intermediates is an under-researched topic (Baumol 2007). The lack of macroeconomic research on the BSS and how it interacts with the overall economy in general and with the manufacturing sector in particular is prevalent also in Sweden. No research has explicitly analysed these inter-industry linkages and how they have evolved over time. With this point of departure, the main research question in this chapter is: What role does the BSS play in the national innovation system? In support of this main question, the following questions will also be addressed. Which are the main forces behind the strong growth of the BSS? How dependent is the BSS on the manufacturing sector? To what extent has manufacturing production become more knowledge intensive?

Lundquist et al (2008) argue that one way of pushing the research frontier is to use more elaborate empirical methods to better understand the intermediate linkages between the manufacturing sector and the producer services

sectors. In this chapter, this is done by the use of IO analysis. According to Tomlinson (2001) and Rubalcaba and Kox (2007) among others, IO analysis has emerged as an often used empirical tool to analyse the growth of the BSS and its economy-wide interactions.[79] Lundvall (2007) argues that IO analysis represents an appropriate method to analyse the overall structure of the innovation system.[80] The chosen methodology implies, however, that it is not possible to identify the causality between the use of BSS intermediates and innovation and productivity. Following the literature, one assumption is therefore that strong forward linkages between the BSS and the using sectors are a reliable indicator of an efficiency enhancing use of BSS intermediates. As argued by Kox and Rubalcaba (2007, p 84) on the indirect role of the BSS as an engine of knowledge creation and innovation: "The key position of the business-services industry in this process can be expected to go along with high forward-linkage intensity: a one-unit increase in final demand in the economy will necessitate the business-services industry supplying a more-than-average increase of intermediates to accommodate the economy-wide demand." Wolff and Nadiri (1993) argue that the size and structure of the forward linkages provide a measure of R&D and technological spillovers. OECD (2007, p 4) argues that: "The business services sector exhibits significant spillover effects as evidenced in the strength and dispersion of the forward linkages…"

The chapter is structured in the following way. The next section defines the BSS and clarifies how it can affect the economy through rent spillovers. Section 4.3 presents estimates of the forces behind the strong growth of the BSS, and how the use of BSS intermediates differs among the main sectors of the economy. Size-independent forward linkages and the presence of the BSS in the national innovation system are presented and discussed in section 4.4. Section 4.5 is mainly concerned with the employment interaction between the manufacturing sector and the BSS, and how the knowledge content of these linkages has evolved over time. A final section concludes the chapter.

79 Examples of IO research on the BSS or related concepts are found in Tomlinson (1997), Katsoulacos and Tsounis (2000) and Antonelli (2001), Ecorys-Nei (2004), Franke and Kalmbach (2005), OECD (2006) and Ciriaci and Palma (2012).

80 Hauknes and Knell (2009) argue that the linkages within the innovation system are closely related to the IO based backward and forward linkages.

4.2 Definition of business services and their contribution to economic growth

Definition of the BSS

Several definitions of the BSS are proposed in the literature. Developed by leading scholars, one often used definition is found in Kox and Rubalcaba (2007, p 3).[81] They define business services in the following way: "Business services is a set of service activities that – through their use as intermediate inputs – affect the quality and efficiency of the production activities, by complementing or substituting the in-house service functions." This definition makes it clear that the BSS primarily concerns intermediates traded between companies and sectors. Second, it includes all services that affect the quality and efficiency of the output produced by the client businesses. This means that BSS contains a broad spectrum of services. Finally, the definition makes it clear that the fast growth of the BSS is not only a matter of externalization of services previously performed in-house. The replacement aspect of business services should not be neglected, but they also represent new types of services used in production processes throughout economies. Based on this definition, the BSS is part of a broader category of producer services, and is often divided into two categories: (1) knowledge intensive business services (KIBS) and (2) operational business services. The former contains a high degree of client-specific services with a high knowledge content. Types of services delivered within this category are software and computer services, engineering services, management services and marketing services. The latter group contains more standardized services, such as security, cleaning, bookkeeping and temporary work agencies.

Business services need to be classified within the national accounts. Since the 1990s and at the two-digit level, they are often defined as the following sectors: (71) renting and leasing of machinery, (72) computer services, (73) research and development, and (74) other business services. This is a definition often used in applied research and it will be used in this chapter.[82] When questions are addressed towards the KIBS, attention will be directed towards 72-74.[83] Other business services contain many disparate sub-sectors. These are (a) law and economic consultancy, (b) architects and technical consultancy, (c) technical testing and analysis, (d) advertising and marketing, (e) temporary work agencies and recruitment, (f) security and surveillance,

81 Other definitions are, for example, found in Muller and Doloreux (2009).
82 See, for example, Ecorys-Nei (2004), OECD (2005), Nählinder (2005) and Pilat (2007).
83 See, for example, Johansson et al (2011).

(g) cleaning and (h) other business services. According to OECD (2007), 74 (a)-(d) are defined as knowledge intensive, while 74 (e)-(h) are defined as operational business services.

The BSS and rent spillovers

Research suggests that the growth of the BSS since the 1980s has gone through three phases (Kox and Rubalcaba 2007). In the first phase, from the early parts of the 1980s and initiated by new management ideas about flexible and lean businesses, outsourcing mainly concerned low- or medium-skilled services, such as cleaning, catering and transportation. In the second phase, between the mid-1980s and the mid-1990s, more standardized in-house services were outsourced, such as security, training, administration, technical testing, computer services and recruitment. At this stage, wage costs and economies of scale mainly constituted the driving force. Together with the improved ICT driven possibilities to outsource to foreign countries, in the last phase, from the mid-1990s and onwards, change has mainly concerned more specialized services, often related to the core competencies of the client companies. These are often knowledge intensive and they contribute with specialized knowledge to innovative processes. Kox and Rubalcaba (2007) argue that this last stage reflects a growing complexity of the economy and is not mainly a matter of outsourcing of previously performed in-house activities. Miles (2007) follows the same line of argument and states that a great deal of the growth of the BSS is a consequence of challenges in the market place, which require competencies not generally available in-house.

The process of externalization and servitization has gradually turned the attention towards the BSS as an important component of the national innovation system. Following Lundvall (1988, 2007) among others, BSS companies do not only sell efficiency enhancing or cost reducing intermediates, but also contribute to knowledge transfer and knowledge generation; they become a central co-operative agent within the innovation system, and enter a strategic role for growth and competitiveness of whole economies. OECD (2007, p 4) argues that this position is supported by firm-level research: "…several firm-level studies have confirmed the positive spillover effects of business services."[84] Kox and Rubalcaba (2007) argue that the spillover effects are in general stronger for some parts of the BSS, mainly those related to ICT and computer services. In a literature review, Muller and Doloreux (2009)

84 See also, for example, Antonelli (2000), Katsoulacos and Tsounis (2000), Tomlinson (2001), Baker (2007), Crespi (2007), Camacho and Rodriguez (2007) and Francois and Woertz (2008).

argue that KIBS companies are major innovators. In another recent review, Evangelista et al (2012) support the argument that the BSS is important for the performance of its clients' businesses and for the aggregate economy. Nählinder (2005) and Johansson et al (2011) indicate that micro level studies on Sweden confirm the existence of positive spillovers from BSS in general and KIBS in particular.

What kind of spillovers can the BSS generate? Griliches (1979) made a distinction between two types of spillovers. Pure knowledge (technological, disembodied) spillovers do not require any economic transaction between buyers and sellers in advance; the benefits are just out there, for the taking of everyone. It is a matter of knowledge transmission, due to the public good nature of many BSS services. On the other hand, rent (embodied) spillovers concern quality improvements of intermediates, and these improvements are not fully reflected in the price of the product. This means that the full value of the product is not kept within the domains of the selling company. The value added generated in the BSS is therefore reduced and its direct contribution to the aggregate economy will be underestimated. The flip side is the economy-wide spillover effects caused by the discrepancy between the value for the buyer and the value for society. It is difficult, however, to separate these two types of spillovers. Not the least, knowledge transmission often occurs through the exchange of intermediates. Kox and Rubalcaba (2007) argue that spillovers generated by business services companies are generally rent spillovers.

Through the rent spillovers, the indirect contribution of the BSS to the aggregate economy can come in different forms. Kox and Rubalcaba (2007) argue that the importance of the BSS companies within the national innovation system is due to three forms of rent spillovers. These are: (1) original innovations, (2) knowledge diffusion, and (3) surpassing human capital indivisibilities. The first type of contribution concerns the direct contribution to innovation in clients' businesses, both with technical and non-technical content. The diffusion aspect of the innovation system relates to the BSS companies' capacity to establish best-practice information and spread it to other clients. With the expertise and an outside perspective, BSS companies can thus improve the innovative work and find inefficiencies within clients' operations. Finally, BSS companies give small and medium sized companies the possibility to use knowledge intensive intermediates in a more sophisticated way. Before the strong growth of the BSS, small companies did often not have the resources to set up knowledge intensive and specialized units within their businesses; the BSS has therefore reduced the value of firm-specific scale economies.

4.3 Direct estimates of the size and role of the business services sector

Sources behind the strong BSS growth

As mentioned, one argument as concerns the BSS and KIBS is that they mainly produce intermediates, through which the growth enhancing rent spillovers are spread to downstream sectors. This seems to be the case in Sweden. Table 4.1 shows that the share of intermediate production in gross output is considerably higher for the BSS than for the total economy, and this has been the case since the mid-1970s. In the BSS there is, however, a non-linear pattern of the intermediate share of total production, with a relative focus on intermediate production during the 1980s. Despite that, the relative growth rates in the second part of the table indicate that the growth in final production has generally been stronger than the growth in intermediate production. This is at odds with the often used argument that the main engine behind the strong growth of the BSS has been intermediate demand caused by new ways of organizing production and more integrated products. This perspective has not been unimportant, but the strongest growth is by far found in the production of BSS products delivered to final demand. This conclusion holds true also for the third stage of BSS development, between 1995 and 2005, and this is especially the case for the knowledge intensive parts of the BSS. In this case, growth in final production has been approximately twice as high as growth in intermediate production.

Table 4.1. Aspects of the business services sector, direct measures, domestic economy, 1975-2005, nominal shares and growth rates.[85] Sources: Statistics Sweden and own calculations.

Intermediate production in gross output							
	1975	**1980**	**1985**	**1991**	**1995**	**2000**	**2005**
Total economy	0.38	0.36	0.38	0.37	0.37	0.37	0.36
Business services	0.59	0.48	0.51	0.56	0.67	0.63	0.59
Renting of machinery					0.54	0.53	0.54
Computer services					0.58	0.49	0.48
R&D and other BS					0.72	0.69	0.64
Relative growth: ratio between intermediate and final demand growth							
	1975-80	**1980-91**	**1995-2005**				
Business services	0.42	0.86	0.54				
Renting of machinery			1.01				
Computer services			0.52				
R&D and other BS			0.53				
Share of BSS intermediates in total economy intermediates							
	1975	**1980**	**1985**	**1991**	**1995**	**2000**	**2005**
Business services	0.05	0.05	0.06	0.11	0.16	0.20	0.20
Renting of machinery					0.01	0.01	0.01
Computer services					0.03	0.04	0.04
R&D and other BS					0.12	0.15	0.15
Share of BSS final demand in total economy final demand							
	1975	**1980**	**1985**	**1991**	**1995**	**2000**	**2005**
Business services	0.02	0.03	0.04	0.05	0.04	0.07	0.08
Renting of machinery					0.01	0.01	0.01
Computer services					0.01	0.02	0.02
R&D and other BS					0.03	0.04	0.05

The relative dominance of final production in the growth of the BSS cannot hide the fact that the BSS is still dominated by intermediate production. The two last parts of table 4.1 show that the BSS share of total economy intermediate production has clearly outperformed the BSS share of total economy final demand since the mid-1970s. In 2005, the latter only amounted to 40 per cent of the former. Apart from this relative performance, these parts of the table show that the role of the BSS in both intermediate and final production increased by around 300 per cent between 1975 and 2005 – with the difference that the relative position of final demand started to improve already in the second part of the 1970s. The initiating growth force of the BSS was thus final

85 Direct measures exclude the indirect repercussions generated by the Leontief inverse.

production, not intermediate production. In the case of intermediate demand, the BSS emerged as an important part of the economy in the latter phase of the 1980s.

Sectoral use of BSS intermediates

How are the aggregate figures on the use of BSS intermediates distributed among the main sectors of the economy? One way of answering this question is to measure each sector's share in the economy-wide use of BSS intermediates. These figures are presented in the first part of table 4.2. One main finding is that the role of the manufacturing sector in the total use of BSS intermediates is rather modest, although it has improved since the late 1980s. On the other hand, since the mid-1970s, more than 50 per cent of the total use of BSS intermediates can be derived to market services. If the public sector is included, in 2005, as much as two thirds of the use of BSS intermediates were generated by the service sector, and only little more than one fourth by the manufacturing sector. This contradicts the dominant perspective of the manufacturing sector being the prime engine behind the strong growth of BSS intermediates. Instead, the use of BSS intermediates is highly oriented towards the service sector. This is especially the case for the BSS itself – the BSS share in the economy-wide use of BSS intermediates is almost as large as for the manufacturing sector. One main engine behind the strong growth of the BSS is therefore high levels of intermediate demand from the BSS itself.
According to the second part of table 4.2, production processes in all main sectors have become more BSS intensive. This process was initiated by the BSS itself in the latter part of the 1970s. This change gradually spread throughout the economy. For example, the use of BSS intermediates in the manufacturing sector took off in the latter part of the 1980s, and has grown fast since then. In 2005, 17 per cent of the manufacturing use of domestic intermediates consisted of BSS products. This intensity is larger in all service sectors, however. With more than 40 per cent, the most BSS intensive production processes are found in the BSS. The importance of the BSS, and the relative unimportance of the manufacturing sector, in the use of BSS intermediates, is confirmed in the third part of the table, where the share of total economy BSS use is related to each sector's share of total economy gross output.

Table 4.2. Sectoral aspects of business services intermediates, direct measures, domestic economy, 1975-2005, nominal shares. Sources: Statistics Sweden and own calculations.

Share of economy-wide use of BSS intermediates							
	1975	**1980**	**1985**	**1991**	**1995**	**2000**	**2005**
Mining	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manufacturing	0.40	0.32	0.25	0.25	0.30	0.33	0.28
Construction	0.06	0.09	0.06	0.05	0.03	0.02	0.03
Utilities	0.01	0.02	0.01	0.01	0.01	0.01	0.02
Market services	0.51	0.56	0.67	0.68	0.52	0.52	0.54
Wholesale and retail trade	0.15	0.15	0.13	0.10	0.12	0.09	0.10
Bank and insurance	0.07	0.06	0.06	0.06	0.04	0.04	0.03
Business services	0.15	0.16	0.31	0.37	0.24	0.26	0.26
Services					0.65	0.63	0.67
Share of BSS intermediates of total intermediate use							
	1975	**1980**	**1985**	**1991**	**1995**	**2000**	**2005**
Mining	0.02	0.02	0.03	0.08	0.13	0.14	0.12
Manufacturing	0.04	0.03	0.03	0.06	0.12	0.19	0.17
Construction	0.02	0.04	0.04	0.06	0.13	0.13	0.15
Utilities	0.04	0.05	0.04	0.06	0.12	0.16	0.21
Market services	0.09	0.07	0.10	0.19	0.19	0.22	0.23
Wholesale and retail trade	0.10	0.08	0.10	0.14	0.27	0.24	0.25
Bank and insurance	0.14	0.04	0.04	0.19	0.29	0.30	0.34
Business services	0.23	0.26	0.41	0.50	0.36	0.42	0.43
Services					0.21	0.24	0.24
Ratio between the share of total use of BSS intermediates and share of gross output							
	1975	**1980**	**1985**	**1991**	**1995**	**2000**	**2005**
Mining	0.29	0.54	0.35	0.93	0.93	0.83	0.57
Manufacturing	0.85	0.68	0.58	0.68	0.94	1.05	0.96
Construction	0.57	0.95	0.72	0.55	0.78	0.66	0.73
Utilities	0.38	0.65	0.43	0.36	0.44	0.61	0.76
Market services	1.47	1.54	1.61	1.42	0.89	0.85	0.87
Wholesale and retail trade	1.60	1.52	1.32	1.06	1.36	1.01	1.07
Bank and insurance	2.90	1.99	1.51	1.22	1.33	1.14	1.13
Business services	4.94	4.71	6.72	5.30	2.73	2.24	2.13
Services					1.10	1.03	1.06

To sum up, this section has shown that the strong growth of the BSS since the mid-1970s is more related to final production than to intermediate production. This contradicts the general perception that the intermediate role has been the prime engine behind the strong growth of the BSS during the Third industrial revolution. Within the general trend towards more BSS intensive production

processes, another main conclusion is that the role of the manufacturing sector in the economy-wide use of BSS intermediates is rather modest, although it has recovered to an average position since the beginning of the 1990s. Instead, two thirds of the BSS use is directed towards the service sector in general and the BSS in particular.

4.4 Forward linkages and the innovation process

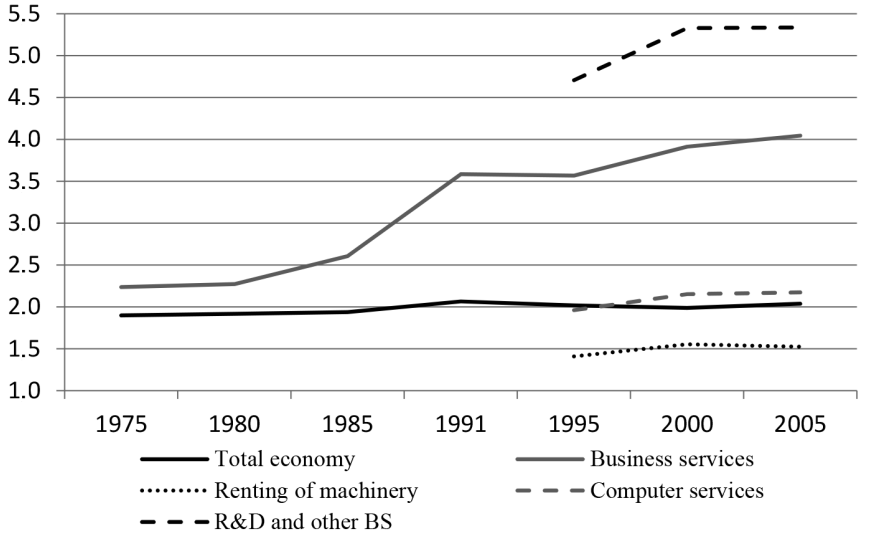
BSS forward linkages and their diffusion

As mentioned, the key position of the BSS in the contemporary growth process is often identified by the forward linkages within an IO framework, including all indirect repercussions caused by the circular character of the economy. It is argued that these linkages are a sign of positive rent spillovers, to the benefit of the overall economy. BSS intermediates are sold below the societal value and contribute to the diffusion of growth impulses throughout economies. For example, Kox and Rubalcaba (2007) argue that the key position of the BSS in knowledge creation and innovation processes comes with large and widely spread forward linkages, implying large amounts of intermediate deliveries when final demand increases in the economy. This is the perspective addressed in the size-independent forward linkages: how much will the intermediate output increase from a simultaneous unit change in final demand in all sectors of the economy? Accordingly, if this forward linkage – from a backward perspective – increases over time, the role of the BSS as a provider of intermediates has increased. If a stronger input multiplier in this setting is combined with a wider distribution, this is an additional indication of the strengthening of the position within the intermediate structure and, hence, an important contributor to the overall functioning of the national innovation system (OECD 2007).

Using the estimates presented in chapter two, figure 4.1 shows the forward linkages in the aggregate economy and within the BSS between 1975 and 2005. The development is rather striking. In 1975, the BSS was pretty much a sector with an average forward linkage; its role as an intermediate provider was not particularly strong. However, this role gradually became more established, generating more indirect intermediate deliveries per unit of final demand. This change took off in the first part of the 1980s, but especially so during the latter part of the decade. This gradually improved role as an important intermediate provider has continued since the 1990s, although at a slower pace. Between

1975 and 2005, the BSS forward linkage increased by more than 80 per cent. As a consequence, the BSS has been the sector in the economy with the largest forward linkage since the mid-1990s. From the figure, it can also been seen that between 1995 and 2005, the reason behind the large and growing BSS forward linkage is R&D and other business services. In 2005, this forward linkage was 60 per cent larger than the second largest input multiplier in the economy (wholesale and retail trade). On the other hand, computer services, with a positive trajectory, are found around or slightly above the economy-wide average. Renting of machinery, the only completely non-KIBS part of the BSS, has had a forward linkage clearly below the economy-wide average during the period 1995-2005.

Figure 4.1. Forward linkages, total economy, the business services sector and its sub-sectors, domestic economy, 1975-2005. Sources: Statistics Sweden and own calculations.



The level of diffusion of the forward linkages is a main indicator of how the BSS intermediates affect overall efficiency. One way of analysing this is to use the coefficient of variation (CV), used in chapter two to identify key sectors. From this perspective, a normalized CV of less (larger) than one indicates an above (below) average diffusion, when final demand simultaneously increases by one unit in all sectors of the economy. From table 4.6 in the appendix of this chapter, it can be seen that during the period of strong growth of the BSS forward linkages, the use has spread considerably. Although these products have been widely used over the whole period, the intensity has gradually increased. In the latter part of the 1980s, the growing diffusion

was particularly strong. This intensified diffusion continued between 1995 and 2005, further indicating a wider use of BSS intermediates in production processes throughout the economy. This was the case for all three sub-sectors. R&D and other business services are, however, the main reason behind the widely distributed use of BSS intermediates. Since the mid-1990s, R&D and other business services by far constitute the sector in the economy with the widest distribution of intermediate sales.

Following earlier research, these estimates, together with figure 4.1, clearly suggest that the BSS has emerged as an important provider of knowledge intensive intermediates. This means that production processes have become much more BSS intensive; each final product requires more indirect BSS intermediates to be finalized. Together with a strong propagation, this indicates that the BSS has emerged as a node in the innovation system, creating and transmitting knowledge between buyers and sellers of BSS products. In this respect, the process of value creation seems to have become more inter-linked in a complex web of BSS intermediates. Following the assumptions mentioned earlier, this supports the use-producer perspective of the innovation process, in which stronger vertical linkages contribute to increased efficiency through specialization and interactive learning processes. Accordingly, the overall functioning of the innovation system seems to have changed, with knowledge intensive companies as a more important and vital part. The relatively strong performance of computer services and the almost exceptional performance of R&D and other business services also indicate that the KIBS part of the BSS can explain the strong performance of the BSS. An unresolved issue is still, however, how the strong performance of R&D and other business services, by far with the largest and most widely diffused forward linkages among all sectors in the economy, is distributed among its KIBS and non-KIBS parts. This question will be analysed in the next section. Before moving in that direction, the interaction between the manufacturing sector and the BSS will be scrutinized somewhat further.

Interaction between the manufacturing sector and the BSS

Another perspective of the role of the BSS as a provider of knowledge intensive intermediates is how the multipliers differ between sectors. Since the forward linkage of the BSS is a backward linkage from the buying sector's perspective, this can be addressed by the following question: when final demand increases by one unit, how much will the total, direct and indirect, use of BSS intermediates increase? Not the least, this question is important to address in order to investigate the intermediate interaction between the

manufacturing sector and the BSS; due to the lack of indirect effects, the direct measures in section 4.3 may have a tendency to underestimate the role of the manufacturing sector. Using the individual coefficients in the Leontief inverse, the answer to the question is found in table 4.3. Clearly, the interaction between the manufacturing sector and the BSS, including all indirect linkages, has increased over time. In 1975, each unit of manufacturing final demand generated a 0.028 unit increase in BSS intermediate demand. During the 1980s, there was a gradual increase in the demand for BSS intermediates, especially so during the latter part of the decade. This quite dramatic change has continued over the 1990s and after the millennium, with a total increase of around 350 per cent over the whole period.[86]

Table 4.3. Business services intermediates per unit of manufacturing final demand, domestic economy, 1975-2005. Sources: Statistics Sweden and own calculations.

	1975	1980	1985	1991	1995	2000	2005
Business services	0.028	0.023	0.028	0.057	0.106	0.139	0.127
Renting of machinery					0.006	0.008	0.007
Computer services					0.018	0.021	0.023
R&D and other BS					0.082	0.100	0.097

Despite this intensified intermediate interaction, the manufacturing sector is not the most intensive user of BSS intermediates. In 2005, for example, computer services, post and telecommunication and R&D and other business services, were the most intensive users of BSS intermediates.[87] Among the ten sectors with the largest backward linkages towards the BSS, three were manufacturing sub-sectors. Although the increase among the manufacturing sub-sectors is broad based, the use of BSS intermediates is in general more pronounced in high-tech and medium high-tech sub-sectors, such as electronic equipment, chemicals, motor vehicles and machinery. Between 1995 and 2005, around 97 per cent of manufacturing final demand was produced in sub-sectors with growing backward linkages towards the BSS. Table 4.3 indicates, once again, that there are important differences among the BSS sub-sectors, with R&D and other business services as the main supplier of BSS intermediates to the manufacturing sector.

To sum up, the BSS forward linkages towards the manufacturing sector, the inter-industry interactions most often referred to in the technology and innovation literature, have strengthened rather dramatically but are not

86 Estimates indicate that the use of imported BSS intermediates per unit of manufacturing final demand has increased by more than 700 per cent since the mid-1970s – from 0.5 to 4.4 öre.

