

FACTOR DECOMPOSITION OF SECTORAL GROWTH IN SOUTH AFRICA, 1970-2007

FIONA TREGENNA[†]

Contact: fmt21@cam.ac.uk

Faculty of Economics, University of Cambridge.

ABSTRACT

Chenery's factor decomposition method is used to analyse the sources of growth, by sector, in South Africa from 1970 to 2007. Using input-output data, the growth of each sector is decomposed into components associated with export growth; import substitution; growth in domestic demand; and growth in intermediate demand. The results highlight the dependence on domestic demand expansion as a source of growth in the period since 2000, especially for manufacturing. However, subsectors which relied exclusively or primarily on domestic demand expansion generally performed relatively poorly. The technological change component of growth is the only component with a consistently positive and statistically significant correlation with sectoral growth. The only two manufacturing subsectors for which all four components were positive in the period since 2000, were also the two fastest growing subsectors of the whole economy. The analysis also enables a typology of the subsectors of each of manufacturing and services, according to the relative importance of each of the four components.

Keywords: growth, sectors, factor decomposition, South Africa.

JEL codes: E20, O11, O14, O40.

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1 INTRODUCTION

This paper decomposes sources of sectoral and subsectoral growth in South Africa over the period 1970-2007. The focus is on manufacturing and (private) services; together, these account for 69% of total value added and around 65-66% of total employment (excluding general government).¹ The analysis indicates the extent to which growth of each sector is associated with each of export growth; import substitution; growth in domestic demand; and growth in intermediate demand.

The method used here is based on Chenery's factor decomposition approach, developed initially in Chenery (1960) and subsequently extended by *inter alia* Chenery et al (1962), Chenery and Syrquin (1980), and Kubo et al (1986). The essential methodology has since been applied in a range of studies internationally in recent years, such as Celasun (1983) for Turkey, Akita (1991) for Indonesia, Bharadwaj and Chadha (1991) using Indian data, Korres (1996) for the case of Greece, and Zakaria and Ahmad (1999) for Malaysia.

This analysis utilises South African I-O data.² Although the South African I-O data are of reasonable quality, they are unlikely to be entirely accurate and therefore interpretation of results should be with a degree of caution.

2 EMPIRICAL ANALYSIS

Over any given period, growth in a sector can be decomposed into the following four components:

- *Domestic demand expansion* is the (direct and indirect) effect of the expansion in domestic final demand throughout the economy on the output of the sector. (Domestic demand includes household consumption expenditure, government consumption expenditure, gross capital formation, and a residual item.)

¹ Value added figures derived from the South African Standardised Industry Database (SASID); employment figures derived from SASID and from the September 2007 Labour Force Survey (LFS).

² The I-O tables were accessed through Quantec. It should be noted that there are some years for which certain base information is not available and hence extrapolative techniques were used in the construction of the tables.

- *Export expansion* refers to the (direct and indirect) effect of increasing exports on sectoral output. Note that this is affected not only by direct exports of the sector in question, but by exports of other sectors with which that sector is linked.
- *Import substitution* is the (direct and indirect) effects on sectoral output of increasing the proportion of domestically produced goods. As with export expansion, this is not only import substitution in a specific sector, but also derives from import substitution in other sectors with which a sector is linked. A negative result for import substitution could be thought of as import penetration.³
- *Technological change* denotes the change in sectoral output associated with changing economy-wide technical (input-output) coefficients (in terms of the goods and services which go as intermediate inputs into production). This component is calculated from changes in the matrix of technical coefficients, which shows the flow of intermediate inputs (both domestically produced and imported) into the production of all goods and services in the economy. The technological change component has also been referred to in the literature as intermediate demand expansion.⁴

Technical details of the methodology are summarised in the Appendix. A strength of the method is that it takes account of the interlinked nature of the economy, as opposed to analyses of sectoral trends in isolation from one another. For instance, rather than simply looking at changes in exports by sector, this analysis allows for a quantification of the economy-wide effects of changes in exports once intersectoral linkages are factored in. However, definitive conclusions cannot be drawn about causal relationships or the underlying determinants of growth.

Sectoral growth rates were decomposed over five periods: 1970-1980; 1980-1990; 1990-1995; 1995-2000; and 2000-2007. The 1990s are broken into two periods because of the

³ If comparing the export expansion and import substitution components, an asymmetry needs to be noted in that exports enter as a flow, which is relatively unbounded, whereas imports enter as a ratio to total demand and thus the scope for expansion is bounded at a certain point. (Kubo et al, 1986).

⁴ Note that this component includes linkages with both domestically produced and imported intermediates.

shift to democracy in 1994, with economic policy only really falling under control of the governing African National Congress (ANC) in 1996; furthermore, there were specific dynamics at work in the dying years of the Apartheid regime and beginning of the political transition in the early 1990s. The analysis is undertaken using data in constant (2000) prices.

Figure 1 shows the results of these growth decompositions for the various subsectors of manufacturing and (private) services between 2000 and 2007, while figures 2-5 show the results for earlier periods. Subsectors are grouped into those in manufacturing and those in services. The results are normalised to one hundred to show the relative importance of each component to sectoral growth. Sectors for which the negative component(s) exceeds the positive (the clearest example being basic non-ferrous metals) experienced negative real growth during this period.

