Explaining the changing input-output multipliers in South African: 1980-2010

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1 INTRODUCTION

The aim of this paper is to measure and explain the total impact that industries, comprising the South African Economy, have on one another. This is important in order to understand the interdependence of industries and how changes in one industry might affect other industries and hence a regional, national or world economy (Leontief, 1974:387). Studies of this nature are generally heavily reliant on the calculation of GDP (Gross Domestic Product) multipliers from input-output tables.

Wasilly Leontief, the 1973 Nobel-laureate for economics, is generally regarded as the most prominent figure in the development of input-output analysis. He described the latter as, "a method of analysis that takes advantage of the relatively stable pattern of the flow of goods and services among the elements of our economy, to bring a much more detailed statistical picture of the system into the range of manipulation by economic theory" (Leontief, 1986:4). The inter-dependence of different industries of the economy is generally not well understood and few other studies in recent years have focused on the magnitude, nature and changes in these relationships over time.

Previous studies that involved the calculation and application of multipliers for the South African economy generally focused on one sector or industry. The aim of a study by Stillwell (1999) was to calculate the impact of the mining industry on the economy over the period 1971 to 1993. He did this by using input-output tables and a "closed" model to calculate a range of multipliers, including total GDP multipliers, GDP type II multipliers, total employment multipliers, and type II total employment multipliers.

The insight gained from input-output analysis is fundamental to understanding the links between industries, sectors and households in the economy. It provides an important perspective on the functioning of the economy and is an important tool for policymakers to review and analyse the past, and use it as a basis for future planning. It can provide important information on how to prioritise government policy and capital investment, and on which industries to focus in order to yield the biggest returns to meet government's economic and social objectives.

In section 2, the basic theory underlying input-output tables is covered. It also presents a brief South African perspective on this topic. Section 3 deals with output multipliers and their calculation from input-output tables. It also briefly discusses the different types of multipliers relevant to input-output analysis. The model, that is used to calculate the four sets of multipliers for each of the seven data sets (1980, 1985, 1990, 1995, 2000, 2005 and 2010), is developed in section 4. Section 5 presents the results of the open and closed model calculations for the seven sets of the four types of inter-industry multipliers produced. The multipliers are analysed, the observations are discussed and conclusions are drawn. Section 6 concludes the paper with an indication of some policy implications of the findings and makes some suggestions for future studies of this nature.

2 BASIC THEORY OF INPUT-OUTPUT TABLES

Miller & Blair (2009:1-2) describes the input-output model as, "a set of linear equations, each one which describes the distribution of an industry's product throughout the economy". The model is therefore a way of representing the flow of money in an economy, mainly among industries, but also incorporates government, households, imports, and exports (Robison, 2009:6). Stone (1961: 14), in turn, describes input-output tables and analysis as, "a means of describing and analysing the productive process of a complete economic system".

Input-output tables originate from Francois Quesnay's *Tableau Economique,* an eighteenth century descriptive table showing sales and purchase relationships between a range of producers and consumers in the economy. Wassily Leontief further developed input-output methodology and transformed it into a practical tool for economic analysis. His work in this field earned him the Nobel Prize for economics 1973 (United Nations, 1999:3). He published the first input-output tables for the US economy based on census data for the year 1919 in 1936 (Leontief, 1936:105-125).

During the 1960's Richard Stone played a key role in improving input-output methodology by developing the so-called "RAS" technique, also called the bi-proportional method, which enabled input-output relationships to be updated or revised with a minimum of information. This, together with his work in the area of the integration of the input-output framework into the system of national accounts, earned him the Nobel Prize in 1984 (Allen and Gossling, 1975:15; United Nations, 1999:3).

An input-output table is an analysis of the production process based on recorded data, rather than complex mathematical formulas. Today input-output analysis is an important part of modern economics and became part of the United Nations' system of national accounts (United Nations, 1999:3). Governments of developed countries around the world extensively use input-output models for economic analysis and it serves as the basis of important economic policy decisions in many countries. The United States government notably used the 1947 publication of input-output tables as a basis for planning to avoid massive post-war unemployment following de-mobilisation (Miller and Blair, 2009:731).

2.1 Assumptions

According to McLennan (2006:24) there are five basic assumptions underlying input-output models:

1 The returns to scale are constant – Doubling of all inputs will result in a doubling of output. The production function is therefore assumed to be linear.

2 Supply constraints do not exist – The supply of the factors of production is assumed to be limitless. Output is therefore only limited by demand, and not supply.

3 The commodity input structure is fixed – It is assumed that the changes in the economy will only be reflected in the level of output, not the composition of its inputs. The combination of commodities and services needed for production remain the same, and price changes do not lead producers to switch to substitutes.

4 The industry output is homogeneous – The combination of the goods and services that an industry produces is assumed to remain the same, regardless of the level of output. All changes in an industries' level of production, would therefore be in fixed proportions.

5 An industry uses the same technology to produce all its products – It is assumed that an industry uses particular technologies to produce one primary product. All other outputs of the industry are considered by-products of the same production process using the same technology.

2.2 Limitations

The Australian Bureau of Statistics (2009:1-2) identified the following limitations of input-output tables for economic impact assessment:

1 The most important limitation is the assumption that the economy has no supply-side constraints.

It implies that the economy can produce additional output without re-allocating resources from one area to another. This limitation becomes especially problematic when the economy is functioning near full capacity. Economic impacts are therefore often overstated.

2 The input-output model does not allow the price mechanism to reflect changes in the scarcity of resources, and therefore prices do not act as a rationing device. The model cannot accommodate the effect of policy on prices and hence limits the utility of the model. It cannot for instance account for crowding-out effects.

3 Input-output analysis assumes the production process uses inputs in fixed ratios. The multipliers produced therefore describe average, rather than marginal effects. The model cannot reflect a change in the proportion of imports to local content, or the diversion of exports to local consumption.

4 The model assumes that the composition of the household consumption "basket" of goods and services remains unchanged if the level of household consumption changes. It therefore does not take into account the fact that the pattern of household expenditure might change if household incomes increase. This also holds true for the purchases of intermediate goods, raw materials and labour for the production process.

5 The input-output model does not recognise that consumption expenditure might be subject to budget constraints. This is especially relevant in the case of household and government expenditure.

6 It is inappropriate to use national input-output tables to calculate the economic impact of projects in smaller regions. Linkages with other industries at a local level are generally weaker than at a national level and leakages to other areas are generally larger than when calculated for a national economy. Economic impact calculated in this manner is therefore easily overstated.

2.3 Uses of input-output analysis

According to Thirlwall (2006:384) input-output analysis can be used in a number of ways:

1 It is an important tool for planners for forecasting and projecting purposes. It allows policy makers to predict the input needs (commodities, intermediate goods, and services) of the different industries in the economy at a future date given a certain GDP growth forecast. It can therefore be used to achieve consistency in production to avoid future bottlenecks in the production process.

2 Input-output analysis can also be used for simulation purposes. By manipulating input-output tables, planners and policy makers can get an indication how, for instance, large investments in certain industries, or import substitution policies, will affect the production requirements of the economy and they can trace the impact through the economy.

3 Input-output analysis also allows planners to forecast the import requirements and the balance of payments effects of changes in final demand.

4 It also allows the calculation of a range of multipliers, which shows the direct and indirect effect of a unit change in demand for the output of any one activity on the total output of all activities in the system. Input-output analysis also shows the strength of the linkages between activities in the economy.

2.4 The South African input-output tables

The former Central Statistical Service (CSS) first produced input-output tables for the South African economy in 1967. Input-output tables, with imports shown separately, were published for the years 1971, 1975, 1978, 1981, 1894, 1988, 1989 and 1993. Since 1993, only supply-and-use (SU) tables were produced by CSS and subsequently Statistics South Africa (SSA) (Bouwer, 2002:2). Even though these tables showed the inter-industry transactions, they do not have the same properties of conventional input-output tables. Therefore, they do not allow for the simple transformations using matrix algebra and hence the calculation of GDP multipliers for each industry, without having to make additional calculations and assumptions

(Bouwer, 2002:13-18). Statistics South Africa is currently developing a new input-output framework (STATSSA 2012:45) and has released earlier in 2013 a draft input-output table for the year 2009 (STATSSA 2013). For consistency reasons this table was not used in any of the calculations.

Given that input-output tables were therefore not available from Statistics South Africa for most of the 1980-2010 period covered in this study the input-output tables used in this study were extracted from the South African Standardised Industry Indicator Database, which is compiled, administered and owned by Quantec Research. According to Quantec Research (2012:1) the database is compiled by combining a comprehensive set of industry and national account indicators with a consistent input-output framework spanning three decades. It therefore aims to provide a systematic and up-to-date set of standardised industry time-series for South Africa.

Its industry classification follows the framework used by Statistics South Africa, and segregates the economy into 28 manufacturing industries and 17 non-manufacturing industries ("government services" is the 46th "industry"). The database is therefore organised on an industry basis, with each industry's structure explained by up to 400 variables. The methodology used by Quantec Research can be accessed on their website. (Quantec Research, 2012:5).

2.5 The model

The basic input-output model can be summarised as:

(1) $$x_i = z_{i1} + \ldots + z_{ij} + \ldots + z_{in} + Y_i = \sum_{j=1}^{n} z_{ij} + Y_i$$

where:

$x_i =$ The total output (production) of industry i

$z_{ij} =$ The inter-industry sales by sector i (also called intermediate sales) to all sectors j (including itself, when $j = i$)

$Y_i =$ The total final demand for industry i's product

(Miller and Blair, 2009:11-12)

Equation (1) therefore represents the distribution of industry $i's$ output (or production) in an economy that consists of n industries. A series of similar linear equations would represent the sales of the output of each of the n industries in an economy:

(2) $$\begin{aligned} x_1 &= z_{11} + \ldots + z_{1j} + \ldots + z_{1n} + Y_1 \\ x_i &= z_{i1} + \ldots + z_{ij} + \ldots + z_{in} + Y_i \\ x_n &= z_{i1} + \ldots + z_{nj} + \ldots + z_{nn} + Y_n \end{aligned}$$

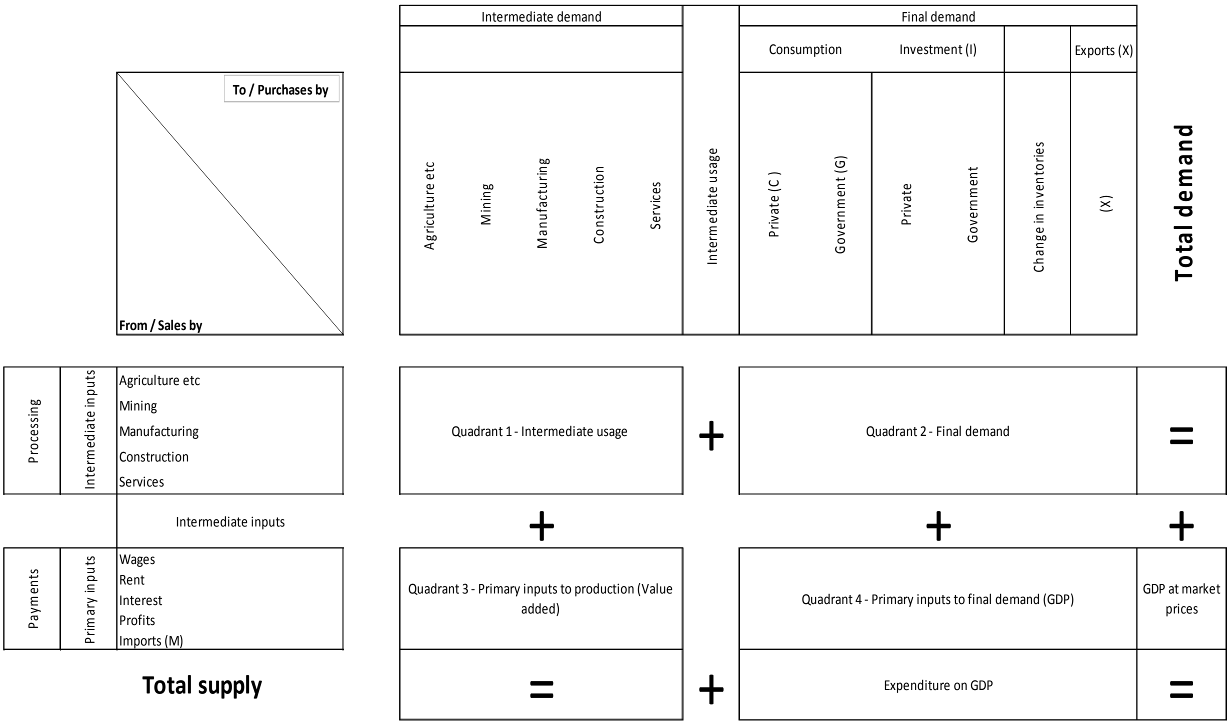
At the core of an input-output table for an economy of n industries is a transactions table. This table with n rows and n columns shows the purchases and sales of each industry, from and to each other industry, at basic prices (excluding transport costs and subsidies) and forms a square matrix. The selling sectors (industries) are listed down the left of the table and the purchasing sectors (industries) across the top (Miller and Blair, 2009:13). The tables obtained for this study from Quantec Research disaggregates the South African economy into 46 industries.

2.6 The structure of input-output tables

The table consist of four sub-matrices that combine to form a larger matrix. Figure 1 shows the basic composition of the input-output table with the four sub-matrices:

1 Intermediate usage
2 Final demand
3 Primary inputs to production
4 Primary inputs to final demand

Figure 1: A simplified input-output table



Sources: Thirlwall (2006:385); McLennan (2006:2-4); Bess & Ambargis (2011:6)

The intermediate usage sub-matrix (Quadrant 1) shows the inter-industry transactions. The columns depict all the goods and services that form the intermediate inputs into an industry's output. The rows show the proportion of the relevant industry's output that are absorbed as intermediate inputs by other industries (McLennan, 2006:1). Quadrant 2, or the final demand sub-matrix, gives the disposition of output into final demand categories. Quadrants 1 and 2, together, show the total usage of goods and services supplied by each industry (McLennan, 2006:1). Quadrant 3 or the primary inputs to production sub-matrix, shows all primary inputs used in production. These include wages, profits and taxes, also known as the components of value added to the output of industries. This quadrant also represents the payments by industries to factors of production (Thirlwall, 2006:385). Payments to foreigners for imports can also be shown here or alternatively in quadrant 2 as a net figure together with exports. Quadrants 1 and 3, together, show the total inputs used in the production process in each industry (McLennan, 2006:1). Quadrant 4 records direct sales of factors of production to final users, or primary inputs into final demand. Value is added by the final demand sectors in their consumption of the intermediate output. Examples of transactions of this nature would be government's salary payments to civil servants, or consumers paying for domestic help (Thirlwall, 2006:385). Quadrants 1 and 3 are used to calculate direct coefficients, from which Leontief inverses and ultimately output multipliers are calculated. The square matrix nature of the input-output table facilitates its transformation by means of matrix algebra, and makes it possible to solve a large number of simultaneous equations.