87 Tables 4.7 and 4.8 in the appendix of this chapter contain the backward linkages towards the BSS for all sectors in the economy between 1975 and 2005.

exceptional, although the most intensive users are typically sub-sectors defined as high-tech or medium high-tech. This intensified use clearly indicates that the organization of manufacturing production processes has changed towards stronger BSS backward linkages. The implication is that knowledge transfers seem to have become a more important part of the production process and contribute to increased efficiency, not the least through the innovation system. Despite that, and including all indirect linkages, the intermediate interaction with the BSS is often stronger in many parts of the service sector than in the manufacturing sector.

4.5 Employment interaction between the manufacturing sector and business services

Manufacturing generated BSS employment since the mid-1970s

In this section, the size and role of the BSS will be analysed from an employment perspective. The reasons for this are threefold. First and foremost, it makes it possible to separate R&D (73) from other business services (74). As has been shown, this separation is crucial in order to correctly understand the dynamic processes within the BSS. More specifically, it makes it possible to further investigate to what extent the increased interaction between the BSS and the manufacturing sector is caused by knowledge intensive intermediates. Second, the size-independent measures used in the previous section should be complemented with measures not only considering the internal structure of the economy, but also addressing the actual size of sectors. Third, when including employment aspects of structural change, it can be investigated how important the BSS and its sub-sectors are for employment generation throughout the economy, not the least in relation to the manufacturing sector.

In chapter three, the gross output levels in the IO model were transformed into employment through each sector's inverted labour productivity level. This created the opportunity to analyse the total employment necessary to produce the final products of each sector in the economy. This vertical approach will be used also in this section, with the attention directed towards the BSS and its sub-sectors. Figure 4.2 presents the overall picture of the employment interaction between the manufacturing sector and the BSS between 1975 and 2005. In terms of levels, the figure shows that the manufacturing generated employment in the BSS was unchanged between 1975 and 1985. Since then,

however, the employment growth has been rather remarkable, especially since the beginning of the 1990s – employment increased from 26 000 in 1985 to more than 116 000 in 2005, an increase of more than 340 per cent. Following the same pattern, each directly employed manufacturing employee generated 0.04 units of employment in the BSS until the mid-1980s, but has since then grown by more than 500 per cent; each manufacturing employee generated 0.27 BSS employees in 2005.[88] As the manufacturing related employment in the BSS has grown faster than along other parts of the supply chains of the manufacturing sector, the BSS employment share of VIS manufacturing employment has increased from two to twelve per cent.[89]

Figure 4.2. Employment interaction between the manufacturing sector and the business services sector, domestic economy, 1975-2005. Sources: Statistics Sweden and own calculations.

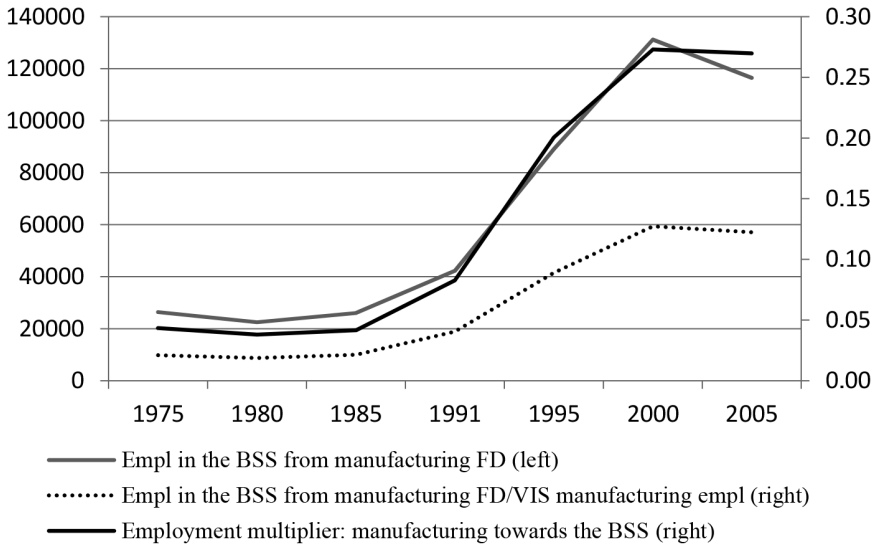


Figure 4.2 clearly shows that the employment interaction between the manufacturing sector and the BSS has changed rather dramatically, which in turn suggests that the level of specialization has increased, at the same time as the process of value creation has become more widespread, including much

88 The improved role of the BSS in manufacturing production processes during the 1980s was broadly based. Between 1985 and 1991, the BSS employment increased in all but one of the manufacturing sub-sectors, and the employment multiplier towards the BSS increased in all but two sub-sectors.

89 This means that the downstream employment in the manufacturing sector due to non-manufacturing final demand is excluded. The reason for this is that it makes a comparison back to 1975 possible. For the same reason, VIS manufacturing employment and the employment multipliers are derived from the business sector.

larger amounts of BSS intermediates.[90] However, all sectors in the economy use BSS intermediates in their production processes. As indicated by table 4.11 in the appendix of this chapter, the number of employees producing BSS intermediates increased by 103 000 between 1995 and 2005, at the same time as the employees delivering to final demand increased by 110 000. This means that the share of the former decreased slightly, to 54 per cent, further supporting the view that even during this last phase of development, the BSS production has, shifted away from intermediate demand to final demand. Over the course of this period, the manufacturing share of total BSS employment has remained constant at around 20 per cent. Accordingly, around 80 per cent of the BSS employment is unrelated to intermediate demand derived from the manufacturing sector. By the same token, only around one third of the growth in BSS intermediate employment since the mid-1990s is caused by the manufacturing sector.

Manufacturing interaction with the sub-sectors of the BSS since the mid-1990s

This chapter has shown that the aggregate of R&D and other business services (73-74) is of particular importance for the aggregate behaviour of the BSS and its inter-industry interactions. This concerns both its size and its size-independent level and diffusion of the forward linkages. One crucial problem with this aggregate is, however, that these two sub-sectors to a large extent use very different production processes. According to the user-producer interactions and learning process, R&D is highly knowledge intensive and is the main growth engine in advanced economies. Other business services, on the other hand, contain both knowledge intensive services and several operational services. Consequently, if the distinction between these two sectors is not considered, it becomes difficult to understand the nature of the interaction between the manufacturing sector and the BSS.

Table 4.4 addresses this issue. First, weaker intermediate demand has caused manufacturing generated employment in renting of machinery to decrease by 20 per cent between 1995 and 2005. More importantly, employment in R&D generated by the manufacturing sector has also decreased between 1995 and 2005. This decrease amounts to almost 5 000 employees, or 39 per cent. Although this level can change between years, it seems as if the knowledge intensive interaction between R&D and the manufacturing sector has been reduced during the third and more knowledge intensive phase of BSS

90 Tables 4.9 and 4.10 in the appendix of this chapter present the employment interaction between the manufacturing sub-sectors and aggregate BSS between 1975 and 2005.

development.[91] An important KIBS oriented part of the BSS has thus reduced its interaction with the manufacturing sector. On the other hand, computer services, the other fully KIBS oriented BSS sector, increased its interaction with the manufacturing sector during the same period. This is an indication of an increased knowledge interaction.

Table 4.4. Employment generated in the four sub-sectors of the business services sector due to final demand for manufactured products, domestic economy, 1995-2005. Sources: Statistics Sweden and own calculations.

	Renting of machinery	Computer services	R&D	Other BS	Total BSS
1995	5903	10465	12430	58595	87393
2000	5567	17652	12253	96149	131621
2005	4708	16488	7596	91407	120200
Change 1995-2005	-1195	6023	-4834	32812	32806
%Change 1995-2005	-20.2	57.6	-38.9	56.0	37.5
Share of manufacturing generated BSS employment					
	Renting of machinery	**Computer services**	**R&D**	**Other BS**	
	0.07	0.12	0.14	0.67	
	0.04	0.13	0.09	0.73	
	0.04	0.14	0.06	0.76	

The main reason behind the increased manufacturing generated BSS employment is, however, found in other business services. Of the net employment increase of the BSS (32 806), other BS explain this entire growth (32 812).[92] In 2005, this sub-sector constituted three quarters of manufacturing generated BSS employment, a nine percentage point increase over a decade. This means we need to understand more about the dynamics within this sub-sector to further understand the extent of knowledge interaction between the manufacturing sector and the BSS. Business statistics from Statistics Sweden shows that employment in the KIBS part of other business services (74.1-74.4) only grew by ten per cent between 1997 and 2005. At the same time, the non-KIBS part grew by more than 90 per cent. Consequently, the KIBS share of other business services was reduced from 70 to 56 per cent. This suggests that the main part of the intensified interaction between the manufacturing sector and other BS concerns less knowledge intensive intermediates. This

91 This is somewhat supported by Lundquist et al (2006), as they show that the growth of the R&D sector was negative between 1995 and 2002.

92 In this table, total BSS employment generated by the manufacturing sector differs somewhat from the estimates presented in figure 4.2. The reason is that the public sector is included in table 4.4 (and in tables 4.5 and 4.11).

is confirmed by Teknikföretagen (2006). They argue that in 2006, about one third of the employees in temporary work agencies, or around 11 000 employees, are employed in engineering companies, and it is mostly a matter of blue-collar workers. Both in absolute and relative terms, these numbers have increased rapidly since the deep crisis at the beginning of the 1990s, and have been further enhanced after the ICT bubble around the millennia.

According to a comprehensive survey, the main reason behind the use of temporary workers is the possibility to quickly adjust the personnel when there are changes in demand, and to keep the core labour force when layoffs are necessary.[93] This need for flexibility in numbers is further emphasized in Teknikföretagen (2009). They also argue that white-collar employees hired from temporary work agencies are mainly working with rather simple administrative tasks. The need for technical expertise and specialized knowledge is to a large extent met by high-skilled consultancies, and the amount of its personnel used in the engineering companies is almost at the same level as the blue-collar workers. Teknikföretagen (2011) argue that the financial crisis in 2008-09 has led to a new strategy concerning the use of temporary work agencies. The need for flexibility has increased even further, and many companies seem to have established a more strategic relationship with the temporary work agencies, indicating a long-term relationship.

This suggests that the strong growth of other business services is to a large extent related to an increased use of blue-collar and less-qualified white-collar workers employed by temporary work agencies, and to a lesser extent to a knowledge intensive interaction between the manufacturing sector and the KIBS part of other business services. Using different sources, it has been possible to make an indicative assessment of the knowledge intensive content of the growth in manufacturing generated BSS employment since the mid-1990s. Following conventional definitions, computer services and R&D are defined as KIBS, and manufacturing generated net employment in these sub-sectors increased by around 1 200 employees during the period, according to table 4.4. However, only 74.1-74.4 are defined as KIBS, and the question is how the manufacturing interaction has developed with this part of other business services.

One way of getting an indication of that is to look at the non-KIBS part related to temporary work agencies. Indications show that the increased demand from the manufacturing sector amounted to approximately 14 000 employees between 1995 and 2005 (Bemanningsföretagen 2009; Teknikföretagen 2006, 2009). This means that 18 000 employees remain to be distributed between

93 See Håkansson and Isidorsson (2004). See also Andersson Joona and Wadensjö (2010) for a recent review of the temporary work agencies.

the KIBS part and the rest of the non-KIBS part of other business services. Based on this, a rough approximation is that about half of the manufacturing generated non-temporary work employment growth in other business services is KIBS related. If this is true, little more than 10 000 employees within the BSS can be defined as knowledge intensive and directly related to increased intermediate demand from the manufacturing sector. If confidence intervals are raised around this figure, table 4.5 indicates that the KIBS interaction with the manufacturing sector constitutes only between three and six per cent of total BSS employment growth between 1995 and 2005.[94]

Table 4.5. Knowledge content of the manufacturing employment interaction with the business services sector, domestic economy, 1995-2005. Sources: Statistics Sweden and own calculations.

				Change
	1995	**2000**	**2005**	**1995-2005**
BSS total employment	418441	580185	631461	213020
of which				
Direct from BSS FD	119464	186783	217844	98380
Indirect from BSS FD	82727	111783	118998	36271
FD in non-BSS sectors	216250	281619	294619	78370
of which				
Manufacturing	87393	131621	120200	32806
of which				
Renting of machinery	5903	5567	4708	-1195
Computer services	10465	17652	16488	6023
R&D	12430	12253	7596	-4834
Other BS	58595	96149	91407	32812
of which				
KIBS - computer services and R&D	22895	29905	24085	1189
KIBS - 50% of non-temporary work				9312
≈				7-12000
Lower limit				0.033
Upper limit				0.056

The conclusion from this exercise is that only a small fraction of the strong growth of the BSS since the mid-1990s is related to knowledge intensive

94 Theoretically the share can be as low as 0.5 per cent. This is the case if all the manufacturing generated increase in demand for other business services intermediates is directed towards the non-KIBS part (74.5-74.8). The share can also be as high as nine per cent, if all the manufacturing generated increase in intermediate demand in other business services is directed towards the KIBS part (74.1-74.4). However, none of these possibilities are very likely, as the manufacturing sector has increased its intermediate demand both for different kinds of knowledge intensive services, such as marketing, accounting and management, and more operational services, such as cleaning, security and call centers.

interaction and growth enhancing rent spillovers related to the manufacturing sector.[95] Instead, the main engine seems to be temporary work agencies. Although the KIBS interaction can be important in level terms, it has not become more intensive during the third phase of the fast development of the BSS – in the literature a period characterized by knowledge intensive interaction, often related to core competencies. Clearly, this highlights the importance of disaggregating the BSS in order to understand its role in the contemporary growth process.

4.6 Concluding discussion

Two observations constituted the starting point of this chapter. First, a fast growing literature emphasizing the importance of the BSS in the contemporary growth process as a provider of often knowledge intensive intermediates throughout economies. Second, this inter-industry interaction is an under-researched aspect of structural change in the Swedish macro economy. Using IO techniques, this chapter has merged these two observations. Based on the questions outlined at the beginning of the chapter, one main conclusion is that the prime engine behind the strong growth of the BSS is final demand, not intermediate demand. This has been the case since the mid-1970s, although the 1980s were relatively more tilted towards intermediate production. Even during the third phase of BSS growth, emphasizing knowledge intensive intermediate transactions often related to core businesses, from the mid-1990s and onwards, final production grew twice as fast as intermediate production. This contrasts with the often used argument that the growth of the BSS is primarily related to inter-industry interdependencies, based on an intensified use of outsourcing and servitization. The BSS is still, however, oriented towards intermediate production and it emerged as a particularly important provider of intermediates during the late 1980s. The underlying structure of the Swedish production system has gradually become much more BSS intensive. Since the mid-1990s, the BSS is by far the most important provider of intermediates to production processes throughout the Swedish economy.

Another conclusion is that the BSS is less dependent on the manufacturing sector than what is often argued in the literature. Although manufacturing production processes have become more BSS intensive, they are not exceptional

95 Table 4.11 in the appendix of this chapter presents the indirect employment generated in the aggregate BSS from final demand of the main sectors of the economy during the period 1995-2005.

by any means. Despite being the largest purchaser of these intermediates, this is more related to the size of the sector than with extraordinary BSS intensive production processes. Although being the largest customer, since the mid-1990s around 80 per cent of BSS employment has been unrelated to intermediate purchases made by the manufacturing sector; consequently, only 20 per cent of BSS employment is generated by the manufacturing sector. Without paying explicit attention to the growth engines of the BSS and the distribution of the BSS use throughout the economy, this is the reason why Eliasson (1993, 2002) and Lundquist et al (2008) overestimate the size of the manufacturing related economy and, consequently, misinterpret the process of deindustrialization.

The BSS is instead highly dependent on the service sector in general and the BSS in particular; the most BSS intensive production processes are found in computer services, post and telecommunication and R&D and other business services. A main reason behind the strong growth of the BSS is therefore the BSS itself, with BSS final production generating large amounts of BSS intermediate production, indicating a rather high level of isolation in the production system. This chapter has also shown that a strong intermediate demand from the BSS was the initiating force behind the emergence of the BSS as an economy-wide provider of intermediates. Following the pattern identified in the literature on the diffusion of GPTs, it is important to first become successful in the own sector before the new technology is diffused to the user sectors. This process seems to have started in the late 1970s and at the beginning of the 1980s within the BSS, and gradually have spread to other parts of the economy. The period from the mid-1980s and the following decade was a period when the BSS intensity of manufacturing production processes increased particularly fast. One likely reason for this is the fast computerization of companies.

Despite the largest and most widely diffused inter-industry linkages, a third conclusion is that the knowledge content of the forward linkages from the BSS to the manufacturing sector has been exaggerated, at least since the 1990s. This concerns both the size-independent multipliers and actual levels of intermediate demand. The explanation for the extraordinary economy-wide BSS forward linkage since then is almost exclusively found in R&D and other business services. Further investigations have shown that the R&D interaction with the manufacturing sector has actually been substantially weakened since the mid-1990s. This implies that only three to six per cent of the BSS employment growth during this period can be explained by an increased knowledge intensive interaction with the manufacturing sector. The main reason is instead a strong growth of the use of temporary work agencies,

with the effect that almost all the increased use of BSS intermediates is related to less knowledge intensive, operational services.

The use of temporary work agencies in the manufacturing sector is strongly related to the ambition to more easily adjust the size of the blue-collar workforce in accordance with changes in the market. Clearly, this contradicts the general understanding in the literature, where the BSS growth since the mid-1990s is assumed to contain large amounts of knowledge intensive and highly specialized intermediates, often related to core businesses and innovation. From the user-producer perspective, the overall functioning of the national innovation system does not seem to have changed towards growing innovation-related vertical linkages since the mid-1990s. Consequently, the rent spillovers are likely to have been smaller and less important for aggregate growth performance than what is usually perceived. The assumption made in Ejermo et al (2011) on an intensified interaction between specialized R&D companies and the manufacturing sector does not seem to have occurred, suggesting that a new understanding of the innovation process is not necessary. However, one reason for this could be a growing use of imported intermediates.

The consequence of the rather dramatic increase in the use of temporary work agencies since the beginning of the 1990s is an irregular BSS growth process. With the use of temporary work agencies growing fast in many advanced countries already in the 1980s, the pressure to adjust the legislation in Sweden gradually became harder.[96] As part of a general trend of deregulating the economy along various dimensions at the beginning of the 1990s, the political decision changed the institutional structure on the labour market, and changed the dynamics of BSS growth. Although R&D and computer services were important in the 1980s, the strong growth of other operational services, such as security, cleaning and call centres, has gradually been taken over by another type of operational BSS intermediate – temporary work agencies. This shows the difficulties when analysing the BSS as a homogenous sector. In order to understand the dynamics of the BSS and, hence, the underlying forces behind the increased service sector's share of nominal GDP and employment, it is necessary to disaggregate the BSS. If not, and from the perspective of the main research question of this chapter, less knowledge intensive interdependencies, with their focus on substitution and replacement, can be interpreted as growth enhancing rent spillovers indicating a fundamental change in the functioning

96 Using conventional statistics, the Swedish BSS lagged behind most other advanced economies during the 1980s in terms of growth in value added. Since the mid-1990s, however, the Swedish growth rate has been considerably higher, with the consequence that the BSS share of the economy was very similar in 1970 and in 2007 among this group of countries.

of the national innovation system – of how and where value creation takes place in the contemporary Swedish economy.

Appendix

Table 4.6. Diffusion of business services intermediates using size-independent forward linkages, normalized coefficients of variation (CV), domestic economy, 1975-2005. Sources: Statistics Sweden and own calculations.

	1975	1980	1985	1991	1995	2000	2005
Business services	0.68	0.65	0.63	0.48	0.52	0.48	0.45
Renting of machinery					0.97	0.87	0.88
Computer services					0.74	0.69	0.66
R&D and other BS					0.32	0.28	0.27

Table 4.7. Use of business services intermediates per unit of final demand, domestic economy, 1975-91. Sources: Statistics Sweden and own calculations.

					Change	%Change
	1975	1980	1985	1991	1975-91	1975-91
Agriculture	0.02	0.01	0.02	0.03	0.01	46.1
Forestry	0.01	0.01	0.01	0.02	0.01	63.2
Fishing	0.01	0.01	0.01	0.01	0.00	60.9
Iron ore mining	0.01	0.02	0.02	0.08	0.07	478.2
Non-ferrous ore mining	0.03	0.02	0.02	0.13	0.10	352.9
Quarrying and other mining	0.01	0.02	0.02	0.04	0.03	271.8
Protected food	0.03	0.01	0.03	0.06	0.03	118.1
Import-competing food	0.02	0.02	0.02	0.05	0.03	141.6
Beverage and tobacco	0.03	0.05	0.05	0.08	0.05	155.7
Textile, wearing apparel and leather	0.03	0.02	0.02	0.04	0.01	40.2
Saw mills	0.02	0.02	0.03	0.05	0.03	165.2
Wooden building materials	0.03	0.03	0.03	0.06	0.03	114.4
Pulp	0.02	0.02	0.02	0.04	0.02	96.8
Paper and paperboard	0.02	0.02	0.02	0.03	0.01	70.8
Fibreboards and other paper	0.02	0.02	0.02	0.04	0.01	55.1
Printing and publishing	0.09	0.06	0.08	0.11	0.02	25.9
Industrial chemicals and fertilizers	0.02	0.03	0.03	0.06	0.04	188.3
Other chemicals	0.04	0.07	0.09	0.13	0.09	244.8
Petroleum refining	0.01	0.00	0.00	0.01	0.00	-5.9
Rubber	0.03	0.02	0.02	0.06	0.02	61.0
Plastics	0.03	0.02	0.02	0.05	0.03	95.9
Non-metallic mineral	0.03	0.03	0.03	0.06	0.03	90.3
Iron and steel	0.02	0.02	0.02	0.05	0.02	92.6

Non-ferrous metal	0.02	0.02	0.02	0.04	0.02	76.5
Fabricated metals	0.02	0.02	0.03	0.05	0.03	129.3
Machinery and equipment	0.02	0.03	0.03	0.05	0.03	111.2
Electrical machinery	0.04	0.03	0.03	0.06	0.03	80.1
Ship building and repairing	0.03	0.03	0.03	0.06	0.04	144.5
Transport equipment	0.03	0.02	0.02	0.05	0.02	67.9
Instruments	0.04	0.03	0.03	0.07	0.03	71.7
Other manufacturing	0.03	0.02	0.02	0.07	0.03	97.4
Electricity and gas	0.01	0.01	0.02	0.02	0.01	98.8
Water	0.01	0.04	0.03	0.05	0.04	306.1
Construction	0.02	0.03	0.03	0.05	0.02	99.8
Wholesale and retail trade	0.04	0.04	0.05	0.07	0.03	65.8
Hotels and restaurants	0.02	0.03	0.03	0.04	0.02	101.2
Transportation and storage	0.03	0.03	0.04	0.05	0.03	102.8
Post and telecommunication	0.03	0.05	0.08	0.10	0.07	251.6
Financial institutions	0.08	0.11	0.18	0.07	-0.01	-7.6
Dwelling and real estate	0.01	0.01	0.01	0.02	0.01	55.8
Business services	0.12	0.10	0.20	0.28	0.17	143.5
Reparation	0.02	0.03	0.03	0.04	0.02	122.3
Other private services	0.04	0.05	0.05	0.07	0.03	65.9

Table 4.8. Use of business services intermediates per unit of final demand, domestic economy, 1995-2005. Sources: Statistics Sweden and own calculations.

				Change	%Change
	1995	**2000**	**2005**	**1995-2005**	**1995-2005**
Agriculture, hunting	0.02	0.03	0.07	0.05	211.4
Forestry, logging	0.02	0.03	0.07	0.05	211.4
Fishing	0.03	0.05	0.04	0.01	20.8
Coal and lignite	0.13	0.14	0.12	-0.01	-4.3
Petroleum and natural gas, uranium	0.14	0.12	0.13	-0.02	-12.9
Metal ores	0.10	0.12	0.08	-0.02	-15.5
Food, beverage and tobacco	0.09	0.11	0.12	0.03	29.1
Textiles	0.07	0.12	0.12	0.05	68.6
Wearing apparel	0.06	0.13	0.13	0.07	116.0
Leather	0.09	0.08	0.10	0.00	3.8
Wood	0.06	0.08	0.08	0.03	44.1
Pulp and paper	0.06	0.09	0.09	0.03	58.8
Printed matter and recorded media	0.12	0.16	0.16	0.05	41.3
Coke, refined petroleum	0.04	0.02	0.02	-0.02	-59.4
Chemicals	0.14	0.14	0.15	0.01	8.2
Rubber and plastic	0.12	0.15	0.10	-0.02	-13.3
Non-metallic mineral	0.08	0.11	0.11	0.02	28.2
Basic metal	0.06	0.10	0.09	0.03	43.4
Fabricated metal	0.08	0.11	0.10	0.02	25.4
Machinery and equipment	0.12	0.13	0.14	0.02	15.6
Office machinery and computers	0.11	0.09	0.15	0.04	39.4
Electrical machinery, radio and telecom	0.17	0.24	0.20	0.03	15.6
Medical and precision instruments	0.13	0.12	0.12	-0.02	-12.0
Motor vehicles	0.11	0.14	0.15	0.03	30.8
Other transport	0.09	0.09	0.11	0.01	16.5
Furniture	0.10	0.13	0.13	0.03	28.2
Secondary raw materials	0.10	0.17	0.11	0.01	6.6
Electricity, gas and steam	0.04	0.07	0.09	0.04	104.3
Water	0.07	0.10	0.10	0.03	51.4
Construction	0.08	0.09	0.10	0.01	14.2
Retail and wholesale trade	0.12	0.12	0.12	0.00	2.4
Hotels and restaurants	0.07	0.08	0.08	0.01	21.1
Land transport	0.09	0.12	0.12	0.03	29.3
Water transport	0.08	0.17	0.15	0.07	91.5
Air transport	0.08	0.10	0.12	0.05	61.2
Transport services	0.11	0.11	0.11	0.00	0.2
Post and telecom	0.12	0.19	0.21	0.09	76.7
Financial intermediation	0.11	0.13	0.13	0.01	13.3
Insurance and pension	0.11	0.09	0.08	-0.03	-29.1
Services financial intermediation	0.19	0.19	0.19	0.00	0.6
Real estate	0.06	0.07	0.08	0.02	44.6
Renting of machinery and equipment	0.15	0.16	0.16	0.00	2.5

Computer services	0.22	0.27	0.25	0.03	13.7
R&D and other business services	0.23	0.23	0.21	-0.02	-10.1
Public administration and defence	0.10	0.12	0.13	0.02	21.9
Education	0.05	0.05	0.06	0.01	24.3
Health and social work	0.04	0.05	0.05	0.01	24.1
Sewage and refuse disposal	0.15	0.20	0.21	0.06	42.5
Membership organisations	0.11	0.11	0.11	0.00	-1.1
Recreation, culture and sports	0.10	0.12	0.13	0.03	35.1
Other services	0.11	0.08	0.08	-0.03	-25.9

Table 4.9. Employment in the business services sector due to final demand for manufactured products, employment multipliers, domestic economy, 1975-91. Sources: Statistics Sweden and own calculations.

