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Changes in New Zealand's Production Structure: An Input Output Analysis

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Changes in New Zealand's Production Structure: An Input Output Analysis

Iris Claus

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Changes in New Zealand's production structure: an input output analysis

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Abstract

This paper investigates changes in the production structure of the New Zealand economy using input output data. The analysis is undertaken at the 25-industry level using inter industry transactions for 1971-72, 1977-78, 1981-82, 1986-87, 1990-91 and 1994-95. Changes in the composition of gross output and value added are examined. Backward and forward linkages, indices of industry interconnectedness, a value added production multiplier, a cumulated primary input coefficient for compensation of employees and a measure of import content of final demand output are calculated, taking into account both direct and indirect transactions. The results suggest that some industries have been subject to large structural change and that a shift in New Zealand's pattern of industrial activity has occurred. These changes will have affected the transmission and propagation of shocks in the economy.

JEL CLASSIFICATION C67 (input output models)
L16 (macroeconomic industrial structure)

KEYWORDS Input output models; industry importance; production structure; inter industry dependencies

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Changes in New Zealand's Production Structure: An Input Output Analysis

"In the early 1980s government policy changed abruptly (in New Zealand) from one based on protection, regulation, and industrial assistance to radical deregulation of entry and operating conditions in industry and trade liberalization." (Bollard 1991)

1 Introduction

The purpose of this paper is to examine how New Zealand's production structure has changed using input output analysis. Input output data contain detailed information about the process of production, the use of goods and services (products) and the income generated in that production (United Nations 1993). They can be used to assess the composition of industries' gross output and value added, the degree of specialisation of industries and the contribution of primary inputs in the production of the economy.

The economic transformation of New Zealand, beginning in 1984, is notable for its comprehensiveness, rapid pace and the level of intervention from which it started. More specifically, the reforms centred around (i) the liberalisation of domestic markets and trade, (ii) the reduction of the size and scope of the state, (ii) monetary policy, driven by an overriding goal of price stability, (iv) labour market deregulation and de-unionisation of the workforce, and (v) fiscal restraint, through broadening the taxation base and cutting state spending and social support (Kelsey 1995).

Understanding changes in the production structure is important as they affect the transmission and propagation of shocks in the economy. For example, an increase in the linkages of the finance, insurance etc. industry with other industries and sectors means that the effects of a shock in this industry will be magnified through the rest of the economy.

Historical input output data are available in New Zealand on a comparable basis for 1971-72, 1976-77, 1981-82, 1986-87, 1991-92 and 1994-95. A comparison of New Zealand's production structure in these years allows structural change in the economy to be examined. The input output methodology adopts a technological definition of production structure. This definition refers to "the input coefficients of an input output model derived from Leontief-type fixed-proportion production functions" (Soofi 1992).

The remainder of the paper proceeds as follows. Section 2 provides a brief description of input output tables and data available for New Zealand. The composition of gross output and value added are discussed in section 3, while section 4 investigates changes in inter industry linkages. Six measures of inter industry linkages are used: (i) backward and forward linkages, (ii) indices of industry interconnectedness, (iii) a value added production multiplier, (v) a cumulated primary input coefficient for compensation of employees and (vi) a measure of import content of final demand output. Section 6 summarises and concludes.

2 Input output tables[1]

Inter industry tables provide a summary of the industrial structure of an economy for a given year. They contain information on the values of flows of goods and services between industries and sectors of the economy.

Input output data are available in New Zealand for 1971-72, 1976-77, 1981-82, 1986-87, 1991-92 and 1994-95 on a System of National Accounts 68 (SNA68) basis. They can be compared at the 25-industry level of aggregation.[2] The data are comparable although two differences are worth noting. First, the 1991-92 and 1994-95 tables were obtained through input output balancing while the other four data sets were compiled from full inter industry studies. Second, data are only available rounded to the closest million for 1971-72 and 1976-77. This introduces a potential bias in 1971-72 and 1976-77, as transactions of less than $0.5 million are not recorded.[3]

Input output data are also available for 1995-96, compiled on a System of National Accounts 93 (SNA93) basis and using a new commodity and industry classification. The change in methodology means that the 1995-96 table cannot be readily compared to earlier data -- only some industries are comparable over time. Because only some industries are comparable and because New Zealand's production structure is not expected to have changed substantially between 1994-95 and 1995-96, at least not at the given level of aggregation, the 1995-96 data are not incorporated in the analysis.[4]

All commodity and industry flows in the input output tables are recorded in New Zealand dollars at *basic prices*.[5] The basic price of a good or service is the amount receivable by the producer minus any tax payable and plus any subsidy receivable. The p*roducer price* is the amount receivable by the producer minus any deductible goods and services tax (GST) invoiced to the purchaser. The *purchaser's price* is the amount paid by the purchaser, excluding any deductible GST in order to take delivery of a unit of a good or service. In the case of goods, the purchaser's price includes any trade margins and transport charges paid by the purchaser. Both basic and producer prices exclude transport charges invoiced separately by the producer.

[1] On input output tables see (United Nations 1993).
[2] A high level of aggregation helps ensure a consistent definition of industries across time.
[3] Inter industry transactions obtained through input output balancing are available for 1992-93. However, they are not considered in this analysis because data are only available rounded to the closest million.
[4] The 1995-96 tables were investigated in (Claus 2002).
[5] The results reported in sections 3 and 4 do not seem to be affected by inflation, i.e. high and rising inflation over much of the 1970s and 1980s and low and stable inflation over the 1990s. This is probably because of the high level of aggregation of the industries and the generalised inflation pressures throughout the economy.

The focus of input output analysis tends to be on inter industry transactions or the *industry by industry* flow matrix. Table 1 provides an example of such a matrix.[6] The rows of the inter industry transactions table describe the distribution of an industry's output throughout the economy, while the columns describe the composition of inputs required by a particular industry to produce its output.

Rows 1 to 25 record how much each industry sells to other industries (columns 1 to 25) and final demand output (columns 27 to 33), where final demand consists of household consumption, private non-profit final consumption, central and local government final consumption, exports, increase in stocks and gross fixed capital formation. Column 26, labelled "total industry", is the sum of intermediate products supplied by a particular industry.[7] The column labelled "total economy" (column 35) shows the total sales of intermediate and final demand products.

Columns 1 to 25 show how much each industry purchases from other industries (rows 1 to 25) and other inputs to production (rows 26 to 35). Compensation of employees (row 26), operating surplus (row 27), non-commodity indirect taxes (row 29), non-commodity subsidies (row 31) and consumption of fixed capital (row 32) add up to total value added at basic prices (row 39).[8] Entries along the principal diagonal (row 1, column 1; row 2, column 2; … row 25, column 25) of the intermediate input flow matrix (grey shaded area) show the amount of intra industry trade.

Table 1 also shows the link between total use in basic prices (row 36) and purchaser's prices (row 38).

From Table 1 gross domestic product (GDP) at market prices can be calculated. The sum of total use in purchaser's prices of final demand ($M 69,545) less total economy imports ($M 15,279) is equal to GDP ($M 54,266). Alternatively, GDP can be calculated as total industry value added in basic prices ($M 49,347) plus total economy taxes on products ($M 4,926) minus total economy commodity subsidies ($M 6).

The inter industry transactions table shows the composition of gross output and value added by industry. Moreover, the table can be used to construct input output coefficients to assess inter industry linkages that take into account direct *and* indirect transactions.

The basic input output identity can be expressed as follows

$$x = Ax + f \qquad (1)$$

where $x = [x_1, \ldots, x_N]'$ is the vector of gross output (column 35 in Table 1), N denotes the number of industries, i.e. 25, $f = [f_1, \ldots, f_N]'$ is the vector of final demand (column 34 in Table 1) and $A = [a_{ij}]$ is the matrix of technical coefficients.[9] Technical or input coefficients record the inputs directly required from one industry in order to produce one dollar's worth of output of another industry. They are calculated as follows

[6] For more details and an excellent introduction to inter industry transactions and input output analysis see (Dixon 1996).

[7] The total value of intermediate output is equal to the total value of intermediate inputs; that is, aggregate intermediate supply is equal to aggregate intermediate demand.

[8] Non-commodity indirect taxes and non-commodity subsidies are those which cannot be identified with individual commodities.

[9] Subscript i refers to the industry in the ith row and j to the industry in the jth column.

Table 1: Inter industry transactions 1986-87 (dollar millions)

		Industries					Categories of final demand								
		1	2	24	25	26	27	28	29	30	31	32	33	34	35
		Agriculture	Fishing and hunting	… Private non-profit services	Household domestic services	Total industry (columns 1 to 25)	Household consumption	Private non-profit final consumption	Central government final consumption	Local government final consumption	Exports	Increase in stocks	Gross fixed capital formation	Final demand (columns 27 to 33)	Total economy (columns 26 + 34)
Industries	1 Agriculture	1,258	1	14	0	5,501	203	1	0	1	1,235	99	21	1,560	7,061
	2 Fishing and hunting	17	36	1	0	333	3	0	0	2	165	4	0	174	507
	…						0								
	24 Private non-profit services	12	0	11	0	222	481	443	0	0	48	-1	5	976	1,198
	25 Household domestic services	0	0	0	0	0	35	0	0	0	0	0	0	35	35
Primary inputs	26 Compensation of employees	652	37	489	35	27,692	0	0	0	0	37	0	0	37	27,729
	27 Operating surplus	1,898	81	0	0	16,020	0	0	0	0	0	0	0	0	16,020
	28 Commodity indirect taxes	108	7	30	0	1,557	2,123	0	0	0	221	26	359	2,729	4,285
	29 Non-commodity indirect taxes	156	18	18	0	1,446	0	0	0	0	0	0	189	189	1,636
	30 Commodity subsidies	-6	0	0	0	-6	0	0	0	0	0	0	0	0	-6
	31 Non-commodity subsidies	-32	0	0	0	-298	0	0	0	0	0	0	0	0	-298
	32 Consumption of fixed capital	450	26	61	0	4,486	0	0	0	0	0	0	0	0	4,486
	33 Second hand assets	5	4	3	0	508	327	0	0	0	81	32	-947	-508	0
	34 Imports	237	86	24	0	8,506	3,899	0	0	0	322	93	2,459	6,773	15,279
	35 Import duty	5	0	1	0	343	207	0	0	0	0	5	85	297	641
	36 Total use in basic prices (rows 1 to 25 + 34)	3,824	334	597	0	66,992	29,956	444	7,767	1,042	14,977	857	11,985	67,027	134,019
	37 Taxes on products (rows 28 + 35)	113	7	30	0	1,900	2,330	0	0	0	221	30	444	3,026	4,926
	38 Total use in purchasers' prices (rows 36 + 37 - 30 + 33)	3,948	344	630	0	69,405	32,613	444	7,767	1,042	15,279	918	11,482	69,545	138,951
	39 Total value added in basic prices (rows 26 + 27 + 29 + 31 + 32)	3,126	163	568	35	49,347	0	0	0	0	37	0	189	227	49,573

Note: Purchases of second hand assets will make a positive contribution to gross fixed capital formation, even though they don't change the economy's holdings of physical assets, if they involve installation, transportation and\or transfer costs. The cell at the intersection of row 33 and column 33 shows the net sales of second hand assets by industries on capital account.

$$a_{ij} = \frac{r_{ij}}{x_j} \tag{2}$$

where $R = [r_{ij}]$ is the intermediate input flow matrix (rows 1 to 25, columns 1 to 25 in Table 1). Equation (1) thus states that gross output, x, is the sum of all intermediary output, Ax, and final demand, f.

Equation (1) can be solved for x to obtain

$$x = [I - A]^{-1} f \tag{3}$$

if $[I - A]$ is non-singular and where I is the identity matrix.[10] The matrix $[I - A]^{-1}$ is called the inverted Leontief matrix or total requirement matrix. Total requirement coefficients show how much output is required directly and indirectly from each industry for every dollar's worth of output produced for final use. The elements of $[I - A]^{-1}$ are denoted b_{ij}.

3 Composition of gross output and value added

The inter industry transactions matrix provides information on the composition of gross output and value added in basic prices in the economy. The composition of industries' gross output is plotted in Figure 1 for the six years 1971-72, 1976-77, 1981-82, 1986-87, 1990-91 and 1994-95. Figure 1 shows that the share of intermediary output in total gross output grew from 40.4 percent in 1971-72 to 49.3 percent in 1986-87 before falling back to around 46 percent in 1990-91 and 1994-95. Changes in the composition of value added occur, in part, because of changes in relative prices and the adoption of labour saving technology or more productive capital.

The largest category of final demand is consumption, contributing about 30 percent to total gross output. The second largest category is exports and their share seems to have been increasing. The share of exports in gross output was around 12.5 percent in 1976-77, 1981-82 and 1986-87, rose to 13.5 percent in 1990-91 and 15.2 percent in 1994-95.

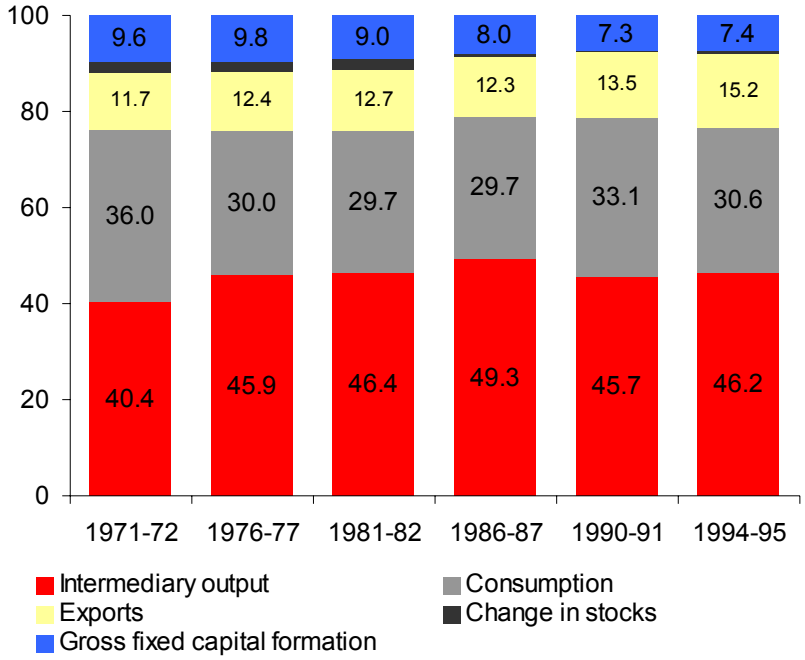
Figure 2 plots the proportion of exports in gross output for the 25 industries. It shows that the share of exports jumped to a higher level in 1986-87 for communication, and community, social services etc.[11] Moreover, the share of exports has been trending upwards for mining and quarrying, textile, apparel and leather, wood and wood products, fabricated metal products, chemicals, petrol, rubber etc., and basic metals. Also note the sharp increase in the share of exports in gross output for other manufacturing.

[10] The condition that $[I - A]$ is non-singular means that $\lim_{T \to \infty} A^T = 0$ and the economic system produces the intermediate inputs needed to produce the intermediate inputs needed to produce the intermediate inputs needed, and so on … .

[11] Activities that have contributed to the rise in export share of community, social services etc. more recently include sports, leisure, other tourist pursuits and education.

Likely contributors to the increase in the share of exports were the lowering of tariffs and phasing out of import licensing during the second half of the 1980s and the complete free trade of goods and services with Australia in 1990. Moreover, a rise in exports to the United States, Australia, Japan and other Asian countries enabled New Zealand to benefit from lengthy economic expansions in some of these countries, in particular the United States and Australia.

Figure 1: Composition of gross output (in percent)



The share of gross fixed capital formation and increase in stocks in gross output has been declining (Figure 1). The fall in the gross output share of gross fixed capital formation sourced from domestic industries is partly the result of higher import content (discussed further in the next section). Moreover, changes in relative prices, e.g. computers, have likely affected the share.

The decline in inventories or change in stocks is probably due to the introduction of inventory control methods, such as "just-in-time" management techniques and the use of bar coding and computer based inventory management and ordering techniques. As noted in (Buckle 2000), the adoption of these inventory control methods was likely encouraged by the deregulation of the transport sector and increased use of computer technology. A less volatile domestic (and foreign) economy probably also have reduced the demand for inventories.