Domestic demand expansion is positive for all sectors for 2000-2007. This period is the only one for which this is the case. This can probably be attributed to the relatively high overall growth rates achieved during this period.⁵ Most output growth for most sectors is accounted for by the expansion in domestic demand. For certain subsectors of manufacturing (such as textiles), the expansion of domestic demand is actually the only positive component of growth. Output growth in these sectors was hit particularly hard by negative import substitution (i.e., import penetration). Most subsectors of both manufacturing and services, but particularly of manufacturing, in fact experienced negative import substitution during this period. This is probably related to the inability of the economy to compete internationally with lower-cost producers, even during this period of relatively rapid growth.

Even export expansion contributed negatively to output growth for a handful of manufacturing subsectors, primarily the relatively labour-intensive activities. A clear pattern can be observed of export expansion contributing positively (and in some cases to a quite large extent) to output growth in heavy manufacturing, as compared to generally negative

⁵ Average annualised GDP growth was 4.3%, which although not particularly impressive relative to other developing countries and especially commodity-exporters during this period, was the highest sustained growth reached in South Africa since the 1960s.

contributions in light industry. Relatively export-driven manufacturing sectors include machinery and equipment; basic iron and steel; and motor vehicles and parts.

As for the export expansion component in the case of services, this was positive for all subsectors and was a significant contributor to output growth in certain subsectors. This is surprising given that services are generally relatively non-tradable. However, this contribution is not dramatically higher than in earlier periods. The latter finding might challenge the idea circulating in some policy circles in South Africa that rapid growth in the export of services (particularly finance and retail, and especially to the rest of Africa), is increasingly playing a role as a key engine of growth. Despite reservations in this regard, we might anticipate a fall in the domestic demand component of services growth in the coming few years with the current economic downturn, and if South African companies are able to continue their penetration of African markets in service activities then the export expansion component might be expected to become increasingly important to the growth of services.

Technological change was an important contributor to output growth in services in particular, which may be related to the increasing dependence of manufacturing and the rest of the economy on intermediate inputs from services and outsourcing to services.

Manufacturing can be broken down into five categories of subsectors based on the results from the recent period:

- First, in five light manufacturing subsectors domestic demand expansion is the only positive component of sectoral growth. These are essentially labour-intensive sectors producing mainly consumer goods: textiles; clothing; footwear; tobacco; and furniture. Significantly, these were amongst the slowest growing subsectors of the entire economy during this period, with several of them shrinking in real terms.⁶ These activities were probably particularly strongly negatively affected by competition from lower-cost producers.

⁶ A fuller analysis of the correlation between sectoral growth rates and the results of the growth decomposition analysis follows below.

- In a second group of primarily light and relatively labour-intensive manufacturing sectors, not only the domestic demand expansion but also the technological change components were positive, with the two trade-related components – export expansion and import substitution – being negative as in the first group. This second category includes: food; leather; wood and wood products; and paper and paper products (the latter two might be regarded as ‘semi-light’ manufacturing). These subsectors had medium-low growth rates during this period.
- Third, in a few heavy industry subsectors the import substitution and technological change components are negative but the domestic demand expansion and export expansion components are positive. These subsectors are: rubber and rubber products; non-metallic minerals; basic non-ferrous metals; electrical machinery.
- The fourth category includes most subsectors of heavy industry, in which all components are positive except for import substitution. These are: basic chemicals; other chemicals and man-made fibres; plastic products; glass and glass products; basic iron and steel; machinery and equipment; TV, radio, and communications equipment; and motor vehicles and parts.
- Fifth, in just two subsectors of manufacturing – professional and scientific equipment, and other transport equipment⁷ – all four components were positive. It is significant to note that these were the two fastest growing subsectors of the entire economy during this period.

Four of the 28 subsectors of manufacturing do not fit clearly into this classification. Beverages would be classified into category 2, but we do not include it here as it is a consumer goods subsector unlike the rest of category 2. Nonetheless, it is interesting to note that the beverages subsector is relatively capital-intensive, in common with category 2 and unlike most category 1 subsectors. Conversely, coke and refined petroleum products would fit into category 1, but we have omitted it here since it is a heavy industry. Thirdly, printing, publishing, and recorded media is the only manufacturing subsector with a positive import substitution component, and thus it does not fit into any of the four categories set

⁷ ‘Other transport equipment’ refers to the manufacture of transport equipment other than motor vehicles and parts (e.g., ships and boats, motorcycles, etc.).

out here for manufacturing. In this respect, it is interesting to note that this subsector has a 'service' component and is something of a grey area in terms of the national accounting typology of manufacturing and services. Finally, other manufacturing fits into category 2, but we have not allocated it here since the content of this subsector might change over time (as it is something of a residual category within manufacturing) and hence it is not clear how meaningful the results in this respect might be.

Three groups of services subsectors can be distinguished on the basis of the 2000-2007 results. There were no services activities in which the export expansion component was negative (as in the first two categories of manufacturing identified above).

- In just two subsectors of services (wholesale and retail trade, and transport and storage), the import penetration and technological change components were negative, as in category 3 of manufacturing. However, in both cases the negative technological change component was marginal, and hence these cases are actually close to the next category below. These two subsectors were amongst the slowest growing service subsectors.
- In four of the nine services subsectors, only the import substitution component is negative: these are communication; finance and insurance; business services; and other producers⁸. This group is analogous to category 4 of manufacturing.
- Finally, all four components were positive in catering and accommodation; medical, dental, and veterinary services; and other services excluding medical, dental, and veterinary services⁹.

Table 1 consolidates the results from the various periods analysed, for the economy as a whole and for each of manufacturing and private services, in percentage form (each row sums to 100%).

⁸ 'Other producers' includes laundries and dry-cleaning, hairdressing and other beauty treatments, funeral services, and other services not elsewhere classified.