If all the elements that make up GDP, namely wages (remuneration of employees), profits (gross operating surplus) and net indirect taxes, are found in the Quadrant 3, the input-output model is said to be "open" with respect to households. If wages (remuneration of employees) are included in Quadrant 1, the model is viewed as "closed" with respect to households. The ability to include or exclude households from the table in this manner enables us to separate the induced effect from the direct and indirect effect in the calculation of GDP multipliers in the chapters that follow (Stillwell & Minnit, 2000:457).The transaction matrix shows the value of sales and purchases between the industries that comprise the economic system for a given period, usually one year, and at current prices. Quadrant 1 in Figure 1 shows these inter-industry transactions.

If x represents the value of output and the two subscripts denote the origin (i) of the output and its destination (j) respectively, then:

$x_{ij} =$ Sales by industry i to industry j (or the inputs into industry j from industry i)

where $i = 1,\ldots,n$ *and* $j = 1,\ldots,n$

Then:

$\sum_i x_{ij} =$ The total input of goods and services into industry j (a column industry) from i industries (row industries)

and:

(3) $X_j = \sum_{i=1}^{n} x_{ij} + W_j + \pi_j + T_j + M_j$ = Total inputs (or total cost) into industry ..

where:

$W_j =$ Wages paid in industry j (Remuneration of employees)

$\pi_j =$ Profits made in industry j (Gross operating surplus)

$T_j =$ Net indirect taxes paid by industry j

$M_j =$ Imports into sector j

and:

(4) $VA_j = W_j + \pi_j + T_j =$ Value added to inputs in sector j

For every row in the matrix, it can therefore also be shown that:

$\sum_j x_{ij} =$ The total output of goods and services absorbed by industry j (a row industry) from i industries (column industries)

and:

(5) $X_i = \sum_{j=1}^{n} x_{ij} + X_{iC} + X_{iG} + X_{iI} + X_{iE}$ = Total domestic output (or usage, both intermediate and final) of

industry i (or sector)

where

$X_{iC} =$ Private consumption expenditure on the goods and services produced by industry i

$X_{iG} =$ Government consumption expenditure on goods and services produced by industry i

$X_{iI} =$ Investment expenditure on goods and services produced by industry i

$E_{iE} =$ Exported value of goods and services produced by industry i

and:

(6) $Y_i = X_{iC} + X_{iG} + X_{iI} + X_{iE}$ = The final demand for the output of industry i

The linear equations that make up the input-output table need to balance, because ultimately total inputs need to equal total outputs, and therefore:

(7) $X_j = X_i$

The second phase in input-output analysis is to derive input coefficients from the inter-industry section (Quadrant 1) of the transaction table. Ten Raa (2005:87) defines input coefficients (or technical coefficients) as the input requirements per unit of output. Input coefficients are generated by dividing every value in the column by the column total, therefore:

(8) $$a_{ij} = \frac{x_{ij}}{X_j}$$

where:

$a_{ij} =$ Input coefficient (also called the technical coefficient) that gives the amount of purchases from each industry to support one unit of output of industry j

$x_{ij} =$ Sales by industry i to industry j (the column entry)

$X_j =$ Total inputs into industry j (the column total)

Then:

(9) $x_{ij} = a_{ij} X_j$

Equation (5) can be rewritten from equation (9) as:

(10) $$X_i = \sum_{j=1}^{n} a_{ij} X_j + X_{iC} + X_{iG} + X_{iI} + X_{iE}$$

The above procedure produces a set of n simultaneous equations, each representing an industry row in the transactions matrix of n industries, $i = 1,...,n$, which can be solved if a number of conditions are met. By applying matrix algebra to the matrix of input coefficients, it can be calculated what effect a change in demand in the output for one industry would have on all other industries. In specifying the final demand per industry, the following set of equations can be derived:

From (6) equation (10) can be rewritten as:

(11) $$X_i = \sum_{j=1}^{n} a_{ij} X_j + Y_i$$

Hence, equation (11) can be rewritten as:

(12) $$Y_i = X_i - \sum_{j=1}^{n} a_{ij} X_j$$

where:

$i = 1, \ldots, n$

$Y_i =$ Total final demand

$X_i =$ Total output

$\sum_{j=1}^{n} a_{ij} X_j =$ Sum of intermediate demands

The set of all the linear balance equations in the input coefficient matrix can be represented as:

(13) $$X = A_{NN} + Y$$

where:

$A_{NN} =$ A matrix of the technical coefficients derived from the transactions matrix

$Y =$ Final demand of each industry

Input coefficients, because they represent ratios rather than absolute values, allow comparisons between economies, and allow the derivation of inverse coefficients (Stillwell, 1999:50).

The third phase of input-output analysis is to derive inverse coefficients from input coefficients. Inverse coefficients show the input requirements per monetary unit of final demand. It allows the impact of one additional unit increase in the final demand of any industry's output, to be traced through all the industries that comprise an economy. It also enables the calculation of the magnitude of such an impact overall, and in every industry. It allows the analysis of the inter-dependence of industries in an economy.

The input-output model can be solved with households either included, or excluded, from the transactions table. If households (wages and private consumption expenditure) are included in the transactions matrix the model is "closed" with respect to households, and inverse coefficients would reflect the direct, indirect and induced requirements per unit of final demand. The exclusion of households make the model "open" with respect to households, and inverse coefficients would only reflect the direct and indirect requirements of a unit of final demand.

Inverse coefficients, also known as Leontief inverses, can be calculated by taking the inverse of the difference between the identity matrix and the matrix of input-coefficients. Matrix algebra can be used to solve the set of linear balance equations. Mathematically, inverse coefficients can be represented as follows:

(14) $$[I - A]^{-1}$$

3 OUTPUT MULTIPLIERS

A multiplier represents to what extent some aspect of a model will change in response to an exogenous change (Robison, 2009:8). In the case of input-output models, it quantifies the relationship between an increase in the output of an industry and the effects generated on the economy. Impact analysis is the study of how the effect of an exogenous change from outside the system would work its way through the economy in the short run (Miller and Blair, 2009: 243).

Miller and Blair (2009:244) distinguishes between, the initial, and the total impact on an economy in response to a change in final demand. The idea that the multiplier effect increases the value of the initial effect to a larger, economy-wide, total effect, once the system reaches a new equilibrium, is the essence of multiplier analysis. The total effect can be described in two ways:

1 In the open model calculation, from which households are excluded, it is the direct and indirect effect only.
2 In the closed model calculation, where households are included in the inter-industry calculation, it is the direct, indirect and induced effect.

The open model calculation produces a simple multiplier, which describes the total amount of output induced by the requirement from all industries (direct and indirect effects) to produce output to satisfy the demand for an extra unit of output from an industry (McLennan, 2006:18). The simple multiplier is calculated by multiplying the direct (input) coefficient output vector of the industry, in which the change in demand of output occurs, with the Leontief inverse (inverse coefficient) in equation (14), obtained from the transactions matrix with households (wages and private consumption) excluded (Stillwell, 1999:54).

The closed model calculation produces a total multiplier, which describes the total amount of output induced by the requirement from all industries to produce output to satisfy the demand from an extra unit of output from an industry, and by the spending of the extra wages and salaries earned (from producing the additional output) by households (McLennan, 2006:18). The total multiplier is calculated by multiplying the direct (input) coefficient vector of the industry, in which the change in demand of output occurs, with the Leontief inverse (inverse coefficient), obtained for the transactions matrix, which include households (Stillwell, 1999: 55).

3.1 Calculation of multipliers

Chiang and Wainwright (2005: 112) suggest that the flow of goods and services in an economy with n sectors can be represented by a set of simultaneous linear equations. If x_i denotes the total output of industry i, Y_i the total final demand for industry $i's$ product, and z_{ij} the inter-industry sales from industry i to industry j, the economy can be represented as follows:

$$
\begin{aligned}
x_1 &= z_{11} + z_{12} + \ldots + z_{1j} + \ldots + z_{1n} + Y_1 \\
x_2 &= z_{21} + z_{22} + \ldots + z_{2j} + \ldots + z_{2n} + Y_2 \\
&\ldots \\
x_i &= z_{i1} + z_{i2} + \ldots + z_{ij} + \ldots + z_{in} + Y_i \\
&\ldots \\
x_n &= z_{n1} + z_{n2} + \ldots + z_{nj} + \ldots + z_{nn} + Y_n
\end{aligned}
\tag{15}
$$

The ratio of input to output (or technical coefficient), is denoted by a_{ij} (which equals z_{ij}, the flow of input from i to j, divided by X_j, the total output of industry j). It is assumed that technical coefficients are fixed, implying that inputs are employed in fixed proportions. Hence, equation (15) can be rewritten as: (Chiang and Wainwright, 2005:114)

(16)
$$\begin{aligned}
x_1 &= a_{11}x_1 + a_{12}x_2 + \ldots + a_{1j}x_j + \ldots \ + a_{1n}x_n + Y_1 \\
x_2 &= a_{21}x_1 + a_{22}x_2 + \ldots + a_{2j}x_j + \ldots \ + a_{2n}x_n + Y_2 \\
&\ldots \\
x_i &= a_{i1}x_1 + a_{i2}x_2 + \ldots + a_{ij}x_j + \ldots \ + a_{in}x_n + Y_i \\
&\ldots \\
x_n &= a_{n1}x_1 + a_{n2}x_2 + \ldots + a_{nj}x_j + \ldots \ + a_{nn}x_n + Y_n
\end{aligned}$$

In matrix notation (16), which represents the whole system of equations, is expressed as

(17) $x = Ax + Y$

From (17) follows:

(18) $x = (I - A)^{-1} Y$

where:

$x =$	The output multiplier matrix
$I =$	Identity matrix, i.e. a square null matrix with 1's along the main diagonal
$A =$	Input coefficient matrix
$(I - A)^{-1} =$	The inverse coefficients (or Leontief inverses)
$Y =$	Final demand

3.2 Application of multipliers to data

Multipliers are summary measures used to predict the total impact on industries in an economy if exogenous changes in final demand for the output of a particular industry occur (McLennan, 2006:6). Multipliers can be calculated for a number of economic variables, such as GDP, income and employment. Matrix algebra enables the application of multipliers to data sets of economic variables, provided they are either:

1. In the form of a diagonal matrix with the same dimensions (number rows are equal to the number of columns) as the matrix containing the output multipliers, or
2. In the form of a vector, with the same number of rows, as the number of columns of the matrix it is being multiplier with, or vice versa.

In equation (18) the dimensions (number of rows and columns) of x would have to equal that of Y to enable its manipulation by means of matrix algebra.

In order to calculate the total effect of an increase in Y on each of the industries in the economy, a diagonal matrix for the vector variable, by which we can multiply the inverse coefficients, needs to be constructed. The sum of the separate multipliers in each column will equal the multipliers shown in the vector matrix (Stillwell, 1999:57).

The two matrices would hence be compatible, and allow the multiplication to be done. The product would be a matrix of output multipliers, with the same number of rows as both the vector matrix and the diagonal matrix, and the same number of columns as the inverse coefficient matrix.

The accuracy of the value of multipliers is however subject to a number of factors. These are the correctness of its components, as well as the final demand and inverse coefficients. It is important to note that in most industries technological change takes time, resulting in multipliers being reasonably stable over the medium term, which allows the attainment of reasonable results using multipliers in economic impact analysis. Industries that are characterised by wide fluctuations in prices, such as commodities, are however an exception, with the accuracy of impact analysis being compromised to a larger degree (McLennan, 2006:6). If multipliers are used for forecasting purposes, it can generally be assumed that their accuracy and usefulness would decrease with an increase in the horizon of the forecast. The focus of this study is on the past three decades, and hence does not aim to take a future perspective.

Generally, the multipliers used most often are:

1 GDP multipliers
2 Income multipliers
3 Employment multipliers

This study however focuses only on GDP Multipliers. The GDP multiplier determines by how much total GDP increases as autonomous expenditure increases. It is expressed as a ratio showing how much GDP will increase because of a R 1 increase in the final demand for the output of a specific industry.

4 THE BASIC MODEL

In this section, the methodology used in calculating GDP multipliers for the South Africa will be presented. The model used in this study is similar to that used in Stillwell (1999:61-76).

From equation (18) the base equation for the model can be stated as:

(19) $x=(I-A)^{-1}Y$

This model will be used to calculate GDP multipliers for the South African economy for the seven data sets spanning the 1980-2010 period with 5-year intervals. The GDP multipliers are the factor by which the total GDP of the economy increases due to a R 1 increase in the final demand for a specific industry's product. The data sets produced by the calculations will allow the comparison of the relative contribution of each industry to national income (GDP). It will enable the measurement of the extent to which the national GDP benefits from the increase in a unit of output in the case of each of the 46 individual industries that comprise the South African economy.

Both simple GDP multipliers and total GDP multipliers are calculated, using the open and closed model calculation respectively. This allows the separation of the induced effect from the direct and indirect effects, and hence the separation of the economic impact of households on GDP from that of industries alone.

The model calculates a set of multipliers for each of 46 individual industries comprising the South African economy. The calculation follows eighteen logical steps for each of the seven input-output tables for each of the data sets accounting for the years mentioned above. For each data set, the calculation is performed for both the open and closed model.

4.1 The open model

The open model calculation, as stated above, is open with respect to households, and excludes the "compensation of employees" row and the "total private consumption expenditure" column from

"Quadrant 1" of the transaction tables. GDP multipliers produced by this model are referred to as simple GDP multipliers, which measure the direct and indirect impact only.