					Change	%Change	Empl.multiplier				Change	%Change
	1975	**1980**	**1985**	**1991**	**1975-91**	**1975-91**	**1975**	**1980**	**1985**	**1991**	**1975-91**	**1975-91**
Food, drinks, tobacco	3500	4112	3987	6615	3115	89.0	0.06	0.08	0.07	0.13	0.06	95.3
Textile	1297	653	570	648	-649	-50.0	0.03	0.02	0.02	0.04	0.01	45.9
Wood	1210	1350	1450	2102	892	73.7	0.03	0.04	0.03	0.07	0.04	118.9
Paper, pulp	2112	1753	1813	2611	499	23.6	0.05	0.05	0.04	0.08	0.03	50.0
Printed matter	2655	1492	1891	2716	61	2.3	0.13	0.07	0.10	0.12	-0.01	-8.4
Chemistry, rubber, plastics	1429	2512	3408	6155	4725	330.6	0.06	0.10	0.12	0.16	0.10	162.8
Petroleum	121	142	131	154	33	27.1	0.01	0.01	0.01	0.08	0.06	488.4
Glass, concrete, bricks	248	289	294	311	63	25.2	0.04	0.04	0.04	0.08	0.04	113.1
Iron and metal	2523	2017	2307	3492	969	38.4	0.03	0.03	0.03	0.06	0.03	93.9
Machinery	3418	3233	3495	5599	2181	63.8	0.03	0.03	0.03	0.06	0.03	104.3
Motor vehicles	3180	1877	3264	5598	2418	76.0	0.07	0.03	0.04	0.07	0.00	3.6
Instruments	408	380	471	1219	810	198.5	0.01	0.02	0.04	0.09	0.07	570.9
Tele, electro	2685	1908	2292	4259	1574	58.6	0.04	0.03	0.03	0.08	0.04	98.9
Shipyards	1338	607	551	450	-888	-66.3	0.12	0.07	0.05	0.07	-0.05	-43.2
Other manufacturing	233	156	121	304	70	30.2	0.01	0.01	0.01	0.02	0.01	95.6

Table 4.10. Employment in the business services sector due to final demand for manufactured products, employment multipliers, domestic economy, 1995-2005. Sources: Statistics Sweden and own calculations.

				Change	%Change	Empl.multiplier			Change	%Change
	1995	2000	2005	1995-2005	1995-2005	1995	2000	2005	1995-2005	1995-2005
Food, beverage and tobacco	7916	8443	9657	1741	22.0	0.18	0.19	0.22	0.04	20.7
Textiles	627	819	715	88	14.1	0.07	0.11	0.12	0.04	57.5
Wearing apparel	235	295	296	61	26.1	0.05	0.11	0.15	0.10	193.4
Leather	118	98	109	-9	-7.9	0.10	0.09	0.09	-0.01	-11.0
Wood	1947	2164	2522	574	29.5	0.11	0.13	0.16	0.06	54.5
Pulp and paper	5000	6958	6890	1890	37.8	0.18	0.24	0.27	0.09	51.6
Printed matter and recorded media	1854	2273	2331	477	25.7	0.15	0.22	0.24	0.08	52.3
Coke, refined petroleum	750	924	798	49	6.5	0.36	0.39	0.28	-0.08	-21.8
Chemicals	9311	10500	13209	3898	41.9	0.36	0.36	0.46	0.10	29.0
Rubber and plastic	2362	3052	2276	-86	-3.6	0.17	0.20	0.16	-0.01	-7.1
Non-metallic mineral	755	966	1004	249	33.0	0.12	0.13	0.16	0.04	37.9
Basic metal	2987	5082	5872	2885	96.6	0.16	0.25	0.27	0.11	72.5
Fabricated metal	2657	3916	3537	879	33.1	0.10	0.14	0.14	0.04	42.6
Machinery and equipment	13376	15183	18242	4866	36.4	0.18	0.19	0.24	0.05	30.5
Office machinery and computers	575	472	716	141	24.5	0.14	0.13	0.23	0.08	55.8
Electrical machinery	3213	4550	4911	1698	52.9	0.17	0.16	0.24	0.07	39.0
Telecommunication	13779	38647	15760	1982	14.4	0.44	0.88	0.65	0.22	49.2
Medical and precision instruments	3463	3655	3694	231	6.7	0.18	0.18	0.19	0.00	2.6
Motor vehicles	13002	18981	22776	9774	75.2	0.26	0.38	0.46	0.20	77.6
Other transport	1580	1855	1965	385	24.4	0.12	0.12	0.15	0.03	26.9
Furniture	1885	2787	2918	1033	54.8	0.08	0.12	0.14	0.06	68.9

Table 4.11. Employment in the business services sector due to final demand of the main sectors, employment multipliers, domestic economy, 1995-2005. Sources: Statistics Sweden and own calculations.

				Change	%Change	Empl.multiplier			Change	%Change
	1995	**2000**	**2005**	**1995-2005**	**1995-2005**	**1995**	**2000**	**2005**	**1995-2005**	**1995-2005**
Agriculture, forestry, fishing	819	737	498	-321	-39.2	0.03	0.02	0.04	0.01	37.2
Mining	768	703	664	-104	-13.6	0.17	0.20	0.24	0.06	37.2
Manufacturing	87393	131621	120200	32806	37.5	0.20	0.27	0.28	0.08	41.5
Utilities	1483	2298	3745	2262	152.6	0.11	0.22	0.32	0.21	182.4
Construction	9269	9325	12064	2796	30.2	0.07	0.08	0.09	0.01	15.7
Wholesale and retail trade	24749	31405	36367	11618	46.9	0.08	0.09	0.10	0.02	20.8
Hotels and restaurants	2379	3907	4719	2340	98.4	0.04	0.05	0.05	0.02	51.7
Transportation	14924	22541	27227	12303	82.4	0.18	0.24	0.29	0.11	59.0
Finance and insurance	11507	8827	8168	-3339	-29.0	0.17	0.19	0.19	0.02	12.6
Real estate	17887	15653	18873	987	5.5	0.22	0.15	0.17	-0.05	-23.3
Business services	24139	43336	48658	24519	101.6	0.20	0.23	0.22	0.02	10.5
Public services	45071	54604	62094	17023	37.8	0.03	0.04	0.04	0.01	28.5
FD in other sectors	240389	324955	343278	102889	42.8					
FD in BSS	178052	255230	288183	110131	61.9					
Tot BSS employment	418441	580185	631461	213020	50.9					

5. Vertical distribution of productivity

5.1 Introduction

Productivity growth has been the defining feature of the process of industrialization since the late 18th century. In the decades after the Second World War, labour productivity growth reached record levels, in Sweden and elsewhere in the Western world. The effects of the economic turbulence of the world economy in the 1970s were, however, far reaching (Crafts 2006). Deeply rooted in the Second industrial evolution, Sweden was disproportionally affected, with a long period of weak absolute and relative labour productivity growth (Schön 2010a). Generally, the weak period lasted until the deep crisis at the beginning of the 1990s. Since then, labour productivity growth has rebounded rather dramatically.[97] In the manufacturing sector, it has almost reached the levels of the 1960s. This has caused a strong pick up in GDP growth, and is the main reason why the Swedish economy is, by many, considered to be a successful and innovative economy in a world characterized by increased low-wage competition, and a pressing need for the most advanced countries to radically climb the value chains.

Research on productivity is plentiful, not the least in Sweden.[98] This research has also attracted renewed attention since the 1990s. There are several reasons for this. First, new theoretical approaches emphasize new sources of growth and productivity. Second, the process of convergence within the group of the most advanced countries came to a halt during this period. This is especially the case from the US-Europe perspective, in which a long period of European convergence came to a halt in the 1990s. Third, and maybe most importantly, the production and use of ICT have become more important, as new innovations set the stage for productivity enhancing changes in production processes and business organizations.[99]

97 According to Timmer et al (2010), Ireland was the only EU15 country with a stronger labour productivity growth than Sweden in the market economy between 1995 and 2005. In a comparison with the US, the Swedish yearly average was 0.7 percentage points higher. From a Nordic perspective, Hagén (2010) shows that during the period 1996-2009, labour productivity growth was similar in Sweden and Finland, clearly above the EU15 average.

98 For long-run analyses of the Swedish productivity performance, see Schön (1998, 2000, 2004, 2006b).

99 In a Swedish context, see Lindström (2003), Mellander et al (2005) and Konjunkturinstitutet (2005) for growth accounting exercises with a particular emphasis on ICT.

Since the late 1950s and the work of Solow (1957), the conventional approach in productivity research has been to apply neoclassical production and cost function theory.[100] From an empirical point of view, mainly econometric estimations of production functions and growth accounting techniques have been used to estimate the relationship between factor inputs and sectoral and macroeconomic outcomes. This research tradition almost exclusively focuses on isolated sectors of activity. Consequently, aspects of productivity related to the intermediate structure and inter-industry linkages are not considered.

One of the main stylized facts of this horizontally oriented research is the distinction between a high productivity manufacturing sector and a low productivity service sector, formalized in Baumol (1967). In the former, production can be standardized and mechanized on a large scale, while production in the latter is highly personal and, consequently, less possible to mechanize and standardize. The implication is that aggregate productivity growth is unbalanced, due to differences in the general characteristics of the two main aggregates of the economy. Schön (2010a) argues that the dynamics of the Swedish economy since the 1970s supports Baumol's distinction. With the strong productivity pick-up in the manufacturing sector since the beginning of the 1990s, the validity of this notion seems to have grown stronger over time.

Applying a vertical perspective on productivity, the main research question in this chapter is the following: is the service sector a productivity laggard? With this approach, the difference in the use of intermediates between the manufacturing sector and the service sector will be accounted for – all stages of the production processes will be included. With stronger input multipliers from the latter to the former, it suggests that the horizontally based difference in productivity between the two main aggregates has increased. In support of the main research question, the following question will therefore also be addressed: to what extent is the strong productivity performance of the manufacturing sector explained by a growing use of outsourcing? If services with a lower labour productivity than the goods production part of the manufacturing production process are outsourced, the horizontally measured manufacturing labour productivity will increase, but the positive effect on the aggregate economy is not evident. As argued by ten Raa and Wolff (2001, p 151): "It is of direct interest to determine how much of the change in the measured productivity growth in manufacturing is due to changes in intermediate demand for services." The difference and change in the verticality of production also apply to the manufacturing sub-sectors. An additional question will thus be the

100 After the work of Solow (1957), the field has developed considerably. Main contributors are Dale Jorgenson, Zvi Griliches and Erwin Diewert.

following: how does a vertical perspective on productivity alter the competitive position of the manufacturing sub-sectors.[101]

A vertical perspective of productivity was suggested by Leontief (1953), and further developed by Carter (1970).[102] The idea was to use IO methods to estimate total factor productivity (TFP). The starting point is final demand, and the main question is how much direct and indirect labour and capital are needed throughout the economy in order to the produce the final products. This contrasts with the conventional approach, in which the perspective is horizontal. This means that sectors are studied in isolation. No distinction is made between intermediate and final production and interdependencies between sectors are of no significant interest. In support of Leontief's approach and the usefulness of IO techniques, Rosenberg (1970, 1982) argues that productivity analysis should pay attention to the productivity dependencies across sectors generated by deliveries of intermediates. This is especially the case when stronger intermediate linkages between the manufacturing sector and the service sector are a common feature of the production system. Following the argument made by Fujikawa and Milana (1996), the focus on isolated sectors limits the analysis along certain dimensions, as technical change and quality improvements are often embodied in the purchased intermediates. Due to differences in intermediate use, a complete picture of productivity in different parts of the economy requires that production processes are vertically integrated (Schettkat and Salverda 2004).

The outline of the chapter is the following. The next section examines the arguments for the vertical approach to productivity. As an introduction to the analyses performed in the following sections, section 5.3 briefly presents the conventional productivity development in the manufacturing sector since the 1950s, and relates it to other advanced countries. In section 5.4, direct and total labour productivity measures are used to compare the manufacturing sector and the service sector. This distinction is also used to compare the manufacturing sub-sectors from the perspective of technical intensity. Section 5.5 considers the effects of outsourcing on the labour productivity performance of the manufacturing sector. A final section concludes the chapter.

101 In this chapter, sector-by-sector IO tables in constant prices are used. This restricts the analyses to the years 1995-2005.

102 Several attempts have been made to reconcile neoclassical economics and IO economics. See, for example, ten Raa (1994, 2004) and ten Raa and Mohnen (2002).

5.2 Earlier research on vertical productivity

Following Carter (1970), Östblom (1986) is the main previous attempt to analyse the productivity performance of the Swedish economy from a vertical perspective. This was done both at the sectoral level and in the aggregate economy for the period 1957-80. The main argument for the chosen approach is that all labour, including the indirect employment embodied in the intermediate deliveries, should be included when the analysis is concerned with the requirements of primary factors in order to satisfy final demand.

Despite the lack of any broader use of the IO approach to productivity among Swedish social scientists, it is an established research tradition, not the least in the US.[103] Ochoa (1986) follows in the footsteps of Leontief (1953) and Carter (1970), and studies labour productivity in the US economy between 1947 and 1972 using an IO framework. The argument for the chosen approach is that in order to correctly measure changes in the efficiency of production, it is not only necessary to analyse the last stage of production, but also every prior stage. This productivity measure is defined as total productivity. Gowdy and Miller (1990) use the IO framework to estimate TFP growth in the US economy between 1967 and 1977, and to compare these results with those derived with the conventional method. The main arguments for the use of the vertical approach are that it is more directly related to economic welfare (final products) and incorporates productivity driven spillover effects between sectors.[104] Panethimitakis (1993) argues that productivity measures based on vertically integrated sectors increase the realism of productivity analyses, as the conventional measures do not consider the effects of intermediate production. It is also argued that the vertical approach is a better guide for the allocation of resources in the aggregate economy. Accordingly, if indirect labour is excluded, the productivity levels are overestimated. Wolff (1994, p 75) argues in a similar vein: "In many respects, the I-O system provides distinct methodological advantages over more standard productivity analysis based on industry gross product originating." One of the advantages mentioned by Wolff is that the IO framework avoids the contracting-out problem. The effects of outsourcing on productivity are difficult to capture with the conventional approach, but are well suited to be analysed within the IO framework. From

103 ten Raa and Wolff (2012) contain a collection of seminal articles considering the vertical perspective on productivity.

104 Leontief (1941) argues that the efficiency of a commodity consists of two parts: (1) the productivity of the sector in which it is produced and (2) the productivity of the commodity. The latter refers to all industries using the commodity as an intermediate. If these two dimensions develop in opposite directions, the efficiency of the commodity can be unchanged from the perspective of the vertically integrated production process.

the statement that sectoral TFP growth rates are interrelated through the intermediate structure, ten Raa and Wolff (2000) argue that it is important to identify the sectors which are the most significant transmitters of innovation and technical change.

When estimating and comparing vertically integrated labour productivity growth rates in six EU countries between 1975 and 1985, Dietzenbacher et al (2000) argue that the horizontal approach overlooks the effects on productivity of changes in the intermediate structure. De Juan and Febrero (2000) argue that the preferable measure of sectoral competitiveness should incorporate all labour necessary to produce a final product. Their main concern is that the conventional productivity measures treat each sector in isolation and, hence, cannot identify or measure transfers of productivity between sectors. This transfer of productivity is especially important in highly specialized and knowledge intensive economies. Garbellini and Wirkierman (2010) argue that the vertical perspective on productivity makes it possible to analyse at what stage of the production process a productivity change has taken place.[105] Following this line of reasoning, Oulton (2001) shows that Baumol's cost disease, and the ongoing deindustrialization, may not necessarily lead to stagnant productivity growth if the stagnant (service) sectors are producing intermediates. The cost disease therefore seems to be valid only under the assumption that the service sectors produce final products. From a two-sector model, exemplified with car production and business services, it is shown that more resources allocated to the latter may increase aggregate productivity growth even if the sector itself is productivity stagnant.

The choice between the conventional approach and the vertical approach is determined by the chosen perspective. Supported by the growing domestic linkages between the manufacturing sector and the service sector, the latter approach is the most relevant in this chapter. Casler and Gallatin (1997) use the IO framework to increase the understanding of the productivity slowdown in the US economy in the late 1960s and at the beginning of the 1970s. Analogously, this chapter uses a vertical perspective to increase the understanding of the labour productivity surge and the labour productivity dynamics of the Swedish economy since the mid-1990s.

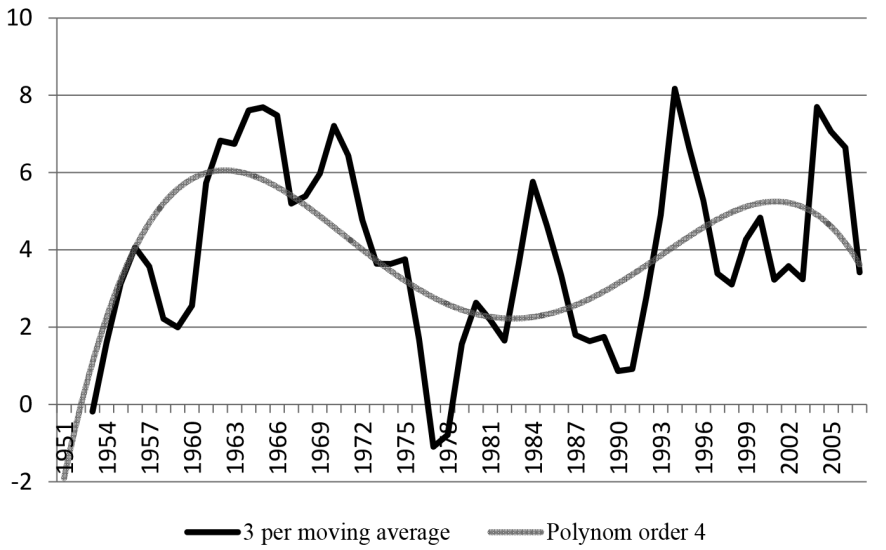
105 See also Wolff (1985), Gollop (1987), Gowdy and Miller (1992), Aulin-Ahmavaara (1999) and Timmer and Aulin-Ahmavaara (2007).

5.3 Horizontal productivity during the Third industrial revolution

From an evolutionary perspective, productivity growth is a nonlinear process. New production processes, caused by new inventions often centred round a GPT, create new possibilities to improve productivity. The efficiency gains are gradually diffused throughout the economy, accompanied by institutional changes in support of the productivity enhancing technology. This process is time consuming and the timespan between the initial invention and the effect on the overall productivity is often substantial.

As evident from figure 5.1, the nonlinear character of the productivity development has been pronounced in the Swedish economy since the 1950s. Being deeply rooted in the Second industrial revolution and its growth stimulating processes, labour productivity growth reached record levels in the late 1950s and the 1960s. Although the strong development was broad based, the strongest growth was found in the manufacturing sector. In the late 1960s, however, some signs of a weaker labour productivity growth became evident. This trend continued during the first half of the 1970s, and levelled out on a rather low level in the 1980s; between 1975 and 1991, the average early labour productivity growth in the manufacturing sector only reached 25-30 per cent of the average during the 1960s.

Figure 5.1. Labour productivity growth, real value added per employee, manufacturing sector, 1951-2007. Sources: Krantz and Schön, Historical Accounts 1560-2010 and own calculations.



As part of a general trend in the Western World, the labour productivity slowdown was more pronounced in Sweden than in most similar countries during the 1970s and the 1980s. The reasons behind the international slowdown are closely related to the oil crisis and the breakdown of the Bretton Woods system.[106] The transition from the latter part of the Second to the first steps towards the Third industrial revolution was cumbersome.[107] However, during this period, the foundations of the Third industrial revolution also began to emerge, not the least the innovations within the domains of ICT (Schön 2010a). The role of knowledge intensive manufacturing sub-sectors, such as chemicals and electronics, was reinforced. Although some signs of a labour productivity rebound could be identified in some parts of the manufacturing sector in the mid-1980s, it was not until after the deep crisis at the beginning of the 1990s that labour productivity growth once more took off in the Swedish economy, not the least in the manufacturing sector. Almost no other of the most advanced economies has had such a strong labour productivity growth in this part of the economy between the beginning of the 1990s and the years before the financial crisis in 2008-09.[108] This has been the main reason behind

106 In a US-Europe perspective, the process of catch-up in terms of labour productivity was prevalent from the 1950s to the mid-1990s. The reason for the relative and absolute slowdown in Europe since the 1990s is mainly found in the manufacturing sector and other goods producing sectors, such as mining, utilities and construction. The reason for the surge in the US is more related to services in general and business services in particular. See Timmer et al (2010). The relative European TFP growth was, however, not as impressive during the catch-up process. See, for example, van Ark et al (2010). After a decade of convergence of labour productivity levels within the manufacturing sector in the most advanced countries, the period since the mid-1990s is characterized by divergence, indicating particularly strong growth rates in countries with already high labour productivity levels (Timmer et al 2010). The TFP level of the Swedish manufacturing sector increased from 83 to 88 per cent of the US level between 1995 and 2007.

107 The relative decline of the Swedish manufacturing sector was much more pronounced in terms of production than in terms of labour productivity. In the early 1970s, the manufacturing sector to a large extent consisted of processing industries, such as wood, mining, steel and pulp and paper, which were strongly affected by the weak global business climate. As can be seen from figure 5.6 in the appendix of this chapter, the relative production decline started already in the late 1960s, in comparison with 13 of the most advanced countries, and continued until the mid-1990s. If this last period is included, the Swedish growth in value added has outperformed the average advanced economy between 1960 and 2007. Figure 5.7 in the appendix of this chapter shows a related but much less pronounced pattern for the relative labour productivity development. Despite a particularly weak period in the late 1980s, the strong labour productivity growth since the 1990s means that the Swedish manufacturing sector clearly outperforms the average of 13 other advanced economies between 1960 and 2007.

108 This position is supported by Edquist (2013). However, the author argues that one reason for the strong manufacturing labour productivity growth is the computer and electronics sub-sector, and in this sector the performance is highly dependent on the choice of numerator – value added or gross output. Applying different deflation methods, the

the strong GDP growth during this period and, consequently, the reason why Sweden is by many people considered to be a knowledge intensive and highly innovative economy in an era of global competition.[109]

From a sectoral perspective, table 5.1 summarizes the horizontally oriented labour productivity development in the Swedish economy during the Third industrial revolution. From a ten-sector disaggregation, the table shows that the pick up since the mid-1990s is rather broad based. Post and telecom, closely related to the ICT revolution and identified as an emerging key sector in chapter two, and the manufacturing sector, however, are the main labour productivity engines. Finance, another sector closely related to the ICT revolution, is also showing a strong rebound in 1995-2005 as compared to the period 1975-95.[110] Despite high knowledge levels and strong ICT use, the business services sector has performed poorly, although an improvement is visible for the latter part of the period.

Table 5.1. Labour productivity growth, real value added per hours worked, main aggregates, 1975-2005. Sources: EU Klems and own calculations.

	1975-2005	**1975-1995**	**1995-2005**
Total economy	1.8	1.4	2.6
Agriculture	2.8	2.2	3.6
Mining	2.1	2.6	1.4
Manufacturing	3.9	2.8	6.2
Utilities	2.4	3.3	1.1
Construction	1.3	2.1	0.1
Wholesale and retail trade	2.6	1.6	4.6
Transport and storage	1.5	1.3	2.4
Post and telecom	5.0	3.8	8.1
Finance	1.3	0.1	3.3
Business services	-0.7	-1.5	0.4

In an EU perspective, mining and construction have been important productivity engines in the past, but this role has faded over time (Timmer et al 2010). A similar pattern is visible in Sweden, with reduced labour productivity growth rates since the mid-1990s. However, Sweden is one of the EU countries with the strongest labour productivity contributions from market services since the mid-1990s. This is especially the case for wholesale and retail trade and

average labour productivity growth in the manufacturing sector varies between 4.5 and six per cent between 1995 and 2010.