Figure 2: Direct exports as a percent of gross output

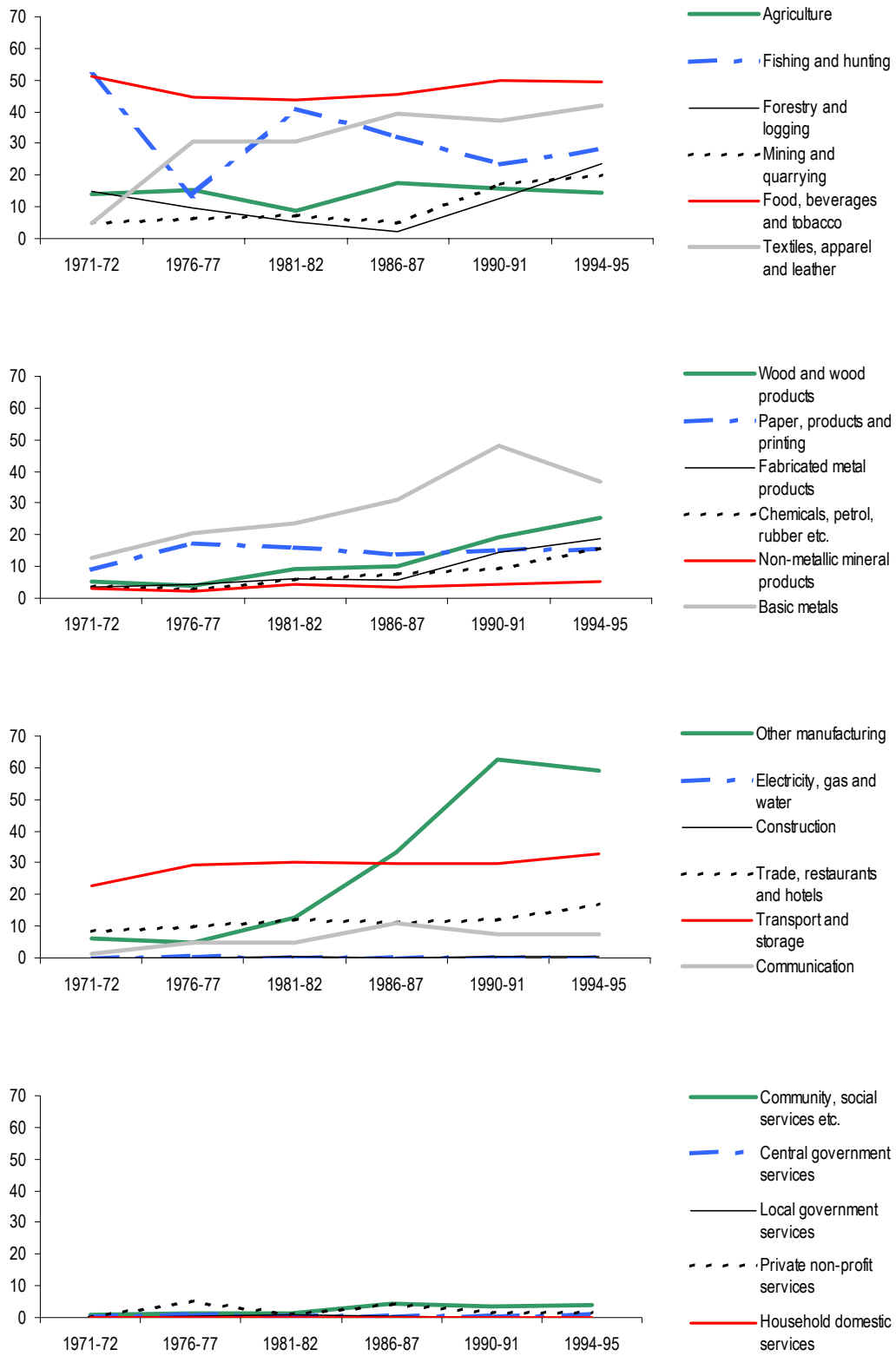


Figure 3: Change in stocks as a percent of gross output

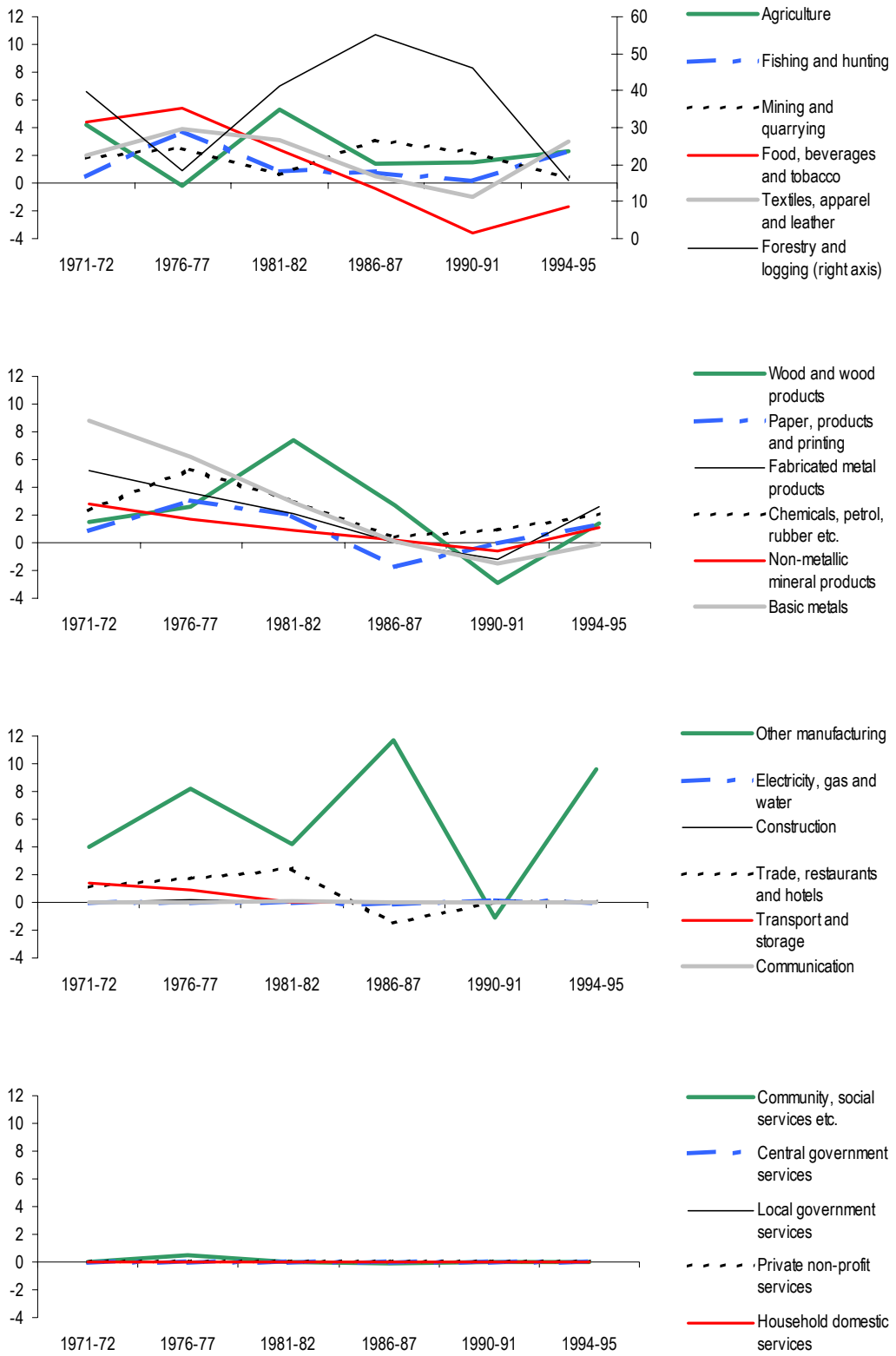
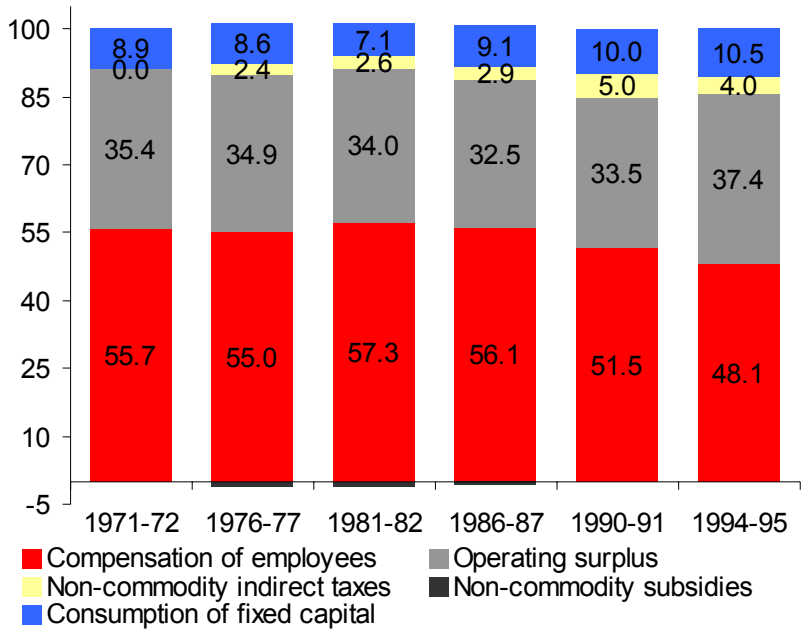


Figure 3 plots the change in stocks as a percent of gross output for the 25 industries. It shows that the decline in inventories was particularly pronounced for food, beverages and tobacco, wood and wood products, paper, products and printing, fabricated metal products, chemicals, petrol, rubber, etc., non-metallic mineral products, and basic metals. Inventories as a percent of total gross output also fell somewhat for fishing and hunting, and textile, apparel and leather, while remaining fairly stable for agriculture, and mining and quarrying. Forestry and logging, and other manufacturing generally seem to have been subject to large inventory swings. The swings in other manufacturing inventories, particularly in 1986-87 and 1990-91, coincide with volatile manufacturing production during the reform period as noted in (Evans *et al* 1996). For forestry and logging, a "wall of wood" that was planted in the 1960s matured in the 1980s and early 1990s.

Figure 4: Composition of value added



The composition of aggregate value added is plotted in Figure 4.[12] The graph shows that the share of compensation of employees for the economy as a whole rose to 56-57 percent in 1981-82 and 1986-87, but dropped sharply in 1990-91 and 1994-95 to reach 48.1 percent in 1994-95. High unemployment, low employment rates and labour market reforms that ended compulsory unionism and centralised wage setting and facilitated employer-employee individual contracts all likely contributed to the fall in the share of compensation of employees. Moreover, the share of compensation of employees fell as the number of self-employed rose following the downsizing of publicly owned companies and public sector organisations in the mid-1980s. The small decline between 1981-82 and 1986-87 may have been the result of a wage freeze during the first half of the 1980s.

Profitability as measured by the share of operating surplus in total value added fell from 36.4 percent in 1971-72 to 32.5 percent in 1986-87, recovered slightly in 1990-91 and rose to 37.4 percent in 1994-95.

[12] Note that the 1971-72 data do not distinguish between subsidies and non-commodity subsidies. Subsidies for 1971-72 are therefore excluded from value added.

Figure 5: Industry composition of value added

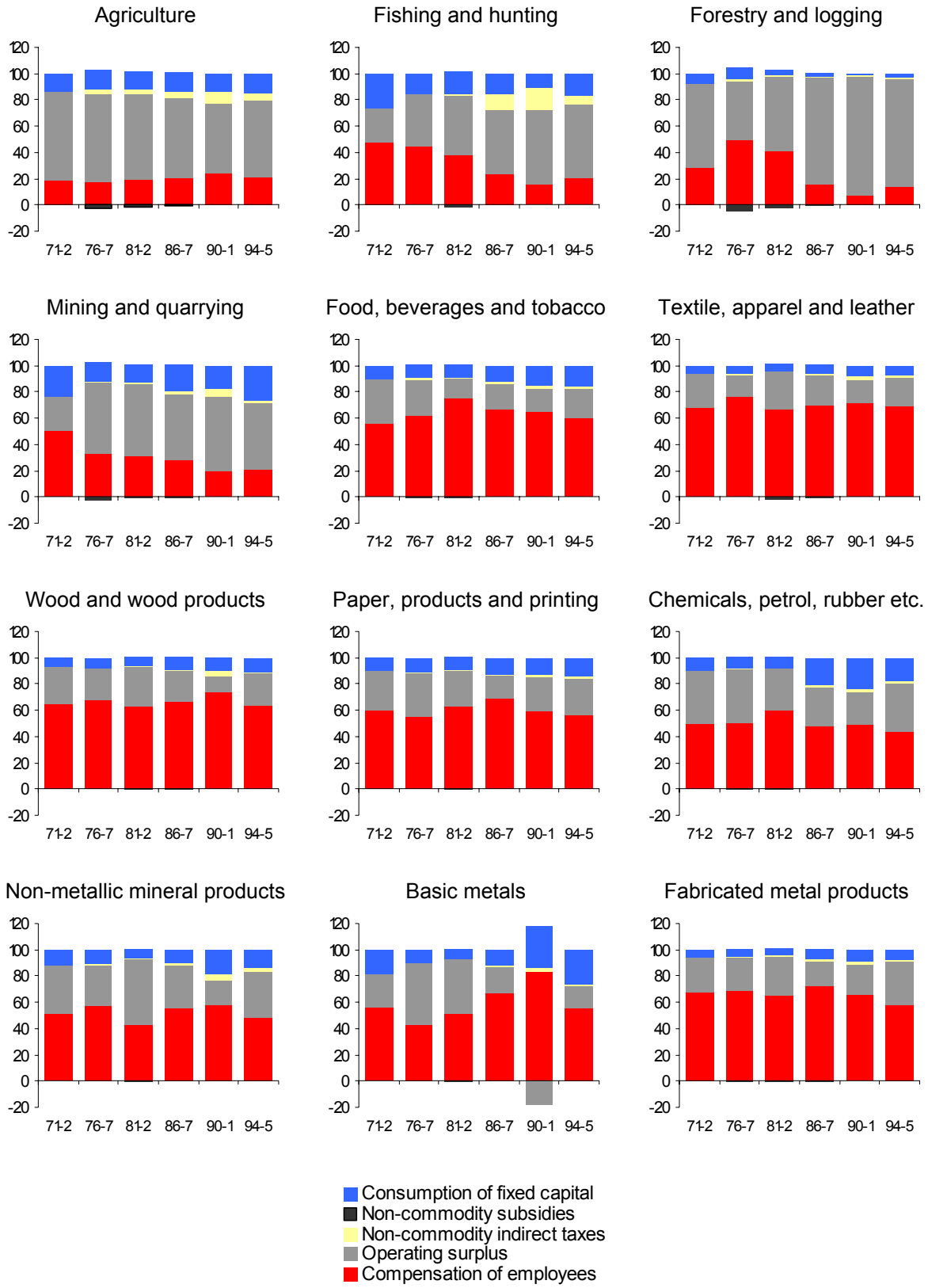
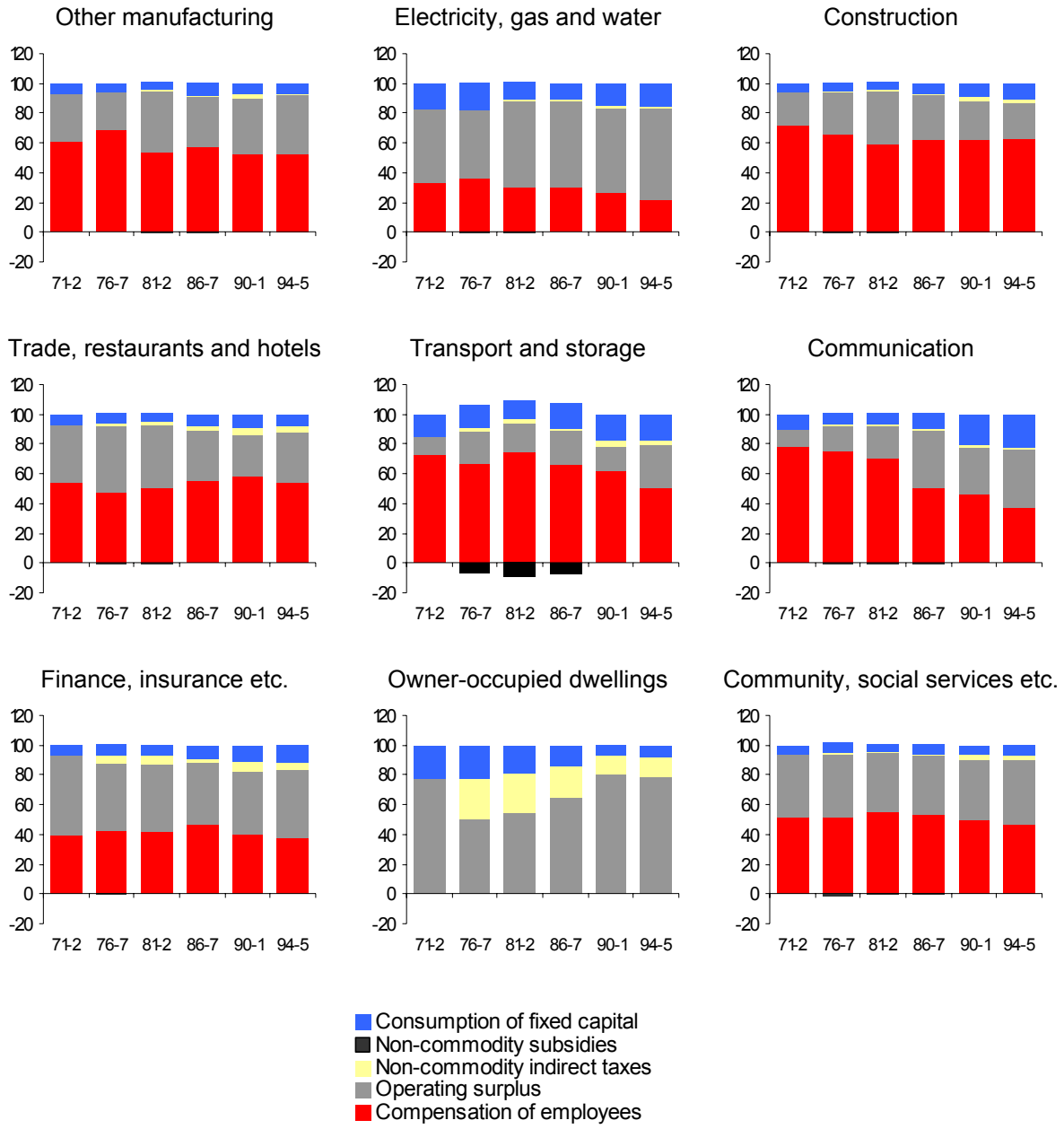
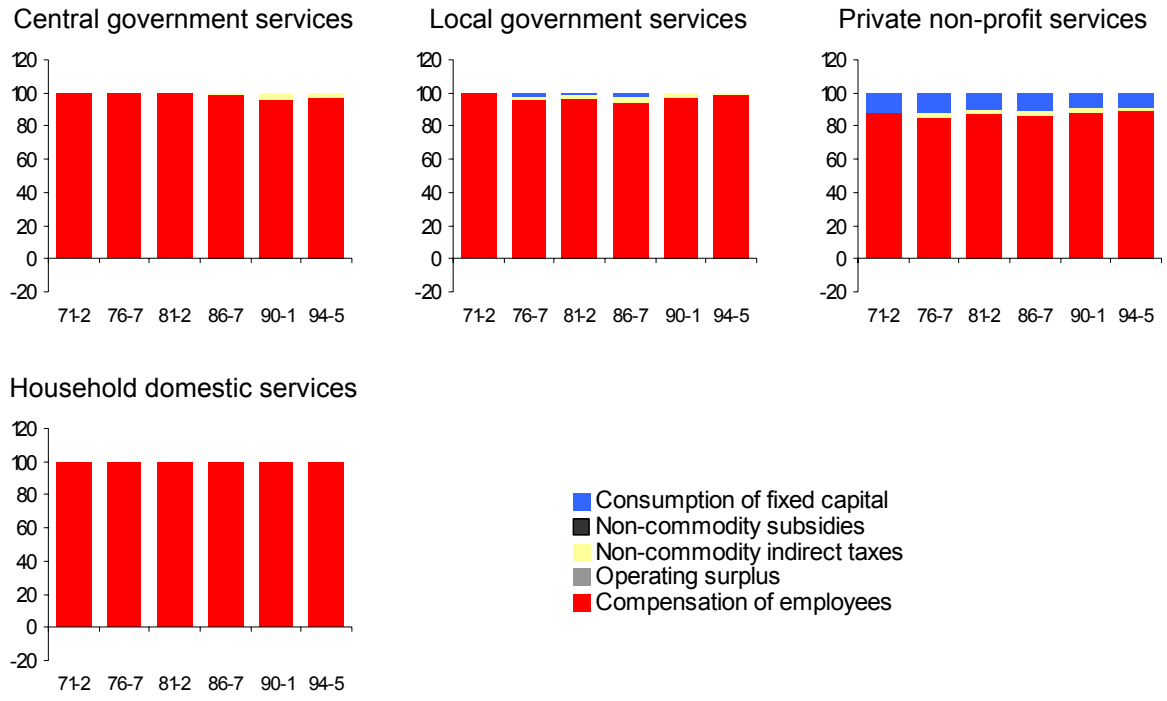


Figure 5: Industry composition of value added (cont.)



Consumption of fixed capital as a proportion of value added declined between 1971-72 and 1981-82 from 8.9 percent to 7.1 percent. Since then it has been rising to reach over 10 percent in 1994-95. The increase in consumption of fixed capital is probably the result of the strong investment that followed the restructuring and large-scale obsolescence of capital following the reforms. A change in the mix of investment goods toward a higher proportion of components with shorter service lives may also have been contributing to the higher share.

Figure 5: Industry composition of value added (cont.)



The composition of value added at the industry level is plotted in Figure 5. It shows that the share of compensation of employees fell in 1986-87, 1990-91 and 1994-95 for fishing and hunting, forestry and logging, food, beverages and tobacco, chemicals, petrol, rubber etc., transport and storage, and communication, and in 1990-91 and 1994-95 for mining and quarrying, and paper, products and printing. The sharp decline in compensation of employees for forestry and logging, communication and transport and storage between 1981-82 and 1986-87 was largely the result of the layoffs in these industries following privatisation. For fishing and hunting, forestry and logging, and communication the decline in the share of compensation of employees was matched by an increase in the share of operating surplus. Changes in the composition of value added for fishing and hunting are partly the result of the introduction of Individual Transferable Quotas (ITQ) for New Zealand fisheries in 1986.

The share of consumption of fixed capital has generally been increasing in all industries, apart for fishing and hunting, forestry and logging, owner-occupied dwellings, central and local government services and private non-profit services.[13, 14]

A key result of the 1980s reforms was "a massive reduction in direct government assistance to industry" (Evans *et al* 1996). A look at the data that underly Figure 5 shows that during the 1980s all but five industries received non-commodity subsidies, reflecting a subsidy scheme based on the principle of universality rather than targeted support (Silverstone *et al* 1996). These five industries were owner-occupied dwellings, central and local government services, private non-profit services, and household domestic services. Most of the industries that received government assistance during the 1980s also received assistance in 1976-77. Electricity, gas and water, and finance, insurance etc. were the first industries to have non-commodity subsidies removed, a reflection of the

[13] Consumption of fixed capital has only been recorded for central and local government non market industries since the 1995-96 inter industry study.

[14] Value added for household domestic services consists entirely of compensation of employees.

early reforms in these industries although more protracted in the case of electricity, gas and water. Transport and storage had the largest share of non-commodity subsidies in value added, followed by agriculture, and forestry and logging.

4 Inter industry linkages

To assess changes in New Zealand's production structure in terms of industry linkages this section applies input output coefficients. They are calculated from the inter industry transactions matrix and take into account both direct and indirect transactions. The production structure is examined using six types of measure: (i) backward and forward linkages, (ii) indices of industry interconnectedness, (iii) a value added production multiplier, (v) a cumulated primary input coefficient for compensation of employees and (vi) a measure of import content of final demand output.

Changes in the relative importance of industries occur because industries are affected differently by (de)regulation, changes in industrial assistance, domestic and foreign conditions. Moreover, they can be the result of changes in industry composition within industries or changes in classification, like the removal of some secondary production.[15]

4.1 Backward and forward linkages[16]

Backward and forward linkages are descriptive measures of the economic interdependence of industries in terms of dollar transactions. Backward and forward linkages, which were first proposed by (Rasmussen 1956), are calculated from the Leontief inverse or total requirement matrix $[I - A]^{-1}$, weighted by final demand.[17]

The elements of the final demand weighted Leontief inverse are denoted by b_{ij}^{w} and calculated as follows

$$b_{ij}^{w} = b_{ij} \frac{f_i}{\sum_{i=1}^{N} f_i} \tag{4}$$

The sum of the elements in column j[18]

$$b_{.j}^{w} = \sum_{i=1}^{N} b_{ij}^{w} \tag{5}$$

shows the input requirements for a unit increase in the final demand for industry j's output given each industry's share in total final demand. It is called the *backward linkage*

[15] Removing uncharacteristic output (and its inputs) from an industry will weaken linkages.

