The Role of Services in the Structure of Production and Trade: Stylized Facts from a Cross-Country Analysis *

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Executive Summary

Services dominate the economic landscape of the post-industrial OECD economies, typically accounting for between 60 and 70 percent of employment and a comparable share of GDP. Growth of the service sector is also recognised to be an important aspect of economic development and is strongly associated with income growth and economic modernisation. Explanations for the importance of services in modern economies, relative both to low-income countries and to historic patterns within OECD countries themselves, have emphasised demand-side factors. Yet, while emphasis in the services literature has been placed on final expenditure patterns and prices, some of the most striking aspects of service sector growth relate instead to the relationship of services to the production structure of economies, and particularly the relationship of the service sector to manufacturing.

In this paper, we explore the role of services in the structure of production and trade. Our basic objective is to develop a set of empirically-based stylised facts. Working with a sample of national income data for 15 countries, we explore upstream and downstream service linkages and their relationship to changes in income levels and the input-output structure of production. The analysis provides five results which we interpret as stylised facts.

(i) Income levels are positively associated with employment shares for intermediate services and with the share of indirect labour in total manufacturing employment.

(ii) The share of value added originating in services, including both private services and trade, transport, and communications services, is also positively linked to the level of development.

(iii) Income levels are strongly linked to demand by firms for intermediate or producer services, particularly in manufacturing.

(iv) While changes in the allocation of non-production (i.e. service) activities between manufacturing and service firms may explain a small share of service sector growth, the basic story seems instead to be one of fundamental changes in the structure of production.

(v) The importance of services for export performance depends on the level of development. As we move from the middle-income to upper-income range of our country sample, private services and trade, transport, and communications services become the most important sectoral elements of exports via interindustry linkages.

The last result relates to the economic structure of the OECD economies. While their exports are concentrated in manufactures, their economies are concentrated in services. At the same time, however, our results serve as a reminder that, in terms of the intermediate structure of production, services are a major aspect of production, even for exportables. Hence, while Japan's exports in material terms are concentrated in transport equipment and other machinery and equipment, the activity composition of Japanese exports is actually concentrated in services, which are almost 50 percent again more important than transport equipment and machinery and equipment on an activity basis. Similar patterns hold for Canada, the European Union, and the United States. Even for middle-income countries such as Korea, the significance of the service sector for overall exports is much greater than the direct trade balance suggests.

Introduction

Services dominate the economic landscape of the post-industrial OECD economies, typically accounting for between 60 and 70 percent of employment and a comparable share of GDP. Growth of the service sector is also an important aspect of economic development and is strongly associated with income growth and economic modernisation. Explanations for the importance of services in modern economies, relative both to low-income countries and to historic patterns within OECD countries themselves, have emphasised demand-side factors. Clark (1940) was the first to note a rising share of services associated with economic growth and attributed this to demand side factors. A related issue emphasised by Clark and later by Kravis, Heston, and Summers (1982) is the correlation between final-expenditure service prices and income levels. The theoretical literature on income-price linkages includes Balassa (1964), Samuelson (1964), Bhagwati (1984a, 1985), and Panagariya (1988). Also in this vein, Baumol *et al.* (1985) relate the pattern of rising service prices to relative productivity differentials.

While emphasis in the services literature has been placed on final expenditure patterns and prices, some of the most striking aspects of service sector growth relate instead to the relationship of services to the production structure of economies, particularly the relationship of the service sector to manufacturing. As discussed in the later sections of this paper, the cross-country pattern of employment and GDP shares for producer services (services employed as intermediates in production) is strongly correlated with income levels. The share of producer services in total intermediate demand by manufacturing firms is also linked to income levels. Katouzian (1970) and Greenfield (1966) have argued that we should expect to find that the demand for producer services grows with development. Both Katouzian and Francois (1990) link this expansion to growth in round-about production and the associated conversion of local markets into national markets. Alternatively, Bhagwati (1984b) has suggested that such producer service growth may simply be related to "splintering", wherein service activities once performed within manufacturing firms are spun off to specialised service providers.

Past empirical evidence on the rise of the service sector was indirectly provided by Chenery and Taylor (1968) through their examination of GNP shares for agriculture and manufacturing. Park (1989), Park and Chan (1989), and Uno (1989) empirically confirmed rising service inputs into manufacturing. The decline in manufacturing employment and the shift to service sector employment in the post-war period has been well documented (e.g. Sachs and Schatz, 1994, Francois, 1990, and Dighe, Francois, and Reinert, 1995).