109 See, for example, World Economic Forum (2012) and EU (2013).

110 Productivity measurement is in general more difficult in services than in the manufacturing sector. Inklaar and Koetter (2008) argue that these measurement problems are particularly severe in the financial sector.

finance, respectively. Sweden is in this case more similar to the US.[111] On the other hand, with the weak labour productivity performance in the business services sector, Sweden is more similar to the developments in the EU.

With this brief background on labour productivity developments in the Swedish economy since the 1950s, the forthcoming sections are devoted to the analysis of productivity using the vertical perspective. As argued in the introduction, this makes possible analyses that are particularly relevant for a period characterized by a gradually growing manuservice economy.

5.4 Vertical production processes and competitiveness

From a vertical perspective, one main question is how much direct and indirect labour is needed throughout the domestic economy in order to produce a final product. Following Östblom (1986) and De Juan and Febrero (2000) among others, direct labour productivity, *DLP*, is defined as the ratio between gross output and direct labour. At the sectoral level, this is for sector *i* expressed as:

$$DLP_i = \frac{GO_i}{DL_i} = \frac{1}{dl_i} \tag{5.1}$$

where dl_i is the direct labour coefficient, defined as labour requirement per unit of gross output. However, this is only the labour needed in the own sector in the first-round of repercussions to produce its output and, consequently, excludes all indirect labour needed throughout the economy to produce the intermediates used in all successive rounds of increased demand. To find a productivity measure which also includes indirectly used labour, the Leontief inverse has to be pre-multiplied with a row vector of the direct labour coefficients, **dl**, such as:

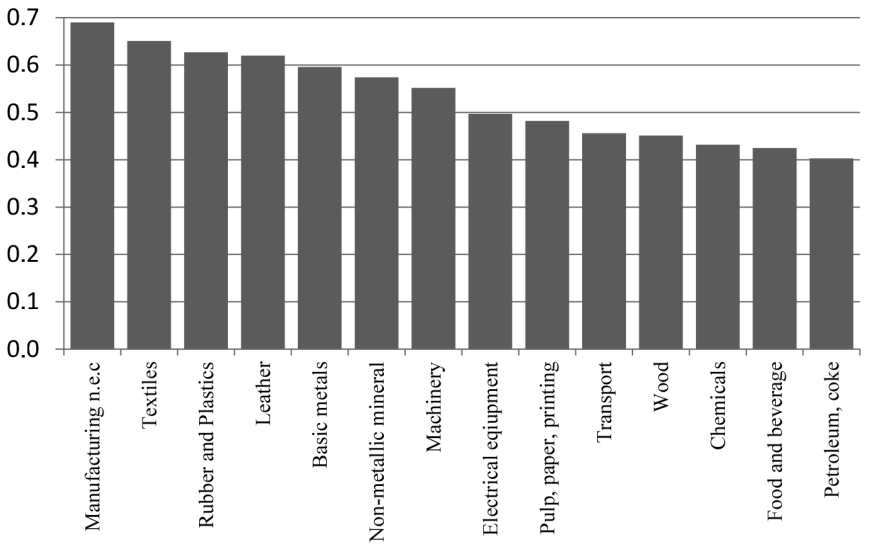
$$\mathbf{tlc} = \mathbf{dl}\,(\mathbf{I} - \mathbf{A})^{-\mathbf{1}} \tag{5.2}$$

where **tlc** is a row vector of total labour coefficients, expressing the total amount of labour needed to produce one unit of final demand. The total labour productivity level is found by the inverse of the total labour coefficients.

111 Especially in the US, the retail sector has gone through rather dramatic changes during the last couple of decades. The main engine behind this structural change is increased use of ICT. See Gordon (2004).

At the sectoral level, the difference between direct and vertically integrated labour productivity can be substantial. For example, in 1995, an average of 38 per cent of the total amount of labour needed in the manufacturing production processes was employed outside the manufacturing sector. Ten years later, the share had increased to 42 per cent, due to changes in the vertical structure of the economy. This shows that excluding indirect employment in the denominator of a labour productivity measure implies that the labour productivity level can be substantially overestimated. Figure 5.2 shows that there are considerable variations among the manufacturing sub-sectors around this average.[112] For example, in 2005, 43 per cent of the total amount of labour used in the chemical production process was employed in the chemical sector. From the opposite perspective, this means that almost 60 per cent of the total labour needed is employed outside the chemical sector. Other high-tech sub-sectors, such as transport and electronics, also generate more than 50 per cent of the total labour outside their own sectors. On the other hand, almost 65 per cent of the total labour used in the production of textiles was directly or indirectly employed in the textile sector.[113]

Figure 5.2. Shares of direct and indirect employment in the own sector, manufacturing sub-sectors, 2005. Sources: WIOD and own calculations.



112 These figures are estimated using equation 3.1.

113 In some public sectors, such as health and education, the share of employed in the own sector is as high as 90 per cent. With a reference to chapter four, with a share of 80 per cent in 2005, the production of business services also generates a large share of the vertically integrated employment in the own sector.

The differences among the manufacturing sub-sectors can be interpreted as a measure of isolation in the domestic production system – to what extent production is dependent on labour in the own sector. Consequently, the more isolated a sector is, the more dependent is total labour productivity on the productivity developments in the own sector. On the other hand, the labour productivity of the production of motor vehicles, chemicals and electronics is relatively more dependent on productivity developments along their supply chains.[114]

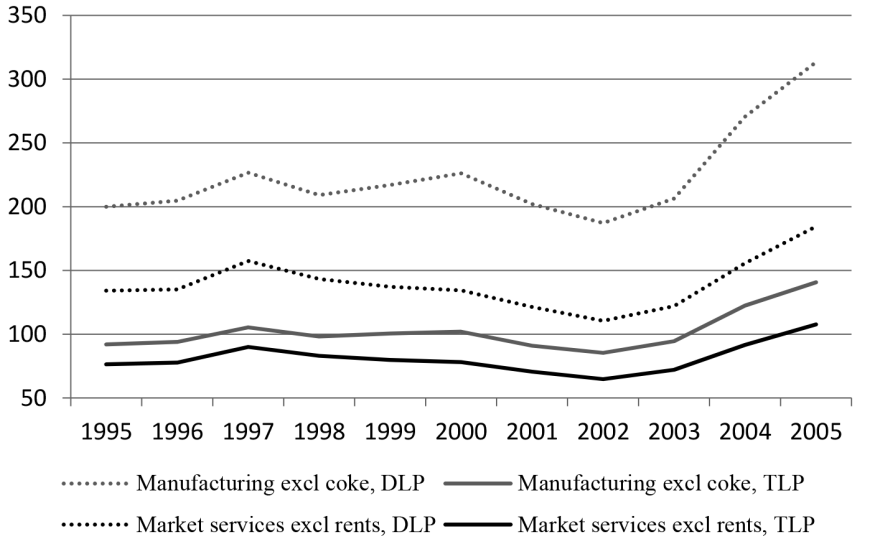
Using a similar reasoning, Montresor and Vittucci Marzetti (2010) argue that the ratio between the own sector and total labour can be used as a proxy for the degree of vertical integration. If the ratio is close to zero, only a small share of total labour is generated within the own sector, and a vertically disintegrated production process, using large amounts of external purchases, is needed to produce the final products. On the other hand, if the ratio is close to one, the amount of labour needed outside the own sector is low, and the production process is more vertically integrated. As a consequence, growth rates in and levels of direct and total labour productivity may differ due to differences in the vertical structure of production.

With this in mind, the developments of direct and total labour productivity levels between 1995 and 2005 are presented in figure 5.3 for the two main aggregates of the economy.[115] As indicated in the previous discussion, there is a substantial difference between the conventional labour productivity level, defined as gross output over direct labour, and the total labour productivity level, including all labour needed in the production process. Obviously, this is the case both for the manufacturing sector and the service sector. One significant aspect, though, is that the difference between the two measures is considerably smaller in the service sector; the service sector ratio between total labour productivity and direct labour productivity is 10-15 percentage points larger than for the manufacturing sector, indicating a lower dependence on labour productivity developments outside the own sector. Consequently, the relative position of the service sector improves considerably in terms of labour productivity levels when a vertically integrated perspective is applied.

114 Baumol and Wolff (1994) argue that economic policy is running the risk of paying too much attention to sectors with high levels of direct labour, although total employment may be substantially larger in some other sectors.

115 Following Timmer et al (2010), real estate activities are excluded from the market service sector, as most of the output consists of imputed rents. Coke and petroleum has also been excluded from the manufacturing sector.

Figure 5.3. Direct and total labour productivity levels, manufacturing and services, constant prices, thousands of dollar, 1995-2005. Sources: WIOD and own calculations.

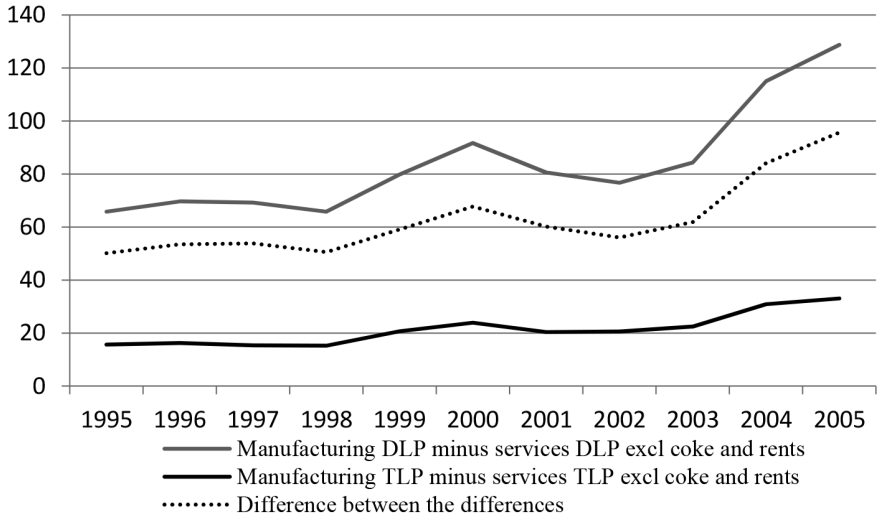


Another difference between the two main aggregates is that total labour productivity growth was faster than direct labour productivity growth in the service sector between 1995 and 2005, while the opposite was the case for the manufacturing sector. Manufacturing labour productivity growth is reduced by four percentage points when moving from direct to total labour productivity. From the opposite perspective, the service sector labour productivity performance improves by four percentage points when moving from the direct to the total measure. Accordingly, also in terms of growth rates, some of the difference in labour productivity performance diminishes between the manufacturing sector and the service sector when a vertical perspective is applied.

Figure 5.4 presents the difference between the manufacturing sector and the service sector in terms direct and total labour productivity levels between 1995 and 2005. As can be seen, the service sector reduced its relative position in terms of both measures, but the difference in absolute terms is substantial. If the conventional direct measure is used, the service sector lagged behind the manufacturing sector by 65 000 dollar in 1995, but only by 16 000 dollar if the vertical production process is included in the analysis. Ten years later, this difference – between the differences – of 50 000 dollar had increased to almost 100 000 dollar. Consequently, if the difference in total labour productivity is related to the difference in terms of direct labour productivity, almost three

quarters of the manufacturing superiority vanish. This is a strong indication that the choice of perspective affects the distribution of productivity between the main aggregates of the economy; the relative position of the service sector improves considerably when the vertical perspective is compared to the horizontal perspective. Expressed in a slightly different way, the curve in figure 5.4 describing how the absolute difference between the two measures has developed since the mid-1990s can be interpreted as an indicator of how much the conventional approach overestimates the relative strength of the manufacturing sector in terms of labour productivity levels. Using the statistics presented in figure 5.3, the service sector's direct labour productivity level only reached 59 per cent of the manufacturing level in 2005, a reduction from 67 per cent in 1995. In terms of total labour productivity levels, the service share reached 77 per cent in 2005, a reduction of six percentage points. The difference of 18 percentage points can be interpreted as an overestimation of the efficiency difference between the two sectors.

Figure 5.4. Differences in direct and total labour productivity levels between the manufacturing sector and the service sector, constant prices, thousands of dollar, 1995-2005. Sources: WIOD and own calculations.



Following the argument made by De Juan and Febrero (2000), total labour productivity is the most appropriate measure of sectoral competitiveness, as it includes all labour necessary throughout the economy in order to produce the final products.[116] This section has thus shown that it can be argued that

116 When discussing the aggregate economy, the authors argue that the conventional measure of value added over direct labour becomes an appropriate measure of social welfare.

the difference in competitiveness between the manufacturing sector and the service sector is much smaller than usually perceived.

Is this discussion also valid for the manufacturing sub-sectors? The competitive position of the sub-sectors of the manufacturing sector does not change to any large extent when measured in terms of total labour productivity instead of direct labour productivity.[117] From table 5.2, it can be seen that the ranking of the manufacturing sub-sectors in terms of direct and total labour productivity levels in 1995 and 2005 is similar, with the high-tech sub-sectors with the highest levels; the Spearman rank correlation is high in both years. Despite the general pattern, there are some important exceptions. For example, food and beverage and wood, respectively, reach a substantially higher ranking in terms of direct labour productivity than in terms of total labour productivity in both 1995 and 2005. Consequently, their relative competitive position diminishes when the economy-wide production process is considered. This is explained by a low share of own sector employment at the same time as they buy large amounts of intermediates from low productivity parts of the economy. On the other hand, rubber and plastics and machinery, respectively, improve their competitive position when measured in terms of total labour productivity.

Table 5.2. Direct and total labour productivity, constant prices, thousands of dollar, manufacturing sub-sectors, 1995 and 2005. Sources: WIOD and own calculations.

	DLP		TLP		Growth rates		TLP/DLP	TLP/DLP
					1995-2005, per cent			
	1995	2005	1995	2005	DLP	TLP	1995	2005
Food and beverage	226.1	286.4	76.8	107.8	26.7	40.4	0.34	0.38
Textiles	111.6	155.1	72.4	100.9	39.0	39.4	0.65	0.65
Leather	130.4	155.5	75.2	96.4	19.2	28.1	0.58	0.62
Wood	178.0	273.2	65.6	105.7	53.4	61.0	0.37	0.39
Pulp, paper, printing	210.1	289.0	90.3	122.8	37.5	36.0	0.43	0.43
Petroleum, coke	1125.8	2021.9	327.6	809.8	79.6	147.2	0.29	0.40
Chemicals	283.1	470.0	131.2	200.0	66.1	52.4	0.46	0.43
Rubber and plastics	141.2	202.7	84.0	124.3	43.6	48.0	0.59	0.61
Other non-metallic mineral	138.6	217.7	77.7	118.8	57.1	52.9	0.56	0.55
Basic and fabricated metals	188.8	249.5	96.4	126.6	32.2	31.2	0.51	0.51
Machinery	162.0	250.1	85.8	131.2	54.4	53.0	0.53	0.52
Electronics and telecom	184.6	356.4	93.1	173.0	93.1	85.7	0.50	0.49
Motor vehicles	237.5	396.2	106.1	158.1	66.8	48.9	0.45	0.40
Manufacturing n.e.c	70.8	115.1	48.8	75.7	62.6	55.2	0.69	0.66

The reason is that in the macroeconomic perspective, the total economy is a vertically integrated sector including both direct and indirect labour.

117 In the appendix of this chapter, table 5.4 presents the direct and total labour productivity measures for all 35 sectors of the economy for the years 1995 and 2005.

Apart from these rank differences, the growth rates of direct and total labour productivity differ considerably among many of the sub-sectors. In some cases, the direct growth rate is more beneficial. In others, the total growth rate is higher. For example, when indirect labour is excluded in the food and beverage sub-sector, labour productivity grew by 27 per cent between 1995 and 2005. When, on the other hand, the whole production process is considered, labour productivity grew by 40 per cent. From the same perspective, total labour productivity growth was considerably higher than the direct measure in leather, wood and rubber and plastics. In these cases, the direct labour productivity measures underestimate the labour productivity growth of the whole production process and therefore underestimate the competitive development of these sub-sectors.

On the other hand, direct labour productivity growth can also overestimate the labour productivity growth of the vertically integrated production process.[118] Particularly, this is the case for the four high-tech and medium high-tech sub-sectors: chemicals, machinery, electrical and optical equipment and motor vehicles. In motor vehicles, the difference is almost 20 percentage points between 1995 and 2005; total labour productivity growth only reached 70 per cent of direct labour productivity growth. This suggests that the labour productivity performance of the most high-tech and innovation oriented sub-sectors depends on the perspective applied. With an approach including all labour needed throughout the economy, the relative performance is reduced, and the difference between several other, non-high-tech sub-sectors shrinks. Consequently, competitive positions even out.

Finally, if the direct measure grows faster than the total measure, the TLP/DLP ratio is reduced. Following from what has been stated, this is the case for the high-tech and medium high-tech sub-sectors. With an increased difference between the conventional approach and the vertical perspective, the former has become a weaker indicator of the labour productivity development of the vertical production process. If this vertical perspective is the preferred measure of sectoral competitiveness, this indicates that the conventional approach has lost some of its appeal since the 1990s. With TLP/DLP ratios between 0.38 and 0.66 in 2005, the direct labour productivity measure overestimates the 'true' labour productivity level within the manufacturing sub-sectors with one to two thirds.

118 Between 1995 and 2005, the average direct labour productivity growth correlates weakly positively with the direct labour productivity level in 1995. This indicates that conventional productivity levels diverged within the manufacturing sector, with sub-sectors with high labour productivity levels at the beginning of the period having a more beneficial labour productivity growth than other sub-sectors. No such correlation exists between the initial total labour productivity level and total labour productivity growth.

5.5 Effects of outsourcing on labour productivity

The labour productivity of a sector may rise for several reasons. First, TFP may increase, not the least through disembodied technological change or changes in the work organization. Second, through capital investments, each employee has a larger amount of capital at her disposal. Third, the level of education gradually rises. Fourth, outsourcing can change both the level and growth of the labour productivity of a sector. However, if a low productivity activity is outsourced, this is positive for the productivity of the outsourcing sector, but this does not automatically change the productivity of the vertically integrated production process; less productive activities are only reallocated to another part of the production process. In the extreme case, outsourcing from the manufacturing sector to the service sector contributes to all labour productivity growth in the manufacturing sector.

Following the arguments in ten Raa and Wolff (2001), the increased use of services outsourcing among many manufacturing companies may explain some of the strong labour productivity growth in the manufacturing sector since the 1990s. This question is strongly related to the functioning of the contemporary growth process – how and where added values are created. Accordingly, in this section, the link between outsourcing and labour productivity will be explicitly analysed from the perspective of the manufacturing sector and its sub-sectors. The main question is: has outsourcing affected the labour productivity performance of the manufacturing sector between 1995 and 2005, a period characterized by very strong horizontally oriented labour productivity growth?

The method used to answer this question is an IO based shift-share technique, which decomposes sectoral labour productivity developments into components concerning both within sector labour productivity and labour productivity related to changes in the employment structure of the vertically integrated production process. In order to analyse the effects of outsourcing on productivity, Russo and Schettkat (2001) construct a productivity measure which relates final products to the vertically integrated labour needed to produce the final products.[119] Final demand for product h is defined as:

$$FPD_h = VA_{hh} + \sum_{i \neq h} VA_{ih} \qquad (5.3)$$

where FPD_h represents final demand for product h, VA_{hh} represents value added created in sector h in order to produce FPD_h, and VA_{ih} is the value added generated in all other sectors along the supply chains needed to produce

119 Greenhalgh and Gregory (2000) address similar questions.

FPD_h. Analogously, final product employment for product h, FPE_h, is defined as the sum of the employment needed in the own sector and the employment generated in all other sectors to produce FPD_h:

$$FPE_h = Emp_{hh} + \sum_{i \neq h} Emp_{ih}. \tag{5.4}$$

Within this framework, labour productivity in the production of product h, FPP_h, is defined as the ratio between the value added created and the employment generated in the vertically integrated sector to satisfy final demand for product h:

$$FPP_h = \frac{FPD_h}{FPE_h} \tag{5.5}$$

Final product demand, FPD_h, and final product employment, FPE_h, are estimated within the IO framework. In matrix form, the former is derived from the following equation:

$$\mathbf{FPD} = \frac{\mathbf{VA}}{\mathbf{GO}} (\mathbf{I} - \mathbf{A})^{-1}\mathbf{F} \tag{5.6}$$

where $\mathbf{VA/GO}$ is a matrix with nominal value added shares in gross output on the main diagonal and zeros elsewhere, and **F** is a diagonal matrix of final demand.[120] The column sum of the **FPD** matrix gives the total value added generated throughout the economy in order to satisfy final demand for product h.

Estimating **FPE** is analogous to estimating **FPD**, but labour requirements – labour per unit of gross output – are used instead of shares of value added in gross output. To get the total, or vertically integrated, employment, the matrix of gross outputs is pre-multiplied with a matrix, **PL**, of labour requirements on the main diagonal and zeros elsewhere:[121]

$$\mathbf{FPE} = \mathbf{PL}\,(\mathbf{I} - \mathbf{A})^{-1}\mathbf{F}. \tag{5.7}$$

Following Russo and Schettkat (2001), *FPP* can be defined as an employment weighted average of all sectors contributing to the production of product h. This means that:

120 Equation 5.6 is equivalent to equation 3.2.
121 Equation 5.7 is equivalent to equation 3.1.

$$FPP_h = LP_h \frac{Empl_{hh}}{FPE_h} + \sum_{i \neq h} LP_i \frac{Empl_{ih}}{FPE_h}. \quad (5.8)$$

Given this level measure of FPP, the most interesting question, apart from finding the effects of outsourcing on labour productivity, is to understand more about the changes in FPP and relate these to the horizontal measure of labour productivity in terms of value added per employee. Russo and Schettkat (2001) show that changes in FPP can be decomposed into a within productivity effect caused by improvements within each sector of the vertically integrated production process, a structural effect caused by changes in the distribution of employment in the vertically integrated sector, and an interaction term:

$$\Delta FPP_h = \sum_i \Delta LP_i a_{ih} + \sum_i LP_i \Delta a_{ih} + \sum_i \Delta LP_i \Delta a_{ih} \quad (5.9)$$

with

$$a_{ih} = \frac{E_{ih}}{FPE_h} \quad (5.10)$$

where a_{ih} is sector $i's$ share of the vertically integrated employment of product h. The first term, the within productivity effect, shows how much of the total change of FPP_h that is due to changes in sector specific labour productivity, keeping the vertically integrated employment structure unchanged. The second term, the structural effect, shows how changes in the vertically integrated employment structure affect FPP_h, with the sector-specific labour productivity levels unchanged. The third term is an interaction term, which exists because of the index problem.

Based on its definition, the structural effect – increased indirect employment and value added through purchased intermediates – is an indication of outsourcing within a vertically integrated sector. The authors suggest, however, that the within and structural effects can be further decomposed into effects derived from the own sector or from all other sectors of the economy. Thus:

$$\Delta FPP_h = \Delta LP_h a_{hh} + \sum_{i \neq h} \Delta LP_i a_i + LP_h \Delta a_{hh} + \sum_{i \neq h} LP_i \Delta a_{ih} + \sum_i \Delta LP_i \Delta a_{ih}. \quad (5.11)$$

This means that the first and third term concern the productivity and structural effects in the own sector, respectively, and the second and the fourth term concern effects in all other sectors. This decomposition is useful when investigating the effects of outsourcing on labour productivity growth. If the third term, $LP_h \Delta a_{hh}$, is negative, this means that the share of own sector employment in vertically integrated employment has been reduced. In this

context, this is defined as outsourcing. If this is the case, then the first term, $\Delta LP_h a_{hh}$, if positive, indicates that low productivity activities have been outsourced. Furthermore, if the fourth term, $LP_i \Delta a_{ih}$, is negative, this indicates outsourcing of low productivity activities to other low productivity sectors. This means that productivity in the outsourcing sector will increase, but the labour productivity along the vertically integrated sector will be unchanged. The fourth term can also be positive, if the outsourcing is directed towards sectors with high productivity levels. This improves the labour productivity of the vertically integrated sector.

Using equation 5.11, a decomposed growth in final product productivity in the manufacturing sub-sectors is presented in table 5.3.[122] From the table, it can be seen that the first two components, which measure the contribution from changes in labour productivity within sectors, explain the main part of the FPP growth in the manufacturing sub-sectors between 1995 and 2005.[123] The first component measures labour productivity growth in the own sector weighted with its vertically integrated employment share. The second component measures the aggregate labour productivity growth of all other sectors used in the production process, with each contributing sector weighted with its vertically integrated employment share; in four sub-sectors, vertically integrated labour productivity growth (excluding the own sector) exceeded own sector development. For example, own sector labour productivity growth was 16 900 dollar between 1995 and 2005 in wood production. At the same time, the aggregated labour productivity growth of all other sectors contributing to the wood production amounted to 13 100 dollar. With a positive third component, the level of outsourcing did not increase between 1995 and 2005. Instead, the share of employment generated outside the wood sector decreased, with a small positive net effect on labour productivity growth along the vertical production process. Including the interaction term, the FPP growth of the production of wood amounted to 29 900 dollar.

