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Servicification of Manufacturing - Evidence from Swedish Firm and Enterprise Group Level Data[1]

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ABSTRACT

The manufacturing industry in industrialised countries is often argued to servicify - use and sell more services - but knowledge is poor. We examine the phenomenon using detailed and comprehensive micro level data at both the firm and enterprise group level for Sweden (1997-2006). We find that manufacturing is servicifying substantially. Services and qualified services are increasingly characterising in-house activity in manufacturing. The results imply that treating services and manufacturing separately - for instance in trade policy negotiations - may be inappropriate in industrialised countries. Finally, the findings illustrate the value of enterprise group level data when studying structural economic changes.

Keywords: servicification, manufacturing, deindustrialisation, enterprise group level data, firm data, outsourcing, offshoring
JEL codes: L23, L16, L60, F14

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I. INTRODUCTION

The manufacturing industry in industrialised countries is in decline. Its share of overall employment has fallen from 19.4 to 13.8 percent only between 1991 and 2006 while the services industry has expanded.[2] The diminishing role of manufacturing is expected. Generally, services employment expands as per capita income rises (Schettkat and Yocarini, 2006). This is mainly due to a shift towards services in final demand. Improvements in manufacturing's productivity as well as relative price changes in manufacturing and other merchandise industries are other explanatory factors (Nickell *et al*, 2008).

Meanwhile, firms in manufacturing and services in industrialised countries outsource and offshore more activities and competition from emerging economies intensifies. As manufacturing's share of industrialised economies falls and services are more easily offshored than before, debate has centred on the implications for industrialised countries' employment and economic growth (see e.g. Smith, 2006; Gresser, 2007; Dobbs, 2006; and Robert-Nicoud, 2006).

Simultaneously, the character of manufacturing seems to change and it interacts more with services industries than before (Pilat *et al*, 2006). Manufacturing uses more intermediate services (Görzig and Stephan, 2002; and Fixler and Siegel, 1999) and employs a rising number services-related workers (Pilat and Wölfl, 2005). As regards output, there is anecdotal evidence that manufacturing generates an increasing share of turnover from sales of ancillary services (Pilat and Wölfl, 2005). The concept of servicification captures this trend and signifies raising the amount of services incorporated in manufacturing (Tomiyama, 2002).

There are still large gaps in our knowledge on servicification of manufacturing. In particular, this applies to trends in in-house services cost shares and their composition in relation to other inputs, including imports. It also pertains to the importance and composition of sales and export of services in manufacturing. The latter is related to the fact that official statistics in most OECD countries have establishment or firms as their key statistical units whereas much of services diversification instead may be expected at the enterprise group level. To be more specific, services activities of a manufacturing enterprise group may be placed in certain subsidiary firms. In official statistics at

[2] No. of employed in 23 OECD-countries, OECD STAN-database and Labour Force Statistics.

both the firm and industry level the activities of those subsidiaries may be classified as belonging to the services industry. However, those subsidiaries' activities may be intimately related to the manufacturing activities of the enterprise group. More generally, structural business changes may today occur more within enterprise groups than between industries. For example, the core business in a manufacturing enterprise group may change from making cellular phones to providing design and software as well as Internet-based after sales services, while buying-in almost ready cellulars from e.g. Asian manufacturers. Since enterprise groups are becoming increasingly prominent, the lack of data at the enterprise group level is unfortunate.

This paper contributes to the literature by analysing in-depth the extent and intricacies of manufacturing's servicification in one industrialised country (Sweden) and using unique micro level data. Comprehensive datasets at *both* the firm and enterprise group level are developed and compared for Sweden (1997-2006). The fine detail of the data allows us to capture changes in the size of industries and their use, sales and exports of different type of goods and services. An aside, is that we shed new light on the potential overestimation of manufacturing's decline in industrialised countries that is discussed by e.g. McCarthy and Anagnostou (2004) and Vittucci Marzetti (2008).

The paper confirms manufacturing's continued decline in Sweden. However, the decline is smaller than previously shown when considering services activities in manufacturing enterprise groups. Moreover, the results confirm in detail that manufacturing is servicifying substantially. On the input side, manufacturing increasingly produce services in-house, rather than merely outsourcing them. On the output side, services export rise substantially more than in the services industry, especially at the enterprise group level, as expected. Overall signs of services sales growth in manufacturing are strongest in firm data whereas the absolute level is almost 60 percent higher in the enterprise group data. Altogether, the paper illustrates the importance of looking also at the enterprise group level when analysing structural economic changes.

The remainder of the paper is organised as follows. In section two, the conceptual framework is developed. Long-term trends in Swedish manufacturing's use of domestic and imported services are reviewed in section three, using input-output data. In section four, we discuss our empirical approach and

account for data used. Results are presented and discussed in section five. Section six concludes. (Additional tables are available in the annex.)

II. CONCEPTUAL FRAMEWORK

In this section, we review recent strategies and motives for firms' organisation and business as well as for manufacturing's use of services. We then arrive at tentative conclusions on manufacturing's servicification.

2.1 Recent changes in firm's organisation and sourcing

There is arguably a wider choice of business strategies available today than two decades ago. Country and firm boundaries are less relevant. International trade increasingly consists of an exchange of value added by various job tasks instead of an exchange of complete goods (Grossman and Rossi-Hansberg, 2008a and 2008b). This has been facilitated by trade and investment liberalisation as well as improvements in transportation and information and communication technologies (ICT).

More generally, with respect to vertical organisation, firms may integrate or specialise. If they specialise, other inputs are sourced elsewhere: at home or offshore. There are four alternative combinations for a firm as regards organisation and sourcing, as displayed in table 1.[3]

Table 1: Concepts in sourcing decisions

	At home	Abroad
Vertical integration	insourcing	offshore insourcing*
Vertical specialisation	outsourcing	offshore outsourcing

** FDI and intra-firm trade*

Note: draws on Antràs and Helpman (2004).

Vertical integration can be in the form of *insourcing*, which is, expanding (or keeping) activities in-house, or in the form of *offshore insourcing* (FDI and intra-firm trade). One strategy observed in recent years is manufacturing firms' *integration downstream* (Pilat *et al*, 2006). For Sweden, Berggren and Bergkvist (2006) illustrate this with numerous examples. Offers of service packages may be bundled with manufactures, including distribution to the final customer but also financial solutions, technical support and sometimes even

[3] Empirically, it is difficult to distinguish between: a) the continuation of an existing strategy and the start of a new one; and b) between a long-term strategy (e.g. outsourcing a firm activity) and a temporary arrangement (e.g. subcontracting an activity of a specific contract).

operation of the delivered products. The business of the telecommunications company Ericsson illustrates this. It has moved from only producing telecommunications equipment to installing, maintaining and operating such equipment world-wide. Today, services account for 40 percent of its turnover (Ericsson, 2009).

Vertical specialisation means that a firm hives off some activity to external suppliers at home – *outsourcing* – or abroad – *offshore outsourcing*.[4] Vertical specialisation may change the character of a manufacturing firm to become more of a services firm, although the opposite is also possible. Since ICT facilitates global marketing strategies, the nurturing of global brands might be considered the core activity of a manufacturing firm (Djef *et al*, 2005). Nike is an example of a manufacturing company that concentrates on services content such as design and marketing while manufacturing to a large extent is provided by external contractors (van Dusen, 1998). Lately, outsourcing has been on the rise in industrialised economies after a long period of vertical integration, facilitated by technological and liberalisation advances (Barrar and Gervais, 2006).