In this paper, we explore the role of services in the structure of production and trade. Our basic objective is to develop a set of empirically-based stylised facts. Working with a cross-country sample of national income data for 15 countries, organised as a set of social accounting matrices, we explore upstream and downstream service linkages and their relationship to changes in income levels and the input-output structure of production. The analysis provides five results which we interpret as stylised facts. First, the employment shares of services increase with the level of development, and within manufacturing there is an increase in indirect labour (manufacturing labour engaged in non-production activities). Second, both value added in commercial services relative to manufacturing value added and intermediate demand for commercial services relative to intermediate demand for manufacturing rise with per capita income levels. Third, the relative economy-wide importance of services is related to expansion of private-sector intermediate demand for services and particularly to increased demand in the manufacturing sector for service inputs. Fourth, while changes in the allocation of non-production activities between manufacturing and service firms may explain a small share of service sector growth, the basic story seems instead to be one of fundamental changes in the structure of production. Finally, the embodied service component of exports is also linked to the level of development, with the exports of the high income countries including the greatest level of embodied services.

National income data

We work with national income data organised into social accounting matrices (SAMs). The SAM is a form of single-entry national income accounting, where incomes or receipts are shown in the rows of the SAM while expenditures or outlays are shown in the columns.[1] This structure provides a comprehensive and consistent record of national income accounting relationships between different sectors and regions. It is based on a fundamental, general equilibrium

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[1] The basic principles of SAMs, with application to trade policy modelling, are summarised in Reinert and Roland-Holst (forthcoming).

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principle of economics -- every income (receipt) has a corresponding expenditure (outlay). The strength of this framework is that it provides a comprehensive and consistent record of the interrelationships of an economy, including intermediate and final demand linkages. For our purposes, it offers the advantage of linking consumption and external trade patterns explicitly to the inter-industry structure of intermediate demand. This allows for a fuller analysis than is possible when working with input-output tables. The SAMs are supplemented with data on employment from the OECD and ILO and data on purchasing power parity based income levels from the International Comparison Project (ICP) as published in the Penn World Tables (Summers and Heston; 1991, 1994).

The basic dataset includes 27-sector SAMs for 15 countries and regions.[2] Each national SAM is a 37 x 37 matrix of national economic activity, and is a combination of the matrix of inter-sectoral expenditures and additional elements for households, government, investment, and trade. The SAMs are drawn from the Global Trade Analysis Project (GTAP) dataset (Gelhar *et al.*, 1996), and represent 1992 values for production, expenditures, and trade. We will focus in this paper on the SAM sector termed *commercial services*. This sector excludes utilities, construction, trade and transportation, and public services. It includes financial services, insurance, legal services, accounting, data processing, engineering, architectural services, advertising, machinery and equipment rental, and other business services. These services are the focus of much of the literature discussed in the Introduction, and are an important aspect of intermediate demand.

Services and the structure of production

We start with the role of services, particularly commercial services, as intermediates in production, and the manner in which this role changes with the level of development. We examine the role of services in the structure of production from four points of view: employment, demand for services as intermediates, interindustry linkages, and splintering vs. changes in the structure of production.

Employment

The cross-country pattern of service sector employment is illustrated in Figures 1 and 2. Figure 1 presents employment in service sectors that serve primarily as intermediates in production (producer services).

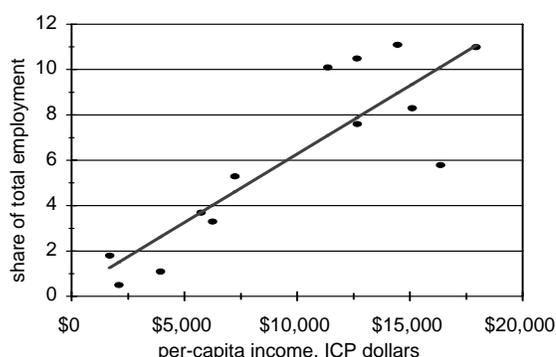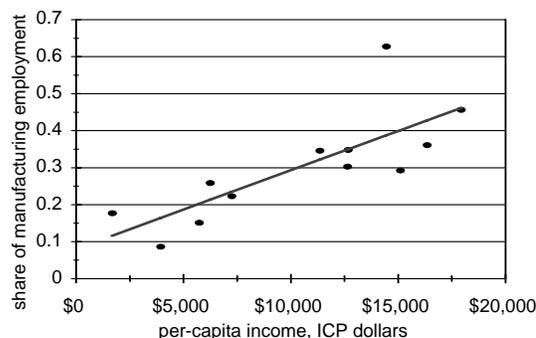**Figure 1: Producer Service Employment and GDP**

Figure 2 presents indirect or non-production labour as a share of total manufacturing employment. Indirect labour, as defined by the ILO, performs intermediate service activities (accounting, engineering, etc.) within manufacturing firms. The Appendix presents ANOVA results for the underlying data in the figures. These relate to correlation patterns between per-capita income levels measured in ICP dollars (see Summers and Heston; 1991, 1994) on the one hand, and either producer service employment shares or the indirect labour share of manufacturing on the other.

