South African Journal of Economics Vol. 76:S2 August 2008

THE CONTRIBUTIONS OF MANUFACTURING AND SERVICES TO EMPLOYMENT CREATION AND GROWTH IN SOUTH AFRICA

FIONA TREGENNA*

Abstract
This study examines the linkages between the manufacturing and services sectors, and between each of them and the rest of the domestic economy, based on analysis of input-output tables and employment trends. This reveals that manufacturing is particularly important as a source of demand for the services sector as well as the rest of the economy through its strong backward linkages, which suggests that in this respect a decline in manufacturing could negatively affect future growth. Services are especially important in terms of employment creation, both direct and indirect.
JEL Classification: D57, J21, L52, L60, L80, O14, R15
Keywords: Manufacturing, services, employment, growth, multipliers, input-output, South Africa

1. INTRODUCTION

The share of services in both GDP and employment has been rising in South Africa over several decades, while the share of manufacturing has been falling slightly. Given the premise that a unit of value added has different growth implications depending on which sector it is in, and similarly that there are sector-specific dimensions of any job created or lost, these changes in the sectoral structure of the economy are worth analysing. The classical development economic literature regards manufacturing as having "special properties" which make it especially important as an engine of sustainable growth. There is however little existing research into the extent to which manufacturing – or subsectors of manufacturing – in South Africa do display these characteristics, or whether parts of services may do so. Of course, sectors that are important for growth may not be the most important for employment retention and creation, which is of critical importance given the crisis of unemployment facing South Africa. This study uses input-output data over time to analysis the relationship between the manufacturing and services sectors and between each of them and the rest of the economy. It is part of a larger project using various methods to analyse the contributions of manufacturing and services to growth and employment in South Africa.

Section 2 discusses the relevance of sectoral structure to growth and development from a theoretical perspective, as well as looking at the changing relationships between manufacturing and services. Section 3 briefly surveys relevant empirical trends regarding

* Faculty of Economics, University of Cambridge. Financial support from the Human Sciences Research Council for this research is gratefully acknowledged. Contact: fmt21@cam.ac.uk. I would like to thank for their comments and contributions Stewart Ngandu, Miriam Altman, Al Berry, Neil Rankin, an anonymous referee, and in particular Rob Davies and Gabriel Palma. All errors and omissions are my own.

employment, value added, and productivity for the manufacturing and services sectors. Section 4 presents the results of the analysis of backward and forward linkages and employment multipliers. Section 5 discusses the implications of the findings and concludes.

2. THEORETICAL BACKGROUND

(a) Importance of Manufacturing

There has traditionally been a strong argument in branches of heterodox economics that there is a sector-specificity in the economic growth process. This implies that a unit of value added is not necessarily equivalent across sectors, notably in terms of its growth-inducing or growth-enhancing effects. Such an approach can be distinguished from those parts of the growth literature that tend to see growth as sector-neutral (as well as activity-neutral in the traditional Solow-type growth models and some endogenous growth theories, or activity-specific such as in the new endogenous growth theories that emphasise the importance of R&D and human capital).[1]

The heterodox literature – notably that in the broad Kaldorian tradition[2] – has regarded the manufacturing sector as being imbued with "special characteristics" not shared by the other sectors. This leads to manufacturing being accorded a special place in understanding the causal relationships of growth, as well as suggesting that from a policy perspective there needs to be a particular focus on the manufacturing sector.

The special characteristics typically attributed to the manufacturing sector include:

- The idea that manufacturing growth "pulls along" economic growth in ways that growth in other sectors of the economy does not.
- Dynamic economies of scale in manufacturing, such that the growth of productivity in manufacturing is higher the higher the growth in manufacturing output.[3] This is related to the notion that "learning by doing" is more important in industry than in agriculture or services. Learning by doing, innovation, and intersectoral linkages thus render overall productivity growth endogenous to growth in dynamic manufacturing sectors. This of course means that expanding the manufacturing sector would raise manufacturing (and non-manufacturing) productivity.
- The argument that most technological change occurs in the manufacturing sector. Further, that technological change that does occur in the rest of the economy actually tends to be diffused out from the manufacturing sector, in part through the use of higher productivity manufacturing inputs in the "production" process of the rest of the economy. These kinds of technological-change externalities are one form of Hirschman-type intersectoral linkages.
- That manufacturing is critical to alleviating balance of payments constraints that can impose a "stop-go" pattern on developing countries' growth and hence to supporting sustained high growth rates, particularly in the absence of a strong primary commodity export sector with stable and favourable terms of trade.

[1] See Palma (2005).

[2] Others associated with this type of approach include Young, Verdoorn, Kalecki, Hirschman, Prebisch, Pasinetti, and Thirlwall.

[3] However, note also that in an open economy, economies of scale may be associated with falling prices, depending in part on demand conditions.

Concerns have arisen in this type of literature in recent years, although more broadly as well, concerning deindustrialisation and premature deindustrialisation in particular. To the extent that manufacturing does indeed have special properties that are especially important for growth, a relative decline in manufacturing could have deleterious effects for maintaining high growth rates in the medium- to long-term. Deindustrialisation typically refers to a fall in the share of manufacturing in employment.[4] A prominent exception to this was the approach of Singh (1977, 1987) who conceptualises deindustrialisation in terms of both output and employment. Singh considers deindustrialisation to be problematic insofar as it is a manifestation of structural disequilibrium in the economy, in the sense that manufacturing is unable to not only satisfy domestic demand at least cost but also to export enough to pay for a full employment level of imports at a "reasonable" exchange rate.

By way of stylised facts, not only have levels of manufacturing employment corresponding to particular levels of GDP fallen, but the turning point of GDP *per capita* at which manufacturing employment as a percentage of total employment has tended to decline as well. Further, trade liberalisation appears to have accelerated deindustrialisation in a number of emerging economies. This has raised concerns that such economies may not be able to take advantage of the apparent broader benefits of manufacturing growth as much as they could have.

(b) Linkages between Manufacturing and Services

The growth and increasing sophistication and specialisation of manufacturing may generate increased demand for service inputs into manufacturing. To the extent that services grow as a result of this, such a shift in the composition of the economy should not be interpreted as services *replacing* manufacturing, as the shift is associated with an increased demand arising from manufacturing itself. On the other hand, a rise in services associated with increasing *per capita* income is less directly connected with manufacturing (although this depends in part on the source of the rising incomes).

Ballance (1987) argues that manufacturing itself has taken on a greater "service orientation" over the last few decades, although he notes that there is very little empirical evidence in support of this. Aspects of this shift are said to include an increasing focus (among manufacturing firms) on product differentiation and product specialisation, which necessitate a close relationship with consumers and the assumption of various "service"-type activities; the services dimension of the growing ICT sector; and the increasing importance of functions such as marketing, human resources, and the granting of consumer credit within manufacturing firms. These intra-firm shifts may not be adequately measured in national accounting. To the extent that these functions are outsourced to specialised service providers, however, this would show up as a relative decline in manufacturing and growth in services.

There are dual spillover effects between manufacturing and services. On the one hand, the growth in manufacturing leads to structural changes that render contracting out and outsourcing less costly and more efficient, creating additional demand for services and growth in the services sector. One component of this is simply a reallocation of output and employment from being measured in the manufacturing sector to being measured in the services sector, which is a "statistical" rather than "real" change. Another component

[4] See, for example, Rowthorn and Wells (1987) and Palma (2008).

may be more "real" shifts associated with an increasing demand for service activities. Insofar as there are economies of scale in some services, such reallocation and real shifts may both have important effects in increasing productivity.

One of the key changes in the relationship between manufacturing and services in recent years has been the increased outsourcing of service functions previously performed in-house within manufacturing. The business-type literature identifies various motivations and explanations for this trend. One of these is a move in favour of firms concentrating on their "core competencies", which would suggest the hiving off of service activities considered to be non-core. Outsourcing is also purported to be cost-saving insofar as specialised external companies can provide the services at lower costs than would be the case in-house, for instance due to specialisation and economies of scale.

The trend towards outsourcing is also traced to changes in the manufacturing process, and the resultant need for increasingly sophisticated and specialised service inputs; and similarly an increase in the demand for highly technology- and skill-intensive service inputs. Such inputs tend to be more costly to maintain in-house than service inputs might have been previously, which may also increase the likelihood of their being outsourced.

On the other hand, outsourcing may also be an attempt to increase profits at the expense of workers. This could be achieved through lower wages, higher productivity through uncompensated higher effort levels, or the circumventing of labour legislation.

Tregenna (2007b) explores outsourcing in South Africa in recent years. The focus is on attempting to estimate the extent to which employment has shifted between the manufacturing and services sectors, associated with outsourcing. The study finds that a significant part of the relative decline in manufacturing employment and increase in services employment can be explained by this intersectoral outsourcing, although there does appear to be a real structural shift in the structure of the economy away from manufacturing and towards services.

3. EMPIRICAL BACKGROUND

Figs 1 and 2 summarise trends in value added, labour productivity and employment, for the manufacturing and (private) services[5] sectors, over the period 1970-2005. Fig. 1 uses South African Standardised Industry Database (SASID) data and shows the trends from 1970 to 2005, while Fig. 2 uses OHS/LFS data and is limited to the period 1997-2005.[6]

Looking at the entire period from 1970 onwards (using SASID data), services show fairly steady growth throughout, without clear changes in patterns over the entire period. The growth in services employment is "explained" (in a narrow mathematical sense) by

[5] Services in this article refers to the sectors with SIC codes 6-9 excluding general government; that is, trade catering and accommodation services; transport storage and communication; financial intermediation real estate insurance and business services; and community social and personal services excluding general government.

[6] Both of these sources of employment data have serious limitations. The recent SASID data (provided by Quantec) is based primarily on data from the Survey of Employment and Earnings, meaning that it probably underestimates employment especially in the services sector. There are a number of problems associated with the OHS/LFS data; of particular relevance here is that treating the data as a single series is problematic due to the switch between the OHS and LFS as well as the methodological changes between years.