[16] The derivation of measures in sections 4.1 and 4.2 follows (Chatterjee 1989) and (Soofi 1992).

[17] The total requirement coefficient matrix is weighted by final demand to avoid a possible bias. The forward linkage would be subject to a bias noted in (Chatterjee 1989) if the total requirement matrix wasn't weighted. This is because "for the row sum to measure the forward linkage in an unbiased fashion, it is necessary to make the assumption that the demands for all sectors increase by one unit. All sectors are unlikely in practice to be of equal importance in the structure of demand, so if a small sector j uses inputs from sector i disproportionately largely, the forward linkage index will be blown up artificially by the assumption of equal expansion of all sectors" (Chatterjee 1989, p. 96). Weighting the total requirement matrix avoids this problem.

[18] Subscripts .j and i. denote column and row sums respectively.

as it measures the impact on the supplier industries of a unit increase in final demand.[19] Expressing the backward linkage as an index

$$U_{.j}^{w} = \frac{(1/N)b_{.j}^{w}}{(1/N^{2})\sum_{j=1}^{N} b_{.j}^{w}} = \frac{b_{.j}^{w}}{(1/N)\sum_{j=1}^{N} b_{.j}^{w}} \tag{6}$$

allows inter industry comparisons to be made. The numerator in equation (6) measures the average stimulus to other industries, according to each industry's share in total final demand, resulting from a unit increase in the final demand for industry j's output. The denominator measures the average stimulus to the whole economy resulting from a unit increase in the final demand for the output of all industries.

Conversely, the index of *forward* linkage is given by

$$U_{i.}^{w} = \frac{(1/N)b_{i.}^{w}}{(1/N^{2})\sum_{i=1}^{N} b_{i.}^{w}} = \frac{b_{i.}^{w}}{(1/N)\sum_{i=1}^{N} b_{i.}^{w}} \tag{7}$$

where the sum of the elements in row i

$$b_{i.}^{w} = \sum_{j=1}^{N} b_{ij}^{w} \tag{8}$$

shows the increase in the output of sector i needed to supply the inputs required to produce an additional unit of final demand output, given each industry's share in total final demand.

To assess how New Zealand's production structure has changed, the backward and forward linkages are calculated for each of the 25 industries for 1971-72, 1976-77, 1981-82, 1986-87, 1990-91 and 1994-95. The ranking of the industries in each year is shown in Figure 6. The actual measures that determined the ranking are plotted in the Appendix.[20]

[19] (Hirschman 1958) labelled $U_{.j}^{w}$ and $U_{i.}^{w}$ (discussed further below) backward and forward linkages. (Rasmussen 1956) used the term "power of dispersion" for $U_{.j}^{w}$ and "sensitivity of dispersion" for $U_{i.}^{w}$.

[20] All measures, whose ranking only are reported in the paper, are plotted in the Appendix.

Figure 6: Ranking of backward linkages (final demand weighted)

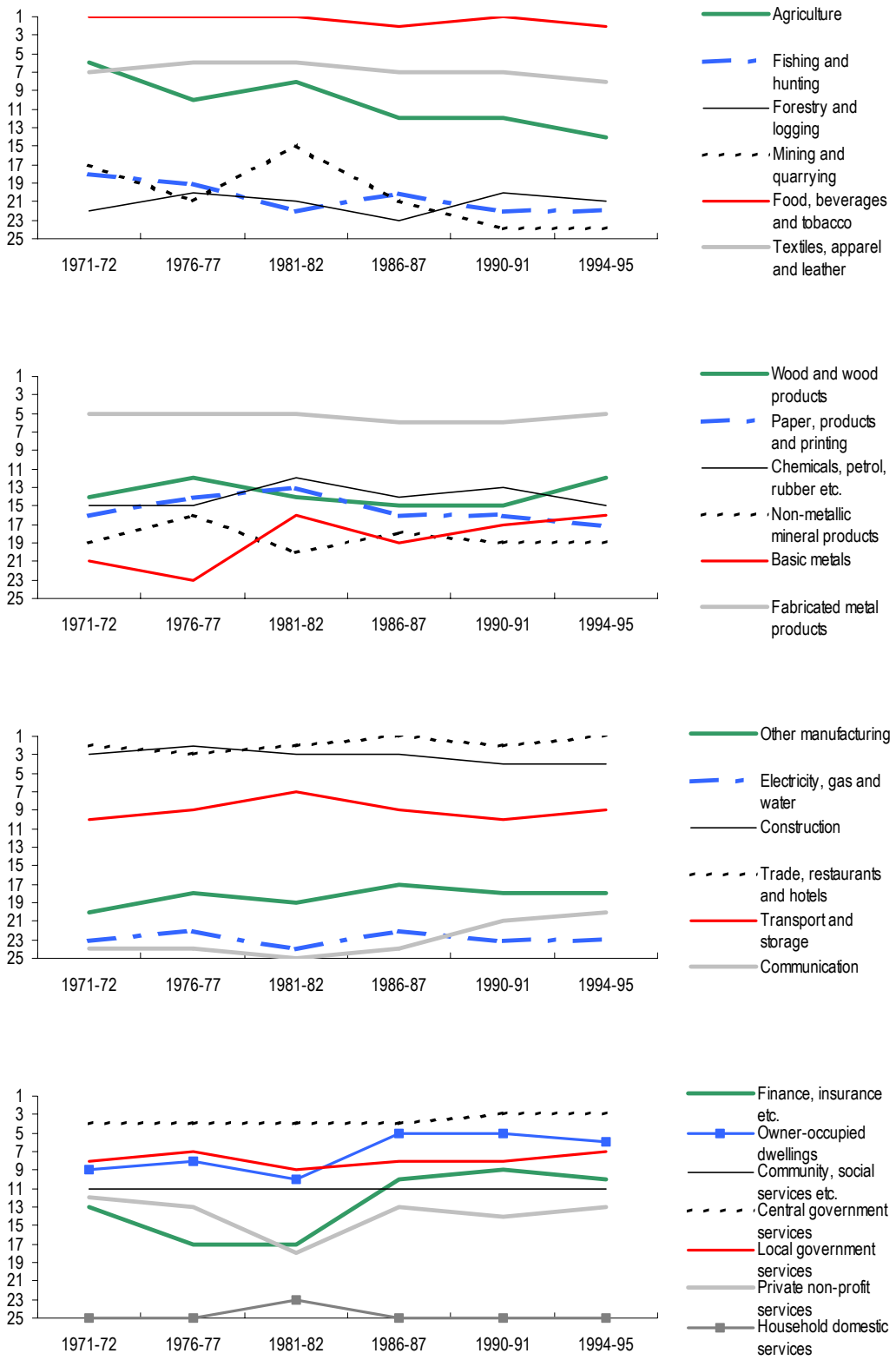


Figure 7: Ranking of forward linkages (final demand weighted)

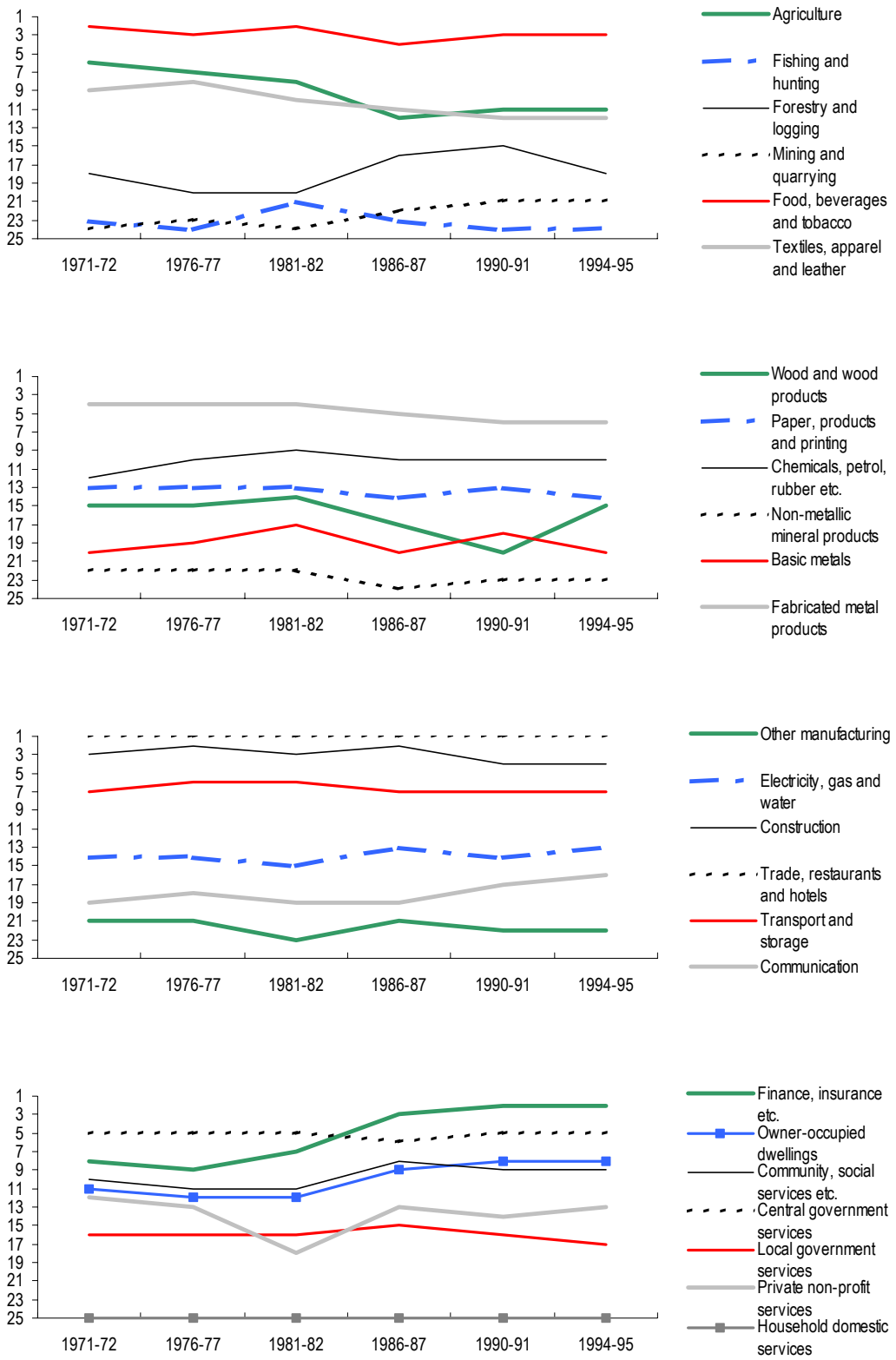


Figure 8: Ranking of backward linkages (export weighted)

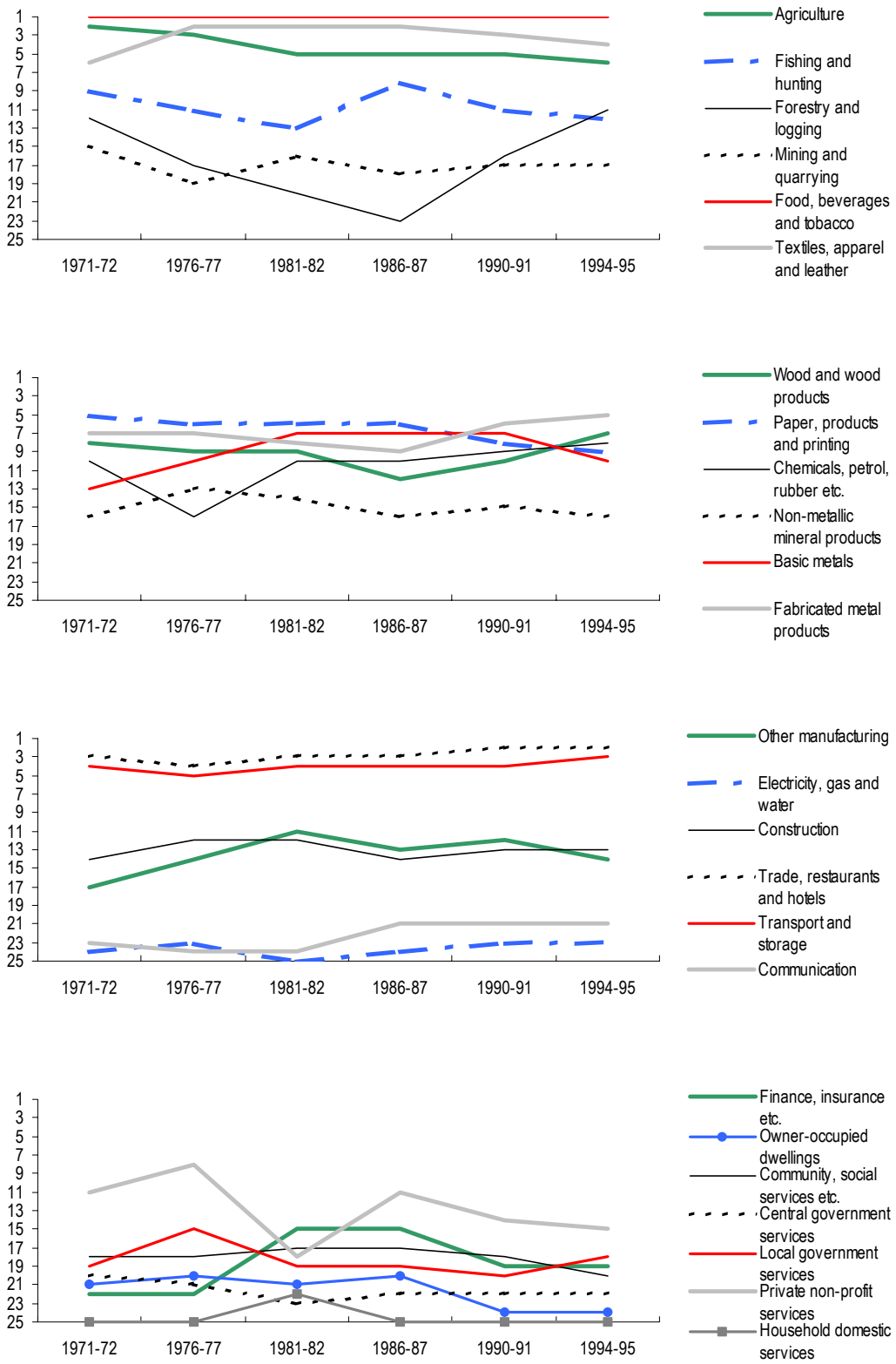
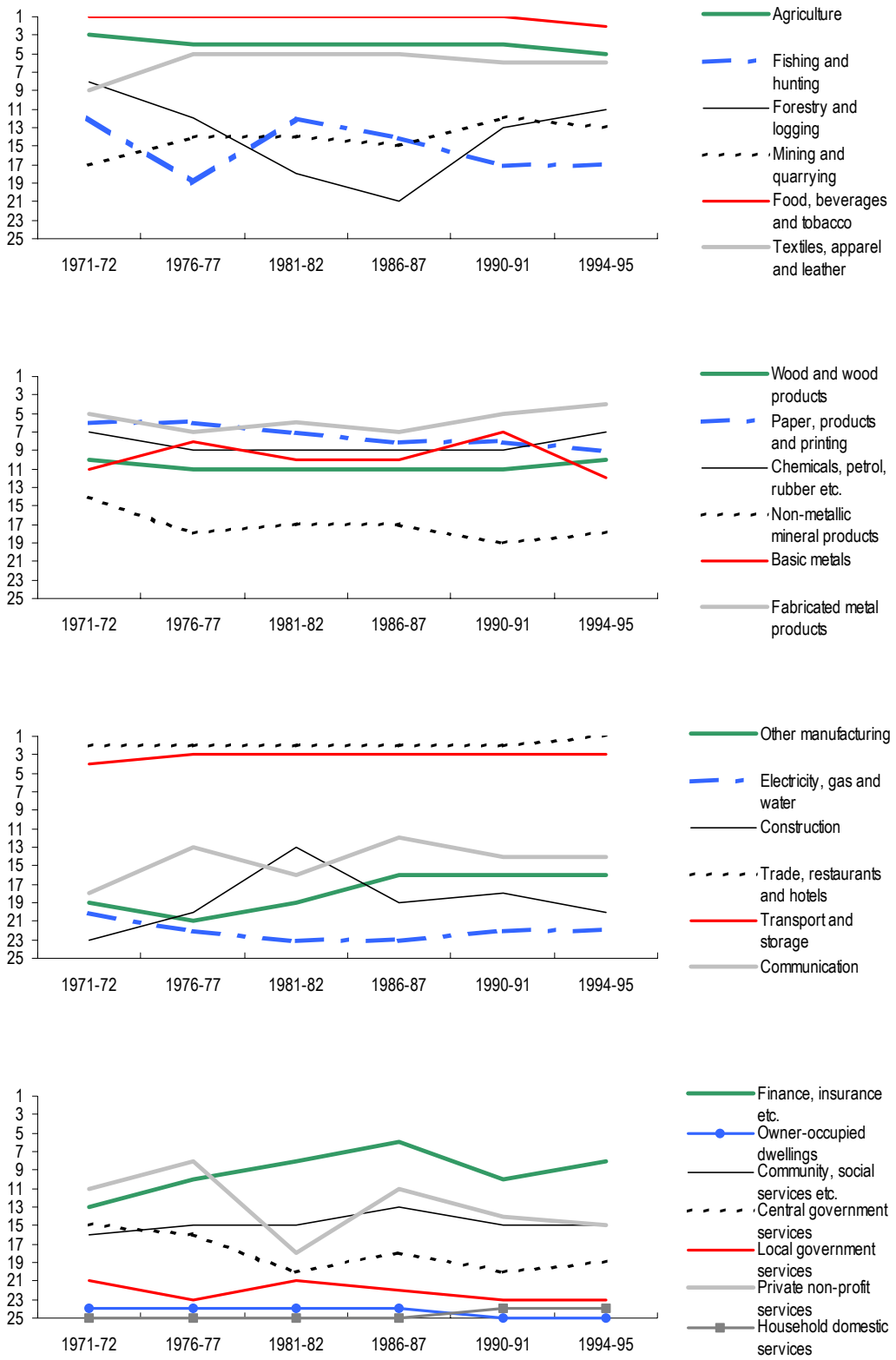


Figure 9: Ranking of forward linkages (export weighted)



Food, beverages and tobacco, trade, restaurants and hotels, construction, and central government services have the largest backward linkage (see Figure 6). A high backward linkage means that an increase in the final demand of any of these industries' output will have a large impact on industries that supply inputs in the production of these industries' output.

Figure 6 shows large changes in the ranking of some industries. The relative importance of finance, insurance etc. and owner-occupied dwelling increased in 1986-87, while communication, which purchased the least inputs from other industries in 1981-82, jumped to 21st place in 1990-91 and 20th in 1994-95. Basic metals and chemicals, petrol, rubber etc. also have purchased more and more inputs from other industries, while agriculture, relative to other industries, has been purchasing less. The increase in the relative importance of basic metals and chemicals, petrol, rubber etc. occurred between 1976-77 and 1981-82, possibly a reflection of the "Think Big" energy and industrial projects.

Trade, restaurants and hotels has had the largest forward linkage (see Figure 7); that is, following a dollar increase in final demand output, trade, restaurants and hotels must increase their output the most to provide the required inputs for the additional production of final demand. Finance, insurance etc. had the second largest forward linkage in 1994-95, increasing from 7th place in 1981-82 to 3rd place in 1986-87 and 2nd in 1990-91 and 1994-95. Forestry and logging, and owner-occupied dwellings also moved up in terms of direct and indirect sales to other industries in 1981-82, while agriculture fell.

Alternatively, exports can be used as a weighting factor of the Leontief inverse. Backward and forward linkages then show the effect on industries of a unit increase in export demand. The results of weighting backward and forward linkages by exports are reported in Figures 8 and 9. Backward linkages are highest for food, beverages and tobacco, trade, restaurants and hotels, and transport and storage; that is, following a unit increase in exports demand, purchases by these industries from other industries rise more than other industries' purchases. The relative importance of fishing and hunting, and chemicals, petrol, rubber etc. has been rising and stronger export demand in these industries is increasingly affecting the output of other industries. The export contribution of forestry and logging dropped sharply between 1971-72 and 1986-87 but rose in 1990-91 and 1994-95.