⁹ 'Other services excluding medical, dental, and veterinary services' includes community, social, and personal activities other than those specifically listed in other categories; the major categories included here are as follows: education, sewage and sanitation, non-governmental organisations, media, and the arts.

Table 1: Summary of results from growth decompositions

		Domestic demand expansion	Export expansion	Import substitution	Technological change
1970-1980	All	74.7	7.7	18.6	-1.0
	Manufacturing	62.6	22.2	30.7	-15.4
	Services	83.5	-3.2	16.6	3.2
1980-1990	All	52.2	14.3	9.3	24.3
	Manufacturing	20.0	28.5	10.3	41.2
	Services	58.5	12.0	7.1	22.4
1990-1995	All	61.5	72.6	-70.4	36.3
	Manufacturing	96.9	165.1	-178.5	16.4
	Services	78.4	37.7	-29.9	13.8
1995-2000	All	29.0	22.2	10.1	38.7
	Manufacturing	23.8	30.3	14.7	31.2
	Services	31.5	12.3	7.9	48.3
2000-2007	All	84.3	18.7	-18.3	15.3
	Manufacturing	111.0	24.0	-52.0	16.9
	Services	64.9	15.0	-5.3	25.4

The results seem reasonable and realistic. A few pertinent observations can be made concerning the results from earlier periods. First, in the 1980s and in the first half of the 1990s, the domestic demand component was negative for a number of sectors (also for one sector in the 1970s and two in the second half of the 1990s). This is probably related to South Africa's very poor growth performance during this period, with an average annualised rate of just 1.3% between 1980 and 1995 (i.e., below population growth).

Second, the export expansion component is particularly important in the first half of the 1990s, and the import substitution component heavily negative. These results are likely to be related to the initial opening up of the economy during this period (after the beginnings of the political transition in February 1990).

Third, in the second half of the 1990s, all four components were positive for all subsectors of services bar one (other producers). Technological change was particularly important here (however, this component was of low importance in the early 1990s, so the relatively high importance in the second half of the decade may have been primarily a 'catch-up').

Fourth, amongst manufacturing subsectors, technological change has generally been a much more significant source of growth in heavy industry than in light industry. This makes sense, given the role of heavy industry as intermediate inputs into the rest of the economy whereas light industry produces mostly consumer goods.

Fifth, the technological change component appears to be increasing over time for the economy as a whole (focussing here on the period from 1980 onwards, since the results from the period 1970-1980 are rather odd in this respect). This is indicative of the increasing contribution of intersectoral linkages to growth. However, it is surprising – and potentially of concern – that the relative importance of this component declines in the most recent period. This is less so in the case of services, which have become increasingly integrated with other sectors.

Lastly, the relative importance of domestic demand expansion to the growth of all sectors is highest in the period 2000-2007. As noted earlier, South Africa experienced its most rapid sustained growth during these years and hence it is not surprising that domestic demand expanded and accounted for a high proportion of growth. However, this was also a period of reasonably rapid global growth, in which commodity-producing countries in particular benefited from high demand. In this light it is disappointing that export expansion did not play a more important role (as can be seen from the relatively low importance of the export expansion component), especially for the economy as a whole (including mining and agriculture, of which exports would have been expected to flourish during the recent period). The negative coefficients for import substitution during this period are also of concern, especially when contrasted with previous periods where these were positive (with the exception of the first half of the 1990s). The particularly large negative value for import substitution for manufacturing during this period highlights the lack of competitiveness of South African manufacturing. As noted earlier, the only two manufacturing subsectors for which this component was positive were the two fastest growing subsectors of the entire economy.

The final part of this analysis looks at correlations between the relative importance of each of the four components of sectoral growth and the growth rate of each sector. (This analysis

of course does not shed light on any causal relationships involved.) Table 2 shows these correlation coefficients, by period, calculated across all 46 subsectors of the economy. Tables 3 and 4 show the correlation coefficients for the subsectors of manufacturing and services respectively. Caution should be exercised in the interpretation of the results from services given the relatively small number of subsectors. For each period, we show the correlation between the rankings of each sector in terms of the relative importance of that component to sectoral growth and in terms of sectoral growth rates.

Technological change is the only component which has a consistently positive correlation with sectoral growth (in terms of rankings), and this correlation is highly statistically significant in every period except the first half of the 1990s (which was a very specific period politically) for the economy as a whole as well as for manufacturing. This suggests a positive relationship between deepening integration and the strength of intersectoral linkages, and sectoral growth rates.

Somewhat surprisingly, there is no strong or statistically significant correlation between rankings in the relative importance of export expansion and in sectoral growth, except in the case of services in later periods (although the sign is unstable between periods). It is not clear why this is the case, and we might only speculate that the underlying determinants of the relative importance of export expansion to sectoral growth differ from those of sectoral growth.

There is a generally positive and statistically significant correlation between rankings in the relative importance of import substitution and in sectoral growth rates in the three periods since 1990 (with the exception of manufacturing between 1990 and 1995, which is positive but not statistically significant, and services between 1995 and 2000, which is negative). There is a particularly strong correlation in this regard since 2000, for the whole economy and for manufacturing, which is interesting as it follows the period of rapid trade liberalisation in the mid- to late-1990s. This might suggest either that subsectors that were less affected by import penetration (for instance, because there was less dramatic tariff liberalisation affecting them) were able to grow relatively fast, or that sectors that were

relatively competitive and healthy were growing fast and were better able to withstand import pressures.