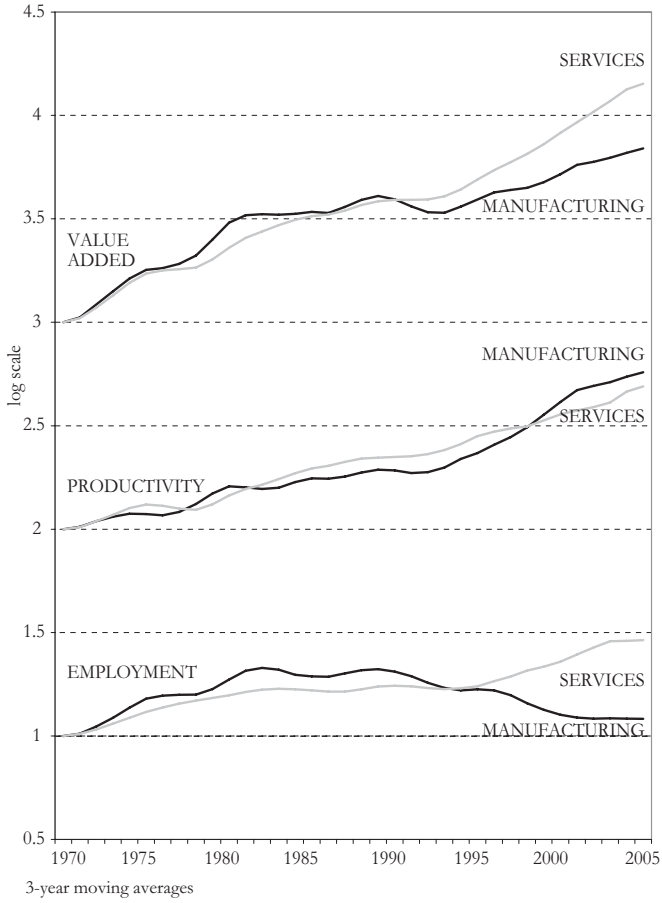

Figure 1. Value added, labour productivity and employment in manufacturing and services, 1970-2005 (SASID employment data)

the much faster rate of growth of value added over the rate of growth in productivity. If this data undermeasures employment and services employment in particular, this would mean that productivity and the rise in productivity is overstated, especially for services. In the manufacturing sector, on the other hand, since about 1990 value added has risen but employment fallen, associated with rising productivity (at a faster rate than in services). Over the last decade the rate of growth in manufacturing value added has actually picked up, yet has been outstripped by productivity growth.

OHS/LFS data (Fig. 2, shown for 1997 onwards) show increasing employment in both the manufacturing and services sectors (although much higher in services than in manufacturing). The increases in employment however lag behind increases in value added, especially for manufacturing, hence labour productivity is still seen to rise particularly for manufacturing. The higher employment figures compared to the SASID data result in lower increases in productivity.

Figs 3 and 4 show the contribution of subsectors of manufacturing and services to value added and employment. The relative size of sectors is of course evident from their

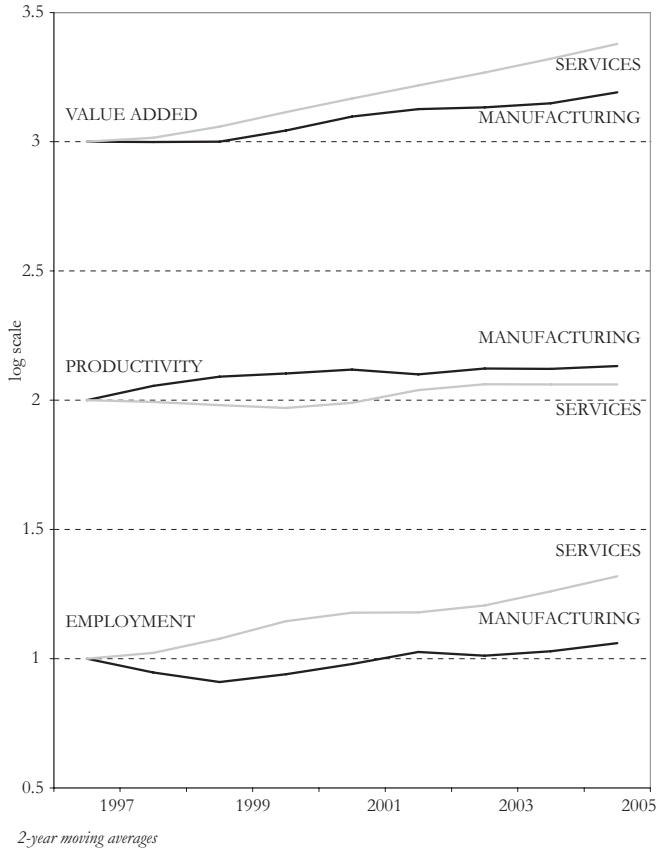

Figure 2. Value added, labour productivity and employment in manufacturing and services, 1997-2005 (LFS employment data)

positions.[7] The object of this exercise is to examine sectors' differential importance in terms of value added and employment, and further to investigate whether different patterns are evident for the manufacturing and services sectors. Although the picture is mixed, on balance it appears that services sectors tend to be relatively more important in terms of employment, while manufacturing sectors tend to be relatively more important in terms of value added. The total manufacturing and services sectors are not shown for reasons of scale, but manufacturing as a whole falls in the lower-right triangle (value added relatively more important) and private services in the upper-left triangle (employment relatively more important). Of course, these figures only show sectors' direct contribution to value added and employment; the next section of this article discusses direct and indirect sectoral multipliers.

[7] As appropriate and where their shares are very small, some sectors are clustered for heuristic purposes.

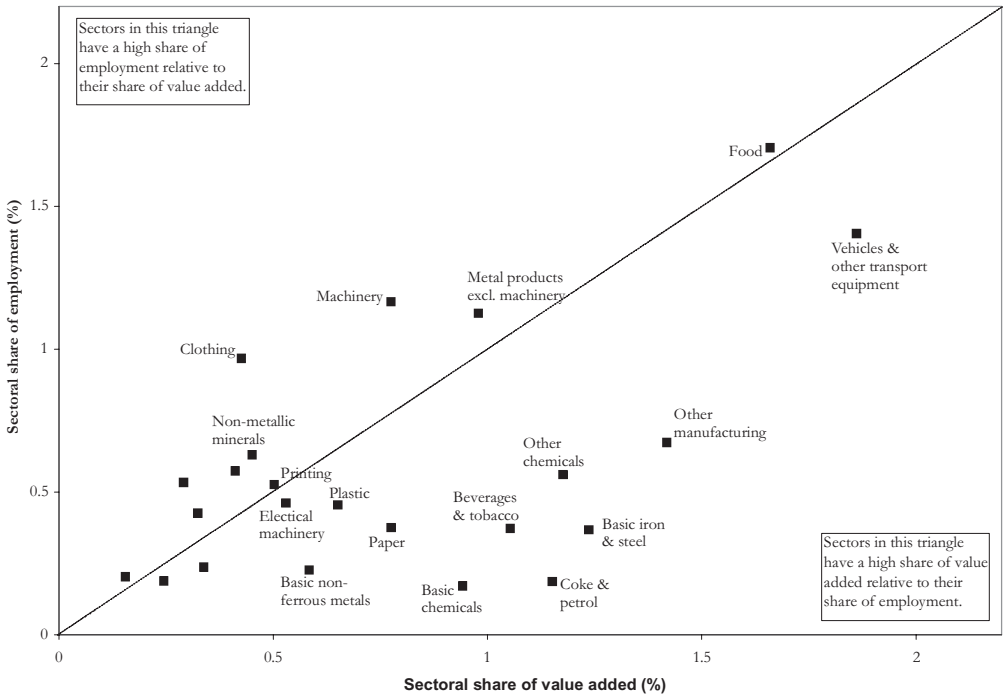

Figure 3. Share of value added and employment by manufacturing sector, 2005

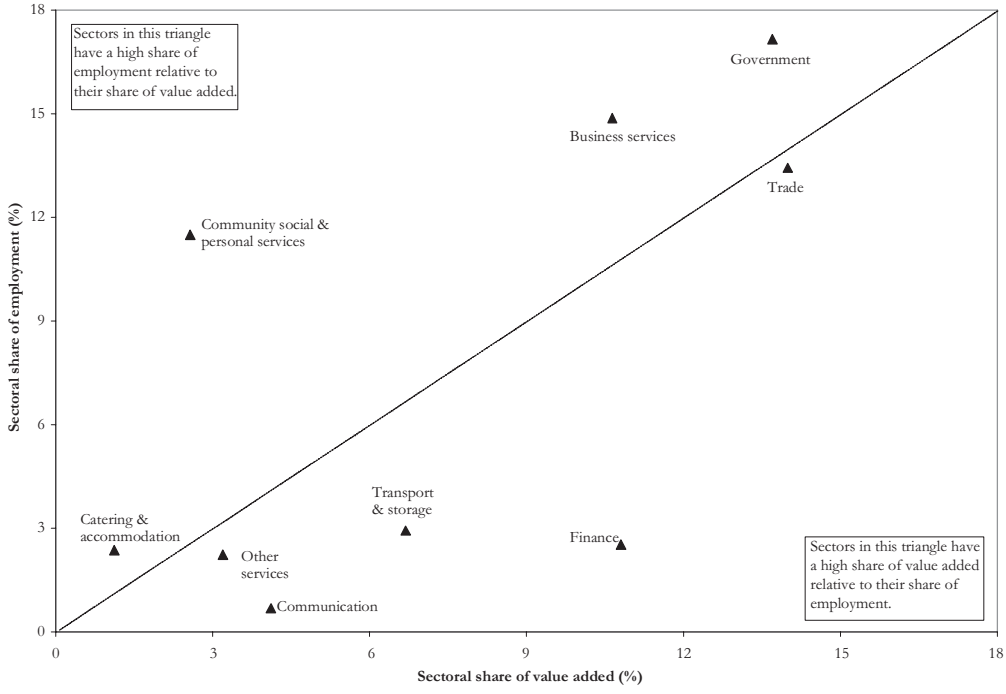

Figure 4. Share of value added and employment by services sector, 2005

4. SECTORAL LINKAGES AND MULTIPLIERS

(a) Forward and Backward Linkages

Input-output tables can be used in analysing the state of the economy from a sectoral perspective, in identifying potential motive forces of growth, and in analysing changes over time. This section quantifies various direct and indirect backward and forward linkages and multipliers (including employment multipliers) of each sector and measures the changes over time. This yields interesting results in terms of the relative strength of these linkages, particularly comparing the manufacturing and services sectors.

Backward linkages create additional demand for the output of upstream sectors. This additional demand can contribute to growth through increased upstream investment and/or capacity utilisation, as well as possibly contributing to upstream technological upgrading. How much a given sector contributes to growth through backward linkages depends directly on the strength of its upstream vertical integration with the domestic economy, as well as indirectly through the degree of integration of those upstream sectors to which it is linked.