Weighted by exports, food, beverages and tobacco, trade, restaurants and hotels, and transport and storage also have the largest forward linkages. Moreover, Figure 9 shows that the relative importance of communication and finance, insurance etc. is much higher in terms of forward linkages weighted by exports than backward linkages and increasing. This implies that a rise in exports has increasingly required more output by these industries to meet higher export demand. The relative importance of other manufacturing has also been rising.

4.2 Industry interconnectedness

Indices of industry interconnectedness focus on the number of direct and indirect transactions between industries and provide an indication of the degree of outsourcing and diversification in the economy. More purchases of intermediate products by industries indicates an increase in outsourcing, while a rise in the number of sales to other industries suggests an increase in diversification; that is, an expansion of an existing industry into other commodities or markets.[21]

Following (Soofi 1992), two measures of industry interconnectedness are calculated: (i) a measure of concentration and (ii) entropy as a measure of variation.[22] The concentration measure is calculated from the *unweighted* total requirement matrix and thus focuses on the intermediate sector. The entropy based measure of dispersion is more descriptive of the characteristics of the economy as a whole as it takes into account final demand sales.

The backward concentration index is defined as

$$G_{.j}(b_{ij}) = \left[N\left(1 - \sum_{i=1}^{N} (c_{.j,ij})^2 \right) \right]^{1/2} \tag{9}$$

and the forward index as

$$G_{i.}(b_{ij}) = \left[N\left(1 - \sum_{j=1}^{N} (c_{i.,ij})^2 \right) \right]^{1/2} \tag{10}$$

where $c_{.j,ij} = \dfrac{b_{ij}}{\sum_{i=1}^{N} b_{ij}} = \dfrac{b_{ij}}{b_{.j}}$ and $c_{i.,ij} = \dfrac{b_{ij}}{\sum_{j=1}^{N} b_{ij}} = \dfrac{b_{ij}}{b_{i.}}$ for all i and j.

The larger is the measure of concentration, the more industries' transactions or the higher the degree of outsourcing and diversification. Conversely, the smaller the measure of concentration is, the fewer inter industry sales or purchases.[23]

[21] Diversification may be related or unrelated. Related diversification occurs when an industry (firm) expands into similar product lines. Unrelated diversification takes place when the products are very different from each other, for example, a food processing firm manufacturing leather footwear as well. Diversification may arise for a variety of reasons: to take advantage of complementarities in production and existing technology; to exploit economies of scope; to reduce exposure to risk; to stabilise earnings and overcome cyclical business conditions; etc. See the OECD's *Glossary of industrial organization economics and competition law* www.oecd.org/pdf/M00007000/M00007651.pdf.

[22] Entropy is explained further below.

[23] The index would probably be more adequately called a "de-concentration" index.

Figures 10 and 11 plot the ranking of industries for the backward and forward concentration index. Figure 10 shows that input purchases from other industries overall have been rising faster for agriculture, textile, apparel and leather, basic metals, fabricated metal products, and communication than the rest of the economy. Agriculture was buying inputs from more industries relative to other industries in 1986-87, while purchases by communication increased between 1986-87 and 1990-91. For communication the shift occurred later, probably because telecommunications operations and assets were only deregulated and restrictions on the supply of telecommunications equipment removed in the late 1980s.

The relative importance of forestry and logging, mining and quarrying, and owner-occupied dwellings in terms of input purchases from other industries has been declining. For other manufacturing, purchases rose until 1986-87 but fell in 1990-91 and 1994-95. The temporary improvement in the ranking of household domestic services in 1981-82 is the result of a different classification for that year. In 1981-82 household domestic services also purchased inputs from other industries in addition to labour input.

The ranking of industries for the forward concentration index, which shows the dispersion of a unit increase in final demand output on industries' sales to other industries, is plotted in Figure 11. The ranking of industries for the forward index appears to be more stable than the backward index; that is, industries tend to sell intermediary output to the same industries. This finding is in line with the results in (Redding 2002), who finds no evidence of an increase in countries' overall degree of specialisation using disaggregated data on 20 manufacturing industries in seven OECD countries during 1970-90.

A few industries' rankings have changed. Inter industry sales of other manufacturing, and community, social services etc. fell relative to other industries between 1981-82 and 1986-87 probably because of a decline in the goods and services produced by these industries, while sales of mining and quarrying to other industries rose. Sales by fabricated metal products dropped between 1986-87 and 1990-91 relative to the rest of the economy.

The forward concentration index for agriculture has been rising steadily although slightly, reflecting increased diversification in agriculture, with sheep farmers switching to beef and shifts into horticulture, goat and deer farming, and cropping (Easton 1997).

Figure 10: Ranking of backward concentration index

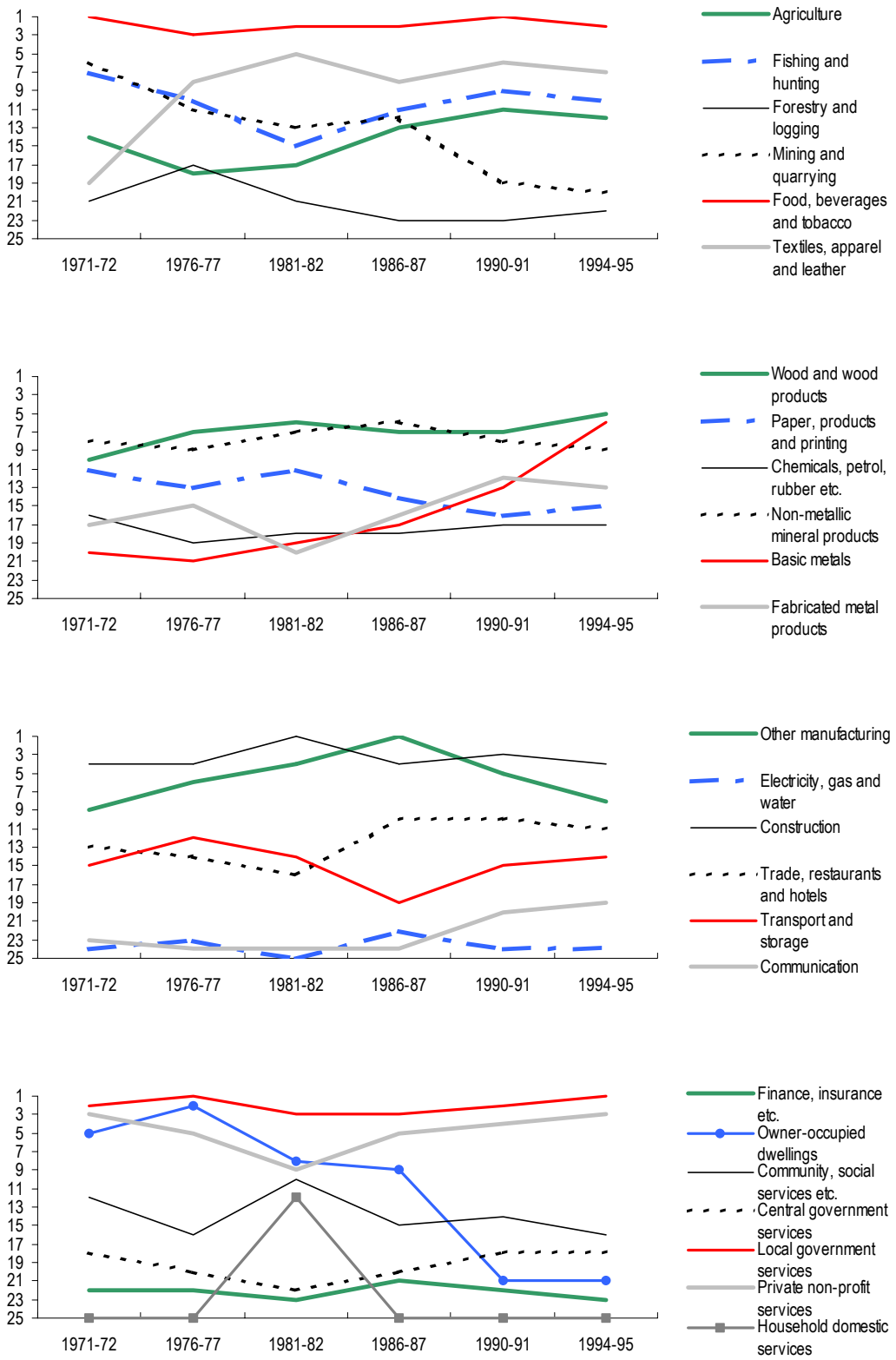
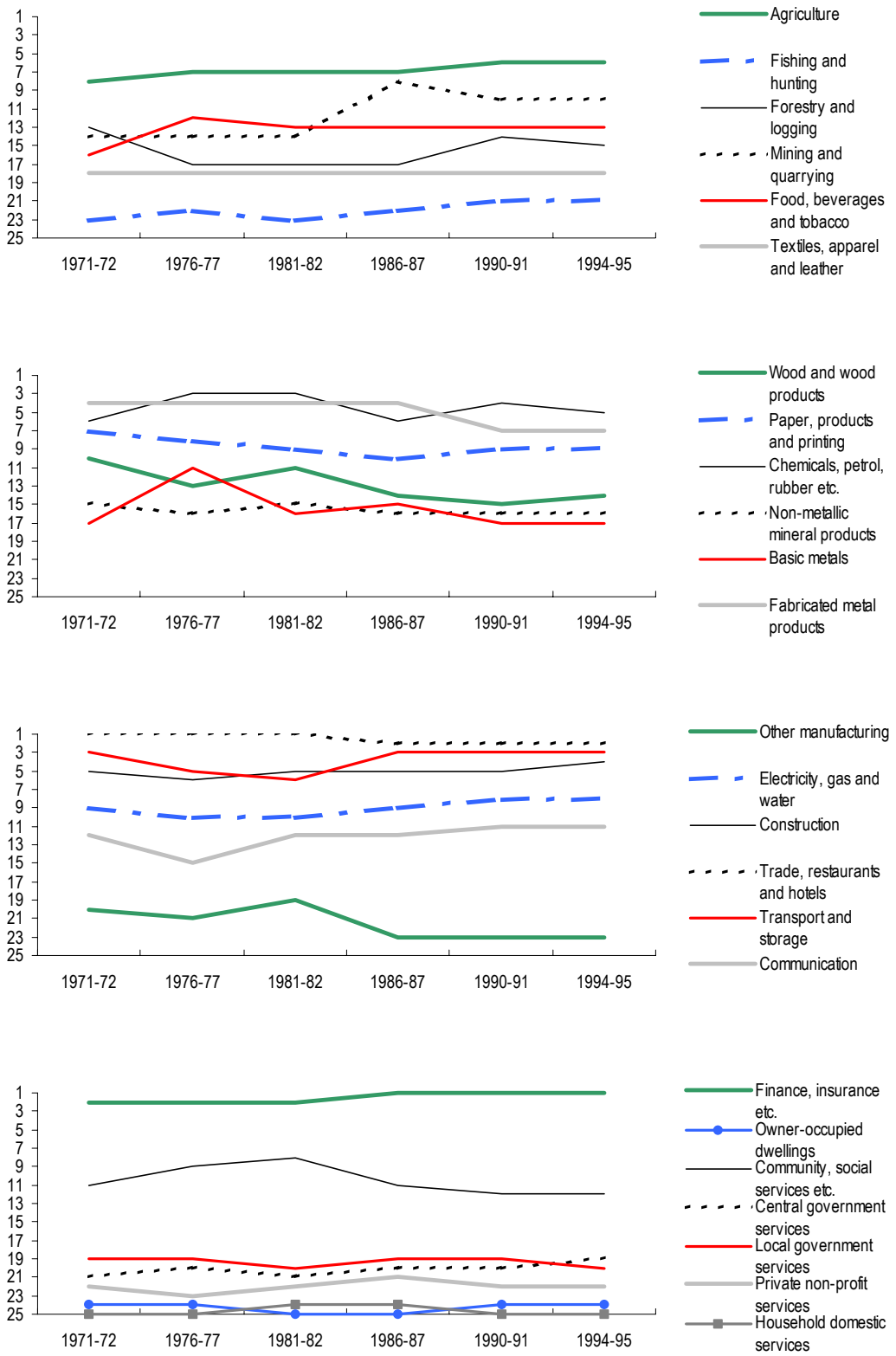


Figure 11: Ranking of forward concentration index



An alternative measure of industry interconnectedness is entropy. Entropy has its origin in physics and is a measure of disorder. Consider, for example, two gases, one with all A molecules and one with all B molecules. Mixing the two gases leads to a final mixture of A and B molecules that is less ordered than the initial system of pure A and B molecules. The mixed state is more probable than the unmixed state, i.e. it has a higher entropy, because there are more ways of distributing the molecules of A and B so as to yield mixed states than there are ways to yield pure states. The two gases in the example can be interpreted as industries in an economy. The higher is the entropy, the more integrated and thus specialised industries are. The more integrated and specialised industries are, the less probable it is that the economy returns to its initial state (of barter).

The row entropy of sector i is calculated as follows

$$H_{i.}(b_{ij}^{w}) = \sum_{i=1}^{N} d_{i.,ij} \log\left(\frac{1}{d_{i.,ij}}\right) \tag{11}$$

and the column entropy of sector j as

$$H_{.j}(b_{ij}^{w}) = \sum_{j=1}^{N} d_{.j,ij} \log\left(\frac{1}{d_{.j,ij}}\right) \tag{12}$$

where $d_{i.,ij} = \dfrac{b_{ij}^{w}}{\sum_{j=1}^{N} b_{ij}^{w}} = \dfrac{b_{ij}^{w}}{b_{i.}^{w}}$ and $d_{.j,ij} = \dfrac{b_{ij}^{w}}{\sum_{i=1}^{N} b_{ij}^{w}} = \dfrac{b_{ij}^{w}}{b_{.j}^{w}}$ for all i and j.

Note that $d_{..,ij} \log\left(\frac{1}{d_{..,ij}}\right)$ is generally replaced by $\lim_{d_{..,ij} \to 0}\left[d_{..,ij} \log\left(\frac{1}{d_{..,ij}}\right)\right] = 0$ for $d_{..,ij} = 0$ (Theil 1971).

The row and column entropy are conceptually similar to the backward and forward concentration index, but more descriptive of the characteristics of the economy as a whole as they are calculated from the final demand weighted matrix of total requirement coefficients.

Taking into account final sales increases the relative importance of agriculture in terms of purchases from other industries (Figure 12). Agriculture ranked 18th in 1976-77 and 12th in 1994-95 for the backward concentration index compared to 14th in 1976-77 and 6th in 1994-95 for the row entropy. This implies that the contribution of agriculture to economic activity has been rising because of (i) increased purchases from other industries and (ii) a rising share in total final demand. The opposite holds true for owner-occupied dwellings, whose ranking is lower and declined faster for the final demand weighted entropy measure than the backward concentration index.

Figure 12: Ranking of row entropy (final demand weighted)

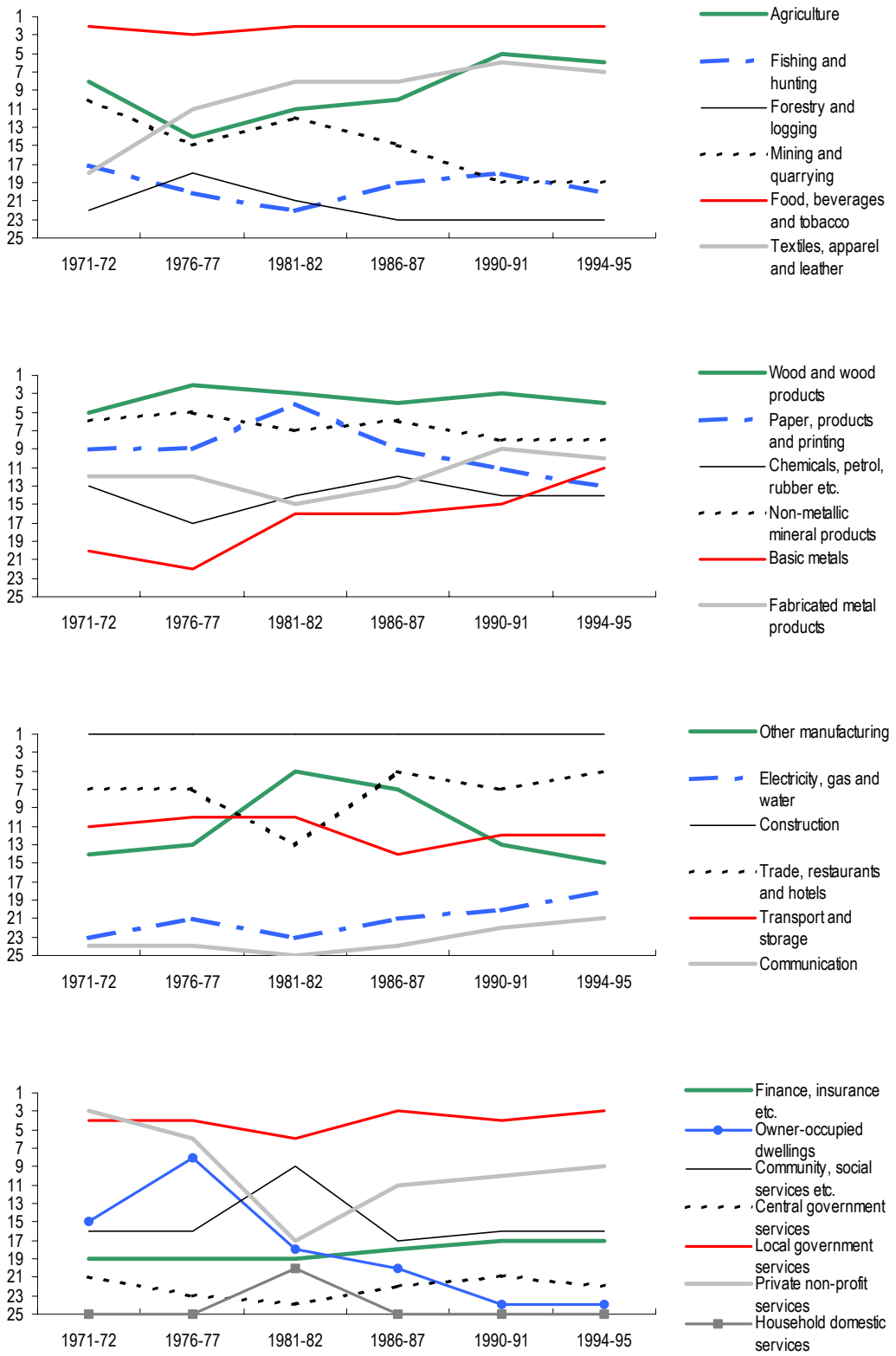
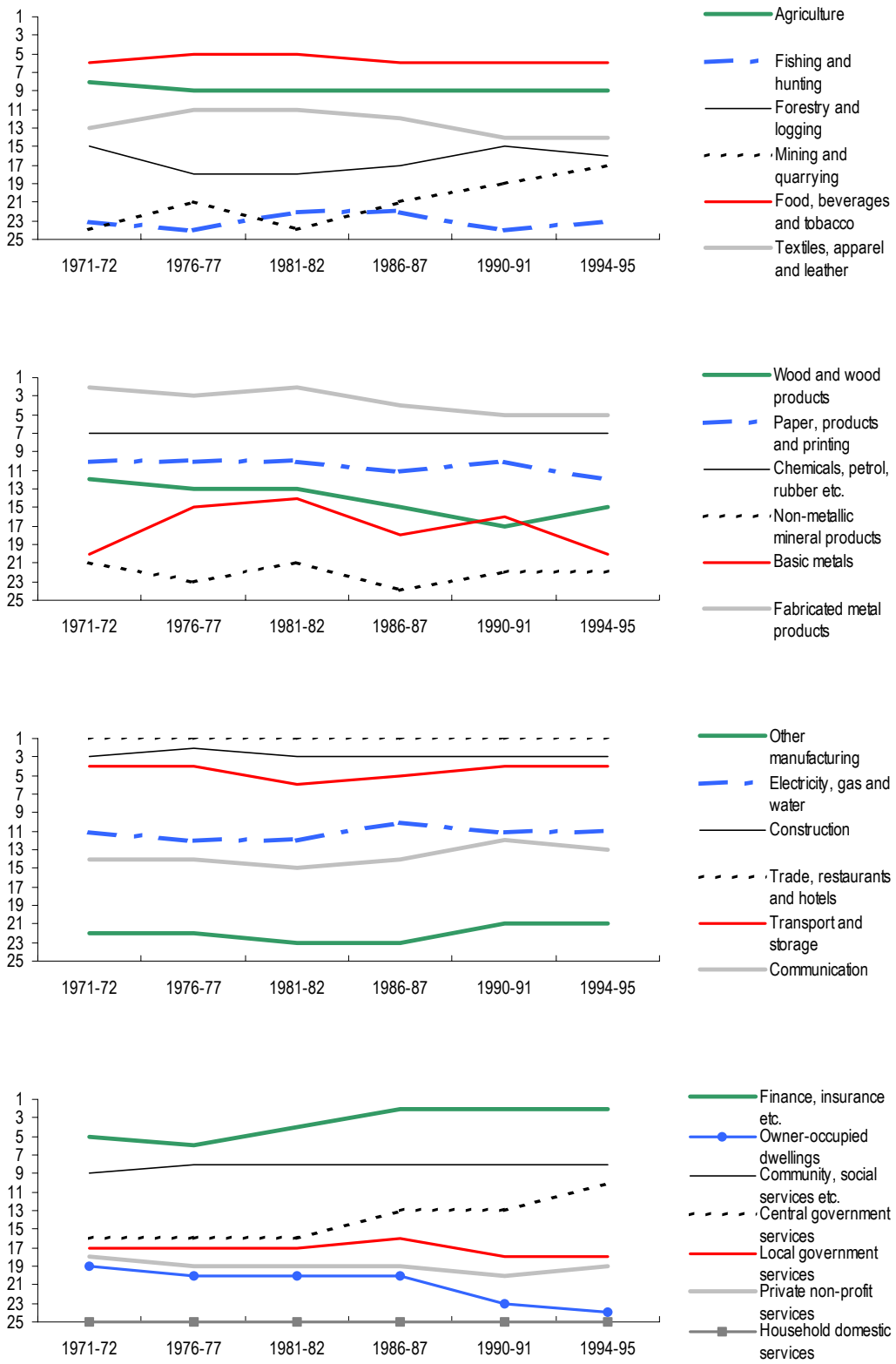


Figure 13: Ranking of column entropy (final demand weighted)



The improvement in the ranking is less sharp for basic metals and more gradual for textile, apparel and leather for the demand weighted entropy measure than the backward concentration index. The overall ranking is lower for forestry and logging and higher for trade, restaurants and hotels, while the ranking for electricity, gas and water is higher and increasing. As for the backward concentration index, the ranking of other manufacturing also increases and then falls for the row entropy, but taking into account the share of other manufacturing in final demand the decline occurs earlier.