Generally, component three shows that there is a trend towards increased outsourcing, as indicated by the emerging manuservice economy identified in chapter three. Among the high-tech sub-sectors, the trend towards outsourcing is stronger than for the average sub-sector. Despite this pattern, the effects of outsourcing on vertically integrated labour productivity growth rates are rather modest. The strongest effect is found in chemicals. In this case, increased outsourcing reduced FPP growth by 6 400 dollar. Following the dynamics of Russo and Schettkat (2001), a positive first component and a

122 Coke and petroleum is excluded due to negative value added in 2005.

123 In different settings, the common result in shift-share analysis is that the within component dominates.

negative third component is an indication that low productivity activities have been outsourced. If the fourth component is positive, it indicates that the receiving sectors are relatively productive. This should benefit the efficiency of the vertically integrated production process. Between 1995 and 2005, this dynamic has characterized all high-tech and medium high-tech sub-sectors.

Table 5.3. Changes in final product productivity, manufacturing sub-sectors, constant prices, thousands of dollar, 1995-2005. Sources: WIOD and own calculations.

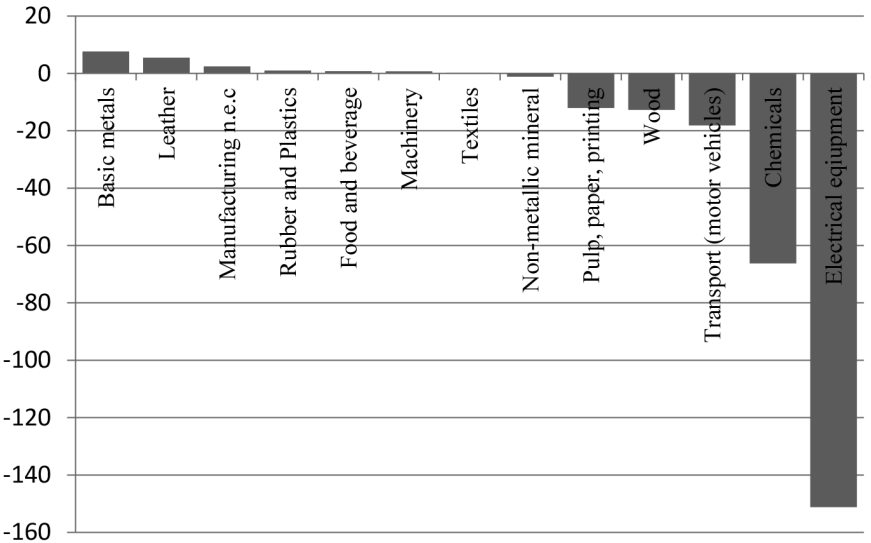
	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	FPP change
Food and beverage	8.0	13.7	1.6	-1.0	-1.4	20.8
Textiles	9.9	6.7	-0.6	0.9	-1.8	15.0
Leather	1.0	8.4	1.9	-3.0	-1.1	7.2
Wood	16.9	13.1	2.3	-2.0	-0.4	29.9
Pulp, paper, printing	19.6	9.4	-2.1	1.4	-1.8	26.5
Chemicals	59.1	7.8	-6.4	2.5	-6.3	56.7
Rubber and Plastics	8.2	8.2	0.6	-1.0	-1.7	14.3
Other non-metallic mineral	7.5	6.1	-0.4	-0.5	-0.9	11.8
Basic and fabricated metals	-3.0	7.1	-2.4	1.8	-0.6	2.9
Machinery	7.6	7.8	-1.4	1.5	-1.6	13.9
Electronics and telecom	167.2	7.3	-2.2	2.2	-13.3	161.2
Motor vehicles	23.5	10.0	-2.6	2.7	-4.3	29.4
Manufacturing n.e.c	6.3	5.6	-0.2	0.7	-1.0	11.4

With this methodology, the effects of outsourcing on manufacturing labour productivity exist, especially in the most technology-intensive sub-sectors, such as chemicals, electronics and motor vehicles. The effects are, however, modest in comparison with the productivity developments of within sector components one and two.

With the inclusion of the vertical perspective, sectoral labour productivity growth rates are weighted according to the labour use in the vertically integrated production process. This affects how the labour productivity is distributed in the economy. Figure 5.5 presents the difference in productivity growth between the FPP and the conventional sectoral value added per employee between 1995 and 2005 for the manufacturing sub-sectors. For the sub-sectors on the left-hand side in the figure, the growth in FPP exceeded the horizontally estimated growth rate. Although the differences are small, this group consists of sub-sectors defined as low-tech or medium low-tech by OECD (2011). The substantial differences are, however, found among the high-tech and medium high-tech sub-sectors, including pulp and paper and wood, respectively. In this case, the conventional measure overestimates labour productivity growth along the vertical production process. For example, within the production of motor vehicles, the difference is almost 20 000 dollar during a ten-year period,

and for chemicals and electronic equipment the difference is even considerably larger. In terms of growth rates, the FPP growth amounted to only 46 per cent of the conventional growth rate in chemicals during the period. In electronics equipment and motor vehicles, the share was just above 50 per cent and 60 per cent, respectively.

Figure 5.5. The difference between horizontal labour productivity growth (value added per employee) and final product productivity growth, manufacturing sub-sectors, constant prices, thousands of dollar, 1995-2005. Source: WIOD, EU Klems and own calculations.



This comparison shows that the distribution of productivity in the economy is affected by the perspective applied. If a vertically integrated perspective is chosen, this evens out the labour productivity performance of the manufacturing sub-sectors during the strong economy-wide period since the mid-1990s. Clearly, the relative dominance of the most technology oriented sub-sectors is reduced, as their labour productivity growth rates are reduced at a magnitude of around 50 per cent. With manufacturing being the prime engine behind the economy-wide labour productivity pick-up, it affects the interpretation of the strong GDP growth during the same period, with a stronger emphasis on the less technology oriented manufacturing sub-sectors. The reason for the differences in measured labour productivity growth among the high-tech and medium high-tech sub-sectors is that the benefits from the strong within sector development are reduced when indirect labour is included, as the purchased intermediates are produced with slower efficiency gains.

5.6 Concluding discussion

Maybe needless to say, in the social sciences the perspective applied and the methods used often determine how different phenomena are measured and interpreted. With this starting point, it is in this chapter argued that a vertical perspective of the strong labour productivity performance since the 1990s can shed some further light on value creation and structural change in the Swedish economy. This is especially the case as stronger intermediate linkages between the manufacturing sector and the service sector imply a more intensified use of market transactions to diffuse intermediates within the production system. Accordingly, the role of the intermediate structure in the process of generating increased productivity has become more important. With a growing use of intangible investments, the increased importance of the intermediate structure also has a strong qualitative dimension.

Based on the main research question, this chapter has shown that the labour productivity difference in terms of both levels and growth rates becomes substantially smaller between the manufacturing sector and the service sector when a vertical perspective is applied; around three quarters of the manufacturing sector labour productivity lead vanish when a vertically integrated perspective is used. This is explained by the fact that the manufacturing sector uses larger amounts of indirect labour to finalize production. This supports the argument made by Dietzenbacher et al (2000) and Schettkat and Salverda (2004) among others that a complete picture of labour productivity in different parts of the economy requires that production processes are vertically integrated. When this difference is accounted for, the relative labour productivity growth of the service sector has also strengthened since the mid-1990s, although it has lost ground in relation to the manufacturing sector along both dimensions. Expressed in another way, in 2005 the service sector only reached 59 per cent of the conventional manufacturing labour productivity level, but 77 per cent in terms of total labour productivity. This difference is substantial and affects the interpretation of the competitive position of the two main aggregates, and how it has changed since the 1990s. If total labour productivity is the most appropriate measure of sectoral competitiveness, as argued by De Juan and Febrero (2000), this chapter has shown that the difference between the manufacturing sector and the service sector is substantially smaller than what is often perceived.

Within the manufacturing sector, the comparison between the conventional and vertically integrated labour productivity measure shows that the competitive position of food and beverage and wood, respectively, is reduced in terms of the latter. On the other hand, rubber and plastics and machinery improve their position in terms of total labour productivity levels. The general pattern,

though, is that the rank differences are rather small between the two measures. When it comes to growth performance, the differences are more pronounced, however. The general pattern is that the difference between the high-tech and medium high-tech sub-sectors and the less technology oriented sub-sectors is reduced when all labour is accounted for. The reason is that sub-sectors with weak own sector developments are supported by the labour productivity of the supplying sectors. Within the high-tech and medium high-tech sub-sectors, such as chemicals, electronics and motor vehicles, the highly productive own sector production is instead mixed with intermediates produced with weaker labour productivity performance. Accordingly, using a vertically integrated perspective does not only strengthen the relative competitive position of the service sector but also the less technology oriented manufacturing sub-sectors. The labour productivity dominance of the high-tech and medium high-tech manufacturing sub-sectors since the 1990s is therefore reduced. With a strong own sector development among this group, the difference between the conventional measure and the vertically integrated labour productivity level has increased over time. As they have generally increased their use of indirect labour, this indicates that horizontally oriented labour productivity analyses have become a weaker indicator of the performance and competitiveness of the most sophisticated parts of the manufacturing sector.

In a comparison with a conventional value added based labour productivity measure, it has been shown that the concept of final product productivity in some respects gives another picture of the labour productivity dynamics of the manufacturing sub-sectors. This is especially the case for high-tech and medium high-tech sub-sectors, with a considerable reduction in terms of final product productivity. In chemicals, for example, the labour productivity growth rate is more than halved, and in electronics it is almost halved. Consequently, using a vertical perspective, this evens out the labour productivity performance among the manufacturing sub-sectors. This is explained by a reduced performance of the most technology oriented sub-sectors.

When it comes to the effects of outsourcing on the labour productivity performance of the manufacturing sector, this chapter has shown that the level of outsourcing has in increased in the manufacturing sector. Using the concept of final product productivity, this change in the production structure has slightly affected the labour productivity growth among the manufacturing sub-sectors. However, as is common in shift-share analysis, the most important source of change is by far found in the within sector components. Despite that, the effects of outsourcing are to different degrees prevalent in all high-tech and medium high-tech sub-sectors. This analysis indicates that the outsourcing

trend has been directed towards other highly productive sectors, which has improved the efficiency of the vertically integrated production processes.

Clearly, different approaches to labour productivity affect its distribution throughout the economy. If a vertical perspective is applied, the relative position of the service sector improves, especially in terms of levels but also in terms of growth rates. Second, this perspective also strengthens the relative position of the less technology oriented and less productive manufacturing sub-sectors. Consequently, the issue of sectoral competitiveness becomes less straightforward. With the distribution of labour productivity spread more evenly, value creation and structural change are more than before an issue related to independencies and inter-industry linkages. With stronger forward linkages between the service sector and the manufacturing sector as a general trend, the difference between the horizontal and the vertical perspective on labour productivity has increased. The interpretation of the contemporary economy has therefore become less obvious; the dependency of the most technology oriented manufacturing sub-sectors for the strong labour productivity rebound of the Swedish economy since the mid-1990s comes somewhat into question.

Appendix

Figure 5.6. Growth in real value added, manufacturing sector, Sweden and a weighted average of 13 of the most advanced economies. Index: 1960=100. Source: Bureau of Labor Statistics and own calculations.

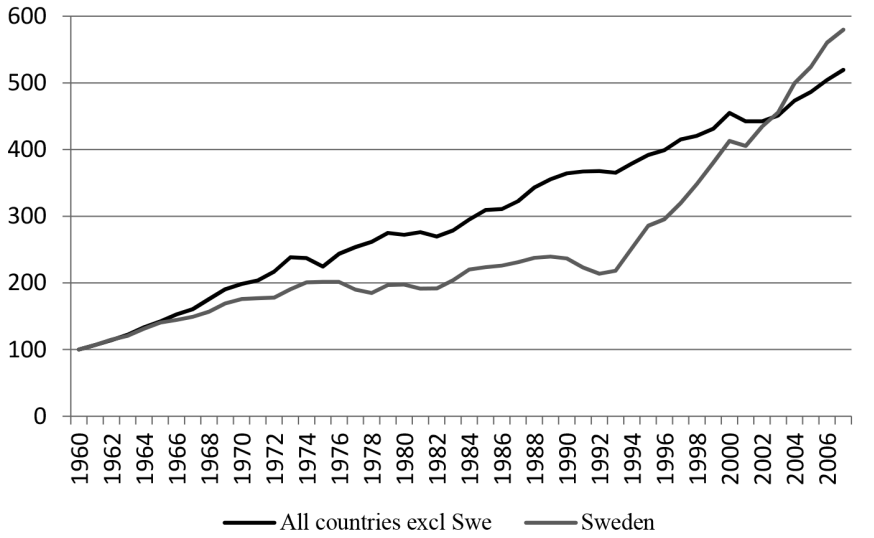


Figure 5.7. Labour productivity growth, real value added per hour, manufacturing sector, Sweden and a weighted average of 13 of the most advanced economies. Index: 1960=100. Source: Bureau of Labor Statistics and own calculations.

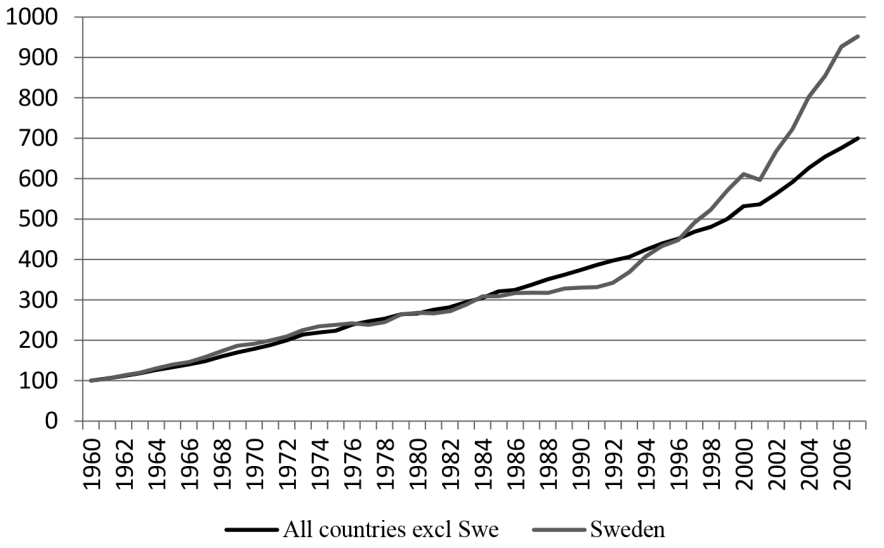


Table 5.4. Direct and total labour productivity, 1995 and 2005, constant prices, thousands of dollar. Sources: WIOD and own calculations.

	DLP		TLP		Growth rates		TLP/DLP	TLP/DLP
					1995-2005, per cent			
	1995	2005	1995	2005	DLP	TLP	1995	2005
Agriculture, forestry, fishing	71.4	107.9	57.7	81.7	51.1	41.6	0.81	0.76
Mining and quarrying	190.1	291.4	96.4	145.1	53.3	50.5	0.51	0.50
Food, beverages and tobacco	226.1	286.4	76.8	107.8	26.7	40.4	0.34	0.38
Textiles and wearing apparel	111.6	155.1	72.4	100.9	39.0	39.4	0.65	0.65
Leather	130.4	155.5	75.2	96.4	19.2	28.1	0.58	0.62
Wood	178.0	273.2	65.6	105.7	53.4	61.0	0.37	0.39
Pulp, paper, printing	210.1	289.0	90.3	122.8	37.5	36.0	0.43	0.43
Petroleum, coke	1125.8	2021.9	327.6	809.8	79.6	147.2	0.29	0.40
Chemicals	283.1	470.0	131.2	200.0	66.1	52.4	0.46	0.43
Rubber and plastics	141.2	202.7	84.0	124.3	43.6	48.0	0.59	0.61
Other non-metallic mineral	138.6	217.7	77.7	118.8	57.1	52.9	0.56	0.55
Basic and fabricated metals	188.8	249.5	96.4	126.6	32.2	31.2	0.51	0.51
Machinery and equipment	162.0	250.1	85.8	131.2	54.4	53.0	0.53	0.52
Electrical and optical equipment	184.6	356.4	93.1	173.0	93.1	85.7	0.50	0.49
Transport equipment	237.5	396.2	106.1	158.1	66.8	48.9	0.45	0.40
Manufacturing n.e.c	70.8	115.1	48.8	75.7	62.6	55.2	0.69	0.66
Electricity, gas and water	349.0	467.2	191.0	246.2	33.9	28.9	0.55	0.53
Construction	113.6	147.2	70.3	96.4	29.6	37.1	0.62	0.65
Sales and repair of motor vehicles	75.9	127.1	61.2	97.5	67.5	59.3	0.81	0.77
Wholesale trade	101.4	135.2	71.1	100.6	33.4	41.5	0.70	0.74
Retail trade	50.1	76.1	43.6	65.0	52.0	49.0	0.87	0.85
Hotels and restaurants	67.1	90.0	48.5	66.3	34.1	36.8	0.72	0.74
Inland transport	101.2	152.8	66.8	100.5	51.0	50.3	0.66	0.66
Water transport	331.5	354.1	141.9	160.1	6.8	12.8	0.43	0.45
Air transport	178.3	483.7	98.4	160.2	171.3	62.9	0.55	0.33
Transport services	274.3	344.8	95.9	127.7	25.7	33.2	0.35	0.37
Post and telecommunication	132.7	240.5	79.6	121.7	81.2	52.9	0.60	0.51
Financial intermediation	184.1	254.0	112.0	164.2	37.9	46.6	0.61	0.65
Real estate	621.2	826.1	178.2	220.7	33.0	23.9	0.29	0.27
Business services	104.5	142.0	67.2	96.2	35.9	43.3	0.64	0.68
Public administration and defence	82.6	118.8	60.1	86.6	43.7	44.2	0.73	0.73
Education	45.9	61.3	39.4	54.0	33.6	37.1	0.86	0.88
Health and social work	43.6	64.9	38.1	58.3	48.8	52.9	0.87	0.90
Other community services	62.1	94.8	46.2	70.1	52.7	51.5	0.74	0.74

6. Global value chains and competitiveness

6.1 Introduction

One of the most pronounced structural changes in the world economy since the Second World War is the growing trade between nations. The structure and content of this process have, however, changed during the Third industrial revolution. Further increases in the division of labour have altered the composition of international trade. Production processes have become more sequential and are increasingly located around the world independently of national borders. Nations and companies specialize in different activities and tasks along global value chains (GVCs). Due to the ICT revolution, lower transport costs and trade liberalizations, companies can better than before exploit factor cost disparities without sacrificing the gains from specialization (Grossman and Rossi-Hansberg 2008). With more disintegrated and fragmented production processes, trade in intermediates has to increase for the products-in-process to reach the final consumer. Consequently, international trade is today dominated by vertical flows of intermediates. This challenges the nature of globalization and the functioning of the world economy (OECD 2013a). Although not an entirely new phenomenon, the speed, scale and complexity of the current process of vertical disintegration are new. The globalization of production processes has deepened, in terms of nations, sectors and functions.

This change is a defining feature of the contemporary growth process, and poses challenges both for the research community and for policy makers. In terms of the former, measures of competitiveness have historically been based on trade volumes and trade shares. This approach uses gross measures, but GDP is mea[s]ured in net values. In practice, this difference was not a problem when almost all benefits from trade accrued to the final export country. Due to changes in the vertical structure of production and the emergence of the GVCs, the benefits are today widely spread around the world. From this perspective, Grossman and Rossi-Hansberg (2006, p 6) argue that: "The measurement of trade as gross values of imports and exports was perhaps appropriate at a time when trade flows comprised mostly final goods. But such measures are inadequate to the task of measuring the extent of a country's international

integration in a world with global supply chains and internationally dispersed production processes." Timmer et al (2012b, p 2) argue along similar lines that: "…in today's world export statistics are a weak indicator for the actual value which a country adds in the global production process."

Accordingly, there is a growing awareness that conventional trade statistics can give misleading indications of the importance of trade for domestic growth, employment and incomes (OECD-WTO 2012). Along similar lines, Johnson and Noguera (2012a, 2012b) argue that there is a hidden structure of trade in value added underneath the conventional trade flows, and Daudin et al (2011) emphasize that the conventional figures give the wrong idea of the exposure of global competition in different sectors.[124] This means that analyses of value creation and structural change should not only focus on imports and exports, but also distinguish between intermediate trade and trade in final products. Antrás and Costinot (2011) argue that trade in intermediates is instrumental in bringing to life the gains from globalization. Due to the importance of trade in intermediates and the growing gap between gross trade measures and net GDP measures, trade should be measured in terms of value added (OECD 2013b).[125]

As a small and open economy, the Swedish trade share (import plus export) has increased from 55 per cent of GDP in 1975 to almost 100 per cent of GDP in 2008. Further exacerbating a long-term trend initiated already in the first decades of the 19th century, the Third industrial revolution is characterized by imports and exports growing faster than GDP. This process of structural change has, however, not been analysed from the perspectives applied in the fast growing literature on trade in intermediates, GVCs and competitiveness. This chapter adjoins the Swedish economy to this literature. Using well-established, vertically oriented empirical methods, the main research question of this chapter is therefore the following: has the competitive position of the Swedish economy deteriorated? In support of this main question, and to

124 One explanation for the increase in world trade is reduced tariffs. However, the growth in global manufacturing trade has been much stronger than what seems reasonable from the tariff reductions. The strongest growth has also occurred since the mid-1980s, a period in which the tariffs have been reduced at a slower rate than in previous decades. Yi (2003) argues that this puzzle is explained by vertical specialization and the increase in intermediate trade. When intermediates cross national borders several times before the final product is finished, a tariff reduction can generate non-linear effects on the global trade in intermediates.

125 In a speech in 2010, the WTO Director-General Pascal Lamy argued that trade statistics should be improved to better capture the global distribution of value added. In 2012, WTO and OECD launched a joint initiative of measuring trade in value added. The first indicators were released in January 2013. A second release was launched in May 2013. See http://www.oecd.org/industry/ind/measuringtradeinvalue-addedanoecd-wtojointinitiative.htm.

improve the understanding of and the knowledge about the current process of global fragmentation, a further question will be: how have the GVCs changed the patterns of vertical specialization in the Swedish economy? Along the lines of the manuservice economy, another question will be: how has the emergence of the GVCs affected the global competitive pressure among sectors?

While this process of structural change has mainly been discussed on theoretical and case study-levels, empirical research on the aggregate effects on the world economy and in individual countries has been rather uncommon (De Backer and Yamano 2012). The main reason for this is the need for new empirical methods to analyse the complex web of global interdependencies, and to measure trade in terms of value added. Over the last decade or so, however, several attempts have been made to develop the analytical tools. One general theme in this research is the recognition that IO analysis is an important empirical technique to understand the current process of global specialization and international division of labour. OECD (2007, p 24) argues that: "I-O data are the most readily available source of information to get some insight into the increasing dependency of countries' export performance on imports." Lopez Gonzalez (2012, p 40) argues about the advantages of IO analysis: "… its ability to capture the interplay between foreign and domestic value added makes it an invaluable tool in analysing the surge in vertically specialized trade." Globally fragmented production processes generate interdependent production structures, which should be accounted for in economic analysis. This is done using IO analysis (Dietzenbacher et al 2013).[126]

The chapter is structured in the following way. From the notion of a second unbundling, the next section outlines a framework for the understanding of the global organization of production. Section 6.3 estimates and discusses vertical specialization of the Swedish economy – the domestic benefits from exports. Section 6.4 contains several empirical aspects related to the GVCs, such as trade in value added, distribution of competitive pressure and competitiveness, in Sweden and other advanced countries. A final section concludes the chapter.

6.2 The second unbundling

The global fragmentation of production processes is often analysed using case-studies on high-tech manufacturing production. For example, the fifth

126 Although the IO based research on global production processes referred to in this chapter is rather new, it was formalized already in the 1960s by Leontief and Strout (1963).

generation of the Video iPod 30 GB version is designed and marketed by Apple, an innovative multinational American company. The final assembly takes place in China by the Taiwanese company Foxconn. The intermediates are transported to Shenzhen from several countries, such as Korea, Japan, Taiwan, Germany and the US. After the final assembly, the iPod is exported to the US or other consumer markets. Each stage of this production process adds value to the product, but how are these values distributed around the world? Using detailed statistics, Linden et al (2009) show that only five dollar of added value are generated during the final assembly in China. As the retail price was 299 dollar, the Chinese share of the value added of this highly fragmented production process was less than two per cent, although the US trade deficit with China increases by about 150 dollar per iPod.[127] Ali-Yrkkö et al (2011) use a similar method to track value added along the supply chains of the Nokia N95 smartphone. Depending on where the final assembly takes place – in Finland or in China – and if it is sold in Europe or not, the added value generated in EU27 varies between 51 and 68 per cent. The authors also show that the assembly stage only generated two per cent of the total value added. Accordingly, services and intangible assets are dominating the value creation along the supply chains of the Nokia N95 smartphone.