2.2 Decisions of firms on organisation and sourcing

Decisions of firms on whether to internalise a particular activity or keep it external have been deliberated upon at length and in different veins of the literature. Works by Coase (1937), Williamson (1979), Dunning (2001) and others shed light on the interaction between a firm's specific advantages or disadvantages and transaction costs involved in a particular organisational set-up of the business. The strategic management literature discusses competencies of firms and pros and cons of a deepened division of labour (e.g. Quinn and Hilmer, 1994). Finally, literature on the international dimension contributes reasons for foreign trade, including comparative advantages and technology transfer, as factors behind offshoring activities (e.g. Grossman and Helpman, 2005; Lewin *et al*, 2009; Antràs and Helpman, 2004; and Barba Naveretti *et al*, 2005).

Essentially, key reasons for internalisation as well as outsourcing appear to be the same (Paul and Wooster, 2008). After reviewing previous work, Mas-

[4] Outsourcing proper is the hiving off of an existing activity rather than the buying-in of a new activity. Since data of necessary detail is lacking on intra-firm activities, this distinction is commonly not considered.

kell *et al* (2006) boil down motives behind the make-or-buy decision to an assessment of cost and differentiation advantages of outsourcing a particular firm activity, in responding to a more competitive environment. Differentiation advantages pertain to quality and innovation benefits.

Cost advantages with outsourcing are related to: economies of scale and scope of contractors; lower organisational costs for outsourced activities; and the possibility of turning fixed into variable costs. A downside with outsourcing may be the higher cost of governing a complex supply chain. Bargaining over e.g. contract details is costly and the firm and its contractors may both act in their self-interest in such a way that the overall outcome is suboptimal. On the overall, outsourcing costs are related to: the activity's complexity; the thickness of the market; and the extent of specific assets involved in the activity being outsourced.[5]

The relative demise of country and firm boundaries over the last few decades means that markets of firms have expanded, both on the input and output side. This is a reason for vertical specialisation. The larger the market, the more firms will focus on activities with increasing returns to scale and where it has comparative advantages, while buying-in other inputs from domestic and foreign suppliers (Stigler, 1951). The demise of boundaries also means that agglomeration forces - such as previous experience - increasingly influence sourcing and specialisation (Grossman and Rossi-Hansberg, 2008b). For example, if a few large multinational firms in a specific industry already buy an essential input from suppliers in a certain geographical area, it is more likely today that new firms in that industry will also choose to source that input there. The reason is that suppliers in that area already have the know-how and experience necessary to be competitive in comparison with suppliers elsewhere.

2.3 Services in manufacturing

In the business strategies above, the profit-maximising manufacturing firm may put an emphasis on raising services content – whether supplied in-house or externally – along the product life cycle. Such a servicification (Tomiyama, 2002) is interpreted here as raising the amount of services incorporated into the

[5] See e.g. Barrar and Gervais (2006).

manufacture as well as services offered in conjunction with it.[6] Thus, focus is changed from the manufacture of a good to the provision of value-in-use (Martinez *et al*, 2008).

Servicification is illustrated in Sandvik, a Swedish engineering multinational with some 50,000 employees world-wide (National Board of Trade, 2010a). Only its subsidiary Sandvik Tooling uses some 40 types of services - ranging from accountancy services to audio-visual services - to uphold its delivery chain. Moreover, it offers some 15 types of services to its customers such as design, maintenance, research and development (R&D) and logistics services. Neely (2008) finds a rising trend of services focus in manufacturing firms, using cross-country firm level data. However, methodological issues limit the value of the study, especially in capturing actual firm behaviour. For Sweden, Braunerhjelm *et al* (2008) provide some evidence that Swedish manufacturing is being servicified.[7] Generally, Pilat and Wölfl (2005) find indications on more emphasis on services in industrialised countries' manufacturing.

The emphasis on services may apply more to qualified non-personal services (e.g. R&D, information technology services and finance) than other services (e.g. cleaning and construction). Many non-personal services are skills-intense (Peneder, 2007), have capital-intensity ratios closer to that of manufacturing (Triplett and Bosworth, 2003) and can more easily be traded, for example, using the Internet.[8] Non-personal services include distribution, producer and social services (Singelmann, 1978).[9]

A basic reason for manufacturing to increasingly use non-personal services in manufacturing, for example ICT, may be to raise a firm's productivity. Moreover, qualified services could be used to further differentiate, customise and up-grade offers in order to raise profits and compete in the market. By differentiation, competition may lessen. This applies both to the product market itself and to the markets for support or management of the product.

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[6] Other terms used are servicisation, servification and servitization, while other related concepts are functional products and product-service system. , see e.g. Sakao *et al* (2009), Kindström and Kowalkowski (2009) and Vandermerwe and Rada (1988).

[7] Using case studies and basic information from employer organisations in manufacturing.

[8] The tradability of non-personal services is related to the fact that they are more separable, can be standardised and are intermediate rather than final in character; this in contrast with personal services as traditionally characterised e.g. in Wolak *et al* (1998).

[9] Producer services are essentially financial and business services whereas personal services e.g. include repair, laundry, hotels, catering and entertainment.

An additional effect of these developments could that the firm and its customers develop closer and more longstanding contacts. Rather than being limited to the actual sales event, the relation may be kept over the manufacture's entire lifetime. (An example is the telecom industry. Advanced cellular phones have operating system and built-in additional software that are upgraded and may be expanded during the cellular phone's lifetime and where the phones may be connected to e.g. online record stores.) There are also some indications that the complexity of the manufacture is positively correlated with servification (Avadikyan and Lhuillery, 2007).[10]

Another reason for a relative expansion of services in the activities of manufacturing firms may be investments abroad. One example is the offshoring of manufacturing production (vertical specialisation), assuming that this cuts costs for production. More generally, if a firm invests in production, sales or other services activities abroad, then its headquarters in the home country is likely to export more services than before. This includes intra-enterprise group services such as management services, R&D services, IT services and human resources services. Thus, the relative importance of services in the business in the home country may grow for manufacturing firms who invest abroad. However, this is not clear cut. Manufacturing firms may invest in services activities abroad in order to focus on production back home. In that case, the rise in intra-enterprise group services exports may be small relative to total activities in the home country. For Sweden, however, investments abroad may be part of the reason behind the servicification suggested by numerous case studies.[11]

With respect to effects of servicification, productivity should rise for the firm, the industry and the overall economy, everything else equal. However, prerequisites are international competition in the market supplied by the firm and free entry domestically.[12] van Ark (2004) argues that combining manufac-

[10] The management literature points to the need for including services as part of manufacturers' product offers (Oliva and Kallenberg, 2003). Witell *et al* (2009) survey servicification and its motives in the Swedish motor vehicle industry.

[11] SOU (2008) shows that net-exports of royalties and licenses have expanded substantially in the last decade and profits from activities abroad are considerable. Swedish multinationals' activities abroad have also expanded substantially in recent years. As a whole, there is reason to believe that this is behind part of the servicification in Swedish manufacturing.

[12] Evidence on productivity effects of services outsourcing is limited. ten Raa and Wolff (2001) analyse services outsourcing in the US over the 1977-1996 period at the industry-level. They find it to contribute positively to manufacturing's productivity. However, services' tradability and general character have changed considerably since then.

tures and services in offers might be important for the EU to catch up in services productivity with the US.