For our sample, changes in the employment share of services (and conversely negative changes in manufacturing

Figure 2: Indirect Labour Shares and GDP

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[2] The countries/regions are: Australia; Canada; China; the European Union; Indonesia; Japan; South Korea; Malaysia; Mexico; New Zealand; the Philippines; Singapore; Taiwan; Thailand; and the United States. The sectors are: grains; other crops; livestock; forestry; fisheries; primary mining; processed food; textiles; clothing; leather manufactures; wood products; pulp, paper, and printing; petroleum and coal products; chemicals; non-metallic mineral products; primary steel; primary non-ferrous metals; fabricated metal products; transport equipment; machinery and equipment; other manufactures; electricity, water, and gas; construction; trade, transport, and communications; commercial services; public services; ownership of dwellings.

employment) are positively related to income levels. Even within manufacturing, there is an apparent shift from direct production labour towards indirect labour. In other words, the rise in services employment is linked to an associated parallel shift toward service activities within the "manufacturing" labour force itself. This cross-sectional result is consistent, at least in spirit, with the findings of Berman, Bound, and Griliches (1994) on the recent historical experience of the United States. They report, over time, a rising share of skilled non-production labour employment within manufacturing which is also linked to changes in the structure of production. The importance of non-production workers in the United States is strongly linked to R&D spending and labour-saving technological change. As developed further below, the broad employment patterns we have identified here also relate to an increased use (in relative terms) of services as inputs by manufacturing firms.

Demand for producer services

An important feature of service sector growth in the OECD countries has been expansion of the intermediate service sector. Based on our social accounting data, Figures 3 and 4 present the share of the commercial services sector in value added relative to manufacturing, and the share of commercial services in total manufacturing demand for intermediates. Both are plotted relative to per-capita income. Underlying ANOVA results are again presented in the Appendix. There is a strong correlation, within our sample, between per-capita income levels, rising relative demand for services by the manufacturing sector, and a rising share for intermediate services in total value added.

Intermediate linkages

We next turn to intermediate linkages. In an earlier cross-country comparison of input-output structures, Park and Chan (1989) found that services exhibit fewer interindustry linkages overall than manufacturing. At the same time, cross-country studies of the structure of demand point to non-homothetic preferences as an important final demand factor in the growth of the service sector (e.g. Hunter and Markusen 1988, Kravis, Heston, and Summers 1985, and Cornwall and Cornwall 1994). The pattern of non-unitary income elasticities implies a demand-side shift in preferences from agriculture through manufacturing and into services as incomes rise. On net, we therefore expect a shifting pattern of production, driven both by demand and supply side changes, which will also lead to a consequent shift in the pattern of economy-wide, interindustry linkages.

Manufacturing is characterised by particularly strong intermediate linkages to other sectors, relative to both agriculture and services. With development, therefore, an initial shift from agriculture implies increased density of the intermediate use matrix (i.e. an increase in the relative importance of intermediate production linkages). This pattern may be reinforced by increased round-about production and the integration of internal markets (Katouzian 1970). With a further shift from manufacturing and into services, economy-wide density of the intermediate use matrix should fall again.[3]