The methodological perspective behind these detailed micro studies can also be applied to the macro economy. Richard Baldwin is an economist who has worked intensively on globalization and the new logic of global production.[128] His startin[g] point is that the analysis of the industrialization process over the last centuries can be structured around two great unbundlings. Over the modern history of industrialization, the cost of transportation has to a large extent determined the geographic clustering of production and people. Since the late 18th century, transport costs have gradually been reduced. This caused the first unbundling – the spatial separation of production and consumption. Inventions like the railroads and steam ships made it economically feasible to move production from homes to factories. Baldwin argues that the first unbundling was made possible by the steam, and it was made profitable by

127 Xing et al (2010) estimate that the production of iPhones in 2009 contributed with 1.9 billion dollar to the US trade deficit with China. If the added value of each country had been considered, the iPhone trade would instead have generated a US trade surplus with China. Research has shown that approximately half of the US trade deficit with China would vanish if the trade figures were corrected for the US export of intermediates to China. Koopman et al (2008) estimate that the foreign value added in China's manufacturing exports reached around 50 per cent between 1997 and 2002. Five years after China joined the WTO in 2001, the foreign share was over 60 per cent. The domestic content of the manufacturing export is particularly low in high-tech sub-sectors, such as computers, telecommunication and electronic devices.

128 See, for example, Baldwin (2006, 2011, 2012) and Baldwin and Venables (2010).

scale economies. Once this process got started, comparative advantage further strengthened this process.

Until the 1980s, global competition mainly concerned companies and sectors, and the production tended to be clustered in one (or in a few) geographical locations – the large domestic factory, viewed as a black box. The process of industrialization was based on import substitution and domestic supply chains. Over the last decades, there has been another great leap in communication and reductions in coordination costs, along the lines of the ICT revolution. This initiated the second unbundling. As the productivity-adjusted wage gap grew between North and South, it became more attractive to move parts of the production process to the latter. This process was further supported by lower costs for the separation of production stages. Especially ICT has reduced the costs associated with organizing supply chains over long distances. Consequently, the balance between centripetal and centrifugal economic forces has changed, and multinational companies can combine knowledge intensive production at home with low-wage production abroad.[129] ICT made the second unbundling possible, wage costs made it profitable.[130]

The main change brought about this time is that there is no need to perform different stages of the production process close to each other. The black box has opened up, and allocations within factories have turned into trade in intermediates along the GVCs. Trade in goods has turned into trade in tasks that are possible to perform in many places around the world. The restriction is not demand, but the capacity to identify and exploit competitiveness in certain parts of the production process. In the most recent stage of the second unbundling, this process has also entered the offices; more service tasks have become possible to perform over long distances.

6.3 Vertical specialization of the Swedish economy

In an influential article, Hummels et al (2001) argue that vertical specialization, or the international fragmentation of production, is the main force in the current phase of globalization. This means that companies to a greater

129 As argued by Baldwin, one of the most important factors behind the tendency of agglomeration is backward and forward linkages. The first unbundling fostered agglomeration in the North, the second fosters dispersion to the South.

130 From the perspective of not exaggerating the uniqueness of the 1990s in contemporary economic history, Eichengreen (2006) argues that one defining feature of the 1990s was the strong growth of foreign sourcing and the organization of global supply chains.

extent than before specialize in particular stages of the production process and, consequently, import intermediates, add domestic value added and export the product to the next country, maybe as a final product. Addressing the same perspective as Baldwin (2006, 2011, 2012), the authors argue that the nature of international trade has changed and that new ICT applications make it possible to separate the production process to different geographical locations around the world. The values created along the more interdependent chains of production are, accordingly, more widely spread around the world. However, these processes are hard to quantify, despite a strong theoretical interest in vertical specialization and fragmented production. The authors therefore argue that there is little systematic empirical evidence of the nature of this fundamental change in the structure of the world economy. In order to overcome this, they initiated a new strand of research on empirical measures of vertical specialization using IO techniques.

In order to analyse these changes, Hummels et al (2001) develop an empirical measure of vertical specialization: imported products used as intermediates to produce a country's exports.[131] The idea is that countries are sequentially linked. This means that vertical specialization occurs when (1) the product is produced in two or more sequential stages, (2) two or more countries add value to the product, and (3) at least one country imports intermediates in its stage of production, and exports some of its output. Based on this, the vertical specialization is for sector i defined as:

$$VS_i = \left(\frac{imported\ intermediates}{gross\ output}\right) * exports \qquad (6.1)$$

The first term in equation 6.1 is simply the share of imported intermediates in gross production. When this ratio is multiplied with the level of exports, the product is the monetary value of the imported input content of exports – or, equivalently, foreign value added embodied in exports. Following this definition, if a country is not importing any intermediates or if all products are consumed in the domestic market, the $VS_i = 0$. The VS measure for the aggregate economy is defined as the export-weighted sectoral VS estimates. Using IO techniques, including all indirect effects on the demand for intermediate imports, the VS share of country k is defined in the following way:

$$VS\ share\ of\ exports = \mathbf{uA^{im}(I - A^{d})^{-1}x}/\mathrm{X_k} \qquad (6.2)$$

131 The general ideas are established in Hummels et al (1998). European Commission (2012) argues that the indicator established by Hummels et al (2001) is the most widely used measure of vertical specialization.

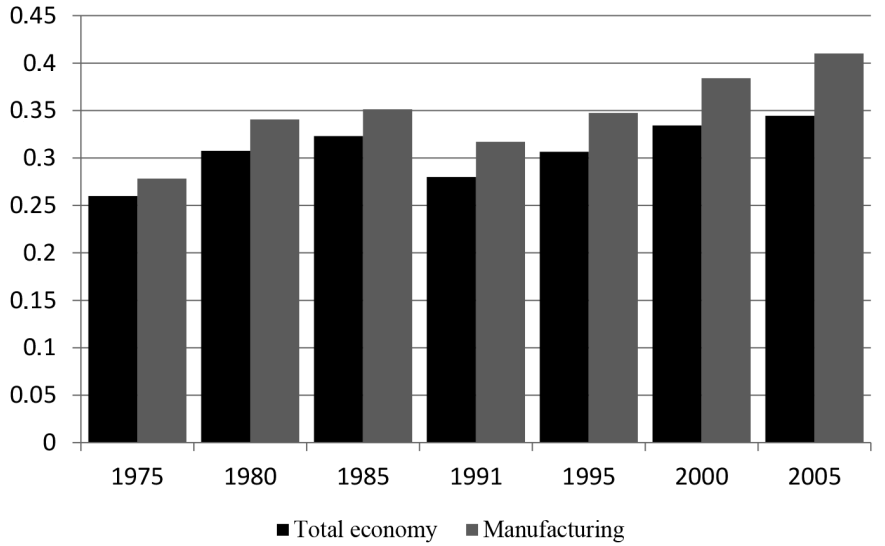
where $\mathbf{u}$ is a 1*n vector of ones (summation vector), $\mathbf{A^{im}}$ is the n*n intermediate import coefficient matrix, $\mathbf{I}$ is the n*n identity matrix, $\mathbf{A^{d}}$ is the domestic IO coefficient matrix, $\mathbf{x}$ is an n*1 vector of exports and X_k is total economy export. The term $(\mathbf{I} - \mathbf{A^{d}})^{-1}$ is the conventional Leontief inverse. If the purpose is to estimate the VS share of exports in each sector, the summation vector is excluded, and $\mathbf{x}$ is transformed into a diagonal matrix with the export values on the main diagonal and zeros elsewhere.[132]

Following this empirical approach, estimates of the VS share of the Swedish economy are presented in figure 6.1. As can be seen, the Third industrial revolution is about a gradual increase in the vertical specialization of the economy; each unit of exports has become more dependent on imports. In 1975, the VS share of exports reached 26 per cent in the aggregate economy, but 30 years later the share was as high as 34 per cent – an increase of more than 30 per cent. This process of global fragmentation has, however, not been linear. The latter part of the 1970s was characterized by a strong growth of the VS share in the manufacturing sector (and, thus, in the total economy). At a slower pace, this process continued at the beginning of the 1980s, but the general trend during the 1980s is more or less flat; the level of vertical specialization was not higher in 1995 than 10-15 years earlier. On the other hand, since the 1990s the growth of vertical specialization has once more increased and in 2005, it reached over 40 per cent in the manufacturing sector, an increase of almost 50 per cent since the mid-1970s.

According to Hummels et al (2001), the weak development during the 1980s was not an uncommon trend in the Western world, especially so in the latter part of the period. Sweden seems to have been part of this general trend, and one reason seems to be related to the imports of oil. The analysis of Sweden indicates that the oil dependence was reduced in terms of intermediate use, especially so during the latter parts of the 1980s; the oil share in imports of intermediates was reduced from twelve to four per cent between 1975 and 1991. Following Hummels et al (2001), the VS measure is re-estimated when the intermediate imports of petroleum are set to zero. However, this shows that even without the relative reduction in the use of imported petroleum, the VS share was reduced by three percentage points between 1985 and 1991. Oil is part of the story, but the main trend is unchanged.

132 One assumption using the VS share of exports is that imports originate entirely from abroad. This means that exported intermediates cannot be re-imported and further used in the domestic production process. A similar indicator, including a downstream perspective, is the participation index (OECD 2013a).

Figure 6.1. Vertical specialization, total economy and the manufacturing sector, 1975-2005. Sources: Statistics Sweden and own calculations.



Estimates of the level of vertical specialization in the manufacturing sub-sectors are presented in tables 6.4 and 6.5 in the appendix of this chapter. Without going too much into the details, some aspects are worth mentioning. First, the period between 1985 and 1991 is at odds with the overall trend towards a higher level of foreign value added embodied in exports. Between 1975 and 1985, the VS share increased in all sub-sectors except petroleum.[133] If we add six more years, more than 40 per cent of the sub-sectors reduced their level of vertical specialization. Except for textiles and wearing apparel, all sub-sectors increased the VS share between 1995 and 2005. In 2005, the motor vehicle sector, with a share of 48 per cent, was the manufacturing sub-sector with the largest level of vertical specialization (excluding petroleum). Also, the level of technology is a determining factor of the VS share and it seems as if this positive association has become stronger over time.[134]

133 The strong growth in the manufacturing VS share between 1975 and 1980 was supported by all sub-sectors except one (protected food). Between 1980 and 1985, six out of 25 sub-sectors reduced their VS share.

134 Another way of estimating the foreign use of intermediates is suggested by Feensta and Hanson (1996, 1999) and Feensta (1998). They suggest two measures of offshoring: one broad and one narrow. The former is defined as the share of imported intermediates in the total use of non-energy intermediates, and the latter as the share of imported intermediates within the same sector in the total use of non-energy intermediates. Generally, the broad measure gives results close to the VS measure, but the results for the intra-trade measure show that the stagnant period of the aggregate manufacturing sector during the 1980s and

This section has analysed the vertical structure of the Swedish economy since the 1970s. Although not linear, one of the main lessons is that the unbundling of the economy has been pronounced during the Third industrial revolution. This indicates that the link between global trade and domestic incomes and employment has been weakened; each unit of export contains larger amounts of foreign value added. It also means that it has become more difficult to identify where the benefits of trade end up along the GVCs. This issue will be analysed and discussed in the next section.

6.4 Global value chains in the world economy

Fragmentation of the world economy

Los et al (2012) argue that there are two main methodological approaches proposed in the literature to measure global fragmentation, and linking domestic value added to exports. Apart from using domestic IO tables and estimating the import content of exports along the lines of Feenstra and Hanson (1996, 1999) and Hummels et al (2001), the second alternative is the GVC approach. In this case, value added among the separate stages of production, in different countries and sectors, is traced. This means that each country's contribution to a global production process is identified – how much value added it embodies in the final products. This is done by reallocating the value of intermediate trade to the initial producer. Global IO models, constructed from domestic IO tables and trade statistics, are needed to measure the GVCs.[135]

In a period characterized by a strong interest in the fragmentation of production processes and the increased importance of vertical trade, this approach has become a lively field of research.[136] An influential contribution

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the beginning of the 1990s in terms of the VS measure is not mirrored in the intra-trade development; it continued to grow during this period. This suggests that the stagnancy was caused by manufacturing companies becoming less prone to buy foreign supplies from outside their own sector. The intra-trade measure has also been constant since the mid-1990s, and its share of the broad measure has been reduced. This indicates that the use of foreign supplies has become more widespread and concerns more products, not the least services. Tables 6.6-6.9 in the appendix of this chapter contain the two measures for the manufacturing sector and its sub-sectors between 1975 and 2005.

135 This approach is based on the inter-regional IO literature. In a global context, however, regions are represented by countries.

136 The recent empirical interest has grown alongside new theoretical work trying to characterize this phase of international trade and globalization. See, for example, Grossman and Rossi-Hansberg (2010), Baldwin and Robert-Nicoud (2010) and Antrás and Costinot (2011).

to this research is Johnson and Noguera (2012a, 2012b, 2012c).[137] Their starting point is that conventional trade statistics register the gross value of products at each border crossing, instead of the net values added between each border crossing. This double counting implies that conventional trade statistics overestimate the domestic value added content of exports, and this problem is exacerbated when global fragmentation implies that products-in-process cross more borders than before. It is also argued that global production networks mean that an intermediate can take an indirect route to the country where the final product is consumed. For example, Swedish intermediate exports to Germany may end up as consumption in the US. This means that German bilateral trade relations with the US contain value added generated in Sweden, although no conventional trade has taken place between Sweden and the US.

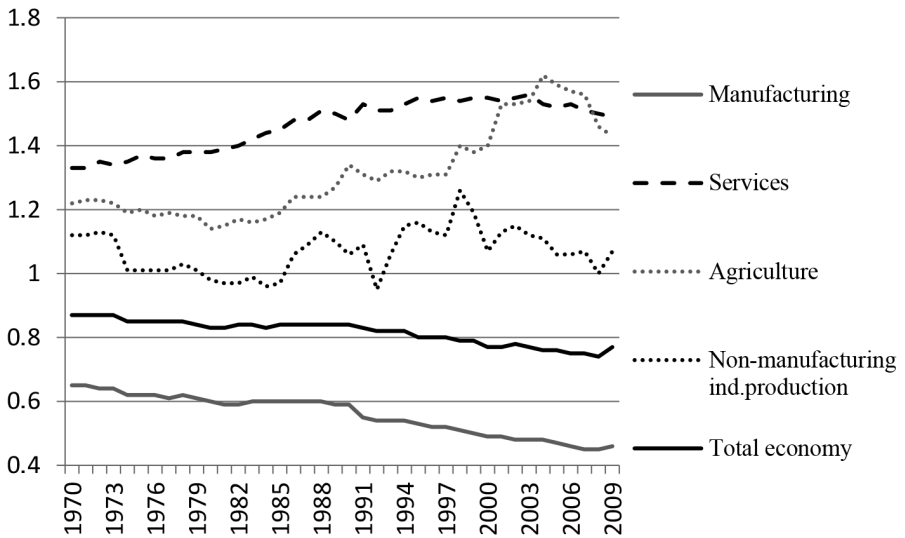
Due to these two measurement challenges, the authors argue that there is a hidden structure of trade in value added underlying the conventional trade flows. This trade in value added, including all indirect linkages between countries and sectors, is identified and related to the conventional export statistics, based on sales values. The ratio between the value added trade and gross trade is defined as the VAX ratio, and measures the extent of double counting in trade statistics. If this ratio is reduced, the domestic incomes generated from exports have shrunk and the problem with double counting has increased. Expressed in another way, a reduced VAX ratio indicates that vertical trade has increased, and that production processes have become more globally fragmented. At the bilateral level, the VAX ratio expresses the structure of cross-border supply chains. Johnson and Noguera (2012b) estimate VAX ratios over the period 1970-2009. By doing this, they can analyse changes in the fragmentation of the world economy, in individual countries and in different, rather aggregate, sectors over four decades. In figure 6.2, the development of the world VAX ratio between 1970 and 2009 is presented, based on 42 countries covering more than 90 per cent of world GDP and 80-90 per cent of world trade after 1990.[138] Clearly, the ratio has been considerably reduced over this period, indicating that the domestic value added related to gross exports has shrunk in the world economy by around 15 per cent since 1970; consequently, export statistics have become a less reliable indicator of domestic welfare. This is also a clear indication of an intensified global fragmentation of production processes. The interrelatedness with the second unbundling seems to be quite straightforward – the decline of the VAX ratio is roughly three times as fast after 1990 than before 1990. The figure also indicates that the process of global fragmentation has gone through three distinct phases. First, the period between 1970 and the

137 See also, for example, Koopman et al (2010, 2012).

138 The world VAX ratio is defined as the export weighted sum of the national ratios.

beginning of the 1980s is characterized by a substantial increase in the global fragmentation. On the other hand, this process of structural change came to a halt in the 1980s, and the VAX ratio remained flat over the coming decade. As the world economy entered a more intensified process of globalization during the 1990s, the global fragmentation found a new momentum, and the speed of structural change has been faster than in any period since 1970.

Figure 6.2. World VAX ratios, total economy and four main aggregates, 1970-2009. Source: Johnson and Noguera (2012b).



If the results are disaggregated according to the four main aggregates, figure 6.2 shows that the reduction in the world VAX ratio since 1970 is solely explained by the manufacturing sector; this sector is the only sector with falling ratios over time – in this case, with 30 per cent during the whole period. The manufacturing sector also explains the nonlinear process of global fragmentation since 1970. However, since the first years of the new millennium, the VAX ratio is reduced also for the service sector. This could be a first indication of the increased use of global supplies of service intermediates during the latter part of the second unbundling. According to Amiti and Wei (2005), this is often a matter of knowledge intensive intermediates related to R&D and ICT services, but also call centres and book keeping services.

What is the reason behind the divergent trends between the manufacturing sector and the three other main aggregates? The answer is that it mainly accrues from how sectors are engaged in global trade. For example, the service

sector's direct presence in world exports is rather weak; the ratio of gross exports to output is relatively low. On the other hand, service sectors more often deliver intermediates to sectors from where the products are eventually exported. This means that the service sector's engagement in global trade is indirect to a large extent, contributing with value added to the exported manufactured product. Apart from the high VAX ratio, figure 6.2 suggests that the intensified interaction between the manufacturing sector and the service sector, identified in chapter three for the Swedish economy, has a strong global flavour, but this process has been counterbalanced by a stronger gross services export performance since the late 1990s.

The manufacturing sector is in the opposite position. Production is highly dependent on upstream linkages to other sectors and countries, all of which contribute to the embodiment of value added in the manufactured products. Accordingly, a low VAX ratio indicates that the export figures contain a large share of value added generated outside the sector. A reduced VAX ratio therefore implies that the gross export growth has been faster than the growth of domestic incomes generated by this export growth. Obviously, the current phase of globalization is characterized by an increased global fragmentation of manufacturing production processes, affecting the structure of world production as a whole.

Fragmentation of the Swedish economy

Johnson and Noguera (2012b) also present figures for individual countries. In table 6.1, the figures for Sweden and four other countries are presented. Clearly, the total economy VAX ratio has been reduced in all countries between 1970 and 2009. As have been stated, this means that the problem of double counting has increased, and that domestic incomes generated from exports have been reduced. The two columns called within and between show the decomposition of the change in the total economy VAX ratio between a component due to changes in the ratio within sectors and a component due to changes in the composition of trade. This means that the decline in the aggregate VAX ratio can be explained either by a reduction within the manufacturing sector, or if the share of manufacturing in total gross exports has increased. The main aspect of these columns is the striking similarities within the group of the four advanced economies, and the opposite trend in China. For example, in Sweden, the total economy reduction is completely explained by an increased fragmentation within the manufacturing sector, and Sweden actually gained foreign value added due to a shift away from manufacturing in its composition of trade. This is the general case for all four advanced countries: reduced VAX

ratios within the manufacturing sector are partly offset by gains from changes in the composition of trade. The situation is the opposite for China. As a country, it has gained large amounts of value added within the manufacturing sector, but the movement towards the "factory of the world" also implies that a larger share of its exports is related to a manufacturing sector characterized by high levels of global fragmentation and, accordingly, to rather low levels of domestically generated value added.

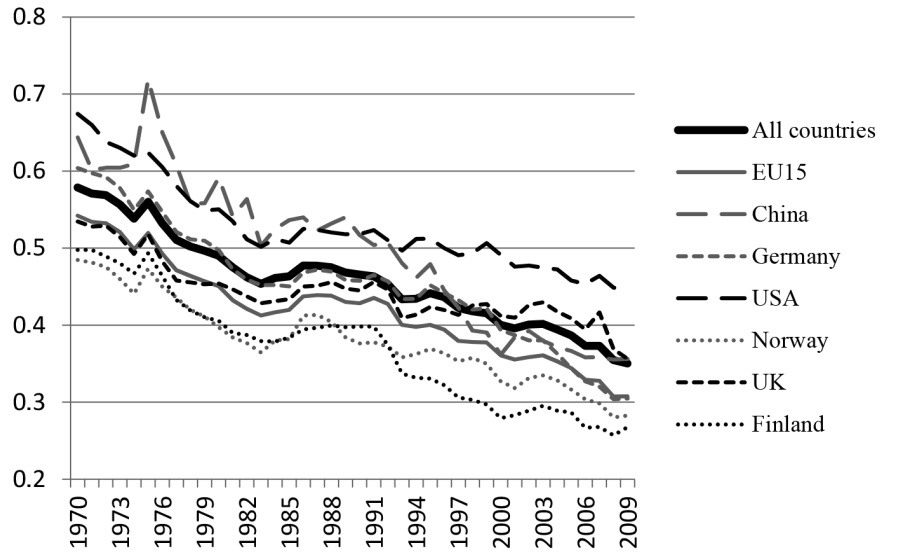
Table 6.1. Country VAX ratios, change between 1970 and 2009. Source: Johnson and Noguera (2012b).

	Total economy	**Tot ec. within**	**Tot ec, between**	**Manufacturing**
Sweden	-0.15	-0.25	0.1	-0.23
USA	-0.11	-0.12	0.01	-0.26
Germany	-0.17	-0.22	0.05	-0.23
Finland	-0.11	-0.22	0.11	-0.12
China	-0.18	0.22	-0.41	-0.23

The methodology in Johnson and Noguera (2012b) also gives the opportunity to analyse bilateral trade relations and the developments of the Swedish export VAX ratio between 1970 and 2009. This ratio is affected by the structure of the bilateral trade. Two perspectives are crucial: (1) back-and-forth trade – when the production process is structured around several rounds of trade between two countries – and (2) multilateral production chains that involve three or more countries.

For the Swedish manufacturing sector, these ratios are presented in figure 6.3, in relation to its five largest export markets, EU15, China and the world production of manufactured products. Clearly, in relation to all countries in the world, the global fragmentation of production processes in the Swedish manufacturing sector has been prevalent during the period between 1970 and 2009; the decrease in domestic content of exports amounts to almost 40 per cent. To put it in another way, there has been a considerable discrepancy between value added trade and gross trade. In concordance with other estimates presented in this chapter, this process did, however, come to a halt a few years into the 1980s and prevailed until the beginning of the 1990s. Between 1970 and 1983, the VAX ratio was reduced by 22 per cent, but it increased slightly between 1983 and 1991. The process of increased fragmentation has continued since the crisis years at the beginning of the 1990s, and the VAX ratio was reduced by a further 24 per cent between 1991 and 2009.

Figure 6.3. Export VAX ratios of the Swedish manufacturing sector, in relation to Sweden´s five largest export markets (in 2009), EU15, China and the world manufacturing production, 1970-2009. Source: Statistics provided by Johnson and Noguera and own calculations.



Without exceptions, the difference between value added in trade and gross exports has increased, indicating weaker positive effects on the domestic economy from gross exports. When it comes to the Swedish exports to China, figure 6.3 shows that the VAX ratio has been reduced since 1970, but the main reduction has occurred from the late 1980s; due to strong export growth, between 1989 and 2009 the fragmentation increased by 34 per cent, faster than in almost all other bilateral trade relations. The general pattern of weaker VAX ratios in the bilateral export relations indicates that the global fragmentation is broad based and is a general trait of the Third industrial revolution. The figure also suggests, however, that there are substantial differences in the bilateral trade with different countries. As mentioned, the reason is that the bilateral VAX ratio is affected by the back-and-forth trade. This type of trade is typically geographically concentrated. The VAX ratio is therefore generally lower in trade relations where the economies are interwoven with strong linkages in terms of trade and intermediate production. Figure 6.3 confirms this relationship, as the VAX ratios are substantially lower for Finland and Norway than for the US. Consequently, Swedish exports to the US generate larger domestic gains in terms of value added. This shows that the Swedish structure of manufacturing production and its supply chains are strongly

interconnected with Europe in general and the Nordic countries in particular. The global character of the process of vertical specialization is very much a matter of regional integration of supply chains.

Distribution of global competitive pressure

Daudin et al (2011) is another recent article on global fragmentation and trade in value added. Their starting point is that the impressive expansion of international trade since the 1980s is strongly related to the second unbundling, and the fact that intermediates need to cross several borders to serve the sequentially organized manufacturing production processes. This change is based on a new international division of labour. Following the standard argument that conventional trade statistics cannot address the question of the distribution of value added in the world economy, the authors state that research should consider all stages of the production process to be able to estimate how value added is distributed between countries and sectors. Using similar methods and statistics as Johnson and Noguera (2012a), the authors estimate trade in value added for a large set of countries for the years 1997, 2001 and 2004.

One of the perspectives addressed is the relation between standard measures of openness and openness based on trade in value added. For 113 countries (and regions) in the year 2004, the authors estimate the conventional export share and compare this with the share of exports in value added for a large number of sectors. In table 6.2, the results for a selection of these sectors are presented. As expected, the standard measure of openness, defined as the ratio between conventional exports and value added, shows that the manufacturing sector is the most globally oriented sector; the rate of openness being 66 per cent. On the other hand, the service sector is domestically oriented, with an openness rate of only eight per cent. All in all, this gives a global aggregate openness rate of 27 per cent.