Forward linkages with downstream sectors of the domestic economy can also be a channel through which sectoral growth can raise overall growth. The primary mechanisms through which this can be realized are lower costs of intermediate inputs into downstream sectors, which can induce higher investment and/or capacity utilisation, technological upgrading, and increased productivity in those downstream sectors (as well as potentially indirectly into other sectors with which those downstream sectors are integrated). Hirschman also argues that a sector whose output can be used as intermediate inputs in other sectors will result in attempts to employ these products in new activities. The strength of this forward-linkages growth channel for a given sector depends on the strength of its downstream vertical integration with the domestic economy as well as of those downstream sectors with which it is integrated.

Differential forward and backward linkages between sectors, and the potential of these linkages to contribute to higher economic growth, suggest that an unbalanced growth path in which sectors with high linkages are prioritised – not that this is the only relevant criterion of course – could potentially reach higher growth than a balanced growth path. Of course, not all linkages of similar size are equivalent, either analytically or in terms of policy implications. A high linkage coefficient does not necessarily indicate causality. Jones (1976) makes a useful distinction in this regard between *permissive* linkages and *causal* linkages. For instance, high forward linkages from sectors such as communications or electricity do not necessarily suggest that an expansion of these sectors would lead to the growth of downstream industries. These high linkages may actually reflect causality from the demand generated by downstream industries. Even so, high linkages in such a situation do indicate the importance of the upstream sector, as any failure on its part to meet downstream demand (assuming that this could not be substituted by imported inputs) would constrain downstream growth.

The methodology used to calculate the various linkages and multipliers is shown in Appendix 2. All linkages and multipliers are calculated using SASID data.

An important methodological issue in the calculation of intersectoral linkages relates to imported intermediates. When the total flow matrix is used to calculate linkages, there is

no distinction between inputs sourced domestically or abroad. This means that there is no distinction between the potential stimulation of upstream industries in South Africa or in other countries from which inputs are imported. Failure to distinguish these – as is often the case in analysis of intersectoral linkages – is thus very problematic. For instance, a backward linkage between two sectors that appears to show significant "pulling power" from the downstream to the upstream sector may be misleading if a large proportion of the upstream inputs are in fact imported, with little stimulatory effect on the domestic economy.

When the difference between "domestic" and "worldwide" backward linkages arises because of differential resource endowments or because of differential capacities that are unlikely to converge in the short to medium term (or at least over the period of interest for the analysis), then "worldwide" linkages over and above the domestic ones are irrelevant to Hirschmanian growth processes. On the other hand, insofar as the gap between domestic and worldwide backward linkages is due to differences in the stage of development or to differential capacities which are subject to "catch-up", then the gap actually points to the potential for import substitution.

Thus, use of the *domestic flow matrix* is relevant to ex post analysis of what has actually happened, as well as the relevance of this for what is likely to happen in the future period of interest. The *total flow matrix* is relevant to the "upper bound" of backward linkages (if all imports could be substituted by domestically produced goods, and in the absence of changes in the degree of intersectoral integration). In order to take into account this issue of imported intermediate inputs, for each of the sets of linkages discussed below the results are analysed using both the estimated direct flow matrix (which includes imported intermediates) as well as the adjusted matrix (excluding these imported intermediates). This distinction is often neglected in the calculation of intersectoral linkages in the literature.

A caveat to be noted is that all multipliers discussed here are actually based on average and not marginal analysis. Any interpretation regarding what might happen if, for example, final demand for a certain sector rose, should be treated with caution. Such projections are most likely to be accurate for relatively small increases in the short to medium term. For example, a huge increase (decrease) in demand for the output of a given sector would not necessarily be associated with the same linkages and employment patterns as currently characterise the sector. This is especially pertinent in a relatively open economy, as expanded demand can be met through imports in greater proportion than is the case initially. To the extent that this is the case, it implies that the analysis might overstate the stimulatory effects on the domestic economy of an increase in demand. Further, this is likely to be stronger for manufacturing than for services, as tradables can generally be more easily substituted with imports.

A final caveat at this point is that, since these calculations are not integrated in an economy-wide model, no consideration is given to supply constraints or to macroeconomic considerations. Modelling the relationships between sectors within a CGE or similar framework would allow for an estimation of the broader effects of an expansion in one or other sector, although of course the veracity of such estimations would be only as strong as the assumptions required for employed in the model. An attractive feature of the analysis of linkages using input-output tables, as presented here, is that relatively little is required by way of assumptions as there is a close relationship

between the actual data available andthe relationships being measured. The size of the backward and forward linkages and employment multipliers was also calculated using a Social Accounting Matrix (SAM), and while the linkages and multipliers was higher (given the indirect channels included in the SAM), the overall pattern of results was broadly consistent with those reported here.

(b) Output Iinkages

The tables of results are shown in Appendix 1, although most are omitted here owing to space constraints. The key results in terms of manufacturing and services are highlighted here.

First, we look at backward linkages in order to evaluate how "dependent" one sector is on upstream sectors (suppliers) for its inputs. The upstream linkages coefficient of sector j with respect to sector i measures the percentage of sector i's intermediate inputs purchased from sector j.

25.3% of the intermediate inputs into manufacturing come from services (of which the bulk comes from trade and from finance); 24.7% of the intermediate inputs into services come from manufacturing. The transport and community social and personal services subsectors of services are particularly dependent on manufacturing for their intermediate inputs. In this first measure, manufacturing and services are thus roughly equally dependent on each other for their intermediate inputs as a share of their total intermediate inputs.

As discussed earlier, it is also important to measure linkages when imported intermediates are excluded, as backward linkages through imported intermediates would not have much stimulatory effect on the domestic economy. 31.4% of all domestically produced intermediates into manufacturing are purchased from the services sector (especially the trade and finance subsectors of services). On the other hand, 18.6% of all domestically sourced intermediate inputs into services come from manufacturing. When imported intermediates are excluded, manufacturing is thus seen to be more "dependent" on services inputs than the other way around (whereas they appeared roughly equal when looking at all intermediate inputs). Of course, the converse dimension of this "dependence" of manufacturing for inputs from services is the demand generated by manufacturing for the output of the services sector.

The above calculations of backward linkages measured intermediate inputs from upstream sectors as a share of total intermediate inputs into each downstream sector. Next, we measure intermediate inputs from sector i into sector j as a share of the total inputs into sector j (that is, not only intermediate inputs from the same and other sectors but also remuneration, net operating surplus, consumption of fixed capital, and taxes and subsidies). These results are shown in Table A1. 18.7% of the total inputs into manufacturing come from services, while 11.8% of the total inputs into services come from manufacturing. In this respect, manufacturing has greater "backward dependence" on services for its inputs than the other way around.

When these figures are adjusted to exclude imported intermediates, the backward link from manufacturing to services is slightly brought down to 18.2% whereas the backward link from services to manufacturing is brought down more to 8%. (The greater drop in the latter case is due to the higher share of imports in the intermediate inputs used in manufacturing than in services.) Excluding imported inputs, the greater "backward dependence" of manufacturing on service inputs is thus underlined. This

means that manufacturing uses relatively more inputs from services than the other way around.

In the final part of the analysis of backward linkages, we factor in both direct and indirect linkages through the input inverse (also referred to as the Leontief inverse). This is the key measure of the strength of total backward linkages. The input inverse shows the inputs from sector i that would be required (both directly and indirectly) for sector j to meet one additional unit of final demand. As can be seen from Table A2, an additional unit of final demand for manufacturing output would require an additional 0.65 units of services. On the other hand, an additional unit of final demand for services output would require an additional 0.35 units of manufacturing. Excluding imported intermediates (see Table A3), manufacturing is still more "dependent" on services in terms of backward linkages than the other way around: a unit of final demand for manufacturing output requires 0.46 units of inputs from services while a unit of final demand for services output requires 0.19 units of inputs from manufacturing.

For the economy as a whole – reading from the last rows of Tables A2 and A3 – an additional unit of final demand for manufacturing would require an additional 2.9 units of output (2.1 when import adjusted). An additional unit of final demand for services would have a weaker stimulatory effect on the economy as a whole: 2.1 units of additional output (or 1.8 when import adjusted). This is a central result, which suggests that a stimulus to manufacturing would have greater multiplier effects on the economy than an equal stimulus to services.

Fig. 5 shows total backward linkages for subsectors of manufacturing and services in 2005. The black bars represent the totals, while the grey bars show the import-adjusted figures. While there is considerable heterogeneity within each of the manufacturing and services sectors, what is most striking is the different ranges of the two sectors overall. With the exception of "other manufacturing", even the services subsector with the highest overall backward linkages is still lower than the manufacturing subsector with the lowest. The differences between the manufacturing and services subsectors are not quite as stark when adjustments are made for imported intermediates (see the grey bars), yet the manufacturing subsectors still have stronger backward linkages than services, both overall and for most of the subsectors individually.

Having analysed backward linkages, we now turn to *forward linkages*. The object is to assess the relationship between each sector and its downstream (user) industries.

Initial analysis suggests approximate symmetry between manufacturing and services in this regard, although services is slightly more dependent on manufacturing as a source of demand for intermediate output than the other way around. *23.2% of the output of manufacturing that goes as intermediate inputs into other sectors, goes into services* (*i.e.* services accounts for 23.2% of the demand for intermediate outputs from manufacturing). The main component of this demand from services is from the transport, storage, and communication subsector of services. On the other hand, *24.2% of the output from services that goes as intermediate inputs into other sectors, goes into manufacturing*. As would be expected, these figures are only slightly affected by the exclusion of imported intermediates.