Finally, the correlations between the rankings in domestic demand expansion and rankings in sectoral growth are generally negative and mostly statistically significant. While we cannot impute causality, it is possible that sectors which ‘rely’ primarily on growth in domestic demand are unlikely to be particularly competitive or dynamic. There are particularly high negative correlations for this component since 2000 for the whole economy and for manufacturing, and these are particularly meaningful given that the results for services would also be influenced by their relatively low tradability. These strong correlations might hint at a distinction between dynamic sectors that led the relatively rapid growth rates during this period and sectors that simply depended on the positive spinoffs of this growth by way of expanding domestic demand.

Table 2: Correlation coefficients between each component of sectoral growth and sectoral growth rate, all sectors

	Domestic demand expansion	Export expansion	Import substitution	Technological change
1970-1980	-0.42 ^{***}	0.05	-0.06	0.52 ^{***}
1980-1990	0.37 ^{**}	-0.13	0.04	0.42 ^{***}
1990-1995	0.09	-0.09	0.36 ^{**}	0.22
1995-2000	-0.26 [*]	-0.04	0.29 [*]	0.59 ^{***}
2000-2007	-0.71 ^{***}	-0.01	0.66 ^{***}	0.58 ^{***}

Note: *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. N=46.

Table 3: Correlation coefficients between each component of sectoral growth and sectoral growth rate, manufacturing subsectors

	Domestic demand expansion	Export expansion	Import substitution	Technological change
1970-1980	-.049 ^{***}	-0.18	-0.15	0.66 ^{***}
1980-1990	0.56 ^{***}	-0.13	0.09	0.44 ^{**}
1990-1995	-0.07	0.08	0.26	0.28
1995-2000	-0.49 ^{***}	0.12	0.35 [*]	0.53 ^{***}
2000-2007	-0.88 ^{***}	0.07	0.62 ^{***}	0.56 ^{***}

Note: *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. N=28.

Table 4: Correlation coefficients between each component of sectoral growth and sectoral growth rate, services subsectors

	Domestic demand expansion	Export expansion	Import substitution	Technological change
1970-1980	-0.85 ^{***}	0.07	0.25	0.64
1980-1990	-0.25	-0.79 ^{**}	0.19	0.29
1990-1995	0.81 ^{***}	-0.72 ^{**}	0.86 ^{***}	0.63 [*]
1995-2000	-0.53	-0.89 ^{***}	-0.86 ^{***}	0.68 ^{**}
2000-2007	-0.49	-0.40	0.73 ^{**}	0.51

Note: ^{***} indicates statistical significance at the 1% level, ^{**} at the 5% level, and ^{*} at the 10% level. N=9.

3 CONCLUSIONS

In the period since 2000, growth in South Africa has been heavily reliant on domestic demand expansion, particularly in the case of manufacturing. While this is probably related to the reasonably high growth rate in this period, in the light of the relatively robust global growth during this time we might also have expected a higher contribution from export expansion. In the absence of a more important role for export expansion during the recent past period, it is unlikely that export expansion can make a significant contribution in the coming period without meaningful change, for instance in industrial policies.

Subsectoral analysis suggests that sectors which relied exclusively or primarily on domestic demand expansion performed relatively poorly. There are negative (and mostly statistically significant) correlations between sectoral rankings in the relative importance of the domestic demand component and in growth. The relationship between dependence on domestic demand expansion and the overall dynamism of a sector is obviously complex, and it needs to be borne in mind that certain sectors are by their nature more likely to be domestic demand oriented than others. Nonetheless, it is reasonable to surmise that 'lazy' sectors that are prone – for instance because of institutional reasons and patterns of ownership and control – to rely primarily on domestic demand for their growth, will not only run up against the limits of domestic demand expansion but will also become increasingly vulnerable to import penetration. This is even more so with increasing tradability (for example, because of advances in ICT) of many goods or services traditionally regarded as relatively non-tradable.

The capacity of domestic demand to continue to sustain growth in the coming few years is questionable, in the light of the downturn in growth which South Africa is already experiencing. The level of domestic demand will also be affected by any changes in income distribution, given the differences by income level in marginal consumption propensities, especially of domestically produced goods. Progressive distributional change could potentially boost domestic demand and sustain this component of growth (albeit probably to a rather limited extent), even in the face of low overall growth.

The decomposition of sectoral growth rates also allowed for a typology of the subsectors of each of manufacturing and services, according to the relative importance of each of the four components. Interestingly, the way in which the sectors fall within the various categories set out has some connection with relevant characteristics of those sectors and their performance, such as in their labour-intensity and in their growth rates. For instance, in most labour-intensive light manufacturing activities domestic demand expansion was the only positive component of growth; these were also amongst the sectors with the weakest growth performance economy-wide during this period. In contrast, for most of heavy industry import substitution was the only negative component.

The results from this part of the empirical analysis are also suggestive as to the importance of intersectoral linkages to growth. The technological change component of growth – which essentially represents changes in intersectoral linkages – is the only component found to have a consistently positive and statistically significant correlation with sectoral growth (in terms of the rankings of each).

An interesting finding was that the only two manufacturing subsectors for which all four components were positive in the period since 2000, were also the two fastest growing subsectors of the whole economy. While definitive conclusions cannot be drawn from this, it might highlight the importance of both competitiveness and increasing integration with the rest of the economy for rapid growth.