To examine these production linkages, we begin by denoting a country's n x n social accounting matrix by **S** and a column unit n-vector by **e**. Then $\mathbf{c} = \mathbf{e'S}$ is the column-sum vectors of **S**. If a ^ over a vector is used to denote the corresponding n-dimensional diagonal matrix, then
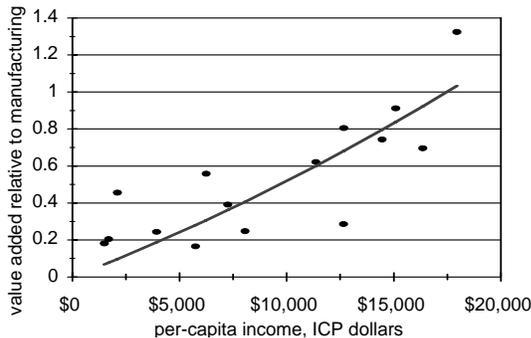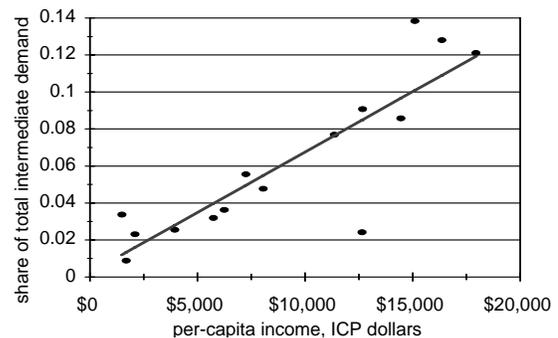
Figure 3: Commercial Services Value Added

Figure 4: Manufacturing Demand for Services

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[3] We may also expect density to fall, even within manufacturing, if development is also associated with a process of horizontal integration. We do find some evidence of such a pattern for the manufacturing sector in our data.

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$$A = S \, \hat{c}^{-1} \qquad (1)$$

represents the column-sum normalised SAM. An element A_{ij} is the proportion of sector j's expenditure received by sector i. Working with the column-normalised **A** matrix, we examine correlations between cross-country per capita income levels and the basic density of the intermediate use matrix by formally defining the linkage index D as:
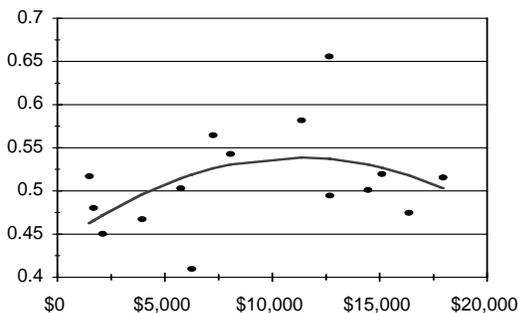
$$D = \frac{\sum_{j \in \lambda} \sum_{i \in \lambda} A_{ij}}{\sum_{j \in \lambda} \sum_{i \in \omega} A_{ij}} \qquad (2)$$

where λ is the set of industry accounts and ω is the set of industry plus value-added accounts. The index D measures the relative importance of intermediate linkages as a share of total sectoral activity.[4] It reflects the importance of backward linkages between sectors, relative to the total level of production activity. The Appendix presents ANOVA results for the relationship between interindustry SAM density and income levels. Data points and the estimated functional form are plotted in Figure 5. While there is a great deal of variability in the data, we do identify a broad pattern of rising economy-wide interindustry density through $12,000 per-capita income, and a falling-off from that point on.

Splintering vs. the structure of production
We next turn briefly to the production factors driving the apparent growth of demand for producer services, particularly with regard to demand from the manufacturing sector. Splintering refers to outsourcing of indirect production activities, and has been emphasised as a

Figure 5: Interindustry Linkages

possible explanation for the apparent growth in producer services. (See Bhagwati 1984b). As we noted in the Section I, explanations in the literature have included both (i) real changes related to a basic shift in the structure of production, or alternatively (ii) apparent changes driven instead by the outsourcing of service-type activities by manufacturing firms.
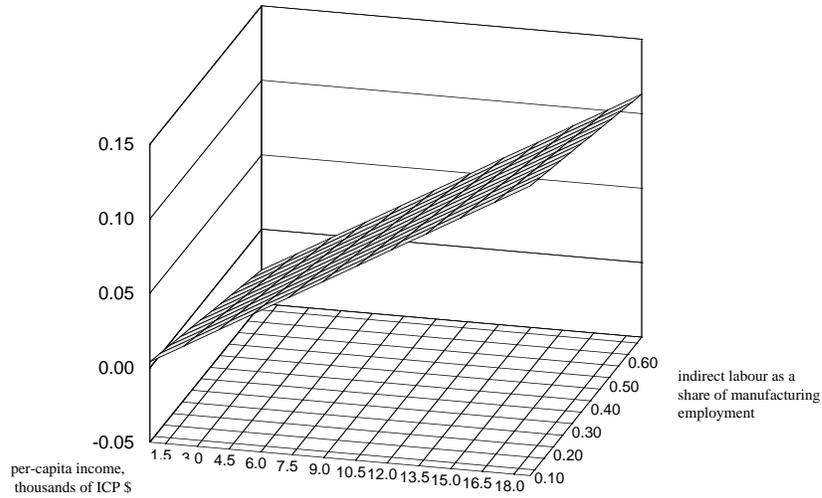
To the extent that the changes can be explained by outsourcing or shifts in the location of service production between firms, we should expect the share of indirect labour within manufacturing firms to fall as the share of services in intermediate demand by manufacturing rises. Alternatively, structural change related to income levels will be reflected in the correlation of demand growth with per-capita income levels. Figure 6 and the Appendix present the results of OLS-based analysis of relative movements between manufacturing demand for private services, on the one hand, and both income levels and indirect manufacturing employment levels, on the other.