Input coefficients are the ratio of the direct intermediate input requirements, to the total output of that industry. The model uses data from the re-organised transactions table to calculate input coefficients. All inter-industry transactions are divided by "Total Input (intermediate costs and value added)". It is also important to note that this is the open model calculation and "compensation of employees" and "total private consumption expenditure" are not included in the inter-industry matrix for this operation. In matrix format, the input coefficient matrix can be shown as:

(20) $$A=\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

where:

$a_{11} =$ Input coefficient showing the fraction of the total inputs that industry 1 supplies to itself
$a_{12} =$ Input coefficient showing the fraction of the total inputs that industry 1 supplies to industry 2

And the identity matrix can be shown as:

(21) $$I_n=\begin{bmatrix} 1 & 0 & \cdots & 0 \\ 0 & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1 \end{bmatrix}$$

Subtracting each of the elements of the matrix of input coefficients from its corresponding elements in the identity matrix produces the technology matrix $[I-A]$. If matrices (20) and (21) are revisited, this operation can be illustrated in matrix format as:

(22) $$\begin{bmatrix} 1 & 0 & \cdots & 0 \\ 0 & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1 \end{bmatrix}-\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}=\begin{bmatrix} (1-a_{11}) & -a_{12} & \cdots & -a_{1n} \\ -a_{21} & (1-a_{22}) & \cdots & -a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ -a_{n1} & -a_{n2} & \cdots & (1-a_{nn}) \end{bmatrix}$$

Revisiting equation (17) delivers:

(23) $$Y=\left(I-A\right)x$$

where:

(24) $$Y=\begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix},\ I=\begin{bmatrix} 1 & 0 & \cdots & 0 \\ 0 & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1 \end{bmatrix},\ A=\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \text{ and } x=\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix}$$

To meet both intermediate and final demand, an industry needs to produce at output levels to satisfy the set of equations in (16). If:

$x_1 =$ Required output from industry 1
$x_2 =$ Required output from industry 2

Equation (23) can be represented in matrix form as:

$$(25)\qquad \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix} = \begin{bmatrix} (1-a_{11}) & -a_{12} & \cdots & -a_{1n} \\ -a_{21} & (1-a_{22}) & \cdots & -a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ -a_{n1} & -a_{n2} & \cdots & (1-a_{nn}) \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix}$$

If the 1's along the principal diagonal axis are ignored, and the "middle" matrix in (25) is expressed as a negative of the input coefficient matrix, $-[A]$, then the "middle" matrix represents the sum of the identity matrix, $[I]$ and the negative input coefficient matrix, $-[A]$ (Chiang and Wainwright, 2005:114).

Matrix (25) can therefore be re-written as equation:

$$(26)\qquad x = (I - A)^{-1} Y$$

where:

$(I-A)^{-1} =$ The inverse coefficient or Leontief inverse of matrix $(I - A)$

(Chiang and Wainwright, 2005:115)

Calculating inverse coefficients by hand is a cumbersome and time-consuming process. Matrices can however easily be inverted by using MS Excel or any other suitable software. The model calculated input coefficients for each of the seven open model technology matrices $[I - A]$.

If equation (4) is revisited, industry *j's* contribution to GDP can be calculated by adding up all the value added by industry j:

$$(27)\qquad VA_j = W_j + \pi_j + T_j = Industry\ j's\ contribution\ to\ GDP$$

where:

$W_j =$ Wages paid in industry j (Compensation of employees)

$\pi_j =$ Profits made in industry j (Gross operating surplus)

$T_j =$ Net indirect taxes paid by industry j

The direct GDP coefficient y_j can be calculated, by dividing value added to industry $j's$ input, by industry $j's$ total input, expressed as:

$$(28)\qquad y_j = \frac{VAj}{Xj}$$

where:

$VA_j =$ Value added to inputs in sector j

$X_j =$ Total inputs (or total cost) into industry j

As in the case with the identity matrix, $[I]$, a GDP diagonal matrix can now be constructed, with the direct GDP coefficients along the principal diagonal axis:

$$(29)\qquad Y = \begin{bmatrix} y_1 & 0 & \cdots & 0 \\ 0 & y_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & y_n \end{bmatrix} = GDP\,diagonal\,matrix$$

The model sums the elements of value added for each industry in the input coefficient matrix, calculates the direct GDP coefficients, and transfers their values to the principal diagonal axis of the GDP diagonal matrix as shown in matrix (29).

4.1.1 Simple GDP multipliers

The final step of the open model calculation produces simple GDP multipliers. Firstly the GDP diagonal matrix is multiplied with the Leontief inverse matrix, i.e.:

(30) $x = Y[I-A]^{-1}$

where:

$x =$ The output multiplier matrix
$Y =$ The GDP diagonal matrix
$[I-A]^{-1} =$ The inverse coefficients matrix (or Leontief inverse)

The sum of the each column of the product matrix would show the simple GDP multiplier for the industry shown in that column. The simple GDP multipliers can therefore be expressed as:

(31) $X_j = \sum_{j=1}^{n} x_{ij}$

where:

$X_j =$ The simple GDP multiplier for industry j
$x_{ij} =$ Direct and indirect impact coefficient for industry $i's$ inputs into industry j

Hence, X_j shows the multiplying effect of R 1 increase in the output of industry j on other industries in the economy, or, put differently, the simple GDP multiplier measure the initial industry j effect, as well as the forward and backward linkage effects on other industries.

4.1.2 Simple type II GDP multipliers

Simple type II multipliers show the effect that an increase in two (of the three – wages are excluded) components of GDP within an industry, will have on other industries. It can be calculated by dividing the direct and indirect coefficient by the direct GDP coefficient. Mathematically it can be expressed as:

(32) $X'_j = \sum_{j=1}^{n} \left(\frac{x_{ij}}{y_j} \right)$

where:

$X'_j =$ The simple type II GDP multiplier for industry j
$x_{ij} =$ Direct and indirect impact coefficient for industry $i's$ inputs into industry j
$y_j =$ Direct GDP coefficient for industry j

4.1.3 Separating the direct and indirect effects

The calculation of the simple type II multiplier also enables the separation of the direct and indirect effects. Since this multiplier represents the ratio of the direct and indirect effects to the direct effect, it can be represented as:

(33) $$X'_j = \frac{Direct\ Effect + Indirect\ Effect}{Direct\ Effect}$$

where:

$X'_j =$ The simple type II GDP multiplier for industry j

Equation (33) can now be re-written as:

(34) $$X'_j = \frac{X_j}{Direct\ Effect}$$

where:

$X_j =$ The simple GDP multiplier for industry j

Hence:

(35) $$Direct\ Effect = \frac{X_j}{X'_j}$$

In addition:

(36) $$Indirect\ Effect = X_j - Direct\ Effect$$

The ability to distinguish between the components of economic impact, i.e. the direct, indirect and induced effects, facilitates a detailed analysis of the effect of exogenous changes in final demand through the economy.

4.2 The closed model

When an exogenous sector of the open input-output model is absorbed into the system as just another industry, the model will become a closed model (Chiang and Wainwright, 2005:119). The exogenous sector in this instance is households. The closed model calculation, is therefore closed with respect to households, and includes the "compensation of employees" row and the "total private consumption expenditure" column in "Quadrant 1" of the transaction tables. The GDP multipliers produced by this model are referred to as total GDP multipliers, which measure the direct, indirect as well as the induced impact.

The square matrix produced needs to be adapted to include the effect of households on economic impact. An additional row, containing "compensation of employees", and a column, containing "total private consumption expenditure", is added to the square matrix of 46 rows and columns, and becomes a square matrix of 47 rows and columns. The calculation of the multipliers is similar to the open model.

4.3 The induced effect

The impact of households (wages and private consumption expenditure) on the economy can now be calculated. Deducting the simple GDP multiplier from the total GDP multiplier yields the measure of the induced impact. It can be expressed mathematically as:

(37) $$Induced\ effect = X_j^{total} - X_j^{simple}$$

where:

$X_j^{total} =$ The total GDP multiplier for industry j

$X_j^{simple} =$ The simple GDP multiplier for industry j

4.4 Total type II GDP multipliers

Total type II multipliers show the effect that an increase in the three components of GDP, within an industry, will have on the economy as a whole. It can be calculated by dividing the direct, indirect and induced coefficient by the direct GDP coefficient. Mathematically it can be expressed as:

(38) $$X'_j = \sum_{j=1}^{n+1} \left(\frac{x_{ij}}{y_j} \right)$$

where:

$X'_j =$ The total type II GDP multiplier for industry j

$x_{ij} =$ Direct, indirect and induced impact coefficient for industry $i's$ inputs into industry j

$y_j =$ Direct GDP coefficient for industry j

5 INTER-INDUSTRY IMPACT

This section focuses on the inter-industry impact, which measures the effect of an increase in output from each of the 46 industries, into which the economy is segregated, on the rest of the economy. The unit of measurement is the multipliers, which will, quantify this effect of how a R 1 increase in the value of an industry's production, create additional value throughout the economy, and quantify that value in rand terms.

In this study four types of multipliers are calculated:

1 Simple GDP multipliers
2 Simple type II GDP multipliers
3 Total GDP multipliers
4 Total type II GDP multipliers

The model calculations generated twenty-eight sets of multipliers from the seven sets of data obtained - one per multiplier per year. In the remainder of this section the data will be presented and analysed in the following ways:

1 Tables ranking the 46 industries in terms of if their relative impact on GDP.
2 Graphs showing the changes in the arithmetic mean and standard deviation of each set of multipliers over the period analysed.
3 Tables presenting a statistical analysis of the data and comparing the multipliers derived from the seven data sets.

The statistical methods and calculations used in this study are based on that of Keller (2005:89-134).

5.1 Simple GDP Multipliers

In this section, the relative importance of industries in terms of their direct and indirect multiplier effects, as measured by the simple GDP multipliers, is investigated. Table 1 ranks industries by the size of the simple GDP multiplier for each of the seven data sets, in five-year intervals over the period 1980 to 2010. It also shows a summary of the rankings over the 30-year period, and it ranks industries according to the average rank achieved over the period.

Table 1: Simple GDP multipliers (open model) – 1980-2010

Simple GDP Multipliers: Open model	Multiplier							Rank										
	1980	1985	1990	1995	2000	2005	2010	1980	1985	1990	1995	2000	2005	2010	Max	Min	Diff	Avg
R111: Agriculture, forestry and fishing [1]	0.9818	0.9752	0.9717	0.9668	0.9636	0.9583	0.9605	19	20	24	33	33	35	35	35	19	16	28.43
R1121: Coal mining [21]	0.9889	0.9797	0.9724	0.9691	0.9690	0.9651	0.9748	6	11	22	31	28	27	17	31	6	25	20.29
R1122: Gold and uranium ore mining [23]	0.9924	0.9868	0.9859	0.9813	0.9795	0.9824	0.9778	3	4	2	7	9	5	11	11	2	9	5.86
R1123: Other mining [22/24/25/29]	0.9874	0.9802	0.9747	0.9731	0.9717	0.9693	0.9718	8	8	14	23	24	24	24	24	8	16	17.86
R12101: Food [301-304]	0.9788	0.9737	0.9725	0.9727	0.9710	0.9697	0.9723	28	24	21	25	26	23	22	28	21	7	24.14
R12102: Beverages [305]	0.9825	0.9771	0.9753	0.9782	0.9794	0.9787	0.9796	15	15	12	13	10	10	8	15	8	7	11.86
R12103: Tobacco [306]	0.9815	0.9870	0.9818	0.9811	0.9796	0.9791	0.9780	20	3	4	8	8	9	10	20	3	17	8.86
R12111: Textiles [311-312]	0.9620	0.9549	0.9548	0.9552	0.9576	0.9569	0.9590	44	41	41	41	37	36	36	44	36	8	39.43
R12112: Wearing apparel [313-315]	0.9573	0.9540	0.9505	0.9550	0.9576	0.9584	0.9616	45	42	43	42	38	34	34	45	34	11	39.71
R12113: Leather and leather products [316]	0.9751	0.9704	0.9690	0.9720	0.9724	0.9731	0.9724	34	32	29	27	22	16	21	34	16	18	25.86
R12114: Footwear [317]	0.9643	0.9537	0.9541	0.9649	0.9713	0.9718	0.9720	42	43	42	35	25	21	23	43	21	22	33.00
R12121: Wood and wood products [321-322]	0.9782	0.9734	0.9723	0.9763	0.9766	0.9762	0.9770	30	27	23	15	13	13	13	30	13	17	19.14
R12122: Paper and paper products [323]	0.9744	0.9731	0.9731	0.9748	0.9731	0.9732	0.9753	35	29	17	19	19	15	14	35	14	21	21.14
R12123: Printing, publishing and recorded media [324-326]	0.9809	0.9798	0.9761	0.9803	0.9807	0.9797	0.9822	24	10	10	10	7	8	6	24	6	18	10.71
R12131: Coke and refined petroleum products [331-333]	0.9730	0.9774	0.9749	0.9711	0.9606	0.9604	0.9673	37	14	13	30	35	32	28	37	13	24	27.00
R12132: Basic chemicals [334]	0.9754	0.9689	0.9662	0.9687	0.9639	0.9603	0.9632	32	34	34	32	32	33	33	34	32	2	32.86
R12133: Other chemicals and man-made fibers [335-336]	0.9689	0.9609	0.9567	0.9569	0.9526	0.9482	0.9511	40	40	40	40	42	41	39	42	39	3	40.29
R12134: Rubber products [337]	0.9742	0.9691	0.9629	0.9650	0.9579	0.9541	0.9567	36	33	37	34	36	37	37	37	33	4	35.71
R12135: Plastic products [338]	0.9724	0.9653	0.9624	0.9645	0.9629	0.9616	0.9657	38	38	38	36	34	30	31	38	30	8	35.00
R12141: Glass and glass products [341]	0.9787	0.9741	0.9706	0.9738	0.9733	0.9725	0.9743	29	23	26	20	18	18	19	29	18	11	21.86
R12142: Non-metallic minerals [342]	0.9825	0.9735	0.9688	0.9732	0.9744	0.9727	0.9747	16	25	30	22	16	17	18	30	16	14	20.57
R12151: Basic iron and steel [351]	0.9841	0.9759	0.9733	0.9732	0.9685	0.9660	0.9679	11	16	16	21	29	26	26	29	11	18	20.71
R12152: Basic non-ferrous metals [352]	0.9844	0.9778	0.9754	0.9763	0.9667	0.9631	0.9670	10	13	11	16	30	28	29	30	10	20	19.57
R12153: Metal products excluding machinery [353-355]	0.9836	0.9756	0.9727	0.9762	0.9742	0.9734	0.9748	14	18	19	17	17	14	16	19	14	5	16.43
R12154: Machinery and equipment [356-359]	0.9836	0.9756	0.9711	0.9712	0.9662	0.9630	0.9650	13	17	25	29	31	29	32	32	13	19	25.14
R1216: Electrical machinery and apparatus [361-366]	0.9811	0.9717	0.9676	0.9633	0.9547	0.9489	0.9493	23	31	31	39	40	39	42	42	23	19	35.00
R12171: Television, radio and communication equipment [371-373]	0.9777	0.9680	0.9597	0.9501	0.9415	0.9333	0.9371	31	36	39	43	45	45	45	45	31	14	40.57
R12172: Professional and scientific equipment [374-376]	0.9799	0.9735	0.9697	0.9641	0.9555	0.9485	0.9508	25	26	28	38	39	40	40	40	25	15	33.71
R12181: Motor vehicles, parts and accessories [381-383]	0.9813	0.9754	0.9704	0.9641	0.9546	0.9463	0.9495	21	19	27	37	41	42	41	42	19	23	32.57
R12182: Other transport equipment [384-387]	0.9852	0.9800	0.9743	0.9726	0.9694	0.9607	0.9657	9	9	15	26	27	31	30	31	9	22	21.00
R12191: Furniture [391]	0.9790	0.9732	0.9673	0.9712	0.9717	0.9711	0.9703	27	28	32	28	23	22	25	32	22	10	26.43
R12193: Other manufacturing [392-393]	0.9709	0.9807	0.9805	0.9822	0.9790	0.9807	0.9872	39	7	6	5	11	6	3	39	3	36	11.00
R1221: Electricity, gas and steam [41]	0.9877	0.9788	0.9805	0.9814	0.9758	0.9720	0.9749	7	12	7	6	14	19	15	19	6	13	11.43
R1222: Water supply [42]	0.9824	0.9676	0.9643	0.9760	0.9829	0.9840	0.9833	17	37	36	18	4	3	5	37	3	34	17.14
R1231: Building construction [51]	0.9652	0.9377	0.9259	0.9324	0.9208	0.9081	0.9061	41	45	46	46	46	46	46	46	41	5	45.14
R1232: Civil engineering and other construction [52-53]	0.9563	0.9217	0.9275	0.9396	0.9452	0.9391	0.9414	46	46	45	45	43	43	43	46	43	3	44.43
R1311: Wholesale and retail trade [61-63]	0.9820	0.9743	0.9731	0.9783	0.9811	0.9802	0.9805	18	22	18	12	5	7	7	22	5	17	12.71
R1312: Catering and accommodation services [64]	0.9752	0.9614	0.9659	0.9797	0.9843	0.9838	0.9853	33	39	35	11	3	4	4	39	3	36	18.43
R1321: Transport and storage [71-74]	0.9635	0.9449	0.9406	0.9435	0.9437	0.9359	0.9386	43	44	44	44	44	44	44	44	43	1	43.86
R1322: Communication [75]	0.9927	0.9912	0.9851	0.9808	0.9724	0.9681	0.9677	1	1	3	9	21	25	27	27	1	26	12.43
R1331: Finance and insurance [81-82]	0.9925	0.9887	0.9892	0.9904	0.9923	0.9917	0.9912	2	2	1	1	1	1	1	2	1	1	1.29
R1332: Business services [83-88]	0.9911	0.9841	0.9808	0.9833	0.9808	0.9785	0.9792	4	6	5	3	6	11	9	11	3	8	6.29
R13411: Medical, dental and veterinary services [93]	0.9794	0.9689	0.9667	0.9730	0.9746	0.9719	0.9728	26	35	33	24	15	20	20	35	15	20	24.71
R13412: Excluding medical, dental and veterinary services [94-96]	0.9838	0.9727	0.9726	0.9769	0.9773	0.9762	0.9777	12	30	20	14	12	12	12	30	12	18	16.00
R1342: Other producers [98]	0.9813	0.9745	0.9781	0.9876	0.9903	0.9892	0.9905	22	21	9	2	2	2	2	22	2	20	8.57
R1343: General government services [99]	0.9895	0.9847	0.9802	0.9826	0.9725	0.9533	0.9546	5	5	8	4	20	38	38	38	4	34	16.86
Mean	**0.9788**	**0.9715**	**0.9687**	**0.9705**	**0.9684**	**0.9654**	**0.9673**											
Standard deviation	**0.0088**	**0.0129**	**0.0129**	**0.0120**	**0.0135**	**0.0160**	**0.0158**											