Table 6.2. Standard and value added based measures of openness in the world economy, 2004, main aggregates and a selection of sub-sectors, per cent. Source: Daudin et al (2011).

	Standard openness	VA openness	Share of exports	Share of VA exports
Primary sector	41	41	9	13
Manufacturing sector	66	31	71	46
of which				
Textiles	111	43	5	3
Wood and paper	42	28	4	3
Chemicals and metals	90	45	19	13
Metals and transport	100	42	13	7
Electronics	123	48	26	14
Service sector	8	12	20	41
of which				
Communication and trade	14	20	10	20
Business services	10	18	7	16
All sectors	27	20		

However, Daudin et al (2011) argue that the conventional measure of openness gives a non-complete picture of the competitive pressure of sectors in a world economy dominated by GVCs. When value added generated by intermediate production is reallocated to the sector where it is generated, some sectors may, as mentioned, have smaller value added ratios than conventional ratios – and vice versa. In comparison with the conventional measure, a sector will have a relatively large value added based openness if it is mainly involved in global trade through intermediate production used to produce final products in other sectors delivered to foreign customers. This can be seen from the second column in table 6.2. When measured from this perspective, the openness of the manufacturing sector is more than halved, and the reduction is even more pronounced in some of its sub-sectors, such as textiles, metal and transport, and electronics. The reason for this is that a large part of the export values of these sectors consist of indirect value added generated in other sectors. On the other hand, the openness of the service sector increases by 50 per cent, and in the case of business services, the increase is as high as 80 per cent.[139] Accordingly, Daudin et al (2011) argue that trade statistics give an incorrect idea of the dependence on global demand of different sectors, and that trade in value added must be taken into account to understand who produces for whom in the world economy. This approach therefore gives a more realistic picture of the global competitive pressure in different sectors, as it includes all indirect

139 From a similar perspective, and using a large set of countries, Francois and Woertz (2008) show that business services are often the most important contributor to final exports, despite their low share in conventional trade statistics. The reason is the intermediate deliveries to the manufacturing sector. It is also shown that the use of imported business services intermediates stimulates the growth of high-tech manufacturing exports.

linkages constituting the circular dimension of the global production system. In a similar vein, the shares of world exports change rather dramatically when measured in terms of value added. For example, the difference between the manufacturing sector and the service sector shrinks from 51 to only five percentage points.

Distribution of competitiveness along the GVCs

In a project financed by the EU Commission, a group of researchers has developed the World IO Database (WIOD).[140] One of the main purposes of this project is to understand more about the world economy in terms of global integration of trade and the fragmentation of production processes.[141] Based on the general trends supporting the examples with the Video iPod and the Nokia smartphone, Timmer et al (2013) argue that traditional measures of competitiveness, such as a country's share in world exports, are becoming less reliable. The reason for this is the increased fragmentation of global production, where competition more intensively plays out at the level of activities within sectors, and less so between sectors; using conventional trade statistics, it is not possible to identify the national and sectoral contributions of value added embodied in final manufacturing products. The authors thus argue that a new measure of competitiveness is needed – a measure based on a country's direct and indirect contribution to the global production of manufactured products. This new measure of competitiveness is called GVC income.

Turning to some results, they have shown that the most advanced countries' share of GVC income in world manufacturing production was reduced from above 70 per cent to little more than 50 per cent between 1995 and 2008. Emerging economies have strengthened their position during this period, with almost all the relative improvement occurring after 2003. The main reason for this is China, especially after the WTO membership. In 2007, the Chinese share of GVC income was larger than the combined share of Brazil, Russia, India, Indonesia, Mexico and Turkey, and almost on par with the US share. In East-Asia, the Japanese share of incomes from world manufacturing production has been considerably reduced over the whole period. In the US, the share in GVC income started to shrink after the millennium. The share of the EU27 was, however, almost unchanged between 1995 and 2008.

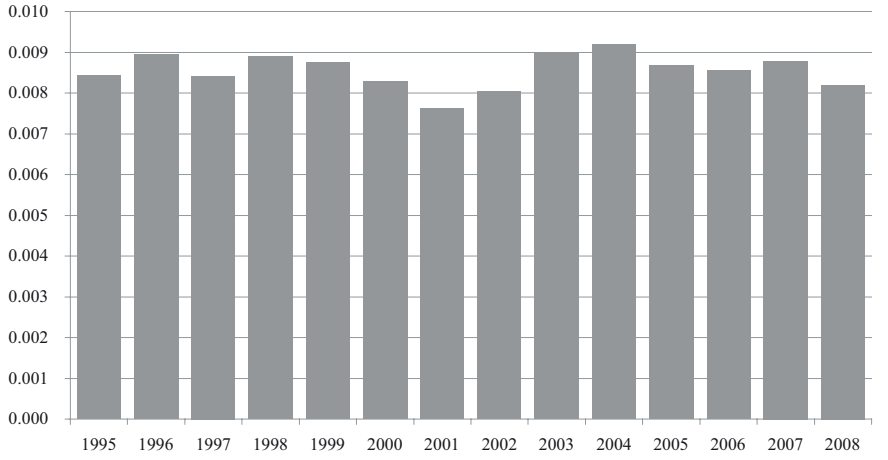
In the case of Sweden, the development of the GVC income between 1995 and 2008 is presented in figure 6.4. Two aspects are prominent. First, the

140 www.wiod.org.

141 See Dietzenbacher et al (2013) for an overview of the project and the underlying methodology.

Swedish share of the total, direct and indirect, incomes generated from the world production of manufactured products amounts to less than one per cent. Second, this level has been unchanged between 1995 and 2008 – a period strongly characterized by increased global competition, and an alleged process of deindustrialization. Following Timmer et al (2012b) and interpreting GVC income as an indicator of competitiveness, the competitive position of the Swedish manufacturing sector has therefore not weakened during this period. Following the analysis of the enlarged VIS employment in chapter three, the unchanged position of the Swedish manufacturing sector in the world production of manufactured products further emphasizes the need for vertically integrated methods in order to properly account for and understand structural changes during the Third industrial revolution. However, the long-term consequences of the financial crisis in 2008-09 remain to be seen.

Figure 6.4. GVC income, Swedish share of direct and indirect incomes generated from final demand for world manufacturing production, 1995-2008. Sources: statistics provided by Groningen Growth and Development Centre and own calculations.



The fear of employment losses due to an intensified global competition is at the heart of the debate in most advanced countries. To what extent this is true can be addressed using the WIOD. This is done by translating each country's GVC income into employment. The metric is called GVC jobs. According to table 6.3, EU15 lost almost 2.8 million jobs within the manufacturing sector between 1995 and 2008. On the other hand, the indirect employment in the service sector dependent on final demand for manufactured products increased by more than 2.9 million employees during the same period. This means that the EU15 countries, on average, gained more employment

in the service sector than what they lost in the manufacturing sector. The number of employed who deliver intermediates from the agricultural sector was, however, reduced during the period. The net effect for the EU15 was a reduction of manufacturing related employment, or GVC jobs, by 970 000 employees between 1995 and 2008.[142]

Table 6.3. GVC jobs, each country's contribution to the total, direct and indirect, employment needed to produce the world production of final manufactured products, change between 1995 and 2008, thousands. Sources: Timmer et al (2012a), OECD and own calculations.

	Agriculture	Manufacturing	Services	Total change	Share of tot.ec empl
Germany	-161	-666	1388	561	1.6
France	-96	-423	368	-151	-0.7
UK	-128	-1148	-347	-1624	-6.5
Italy	-192	-234	517	91	0.5
Spain	-97	185	353	440	3.5
Netherlands	-42	-87	158	29	0.4
Belgium	-18	-86	72	-32	-0.8
Sweden	-23	-49	94	22	0.6
Denmark	-46	-66	51	-41	-1.6
Finland	-25	-12	51	14	0.7
Ireland	-35	-17	40	11	0.9
EU15	-1149	-2758	2936	-971	-0.7

From the eleven countries presented in the table, seven increased their manufacturing related employment between 1995 and 2008, despite a reduction of the employment in the manufacturing sector in all countries except one. On the other hand, the indirect employment in the service sector increased in all countries except one. In absolute terms, the most beneficial improvement in GVC jobs is found in Germany and Spain. By far, the weakest development is found in the UK, where all three sectors contributed negatively to the change in GVC jobs.

How important are these changes for the aggregate economies? The answer is found in the last column of table 6.3, in which the change in GVC jobs between 1995 and 2008 is related to each country's total economy employment in 1995. What becomes clear is that the employment changes along the supply chains of world manufacturing production are, in general, rather modest. For example, the employment loss in EU15 only constituted 0.7 per cent of total employment in 1995. Clearly, the job losses due to deindustrialization and the fragmentation of production processes are at a low level. As can be seen, the

142 In 2008, almost 19 million employees were in EU15 indirectly employed within agriculture and services due to final demand for manufacturing products. This was approximately the same amount as those employed in the manufacturing sector.

big loser in this respect is the UK, with a reduction in manufacturing related employment constituting 6.5 per cent of total employment. For Sweden, the development between 1995 and 2008 meant that 0.6 per cent more employees were added to the global production of manufactured products.

The main message from this analysis is clear. Changes in the international division of labour and increased specialization along the GVCs have altered the structure of manufacturing production in advanced economies. Employment in the manufacturing sector has been offshored, along the lines of the GVCs. On the other hand, the indirect employment generated in the service sector has increased, especially in business services. The net effect is not clear cut, but fragmentation and vertical specialization do not necessary imply an overall job destruction in the most advanced economies. With the shift away from direct manufacturing production to indirect services deliveries, the skill composition of the GVC jobs seems to have changed towards more high-skilled employees, however.

6.5 Concluding discussion

There is a fast growing literature on the global fragmentation of production processes, in which nations and companies specialize in different activities and tasks along the GVCs. Therefore, international trade is today dominated by vertical flows of intermediates. Among other things, this means that analyses of value creation and structural change should focus on the role and consequences of the growing importance of inter-country and inter-industry flows of intermediates. With this point of departure, this chapter has shown that the level of vertical specialization has increased during the Third industrial revolution – or, equivalently, the foreign value added embodied in Swedish exports has grown considerably. In the aggregate economy, the increase amounts to 30 per cent, but to 50 per cent in the manufacturing sector. Each unit of exports has thus become much more dependent on imports in order to be finalized, implying that the domestic benefits in terms of production and employment have been reduced. This process has, however, been non-linear. It seems as if the 1980s was a decade when an earlier trend came to a halt, and did not find a new momentum until the 1990s. In this way, the global fragmentation of Swedish manufacturing production processes follows a three-way dynamic, with the most recent period indicating the fastest increase of the global integration of production processes. The weak period during

the 1980s was an international phenomenon and is partly explained by the oil crisis, but it seems as if the reaction to the economic turbulence of the late 1970s also made many manufacturing companies relatively less prone to use foreign suppliers. Among the manufacturing sub-sectors, the level of technology is associated with higher levels of foreign value added, and this pattern seems to have become stronger over time.

The increase in foreign value added embedded in Swedish exports means that the problem with double counting of trade statistics is exacerbated. As an indication of global production sharing, this is consistent with the analyses presented in this chapter, where the gap between gross trade and value added trade has increased over time, in Sweden and elsewhere in the world economy. For the manufacturing sector, with its extensive use of imported intermediates, the level of global production sharing has increased considerably, indicating a much stronger growth in gross exports trade than in value added trade. The opposite is true for the service sector, suggesting that, not surprisingly, the manufacturing sector is the engine behind the trend towards global fragmentation of production processes. A relatively weak services gross export performance, and the fast growth of inter-industry deliveries of intermediates, mean that the VAX ratio of the service sector has increased considerably in the world economy since the 1970s. With a relative shift towards final exports of services, this pattern has, however, gradually weakened, and has changed directions during the last decade.

The different trends among the two main aggregates suggest that they are engaged in global trade and in global production processes in different ways. Not the least, a large part of the exports of the service sector is indirect, especially through the intermediate deliveries to the manufacturing sector. When this is accounted for, the difference in global trade between the two sectors is considerably reduced; the difference in export shares is reduced from more than 40 percentage points to no more than five percentage points. Accordingly, conventional trade statistics rather severely underestimate the role of the service sector in world trade and the global production networks. When a trade in value added approach is applied, service sector employees are much more exposed to global competitive forces than what is often acknowledged. This is especially the case for knowledge intensive business services. The trend towards a domestic manuservice economy therefore has clear global consequences.

The problem with double counting of gross trade also calls for a rethinking of competitiveness among nations. Indicators of competitiveness based on these figures have lost much of their appeal, as they fail to identify the national contributions of value added embodied in final manufacturing production. With

competitiveness defined as the share of value added generated throughout the world economy from final demand for manufactured products, the competitive position of the most advanced economies is stronger than what is most often argued. Analyses based on gross export figures therefore overestimate the competitiveness of China and other East Asian countries, as the final assembly part of the manufacturing production process typically generates a small share of the value added generated along the chains of production. This is especially pronounced in high-tech manufacturing. In the case of Sweden, the competitive position has remained unchanged since the mid-1990s, a period characterized by strong concerns about globalization and future job creation.

This rethinking is also related to the process of deindustrialization. When all indirect employment generated by world demand for manufacturing production is accounted for, the job loss in the manufacturing production processes of EU15 since the mid-1990s is only 0.7 per cent of economy-wide employment; the indirect service employment growth actually outpaced the employment reduction in the manufacturing sector. In several countries, Sweden being among them, manufacturing related employment actually increased between 1995 and 2008. Instead of a severe reduction in manufacturing related employment, the dynamics is that the vertical structure of the global economy has shifted some manufacturing employment to low-wage countries, while outsourcing and servitization have stimulated the indirect employment growth in the service sector in general and in business services in particular. Consequently, the composition of the work force in the vertically organized manufacturing production processes of the most advanced countries has changed towards high-skilled employees not directly employed in the manufacturing sector. The comparative advantage has thus further shifted towards the importance of knowledge intensity and intangible capital.

Appendix

Table 6.4. Vertical specialization, manufacturing sub-sectors, 1975-91. Sources: Statistics Sweden and own calculations.

					Change	Change
	1975	**1980**	**1985**	**1991**	**1975-91**	**1975-85**
Protected food	0.22	0.08	0.23	0.15	-0.07	0.01
Import-competing food	0.40	0.45	0.45	0.26	-0.14	0.05
Beverage and tobacco	0.20	0.28	0.20	0.22	0.01	0.00
Textile, wearing apparel and leather	0.33	0.36	0.38	0.33	0.00	0.06
Saw mills	0.08	0.10	0.11	0.11	0.03	0.04
Wooden building materials	0.16	0.23	0.24	0.22	0.06	0.08
Pulp	0.16	0.23	0.23	0.19	0.03	0.07
Paper and paperboard	0.17	0.23	0.22	0.18	0.01	0.05
Fibreboards and other paper	0.18	0.22	0.24	0.18	0.00	0.05
Printing and publishing	0.10	0.12	0.14	0.11	0.01	0.04
Industrial chemicals and fertilizers	0.40	0.45	0.50	0.39	-0.01	0.10
Other chemicals	0.30	0.33	0.33	0.26	-0.04	0.04
Petroleum refining	0.89	0.92	0.86	0.68	-0.21	-0.03
Rubber	0.25	0.32	0.33	0.31	0.06	0.08
Plastics	0.32	0.38	0.42	0.37	0.05	0.10
Non-metallic mineral	0.20	0.23	0.23	0.16	-0.03	0.04
Iron and steel	0.36	0.38	0.39	0.33	-0.03	0.03
Non-ferrous metal	0.44	0.50	0.48	0.37	-0.07	0.04
Fabricated metals	0.26	0.30	0.30	0.25	-0.02	0.04
Machinery and equipment	0.28	0.31	0.32	0.31	0.03	0.04
Electrical machinery	0.26	0.33	0.35	0.38	0.12	0.09
Ship building and repairing	0.30	0.38	0.38	0.32	0.02	0.07
Transport equipment	0.33	0.38	0.38	0.41	0.08	0.05
Instruments	0.27	0.28	0.27	0.29	0.02	0.00
Other manufacturing	0.27	0.37	0.32	0.49	0.22	0.06

Table 6.5. Vertical specialization, manufacturing sub-sectors, 1995-2005. Sources: Statistics Sweden and own calculations.

				Change
	1995	**2000**	**2005**	**1995-2005**
Food, beverage and tobacco	0.26	0.27	0.30	0.04
Textiles	0.38	0.34	0.35	-0.03
Wearing apparel	0.45	0.31	0.37	-0.08
Leather	0.30	0.36	0.34	0.04
Wood	0.18	0.21	0.24	0.06
Pulp and paper	0.20	0.25	0.31	0.11
Printed matter and recorded media	0.16	0.20	0.21	0.06
Petroleum, coke	0.77	0.85	0.90	0.13
Chemicals	0.31	0.31	0.34	0.03
Rubber and plastic	0.35	0.34	0.42	0.06
Non-metallic mineral	0.23	0.27	0.30	0.07
Basic metal	0.37	0.39	0.44	0.07
Fabricated metal	0.27	0.26	0.29	0.03
Machinery and equipment	0.31	0.34	0.37	0.06
Office machinery and computers	0.31	0.37	0.36	0.05
Electrical machinery, radio and telecom	0.39	0.48	0.44	0.05
Medical and precision instruments	0.30	0.38	0.34	0.04
Motor vehicles	0.42	0.42	0.48	0.06
Other transport	0.35	0.37	0.35	0.00
Furniture	0.31	0.34	0.37	0.06
Secondary raw materials	0.00	0.00	0.00	0.00

Table 6.6. Broad offshoring in the manufacturing sector and its sub-sectors, 1975-91. Sources: Statistics Sweden and own calculations.

					Change	Change
	1975	**1980**	**1985**	**1991**	**1975-91**	**1975-85**
Protected food	0.22	0.08	0.23	0.15	-0.07	0.01
Import-competing food	0.40	0.45	0.45	0.26	-0.14	0.05
Beverage and tobacco	0.20	0.28	0.20	0.22	0.01	0.00
Textile, wearing apparel and leather	0.33	0.36	0.38	0.33	0.00	0.06
Saw mills	0.08	0.10	0.11	0.11	0.03	0.04
Wooden building materials	0.16	0.23	0.24	0.22	0.06	0.08
Pulp	0.16	0.23	0.23	0.19	0.03	0.07
Paper and paperboard	0.17	0.23	0.22	0.18	0.01	0.05
Fibreboards and other paper	0.18	0.22	0.24	0.18	0.00	0.05
Printing and publishing	0.10	0.12	0.14	0.11	0.01	0.04
Industrial chemicals and fertilizers	0.40	0.45	0.50	0.39	-0.01	0.10
Other chemicals	0.30	0.33	0.33	0.26	-0.04	0.04
Petroleum refining	0.89	0.92	0.86	0.68	-0.21	-0.03
Rubber	0.25	0.32	0.33	0.31	0.06	0.08
Plastics	0.32	0.38	0.42	0.37	0.05	0.10
Non-metallic mineral	0.20	0.23	0.23	0.16	-0.03	0.04
Iron and steel	0.36	0.38	0.39	0.33	-0.03	0.03
Non-ferrous metal	0.44	0.50	0.48	0.37	-0.07	0.04
Fabricated metals	0.26	0.30	0.30	0.25	-0.02	0.04
Machinery and equipment	0.28	0.31	0.32	0.31	0.03	0.04
Electrical machinery	0.26	0.33	0.35	0.38	0.12	0.09
Ship building and repairing	0.30	0.38	0.38	0.32	0.02	0.07
Transport equipment	0.33	0.38	0.38	0.41	0.08	0.05
Instruments	0.27	0.28	0.27	0.29	0.02	0.00
Other manufacturing	0.27	0.37	0.32	0.49	0.22	0.06
Manufacturing sector	0.27	0.30	0.32	0.29	0.13	0.03

Table 6.7. Broad offshoring in the manufacturing sector and its sub-sectors, 1995-2005. Sources: Statistics Sweden and own calculations.

				Change
	1995	**2000**	**2005**	**1995-2005**
Food, beverage and tobacco	0.18	0.20	0.23	0.05
Textiles	0.51	0.46	0.47	-0.04
Wearing apparel	0.57	0.40	0.45	-0.11
Leather	0.31	0.43	0.43	0.12
Wood	0.17	0.16	0.18	0.01
Pulp and paper	0.22	0.28	0.30	0.08
Printed matter and recorded media	0.13	0.17	0.17	0.04
Petroleum, coke	0.81	0.91	0.95	0.14
Chemicals	0.44	0.49	0.51	0.06
Rubber and plastic	0.45	0.45	0.56	0.11
Non-metallic mineral	0.26	0.27	0.31	0.05
Basic metal	0.36	0.38	0.42	0.06
Fabricated metal	0.29	0.30	0.33	0.04
Machinery and equipment	0.37	0.39	0.39	0.02
Office machinery and computers	0.40	0.56	0.46	0.05
Electrical machinery. radio and telecom	0.44	0.50	0.52	0.08
Medical and precision instruments	0.41	0.53	0.49	0.08
Motor vehicles	0.43	0.42	0.43	0.00
Other transport	0.43	0.45	0.41	-0.02
Furniture	0.31	0.34	0.37	0.06
Secondary raw materials	0.33	0.23	0.39	0.06
Manufacturing sector	0.34	0.39	0.41	0.07

Table 6.8. Narrow offshoring (intra-trade) in the manufacturing sector and its sub-sectors, 1975-91. Sources: Statistics Sweden and own calculations.

					Change	Change
	1975	**1980**	**1985**	**1991**	**1975-91**	**1975-85**
Protected food	0.04	0.03	0.03	0.01	-0.03	-0.01
Import-competing food	0.04	0.07	0.08	0.12	0.08	0.04
Beverage and tobacco	0.01	0.11	0.00	0.12	0.11	-0.01
Textile, wearing apparel and leather	0.33	0.32	0.34	0.29	-0.03	0.02
Saw mills	0.00	0.01	0.01	0.01	0.01	0.01
Wooden building materials	0.04	0.05	0.06	0.07	0.03	0.02
Pulp	0.00	0.00	0.00	0.00	0.00	0.00
Paper and paperboard	0.00	0.00	0.00	0.00	0.00	0.00
Fibreboards and other paper	0.00	0.00	0.00	0.00	0.00	0.00
Printing and publishing	0.01	0.01	0.01	0.02	0.00	0.00
Industrial chemicals and fertilizers	0.28	0.31	0.34	0.33	0.05	0.06
Other chemicals	0.08	0.08	0.08	0.08	0.00	0.00
Petroleum refining	0.37	0.22	0.28	0.24	-0.13	-0.09
Rubber	0.11	0.10	0.09	0.12	0.00	-0.02
Plastics	0.01	0.01	0.01	0.01	0.00	0.00
Non-metallic mineral	0.03	0.04	0.04	0.04	0.01	0.01
Iron and steel	0.19	0.17	0.18	0.14	-0.04	-0.01
Non-ferrous metal	0.32	0.33	0.30	0.28	-0.03	-0.02
Fabricated metals	0.07	0.11	0.11	0.10	0.03	0.04
Machinery and equipment	0.18	0.18	0.20	0.21	0.04	0.02
Electrical machinery	0.23	0.29	0.33	0.32	0.08	0.10
Ship building and repairing	0.03	0.05	0.01	0.03	0.00	-0.02
Transport equipment	0.15	0.17	0.20	0.21	0.06	0.05
Instruments	0.25	0.22	0.32	0.27	0.02	0.06
Other manufacturing	0.04	0.04	0.04	0.05	0.01	0.00
Manufacturing sector	0.11	0.12	0.13	0.13	0.03	0.02

Table 6.9. Narrow offshoring in the manufacturing sector and its sub-sectors, 1995-2005. Sources: Statistics Sweden and own calculations.

				Change
	1995	**2000**	**2005**	**1995-2005**
Food, beverage and tobacco	0.07	0.08	0.10	0.03
Textiles	0.24	0.11	0.11	-0.13
Wearing apparel	0.05	0.15	0.16	0.11
Leather	0.15	0.25	0.26	0.11
Wood	0.02	0.04	0.05	0.02
Pulp and paper	0.06	0.06	0.07	0.00
Printed matter and recorded media	0.01	0.01	0.02	0.00
Petroleum, coke	0.04	0.03	0.03	-0.01
Chemicals	0.29	0.28	0.28	-0.01
Rubber and plastic	0.07	0.05	0.07	0.00
Non-metallic mineral	0.04	0.05	0.05	0.02
Basic metal	0.29	0.28	0.30	0.01
Fabricated metal	0.03	0.04	0.04	0.00
Machinery and equipment	0.16	0.14	0.13	-0.03
Office machinery and computers	0.08	0.17	0.15	0.08
Electrical machinery, radio and telecom	0.26	0.31	0.29	0.03
Medical and precision instruments	0.17	0.08	0.14	-0.03
Motor vehicles	0.24	0.22	0.25	0.01
Other transport	0.21	0.20	0.20	-0.01
Furniture	0.02	0.08	0.09	0.07
Secondary raw materials	0.00	0.00	0.00	0.00
Manufacturing sector	0.15	0.16	0.16	0.01

7. Summary and final discussion

7.1 A new perspective applied

This thesis constitutes an attempt to merge two strands of the literature on structural change. With the foundations established by the classical economists of the 19th century, the interest in structural change analysis has increased since the 1980s. The reason for this is the revival of evolutionary or neo-Schumpetarian economics. This strand of economic thinking emphasizes the role of technology and its diffusion in economic growth. However, the diffusion process is not immediate or automatic, but requires cooperation and continuous learning. With the central role of technology diffusion, attention is often directed towards the intermediate structure and how new technologies are spread and alter the way companies choose to organize their production. Therefore, it is logical that evolutionary oriented economic historians and technology oriented economists often highlight the drawbacks of the horizontal representation of the economy, as it studies sectors in isolation and neglects the necessary interdependencies between them. The importance of a vertical perspective on structural change and its association with the diffusion of new technologies has rather recently also been recognized among neoclassical economists. This is closely related to the ICT revolution and its effect on the organization of production, the growing importance of intangible capital, and the emergence of global value chains.