The results reported in the Appendix for Figure 6 "explain" roughly 70 percent of the variation in intermediate demand for services (the adjusted R^2 is .71). The estimated relationship is plotted in Figure 6 overleaf for the range of income levels and indirect labour shares covered by our sample. From the figure, it can be seen that, while falling indirect labour shares do "explain" a small rise in intermediate demand, this effect is far outweighed by a much stronger apparent positive relationship between rising income levels and rising intermediate demand for services. This result does not, of course, in any way explain the pattern of changes underlying the positive relationship between producer service growth and income. It does, however, point strongly to real structural change rather than outsourcing as the most promising direction for further research on this data pattern.

Services and the structure of trade
We next turn to the role of services in the structure of trade. We emphasise the importance of commercial services, not only as direct exports, but also as intermediates embodied in manufacturing exports. Formally, we divide the n accounts of a country's SAM into two groups: m endogenous accounts and k exogenous accounts. Following the standard convention in the SAM literature, we define the k exogenous

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[4] Technically, the D index measures the activity density of the column-normalised intermediate use matrix.
[5] The matrix **M** is not the standard Leontief multiplier matrix, since a number of institutional accounts are endogenous. For a more detailed discussion of this distinction, see Roland-Holst (1990).

Figure 6: Commercial Services as a Share of Manufacturing Intermediate Demand

accounts as the government, capital, and rest-of-world accounts (see Robinson, 1989). All remaining accounts, including the consumption account, are endogenous. We define the submatrix of **A** consisting of the m endogenous accounts as A_{mm}. The multiplier matrix is then given by

$$\mathbf{M} = (\mathbf{I}_m - \mathbf{A}_{mm})^{-1} \qquad (3)$$

A representative element of the **M** matrix, M_{ij} , gives the direct and indirect effects on sector i income caused by an exogenous unit increase in sector i income.[4]

Following Reinert and Roland-Holst (1994), we derive direct and indirect trade linkages from the individual SAMs based on the **M** matrix and the trade vectors. Defining f_i as the export final demand for commodity i and **f** as the column vector of these elements, the coefficient
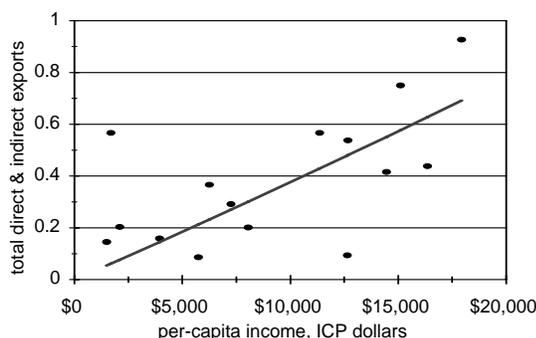
$$\phi_i = f_i / \mathbf{f'e} \qquad (4)$$

then gives the share of commodity i in total export demand, while the column vector ϕ contains the full set of these coefficients. This vector simply represents direct export shares. To account for intermediate linkages, further manipulation is required. We therefore also define the column vector

$$\Omega = \mathbf{M}\phi \qquad (5)$$

which gives the weighted average direct and indirect effect on activity in sector i of increasing export demand by one dollar while holding its sectoral composition constant.