FIGURES

Fig.1: Decomposition of output growth by sector, 2000-2007

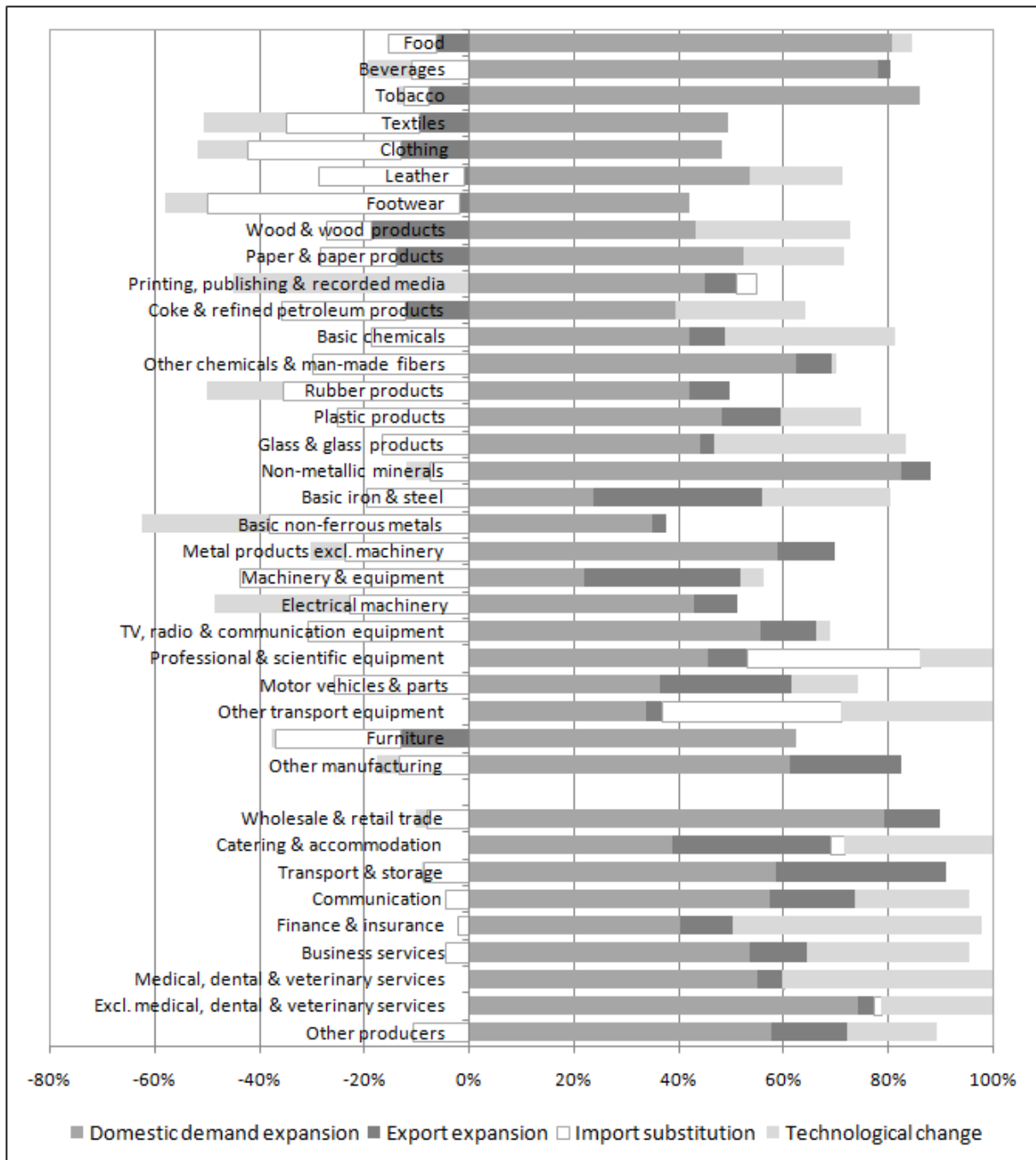


Fig.2: Decomposition of output growth by sector, 1995-2000