2.4 Perspectives from the literature - what to expect

Based on the discussion above, manufacturing firms in industrialised countries are expected to increasingly specialise in high value-added manufacturing and services activities. This includes expansion of in-house production of services. Less complex services activities with lower productivity potential may be candidates for outsourcing or offshoring,[13] along with low-skill-content intermediate goods more cost-efficiently produced offshore. More complex activities may be kept in-house or bought-in externally, depending on outsourcing and offshoring costs as well as agglomeration forces involved.

III. INPUT USAGE IN SWEDISH MANUFACTURING SINCE THE 1970s

Our study of Swedish manufacturing starts with a brief review of input usage in Swedish manufacturing since the mid-1970s, using input-output (I-O) tables. I-O tables capture manufacturing firms' use of *externally* produced services and merchandise in relation to other inputs. Moreover, they distinguish between domestic and imported inputs.

3.1 Bought-in inputs

As displayed in table 2 and column 2, the services input share has more than doubled in Swedish manufacturing between 1975 and 2005, from 12 to 25 percent of the production value. Services and merchandise imports have also become more important. This goes especially for the share of imported services in the total external input of services, which is up some 85 percent, from 9 to 17 percent. In the meantime, manufacturing's merchandise input share has been relatively stable at some 44 percent, column four.[14] However, these figures do not capture merchandise and services incorporated upstream by other firms who then, in turn, sell their intermediate goods and services to the manufacturing industry downstream. For example, the figures exclude services used

[13] Such services may also be more distant to the core business of manufacturing firms than qualified ones.

[14] Our micro-data shows that the total of bought-in inputs rises moderately, 1997-2006.

in producing a datachip that is subsequently used in the motor vehicles industry.

Table 2: Intermediate usage in manufacturing, 1975-2005, as shares (%)

	Services shares		*Merchandise shares*	
	Total services in output (input^{s}/output)	Imported services in services input (import^{s}/input$^{s)}$	Total merchandise in output (input^{m}/output)	Imported merchandise in merchandise input (import^{m}/input$^{m)}$
1975	12	9	44	47
1995	21	9	45	45
2000	25	15	43	52
2005	25	17	44	54

Source: Input-output tables, Statistics Sweden, own calculations

Hagman and Lind (2008) analyse *total* linkages - direct as well as indirect linkages - by looking at employment multipliers for Sweden.[15] Their results confirm that the linkage between the manufacturing and the services industry has been strenghtened. For every new job in manufacturing, 0.34 and 0.64 new jobs were generated in services in 1975 and 2005, respectively. That is, there has been an 88 percent increase in the effect on the services industry's employment of a marginal change in manufacturing's employment.

3.2 Inputs from overseas

Foreign content that is implicit in domestically sourced inputs has also increased in the last decade in Sweden. Using I-O data, Ekholm and Hakkala (2005) and Hagman and Lind (2008) confirm the rising trend in offshore sourcing since 1995. The strongest growth has occurred in the services industry, although from a lower level than for manufacturing.[16] In 2000, the import share in total input use was 17-19 percent for services and 38-53 percent for manufacturing, depending on how narrow a definition of offshore sourcing is used.[17]

[15] The multiplier measures the total employment effect of an increase in demand for an industry's products. If the value is one, no employment is generated in other sectors (direct effect only). A value above one means that employment is also generated in other sectors since they supply the original industry with inputs (indirect effect). Multipliers are calculated using I-O matrices based on the national accounts. Note that the estimates are lower limits since income effects are ignored by the authors.

[16] Analysis of IO-tables from Statistics Sweden for 1995 and 2000 in Ekholm and Hakkala (2005); and for the same years plus 2005 in Hagman and Lind (2008).

[17] For the share of imported inputs in total Swedish merchandise imports, see www.konj.se.

3.3 Conclusions from input-output analysis

Our input-output analysis shows that externally bought-in services accounted for a much larger share of the production value in manufacturing in 2005 than three decades ago. Consequently, the links between manufacturing and services industries are stronger than before. Imports have also become more important for private business and imported services in particular.

What is not clear from the above, however, is whether manufacturing firms merely outsource more services or if it actually uses more services than before. Hence, we will perform more a detailed analysis of recent developments in section five. However, before turning to the results, an account of our empirical approach and data is provided in the next section.

IV. EMPIRICAL APPROACH AND DATA

In the remainder of the paper we will draw on data from the firm and enterprise group levels. Firm-level data has been provided by Statistics Sweden. The database includes core financial information as well as data on employment and foreign trade. All firms in Sweden that existed in any year between 1997 and 2006 are included, except for firms in the primary, financial and core public sectors. (For more details on data, see the annex.)

The reason for also using enterprise group level data is firstly that it can provide information additional to that from I-O or firm data and it is useful when studying structural economic changes. Enterprise groups consist of interdependent firms – e.g. one entity providing advanced and differentiated products, another technical support and a third customised financial solutions – where key economic decisions are made at the enterprise group level.[18] Enterprise groups account for the bulk of the Swedish economy (see section 4.2 below).

Secondly, analysis at the enterprise group level is also called for in the paper since there is an unexpectedly large difference in manufacturing's services diversification in Canada compared with that in other OECD countries when using establishment and enterprise level data. The difference may be re-

[18] The number of enterprise groups has risen by 87 percent, 1997-2006. It can be added that Postner (1990) creates an intermediate statistical unit, the division, for structural analysis of contracting-out in the Canadian services sector.

lated to the fact that statistical offices in North America and Europe use different definitions of an enterprise (Pilat and Wölfl, 2005). In North America the definition includes enterprise groups whereas in Europe it does not.[19]

Thirdly, enterprise group data may shed new light on the potential overestimation of manufacturing's decline that is discussed in the literature (McCarthy and Anagnostou, 2004; Greenhalgh and Gregory, 2001; and Schettkat and Russo, 1998). Changes in how firms are organised and recent fragmentation of production would affect where firms' activities are recorded and how they are classified. Hence, statistics based on the observation unit of the firm or establishment only - such as national accounts and structural business statistics - may support both the view that manufacturing is in decline and that it is not, being merely reorganised.

4.1 Empirical approach

Unfortunately, structural business statistics do not yet exist at the enterprise group level in the EU. Furthermore, there is no industry classification of enterprise groups. A solution would thus be to determine the industry affiliation of enterprise groups and then aggregate firm level data to the enterprise group level. This is the approach taken here.

Firstly, we classify firms of an enterprise group as belonging to the primary, manufacturing or services industry. Secondly, the largest two-digit industry of the dominating overall industry in the enterprise group is identified and this determines the classification of the entire enterprise group. Thirdly, we aggregate firm level data to the enterprise group level. The result is the enterprise group level dataset, which comprises all Swedish business entities (enterprise groups as well as stand-alone firms). In the analysis we will compare information from this dataset with the information from the original firm level dataset. (For more details, see the annex.)

The two micro level datasets of the study, one based on the firm and another having the enterprise group as its key unit, include quite detailed information. For example data on bought-in inputs, employment costs and sales are

[19] The North American Industry Classification System (NAICS) and the International Standard Industrial Classifications (ISIC) includes but the Statistical Classification of Economic Activities in the European Community (NACE) excludes enterprise groups. Generally, classification in official statistics follows the primary activity of the largest entity.

included. With this information we may illuminate the intricacies of servicification in manufacturing. Generally, micro level data is to be preferred over I-O data when in-house production is of interest.

It can be added that with the method we use for industrial classification, enterprise groups may be reclassified. For example, a manufacturing enterprise group will eventually be reclassified as a services enterprise if the relative weight of its services firms in the enterprise group grows over time. Yet, tests with an alternative industry classification method that classify an entity once and for all at the time of establishment do not change the conclusions in the paper and results differ only slightly in numbers. For example, manufacturing employment contracts slightly less than otherwise.