From the matrix ϕ, we have a measure of the direct sectoral trade pattern. It gives the share of sectoral exports in each dollar of total export demand. In contrast, the matrix Ω gives the sectoral intensity of the overall export pattern. It measures the increase in economic activity (in value terms) that follows from a one dollar increase in total export demand. This includes both direct export demand, and demand for intermediates employed in producing exports from other sectors. What stands out in the data is the relative service intensity of exports in the high income countries, based on Ω. Based on net shares (equation (4)), the exports of the high income countries are concentrated in the upper-end of the manufacturing spectrum. However, on an activity basis (equation (5)), where we account for the full set of economy-wide intermediate linkages, we find that the most important sectors for export performance are the service sectors. This pattern is illustrated in Figure 7, in which we plot the pattern of total export intensity of commercial services against income. The underlying ANOVA results for Figure 7 are presented in the Appendix. The adjusted R^2 for the underlying OLS regression is 0.73. In terms of income levels, we find middle income countries (defined as up to $10,000 per year in per capita income) concentrated in exports of manufacturing activities. In Korea,

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Figure 7: Commercial Service Exports

for example, the most important sector for both direct and indirect exports in our data is machinery and equipment. Beyond this point, the economies in our sample shift in relative terms from exporting manufacturing activities to exporting service activities. The trade, transport, and communications sector exhibits an overall pattern similar to that for commercial services shown in Figure 7. For Australia, Canada, the European Union, Japan, Mexico, New Zealand, the United States, these two SAM sectors, (i) trade, transport, and communication and (ii) commercial services, are the most important export sectors measured on an activity basis. Hence, while the net composition of exports is concentrated in tangible exports, the leading cost component of these exports is actually service activities in the OECD economies.

Summary

Services are the dominant feature of the post-industrial OECD economies, and growth of the sector is an important feature of economic development. In this paper we work with a cross-country sample of national income data. We examine changes in the structure of production and trade, and the overall relationship of services to these patterns. What emerges is a set of stylised facts that match closely the historical experience of the OECD countries. To summarise:

(i) Income levels are positively associated with employment shares for intermediate services and with the share of indirect labour in total manufacturing employment.

(ii) The share of value added originating in services, including both commercial services and trade, transport, and communications services, is also positively linked to the level of development.

(iii) Income levels are strongly linked to intermediate demand for services, particularly in manufacturing.

(iv) While changes in the allocation of non-production activities between manufacturing and service firms may explain a small share of growth in intermediate demand for services, the basic story seems instead to be one of fundamental changes in the structure of production.

(v) The importance of services for export performance depends on the level of development. As we move from the middle-income to upper-income range of our sample, commercial services and trade, transport, and communications services become the most important sectoral elements of exports via interindustry linkages.

The last result relates to the economic structure of the OECD economies. While their exports are concentrated in manufactures, their economies are concentrated in services. At the same time, however, our results serve as a reminder that, in terms of the intermediate structure of production, services are a major aspect of production, even for exportables. Hence, while Japan's exports in material terms are concentrated in transport equipment and other machinery and equipment, the activity composition of Japanese exports is actually concentrated in services, which are almost 50 percent again more important than transport equipment and machinery and equipment. Similar patterns hold for Canada, the European Union, and the United States. Even for middle-income countries such as Korea, the significance of the service sector for overall exports is much greater than the direct trade balance suggests.

APPENDIX

ANOVA results — services and the structure of production and trade

	sample size	F	Significance of F	Coefficients	t-Statistic
Figure 1: Service Sector Employment					
	13	33.28	0.00012	Intercept 2.4309E-01	0.2080
				y 6.0329E-04	5.7691
Figure 2: Indirect Labour Employment in Manufacturing					
	12	15.27	0.00293	Intercept 8.0563E-02	1.2747
				y 2.1254E-05	3.9072
Figure 3: Value Added in Commercial Services relative to Manufacturing					
	15	15.46	0.00048	Intercept 1.0259E-08	2.0276
				y 4.4660E-05	2.0276
				y*y 7.1751E-10	0.4680
Figure 4: Manufacturing Demand for Commercial Services					
	15	38.26	0.00003	Intercept 2.2549E-03	0.2012
				y 6.5267E-06	6.1857
Figure 5: SAM Density as a Measure of Intermediate Linkages					
	15	1.51	0.26098	Intercept 4.3766E-08	9.5800
				y 1.7997E-04	1.5070
				y*y -7.9919E-10	-1.2719
Figure 6: Manufacturing Demand for Commercial Services					
	12	14.34	0.00159	Intercept-3.0275E-03	-0.1758
				y 8.5094E-06	3.8938
				s -5.7014E-02	-0.7133
Figure 7: Commercial Services as a Share of Total Exports on an Activity Basis					
	15	6.38	0.01293	Intercept 8.3584E-09	1.5788
				y 3.6387E-05	1.5789
				y*y 1.2086E-10	0.0753

note: s :   indirect labour as a share of manufacturing employment
       y :   per-capita income
       y*y :   per-capita income squared

The sample size for various regressions depends on the coincident availability of SAM data, ICP data, and ILO employment data. As a result, sample size varies.

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