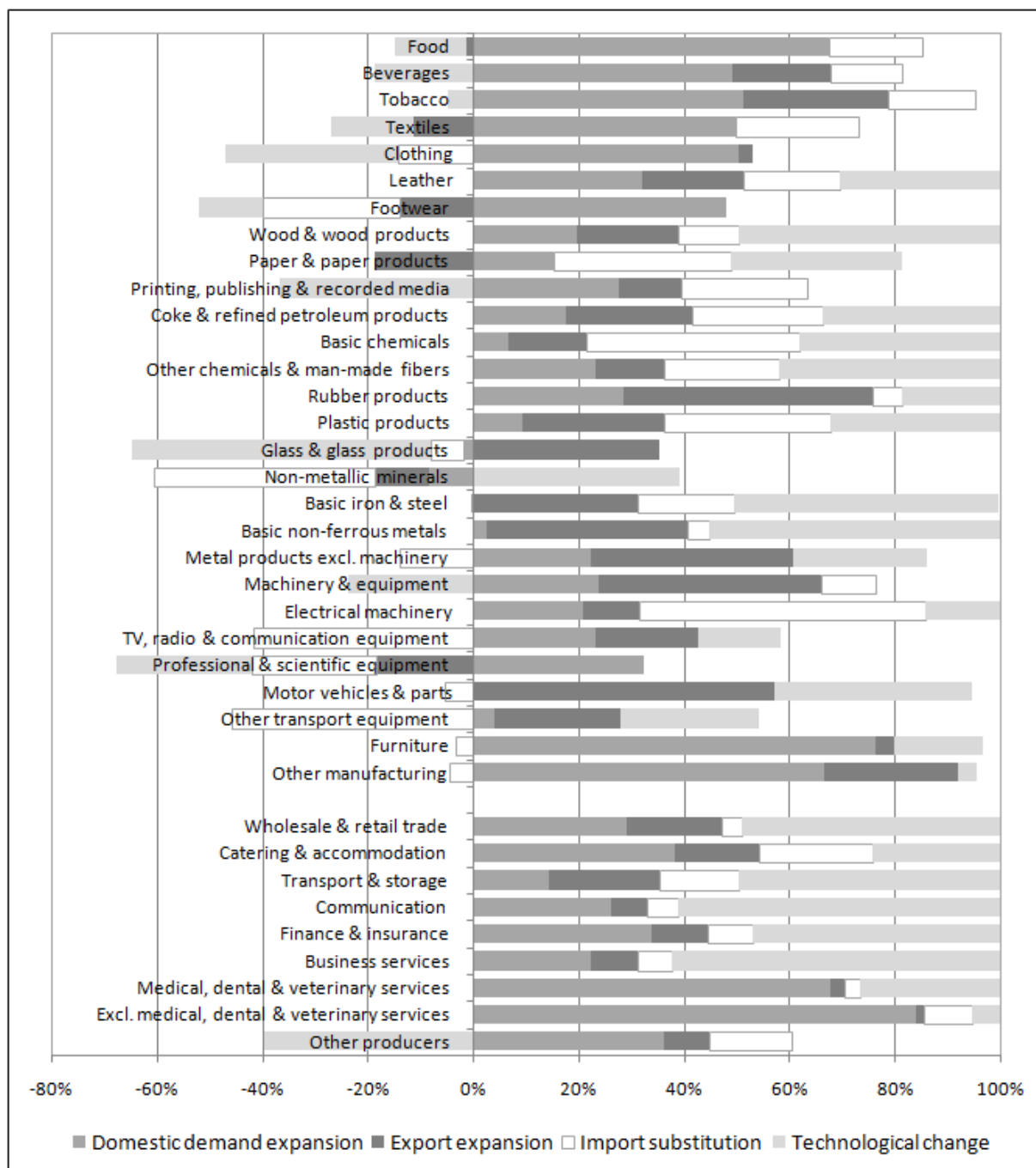


Fig. 3: Decomposition of output growth by sector, 1990-1995

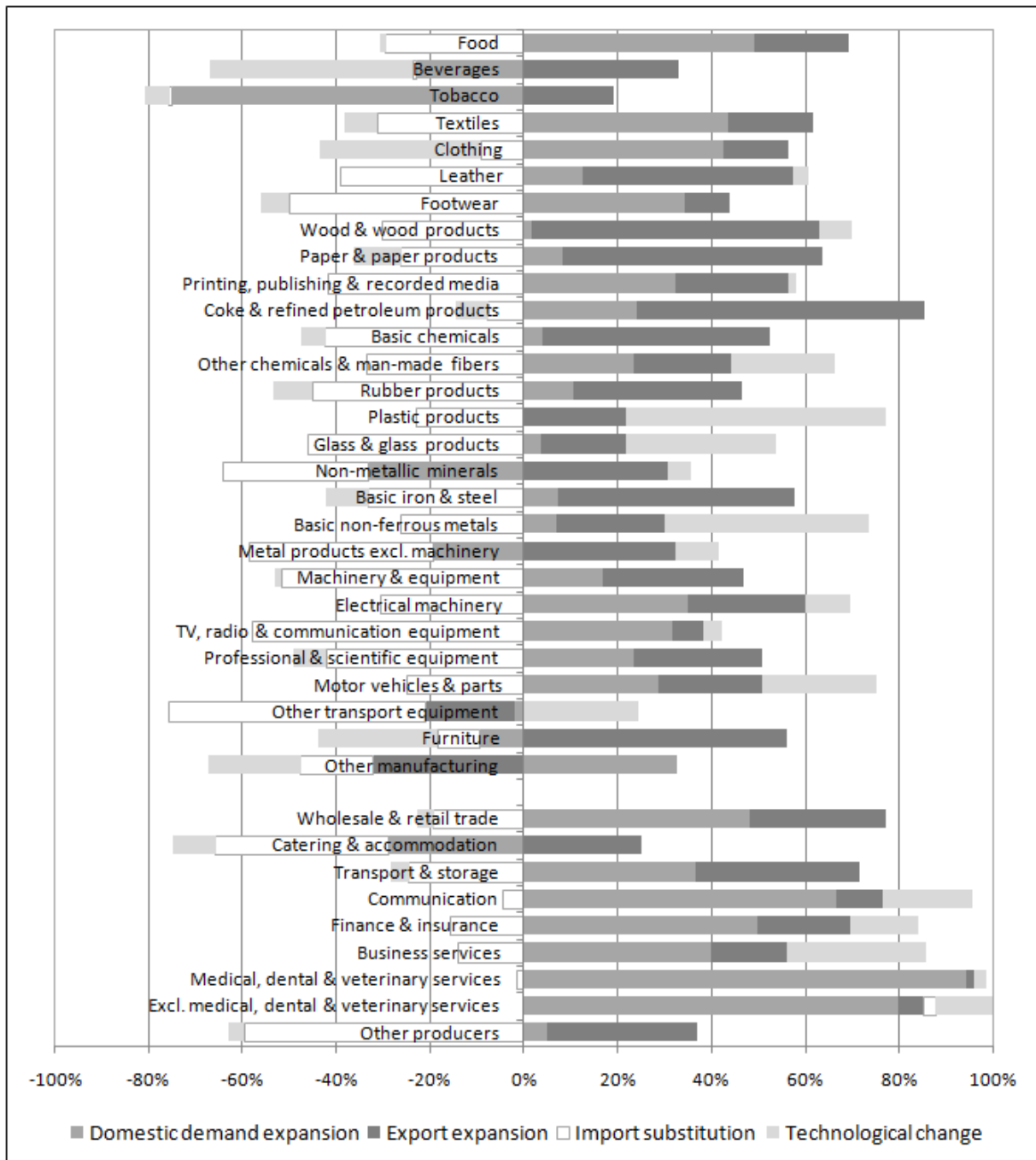