4.2 Data description

In table 3, data summary statistics for 2006 is provided. In rough numbers, 660,000 firms are included in the firm level dataset. Of these, there are some 35,000 parents with 51,000 subsidiaries, while the remainder are stand-alone firms. About four percent of firms export merchandise and five percent import merchandise. This may seem low but is due to the inclusion of the large number of micro firms and small firms in the datasets. Small firms are known to participate less in foreign trade than larger firms. However, if only manufacturing is considered, trade participation is much higher, some 14 percent.

Even though only 13 percent of all firms are part of an enterprise group, enterprise groups account for 75 percent of value added and 69 percent of employment in 2006. (Their share is even higher in manufacturing, representing 90 percent of value added and 82 percent of employment.) Enterprise groups also trade much more frequently than stand-alone firms. 33 percent of enterprise groups import merchandise and 37 percent of them export. Thus, enterprise groups account for the lion's share (93 percent) of foreign trade.[20]

[20] Table available upon request.

Table 3: Descriptive statistics for enterprise groups and all firms, 2006

	Enterprise groups only		All firms	
	Total	Share	Total	Mean
No Employed	1,580,205	69	2,302,678	3.5
Value added	1,210,149,660	75	1,615487,602	2 ,447.1
Sales	4, 567,422,949	79	5,806,030,800	8,794.9
Trade*	1,683,814,906	93	1,810,034,636	4,488.7
No importers*	11,223	33	34,152	na
No exporters*	9,384	37	25,356	na
No Units	34,607	5	660,172	na

Source: SBS, RAMS, FTS, Statistics Sweden, own aggregation and calculations.
Note: Values in 1,000 SEK. "" means that only merchandise is considered.*

V. RESULTS - SWEDISH MANUFACTURING SINCE THE 1990s: DECLINE AND SERVICIFICATION

In this section, we discuss results from our analysis of Swedish firm and enterprise group level data for the period of 1997 to 2006. Focus is on the extent of servicification in Swedish manufacturing. However, we start out by revisiting the issue of the industry's decline.

5.1 Manufacturing declines

Our data confirms that manufacturing's share in the Swedish economy has declined also during the 1997-2006 period, while the services share has expanded.[21] Manufacturing's share of total employment in the private industry has fallen by 19 percent, from 35.4 to 28.7 percent, according to firm level data in table 4. A drop is also shown in manufacturing's share of the total value added in the private sector, primarily in the late 1990s. Enterprise group level data displays a somewhat smaller fall in the share of employment and the share of value added contracts much less and from a lower level, table 5. The lower share of manufacturing in enterprise group level data is due to manufacturing enterprise groups being classified as services enterprise groups in the study if their main activity is in services.

To conclude, the downward trend for manufacturing visible in Sweden's national accounts since the early 1970s continues. However, the decline is

[21] Manufacturing is comprised of SNI-industries 10-37 and services of the rest, while 65-67 (financial services), 75 (public administration, defence and compulsory social security), 95 (household activities) and 99 (extra-territorial organisations) are excluded from our population. (SNI corresponds to NACE at this level.)

smaller when the manufacturing industry's services firms are considered. Those firms are classified as manufacturing in enterprise group level data but not in firm level data. It is possible that outsourcing may account for another part of the contraction. It can be added that manufacturing still dominates the Swedish economy in some other respects. For example, the industry continues to account for the major share of private R&D in Sweden, and this applies even if we disregard R&D in the manufacturing parents of services firms.[22]

Table 4: Firm data: Shares of total value added and employment 1997-2006, percent

	1997	1999	2001	2003	2005	2006
Manufacturing						
Value added	36.3	34.8	31.8	31.9	32.0	32.0
Employment	35.4	34.1	32.1	31.1	29.8	28.7
Services excl finance						
Value added	63.7	65.2	68.2	68.1	68.0	68.0
Employment	64.6	65.9	67.9	68.9	70.2	71.3

Source: SBS and RAMS, Statistics Sweden, own aggregation and calculations.

Table 5: Enterprise group data: Shares of total value added and employment 1997-2006, percent

	1997	1999	2001	2003	2005	2006
Manufacturing						
Value added	32.9	32.8	28.9	33.1	31.6	31.0
Employment	31.9	32.9	28.1	31.6	28.8	27.6
Services excl finance						
Value added	67.1	67.2	71.1	66.9	68.4	69.0
Employment	68.1	67.1	71.9	68.4	71.2	72.4

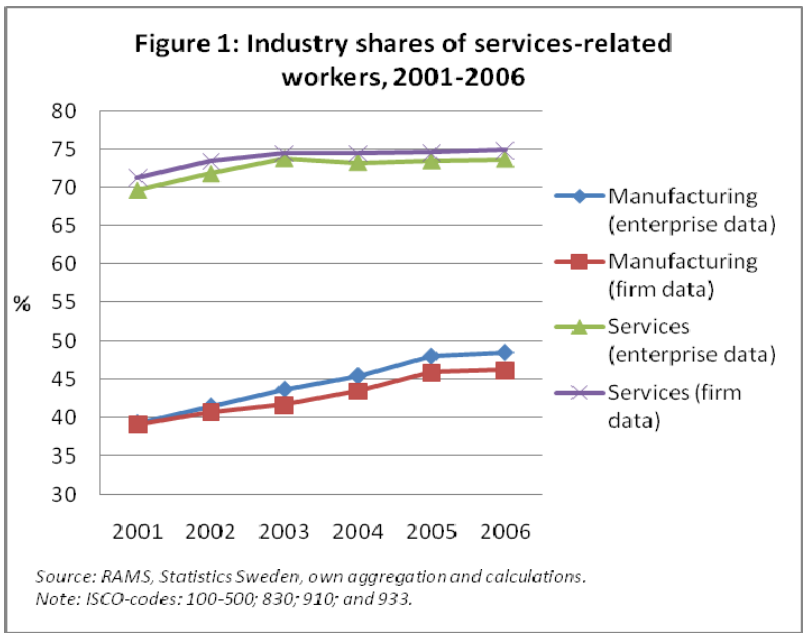
Source: SBS and RAMS, Statistics Sweden, own aggregation and calculations.

5.2 Manufacturing uses more services

As for an earlier period in several OECD-countries (Pilat *et al*, 2006), we find a substantial rise in manufacturing's share of employees in services-related occupations: from 39.1 percent of those employeed in manufacturing in 2001 to 46.2 percent in 2006, figure 1.[23] This corresponds to an 18 percent rise and can be compared with a 5 percent rise in the services sector. Looking at enterprise group data, an even more pronounced increase is noted in manufacturing.

[22] Own R&D expenditure of firms, by industry, current prices, 1997-2007, Statistics Sweden.
[23] Services-related occupations are defined to include these ISCO codes: 100 (legislators, senior officials and managers); 200 (professionals); 300 (technicians and associated professionals); 400 (clerks); 500 (services workers and shop and market sales workers); 830 (drivers and mo-

As a result, almost half (48.5 percent) of those employed in manufacturing in 2006 were in services-related occupations.[24] It can be added that large business entities have a much larger share of employees in services-related occupations than smaller entities do. The share in large manufacturing enterprise groups is more comparable with the one in micro businesses of the services industry than in smaller manufacturing enterprise groups (table A1).