However, since the proportion of output that goes to intermediate inputs varies significantly across sectors, this part of the analysis does not necessarily give a full picture

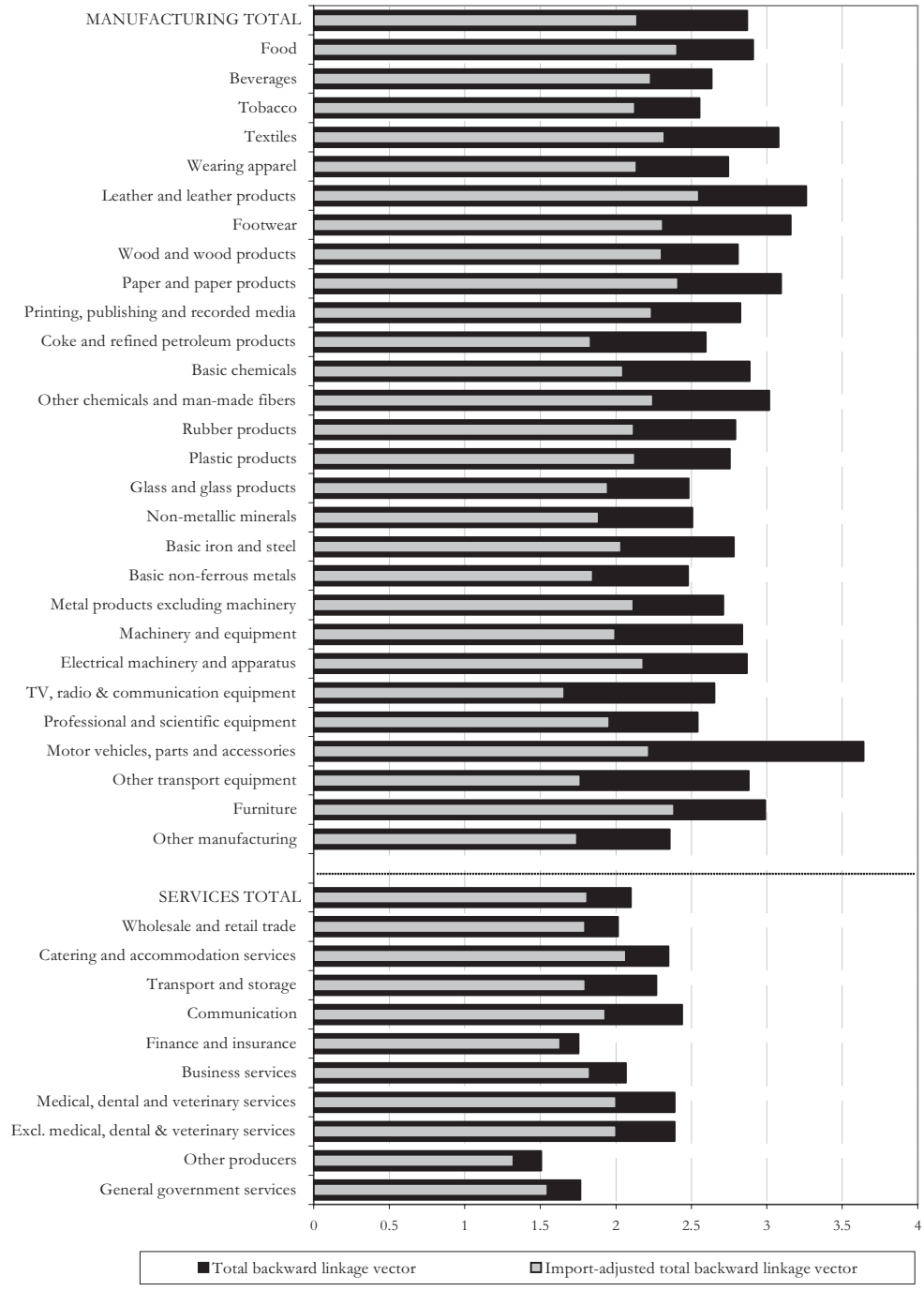

Figure 5. Total backward linkage vectors for manufacturing and services subsectors, 2005
Note: Calculations in current prices.

of the importance of demand from each sector in the total demand for a sector's output. We thus consider forward linkages in terms of total output, which is probably a more relevant measure. Table A4 thus shows the demand from each sector i for a sector j's output, as a share of the total output of that sector j. *15.7% of total manufacturing output goes into services* (as intermediate input); whereas *14.1% of total services output goes into manufacturing* (as intermediate input). Excluding imported intermediates, *10.7% of total manufacturing output goes into services* and *13.6% of total services output goes into manufacturing*. In this sense services is more dependent on manufacturing as a source of demand than the other way around.

One consideration to be borne in mind in comparing these coefficients between the manufacturing and services sectors is that by virtue of the fact that manufacturing is a secondary sector while services are tertiary, one might expect a greater proportion of manufacturing output to go into services than *vice versa*. This makes the greater dependence of services on manufacturing as a source of demand even more noteworthy.

Finally, we consider not only direct but also indirect linkages through the output inverse and total forward linkage vector (see Tables A5 and A6). A one unit increase in primary input into manufacturing would need an additional 0.46 (0.25 when import adjusted) units of services in order to fully utilise it, including both direct and indirect intersectoral linkages. An additional unit of primary input into services would need an additional 0.49 (0.34 when import adjusted) units of manufacturing production in order to fully utilise this initial increase. This suggests stronger forward linkages from services to manufacturing than the other way around.

In terms of economy-wide total forward linkages, an additional unit of primary input into manufacturing would need an additional 2.7 units of total production in order to fully utilise it (1.9 when import-adjusted) while an additional unit of primary input into services would need an additional 2.4 units of total production in order to fully utilise it (2.1 when import-adjusted). These figures are of a roughly similar order of magnitude when comparing manufacturing and services. However, the policy implications of these figures are not as strong as in the case of the total backward linkages, which show the multiplier potential of the different sectors.

(c) Employment Multipliers

Employment multipliers across sectors (for 2005), in total and for each skills category separately, are shown in Tables A7-A10. These project how many additional jobs (actually full-time, full-year equivalents) in each sector and hence overall would be required to meet a R1m increase in final demand for each sector j. The total employment multiplier of services exceeds that of manufacturing. A R1 million increase in final demand for services would be associated with 5.46 jobs, compared with 4 jobs associated with a R1 million increase in final demand for manufacturing. Manufacturing is associated with more indirect jobs in services that the other way around (R1 million increase in final demand for manufacturing would be associated with 1.37 jobs in services, whereas R1 million increase in final demand for services would be associated with only 0.22 jobs in manufacturing).

For broad subsectors of services, the total employment multipliers are highest for community social and personal services, followed by trade, finance, and finally transport. The high-skilled employment multiplier is highest for finance and lowest for transport. The skilled employment multiplier is highest for trade and again lowest for

transport. Finally, the multiplier for semi- and unskilled labour is highest for community social and personal services – making it potentially a key sector for generating employment for unskilled labour – and lowest for transport and for finance.

Fig. 6 below shows employment multipliers for all manufacturing and services subsectors. The black bars are based on overall linkages, while the grey bars are adjusted for imported intermediates. The employment multipliers are higher for services overall than for manufacturing overall, but there is a lot of heterogeneity within each. A number of manufacturing subsectors have higher employment multipliers than overall services, such as wearing apparel, food, furniture, wood and wood products, footwear and textiles. On the other hand, several services subsectors have lower employment multipliers than total manufacturing: finance, communications, and transport and storage are particularly noteworthy here. Nevertheless, overall services tend to have significantly higher employment multipliers than does manufacturing.

Figs 7-10 show the employment multipliers over time.[8] Overall, the employment multipliers of both manufacturing and services have been falling over time. This is consistent with the generally acknowledged declining employment elasticity of output in South Africa. Reasons for this could include capital-augmenting labour-displacing technological change, trade liberalisation, changes in relative factor costs, political economy factors leading to capital intensification, and compositional changes in the economy.

Data limitations need to be pointed out again at this stage. The employment multipliers are calculated using the SASID data, which may underestimate employment – particularly in small firms, in new firms, and in unregistered firms; and as mentioned earlier is likely to especially under-represent services employment. This analysis may thus underestimate employment multipliers as well as overstating the decline, especially in services. However, even if the decline is overestimated, the finding that employment multipliers have been falling is consistent with other evidence (even, for example, with the fact that net employment creation has lagged well behind economic growth).

This decline in employment multipliers is obviously of concern in terms of the employment-absorbing capacity of economic growth. Of the various employment multipliers shown, the only one to increase over time is the skilled employment multiplier of services. The total employment multiplier of services is higher than that of manufacturing throughout the period, and furthermore that of manufacturing has declined at a faster rate than that of services.

(d) Summary of Results

The key empirical results emerging from this analysis of linkages and multipliers in the South African economy can be summarised as follows. Manufacturing uses more inputs from services (as intermediate inputs in manufacturing production), than the other way around. This holds whether or not imported intermediate inputs are excluded. Even when weighted for the relative size of the two sectors, the backward linkages from manufacturing to upstream services are stronger than from services to upstream manufacturing. Factoring in both direct and indirect backward linkages, an additional

[8] Note that the 2005 data in the tables and charts do not correspond as the former are calculated in current prices and the latter in constant prices in order to evaluate trends over time.

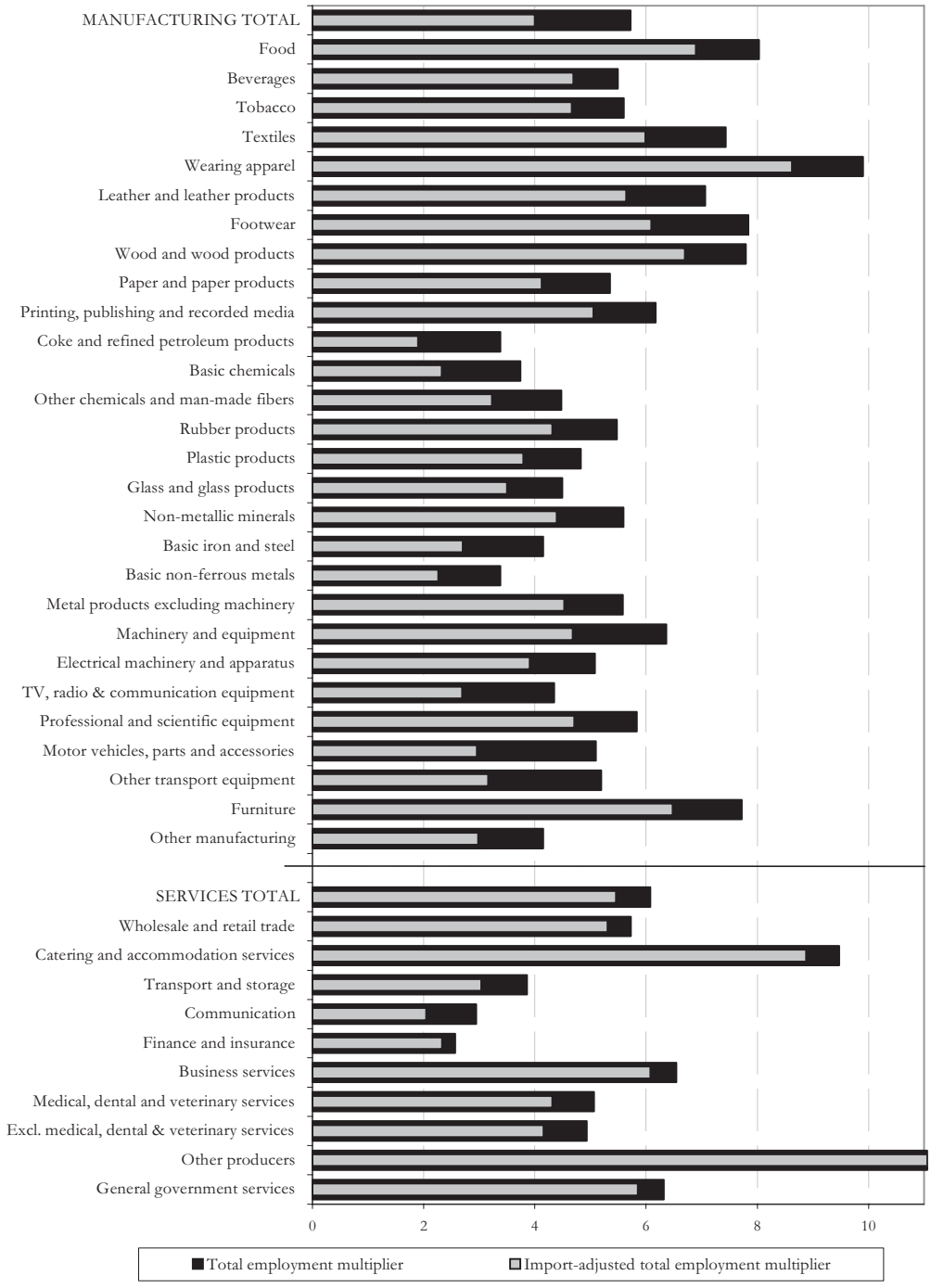

Figure 6. Total employment multipliers for manufacturing and services subsectors, 2005
Notes: Calculations in current prices. Note the truncation of the x-axis for visual clarity.