The other strand of literature on structural change is the formal models developed by Sraffa and Leontief. Pasinetti showed that Leontief´s IO model can be transformed into a set of vertically integrated sectors. This means that sectors are not organized around specific activities, but according to how they are interlinked through actual production processes. This perspective on the economy opens up the black box of companies and sectors and shows how they are dependent on intermediate deliveries to finalize production. With the possibility of empirically studying the diffusion process, IO analysis represents one solution to the often recognized problem of not explicitly considering the intermediate structure when analysing the role of technology in structural change and economic growth (Silva and Teixera 2008); many aspects of technical change are only visible at this level of analysis. Due to the call for a new, vertically oriented empiricism, IO analysis has regained some

of its prominence as a useful empirical methodology among social scientists over the last decades.

Despite a strong focus on evolutionary perspectives and a general recognition of the importance of technology and its diffusion, the Swedish economic historical research tradition has lacked a thorough attempt to integrate evolutionary economics and IO economics. With the general aim and the five notions outlined in the introductory chapter, this thesis has attempted to reduce some of the knowledge gaps caused by this lack of explicit recognition of the vertical perspective on the economy. With the starting point on how new technologies affect how companies choose to organize their production, this perspective is mainly concerned with the technology side of structural change. According to the typology in Fagerberg (2003), it means that this thesis belongs to the strand of evolutionary research that uses applied methods to understand the inner workings of economies. In this respect, this thesis has used rather detailed empirical analyses of the Swedish production structure and how changes in this system affect the interpretations of structural change in its commonly used sense.

However, with stronger interdependencies and complementarities between sectors and nations, the complexity of the production system has increased. No empirical framework can make justice to the dynamics of this system, but they will always represent gross simplifications of the functioning of real world economies. Maybe needless to say, there is a large and probably growing gap between the research questions at hand and the fragments of reality that the empirical framework can identify. Despite these fundamental limitations, this thesis has been written with the ambition to contribute to a new and more complete understanding of value creation and structural change in the contemporary Swedish economy. In this way, this thesis complements the existing knowledge of structural change and the role of technology in the growth process.

7.2 Answers to the main research questions

Have the production processes of the Swedish economy become more vertically disintegrated?

An often used notion states that production processes have become more vertically disintegrated during the Third industrial revolution, in the sense that more intermediates are needed to finalize production. Following the work of

Eliasson (2002), Pavitt (2003) and Crafts (2006) among others, it is argued that the defining feature of the transition from the Second to the Third industrial revolution is a movement from vertical integration to vertical disintegration. Although caused by a complex web of sometimes opposing forces, the ICT driven shift towards outsourcing and the use of new service intermediates in the manufacturing sector – the so-called service duality – are often identified as the main explanation behind this change in the production structure.

This thesis has shown that the interdependencies between the manufacturing sector and the service sector have been intensified. With the business services sector emerging as a new key sector of the Swedish economy, and being the most important provider of intermediates throughout the economy since the 1990s, this deepened interaction seems to have strong knowledge contents. On the other hand, the ICT revolution, reduced transport costs and trade liberalizations have made it easier for the manufacturing companies to offshore some of their production and establish global value chains. Consequently, the use of imported intermediates in domestic manufacturing processes has grown rather dramatically. The net effect on the domestic economy of these opposing forces is that production processes, if anything, have become slightly more vertically integrated during the Third industrial revolution. This conclusion is not completely aligned with the general understanding in the literature. The reason seems to be that the effects of the global value chains on the domestic production structure have not been appropriately considered. When the world economy is seen as one production system, it is clear that the production processes of the manufacturing sector have become much more vertically disintegrated. The service duality and the emerging global value chains have therefore changed the production structure of the Swedish economy in two fundamental ways. First, the intermediate interdependencies between the manufacturing sector and the service sector have grown stronger within the domestic economy. Second, these interdependencies have also grown stronger between domestic manufacturing production and foreign suppliers of manufactured intermediates.

Has the Swedish economy been deindustrialized?

One of the hypotheses explaining the process of deindustrialization in the most advanced countries during the Third industrial revolution is concerned with the growing vertical linkages between the manufacturing sector and the service sector in general and the business/producer services sector in particular. This argument is well-established in the Swedish economic historical literature and implies that it has become more difficult to understand the development of

the manufacturing sector without considering the interdependencies with the service sector. The argument for stronger vertical linkages is, however, not supported by empirical analyses that address the verticality of production in an appropriate way. This thesis has shown that manufacturing processes have become more service intensive; it has approximately doubled since the mid-1970s. This has particularly been the case since the beginning of the 1990s, a period in which the fast growing business services sector solely explains this change.

The role of the service sector as a provider of intermediates to the manufacturing sector has been discussed at least since the 1950s, and already Levitt (1972, 1976) argued that these interdependencies outdate the horizontal perspective on the economy. A recent argument along similar lines is found within the concept of a manuservice economy; it is argued that innovations related to ICTs have made companies more specialized, due to further improvements in the division of labour. This means that economic values are created through the blending of manufacturing and services functions. In this dual process, outsourcing and servitization contribute to stronger intermediate dependencies. Outsourcing transforms in-house production into intermediate transactions through the market. Servitization implies that new services are traded through the market, as manufacturing companies need new types of intermediates to produce and sell integrated products and solutions to clients´ problems.

This intensified interaction means that manufacturing related employment and value added have increased in the Swedish economy. Consequently, there has been an increase in the overestimation of the process of deindustrialization by the horizontally oriented research. On the other hand, earlier vertical attempts have underestimated the deindustrialization process, and this underestimation has increased over time. This is explained by an exaggeration of the importance of the interdependencies between the manufacturing sector and the business/producer services sector. Therefore, this thesis has identified a middle way between the conclusions of the horizontally oriented research and earlier vertical attempts. The Swedish economy has been deindustrialized, but to a much lesser extent than what is most often believed. Moreover, with a strong dependence on services intermediates, the absolute and relative position of the most technology intensive manufacturing sub-sectors improves when employment is addressed from a vertical perspective. Accordingly, the importance of knowledge intensive manufacturing production in the Swedish production system is underestimated when applying a horizontal perspective on the economy.

Earlier research also has had difficulties in accurately evaluating the time profile of the deindustrialization process. With a vertically integrated approach, this thesis has shown that the first part of the Third industrial revolution – between the mid-1970s and the mid-1980s – is characterized by an almost unchanged level of manufacturing related relative and absolute employment. This contradicts the argument that the period since the 1970s has been characterized by a linear process of deindustrialization. With an almost unchanged level of manufacturing related employment since the beginning of the 1990s, it can be argued that the deindustrialization process has been more or less concentrated to the latter part of the 1980s. One reason behind the relatively strong employment performance from the mid-1970s and over the subsequent decade is a relative shift towards the use of domestic intermediates. As part of a global trend, one likely reason for this is a risk-reducing strategy during a period characterized by economic turbulence.

In the public debate it is too often argued that the Swedish manufacturing sector has almost completely disappeared, and that the forces of the global economy mean that manufacturing production has no future in Sweden.[143] Such statements find intellectual support in horizontally represented statistics on production and employment. When a vertical perspective is applied, the conclusion is not so clear cut. Although Sweden has been deindustrialized, the magnitude of this decline is much smaller than what is most often claimed; 36 per cent of the employees in the business sector were in the years preceding the financial crisis 2008-09 dependent on manufacturing production. Together with record high production and labour productivity growth, it can be argued that the period since the 1990s is the most manufacturing intensive since the 1960s.

36 per cent constitute a considerable share and the current structure of production suggests that the competitive position of the manufacturing sector is dependent on the interactions with the service sector. On the other hand, the employment performance of the service sector is dependent on the performance of the manufacturing sector to a non-negligible extent. Consequently, it has become less relevant to discuss policies based on a sharp distinction between sectors. It is not a matter of either-or, it is a matter of both. As important providers of intermediates, it has also become less fruitful to discuss the issue of small businesses without considering their dependency on their often large customers.

143 A recent example is when Prime Minister Fredrik Reinfeldt, during a seminar at the World Economic Forum in January 2013, stated that: "We used to have people in the industry but they are basically gone."

What role does the business services sector play in the national innovation system?

There is a fast growing literature emphasizing the importance of the business services sector in the contemporary growth process as a provider of often knowledge intensive intermediates throughout economies, especially in relation to the manufacturing sector. It is claimed that the business services sector has emerged as a central node in the national innovation system, contributing to and transferring knowledge and innovations in vertically organized production processes. In order to understand the process of value creation and structural change during the Third industrial revolution, attention should therefore be directed towards the inter-industry transactions of the business services sector. Following the international literature, in this thesis it has been argued that the analysis of forward linkages represents an appropriate method to study the overall structure of the national innovation system and identify spillover effects.

Despite the strong attention towards the role of the business services sector as an important provider of intermediates, this thesis has shown that the main engine behind its strong growth is final demand, not intermediate demand. This has been the case since the mid-1970s. Even during the third phase of business services growth, since the mid-1990s, with its emphasis on knowledge interactions and core competencies, final production grew twice as fast as intermediate production. However, the business services sector is still characterized by a large share of production being delivered to production processes of other sectors. In terms of size-independent forward linkages, this role has strengthened considerably, especially since the latter part of the 1980s; the average forward linkage of the business services sector has increased by around 80 per cent during the Third industrial revolution. Since the mid-1990s, the business services sector has been the most important provider of intermediates in the Swedish economy by far.

It has also been shown that the business services sector is less dependent on the manufacturing sector than what is often argued in the literature. Manufacturing production processes have become much more dependent on business services intermediates, but this change is not exceptional. Although being the largest customer, this is more related to the size of the manufacturing sector than with extraordinary business services intensive production processes. Since the mid-1990s, only 20 per cent of the employment in the business services sector is generated by the manufacturing sector, and only one third of its growth of indirect employment is due to the manufacturing sector. The most business services intensive production processes are instead found

in the service sector in general and the business services sector in particular. One main reason behind the strong growth of the business services sector is therefore the business services sector itself.

At least since the mid-1990s, the domestic intermediate deliveries of the business services sector to the manufacturing sector contain a smaller amount of knowledge than what is often argued in the literature. This is explained by the fact that the main force behind the growing forward linkages is almost exclusively related to less knowledge intensive, operational business services. The interaction between the R&D sector and the manufacturing sector does instead seem to have decreased rather substantially. Consequently, only three to six per cent of the employment growth of the business services sector is explained by a domestic increase in the knowledge intensive interaction with the manufacturing sector. The main reason is instead an almost remarkable growth in the use of temporary work agencies. After being allowed in 1993, the use of temporary work agencies has become widespread, not the least in the manufacturing sector. The use of these agencies is strongly related to blue-collar workers and less qualified white-collar workers, based on a growing need for rapidly adjusting the size of the work force when markets change. This flexibility in numbers has little to do with knowledge intensive tasks related to innovation and knowledge diffusion.

Clearly, this contradicts the general understanding in the literature, where the growth of the business services sector since the mid-1990s is assumed to contain large amounts of knowledge intensive and highly specialized intermediates, often related to core businesses and innovation. From the user-producer perspective, the overall functioning of the national innovation system does not seem to have become more dependent on knowledge intensive vertical linkages, despite extraordinarily large and growing forward linkages of the aggregate business services sector. Consequently, the positive spillovers are likely to have been smaller and less important for the aggregate growth performance than what is usually acknowledged. This highlights the problem associated with the treatment of the business services sector as a homogenous sector. To understand one of the main forces of structural change during the Third industrial revolution, it is necessary to disaggregate the business services sector. If this is not the case, less knowledge intensive interdependencies, with their focus on substitution and quantitative flexibility, can be interpreted as growth enhancing spillovers, indicating a fundamental change in the functioning of the national innovation system.

Is the service sector a productivity laggard?

With its strong connection to the material well-being of countries, research on productivity is plentiful. This tradition mainly applies a horizontal perspective on the economy and, hence, excludes aspects of productivity related to the intermediate structure and transfers of productivity. Due to the ICT revolution, a stronger emphasis on knowledge, and changed patterns of convergence among the most advanced countries, the interest in productivity research has surged since the 1990s. Based on the formal model developed by Baumol (1967), one of the long standing stylized facts in this research tradition is the distinction between a high productivity manufacturing sector and a low productivity service sector. This means that the aggregate productivity performance is unbalanced, due to differences in the general characteristics of the two main sectors of the economy. In the literature, it is argued that the dynamics of the Swedish economy since the 1970s supports Baumol´s distinction. However, this distinction does not consider the potential effects of any difference in the use of intermediates. Not the least, if the manufacturing sector generates relatively more indirect employment than the service sector, horizontally based productivity estimates are running the risk of overestimating the productivity difference between the two main sectors. A more complete understanding of the productivity performance in different parts of the economy therefore requires that sectors are vertically integrated. The notion of a manuservice economy, based in the service duality, makes this vertical perspective particularly important. From a qualitative perspective, this is exacerbated by the growing use of intangible capital in manufacturing production processes.

This thesis has shown that the labour productivity difference between the manufacturing sector and the service sector becomes substantially smaller when a vertical perspective is applied. The reason is that the manufacturing sector uses larger amounts of indirect labour to finalize production. More specifically, around three quarters of the labour productivity lead disappears when all labour is accounted for. In terms of growth rates, the relatively weakened position of the service sector since the mid-1990s is reduced. Both these dimensions therefore show that the difference in competitiveness between the two main sectors is reduced when a vertically integrated perspective is applied. Accordingly, this thesis has shown that the distinction made by Baumol is dependent on the chosen perspective to a non-negligible extent – the analysis of isolated sectors of activity. The changed pattern of competitiveness also relates to the manufacturing sub-sectors. From a vertical perspective, the competitive position of high-tech and medium high-tech sub-

sectors, such as chemicals, electronics and motor vehicles, is reduced. There are two reasons for this. First, the production processes of these sub-sectors are highly vertically disintegrated, indicating the use of large amounts of indirect labour. Second, the strong within sector developments of these sub-sectors are mixed with intermediates produced with smaller efficiency gains. These sub-sectors have also increased their use of indirect labour, suggesting that horizontally oriented labour productivity estimates have become a weaker indicator of the performance and competitiveness of the most sophisticated parts of the manufacturing sector.

Consequently, using a vertically integrated perspective does not only strengthen the competitive position of the service sector but also the less technology oriented manufacturing sub-sectors. Sectoral differences in the use of indirect labour constitute the main engine behind these observed patterns. Despite the general trend towards outsourcing, this thesis has shown that it has only slightly affected the labour productivity performance of the manufacturing sub-sectors. However, with the outsourcing trend being more prevalent in the medium high-tech and high-tech sub-sectors, the effects are more pronounced in the most technology intensive parts of the manufacturing sector. These growing purchases of intermediates have typically been directed towards other rather high productivity sectors. This has improved the efficiency of the vertically integrated production processes.

With the distribution of labour productivity being more evenly spread among sectors, value creation and structural change is more than before an issue related to inter-industry independencies and transfers of productivity. With the manuservice economy being a general trend, the difference between the horizontal and the vertical perspective on labour productivity has increased. The interpretation of the productivity dynamics of the contemporary Swedish economy has therefore become less straightforward; the productivity leadership of the manufacturing sector comes into question.

Has the competitive position of the Swedish economy deteriorated?

It is often argued that the competitive position of the most advanced countries has deteriorated during the Third industrial revolution. This notion is supported by a shrinking manufacturing sector and reduced shares in the world exports of manufactured products. However, in this thesis it has been argued that this notion finds support in empirical approaches which have lost some of their attractiveness. The reason is the emergence of global value chains. This means that today, global trade is dominated by intermediates, as production processes have become more fragmented and located around the world independently of

national borders, and is explained by the ICT revolution, trade liberalizations and reduced transport costs. Accordingly, nations and companies specialize in different activities and tasks along the global value chains. This challenges the nature of globalization and the functioning of the world economy. Trade and competitiveness therefore benefit from being approached from a value added perspective, addressing the question of how much added values sectors and countries contribute to the world manufacturing production.

This thesis has shown that production processes of the Swedish economy have become more globally fragmented during the Third industrial revolution, in the sense that the foreign value added embodied in exports has increased. In the aggregate economy, the increase amounts to 30 per cent but it amounts to 50 per cent in the manufacturing sector; in general, high-tech and medium high-tech sub-sectors use more globally fragmented production processes. This implies that the domestic benefits generated by gross exports have been substantially reduced in terms of production and employment. The pattern is non-linear, however. The 1980s was a decade when the fragmentation trend came to a halt, and it did not find a new momentum until the 1990s. In this way, the participation in the global value chains follows a three-way dynamic, with the most recent period indicating the fastest increase in global integration since the 1970s. As part of a global trend of manufacturing generated production sharing, this means that the gap between gross trade and value added trade has increased over time, in Sweden and elsewhere in the world economy; the well-known problem of double counting of trade statistics has therefore become more severe.

On the other hand, the manuservice economy means that the indirect contribution of the service sector to global manufacturing production has grown fast. This is a clear indication that the two main sectors engage in global trade in different ways; a large part of the export of the service sector is indirect, especially through the intermediate deliveries to the manufacturing sector. A trade in value added approach therefore suggests that a considerable part of the gross export values of the manufacturing sector should be distributed to the sectors contributing with value added along the chains of global production. This shows that conventional trade statistics rather severely underestimate the role of the service sector in world trade, and this underestimation has grown considerably during the Third industrial revolution. When a trade in value added approach is applied, the difference between the two main sectors in terms of export shares almost vanishes. Service sector employees are thus much more exposed to global competitive forces than what is often acknowledged. This is especially the case for knowledge intensive business services.

The problem with double counting of gross trade also calls for a rethinking of the competitiveness among nations. Indicators of competitiveness based on horizontally oriented export figures have lost some of their appeal, as they fail to identify the national contributions of value added embodied in global manufacturing production. With competitiveness defined as the share of manufacturing related value added generated throughout the world economy, the competitive position of the most advanced economies is stronger than what is often argued. Accordingly, analyses based on gross export figures overestimate the competitiveness of China and other East Asian countries, as the final assembly part of manufacturing production processes typically generates a small share of the value added generated along the global value chains. This is especially pronounced in high-tech manufacturing. In the case of Sweden, the competitive position has been unchanged since the mid-1990s, a period characterized by strong concerns about globalization and future job creation.

The rethinking also concerns the process of deindustrialization. When all indirect employment is accounted for, the job loss in the manufacturing production processes of EU15 since the mid-1990s only amounts to 0.7 per cent of economy-wide employment; indirect services employment growth actually outpaced the employment reduction in the manufacturing sector. In several countries, Sweden being among them, manufacturing related employment actually increased between 1995 and 2008. Instead of a rather severe reduction in manufacturing employment, the dynamics is that the vertical structure of the world economy has shifted manufacturing employment to low-wage countries while the service duality has stimulated the indirect employment growth in the domestic service sector in general and the business services sector in particular. The composition of the work force in the vertically organized manufacturing production processes of the most advanced countries has therefore changed towards more high-skilled employees indirectly employed by the manufacturing sector. The comparative advantage has thus further shifted towards the importance of knowledge creation, innovation and intangible capital.

From a policy perspective, a vertical perspective on global trade is needed for a more knowledgeable discussion of the competitive position of the Swedish economy. With the dominance of global value chains, a prerequisite for future success is the perception that imports are equally important as exports, and that inward investments are equally important as outward investments. The competitive position of nations and companies is to a growing extent dependent on participation in the global chains of production, and one crucial aspect of this is the possibility to purchase cheaper or better

intermediates from foreign suppliers. Moreover, research suggests that the contribution of the assembly part to the value added generated along the global value chains has been reduced (Baldwin 2011, 2012); the middle part of a so-called smile curve seems to have shifted downwards, indicating a relative shift of value creation towards upstream and downstream activities. With the Third industrial revolution pushing the competitive advantage of the Swedish economy in the direction of knowledge intensive activities, one main challenge is therefore to take advantage of the reshaped smile curve and continue to develop competencies within the most value added generating parts of the global production system.

7.3 A new and more complete understanding

In a competitive environment, profit-seeking companies constantly reconsider the efficiency of their businesses. As part of their intangible capital, process innovations and the boundaries of companies are becoming even more important aspects of competitiveness. Two main questions are: (1) should production be performed in-house or at arm´s-length? (2) Should production be located at home or abroad? The ICT revolution and its effect on the transaction costs have tilted the trade-off between in-house production and outsourcing/offshoring to the benefit of the latter; the reliance on market transactions and the price mechanism have thus grown for the products-in-process to reach the final stage of production. As mentioned, this has changed the production structure of the Swedish economy in two fundamental ways.

With a vertical perspective, this thesis has analysed five well-established notions of the contemporary Swedish economy from a new angle. In all these cases, it is argued that the chosen approach has contributed to a new and more complete understanding of value creation and structural change in the Swedish economy during the Third industrial revolution. Obviously, the horizontally oriented notions are still valid, but they are dependent on the perspective applied to a non-negligible extent; a vertical perspective on value creation and structural change gradates the interpretations of some generally accepted notions concerning the contemporary Swedish economy. Not the least, the vertical perspective illuminates some of the underlying mechanisms of structural change among horizontally represented sectors. Among other things, this concerns the level and dynamics of the deindustrialization process, the role of the business services sector in the innovation process and the

reasons behind its remarkable expansion, the productivity difference between the manufacturing sector and the service sector, and the gross export-based reduction in competitiveness.

The core mechanism justifying the typology of three industrial revolutions since the dawn of industrialization is how new technologies and their gradual diffusion among sectors and countries alter the way companies choose to organize their production processes. From this perspective, this thesis represents an attempt to explicitly analyse a fundamental feature of modern economic history. Obviously, changes in the boundaries of companies have repercussions on the way companies interact to finalize production. This means that the vertical approach is closely related to the evolutionary perspective on long-term growth; much of the impact of new technologies and innovations is realized through inter-industry transactions of intermediates. The Third industrial revolution, with its focus on ICT driven changes towards vertical disintegration and an ever finer level of global division of labour, suggests that inter-industry interdependencies have become an even more important aspect of the growth process, nationally and globally. These interdependencies both have a quantitative and a qualitative dimension. In terms of the latter, this is related to the growing importance of knowledge creation, knowledge diffusion and intangible capital. Also recognized by orthodox economists, these interdependencies are crucial for the functioning of the overall economy and the competitive position of nations. In this respect, it is argued that an evolutionary oriented, vertical perspective on value creation and structural change has become more important to understand some of the most fundamental structural changes of the contemporary Swedish economy. If changes in production processes are neglected, the functioning of the economy and the nature of value creation are running the risk of being misinterpreted.

From a policy perspective, both the manuservice economy and the functioning of the global production system indicate that policies should aim at strengthening networks, learning processes, cooperation and productivity transfers. Not the least, the importance of user-producer relations, and vertical complementarities in general, should be emphasized. Naturally, this perspective is strongly related to and dependent on further improvements in skill levels, investments in intangible capital and efficient industry-university relations. This further emphasizes the importance of knowledge linkages, process innovations and the organization of production. With the competition from low-cost countries, it has also become more important to invest in assets which are less easily copied. Altogether, an updated policy framework should therefore be more evolutionary oriented, with a stronger emphasis on

interdependencies and the dynamic nature of value creation and structural change.

7.4 New patterns of structural change?

With the potential long-term consequences of the financial crisis in 2008-09, many manufacturing companies have come to realize how vulnerable the networks of global interdependencies are to disturbances. The repercussions within a highly interdependent global production system, based on just-in-time, are manifold when a small part is directly hit by a negative chock. Apart from the awareness of these risks, the low-cost advantage of China is shrinking when wages in the average factory grow by 10-20 per cent per year. There is also evidence suggesting that too many companies have been too optimistic about the cost reductions associated with offshoring to emerging economies, and too little aware of the indirect costs related to the chosen business model; distance in itself often dampens cooperation and coordination. These costs are often hard to measure, however. When the labour share in production is gradually reduced, the cost advantage associated with low-cost production is further reduced. Many companies have also come to realize that offshoring to emerging economies can lead to problems with intellectual property rights, and they have recognized the benefits of having production and innovation close to each other. Maybe the balance between centrifugal and centripetal forces is about to change in the world economy, supported by new innovations such as 3D-printing. Instead of a cost reducing behaviour, companies will place more weight on market presence, aiming for new customers rather than new low-cost factories. Does the financial crisis in 2008-09, and its repercussions on domestic and global production structures, mark the first steps towards the transition to the second part of the first phase of the Third industrial revolution, with a relative shift towards horizontal integration, rationalization and the efficiency gains of current structures?

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