Additionally, we analyse the overall trend in educational composition in manufacturing. This is interesting more generally, as regards the character of manufacturing, and is also related to classification of foreign trade into qualified and less qualified trade later in this paper. Firm data shows that the share of employees with post-secondary school education or higher has risen in the manufacturing industry. The share is up by 37 percent, from 17.5 to 23.9 percent between 1997 and 2006, according to table 6 and firm level data. Enterprise group data shows an even stronger rise (39 percent). In the services industry the rise is lower (some 35 percent), both according to firm and enterprise group data.

Next, we analyse expenditures in Swedish manufacturing. Costs for goods and raw materials together with remuneration to blue collar workers constitute “goods input costs”, whereas costs for bought-in services plus remuneration to white collar workers constitute “services input costs”.

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bile plant operators); 910 (sales and service elementary occupations); and 933 (transport labourers and freight handlers).

[24] Of all service-related jobs in Sweden, some 19 percent were in manufacturing.

Table 6: Industry shares of employees with higher education 1997-2006, percent

	1997	1999	2001	2003	2005	2006
Manufacturing						
Firm	17.5	18.4	20.1	21.8	23.3	23.9
Enterprise group	17.7	18.8	18.5	22.5	24.0	24.6
Services excl finance						
Firm	21.3	22.9	25.3	26.4	27.9	28.7
Enterprise group	21.0	22.7	25.7	26.0	27.6	28.4

Source: RAMS from Statistics Sweden, own calculations.

The results show that services input costs account for an increasing share of manufacturing's expenditures, and the same applies to services being produced in-house. Furthermore, at the enterprise group level, the difference is narrowing between the manufacturing and services industries in terms of the input mixture of services and merchandise. Still, services continue to be a relatively small component in manufacturing compared to merchandise. (It can be added that only direct services costs are included in this study, that is, the numbers would be even larger if services used for producing intermediate goods bought by the firm or enterprise group were also considered.)

According to table 7,[25] services costs have risen and represented 32 percent of total (variable) input costs in 2006 at the enterprise group level.[26] The rise is in line with developments in industrialised countries in the late 20th century (Pilat and Wölfl, 2005), and with recent evidence for Sweden (Hagman and Lind, 2008), using I-O tables.

Our micro-data also includes information on in-house services production costs, using labour remuneration as a proxy. While still only accounting for roughly a quarter of the total costs for services input into manufacturing (figure 2), in-house services input costs are higher in 2006 than in 2001 as a percentage of total input costs (table 7).[27] According to firm level data manufacturing has substituted in-house services for external services. Meanwhile,

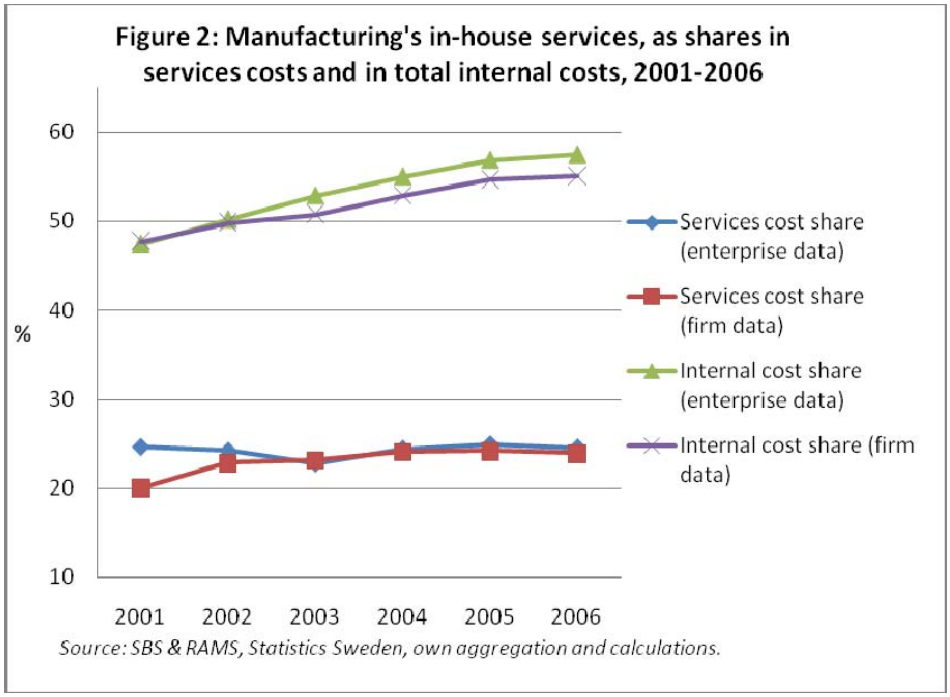
[25] Please note that costs of internally sourced inputs only are available from 2001. In the preceeding years, only costs for externally sourced inputs are presented.
[26] The services industry's small services input share is explained by the domination of the group of other services over the group of business services in the industry and by the fact that the merchandise input share is large in the group of other services.
[27] There is a drop in manufacturing's cost share of externally sourced services between 2001 and 2006 (firm level data). This indicates that internal services are substituted for external services. However, external services costs have risen in absolute terms.

manufacturing's share of in-house services costs in total costs for *internally* sourced inputs has risen, figure 2. (This is particularly pronounced in enterprise group level data, where the in-house services cost share is up 21 percent, from 47 percent in 2001 to 58 percent in 2006.) The rise in the relative importance of in-house services in manufacturing means that services in general, rather than merely being outsourced, increasingly are characterising manufacturing's in-house activity.[28]

Table 7: Industries' services costs as share of total input costs 1997-2006, percent

	1997	1999	2001	2003	2005	2006
Manufacturing						
Firm	29.7	33.7	36.3	34.6	33.5	32.7
In-house			*7.3*	*8.0*	*8.1*	*7.8*
Enterprise group	29.5	31.6	30.4	34.2	33.4	32.0
In-house			*7.5*	*7.8*	*8.3*	*7.9*
Services excl finance						
Firm	32.7	33.3	40.5	43.8	44.4	39.8
In-house			*10.6*	*11.0*	*10.9*	*10.8*
Enterprise group	32.7	34.3	42.2	44.3	44.4	40.0
In-house			*10.3*	*11.2*	*10.9*	*10.8*

Source: SBS and RAMS data from Statistics Sweden, own calculations.
Note: Only externally sourced inputs available for 1997-2000.



[28] That bought-in services have become more expensive in relation to other externally sourced inputs might explain part of the rise in the services cost share. However, employment in services-related occupations has gone up in manufacturing too. This confirms that in-house services activities are becoming increasingly important in manufacturing.