Fig. 4: Decomposition of output growth by sector, 1980-90

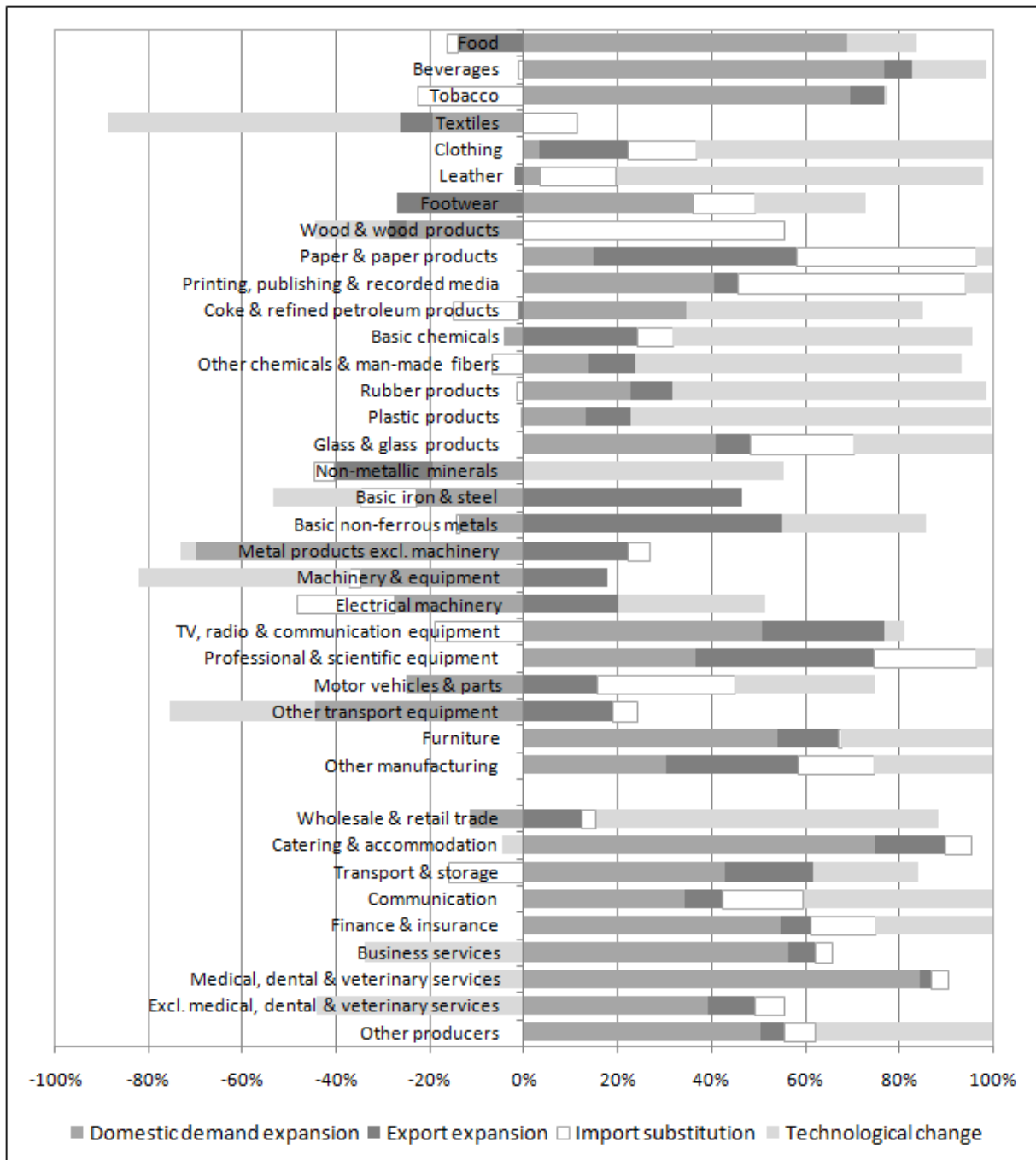
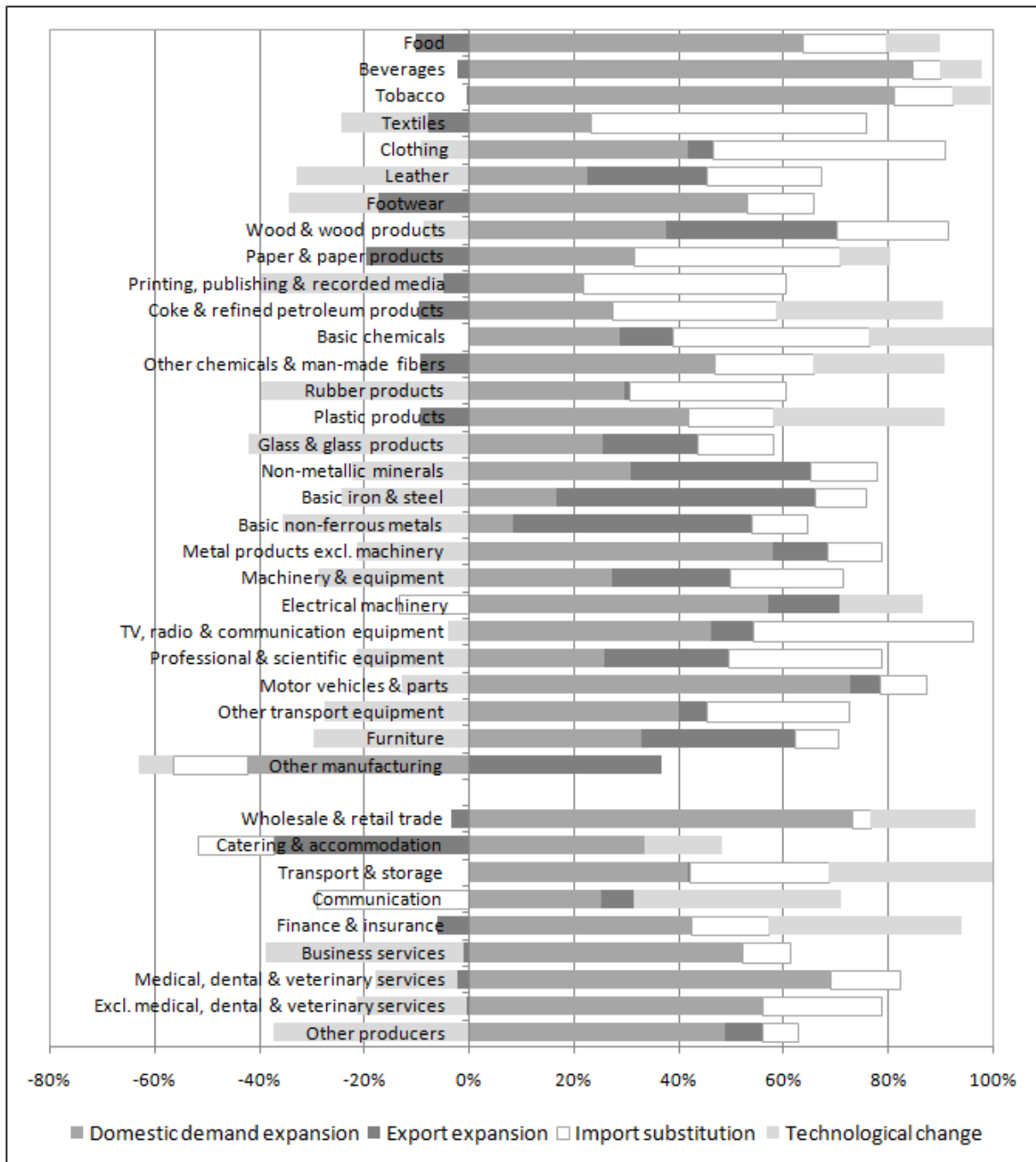