If one considers the relative importance of industries in terms of their direct and indirect impact on GDP, Table 1 shows that the "finance and insurance" industry and "gold and uranium ore mining" industry have constantly had the largest relative potential impact on other industries, with average rankings of 1.29 and 5.86 respectively. The "building construction" industry and "civil engineering and other construction" industry, conversely, creates the smallest direct and indirect impact per additional unit of output, with average rankings of 45.14 and 44.43 respectively. Some industry categories such as "other manufacturing" and "catering and accommodation services" have shown the largest inconsistency in rankings with a difference of 36 places respectively between their highest and lowest rank over the period. This is opposed to the "finance and insurance", "transport and storage", "basic chemicals" and "other chemicals and man-made fibers" industries that have been most consistent in maintaining their relative positions in the rankings, with differences of 1, 1, 2 and 3 between their lowest and highest rankings over the period reviewed.

Figure 2: Change in the mean simple GDP multiplier 1980-2010

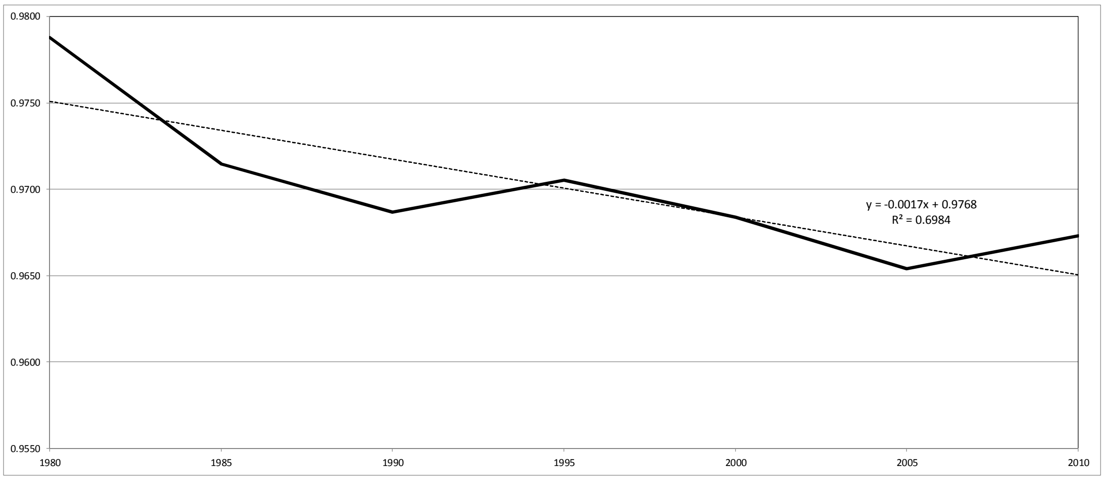
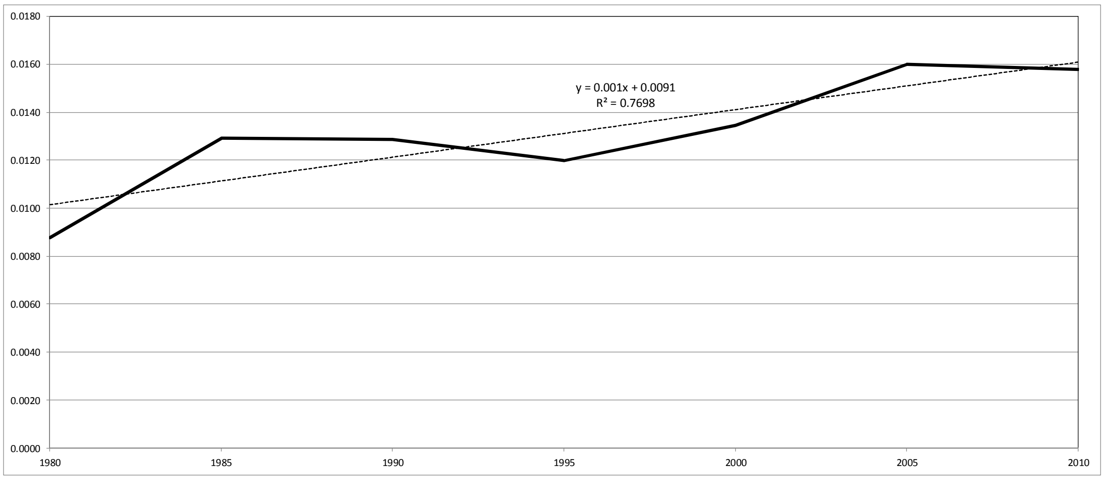


Figure 3: Change in the standard deviation of simple GDP multiplier 1980-2010



The statistical parameters generated by the model, namely, the arithmetic means and standard deviations of the simple GDP multipliers, are evaluated below. Table 1 also summarises the statistical parameters of the data sets over the period.

In absolute terms, the arithmetic mean for the period under review does not change dramatically. It is however evident from Figure 2 that there is a downward trend in the value of the mean simple GDP multiplier. Figure 3 shows that the standard deviation increased from 0.0088 to 0.0160 over the first twenty-five years and then decreased marginally to 0.0158 from 2005 to 2010.

5.2 Simple Type II GDP Multipliers

The simple type II GDP multiplier shows the ratio of the simple GDP multiplier to the direct effects, i.e. the ratio of the direct and indirect effects to the direct effect. One can therefore conclude that, the larger the value of the multiplier, the larger the indirect effect in relation to the direct effect. Table 2 rank industries according to the size of their simple type II GDP multipliers for each of the seven data sets representing the period 1980-2010. It also shows a summary of the latter tables and ranks industries by their average rank over the 1980-2010 period.

Table 2: Type II GDP multipliers (open model) – 1980-2010

Simple Type II GDP Multipliers: Open model	Multiplier							Rank										
	1980	1985	1990	1995	2000	2005	2010	1980	1985	1990	1995	2000	2005	2010	Max	Min	Diff	Avg
R111: Agriculture, forestry and fishing [1]	1.5861	1.7327	1.5807	1.7797	2.0221	2.1657	2.1648	37	34	41	37	37	35	35	41	34	7	36.57
R1121: Coal mining [21]	1.3933	1.6794	1.8423	1.9847	1.9436	1.9666	1.4260	43	36	36	31	38	38	45	45	31	14	38.14
R1122: Gold and uranium ore mining [23]	1.4575	1.5812	1.3525	1.6099	1.7237	1.3485	1.7946	42	40	44	40	42	46	40	46	40	6	42.00
R1123: Other mining [22/24/25/29]	1.4809	1.8181	1.9058	1.8159	1.8471	1.7983	1.7338	40	33	33	36	39	41	42	42	33	9	37.71
R12101: Food [301-304]	5.5949	5.5609	4.7008	4.4149	5.0055	4.6510	4.3555	3	2	3	3	3	4	12	12	2	10	4.29
R12102: Beverages [305]	3.1703	3.6023	3.1589	2.7373	2.9017	2.9455	3.0786	20	13	16	23	25	25	22	25	13	12	20.57
R12103: Tobacco [306]	2.9893	1.5835	2.1669	2.3723	2.6249	2.4886	3.0344	23	39	30	29	29	30	24	39	23	16	29.14
R12111: Textiles [311-312]	3.2612	3.1997	2.7107	3.4542	4.5380	4.2761	5.3198	18	19	24	5	5	7	5	24	5	19	11.86
R12112: Wearing apparel [313-315]	3.0772	2.7684	3.2916	2.8129	3.3130	2.9600	3.3725	22	22	14	21	17	24	17	24	14	10	19.57
R12113: Leather and leather products [316]	4.7356	5.3632	4.9840	4.7723	6.2729	5.1800	11.1950	5	3	1	2	1	2	1	5	1	4	2.14
R12114: Footwear [317]	2.5226	2.5316	2.8078	2.8308	3.7794	3.9232	4.6791	25	23	23	20	13	9	8	25	8	17	17.29
R12121: Wood and wood products [321-322]	4.1457	3.9129	3.3942	2.7451	3.1006	3.1959	3.3910	10	10	13	22	21	20	16	22	10	12	16.00
R12122: Paper and paper products [323]	3.7419	4.0640	3.6588	3.3707	3.9560	4.3342	5.4142	12	8	9	7	8	6	4	12	4	8	7.71
R12123: Printing, publishing and recorded media [324-326]	2.2921	2.2701	2.6584	2.5454	2.6086	3.0497	3.0809	30	26	25	26	30	23	21	30	21	9	25.86
R12131: Coke and refined petroleum products [331-333]	3.4237	2.2312	2.3135	3.1490	3.8735	3.4874	4.4092	14	27	27	11	11	16	11	27	11	16	16.71
R12132: Basic chemicals [334]	6.4723	5.3405	3.9533	3.1619	4.1368	4.4099	4.6539	1	4	5	10	7	5	9	10	1	9	5.86
R12133: Other chemicals and man-made fibers [335-336]	4.2025	4.1532	3.4888	3.6039	4.3494	4.1691	4.4470	9	7	11	4	6	8	10	11	4	7	7.86
R12134: Rubber products [337]	2.3796	2.4094	3.0573	2.8398	3.6981	3.6162	4.1606	27	25	19	19	15	13	13	27	13	14	18.71
R12135: Plastic products [338]	3.3617	3.2794	2.8511	2.9535	2.9996	2.8071	2.6772	16	17	21	16	24	27	29	29	16	13	21.43
R12141: Glass and glass products [341]	3.4139	3.2836	3.4206	2.5807	2.8150	2.8747	3.0512	15	15	12	25	27	26	23	27	12	15	20.43
R12142: Non-metallic minerals [342]	3.2459	3.0762	2.8134	2.4024	2.8823	3.0669	2.9697	19	20	22	27	26	22	25	27	19	8	23.00
R12151: Basic iron and steel [351]	4.2292	4.5970	3.7588	3.2754	4.8914	4.7392	5.2518	8	5	7	8	4	3	6	8	3	5	5.86
R12152: Basic non-ferrous metals [352]	4.7756	3.8939	3.6670	2.8428	3.0691	2.7172	2.4663	4	11	8	18	22	29	30	30	4	26	17.43
R12153: Metal products excluding machinery [353-355]	3.0963	3.2241	3.0682	2.9726	3.5045	3.2192	3.1850	21	18	18	14	16	18	20	21	14	7	17.86
R12154: Machinery and equipment [356-359]	3.2961	3.2817	3.1559	3.0669	3.8804	3.5286	3.3020	17	16	17	13	10	14	19	19	10	9	15.14
R1216: Electrical machinery and apparatus [361-366]	3.5546	3.9580	2.8566	2.9352	3.8654	3.8579	4.9102	13	9	20	17	12	10	7	20	7	13	12.57
R12171: Television, radio and communication equipment [371-373]	5.7814	7.7024	4.8613	3.4447	3.1591	3.2072	3.4683	2	1	2	6	19	19	14	19	1	18	9.00
R12172: Professional and scientific equipment [374-376]	2.8616	2.7788	2.5731	2.7098	3.1537	3.3689	3.3451	24	21	26	24	20	17	18	26	17	9	21.43
R12181: Motor vehicles, parts and accessories [381-383]	4.7094	3.7727	3.8720	4.8301	5.8918	6.3794	7.8803	6	12	6	1	2	1	2	12	1	11	4.29
R12182: Other transport equipment [384-387]	2.2523	2.1965	2.2520	2.2208	2.6676	3.5152	2.8947	31	29	29	30	28	15	27	31	15	16	27.00
R12191: Furniture [391]	2.3930	2.4477	3.2868	3.0976	3.9344	3.8088	5.5294	26	24	15	12	9	11	3	26	3	23	14.29
R12193: Other manufacturing [392-393]	2.3267	2.1081	2.0736	1.8836	2.1724	2.2756	2.1145	28	30	31	35	34	33	36	36	28	8	32.43
R1221: Electricity, gas and steam [41]	1.3783	1.3891	1.4180	1.4087	1.7212	1.7878	1.7133	44	44	43	44	43	42	43	44	42	2	43.29
R1222: Water supply [42]	2.0649	2.0607	2.3092	2.3899	3.0283	2.7508	2.8968	32	31	28	28	23	28	26	32	23	9	28.00
R1231: Building construction [51]	3.8218	3.3840	3.5844	2.9706	3.7631	3.6607	3.4493	11	14	10	15	14	12	15	15	10	5	13.00
R1232: Civil engineering and other construction [52-53]	4.2543	4.1835	3.9920	3.1819	3.2206	3.1766	2.8133	7	6	4	9	18	21	28	28	4	24	13.29
R1311: Wholesale and retail trade [61-63]	1.6577	1.6584	1.6143	1.6894	1.7898	1.7986	1.7879	36	38	39	38	41	40	41	41	36	5	39.00
R1312: Catering and accommodation services [64]	2.3265	2.2175	1.9965	1.8934	2.2676	2.4626	2.3397	29	28	32	34	31	31	33	34	28	6	31.14
R1321: Transport and storage [71-74]	1.4995	1.6723	1.6425	1.6412	2.0877	2.0733	1.9145	39	37	37	39	35	37	37	39	35	4	37.29
R1322: Communication [75]	1.1538	1.0728	1.3160	1.5012	2.0576	2.1327	2.3969	46	46	45	43	36	36	32	46	32	14	40.57
R1331: Finance and insurance [81-82]	1.3000	1.3327	1.3072	1.5452	1.6149	1.7202	1.8336	45	45	46	41	44	43	38	46	38	8	43.14
R1332: Business services [83-88]	1.4795	1.5519	1.6342	1.5155	1.8356	1.9296	1.8235	41	41	38	42	40	39	39	42	38	4	40.00
R13411: Medical, dental and veterinary services [93]	1.6950	1.6933	1.8450	1.9324	2.2139	2.2696	2.2305	34	35	34	32	33	34	34	35	32	3	33.71
R13412: Excluding medical, dental and veterinary services [94-96]	1.6776	1.9919	1.8429	1.9234	2.2284	2.3177	2.4134	35	32	35	33	32	32	31	35	31	4	32.86
R1342: Other producers [98]	1.5255	1.5192	1.5821	1.4052	1.3915	1.4437	1.4089	38	42	40	45	45	45	46	46	38	8	43.00
R1343: General government services [99]	1.8097	1.5161	1.5107	1.3522	1.3532	1.5213	1.6727	33	43	42	46	46	44	44	46	33	13	42.57
Mean	**2.9319**	**2.8836**	**2.7203**	**2.5993**	**3.0686**	**3.0517**	**3.3794**											
Standard deviation	**1.3102**	**1.3608**	**0.9836**	**0.8493**	**1.1371**	**1.0717**	**1.7755**											