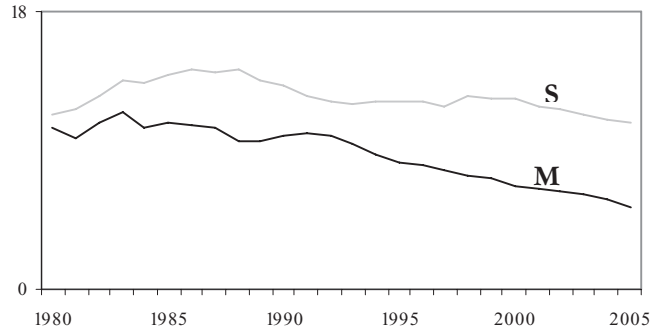

Figure 7. Total employment multipliers 1980-2005

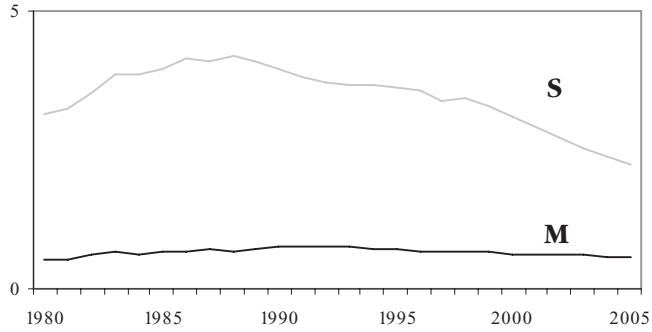

Figure 8. High-skilled employment multipliers 1980-2005

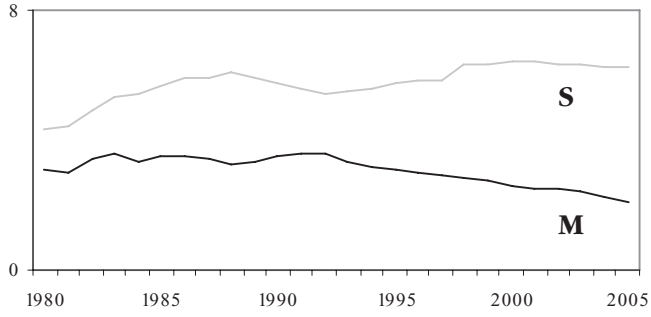

Figure 9. Skilled employment multipliers 1980-2005

unit of final demand for manufacturing would require significantly more additional input from services than the other way around. Similarly for the economy as a whole, an additional unit of final demand for manufacturing would require more inputs than would an additional unit of services. Even when disaggregated into subsectors, manufacturing subsectors consistently have stronger backward linkages than do services subsectors. This points to the importance of manufacturing as a source of demand for services. It also suggests that the costs and quality of services (that form intermediate inputs into manufacturing) are important for the competitiveness of manufacturing.

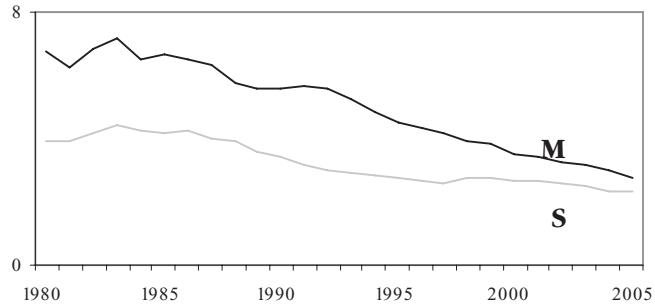

Figure 10. Semi/unskilled employment multipliers 1980-2005

These results are consistent with those from the analysis of forward linkages. In particular, manufacturing is more important as a source of demand for the output of the services sector than is services as a source of demand for the manufacturing sector. This holds whether or not imported intermediates are excluded. This is a striking result, particularly in the light of the greater size of the services sector relative to manufacturing.

These findings could suggest that manufacturing could have greater "pulling power" on services than the other way around. In terms of economy-wide multipliers, an additional unit of final demand for manufacturing would require greater inputs from other sectors than is the case for services, suggesting that in this specific respect growth (decline) in manufacturing would have a greater stimulatory (contractionary) effect on the economy as a whole than an equal increase in final demand for services.[9] Although there is some heterogeneity at a subsectoral level, manufacturing subsectors generally have much stronger backward linkages than do services subsectors.

In terms of economy-wide total forward linkages, and factoring in both direct and indirect effects, the increase in total production that would be required to fully utilise an additional unit of primary input are roughly similar for manufacturing and services.

The strength of the backward linkages from manufacturing to services (or the forward linkages from services to manufacturing) indicates that the cost and quality of service inputs into manufacturing are crucial for the competitiveness of manufacturing. Further, there is an asymmetry between manufacturing and services in terms of the possibilities of substituting imported inputs for domestically produced inputs – given that manufacturing is (in general) more tradable than services, it is easier for services to switch to imported manufacturing inputs than for manufacturing to switch to imported services inputs. This further underscores the importance of the cost and quality of (domestic) service inputs into manufacturing.

It is also worth noting that the amount that the manufacturing sector spends on service inputs far exceeds the total wage bill of the manufacturing sector. In 2005

[9] Of course, this focuses only on growth-enhancing effects through intersectoral linkages; in assessing the overall potential of a sector for stimulatory/contractionary effects of the economy other channels would also need to be factored in, for example, through the balance of payments.

(current prices), manufacturing spent R186 billion on intermediate inputs from domestically produced services and R118 billion in remuneration. This puts in perspective arguments around the importance of manufacturing wages for competitiveness – while the level of manufacturing wages is of course important for the competitiveness of the sector, the cost and quality of inputs sourced from services are likely to be at least as important.[10]

Ominously for the potential for employment creation – particularly with respect to the employment-creating potential of economic growth – the employment multipliers of both manufacturing and services have been falling over time. The total employment multiplier of services is higher than that of manufacturing throughout the period, and further that of manufacturing has declined more rapidly than has the total employment multiplier of services. The high-skilled employment multipliers of services far exceed those of manufacturing, whereas the low-skilled employment multipliers of manufacturing exceed those of services. To the extent that the skills multipliers do convey useful information (given that they are based purely on occupational categories), this does point to the potential importance of manufacturing in (both directly and indirectly) absorbing low-skilled labour.

5. DISCUSSION AND CONCLUSIONS

Growth *per capita* in South Africa has been stagnant for a long time, notwithstanding a pick up in recent years. Net employment creation has lagged far behind growth, such that unemployment remains at crisis proportions. This study has investigated the manufacturing and services sectors in South Africa, with a focus on the relationship between these two sectors and between each of them and the rest of the economy.

The (private) services sector accounts for over half of South African GDP and this share continues to rise, while the share of manufacturing has slowly declined over the past two and a half decades from a peak of 22% to about 18% at present.[11] Services has also accounted for an increasing share of total employment, and manufacturing a declining share.[12] The level of labour productivity in manufacturing outstrips that in services and continues to rise, a development that is probably at least in part related to the capital intensification of manufacturing (although services is also surprisingly capital-intensive). One way of understanding the differing employment performances of the manufacturing and services sectors is that in services the growth of value added has significantly outstripped that of productivity, whereas in manufacturing productivity growth has exceeded growth in value added, particularly over the past decade.

[10] Wages in the services sector would also be germane to the cost of inputs from services into manufacturing, yet wages do not account for the bulk of costs in services.

[11] Real annual growth in manufacturing over the period 1970-2005 was 2.6%, and 3.5% for (private) services.

[12] The significant discrepancies between the employment data in SASID and in the LFS – in terms of both levels and trends – pose a serious problem for analysis of trends in employment, as well as in capital intensity and in labour productivity, and makes it difficult to reach definate conclusions around some key issues.

These changes in the sectoral composition of the South African economy and differing characteristics are relevant for growth and employment. Heterodox and classical development economics approaches have typically focused on the "special characteristics" of manufacturing for a country's growth and development, suggesting that manufacturing has a particular role to play as an engine of sustainable growth. Growth-generating properties attributed to manufacturing include learning by doing and increasing returns to scale, strong linkages with the rest of the economy, technological progressiveness, and the mitigation of balance of payments constraints.

A decline in manufacturing – even if replaced by services – could have negative effects on South Africa's medium- to long-term growth and employment prospects, the former directly and the latter primarily indirectly. To the extent that there has been deindustrialisation in South Africa – specifically in terms of a relative decline in manufacturing employment – a key question is whether this process can be regarded as premature (given our level of income *per capita*), in the sense of foregoing potential benefits of further manufacturing growth.

Rather than taking for granted that manufacturing (still) has the "special properties" attributed to it, this study begins an empirical investigation of this issue in the South African context. The focus is on Hirschmanian linkages as channels of growth-pulling; the special properties of manufacturing have not been comprehensively tested here.