Fig. 5: Decomposition of output growth by sector, 1970-1980



APPENDIX: TECHNICAL DETAILS

The method set out here was developed by Chenery (1960, 1962) and has since been extended and applied in various studies.

Total gross output X can be written as the sum of the following four components:

$$X = Y + D + E + M,$$

Where the $(n \times 1)$ vectors $Y, D, E,$ and M represent domestic intermediate demand, domestic final demand, exports, and imports respectively.

$F_{n \times n}$ is the intermediate flow matrix, where F_{ij} refers to the intermediate inputs from sector

i to sector j , such that $\sum_{i=1}^n f_{ij} = d_i$.

Define $R_{n \times n}$ as a diagonal matrix of import ratios (where $r_i = \frac{m_i}{y_i + d_i}$) and define $P_{n \times n}$ as a diagonal matrix of domestic supply ratios (where $p = I - r$).

Define $A_{n \times n}$ as a matrix of technical coefficients where $a_{ij} = \frac{f_{ij}}{x_j}$, and let

$$B_{n \times n} = (I - pD)^{-1}.$$

Then through basic matrix algebraic manipulation, the change in gross output between two periods t and $t+h$ can be written as follows:

$$\begin{aligned} \Delta X &= B_{t+h} [p_{t+h} \Delta D + \Delta E + \Delta p (A_t X_t + D_t) + p_{t+h} \Delta A X_t] \\ &= B_t [p_t \Delta D + \Delta E + \Delta p (A_{t+h} X_{t+h} + D_{t+h}) + p_t \Delta A X_{t+h}] \end{aligned}$$

The only difference between these two expressions is that the first uses base year volume weights and terminal year structural parameters (analogous to the Paasche price index), with the opposite in the second expression (analogous to the Laspeyres price index).

Although the two expressions sum to an identical value, the individual components differ, and this indexing problem is dealt with here through a simple averaging of the components. The four components of total output change for any sector over period h are calculated as follows:

$$\text{Domestic demand expansion} = \frac{1}{2} [B_t p_t \Delta D + B_{t+h} p_{t+h} \Delta D]$$

$$\text{Export expansion} = \frac{1}{2} [B_t \Delta E + B_{t+h} \Delta E]$$

$$\text{Import substitution} = \frac{1}{2} [B_t \Delta p (A_{t+h} X_{t+h} + D_{t+h}) + B_{t+h} \Delta p (A_t X_t + D_t)]$$

$$\text{Technological change} = \frac{1}{2} [B_t p_t \Delta A X_{t+h} + B_{t+h} p_{t+h} \Delta A X_t].$$

These sum to the change in sectoral output over period h .

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