A comparison of the forward concentration index (Figure 11) and the column entropy weighted by final demand (Figure 13) shows some differences. The ranking of other manufacturing, and community, social services etc. no longer declines when taking into account industries' final demand output. This suggests less diverse outputs from other manufacturing, and community, social services etc., but greater final demand for the (existing) products of these industries. Figure 13 also shows that the relative importance of central government services has been increasing because of higher final demand.

The measures discussed so far ranked industries by sales and purchases with other industries. To take into account inter industry transactions as well as deliveries to final demand, an extended version of the entropy measure can be used. The row entropy of total sales flows is calculated by normalising

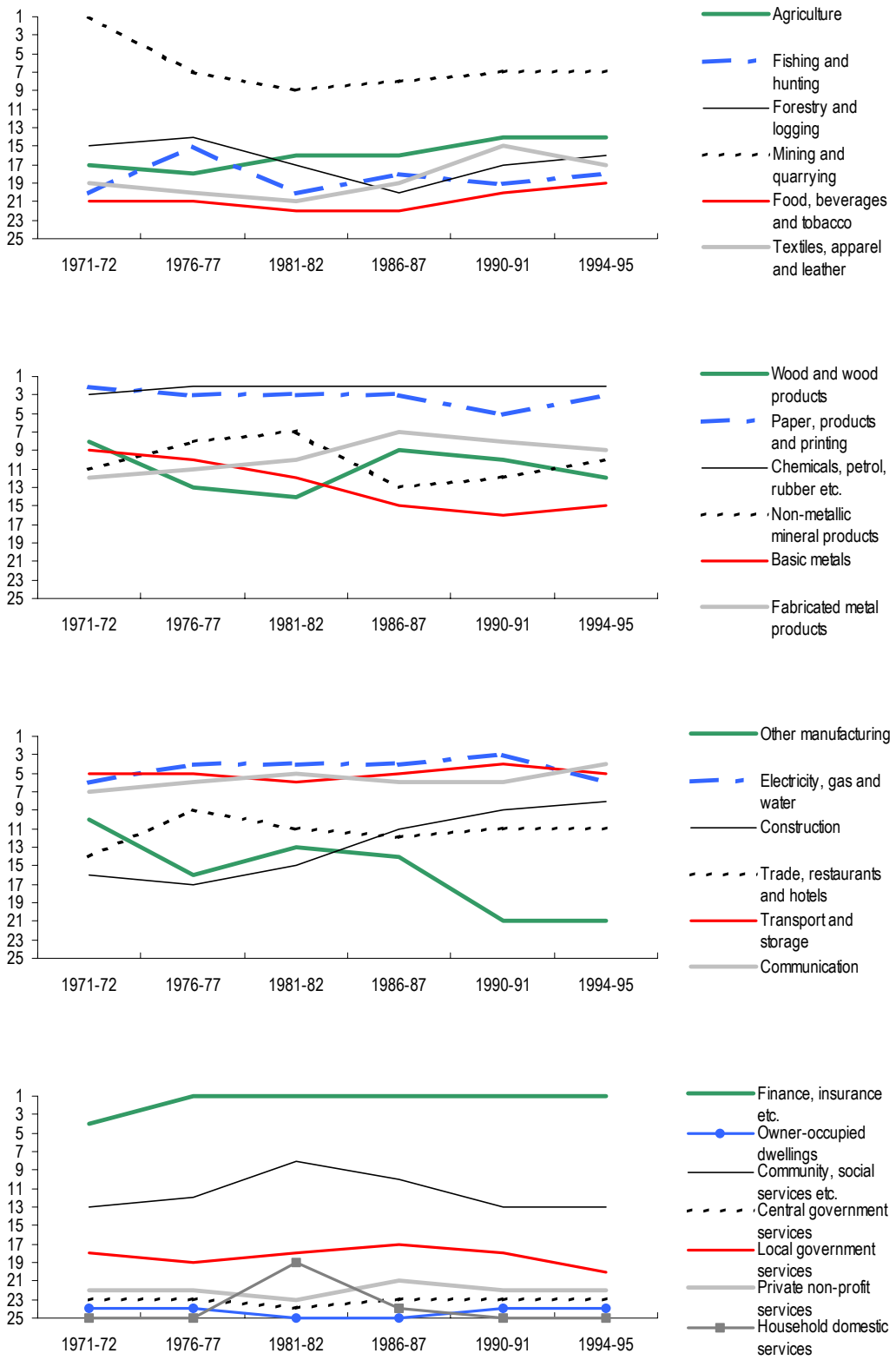
$$x_i = a_{i1}x_1 + a_{i2}x_2 + \ldots + a_{iN}x_N + f_i \tag{13}$$

and then dividing both sides of (13) by x_i and applying the following entropy formula to the proportions, af_{ij}^{w},

$$H_{.j}(af_{ij}^{w}) = \sum_{j=1}^{N} af_{ij}^{w} \log\left(\frac{1}{af_{ij}^{w}}\right) \tag{14}$$

Figure 14, which plots the ranking of industries according to their row entropy for total sales flows, shows that finance, insurance etc., chemicals, petrol, rubber etc., paper products and printing, communication, transport and storage, and electricity, gas and water have the largest linkage. That is, following an increase in these industries' final demand output leads to higher sales to both the intermediate and final demand sectors. The ranking has been rising steadily for agriculture and for textile, apparel and leather since 1981-82 although declining slightly between 1990-91 and 1994-95. The overall ranking of private non-profit services shifted higher between 1981-82 and 1986-87, while sales to other industries and final demand fell sharply for other manufacturing between 1986-87 and 1990-91.

Figure 14: Ranking of row entropy for total sales flows



4.3 Value added production multiplier

To assess the effect of changes in final demand on value added, and hence gross domestic product, the value added production multiplier is calculated. It is measured as follows

$$D_{.j} = v_j b_{.j}^{w} \qquad (15)$$

where $b_{.j}^{w} = \sum_{i=1}^{N} b_{ij}^{w}$ is the input requirement for a unit increase in the final demand for sector j's output, weighted by each sector's share in total final demand, and v_j is the share of value added in industry j's output. The sum of value added production multipliers across industries is one. $D_{.j}$ hence shows the direct and indirect contribution of a unit increase in final demand to value added in industry j relative to other industries.

The ranking of industries for the value added production multiplier weighted by final demand is plotted in Figure 15. It shows that the contribution to value added rose sharply for finance, insurance etc., and community, social services etc. between 1981-82 and 1986-87 and for communication between 1981-82 and 1990-91. The relative contribution of chemical, petrol, rubber etc. has been rising moderately.

Following a unit increase in final demand, the relative contribution to value added and hence GDP has been declining for textiles, apparel and leather, and construction since the early 1980s. Fabricated metal products fell sharply in the ranking between 1981-82 and 1986-87, but rose steadily thereafter. The contribution is largest for trade, restaurants and hotels, and central government services in part because of the large labour component in these industries.

The ranking of industries for the production multiplier weighted by exports is plotted in Figure 16. It shows that the steady increase in the contribution to value added of fabricated metal products following the decline in the mid-1980s (Figure 15) was largely driven by exports. A comparison of Figures 15 and 16 also shows that the contribution of exports by chemical, petrol, rubber etc. has been rising faster than total final demand. The relative contribution to value added of other manufacturing has generally been falling for the export weighted production multiplier since 1981-82. This implies that the increase in the share of exports as a percent of gross output for other manufacturing (Figure 2) did not translate into higher value added or faster GDP growth.

The contribution of forestry and logging fell between 1971-72 and 1986-87 but rose between 1986-87 and 1994-95 relative to other industries. For agriculture, the value added production multiplier weighted by exports has been higher and more stable than the total final demand multiplier. The overall contribution to value added following a unit increase in export demand has been increasing for finance, insurance etc., community, social services etc., and communication.

Figure 15: Ranking of value added production multiplier (final demand weighted)

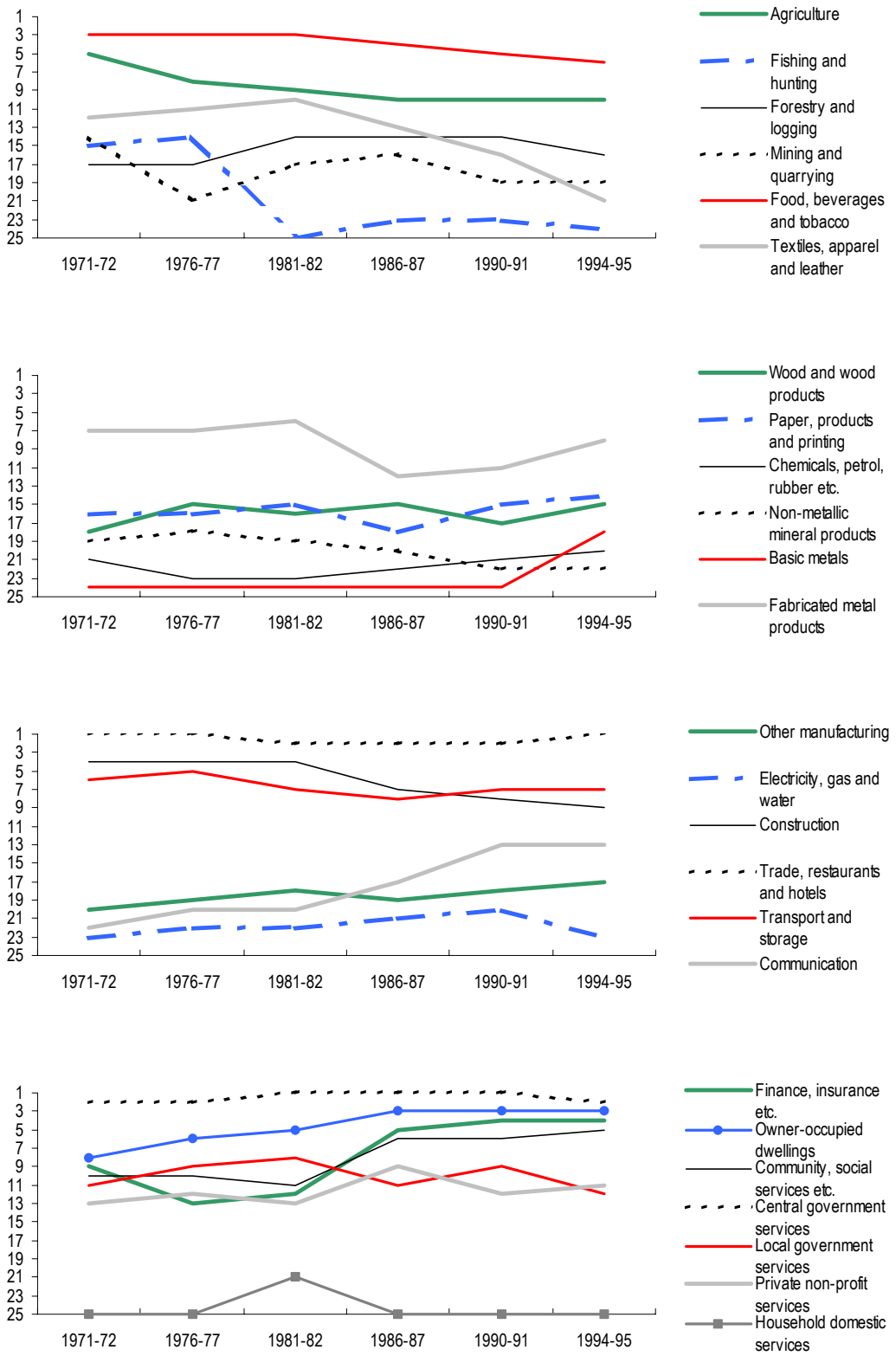
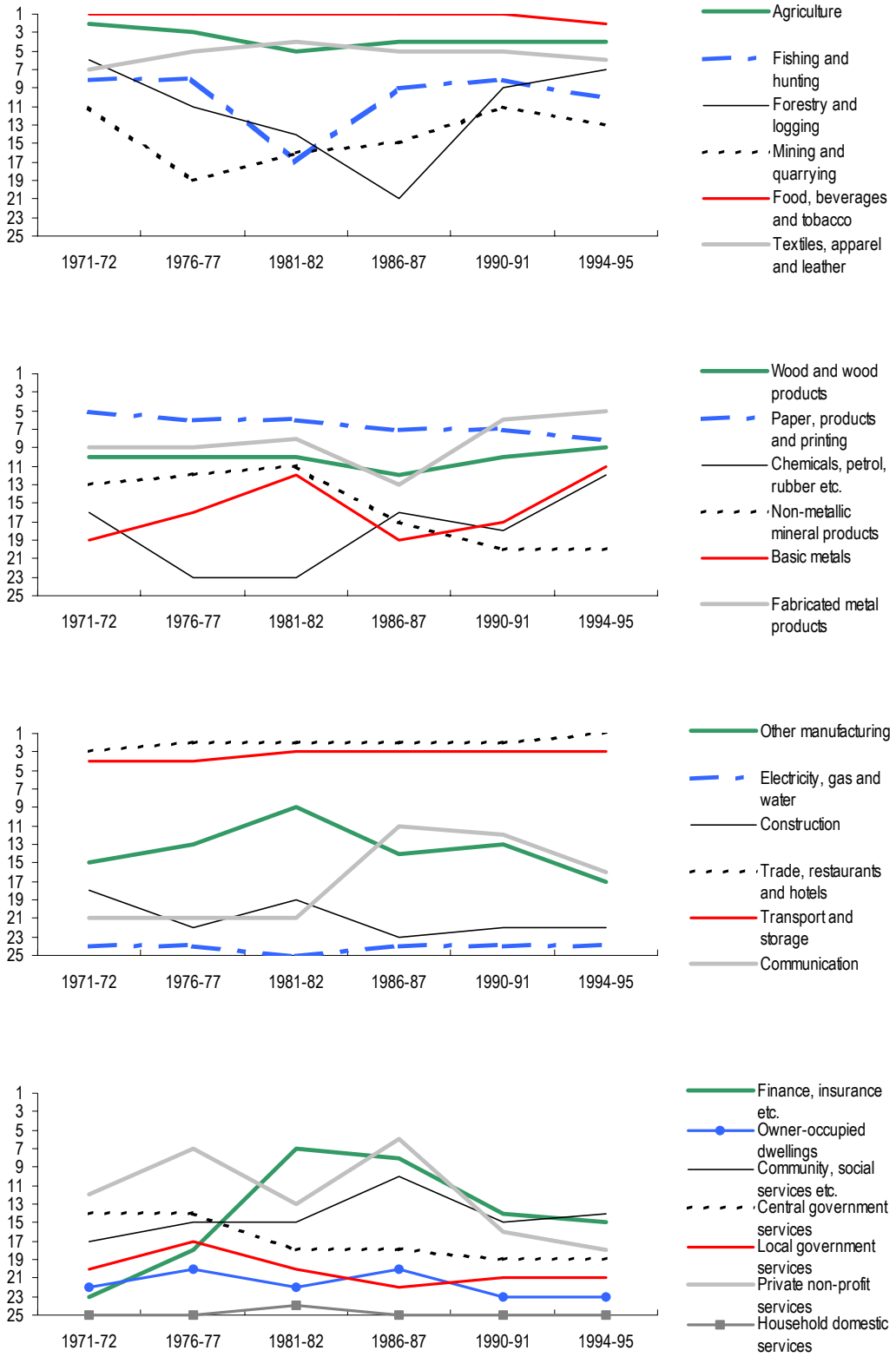


Figure 16: Ranking of value added production multiplier (export weighted)



4.4 Cumulated primary input coefficient for compensation of employees[24]

Wages and salaries are the largest component of value added despite a fall in their share for most industries and the economy as a whole (Figures 4 and 5). The relative importance of industries in terms of contribution to employment can be assessed with the cumulated primary input coefficient for compensation of employees. The coefficient measures the effect of an increase in gross output by one industry on wages and salaries for the economy as a whole. It takes into account direct payments by an industry for salaries and wages and indirect payments, i.e. compensation of employees by industries that produce commodities used in that industry. The cumulated primary input coefficient for primary input l of industry j, E_{lj}, is calculated as follows

$$E_{lj} = \frac{m_{lj} x_j}{\sum_{j=1}^{N} p_{lj} + \sum_{k=1}^{K} p_{lk}} \tag{16}$$

where p_{lj} denotes the primary input l absorbed by industry j, p_{lk} is the primary input l absorbed by final demand category k and K denotes the number of final demand categories. $M = [m_{lj}]$ with $M = P^w B$, where $P^w = [p_{lj}^w]$ is the matrix of industries' primary inputs weighted by their total gross output, i.e. $p_{lj}^w = \frac{p_{lj}}{x_j}$.