Analysis of the backward and forward linkages between sectors revealed interesting results in terms of the way different sectors depend on each other for inputs as well as a market for their intermediate outputs. An important methodological step undertaken in this analysis is the exclusion of imported intermediate inputs, which is often overlooked in empirical work of this nature leading to misleading results. Manufacturing is found to be more important as a source of demand for services, than the other way around. This significant result might suggest that manufacturing has greater "pulling power" on services than the other way around. In terms of economy-wide multipliers, an additional unit of final demand for manufacturing would require more inputs from other sectors than is the case for services, suggesting that growth in manufacturing would have a greater stimulatory effect on the economy as a whole than an equal increase in final demand for services. Conversely, decline in the manufacturing sector would deprive the services sector of an important source of demand, both direct and indirect. The costs and quality of service inputs into manufacturing would be important for the productivity and competitiveness of manufacturing, but less important as a source of demand or driver of growth.

In terms of employment, however, services has a significantly higher employment multiplier than does manufacturing, and although both have declined over time the employment multiplier of manufacturing has fallen more. It is only for low-skilled labour that the employment multiplier of manufacturing is higher than that of services. Notwithstanding the caveat that skills categories are based solely on occupation, this result does suggest that manufacturing might be important in absorbing low-skilled labour in South Africa. That is, unless the nature of the services sector (and the linkages between services and the rest of the economy) changes to favour the absorption of more low-skilled workers. Employment generation for these segments of the labour force is critical, both in the light of the high unemployment rates amongst unskilled workers and the intersection between race and skills (occupation) in the South African labour market.

Manufacturing remains critically important for growth in South Africa. In particular, as a source of demand for other sectors, which is important for pulling along growth in the rest of the economy. However, manufacturing is currently failing to absorb sufficient labour to seriously dent unemployment in South Africa. Even factoring in its indirect contributions (as measured in the employment multipliers) the employment-creating potential of manufacturing growth is lower than that of services per unit of final demand, based on current patterns.

Manufacturing would not typically be expected to be central in employment creation, at least not directly. However, its lack of dynamism appears to be inhibiting its potential to drive growth in the economy as much as it could. The potential growth-driving properties of manufacturing – such as increasing returns to scale – are likely to only be fully operative when manufacturing grows at a faster rate than has been the case in South Africa. In other words, the role of manufacturing as a growth engine may only really kick in in a meaningful way above a certain level of manufacturing growth, and thereafter at an increasing rate (up to a certain point). Although this is difficult to assess empirically, it would be consistent with both theoretical perspectives and international empirical evidence. This would suggest that the acceleration of growth in the manufacturing sector could enhance its growth-pulling effects on the rest of the economy.

Services are unlikely to be central in driving growth in South Africa, but are critical for labour absorption. The relatively low share of unskilled labour in services is however surprising, and it would be important for services to play a much more significant role in "mopping up" unemployed unskilled workers. Services in many developing countries are far more important as an "employer of last resort" than is the case in South Africa. This may be related in part to political economy factors and the racialised character of the South African labour market, which may lead to underemployment (in the sense of lower employment than would otherwise be "optimal" from the perspective of employers) in interpersonal services in particular.

The heterogeneity of sectors also raises questions around whether *all subsectors* of manufacturing share in these properties, and whether certain subsectors of services might also do so at the current stage of South Africa's development process. Services subsectors such as communication and transport share some of the characteristics associated with manufacturing, and show higher backward linkages and lower employment multipliers than most services subsectors.

International comparisons of sectoral composition show South Africa to have a share of manufacturing in GDP higher than would be (econometrically) expected for our level of economic development, but a share of manufacturing in total employment lower than would be expected. The shares of services in both GDP and employment are higher than would be expected. These findings suggest that there is a particular problem around manufacturing employment.

This may be indicative of a distorted development path in which South Africa "leapfrogged" from a minerals and resource-based economy to capital-intensive heavy industry, without going through a period of development of labour-intensive light industry. Now, South Africa may be "leapfrogging" to a services-oriented economy, as a form of premature deindustrialisation – without ever having industrialised fully or derived "full benefits" from that. However, because of global production and trade trends and the context of South Africa's trade liberalisation, it would be challenging at this

point to move into sectors of light manufacturing production, which have been "underdeveloped" up to this point and in which we are not currently competitive, apart from developing the capacity to at least meet domestic demand.

The capital intensification of manufacturing over a long period of time is also part of the explanation for the low and falling share of manufacturing in total employment. This capital intensification has two dimensions: the composition of the manufacturing sector (in terms of the relative capital intensity of different manufacturing subsectors), and more importantly, the shift towards capital over labour across manufacturing. Although there is underemployment in services as well, there is arguably less scope for capital–labour substitution in services than in manufacturing.

A fuller analysis of accumulation in South Africa is central to understanding the growth path that we have been on, as well as what interventions might be needed to shift to a path that is not only higher growth but, of central importance, creates employment adequate to deal with the unemployment crisis facing the country. Not only has accumulation been on an inadequate scale, but the nature of accumulation has been skewed (relative to what would be optimal for growth and in particular for employment). For instance, capital investment that is labour-displacing rather than labour-absorbing (see Tregenna, 2007a).

There is a potential trade-off between sectors that are highly productive, technologically progressive, etc.; and those which are more labour-absorbing, less productive, with a limited range of factor substitution possibilities towards capital, and so on. To some extent, this is an inherent trade-off, as certain of the "progressive" characteristics – such as technological progressivity and factor substitution potential – render them less likely to be prime employment creators, at least directly. Of course, this is not a simple dichotomy. Especially when indirect effects are factored in, a "progressive" yet not particularly labour-absorbing sector can make an important contribution to employment creation through "growth-pulling" effects on high-employment sectors.

The manufacturing sector is generally regarded in the literature as relatively dynamic, highly productive, with the greatest potential for benefits from economies of scale, the most rapid technological progress on balance, and with the most potential for capital-intensifying factor substitution. To the extent that there is empirical confirmation in this regard, while these qualities may be conducive to high growth, they are not necessarily conducive to employment creation, or at least to *direct* employment creation.

On the other hand, the service sectors are generally more labour-intensive, with relatively lower scope for capital-intensifying factor substitution and technological progress. Even if sectors with these types of characteristics are not particularly growth-dynamic, they may be extremely important from an employment perspective.

Such trade-offs are not only at the intersectoral level, but also within broad sectors given their heterogeneity. Although it may sound trite, an important point that emerges from this research is the importance of subsectoral analysis. Significant heterogeneity is evident in both the manufacturing and services sectors. Both manufacturing and services include subsectors that are capital-intensive and labour-intensive, technologically progressive and less so, those that are primarily growth-generating and those that are primarily labour-absorbing, and so on. Nevertheless, there are important commonalities within the manufacturing and services groupings respectively.

Service subsectors such as ICT are highly technologically progressive, both internally and for other sectors, and have significant growth-inducing or at least growth-supporting potential, yet are highly capital-intensive. Subsectors such as communication and transport share some of the characteristics associated with manufacturing, and show higher backward linkages and lower employment multipliers than most services subsectors. Other service sectors such as domestic work are highly labour-absorbing (in a direct sense), yet would have limited growth-inducing potential.

Such trade-offs are only partly associated with the intrinsic characteristics of different sectors, and are subject at least in part to policy interventions – for example, around the relative factor intensity of a sector, the nature of technological progress, and so on.

The potential "growth-employment" trade-off identified is at least in part mitigated in the South African case to the extent that the current level of unemployment is itself a constraint on growth. Higher domestic demand derived from employment creation, as well as the alleviation of the destabilising effects and other negative externalities associated with high levels of unemployment, means that employment creation can in itself raise growth. Nevertheless, as shown in this study the manufacturing and services sectors in South Africa do contribute differentially to growth and to employment, suggesting that some difficult choices are called for in industrial and other policies.

Sectoral characteristics as discussed in this article are partly intrinsic to the nature of the sectors but are also partly reflective of past policies as well as subject to future policies. Clarification of these issues is not only analytically interesting but is also highly relevant from a policy perspective, in terms of where we should look to for future economic growth and employment creation, and what policy interventions might be required in this regard.

APPENDIX 1.
LINKAGES AND MULTIPLIERS – TABLES OF RESULTS

The following sets of tables show the results for all sectors of the various calculations of forward and backward linkages and multipliers, according to the methods set out in Appendix 2. The calculations were also undertaken for the more disaggregated 43-sector structure (and some of those results are shown in Figs. 5 and 8), but are shown here at the nine-sector level for the sake of brevity.

Table A1. Backward linkages in terms of total output

	Agric	Mining	Manufac.	Electricity gas & water	Construction	Trade	Transport	Finance	CSP	Govt	Services total
Agriculture	2.4	0.0	4.9	0.0	0.0	0.2	0.0	0.0	0.1	0.1	0.1
Mining	0.7	0.5	10.8	16.0	4.3	0.0	0.2	0.2	0.3	0.3	0.2
Manufacturing	31.1	15.2	38.4	7.9	33.9	9.0	21.2	7.1	14.5	10.2	11.8
EGW	1.0	2.3	1.2	15.7	0.3	1.1	1.4	0.6	1.1	0.4	1.0
Construction	0.3	0.6	0.0	3.4	19.0	0.9	0.4	1.2	0.6	0.8	0.9
Trade	6.0	2.6	7.2	2.0	4.1	6.2	8.7	4.0	6.1	2.9	6.0
Transport	7.6	21.9	3.8	1.7	2.1	10.4	14.3	5.4	4.2	3.4	8.7
Finance	2.8	2.6	6.3	5.3	8.2	17.9	8.1	23.7	19.1	5.3	18.0
CSP	2.6	1.3	1.4	0.0	0.3	0.3	0.4	1.5	2.1	3.6	1.0
Government	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.9	4.7	0.1
Services total	18.9	28.4	18.7	9.0	14.6	34.9	31.5	34.7	31.5	15.1	33.6
SUM	54.5	47.0	74.1	52.0	72.1	46.1	54.6	43.9	48.8	31.6	47.6

This is the input coefficient matrix A. The last row is the direct backward linkage vector L^{DB}.