Next, we study the composition of manufacturing's expenditures for in-house services production. This is done by dividing costs for employees in services-related occupations into costs for qualified and less qualified workers. Qualified occupations is defined here as managers, professionals, technicians and associated professionals.[29]

We find that manufacturing is not merely using more services in general than before, and in comparison with the services industry, but it is also spending increasingly more on qualified than on less qualified services professionals. The share of manufacturing's costs share for qualified services-related employees has risen by some 6 percent between 2001 and 2006 while it has fallen by 25 percent for other workers, according to enterprise group data, see table 8. The rising importance of qualified services professionals in manufacturing is also reflected in the employment numbers, figure 3.[30]

Table 8: Qualified and less qualified services produced in-house as shares in total costs 2001-2006, percent

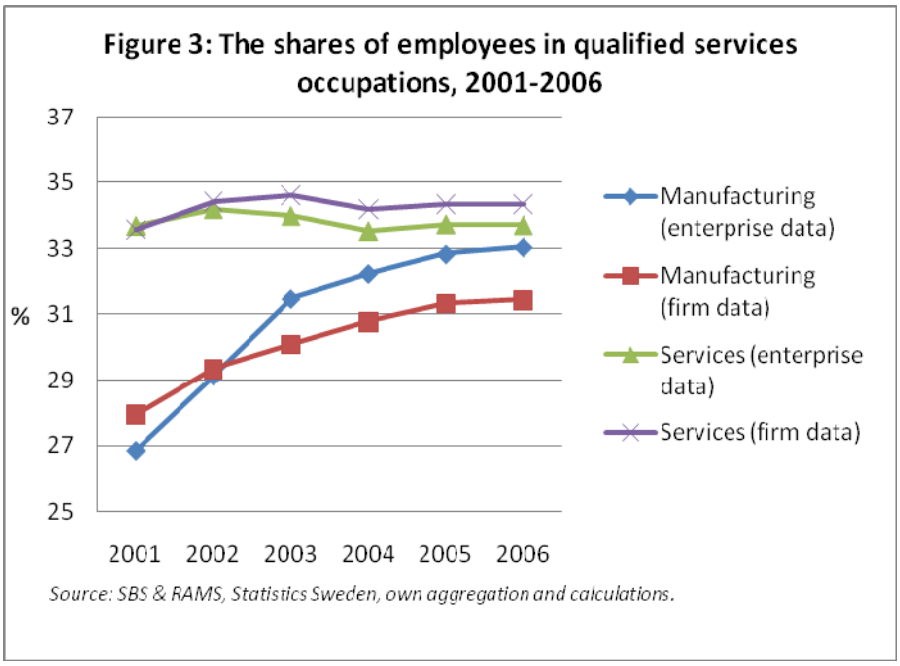
	2001	2003	2005	2006
Manufacturing				
Qualified				
Firm	5.9	6.6	6.5	6.2
Enterprise group	5.9	6.4	6.7	6.3
Less qualified				
Firm	9.3	9.2	8.4	7.9
Enterprise group	9.9	8.3	8.0	7.4
Services excl finance				
Qualified				
Firm	6.6	6.8	6.7	6.6
Enterprise group	6.6	6.8	6.6	6.6
Less qualified				
Firm	6.8	6.8	6.8	6.7
Enterprise group	6.8	7.1	7.0	6.9

Source: SBS and RAMS, Statistics Sweden, own aggregation and calculations. Note: ISCO-codes: qualified (100-300) and less qualified (400-500; 830; 910; and 933) services.

To conclude, the pattern that emerges in manufacturing is one where services and qualified in-house services are becoming increasingly important. Services also constitute an ever-larger share of costs for internally sourced in-

[29] Qualified services occupations are defined as those belonging to ISCO-codes 100-300 while less qualified services occupations are those belonging to codes 400-900.
[30] The trend is especially pronounced in engineering and, as regards services industries, the trend is visible in business services, table availble upon request.

puts. This fits with the upward trend in imports of intermediate goods noted in the literature as well as in this study (see e.g. Falk and Koebel, 2002; and Grossman and Rossi-Hansberg, 2008a).[31]



As regards *bought-in* services in manufacturing, our data does not allow us to decompose them into qualified and less qualified services. However, ITPS (2008) finds that non-personal services industries in Sweden now have more than twice the employment share they had in 1970. In 2005, a substantial share of the employment in several producer services branches was related to demand in manufacturing; this applied to transportation, travel services, post- and telecommunications, real estate, R&D as well as other business services (Hagman and Lind, 2008).

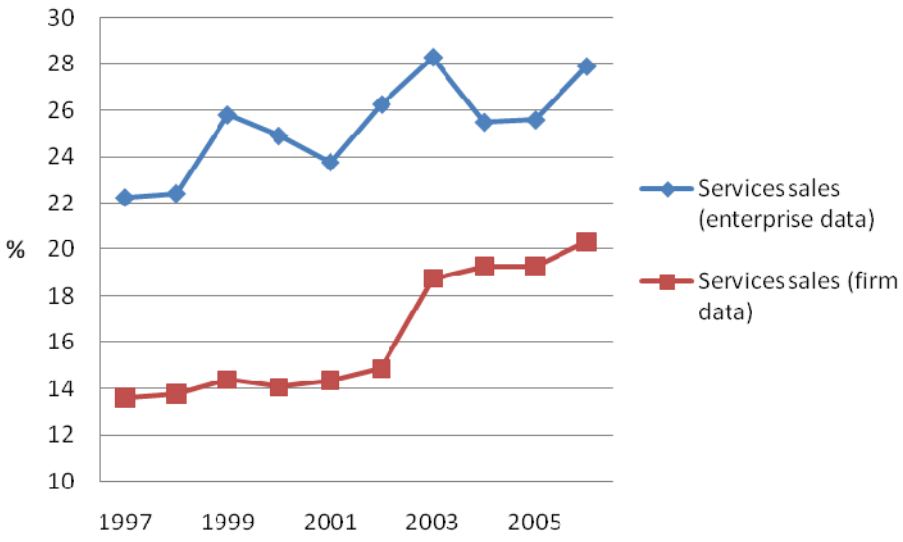
5.3 Manufacturing sells more services

The process of the services diversification indicated earlier for Swedish manufacturing continues but it is stronger than shown previously (Pilat and Wölfl, 2005).[32] Manufacturing's sales of services have gone up by half, from 13.6 to 20.3 percent of total sales over the 1997-2006 period, according to firm level

[31] Tables available upon request.
[32] A firm's services sales data in any year is survey-based if included that year, or else imputed either from information of the preceding year, if available, or from the industry average at the stratum level (four-digit SNI-code).

data, figure 4. This rise is to a large extent explained by the growth of services shares in engineering and changes there in 2002/2003. However, when all of manufacturing's subsidiaries are included, we find a somewhat weaker but smoother and more general upward trend (up 25 percent), and from an initially much higher level (22 percent) than in firm level data (14 percent). The services sales share level in manufacturing is still higher if stand-alone firms are disregarded. With respect to the trend over time, manufacturing's slightly weaker increase in enterprise group data (compared with that in firm data) is nevertheless five times as large as the rise in the services industry, 25 versus 5 percent.

Figure 4: Manufacturing's services sales, as shares in total turnover, 1997-2006



Source: SBS, Statistics Sweden, own aggregation and calculations.

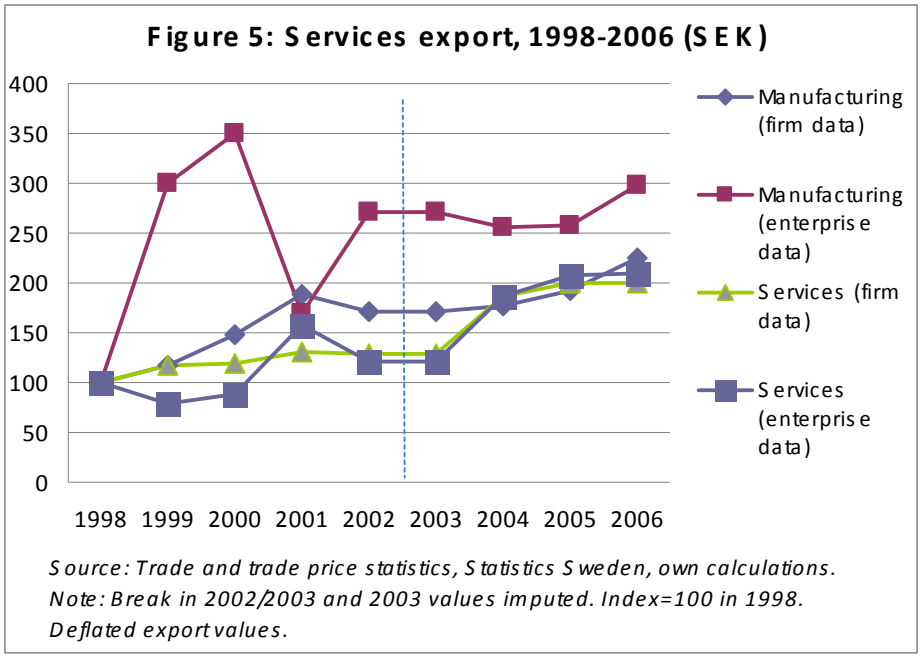
As regards types of services offered by manufacturing business, wholesale, retail and repair dominate with some 79.6 percent, but computer and related services are up from 3.6 to 6.6 percent of services turnover (table A2).[33]