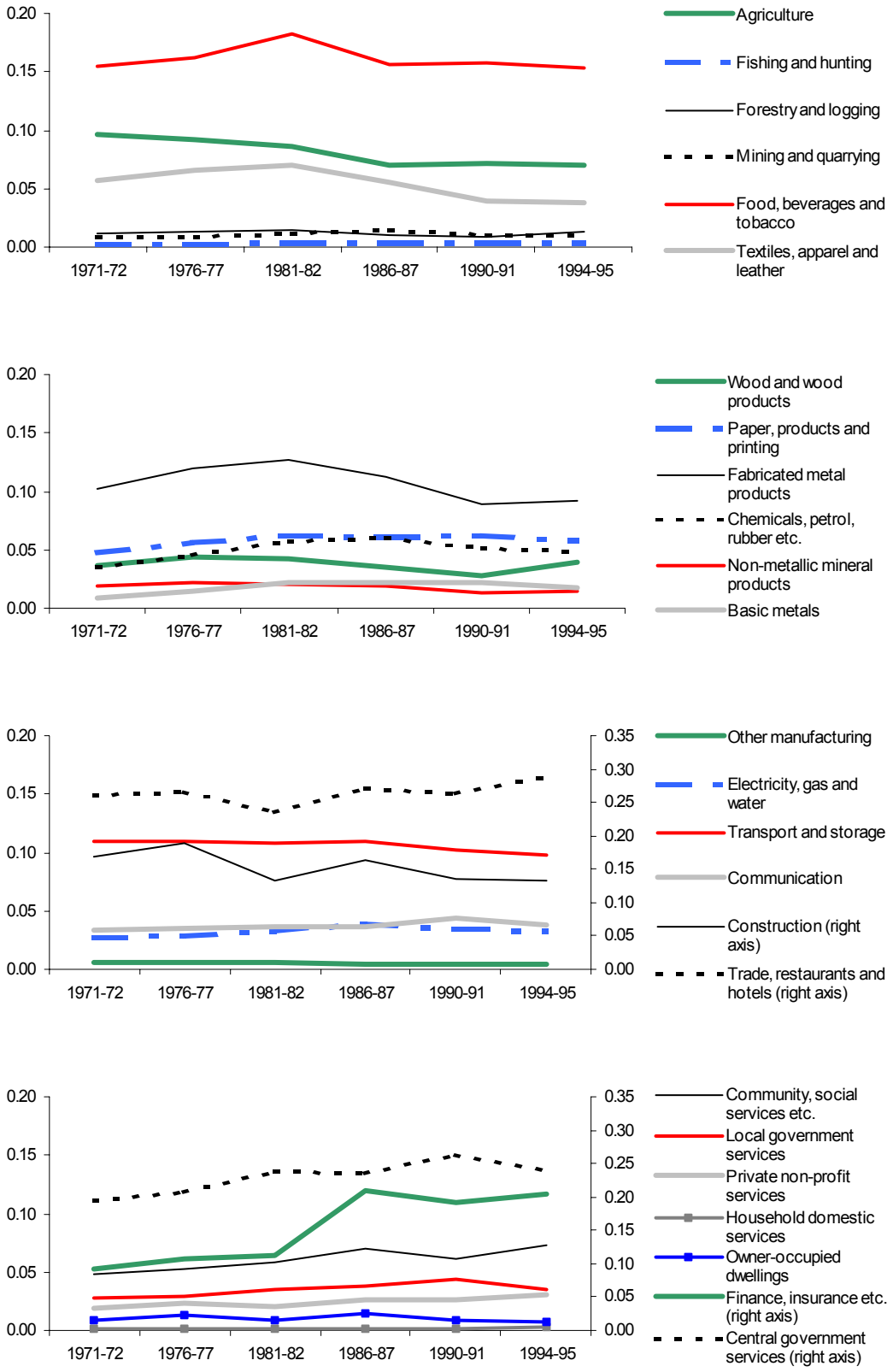
The cumulated primary input coefficient for compensation of employees, shown in Figure 17, is largest for trade, restaurant and hotels, central government services, finance, insurance etc., and construction. The coefficients for these industries ranged between 0.29 (trade, restaurants and hotels) and 0.13 (construction) in 1994-95; that is, given the existing production structure, doubling gross output of trade, restaurants and hotels would have increased compensation of employees for the whole economy by 29 percent.

The cumulated primary input coefficient for compensation of employees rose sharply for finance, insurance etc. from 0.11 in 1981-82 to 0.21 in 1986-87. The coefficient also rose for community, social services etc., local government services, and private non-profit services, reflecting a growing importance of services industries as an employer in the economy. Part of the growing importance is due to manufacturing industries contracting out services that were previously done in-house, including legal services, pay systems, recruitment, design etc. Moreover, the cumulated primary input coefficient for compensation of employees has generally been trending up for paper, products and printing, basic metals, and chemicals, petrol, rubber etc.

The coefficient fell markedly for textile, apparel and leather, and fabricated metal products between 1981-82 and 1990-91.

[24] See (Statistics New Zealand 1989) for more details on cumulated primary input coefficients.

Figure 17: Cumulated primary input coefficients of industries for compensation of employees



A change in gross output of agriculture has a large effect on wages and salaries in the economy as a whole, even though operating surplus is the largest component of value added in this industry rather than compensation of employees (Figure 5). The large impact of agriculture on compensation of employees for the economy as a whole is the result of the size of this industry and its linkages with other industries, although the coefficient has been declining somewhat.

4.5 Import content of exports, gross fixed capital formation and consumption[25]

As discussed in section 2, GDP at market prices can be calculated as the sum of total use in purchasers' prices of final demand less total economy imports. Thus, all else equal, an increase in imports leads to a decline in GDP. To assess the import content of final demand output, the cumulated primary input coefficient for final demand categories can be used. The coefficient shows the contribution of primary inputs (rows 26 to 35 in Table 1) to consumption, exports, gross fixed capital formation and change in stocks taking into account direct and indirect costs of primary inputs by all industries and the ultimate disposition of commodities produced. The matrix of cumulated primary input coefficients for categories of final demand Y is calculated as follows

$$Y = MQ^w + S^w \tag{17}$$

where $Q^w = [q_{ik}^w]$ with $q_{ik}^w = \dfrac{q_{ik}}{\sum_{i=1}^{N} q_{ik} + \sum_{l=1}^{L} s_{lk}}$ is industry i's weighted output absorbed by final demand category k, $S^w = [s_{lk}^w]$ with $s_{lk}^w = \dfrac{s_{lk}}{\sum_{i=1}^{N} q_{ik} + \sum_{l=1}^{L} s_{lk}}$ is the weighted primary input l absorbed by final demand category k, where L denotes the number of primary input categories.

Cumulated primary input coefficients for final demand categories across primary inputs sum to one. The coefficients hence show the contribution of primary inputs to the cost of producing final demand output. The cumulated primary input coefficients for exports, gross fixed capital formation and consumption are plotted in Figures 18 to 20. Primary inputs are broken down into components of value added (i.e. compensation of employees, operating surplus, non-commodity indirect taxes, non-commodity subsidies and consumption of fixed capital), imports and other, where "other" includes commodity indirect taxes, commodity subsidies, second hand assets and import duty. Note that subsidies in 1971-72 also include non-commodity subsidies.[26]

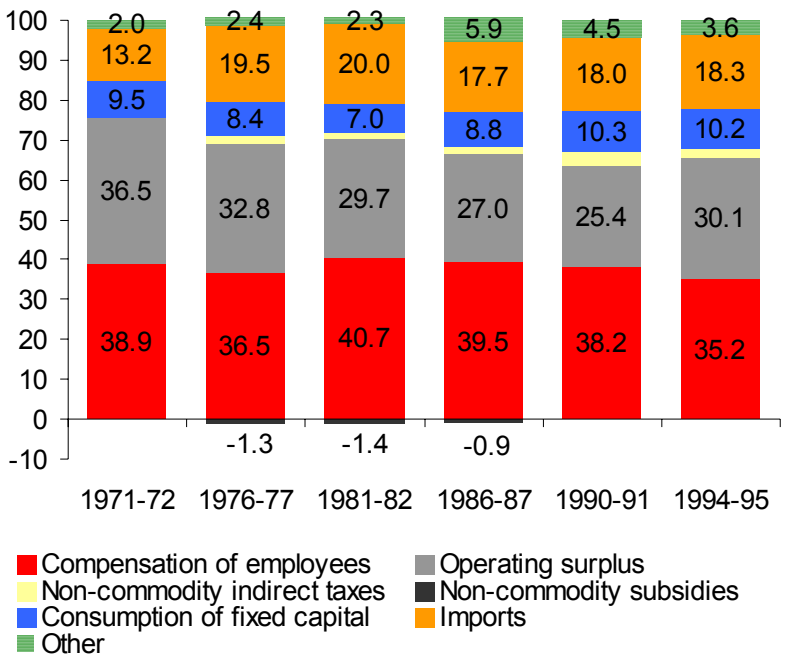
The import content of exports, as measured by the cumulated primary input coefficient for exports, rose from around 13.2 percent in 1971-72 to about 20 percent in 1981-82 (see Figure 18). In 1986-87 it fell to 17.7 percent and increased from 18 percent in 1990-91 to 18.3 percent in 1994-95. The relative decline in the import cost of exports in 1986-87 coincides with an increase in "other" costs, largely due to higher commodity indirect taxes and lower commodity and non-commodity subsidies. Also contributing to the relative

[25] See (Statistics New Zealand 1989) for more details on cumulated primary input coefficients for categories of final demand.
[26] See footnote 12.

decline in import cost was increased consumption of fixed capital following the restructuring of the reforms.

The increase in the contribution of imports to the costs of exports between 1986-87 and 1994-95 coincides with a decline in the contribution of compensation of employees. Operating surplus from exports fell between 1971-72 and 1990-91, but rose sharply in 1994-95.

Figure 18: Cumulated primary input coefficients for exports



As noted in section 2, the share of domestically sourced gross fixed capital formation in aggregate gross output declined, from 9.6 percent in 1971-72 to 7.4 percent in 1994-95 (Figure 1). This decline was more than offset by an increase in the import content of gross fixed capital formation (Figure 19). The import cost of gross fixed capital formation rose from 27.1 percent in 1971-72 to 38.7 percent in 1994-95 while the contribution of labour cost in the form of compensation of employees declined. The contribution of consumption of fixed capital to the cost of gross fixed capital formation fell between 1971-72 and 1981-82, but was higher in 1990-91 and 1994-95.

Figure 19: Cumulated primary input coefficients for gross fixed capital formation

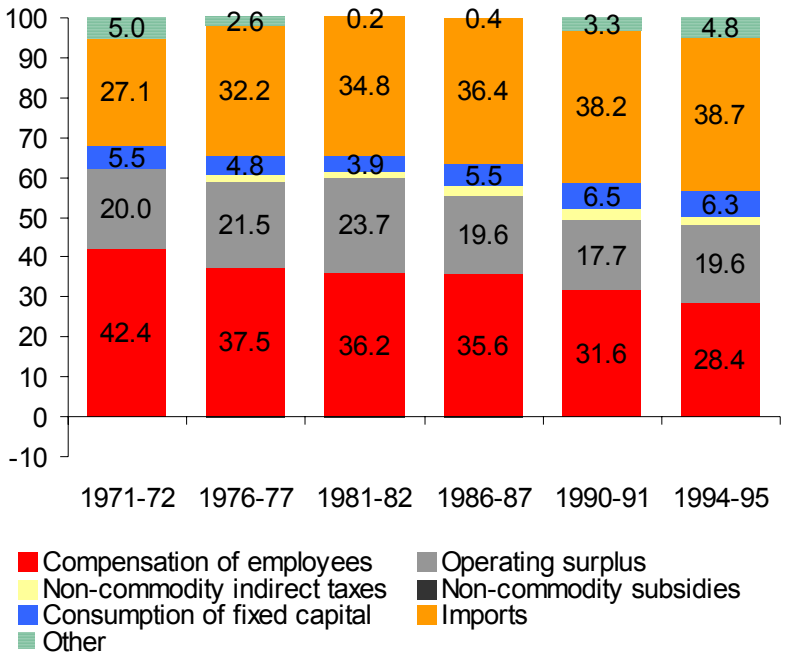
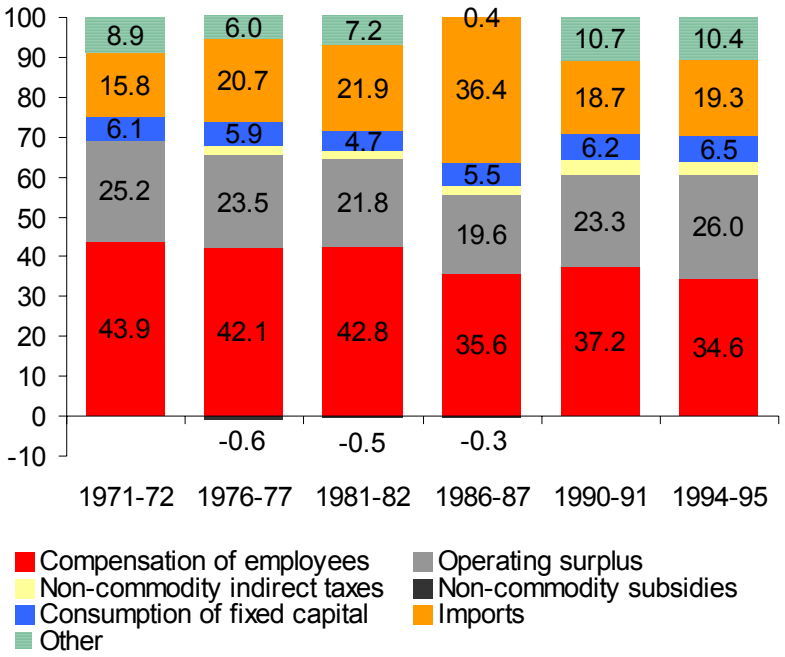


Figure 20: Cumulated primary input coefficients for consumption



The increase in import content of exports (Figure 18) and gross fixed capital formation (Figure 19) between 1990-91 and 1994-95 contributed to a widening of the current account deficit. Also contributing to the current account deficit were imports of consumption goods. The cost of imports of consumption goods rose from 18.7 percent in 1990-91 to 19.3 percent in 1994-95 (Figure 20). It fell in 1986-87 and 1990-91, probably as a result of the removal of import licenses, reduction of tariffs and appreciation of the exchange rate during the period of reform. The New Zealand dollar appreciated partly as a result of tight monetary policy to reduce inflation. High interest rates in turn exacerbated the government's need to finance its budget deficit, leading to an inflow of foreign capital that added further pressure on the exchange rate (Bollard 1991).

5 Summary and conclusions

This paper has investigated changes in the production structure of the New Zealand economy using input output data. The analysis was undertaken at the 25-industry level using inter industry transactions for 1971-72, 1977-78, 1981-82, 1986-87, 1990-91 and 1994-95. Changes in the composition of gross output and value added were examined. Backward and forward linkages, indices of industry interconnectedness, a value added production multiplier, a cumulated primary input coefficient for compensation of employees and a measure of import content of final demand output were calculated. The analysis suggests that some industries have been subject to large structural change.

The contribution of finance, insurance etc. to economic activity rose sharply following the removal of interest rate controls, credit rationing and favoured categories for investment and the introduction of competition for borrowers and new financial instruments. Taking into account direct and indirect transactions, the value of sales and purchases of this industry, the number of industries finance, insurance etc. transacts with and contributions to value added, and hence GDP, all have increased. The shift occurred between 1981-82 and 1986-87 and is consistent with the evidence reported in (Buckle *et al* 2001).

The relative importance of communication also increased but the shift occurred later than for finance, insurance etc. (between 1986-87 and 1990-91). This is probably because telecommunications operations and assets were only deregulated and restrictions on the supply of telecommunications equipment removed in the late 1980s.

For agriculture, the value of transactions has been falling, reflecting a general decline in the agricultural terms of trade and the continuing effect of trade barriers for agricultural products.[27] While the value of transactions has generally been falling, the degree of specialisation, as measured by the number of industries agriculture transacts with, has been rising since the mid-1980s. This increase reflects more outsourcing and diversification in this industry and coincides with gains in total factor productivity reported in (Diewert and Lawrence 1999) and (Hall 1999). Moreover, agricultural exports remain a large contributor to value added and hence GDP in New Zealand.

New Zealand's largest exporters are food, beverages and tobacco, trade, restaurants and hotels, and transport and storage, but the relative importance of several other industries has been increasing, including communication, and chemicals, petrol, rubber etc. Moreover, a rise in exports has increasingly required more output by finance, insurance etc. Inter industry transactions of other manufacturing also have been rising. However,

[27] These barriers include access to European markets, European agricultural export subsidies into third country markets, quarantine and distributive barriers in Japan, complete prohibition of some imports into Korea, restrictions in Middle East markets and quotas in the United States.

the relative contribution to value added of this industry has generally been falling since 1981-82. This has meant that an increase in the share of exports of other manufacturing as a percent of gross output did not translate into higher value added and faster GDP growth.

The results show a shift away from manufacturing towards services industries -- a change that has also been reported for other countries, see for example, (Gowdy 1991). In particular, a rise in the gross output of finance, insurance etc., community, social services etc., local government services, and private non-profit services has had an increasing effect on compensation of employees for the economy as a whole.

Finally, the examination of import content of exports, gross fixed capital formation and consumption goods, as measured by the relative cost of imports, showed an increase in 1990-91 and 1994-95, all contributing to the widening of the current account deficit in the mid-1990s. The import content of gross fixed capital formation increased in each of the six years examined. This possibly indicates an increasing acquisition and diffusion of foreign technology, which is thought to be an important factor contributing to innovation and growth in New Zealand.

The structural change and shifts in New Zealand's pattern of industrial activity are likely to have affected the transmission and propagation of shocks in the economy. The investigation of the dynamic effects of the structural change is left for future work.

References

Bollard, A E (1991) "New Zealand: Radical market-oriented reform." In H Patrick and L Meissner (eds) *Pacific basin industries in distress: Structural adjustment and trade policy in the nine industrialized economies.* Columbia University Press: 129-182.

Buckle, R A (2000) "Macroeconomic stability: Good luck, good policy or good management?" *ISCR Competition & Regulation Times* June: 6-7.

Buckle, R A, D Haugh, and P Thomson (2001) "Calm after the storm?: Supply-side contributions to New Zealand's GDP volatility decline." *New Zealand Treasury Working Paper* 01/03.

Chatterjee, S (1989) "Policy conflicts in economic restructuring: A New Zealand case study in input-output framework." *Massey Economic Papers*.

Claus, I (2002) "Inter industry linkages in New Zealand." *New Zealand Treasury Working Paper* 02/09.

Diewert, E and D Lawrence (1999) "Measuring New Zealand's productivity." *New Zealand Treasury Working Paper* 99/5.

Dixon, R (1996) "Inter-industry transactions and input-output analysis." *Australian Economic Review* 115 (3rd quarter): 327-336.

Easton, B (1997) "Structural transformation." *In stormy seas: The post-war New Zealand economy.* University of Otago Press: 137-185.

Evans, L, A Grimes, B Wilkinson and D Teece (1996) "Economic reform in New Zealand 1984-96: The pursuit of efficiency." *Journal of Economic Literature* 34: 1856-1902.

Gowdy, J (1991) "Structural change in the USA and Japan: An extended input-output analysis." *Economic Systems Research* 3 (4): 413-423.

Hall, V B (1999) "Reform and experience in New Zealand." In P A G van Bergeijk, J van Sinderen and B A Vollaard (eds) *Structural reform in open economies: A road to success?* Edward Elgar: 17-43.

Hirschman, A O (1958) *The strategy of economic development*: Yale University Press.

Kelsey, J (1995) "Market and trade liberalisation." *The New Zealand experiment: A world model for structural adjustment?* Auckland University Press: 85-114.

Rasmussen, P N (1956) *Studies in inter-sectoral relations:* North-Holland.

Redding, S (2002) "Specialisation dynamics." *Journal of International Economics* 58: 299-334.

Silverstone, B, A Bollard, A and R Lattimore (1996) "Introduction." In B Silverstone, A Bollard and R Lattimore (eds) *A study of economic reform: The case of New Zealand*. Elsevier Sciences B V: 1-29.

Soofi, A (1992) "Industry linkages, indices of variation and structure of production: An international comparison." *Economic Systems Research* 4 (4): 349-375.

Statistics New Zealand (1989) *Inter-industry study of the New Zealand economy 1981-82:* Statistics New Zealand.

Theil, H (1971) *Principles of econometrics*: John Wiley & Sons, Inc.

United Nations (1993) "Supply and use tables and input-output." *System of national accounts 1993.* United Nations: 343-378.