Table A2. Input inverse (Leontief inverse) and total backward linkage vector

	Agric	Mining	Manufac.	Electricity gas & water	Construction	Trade	Transport	Finance	CSP	Govt	Services total
Agriculture	1.06	0.02	0.09	0.02	0.04	0.02	0.03	0.01	0.02	0.01	0.02
Mining	0.09	1.06	0.21	0.23	0.15	0.04	0.07	0.03	0.05	0.04	0.05
Manufacturing	0.68	0.43	1.86	0.32	0.86	0.30	0.53	0.25	0.38	0.27	0.35
EGW	0.03	0.04	0.04	1.20	0.03	0.03	0.03	0.02	0.03	0.01	0.03
Construction	0.01	0.02	0.01	0.06	1.24	0.02	0.01	0.02	0.02	0.01	0.02
Trade	0.15	0.10	0.19	0.08	0.16	1.12	0.17	0.09	0.13	0.07	
Transport	0.18	0.32	0.19	0.12	0.15	0.18	1.25	0.12	0.12	0.08	
Finance	0.17	0.14	0.24	0.16	0.27	0.32	0.23	1.38	0.34	0.14	
CSP	0.04	0.03	0.04	0.01	0.02	0.01	0.02	0.03	1.03	0.05	
Government	0	0	0	0	0	0	0	0	0.01	1.05	
Services total	0.54	0.58	0.65	0.37	0.60	1.64	1.67	1.62	1.62	0.34	1.64
SUM	2.41	2.16	2.87	2.20	2.93	2.04	2.33	1.97	2.12	1.73	2.10

The last row is the total backward linkage vector.

Note that for some calculations, it was necessary to recalculate the matrices with services as an aggregate category, where summing across the services subsectors would have been incorrect. In these cases there are no values for the interaction between services and the service subsectors, as in the above Table.

Table A3. Import-adjusted input inverse and total backward linkage vector

	Agric	Mining	Manufac.	Electricity gas & water	Construction	Trade	Transport	Finance	CSP	Govt	Services total
Agriculture	1.04	0.01	0.07	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
Mining	0.03	1.02	0.10	0.19	0.06	0.02	0.02	0.01	0.02	0.01	0.02
Manufacturing	0.38	0.21	1.48	0.17	0.52	0.18	0.26	0.14	0.19	0.14	0.19
EGW	0.02	0.04	0.03	1.20	0.02	0.02	0.03	0.02	0.02	0.01	0.02
Construction	0.01	0.02	0.01	0.07	1.29	0.03	0.02	0.03	0.02	0.02	0.02
Trade	0.12	0.08	0.14	0.06	0.11	1.11	0.14	0.08	0.10	0.06	
Transport	0.13	0.26	0.12	0.09	0.09	0.16	1.20	0.10	0.09	0.06	
Finance	0.12	0.10	0.17	0.13	0.21	0.28	0.18	1.35	0.30	0.11	
CSP	0.04	0.02	0.03	0.01	0.02	0.01	0.01	0.02	1.03	0.04	
Government	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	1.08	0.00
Services total	0.40	0.46	0.46	0.29	0.43	1.56	1.54	1.55	1.52	0.28	1.55
SUM	1.89	1.76	2.14	1.92	2.35	1.82	1.87	1.76	1.80	1.54	1.81

The last row is the import-adjusted total backward linkage vector.

Table A4. Forward linkages in terms of total output

	Agric	Mining	Manufac.	Electricity gas & water	Construction	Trade	Transport	Finance	CSP	Govt	Services total	SUM
Agriculture	2.40	0.04	63.12	0.01	0.01	0.98	0.00	0.05	0.21	0.23	1.24	67.06
Mining	0.30	0.45	61.66	5.83	3.44	0.03	0.31	0.61	0.24	0.53	1.18	73.40
Manufacturing	2.39	2.67	38.43	0.51	4.79	3.22	6.58	3.53	2.36	3.21	15.69	67.70
EGW	1.26	6.37	19.43	15.75	0.63	6.13	6.79	5.05	2.76	1.86	20.73	66.02
Construction	0.18	0.80	0.01	1.52	19.04	2.33	0.77	4.34	0.64	1.77	8.08	31.40
Trade	1.28	1.27	20.04	0.36	1.62	6.22	7.55	5.61	2.79	2.51	22.17	49.26
Transport	1.88	12.38	12.27	0.34	0.95	12.07	14.25	8.76	2.20	3.41	37.27	68.51
Finance	0.43	0.92	12.69	0.68	2.31	12.89	5.02	23.75	6.22	3.34	47.88	68.25
CSP	1.20	1.45	8.50	0.01	0.22	0.59	0.81	4.47	2.05	6.92	7.92	26.23
Government	0	0	0	0	0	0	0.03	0.09	0.47	4.75	0.59	5.34
Services total	1.09	3.75	14.06	0.43	1.55	9.40	7.34	13.01	3.85	3.57	33.59	58.05

This is the output coefficient matrix B. The final column is the direct forward linkage vector L^{DF}.

Table A5. Output inverse ($\hat{W}$) and total forward linkage vector (L^{TF})

	Agric	Mining	Manufac.	Electricity gas & water	Construction	Trade	Transport	Finance	CSP	Govt	Services total	SUM
Agriculture	1.06	0.05	1.21	0.01	0.08	0.08	0.11	0.08	0.04	0.06	0.31	2.79
Mining	0.04	1.06	1.20	0.08	0.12	0.08	0.12	0.10	0.05	0.06	0.34	2.92
Manufacturing	0.05	0.08	1.86	0.02	0.12	0.11	0.16	0.13	0.06	0.08	0.46	2.67
EGW	0.04	0.12	0.66	1.20	0.06	0.15	0.17	0.15	0.07	0.07	0.53	2.69
Construction	0.01	0.02	0.08	0.03	1.24	0.05	0.03	0.08	0.02	0.03	0.18	1.59
Trade	0.03	0.05	0.52	0.01	0.06	1.12	0.15	0.13	0.06	0.06	1.46	2.20
Transport	0.04	0.18	0.60	0.02	0.07	0.21	1.25	0.20	0.06	0.08	1.72	2.72
Finance	0.03	0.05	0.49	0.02	0.08	0.23	0.14	1.38	0.11	0.09	1.86	2.60
CSP	0.02	0.03	0.22	0.00	0.02	0.03	0.04	0.08	1.03	0.09	1.18	1.56
Government	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	1.05	0.01	1.06
Services total	0.03	0.08	0.49	0.02	0.06					0.08	1.64	2.39

The last column is the total forward linkage vector.

Table A6. Import-adjusted output inverse ($\hat{W}$) and total forward linkage vector ($\hat{L}^{TF}$)

	Agric	Mining	Manufac.	Electricity gas & water	Construction	Trade	Transport	Finance	CSP	Govt	Services total	SUM
Agriculture	1.04	0.02	0.88	0.01	0.04	0.05	0.05	0.04	0.02	0.03	0.16	2.19
Mining	0.01	1.02	0.55	0.07	0.05	0.03	0.04	0.04	0.02	0.02	0.13	1.85
Manufacturing	0.03	0.04	1.48	0.01	0.07	0.06	0.08	0.07	0.03	0.05	0.25	1.92
EGW	0.03	0.10	0.48	1.20	0.04	0.13	0.14	0.12	0.06	0.05	0.44	2.35
Construction	0.01	0.02	0.07	0.03	1.29	0.07	0.03	0.11	0.02	0.04	0.23	1.69
Trade	0.02	0.04	0.39	0.01	0.04	1.11	0.12	0.11	0.05	0.05	1.39	1.95
Transport	0.03	0.15	0.37	0.02	0.04	0.18	1.20	0.16	0.05	0.07	1.59	2.27
Finance	0.02	0.04	0.35	0.02	0.06	0.20	0.11	1.35	0.10	0.07	1.76	2.31
CSP	0.02	0.02	0.18	0.00	0.01	0.03	0.02	0.07	1.03	0.09	1.16	1.48
Government	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.08	0.01	1.09
Services total	0.02	0.06	0.34	0.01	0.05					0.07	1.55	2.10

The last column is the import-adjusted total forward linkage vector.

Table A7. Total employment multipliers

	Agric	Mining	Manufac.	Electricity gas & water	Construction	Trade	Transport	Finance	CSP	Govt	Services total
Agriculture	9.78	0.09	0.64	0.08	0.23	0.10	0.11	0.06	0.10	0.07	0.09
Mining	0.08	2.49	0.23	0.46	0.15	0.04	0.05	0.03	0.04	0.03	0.04
Manufacturing	0.44	0.24	1.71	0.20	0.60	0.21	0.30	0.16	0.23	0.16	0.22
EGW	0.02	0.03	0.03	1.01	0.02	0.02	0.02	0.01	0.02	0.01	0.02
Construction	0.03	0.04	0.03	0.19	3.61	0.07	0.04	0.09	0.06	0.05	0.07
Trade	0.44	0.28	0.53	0.23	0.43	4.17	0.53	0.30	0.39	0.22	
Transport	0.13	0.26	0.12	0.09	0.09	0.16	1.20	0.10	0.09	0.06	
Finance	0.35	0.30	0.52	0.38	0.61	0.85	0.54	4.01	0.88	0.33	
CSP	0.26	0.15	0.21	0.06	0.12	0.08	0.09	0.17	7.43	0.31	
Government	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	4.85	0.01
Services total	1.17	1.00	1.37	0.76	1.25	5.26	2.36	4.58	8.79	0.93	5.01
SUM	11.53	3.91	4.00	2.70	5.86	5.69	2.89	4.95	9.27	6.09	5.46

The last row is the aggregate total employment multiplier for each sector j.

Table A8. High-skilled employment multipliers

	Agric	Mining	Manufac.	Electricity gas & water	Construction	Trade	Transport	Finance	CSP	Govt	Services total
Agriculture	0.24	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Mining	0.01	0.20	0.02	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Manufacturing	0.05	0.03	0.18	0.02	0.06	0.02	0.03	0.02	0.02	0.02	0.02
EGW	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.01	0.21	0.00	0.00	0.01	0.00	0.00	0.00
Trade	0.05	0.03	0.06	0.03	0.05	0.47	0.06	0.03	0.04	0.02	
Transport	0.02	0.03	0.01	0.01	0.01	0.02	0.14	0.01	0.01	0.01	
Finance	0.08	0.06	0.11	0.08	0.13	0.18	0.11	0.86	0.19	0.07	
CSP	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.27	0.01	
Government	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	1.04	0.00
Services total	0.15	0.13	0.19	0.12	0.19	0.68	0.32	0.91	0.51	0.11	0.64
SUM	0.45	0.36	0.41	0.34	0.49	0.71	0.37	0.94	0.55	1.18	0.68

The last row is the aggregate high-skilled employment multiplier for each sector j.