One might have expected that the move towards services diversification would be relatively stronger in the enterprise group dataset than in the firm level dataset. One reason for the differing degrees of moves towards services

[33] Services sale by product is a survey-based variable. Other industrial services include services such as installation of sold products and repair of machinery for industry.

diversification in the two datasets might be that sales of services at the enterprise group level take place instead in enterprise groups' firms abroad.[34]

Evidence of manufacturing's services diversification is also apparent in exports.[35] Manufacturing's services exports have risen substantially between 1998 and 2006. The rise is higher than in the services industry and especially pronounced in enterprise group data, see figure 5.[36] Furthermore, we analyse the "skills-content" of trade. Products are divided into qualified and less qualified products, drawing on skills classifications of industries (O'Mahony and van Ark, 2003; and Peneder, 2007).[37] The pattern for overall services exports also applies to the export of qualified services, table A3.[38]



5.4 Servicification across manufacturing industries

Finally, we create an index on servicification in order to get an overall indication of the phenomenon across manufacturing industries, table 14. The index ranges between zero and one, where zero means that an industry ranks the low-

[34] Letting an entity be classified into an industry once and for all at the time of establishment, results only in slightly higher initial levels and somewhat slower growth in services sales.
[35] Services trade is a survey-based variable after 2002.
[36] Services exports are likely to be underestimated in a sense, since much of multinational's services production and sales take place via local presence. Local presence is particularly advantageous for services delivery, e.g. because of language and cultural barriers.
[37] Qualified products are products of high-skill services industries, which, in turn, are industries dominated by occupations requiring high or very high skilled labour.
[38] Manufacturing's imports of services are also up; and more so in enterprise group data, due to an increase in qualified services imports. The basic industry's services trade value is down. It can be added that merchanting and tourism are excluded from our trade data.

est among manufacturing industries in both services use and services sales and one that the industry ranks the highest in both respects. To be specific, the index value is the simple mean of the (normalised) services shares in total costs and in total sales.[39]

The pattern that emerges is one where servicification is spread across manufacturing industries. The medicines industry and the coke, refined petroleum, nuclear and chemicals industry stand out as the most servicified ones, while the basic metals and fabricated metals products industry as well as the other electrical machinery and apparatus industry are the least servicified ones. The most servicified manufacturing industries resemble business services industries as regards services and qualified services cost shares. They also have high shares of qualified services sales compared to many other manufacturing industries. It can be mentioned that the relatively low ranking for the ICT equipment industry is a result of its very low services sales share. Meanwhile it is the number one services user. Morover, its qualified services share is the third highest in manufacturing.

Table 9: Servicification index for manufacturing industries, 2006 (enterprise group data)

Industry	Index	Use of services	Sale of services
Medicines	0.82	0.49	0.21
Coke, refined petroleum, nuclear and chemicals	0.73	0.54	0.15
Furniture, manufacturing n.e.c. and recycling	0.62	0.47	0.13
Mining and quarrying	0.61	0.59	0.09
Rubber and plastic products	0.60	0.38	0.14
Textiles and leather and their products	0.54	0.60	0.06
ITC equipment	0.54	0.76	0.02
Pulp, paper, publishing and printing	0.43	0.55	0.03
Medical, precision and optical instruments	0.43	0.24	0.11
Other transport equipment	0.41	0.25	0.10
Non-metallic mineral products	0.38	0.45	0.04
Other machinery, office machinery and computers	0.35	0.24	0.08
Wood products	0.34	0.29	0.06
Food, beverages and tobacco	0.33	0.08	0.11
Motor vehicles, trailers and semitrailers	0.33	0.16	0.09
Other electrical machinery and apparatus	0.31	0.09	0.10
Basic metals and fabricated metal products	0.23	0.22	0.03

[39] Normalisation is done to give the same weight to services use and services sale in the index. The procedure means that an industry's services share in costs (or sales) is divided by the maximum services cost (or sales) share in any manufacturing industry.

Source: SBS, Statistics Sweden, own aggregation and calculations.

Note: Col's 3 and 4 contains shares in totals, while the index is the mean of the normalised values of these shares.

VI. CONCLUSIONS AND FINAL REMARKS

We conclude that Swedish manufacturing is changing character – it is being servicified. This finding confirms what case studies have indicated. It also fits well with what is expected from the literature.

On the input side, our I-O analysis shows that externally bought-in services now accounts for a much larger share of the production value than three decades ago. Imports have also become more important for private business. Yet, recent micro-data shows that the rise in bought-in services in manufacturing is not matched by a fall in the industry's own services costs. To the contrary, in-house services, and in-house qualified services in particular, increasingly dominate manufacturing's costs. Enterprise group level data shows that nearly 50 percent of manufacturing's employees are in services-related jobs. More than two-thirds of them are in qualified services-related jobs.

On the output side, manufacturing's share of services sales and its services exports are up since the late 1990s. Moreover, we show that sales of services are much greater (almost 60 percent higher) when all activities in manufacturing's enterprise groups are considered. This has not been shown for a European country before. It means that when we consider enterprise groups, the large discrepancy in manufacturing's services diversification between Canada and other OECD countries vanishes, at least for Sweden.

When both the use and sales of services is taken into account – through the creation of a servicification index – it is clear that servicification is unevenly spread across manufacturing industries. The most servicified manufacturing industries resemble business services industries. They also sell relatively much of qualified services when compared with other manufacturing industries.

The analysis illustrates the added value of data at the enterprise group level when studying servicification and other structural economic changes. This is the result of enterprise groups becoming more prominent. In Sweden, they accounted for 69 percent of employment, 75 percent of value added and 93 percent of foreign trade in 2006. In the absence of official data and industry classifications at this level, we have used a simple method for industry classifi-

cation of enterprise groups and then aggregated firm level data to the enterprise group level. Yet, for the future, official enterprise group data or at least an official industry classification of them according to activity would be welcome.

Furthermore, the study confirms that manufacturing's share of the Swedish economy continues to fall. This finding also holds when we include all subsidiaries of manufacturing enterprise groups but the decrease is smaller than otherwise. The smaller fall in enterprise group level data is due to the fact that manufacturing industry's services firms are included at that level while excluded in firm level data. The fundamental reason behind the less pronounced fall at the enterprise group level may be either that manufacturing firms are unbundling or that the services firms of manufacturing enterprise groups are expanding, or a combination of these two explanations. More generally, outsourcing and offshoring may be responsible for another part of the decline in manufacturing but this is difficult to substantiate in the absence of additional data.