It is evident from Table 2 that, in terms of the indirect contribution to GDP, the "leather and leather products" industry, "motor vehicles, parts and accessories" industry and "food" industry, on average, achieved the highest rankings at 2.14, 4.29 and 4.29 respectively. The "finance and insurance" industry, with an average rank of 43.14, and the "electricity, gas and steam" industry, with an average rank of 43.29 are the lowest ranking industries over the relevant period. If the difference between the highest and lowest ranking industries over the period is taken as a measure of inconsistency, then the "basic non-ferrous metals", the "civil engineering and other construction" and the "furniture" industries, with differences of 26, 24 and 23 respectively, can be viewed as the most inconsistent industries. Conversely, the "electricity, gas and steam" industry and the "medical, dental and veterinary services" industries were the most consistent, with place differences of 2 and 3 respectively.

Table 2 also presents the arithmetic means and standard deviations of the simple type II GDP multipliers generated by the model for the 1980-2010 period. Figure 4 shows the time path of the arithmetic mean and Figure 5 the time path of the standard deviation over the thirty-year period under review.

It is evident from both Table 2 and Figure 4 that the mean simple type II GDP multiplier showed a marginally decreasing trend for the first half of the 30-year period and an increasing trend over the second half. It is interesting to note that, with minimum and maximum mean multiplier values of between 2.5993 and 3.3794 over the relevant period, the magnitude of the indirect effect was roughly double that of the direct effect.

Figure 4: Change in the mean simple type II GDP multiplier 1980-2010

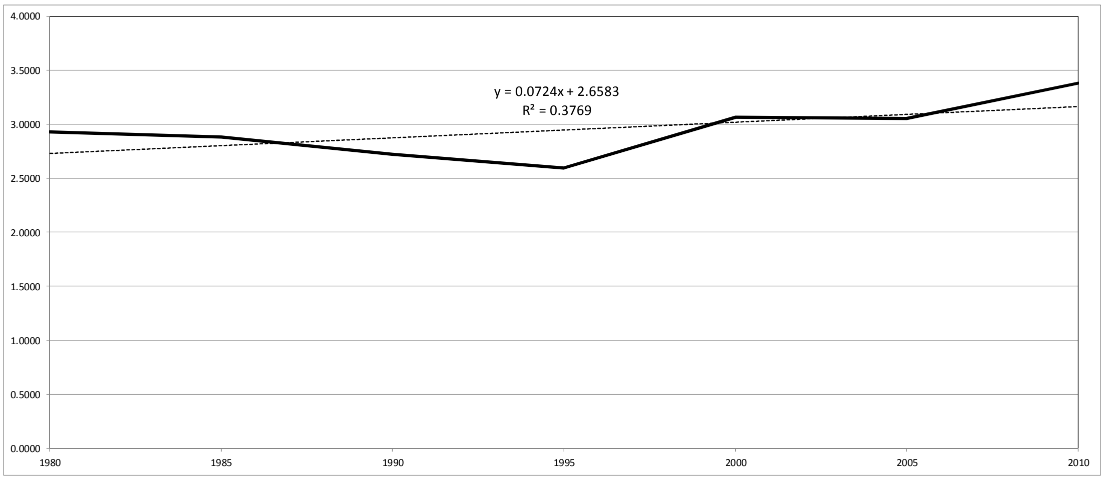


Figure 5: Change in the standard deviation of simple type II GDP multiplier 1980-2010

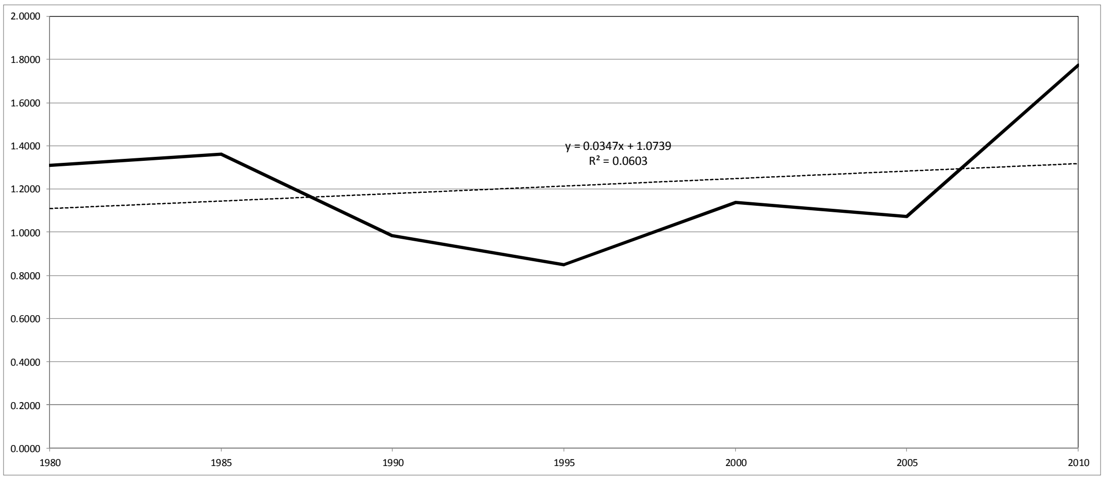


Table 2 and Figure 5 also show that the standard deviation of the simple type II GDP multiplier decreased from 1.3102 to 0.8493 over the first half of the period under review and then increased over the next 15 years to 1.7755 in 2010. This represents a 35% net increase over the 30-year period.

5.3 Total GDP Multipliers

The total GDP multiplier of an industry quantifies the direct, indirect and induced effect on the economy if an additional unit of output is produced, and is arguably the most important of the four types of GDP multipliers calculated. In this section industries are ranked in terms of the value of the total GDP multipliers. Table 3 shows these rankings for each of the seven data sets spanning the 1980-2010 period and also ranks industries according to their average rank achieved over the seven data sets, when ranked according to their total effect. Table 4 is similar to Table 3 but ranks industries according to their average rank achieved if only the induced effect is considered.

If industries are considered for their direct, indirect and induced impact on GDP over the entire period, as presented in Table 3, the top ranked industries are "other producers" and "general government services" with average rankings of 1.29 and 2.29 respectively. The lowest ranking industries in turn are "tobacco" with an average rank of 43.29 and "coke and refined petroleum products" with an average rank of 43.0. If one takes the difference between the highest and the lowest ranking industries as a measure of consistency in rank, one finds that both top ranked industries "other producers" and "general government services" also achieved the most consistent ranking, only varying one place over the 30 year period. The "gold and uranium ore mining" and "communication" industries were most inconsistent with a difference of 42 and 41 places between their highest and lowest rankings over the 30-year period.

If industries are ranked according to the induced effect only, as presented in Table 4, a very similar pattern emerges to what is observed in Table 3. The "other producers" and "general government services" industry categories achieved the highest average ranking and were also the most consistent. The "coke and refined petroleum products" industry and "tobacco" industry again achieved the lowest rankings, while the "gold and uranium ore mining" and "communication" industries were again the most inconsistent with differences 42 and 40 between the highest and lowest ranked positions over the relevant period.

A closer examination of Table 3 however shows significant trends over the relevant period for the key "gold and uranium ore mining" and "communication" industries. The former industry moved from the 45th position in 1980 to 4th in 1995 and the 3rd position in 2010. This dramatic movement up the rankings was also pointed out by Stillwell (1999:81) whose study covered the period 1971-1993. He noted that this implied that the gold mining industry developed greater linkages with the rest of the economy, while its relative importance as a producer of mineral income was falling. Hence, gold mining's contribution to South Africa's GDP increased at a time when the output of its gold mines was falling. It would not be unreasonable to suggest that this trend could largely be attributed to the increased induced effect of the gold mining industry. This is mainly due to the fact that the gold mining industry in South Africa is relatively labour intensive, and the sharp increase in the real wage levels paid by the mining industry occurred since the early 1970's.

The "communication" industry, showed a decreasing trend in its relative position, which decreased from 1st position in 1980 and 1985, 3rd position in 1990, and falling to 42nd position in 2005, before recovering to 31st position in 2010. This could be due to fact that the communication industry is a technology intensive industry, with technology being one of the most important potential influences effecting changes in industries' relative positions over time.

Tables 3 and 4 also show the arithmetic mean and the standard deviation for both the total GDP multiplier and the induced effect, for each of the seven data sets. Figures 6 and 8 show the time paths of the mean total GDP multiplier as well as the induced effect, while Figures 7 and 9 illustrates the time paths of the respective standard deviations over the same period.

The mean total GDP multiplier decreased by 12.5%, and the mean induced effect decreased by 25.5%. The absolute decrease in the values of the means was 0.2272 and 0.2157, respectively, over the 30-year period. It is also evident from Figures 6 and 8 that the shape of the time paths of the two mean values is very similar. Hence, it seems that the induced effect accounted for most of the variation in the mean total GDP multiplier over the observed period of time, given that the latter represents the combined direct, indirect and induced effect.

It can be argued that the decrease in the arithmetic mean reflects the change in the openness (the ratio of imports and exports to the size of the economy) of the economy over the past three decades. We can present the openness of the economy as:

(39) $$Openness = \left(\frac{M}{GDE} + \frac{X}{GDP} \right) / 2$$

where:

$M =$ Imports into the economy

$X =$ Exports from the economy

$GDE =$ Gross domestic expenditure

$GDP =$ Gross domestic product

Table 3: Total GDP multipliers (closed model) – 1980-2010

Total GDP Multipliers: Closed model	**Multiplier**							**Rank**										
	1980	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**	**Max**	**Min**	**Diff**	**Avg**
R111: Agriculture, forestry and fishing [1]	1.5395	1.5935	1.5175	1.5385	1.5297	1.4611	1.4443	42	42	43	40	40	37	37	43	37	6	40.14
R1121: Coal mining [21]	1.5593	1.7300	1.7422	1.6474	1.6286	1.5482	1.4061	39	37	31	31	27	26	44	44	26	18	33.57
R1122: Gold and uranium ore mining [23]	1.4971	1.6837	1.8397	1.9164	1.8569	1.8274	1.9278	45	39	16	4	4	3	3	45	3	42	16.29
R1123: Other mining [22/24/25/29]	1.6012	1.7646	1.7367	1.6208	1.5332	1.4481	1.4141	37	35	32	35	39	40	43	43	32	11	37.29
R12101: Food [301-304]	1.7119	1.7530	1.6945	1.6570	1.6426	1.5617	1.5847	35	36	36	30	24	23	24	36	23	13	29.71
R12102: Beverages [305]	1.7486	1.8274	1.6860	1.6203	1.6168	1.5592	1.6090	32	32	37	36	30	24	20	37	20	17	30.14
R12103: Tobacco [306]	1.5679	1.4167	1.5086	1.4607	1.4400	1.3907	1.4207	38	46	44	45	45	44	41	46	38	8	43.29
R12111: Textiles [311-312]	1.8903	1.9749	1.8701	1.8023	1.7633	1.6203	1.6859	18	11	12	11	13	15	13	18	11	7	13.29
R12112: Wearing apparel [313-315]	1.9823	2.0673	1.8969	1.8583	1.8453	1.7248	1.8105	9	7	7	5	6	6	7	9	5	4	6.71
R12113: Leather and leather products [316]	1.9083	1.8935	1.8155	1.7119	1.6894	1.5589	1.6188	15	23	22	23	17	25	18	25	15	10	20.43
R12114: Footwear [317]	2.0692	2.0840	1.9506	1.8448	1.6882	1.5988	1.6780	4	5	4	7	18	17	14	18	4	14	9.86
R12121: Wood and wood products [321-322]	1.8118	1.8416	1.7474	1.7026	1.7748	1.6762	1.6749	29	30	29	27	12	9	15	30	9	21	21.57
R12122: Paper and paper products [323]	1.8198	1.8787	1.7629	1.6606	1.6505	1.5687	1.6034	27	26	27	29	22	21	21	29	21	8	24.71
R12123: Printing, publishing and recorded media [324-326]	2.0050	2.0768	1.8947	1.8081	1.8517	1.7910	1.8341	8	6	8	9	5	4	4	9	4	5	6.29
R12131: Coke and refined petroleum products [331-333]	1.5252	1.5514	1.5790	1.5489	1.4510	1.3499	1.3546	43	44	40	39	44	46	45	46	39	7	43.00
R12132: Basic chemicals [334]	1.6855	1.8337	1.7483	1.6274	1.5718	1.4897	1.4694	36	31	28	33	34	33	34	36	28	8	32.71
R12133: Other chemicals and man-made fibers [335-336]	1.7777	1.8662	1.7631	1.7041	1.6847	1.5648	1.5820	30	27	26	26	19	22	25	30	19	11	25.00
R12134: Rubber products [337]	1.8903	1.9614	1.8307	1.7427	1.7207	1.6268	1.6286	19	14	19	20	15	14	16	20	14	6	16.71
R12135: Plastic products [338]	1.8350	1.9279	1.8255	1.7480	1.8807	1.7106	1.8111	23	16	20	18	3	7	6	23	3	20	13.29
R12141: Glass and glass products [341]	1.8643	1.9091	1.8035	1.7648	1.7964	1.6126	1.7027	21	19	24	15	8	16	11	24	8	16	16.29
R12142: Non-metallic minerals [342]	1.7706	1.8622	1.8125	1.7080	1.5656	1.4653	1.4615	31	28	23	24	35	36	36	36	23	13	30.43
R12151: Basic iron and steel [351]	1.8299	1.9033	1.8458	1.7532	1.6215	1.5033	1.4945	24	21	15	17	28	32	29	32	15	17	23.71
R12152: Basic non-ferrous metals [352]	1.7460	1.8425	1.7284	1.5989	1.4268	1.3576	1.3402	33	29	33	37	46	45	46	46	29	17	38.43
R12153: Metal products excluding machinery [353-355]	1.9521	1.9922	1.8864	1.7905	1.7221	1.6524	1.6898	11	10	9	12	14	11	12	14	9	5	11.29
R12154: Machinery and equipment [356-359]	2.0058	2.0216	1.9004	1.8553	1.7817	1.6645	1.7290	7	9	6	6	10	10	8	10	6	4	8.00
R1216: Electrical machinery and apparatus [361-366]	1.8757	1.9264	1.8396	1.7775	1.6335	1.5960	1.6258	20	17	17	13	26	18	17	26	13	13	18.29
R12171: Television, radio and communication equipment [371-373]	1.9168	1.9078	1.8329	1.8116	1.7914	1.6332	1.7218	14	20	18	8	9	13	10	20	8	12	13.14
R12172: Professional and scientific equipment [374-376]	1.9424	1.9708	1.8617	1.7453	1.7176	1.5159	1.5928	13	13	14	19	16	30	23	30	13	17	18.29
R12181: Motor vehicles, parts and accessories [381-383]	1.9640	2.1071	1.8797	1.7324	1.6811	1.5758	1.6016	10	4	10	22	20	20	22	22	4	18	15.43
R12182: Other transport equipment [384-387]	2.0164	1.8905	1.9100	1.9472	1.8305	1.7362	1.8329	6	24	5	3	7	5	5	24	3	21	7.86
R12191: Furniture [391]	2.0303	2.0638	1.8675	1.8067	1.7795	1.7056	1.7220	5	8	13	10	11	8	9	13	5	8	9.14
R12193: Other manufacturing [392-393]	1.5471	1.6273	1.5332	1.4840	1.4650	1.4158	1.4407	40	40	42	42	43	43	39	43	39	4	41.29
R1221: Electricity, gas and steam [41]	1.5197	1.5100	1.4979	1.4770	1.5563	1.5324	1.4642	44	45	45	44	37	28	35	45	28	17	39.71
R1222: Water supply [42]	1.3264	1.6026	1.4781	1.4812	1.5365	1.4419	1.4760	46	41	46	43	38	41	33	46	33	13	41.14
R1231: Building construction [51]	1.9065	1.9721	1.8725	1.7567	1.6188	1.4850	1.4943	17	12	11	16	29	35	30	35	11	24	21.43
R1232: Civil engineering and other construction [52-53]	1.8479	1.9137	1.8170	1.7357	1.6439	1.5091	1.5174	22	18	21	21	23	31	27	31	18	13	23.29
R1311: Wholesale and retail trade [61-63]	1.8134	1.8949	1.7669	1.6840	1.6701	1.5844	1.5499	28	22	25	28	21	19	26	28	19	9	24.14
R1312: Catering and accommodation services [64]	1.7438	1.7752	1.6683	1.6408	1.6016	1.5374	1.4799	34	34	38	32	31	27	32	38	27	11	32.57
R1321: Transport and storage [71-74]	1.9071	1.8844	1.6966	1.6228	1.5569	1.4855	1.4205	16	25	35	34	36	34	42	42	16	26	31.71
R1322: Communication [75]	2.3664	2.4066	2.0723	1.7693	1.5954	1.4365	1.4819	1	1	3	14	33	42	31	42	1	41	17.86
R1331: Finance and insurance [81-82]	1.9460	1.7879	1.7113	1.7046	1.6411	1.6492	1.6126	12	33	34	25	25	12	19	34	12	22	22.86
R1332: Business services [83-88]	1.5444	1.5820	1.5525	1.4435	1.4703	1.4526	1.4425	41	43	41	46	42	39	38	46	38	8	41.43
R13411: Medical, dental and veterinary services [93]	1.8293	1.9612	1.7434	1.5966	1.5969	1.5289	1.5073	25	15	30	38	32	29	28	38	15	23	28.14
R13412: Excluding medical, dental and veterinary services [94-96]	1.8223	1.6848	1.6567	1.4988	1.5052	1.4530	1.4333	26	38	39	41	41	38	40	41	26	15	37.57
R1342: Other producers [98]	2.2345	2.2565	2.2136	2.2341	2.2140	2.0988	2.1183	2	2	1	1	1	1	1	2	1	1	1.29
R1343: General government services [99]	2.2009	2.2335	2.1490	2.1867	2.1140	1.9310	1.9337	3	3	2	2	2	2	2	3	2	1	2.29
Mean	**1.8238**	**1.8743**	**1.7828**	**1.7136**	**1.6729**	**1.5791**	**1.5966**											
Standard deviation	**0.2062**	**0.1951**	**0.1549**	**0.1606**	**0.1578**	**0.1432**	**0.1666**											

Figure 10 shows the time path of this measure of openness for the South African economy over the 1980-2010 period. It would suggest that the openness of the economy moved in the opposite direction of the arithmetic mean of the total GDP multiplier over almost every five-year period during the three decades reviewed. This seems to suggest that a negative relationship exists between the total GDP multiplier and the openness of the economy. It probably relates, firstly, to the strengthening of trade links with the rest of the world, which followed the end of political and economic isolation in the 1990's. It can also be attributed to a general increase in world trade in the wake of a wave of trade liberalisation after the Uruguay Round of trade negotiations and establishment of the World Trade Organisation (Carbaugh, 2009:1,189-190).

Figures 7 and 9 show the time paths of the standard deviations of the total GDP multiplier and the induced effect over the period reviewed. It is interesting to observe that the values of two standard deviations are almost equal for all seven data sets.

Figure 6: The change in the mean total GDP multiplier 1980-2010

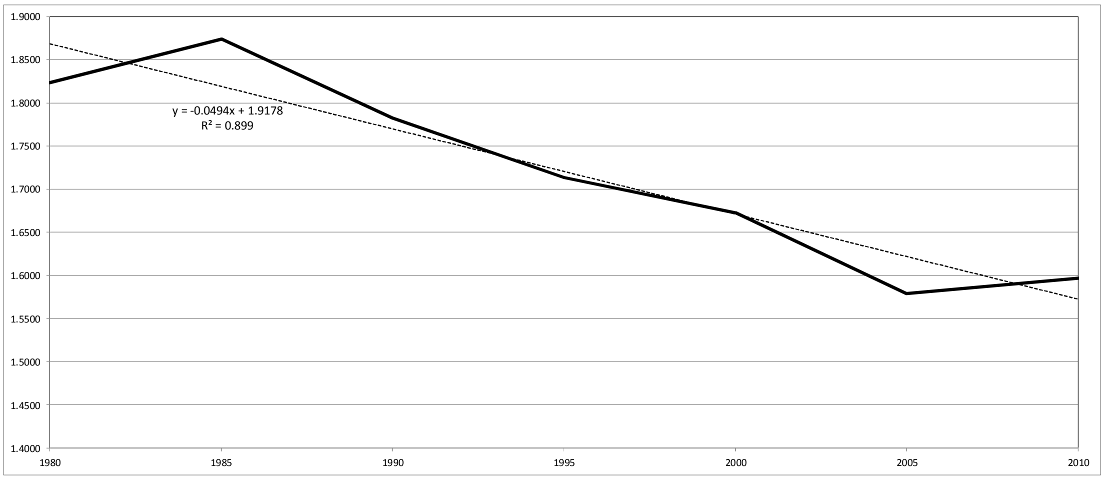


Figure 7: The change in the standard deviation of the total GDP multiplier 1980-2010

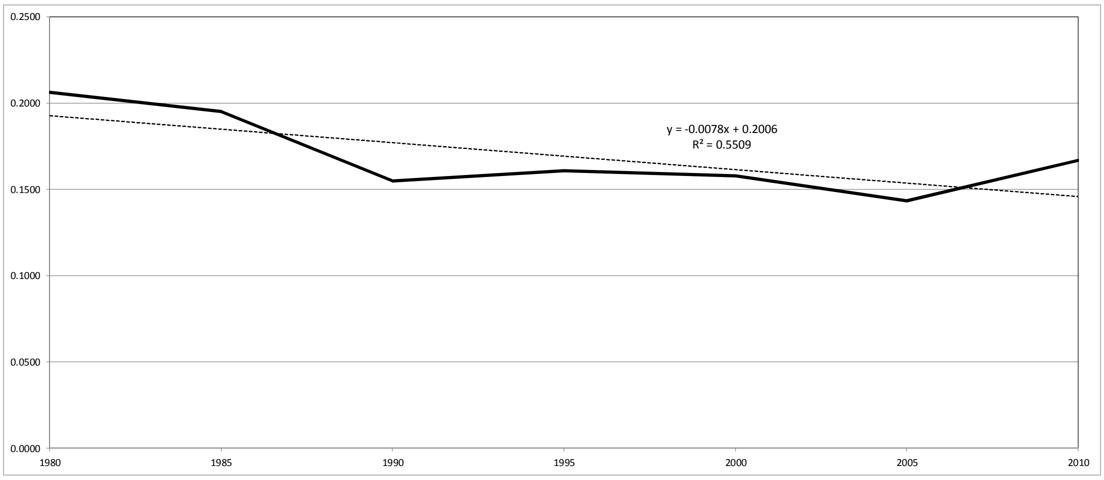


Figure 10 shows an increase of around 50% in the openness of the economy during the middle decade of the period reviewed. The unbundling of the large diversified conglomerates that characterised the apartheid economy also probably resulted in weaker inter-industry links, as companies again had the option to invest in related industries abroad, rather than to diversify domestically. The fact that companies and consumers also had easier and cheaper access to imported alternatives, after the end of the era of economic isolation, could have contributed to a weakening of the multiplier effect over this period.