Appendix

Figure A1: Backward linkages (final demand weighted)

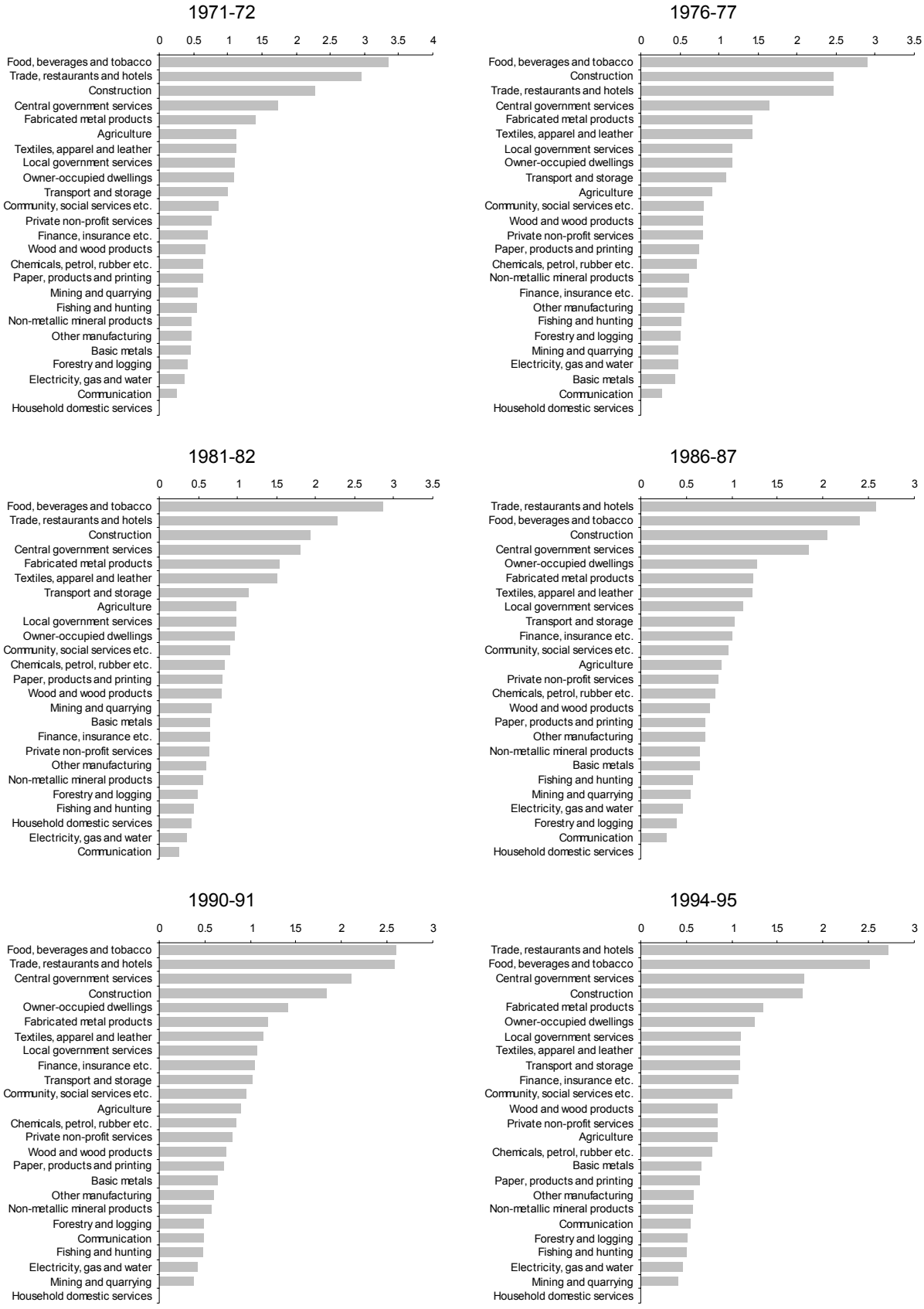


Figure A2: Forward linkages (final demand weighted)

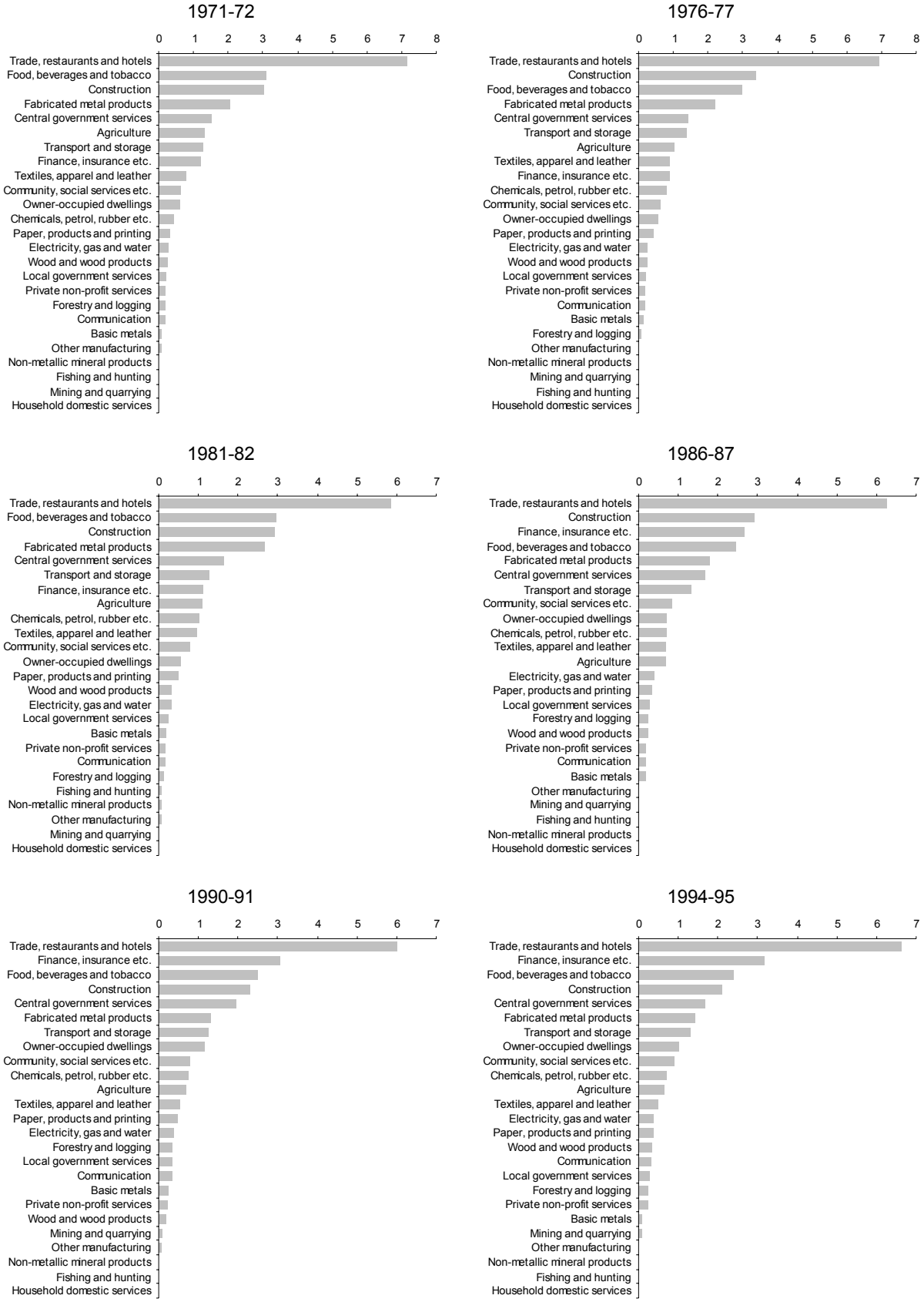


Figure A3: Backward linkages (export weighted)

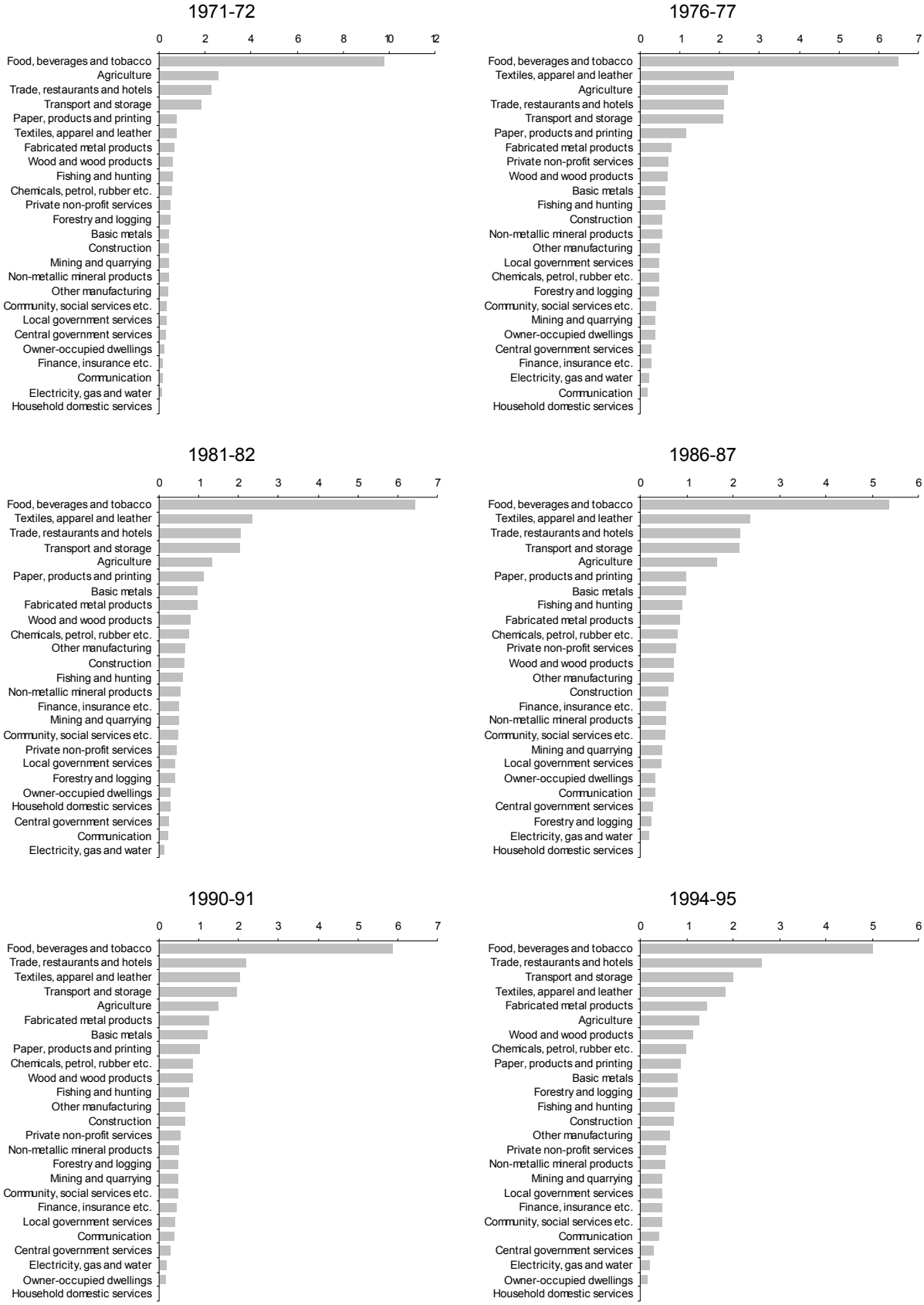


Figure A4: Forward linkages (export weighted)

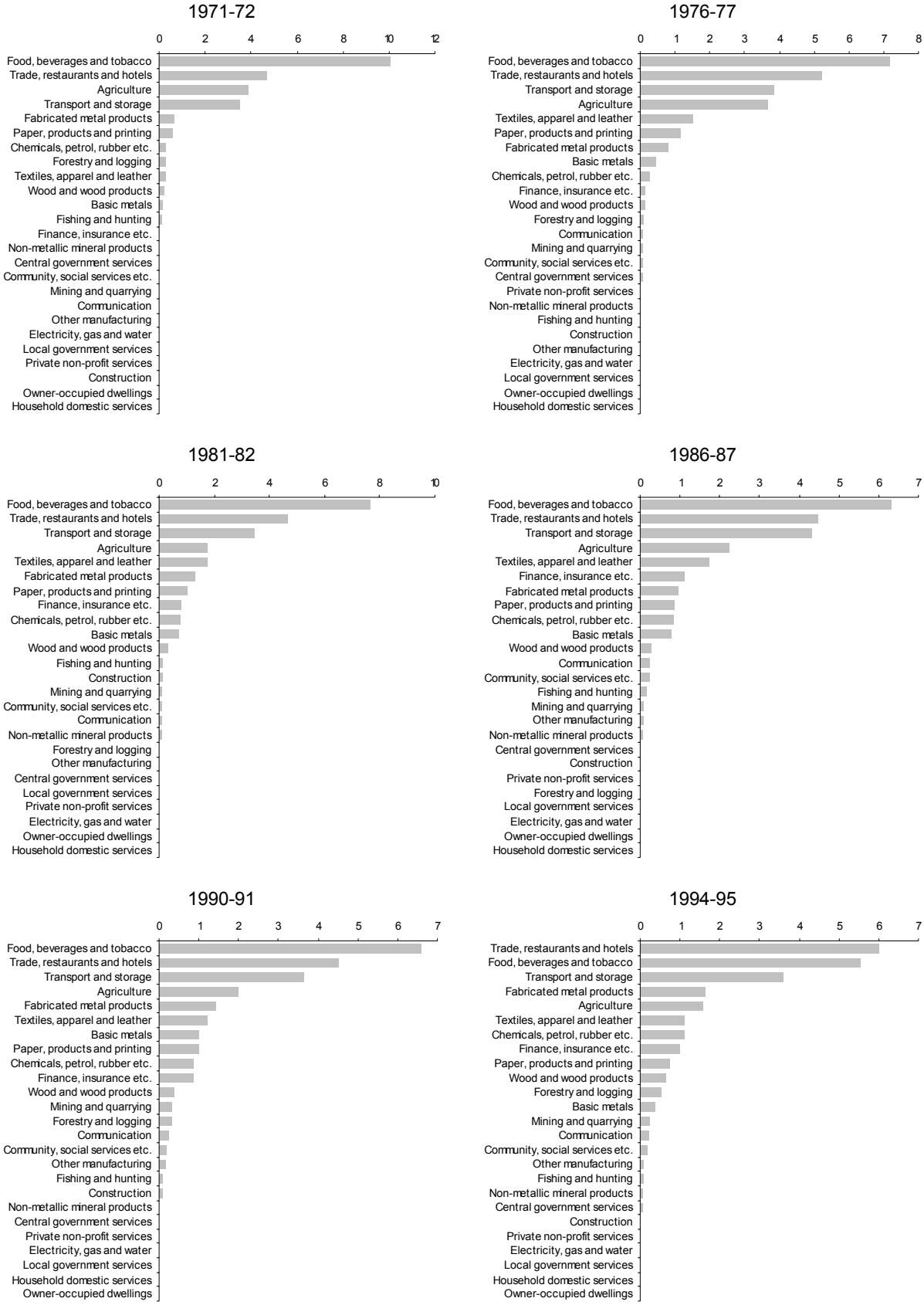


Figure A5: Backward concentration index

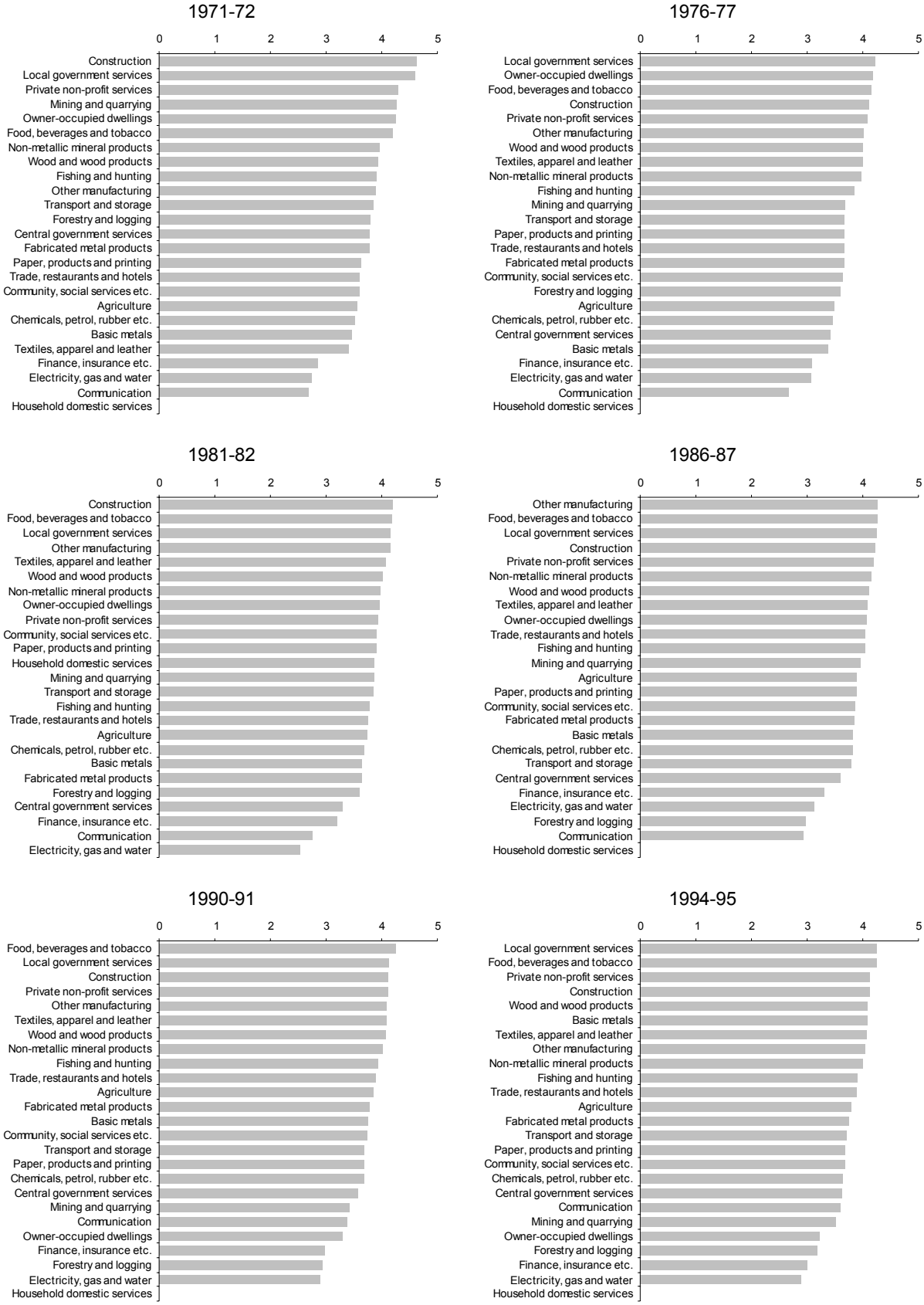


Figure A6: Forward concentration index

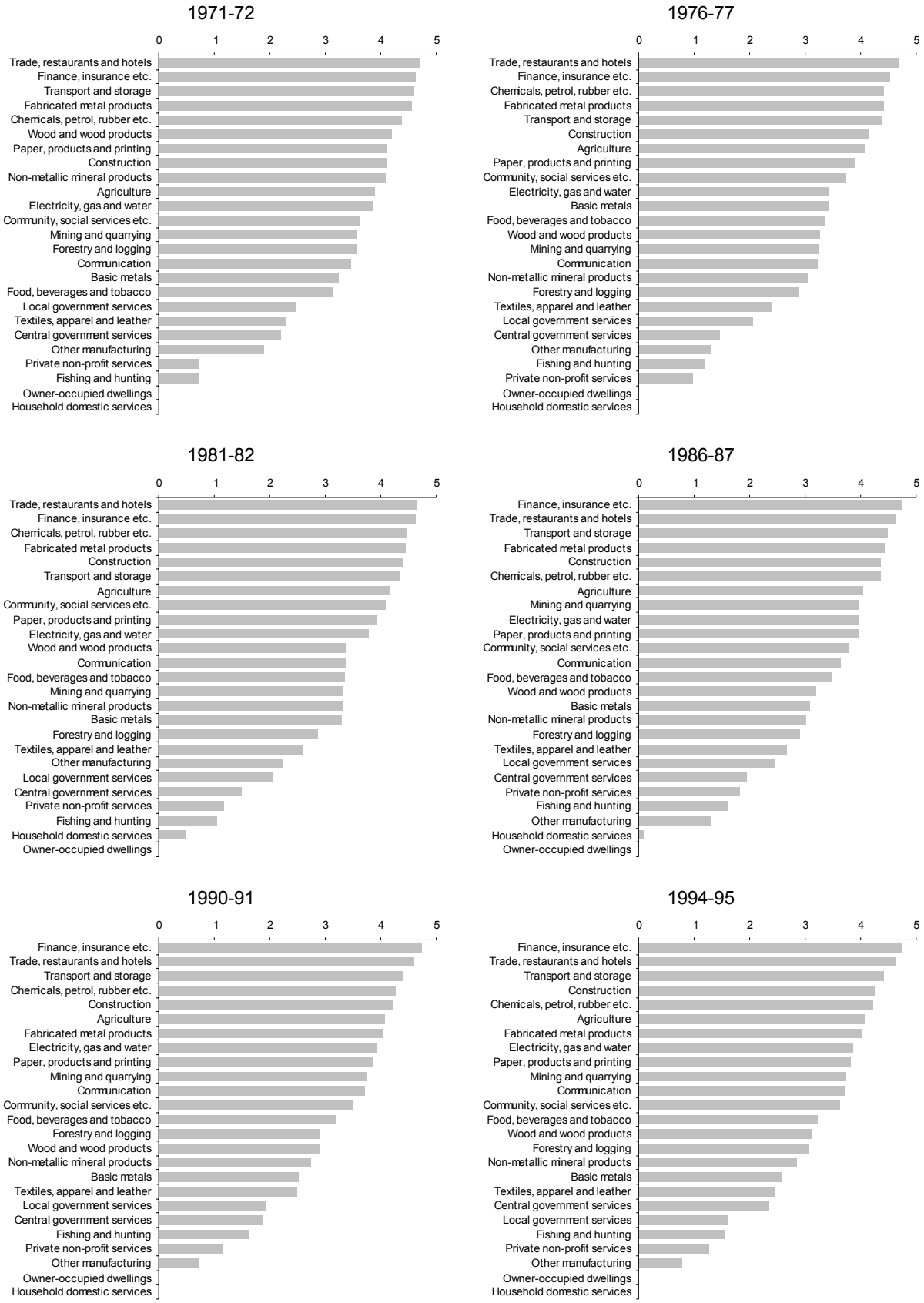


Figure A7: Row entropy (final demand weighted)