Turning to the implications of our findings, the servicification of manufacturing, means that treating services and manufacturing separately – e.g. in trade policy formation and negotiations – may be out-of-date in an industrialised country such as Sweden. Services trade barriers are likely to significantly affect manufacturing. Manufacturing substantially and increasingly uses offshore services and itself provides services abroad, often in combination with manufactures. This underlines the importance of liberalising trade in services. Furthermore, attention should be paid to the interdependence of manufacturing and services industries in analysis of international trade.

It can be added that these trends rely on the present distribution of factors of production across countries and industries and cannot be taken for granted. Industrialised countries such as Sweden may only continue their functional specialisation in high value added services and manufacturing activities if their competitive advantages of highly skilled labour and advanced technologies remain. Skills and technologies are in turn positively related to trade, investment and migration. Openness is therefore key for the firms of industrialised countries, which are ever more fragmented internationally.

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ANNEX 1: ADDITIONAL TABLES

Table A1: Enterprise group data: Industry shares' of service-related employees, 2006, %, by size

Manufacturing	
Micro	39.4
Small and Medium-sized Enterprises	39.3
Large	54.3
Services excl finance	
Micro	64.0
Small and Medium-sized Enterprises	74.9
Large	80.3

Source: RAMS, Statistics Sweden, own aggregation and calculations.

Table A2: Enterprise group data: Services sales by service products 2003-2006, percent

	2003	2004	2005	2006
Manufacturing				
Wholesale, retail and repair	84.0	75.3	76.6	79.6
Hotels and restaurants	0.1	0.1	0.0	0.0
Transport, storage and other communication	3.1	3.7	3.6	3.2
Post and telecommunications	0.1	1.0	0.3	0.3
Financial services	0.0	0.0	0.1	0.1
Real estate and renting	2.3	3.3	2.2	2.4
Computer and related activities	3.6	6.1	7.9	6.6
Research and development	2.4	3.1	3.3	3.0
Other business activities	3.3	5.5	4.9	3.8
Education; and health and social work	0.0	0.1	0.1	0.0
Other community, social and personal services	0.8	1.7	0.9	0.9
Other industrial services	0.2	0.0	0.1	0.0
Services excl finance				
Wholesale, retail and repair	59.1	55.3	56.3	58.8
Hotels and restaurants	1.0	1.3	1.2	1.1
Transport, storage and other communication	12.4	13.2	11.9	11.7
Post and telecommunications	5.9	5.3	5.4	5.1
Financial services	0.2	0.0	0.0	0.0
Real estate and renting	7.1	6.8	7.2	5.8
Computer and related activities	2.6	3.3	3.5	3.3
Research and development	0.2	0.3	0.2	0.1
Other business activities	6.1	8.1	8.2	8.4
Education; and health and social work	2.0	2.5	2.3	2.1
Other community, social and personal services	3.3	3.9	3.7	3.4
Other industrial services	0.1	0.0	0.0	0.1

Source: SBS, Statistics Sweden, own aggregation and calculations.
Note: Services related to SNI 40-45; 65-67 and 75 are excluded.

Table A3: Qualified services export values 1998-2006, index=100 in 1998

	1998	2000	2002	2004	2006
Manufacturing					
Firm	100	153	177	188	241
Enterprise group	100	376	293	276	333
Services excl finance					
Firm	100	128	153	222	236
Enterprise group	100	86	131	226	260

Source: Trade and trade price statistics, Statistics Sweden, own aggregation and calculations. Note: Deflated export values. Break in the series 02/03 and 2003 values imputed. Services classification draws on O'Mahoney & van Ark (2003) and Peneder (2007).

ANNEX 2: MORE ON DATA AND METHOD

Data

Data for chapters 4 and 5 of the study comes from Statistics Sweden and covers 1997-2006. The resulting unbalanced micro panel database encompasses all firms in Sweden except for firms in the primary, financial and core public sectors.[40]

Core financial information comes from the Swedish Structural Business Statistics (SBS). The SBS is based on data of the Swedish Tax Authority but is supplemented by survey data for some variables as well as for the largest firms. A firm is generally defined as the smallest legal entity. However, there are some 50 "composite firms" who report for more than one legal entity within the same enterprise group.[41] Industry affiliation of firms and entities is from the Business Register and is done using the Swedish standard industrial classification (SNI 2002). SNI 2002 corresponds to NACE (rev. 1.1) up to 4-digit level. The Swedish product classification by activity (SPIN 2002) is also used. It can be described as an industry classification of products and corresponds to Eurostat's Classification of Product by Activity (CPA), at the 4-digit level.

Information on enterprise affiliation comes from the Swedish Enterprise Group Register (EGR). Data has been collected by Statistics Sweden and PAR AB. An enterprise group is defined as a group consisting of a parent firm and at least one additional firm, where the parent holds the absolute and therefore controlling majority (>50%) of the stocks.[42]

Statistics on the highest education attained for each resident aged 16-74 comes from the register based labour market statistics (RAMS). Since 2001 RAMS also contains information on number of employees, their occupation and remuneration.

Foreign trade data is from the Swedish Foreign Trade Statistics (FTS). It includes value (SEK) and country of origin or destination. With respect to merchandise trade with non-EU countries, data comes from compulsory registra-

[40] That is, SNI-industries 01-05; 65-67; 75; 95; and 99 are excluded.
[41] For 2006, 55 "composite firms" enclosed 1071 other legal entities.
[42] In 2006 about 70 percent of firms in the EGR were in Swedish-only groups, 17 percent in foreign ones and 13 percent in Swedish multinationals.

tion information of the Swedish Customs. As regards intra-EU merchandise trade, data covers the trade of all firms with an annual imports or exports of 2.2 and 4.5 million SEK, respectively.[43] For services trade, all collated bank transactions larger than 150,000 SEK crossing the Swedish border are included before 2003. Since 2003 data is based on a quarterly survey. A representative sample of some 5,000 services traders is included in the survey – 10 percent of the population – and a third of the sample is replaced each year.[44]

The enterprise group level dataset

Analysis in chapters 4 and 5 is partly based on data at the enterprise group level. Below, we account for the construction of that dataset.

The first step is to classify the firms of an enterprise group in any one year as belonging to the manufacturing or services industry, based on industry classification at the firm level.[45] (For the industries of the study, see table A8.) The industry with the largest value added, sales and number of employees (in consecutive order) determines the overall classification of the enterprise group.

In the second step, the largest two-digit industry of the dominating overall industry in the enterprise group is identified. That two-digit industry decides the classification of the whole enterprise group at that level and year, using the same parameters as in the first step. (The choice of value added as the key parameter in this process is made in line with practice in North America.[46])

Finally, when all enterprise groups have been classified according to industry, firm level data is aggregated to the enterprise group level. This is the study's enterprise group level dataset.

It can be mentioned that Swedish and foreign multinational enterprises (MNEs) are treated no differently in this scheme. However, due to the lack of data on foreign activities and industry classification elsewhere, enterprise groups established in Sweden are by necessity considered on their own.

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[43] Earlier limits for exports and imports being covered were SEK 1.5 million (1998-2004) and SEK 0.9 million (1995-1997). For trade via another EU member, information on the actual sender or receiver is unavailable.

[44] Data for travel funds and some government authorities are reported separately by the Central Bank to Statistics Sweden.

[45] SNI 2002-based classification, corresponding to NACE Rev. 1.1 and ISIC Rev. 3. The primary, financial and core public sector industries are excluded.

[46] www.statcan.gc.ca/subjects-sujets/standard-norme/naics-scian/2002/naics-scian-02intro-eng.htm#a12. Using the no. of employees as a key parameter changes results only marginally.