Table 4: Ranking of industries by the induced effect – 1980-2010

Induced effects	Effect							Rank										
	1980	1985	1990	1995	2000	2005	2010	1980	1985	1990	1995	2000	2005	2010	Max	Min	Diff	Avg
R111: Agriculture, forestry and fishing [1]	0.5577	0.6183	0.5457	0.5717	0.5662	0.5028	0.4839	41	42	43	40	38	36	37	43	36	7	39.57
R1121: Coal mining [21]	0.5704	0.7503	0.7699	0.6783	0.6596	0.5832	0.4313	40	37	31	32	27	25	44	44	25	19	33.71
R1122: Gold and uranium ore mining [23]	0.5047	0.6969	0.8539	0.9351	0.8774	0.8450	0.9500	45	39	21	4	5	3	3	45	3	42	17.14
R1123: Other mining [22/24/25/29]	0.6138	0.7844	0.7619	0.6477	0.5615	0.4788	0.4424	37	35	32	35	39	38	43	43	32	11	37.00
R12101: Food [301-304]	0.7332	0.7794	0.7220	0.6843	0.6715	0.5919	0.6124	35	36	36	30	26	23	25	36	23	13	30.14
R12102: Beverages [305]	0.7661	0.8504	0.7107	0.6422	0.6374	0.5805	0.6294	33	32	37	36	30	26	22	37	22	15	30.86
R12103: Tobacco [306]	0.5864	0.4297	0.5268	0.4796	0.4604	0.4116	0.4428	38	46	44	45	45	44	42	46	38	8	43.43
R12111: Textiles [311-312]	0.9283	1.0200	0.9153	0.8470	0.8057	0.6634	0.7269	18	11	10	9	12	14	12	18	9	9	12.29
R12112: Wearing apparel [313-315]	1.0249	1.1133	0.9464	0.9033	0.8877	0.7664	0.8488	7	6	6	5	4	6	6	7	4	3	5.71
R12113: Leather and leather products [316]	0.9332	0.9230	0.8465	0.7399	0.7170	0.5858	0.6463	17	23	22	24	19	24	19	24	17	7	21.14
R12114: Footwear [317]	1.1049	1.1303	0.9965	0.8799	0.7169	0.6270	0.7060	4	5	4	7	20	19	14	20	4	16	10.43
R12121: Wood and wood products [321-322]	0.8336	0.8682	0.7752	0.7263	0.7982	0.7001	0.6979	28	29	30	26	13	10	15	30	10	20	21.57
R12122: Paper and paper products [323]	0.8454	0.9057	0.7898	0.6858	0.6774	0.5955	0.6281	26	26	27	29	25	22	23	29	22	7	25.43
R12123: Printing, publishing and recorded media [324-326]	1.0240	1.0970	0.9186	0.8278	0.8710	0.8113	0.8519	8	7	9	11	6	4	5	11	4	7	7.14
R12131: Coke and refined petroleum products [331-333]	0.5523	0.5740	0.6041	0.5779	0.4904	0.3895	0.3873	43	44	40	39	42	46	45	46	39	7	42.71
R12132: Basic chemicals [334]	0.7101	0.8648	0.7820	0.6587	0.6079	0.5295	0.5062	36	30	28	34	35	35	32	36	28	8	32.86
R12133: Other chemicals and man-made fibers [335-336]	0.8088	0.9053	0.8063	0.7472	0.7322	0.6166	0.6309	30	27	25	23	17	20	21	30	17	13	23.29
R12134: Rubber products [337]	0.9161	0.9923	0.8678	0.7777	0.7629	0.6727	0.6719	19	15	19	21	14	13	17	21	13	8	16.86
R12135: Plastic products [338]	0.8627	0.9626	0.8630	0.7835	0.9178	0.7490	0.8454	23	17	20	18	3	7	7	23	3	20	13.57
R12141: Glass and glass products [341]	0.8856	0.9350	0.8329	0.7909	0.8231	0.6401	0.7284	22	21	24	16	9	17	11	24	9	15	17.14
R12142: Non-metallic minerals [342]	0.7881	0.8887	0.8437	0.7347	0.5912	0.4926	0.4868	31	28	23	25	36	37	36	37	23	14	30.86
R12151: Basic iron and steel [351]	0.8457	0.9274	0.8726	0.7800	0.6530	0.5374	0.5266	25	22	17	20	28	34	30	34	17	17	25.14
R12152: Basic non-ferrous metals [352]	0.7617	0.8647	0.7530	0.6226	0.4601	0.3945	0.3732	34	31	34	38	46	45	46	46	31	15	39.14
R12153: Metal products excluding machinery [353-355]	0.9686	1.0166	0.9137	0.8143	0.7478	0.6790	0.7149	11	12	11	13	16	12	13	16	11	5	12.57
R12154: Machinery and equipment [356-359]	1.0222	1.0460	0.9293	0.8841	0.8155	0.7015	0.7640	9	9	8	6	10	9	9	10	6	4	8.57
R1216: Electrical machinery and apparatus [361-366]	0.8946	0.9547	0.8721	0.8142	0.6788	0.6471	0.6765	20	18	18	14	24	16	16	24	14	10	18.00
R12171: Television, radio and communication equipment [371-373]	0.9391	0.9397	0.8732	0.8615	0.8499	0.6999	0.7847	16	19	16	8	8	11	8	19	8	11	12.29
R12172: Professional and scientific equipment [374-376]	0.9625	0.9973	0.8919	0.7812	0.7621	0.5675	0.6419	12	13	14	19	15	29	20	29	12	17	17.43
R12181: Motor vehicles, parts and accessories [381-383]	0.9827	1.1317	0.9092	0.7682	0.7266	0.6295	0.6521	10	4	12	22	18	18	18	22	4	18	14.57
R12182: Other transport equipment [384-387]	1.0312	0.9105	0.9357	0.9745	0.8611	0.7755	0.8672	6	25	7	3	7	5	4	25	3	22	8.14
R12191: Furniture [391]	1.0513	1.0906	0.9002	0.8355	0.8078	0.7344	0.7516	5	8	13	10	11	8	10	13	5	8	9.29
R12193: Other manufacturing [392-393]	0.5762	0.6467	0.5527	0.5018	0.4860	0.4351	0.4534	39	40	42	43	44	43	41	44	39	5	41.71
R1221: Electricity, gas and steam [41]	0.5320	0.5312	0.5174	0.4956	0.5806	0.5604	0.4893	44	45	45	44	37	30	35	45	30	15	40.00
R1222: Water supply [42]	0.3441	0.6349	0.5137	0.5052	0.5536	0.4579	0.4926	46	41	46	42	40	42	34	46	34	12	41.57
R1231: Building construction [51]	0.9413	1.0344	0.9466	0.8243	0.6980	0.5768	0.5883	15	10	5	12	22	27	26	27	5	22	16.71
R1232: Civil engineering and other construction [52-53]	0.8916	0.9921	0.8895	0.7962	0.6987	0.5700	0.5760	21	16	15	15	21	28	27	28	15	13	20.43
R1311: Wholesale and retail trade [61-63]	0.8313	0.9206	0.7938	0.7057	0.6890	0.6042	0.5694	29	24	26	28	23	21	28	29	21	8	25.57
R1312: Catering and accommodation services [64]	0.7686	0.8138	0.7024	0.6611	0.6173	0.5536	0.4946	32	33	38	33	33	32	33	38	32	6	33.43
R1321: Transport and storage [71-74]	0.9436	0.9395	0.7559	0.6793	0.6132	0.5496	0.4819	14	20	33	31	34	33	38	38	14	24	29.00
R1322: Communication [75]	1.3737	1.4154	1.0871	0.7885	0.6229	0.4685	0.5141	1	1	3	17	31	41	31	41	1	40	17.86
R1331: Finance and insurance [81-82]	0.9535	0.7991	0.7221	0.7142	0.6488	0.6575	0.6214	13	34	35	27	29	15	24	35	13	22	25.29
R1332: Business services [83-88]	0.5533	0.5979	0.5717	0.4602	0.4896	0.4741	0.4633	42	43	41	46	43	40	39	46	39	7	42.00
R13411: Medical, dental and veterinary services [93]	0.8499	0.9923	0.7767	0.6236	0.6223	0.5570	0.5345	24	14	29	37	32	31	29	37	14	23	28.00
R13412: Excluding medical, dental and veterinary services [94-96]	0.8384	0.7121	0.6841	0.5219	0.5279	0.4768	0.4556	27	38	39	41	41	39	40	41	27	14	37.86
R1342: Other producers [98]	1.2533	1.2820	1.2355	1.2465	1.2237	1.1096	1.1278	2	2	1	1	1	1	1	2	1	1	1.29
R1343: General government services [99]	1.2114	1.2488	1.1688	1.2041	1.1415	0.9777	0.9791	3	3	2	2	2	2	2	3	2	1	2.29
Mean	**0.8450**	**0.9028**	**0.8141**	**0.7431**	**0.7045**	**0.6137**	**0.6293**											
Standard deviation	**0.2073**	**0.1975**	**0.1568**	**0.1617**	**0.1577**	**0.1419**	**0.1663**											

Figure 8: The change in the mean induced effects 1980-2010

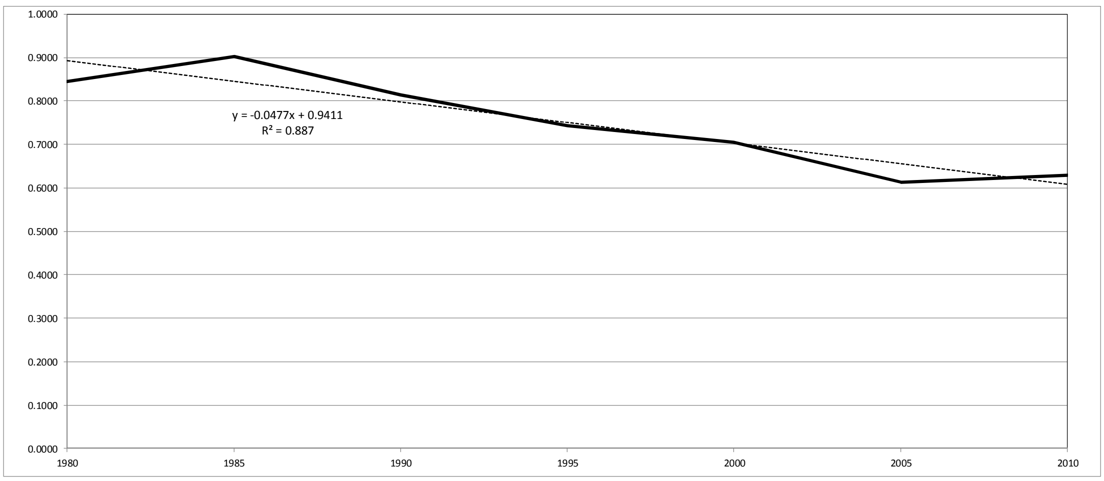


Figure 9: The change in the standard deviation of the induced effects 1980-2010

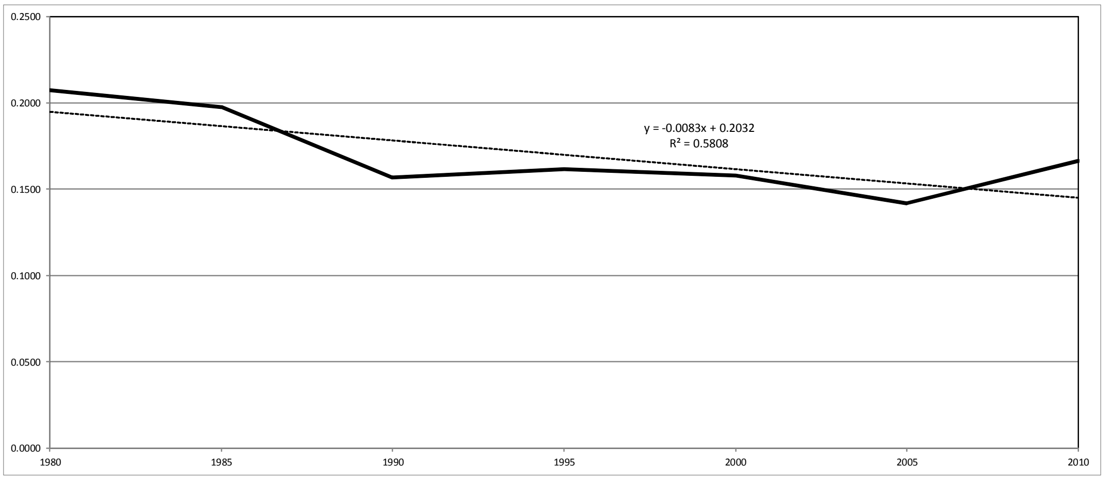
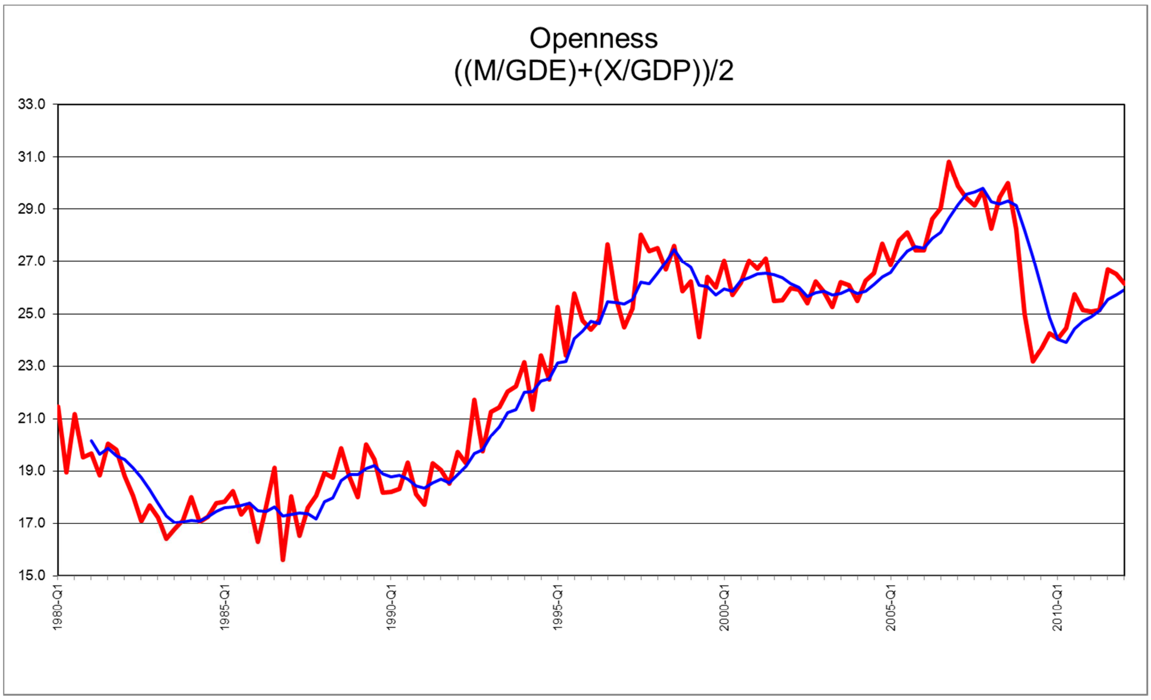


Figure 10: An indication of the openness of the South African economy 1980-2010



Source of basic data: Easydata online database; Quantec Research

5.4 Total Type II GDP Multipliers

This section considers the relative importance of industries in terms of the size of their total type II GDP multipliers. The total type II GDP multiplier shows the ratio of the total GDP multiplier to the direct effects, i.e. the ratio of the direct, indirect and induced effects to direct effects. It can therefore be assumed that, the larger the value of the multiplier, the larger the indirect and induced effect, in relation to the direct effect. Table 5 ranks industries according to the size of their total type II GDP multiplier for each of the seven data sets representing the period 1980-2010 and also according to their average ranking over the 1980-2010 period.