Table A9. Skilled employment multipliers

	Agric	Mining	Manufac.	Electricity gas & water	Construction	Trade	Transport	Finance	CSP	Govt	Services total
Agriculture	2.50	0.02	0.16	0.02	0.06	0.02	0.03	0.02	0.02	0.02	0.02
Mining	0.01	0.46	0.04	0.09	0.03	0.01	0.01	0.01	0.01	0.01	0.01
Manufacturing	0.17	0.10	0.67	0.08	0.24	0.08	0.12	0.06	0.09	0.06	0.09
EGW	0.01	0.01	0.01	0.33	0.01	0.01	0.01	0.00	0.01	0.00	0.01
Construction	0.01	0.01	0.00	0.03	0.60	0.01	0.01	0.01	0.01	0.01	0.01
Trade	0.26	0.17	0.31	0.13	0.25	2.43	0.31	0.18	0.23	0.13	
Transport	0.05	0.09	0.04	0.03	0.03	0.05	0.42	0.04	0.03	0.02	
Finance	0.21	0.18	0.31	0.23	0.36	0.50	0.32	2.39	0.52	0.20	
CSP	0.03	0.02	0.03	0.01	0.02	0.01	0.01	0.02	0.95	0.04	
Government	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	2.90	0.01
Services total	0.54	0.46	0.68	0.40	0.66	3.00	1.06	2.62	1.73	0.39	2.24
SUM	3.24	1.06	1.58	0.95	1.59	3.13	1.23	2.73	1.90	3.38	2.38

The last row is the aggregate skilled employment multiplier for each sector j.

Table A10. Semi- and unskilled employment multipliers

	Agric	Mining	Manufac.	Electricity gas & water	Construction	Trade	Transport	Finance	CSP	Govt	Services total
Agriculture	7.05	0.07	0.46	0.06	0.16	0.07	0.08	0.05	0.07	0.05	0.07
Mining	0.06	1.83	0.17	0.34	0.11	0.03	0.04	0.03	0.03	0.02	0.03
Manufacturing	0.22	0.12	0.86	0.10	0.30	0.10	0.15	0.08	0.11	0.08	0.11
EGW	0.01	0.02	0.01	0.53	0.01	0.01	0.01	0.01	0.01	0.00	0.01
Construction	0.03	0.03	0.02	0.15	2.80	0.06	0.03	0.07	0.04	0.04	0.05
Trade	0.13	0.09	0.16	0.07	0.13	1.26	0.16	0.09	0.12	0.07	
Transport	0.07	0.14	0.06	0.05	0.05	0.08	0.64	0.05	0.05	0.03	
Finance	0.07	0.06	0.10	0.07	0.12	0.16	0.10	0.77	0.17	0.06	
CSP	0.21	0.13	0.17	0.05	0.10	0.07	0.08	0.14	6.21	0.26	
Government	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.91	0.00
Services total	0.48	0.41	0.49	0.24	0.39	1.58	0.98	1.05	6.55	0.42	2.13
SUM	7.85	2.48	2.02	1.41	3.79	1.85	1.29	1.28	6.83	1.53	2.40

The last row is the aggregate semi- and unskilled employment multiplier for each sector j.

APPENDIX 2.
DERIVATION OF LINKAGE COEFFICIENTS AND MULTIPLIERS

Let $F_{(nxn)} \equiv$ the intermediate input flow matrix, which shows the inputs from and to each of the sectors (inputs from the factors of production and excluding final outputs). f_{ij} is the value of the intermediate inputs flowing from sector i to sector j, *i.e.* the payment for intermediate inputs that flows from sector j to sector i.
$X_{(nx1)} \equiv$ the total output flow vector, where x_i is the total output of sector i (the sum of intermediate and final output).
$\text{DIAG}(X)_{(nxn)}$ is a diagonal matrix where $\text{DIAG}(x)_{ij} = x_{ij}$ for all i = j, 0 otherwise.
$Y_{(nx1)} \equiv$ the intermediate output flow vector, where y_i is the intermediate output of sector i (that is, output which goes as intermediate inputs into other sectors).
$\text{DIAG}(Y)_{(nxn)} \equiv$ a diagonal matrix where $\text{DIAG}(y)_{ij} = y_{ij}$ for all i = j, 0 otherwise.
$I_{(nxn)}$ = identity matrix and $1_{(nx1)}$ = unity column vector.
then
$D_{(nxn)} \equiv F\text{DIAG}(Y)^{-1}$ which is the upstream linkages coefficient matrix.
$E_{(nxn)} \equiv \text{DIAG}(Y)^{-1}F$ which is the downstream linkages coefficient matrix.
$A_{(nxn)} \equiv F\text{DIAG}(X)^{-1}$. This is the input coefficient matrix or the technical coefficient matrix in the Leontief system.
$B_{(nxn)} \equiv \text{DIAG}(X)^{-1}F$ is the output coefficient matrix.
$Z \equiv (I - A)^{-1}$, the input inverse or Leontief inverse, is a matrix of technical input coefficients that show intermediate inputs as a share of all inputs (including the value added components). z_{ij} is the value of the additional output that would be required from the i^{th} sector to produce the necessary inputs for one unit of final demand of the j^{th} sector. The j^{th} column sum $\sum_{i=1}^{n} z_{ij}$ is the total increase in output that would be required to supply the necessary inputs for an initial unit in increase in sector j.[13] Z thus represents the effects of expansion on suppliers. It is a measure of *backward linkages.*
$W \equiv (I - B)^{-1}$, the output inverse, is a matrix of technical output coefficients, which each measure output which is sold as intermediate inputs into other sectors as a share of total sales (including final demand of consumers). w_{ij} is the increase in output of the j^{th} sector that would fully utilise the increased output from an initial unit of primary input into sector i. The i^{th} row sum $\sum_{j=1}^{n} w_{ij}$ is the total increase in output that would fully utilise the increased output from an initial unit of primary input into sector i.[14] W represents the effect of an expansion on users, and is a measure of *forward linkages*.
$L^{DF}_{(1xn)} \equiv B1$ is the direct forward linkage vector. (This of course equals the row sums of the output coefficient matrix B.) For each sector i, this shows the direct forward linkages with downstream sectors. The direct forward linkage vector of each sector i is a weighted

[13] The i^{th} row sum of Z represents the increase in output of sector i that would be required to supply the inputs necessary for a one unit increase in final demand from all n sectors. This is not a relevant figure as the size of sectors varies considerably and hence an equal increase in final demand across the board is unrealistic.
[14] The j^{th} column sum of W shows the effect of a one unit expansion of primary inputs into all n sectors. As with the row sums of Z, this is not particularly relevant as an equal expansion across all sectors is unrealistic.

sum of direct forward linkages to downstream industries (with the weighting of course based on the proportion of sector i's output going to each of the downstream sectors.)
$L^{DB}_{(nx1)} \equiv 1'A$ is the direct backward linkage vector. (This of course equals the column sums of the output coefficient matrix *A*.) For each sector j, this vector shows the direct backward linkages with upstream sectors. As above, the direct forward linkage vector of each sector j is a weighted sum of its backward linkages.
$L^{TF}_{(1xn)} \equiv W1$ is the total (direct and indirect) forward linkage vector. (This of course equals the row sums of the output inverse *W*.) For each sector i, this vector shows the direct and indirect forward linkages with downstream sectors.
$L^{TB}_{(nx1)} \equiv 1'Z$ is the total (direct and indirect) backward linkage vector. (This of course equals the column sums of the Leontief inverse *W*.) For each sector j, this vector shows the direct and indirect backward linkages with upstream sectors.
Given that the forward linkage vector of each sector is a weighted sum of that sectors backward linkages (and *vice versa*), aggregate weighted forward linkages equal aggregate weighted backward linkages (with weighting being the value of each sector's output). That is, $X'L^{TF} = L^{TB}X$.

The economy-wide coefficient of interdependence can then be obtained as an output-weighted average of either of these measures, that is, $C \equiv X'L^{TF} \div X'1 = L^{TB}X \div X'1$. This measures the degree of "internal integration" or "industrial depth" at any point in time.

All of the above vectors and matrices were also calculated using an adjusted intermediate input flow matrix $\hat{F}$ that excludes *imported* intermediate inputs. Following all the above steps, all vectors and matrices can be derived adjusting such that the intermediate inputs on which they are based are only domestically produced.

The employment multipliers were then calculated as follows (shown here for the import-adjusted figures, as in the results presented in the article).

$P_{(nx1)}$ is the employment vector, where p_i is the number of people employed in sector i (actually the number of full-time full-year equivalents). Similarly, P^H, P^S and P^U for the numbers of highly-skilled, skilled, and semi- and unskilled people, respectively.

$\text{DIAG}(P)_{(\text{nxn})} \equiv$ a diagonal matrix where $\text{DIAG}(p)_{ij} = p_{ij}$ for all i = j, 0 otherwise.

$\hat{N}_{(nxn)} = \text{DIAG}(P)(\text{DIAG}(\hat{X})^{-1})$, a diagonal matrix in which the diagonal elements are the employment/value added ratios of each sector i.

Then $\hat{M}_{(nxn)} = \hat{N}\hat{Z}$ where $\hat{m}_{ij}$ is the number of additional jobs (full-time full-year equivalents) in sector i that would be associated with one additional unit of final demand in sector j. The column totals $\sum_{i=1}^{n} \hat{m}_{ij}$ show the total number of additional jobs associated with an additional unit of final demand in sector *j*. Similarly for $\hat{M}^H$, $\hat{M}^S$ and $\hat{M}^U$.

REFERENCES

BALLANCE, R. H. (1987). *International Industry and Business: Structural Change, Industrial Policy and Industry Strategies*. London: Allen and Unwin.
JONES, L. (1976). The measurement of Hirschmanian linkages. *The Quarterly Journal of Economics*, 90(2): (323-333.
PALMA, G. (2005). Four sources of "De-Industrialisation" and a new concept of the "Dutch Disease". In Ocampo, J. A. (ed.), *Beyond Reforms: Structural Dynamics and Macroeconomic Vulnerability*. New York: Stanford University Press and World Bank.
——— (2008). Deindustrialisation, premature deindustrialisation, and the Dutch Disease. In Blume, L. and Durlauf, S. (eds), *The New Palgrave: A Dictionary of Economics* (2nd edition). Basingstoke: Palgrave Macmillian.
ROWTHORN, R. and WELLS, J. (1987). *De-industrialization and Foreign Trade*. Cambridge: Cambridge University Press.

SINGH, A. (1977). UK industry and the world economy: A case of de-industrialisation? *Cambridge Journal of Economics*, 1(2): 113-136.
SINGH, A. (1987). Manufacturing and De-industrialization. *The New Palgrave: A Dictionary of Economics*. London: Macmillan.
TREGENNA, F. (2007a). Changes in manufacturing employment in South Africa. In A. Deshpande (ed.), *Globalization and Development: A Handbook of New Perspectives*. Oxford: Oxford University Press.
——— (2007b). *Measuring Intersectoral Outsourcing in South Africa*. HSRC Working Paper, Pretoria.