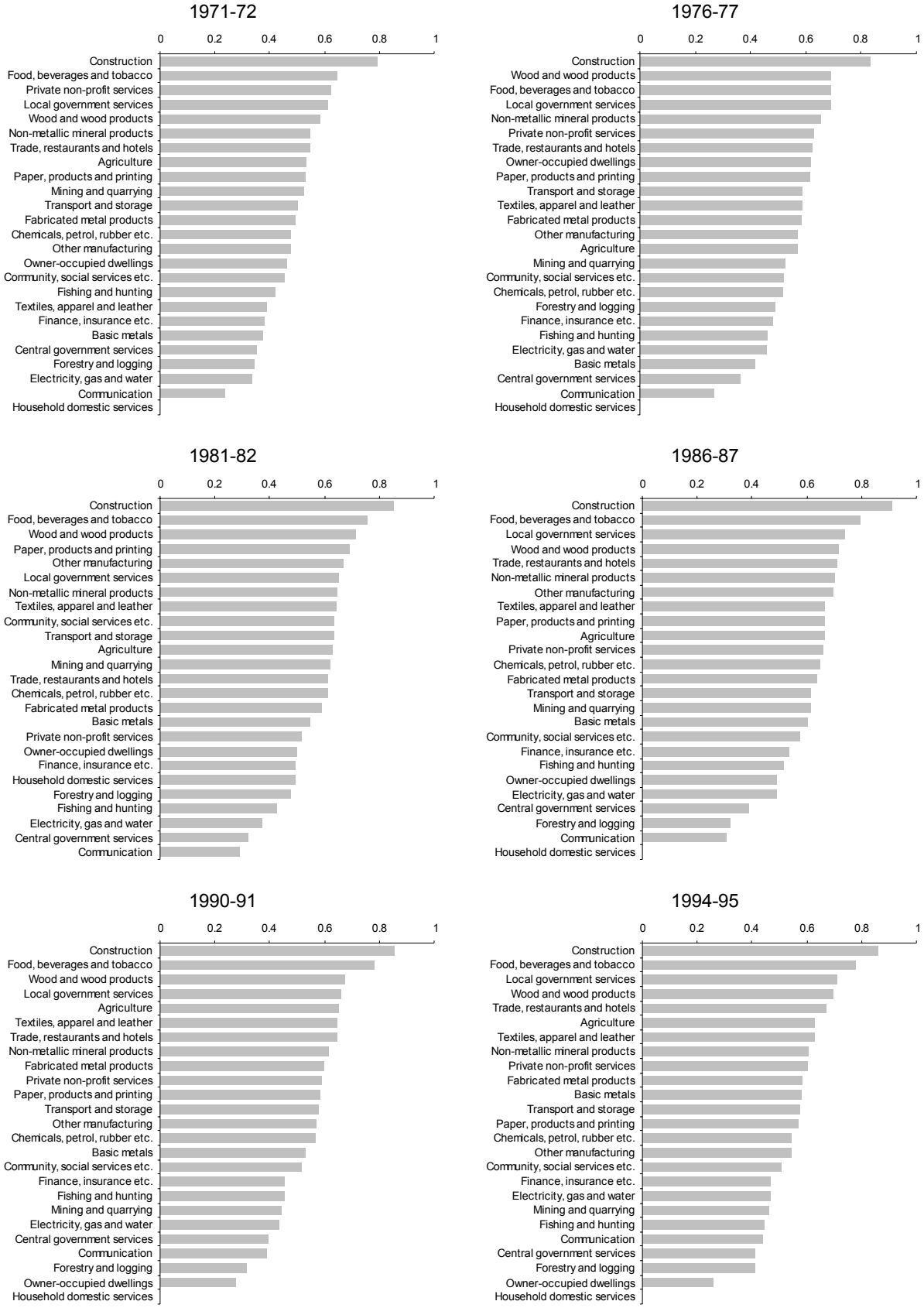


Figure A8: Column entropy (final demand weighted)

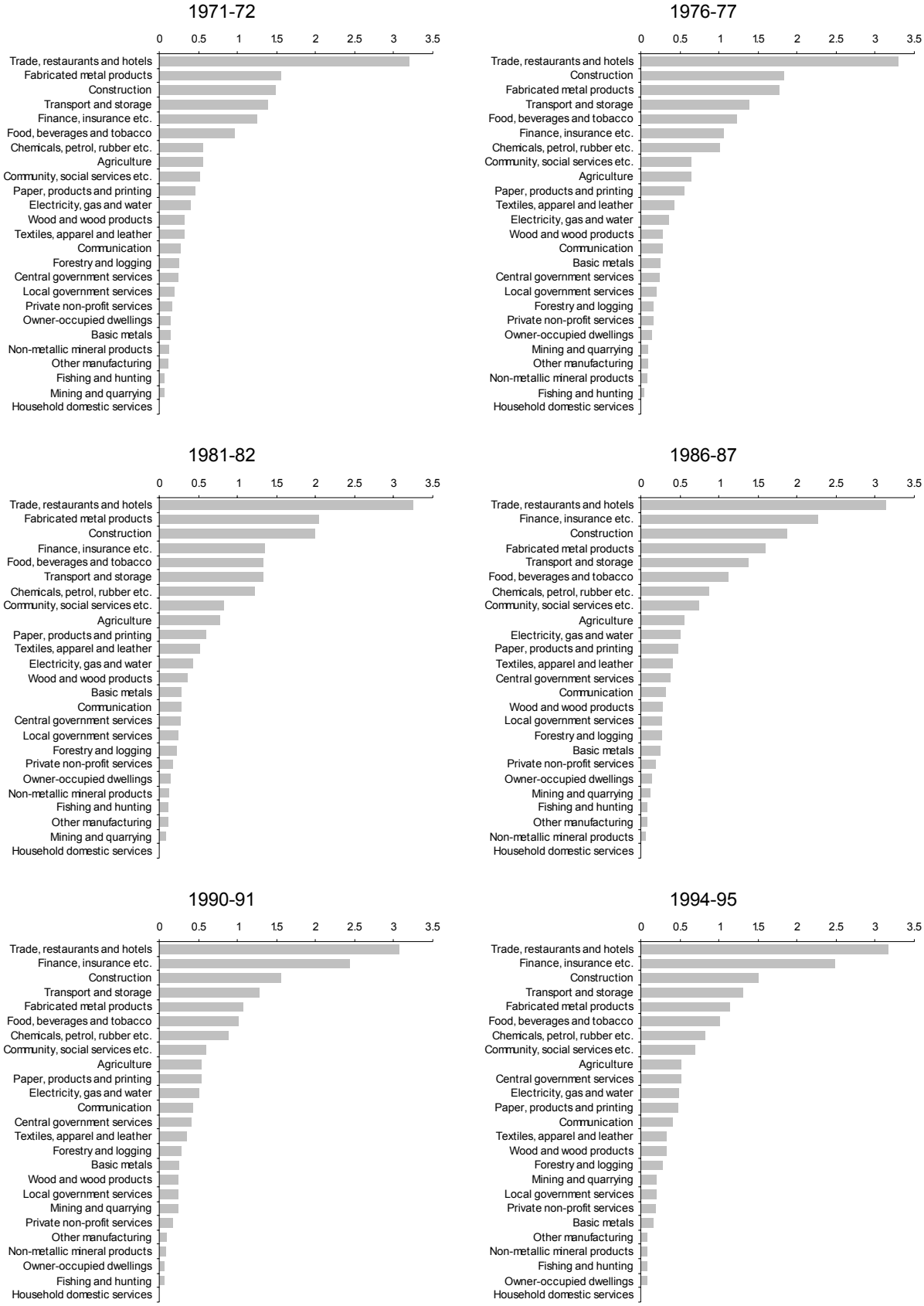


Figure A9: Row entropy for total sales flows

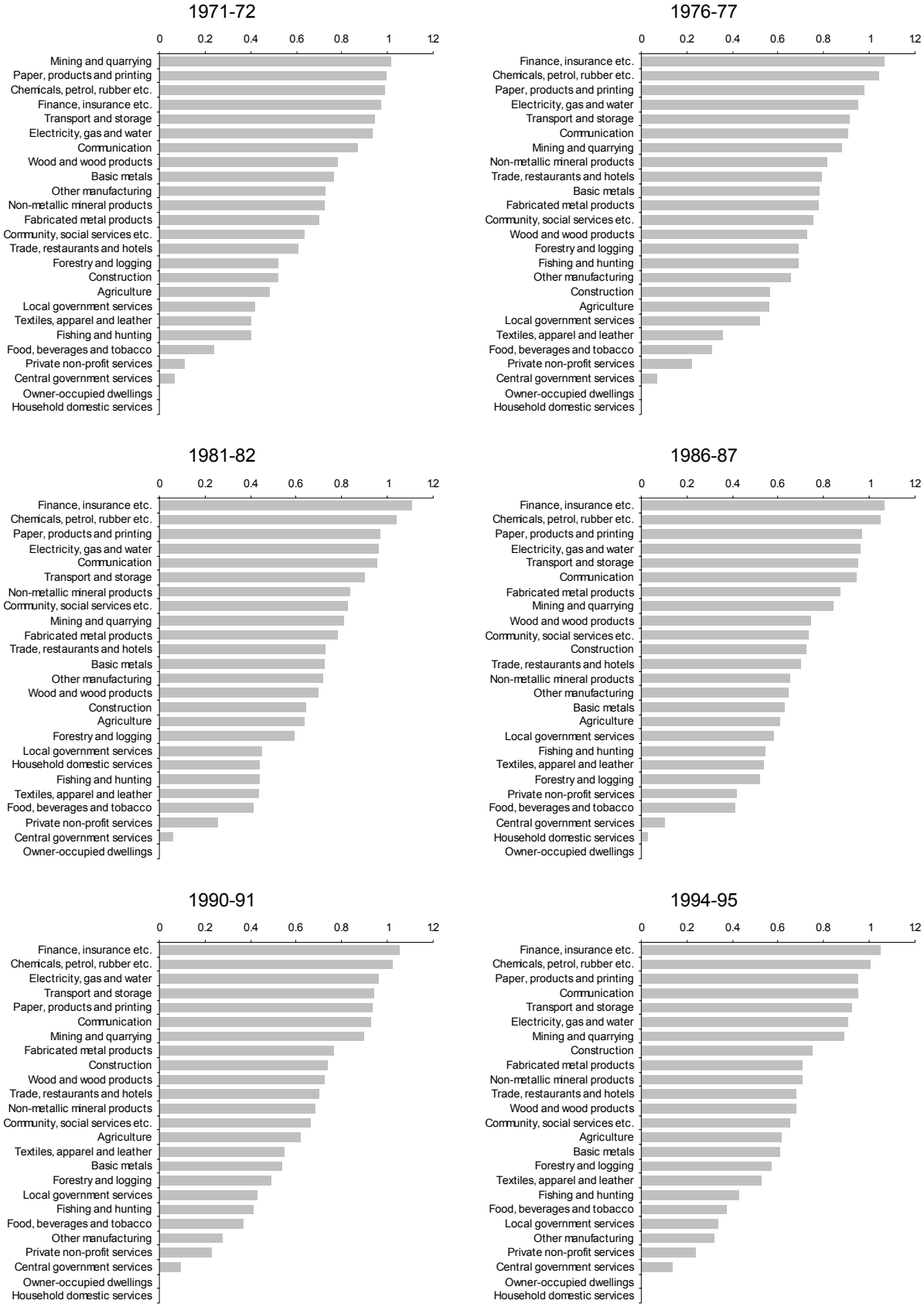


Figure A10: Value added production multiplier (final demand weighted)

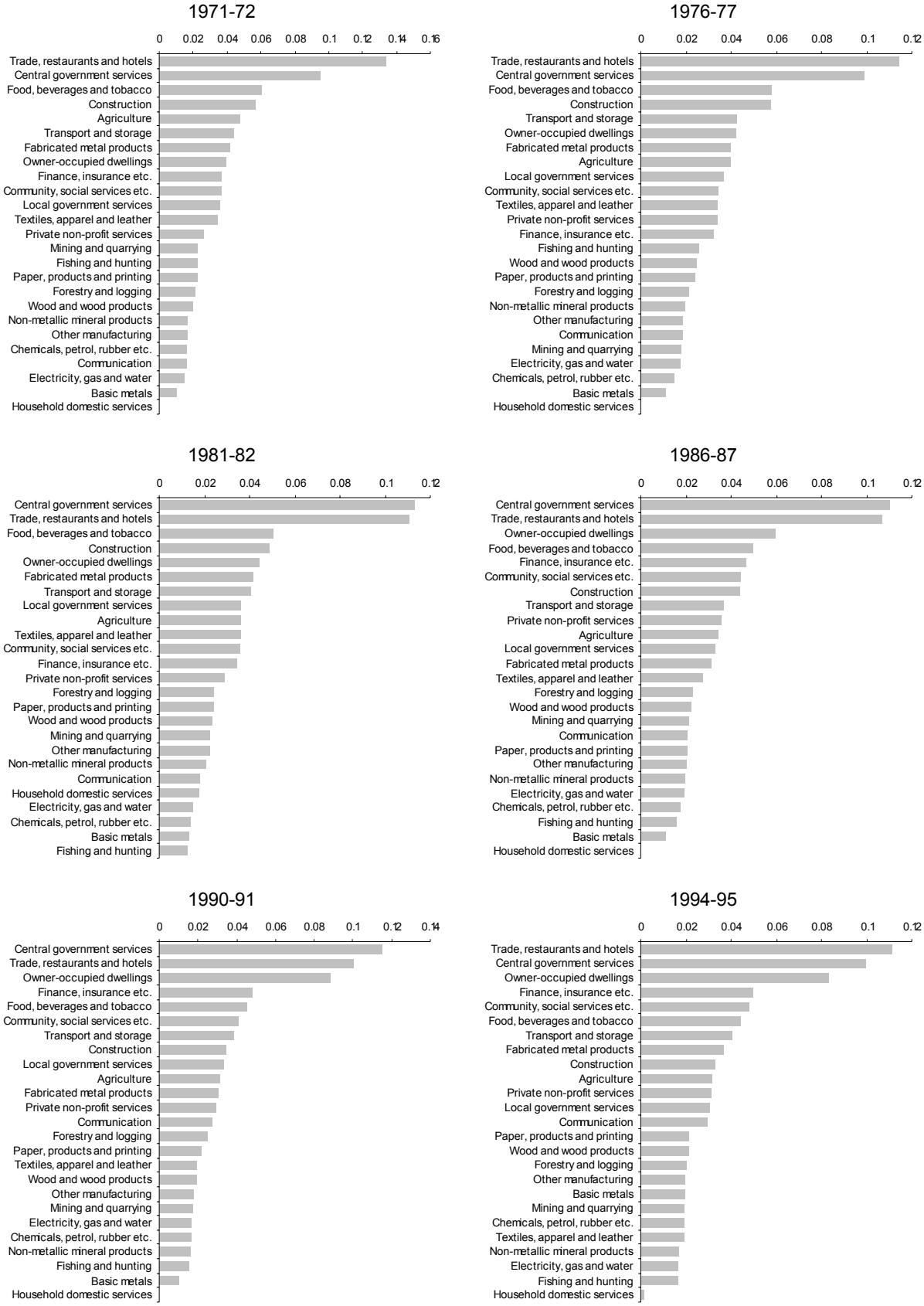
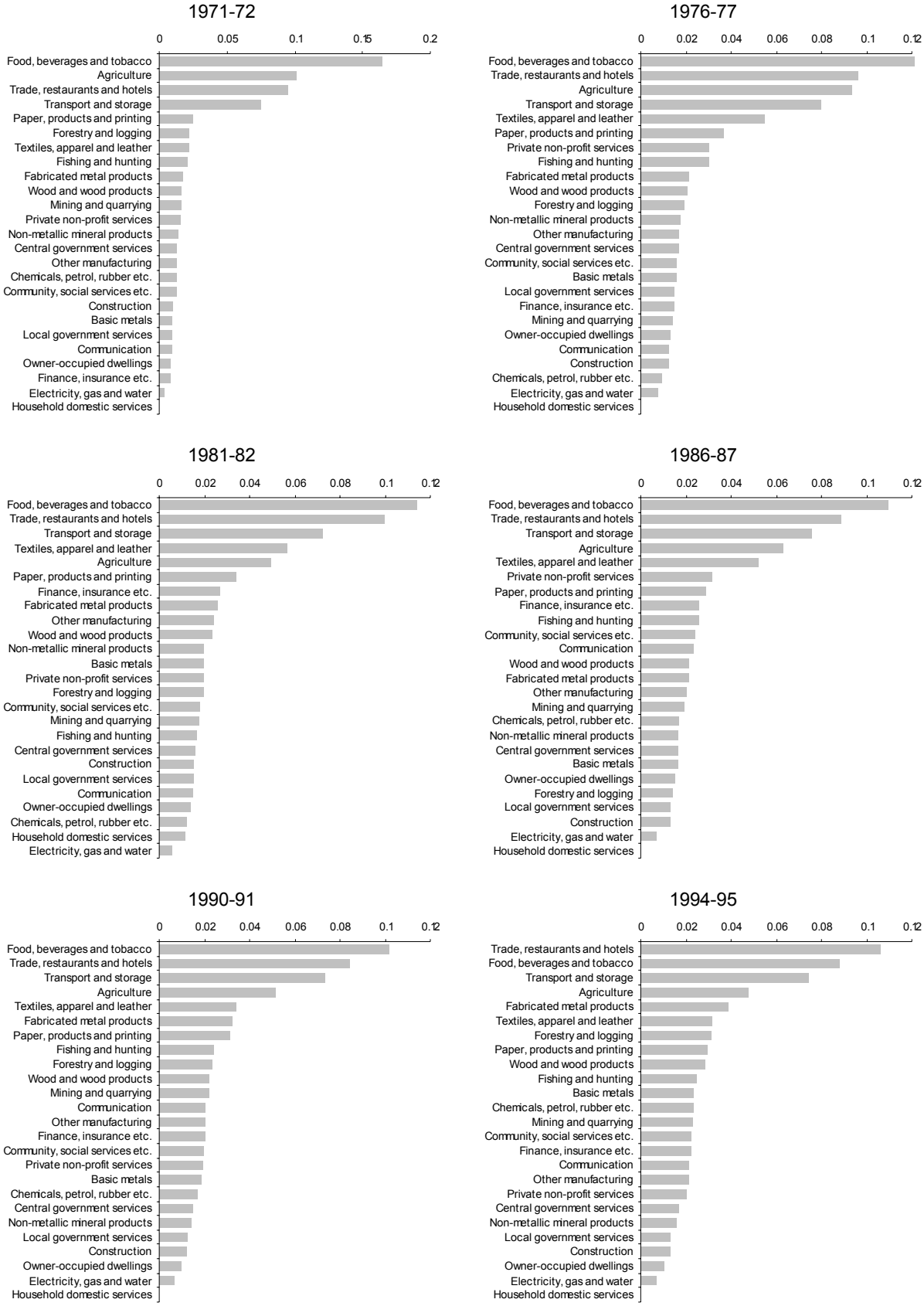



Figure A11: Value added production multiplier (export weighted)