Table 5: Total type II GDP multipliers (closed model) – 1980-2010

Total Type II GDP Multipliers: Closed model	Multiplier							Rank										
	1980	1985	1990	1995	2000	2005	2010	1980	1985	1990	1995	2000	2005	2010	Max	Min	Diff	Avg
R111: Agriculture, forestry and fishing [1]	2.4869	2.831	2.4684	2.8322	3.2102	3.3020	3.2554	41	40	44	41	39	34	37	44	34	10	39.43
R1121: Coal mining [21]	2.1969	2.965	3.3011	3.3738	3.2668	3.1549	2.0570	45	39	36	31	37	38	46	46	31	15	38.86
R1122: Gold and uranium ore mining [23]	2.1987	2.698	2.5239	3.1441	3.2677	2.5084	3.5382	44	41	43	35	36	46	31	46	31	15	39.43
R1123: Other mining [22/24/25/29]	2.4017	3.273	3.3955	3.0246	2.9146	2.6865	2.5230	42	37	32	36	43	45	45	45	32	13	40.00
R12101: Food [301-304]	9.7861	10.012	8.1905	7.5205	8.4671	7.4900	7.0989	3	4	3	3	3	3	11	11	3	8	4.29
R12102: Beverages [305]	5.6422	6.738	5.4610	4.5344	4.7900	4.6924	5.0568	22	15	20	26	26	26	24	26	15	11	22.71
R12103: Tobacco [306]	4.7751	2.273	3.3297	3.5318	3.8585	3.5349	4.4082	26	45	33	30	30	32	28	45	26	19	32.00
R12111: Textiles [311-312]	6.4080	6.617	5.3094	6.5171	8.3561	7.2404	9.3520	16	16	23	5	4	5	4	23	4	19	10.43
R12112: Wearing apparel [313-315]	6.3718	5.999	6.5693	5.4737	6.3840	5.3271	6.3494	17	20	10	13	15	21	14	21	10	11	15.71
R12113: Leather and leather products [316]	9.2681	10.464	9.3381	8.4047	10.8986	8.2984	18.6361	5	2	1	2	1	2	1	5	1	4	2.00
R12114: Footwear [317]	5.4131	5.532	5.7402	5.4122	6.5686	6.4543	8.0778	23	23	19	16	14	11	8	23	8	15	16.29
R12121: Wood and wood products [321-322]	7.6787	7.403	6.1003	4.7872	5.6346	5.4880	5.8130	10	11	16	22	21	18	17	22	10	12	16.43
R12122: Paper and paper products [323]	6.9886	7.847	6.6283	5.7423	6.7097	6.9862	8.9009	12	10	9	11	10	6	5	12	5	7	9.00
R12123: Printing, publishing and recorded media [324-326]	4.6850	4.812	5.1602	4.6949	4.9253	5.5752	5.7532	27	26	25	23	25	17	18	27	17	10	23.00
R12131: Coke and refined petroleum products [331-333]	5.3670	3.541	3.7471	5.0230	5.8511	4.9016	6.1748	24	29	28	20	19	24	15	29	15	14	22.71
R12132: Basic chemicals [334]	11.1844	10.107	7.1530	5.3120	6.7459	6.8414	7.0998	2	3	7	18	9	8	10	18	2	16	8.14
R12133: Other chemicals and man-made fibers [335-336]	7.7105	8.066	6.4290	6.4179	7.6925	6.8800	7.3969	9	8	12	6	6	7	9	12	6	6	8.14
R12134: Rubber products [337]	4.6172	4.876	5.8125	5.1283	6.6434	6.1657	7.0827	28	25	18	19	11	13	12	28	11	17	18.00
R12135: Plastic products [338]	6.3442	6.549	5.4079	5.3525	5.8588	4.9936	5.0211	18	18	22	17	18	23	25	25	17	8	20.14
R12141: Glass and glass products [341]	6.5031	6.435	6.3559	4.6767	5.1954	4.7670	5.3325	15	19	13	24	23	25	23	25	13	12	20.29
R12142: Non-metallic minerals [342]	5.8494	5.884	5.2633	4.2160	4.6312	4.6201	4.4529	20	21	24	28	28	27	27	28	20	8	25.00
R12151: Basic iron and steel [351]	7.8637	8.966	7.1287	5.9005	8.1897	7.3757	8.1090	8	5	8	7	5	4	7	8	4	4	6.29
R12152: Basic non-ferrous metals [352]	8.4709	7.337	6.4977	4.6558	4.5296	3.8302	3.4183	6	12	11	25	29	30	35	35	6	29	21.14
R12153: Metal products excluding machinery [353-355]	6.1454	6.584	5.9501	5.4523	6.1945	5.4646	5.5209	19	17	17	14	16	19	21	21	14	7	17.57
R12154: Machinery and equipment [356-359]	6.7218	6.800	6.1760	5.8587	7.1556	6.0989	5.9162	14	14	15	9	8	14	16	16	8	8	12.86
R1216: Electrical machinery and apparatus [361-366]	6.7959	7.847	5.4312	5.4162	6.6136	6.4889	8.4093	13	9	21	15	13	10	6	21	6	15	12.43
R12171: Television, radio and communication equipment [371-373]	11.3350	15.179	9.2847	6.5685	6.0108	5.6124	6.3725	1	1	2	4	17	16	13	17	1	16	7.71
R12172: Professional and scientific equipment [374-376]	5.6723	5.626	4.9398	4.9053	5.6690	5.3844	5.6035	21	22	26	21	20	20	20	26	20	6	21.43
R12181: Motor vehicles, parts and accessories [381-383]	9.4253	8.150	7.4999	8.6787	10.3764	10.6231	13.2920	4	7	5	1	2	1	2	7	1	6	3.14
R12182: Other transport equipment [384-387]	4.6099	4.237	4.4148	4.4459	5.0371	6.3527	5.4942	29	27	27	27	24	12	22	29	12	17	24.00
R12191: Furniture [391]	4.9628	5.190	6.3455	5.7623	7.2051	6.6892	9.8124	25	24	14	10	7	9	3	25	3	22	13.14
R12193: Other manufacturing [392-393]	3.7076	3.498	3.2425	2.8458	3.2509	3.2851	3.0858	32	31	37	40	38	36	38	40	31	9	36.00
R1221: Electricity, gas and steam [41]	2.1208	2.143	2.1663	2.1200	2.7452	2.8186	2.5731	46	46	46	46	45	44	44	46	44	2	45.29
R1222: Water supply [42]	2.7882	3.413	3.5394	3.6271	4.7342	4.0309	4.3481	38	35	30	29	27	28	29	38	27	11	30.86
R1231: Building construction [51]	7.5491	7.117	7.2490	5.5968	6.6159	5.9858	5.6887	11	13	6	12	12	15	19	19	6	13	12.57
R1232: Civil engineering and other construction [52-53]	8.2207	8.687	7.8205	5.8781	5.6013	5.1046	4.5346	7	6	4	8	22	22	26	26	4	22	13.57
R1311: Wholesale and retail trade [61-63]	3.0611	3.225	2.9313	2.9081	3.0466	2.9071	2.8262	36	38	40	39	41	41	42	42	36	6	39.57
R1312: Catering and accommodation services [64]	4.1601	4.095	3.4485	3.1710	3.6897	3.8483	3.5142	30	28	31	34	31	29	33	34	28	6	30.86
R1321: Transport and storage [71-74]	2.9679	3.335	2.9625	2.8230	3.4442	3.2907	2.8976	37	36	39	42	33	35	41	42	33	9	37.57
R1322: Communication [75]	2.7504	2.605	2.7682	2.7081	3.3756	3.1647	3.6702	39	42	41	43	35	37	30	43	30	13	38.14
R1331: Finance and insurance [81-82]	2.5489	2.410	2.2615	2.6595	2.6708	2.8605	2.9832	40	44	45	44	46	43	40	46	40	6	43.14
R1332: Business services [83-88]	2.3054	2.495	2.5869	2.2248	2.7518	2.8645	2.6863	43	43	42	45	44	42	43	45	42	3	43.14
R13411: Medical, dental and veterinary services [93]	3.1658	3.428	3.3274	3.1711	3.6277	3.5705	3.4560	34	34	34	33	32	31	34	34	31	3	33.14
R13412: Excluding medical, dental and veterinary services [94-96]	3.1073	3.450	3.1391	2.9509	3.4322	3.4496	3.5379	35	32	38	38	34	33	32	38	32	6	34.57
R1342: Other producers [98]	3.4738	3.518	3.5804	3.1789	3.1110	3.0632	3.0131	33	30	29	32	40	40	39	40	29	11	34.71
R1343: General government services [99]	4.0250	3.439	3.3121	3.0093	2.9414	3.0817	3.3883	31	33	35	37	42	39	36	42	31	11	36.14
Mean	**5.4746**	**5.6021**	**5.0367**	**4.6008**	**5.3020**	**4.9816**	**5.5985**											
Standard deviation	**2.4798**	**2.7273**	**1.9250**	**1.5786**	**2.0315**	**1.7907**	**3.0244**											

One can observe from Table 5 that, in terms of indirect and induced contribution to GDP, the "leather and leather products", and the "motor vehicles, parts and accessories" industries have, on average, achieved the highest rankings at 2.00 and 3.14 respectively. The "electricity, gas and steam", "business services" and "finance and insurance" industries with average rankings of 45.29, 43.14 and 43.14 achieved the lowest average ranking over the period reviewed. If the difference in the highest and lowest ranking is taken as an indication of the level of consistency in the rankings, the "basic non-ferrous metals", "furniture" and "civil engineering and other construction" industries with differences of 29, 22 and 22 respectively, can be viewed as having the most inconsistent ranking over the period. The "furniture" industry did however show a consistent increase in its ranking from 25th position in 1980 to 3rd position in 2010. The industries that achieved the most consistent ranking are also the two lowest average ranking industries mentioned above, "electricity, gas and steam"; "business services" and "medical, dental and veterinary services" varying by 2, 3 and 3 positions respectively over the entire period under review.

Table 5 and Figures 11 and 12 show the arithmetic means and standard deviations of the total type II GDP multipliers generated by the model for the period under review. The mean total type II multiplier showed a decrease from 5.4746 to 4.6008 over the first half of the period under review and an increase over the second 15 years to a level of 5.5985 in 2010. It is also interesting to note that the time path of the standard deviation appears to move "in sync" with the arithmetic mean over the same period.

Figure 11: The change in the mean total type II GDP multiplier 1980-2010

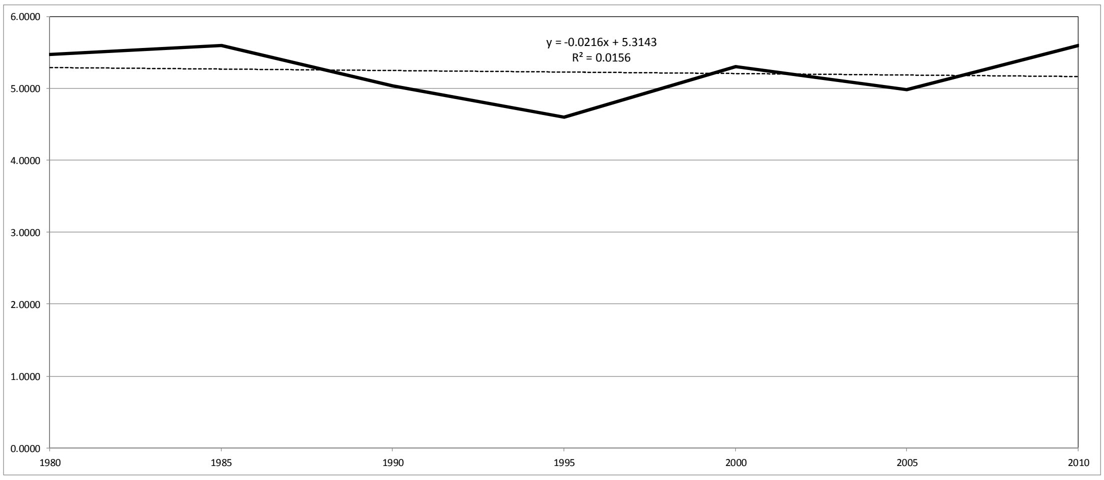
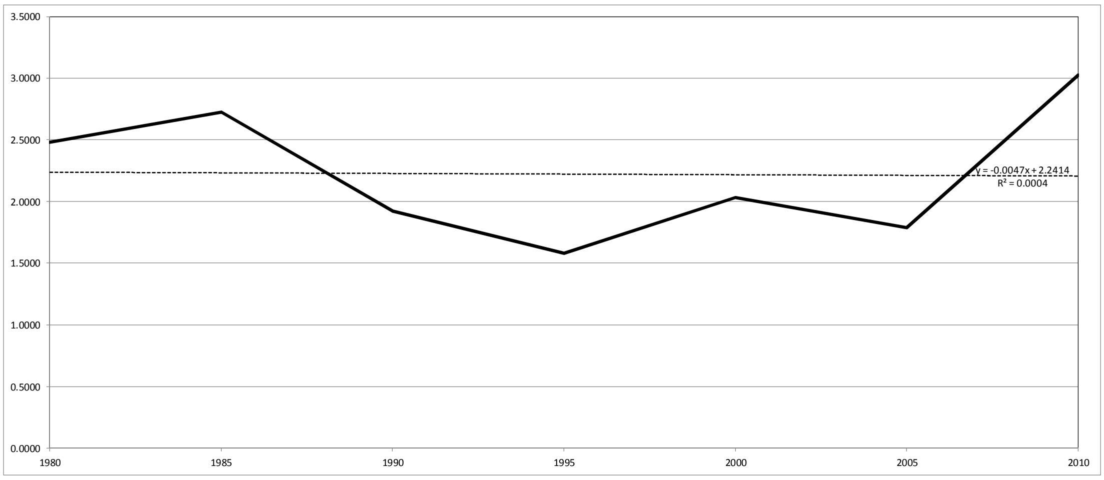


Figure 12: The change in the standard deviation of the total type II GDP multiplier 1980-2010



5.5 Structural change, unemployment and economic impact: 1980-2010

It is also important to focus on the composition of economic impact, and how it has changed over the past three decades. The elements, which add up to the total GDP multiplier, namely the direct, indirect and induced effect, are investigated for all the industries that comprise the South African economy. An important aim of this discussion is to explore the extent to which changes in the value and composition of GDP multipliers can be explained by changes in the structure of the economy.

The decrease in the total GDP multipliers over the period reviewed reflects the structural changes that occurred in the South African economy in an era during which the country made the transition from apartheid to democracy. Some of these changes are very visible in the pattern of employment over the past three decades (Roux, 2008:60). Even though formal employment, of which around 40% still constituted semi- and low-skilled jobs, stagnated during the 1990's, despite an increase in economic growth, the pattern of employment changed significantly. There was a dramatic shift in the share of the labour force employed from industries producing tradable goods (agriculture, mining and manufacturing) to non-tradables (services, etc.). The share of employment of the former industries decreased from 40% to 30%

between the late 1970's and 2005 (Rodrik, 2006:8). The loss of agriculture and mining jobs was therefore not replaced by the creation of manufacturing jobs, as would generally be expected when a country progresses to higher levels of economic development. The decrease in the relative demand for semi- and low-skilled labour reflects the fact that the low-skill intensive parts of the South African economy were in relative decline, and it represented a major structural change in the economy (Roux, 2008:60-61).

Rodrik (2006:9) argues that the manufacturing sector's inability to create low- and semi-skilled jobs was at the centre of South Africa's unemployment and insufficient economic growth problems, but also held the key to addressing it. He shows that even though the economy is characterised by across-the-board skill upgrading, the tradable sectors remain the most low-skill intensive part of the economy, and hence holds more potential for absorbing millions of available low-skilled job seekers. The substitution of capital for labour, or capital deepening, represents another structural trend and is especially prevalent in the tradable activities in recent years, including the manufacturing sector.

There are a number of important causes of the structural changes mentioned above. The first, and most important, is the fall in the profitability of the South African manufacturing sector. Rodrik (2006:14) shows that the relative profitability of manufacturing decreased by around 30% between 1980 and 2004. It is quite plausible that the lack of profit potential in this sector might be an important reason why the local manufacturing sector has attracted little foreign investment capital, compared to the service sectors in recent years.

Rodrik (2006:20) illustrates how the decline in the relative price of manufactured goods was the predominant cause for the decrease in manufacturing employment, and alone accounted for more than 100% of employment reduction.

The second important reason for structural change is the increasing openness of the local economy to international trade. The effect of exposure to greater competitive discipline also lead to the decline of the manufacturing sector, and the effect was compounded by the fact that import weighted effective rate of protection decreased from 35.6% in 1989 to 14% in 2000. Import penetration levels in the local economy consequently increased from around 20% before 1990 to around 28% in 2005 Rodrik (2006:15).

Rodrik (2006:23) found that 25% of the local manufacturing industry's decline in profitability could be ascribed to import competition. He also found that the manufacturing sector's profitability is strongly linked to trade competition and performance, with causality running from trade to prices (and hence profitability), rather than vice versa. During the 1990's South African manufacturers were caught between advanced countries on the high end and China at the low end and were probably not particularly well equipped to compete with either.

The volatility and overvaluation of the Rand exchange rate is cited by Roux (2008:184) as an important impediment to economic growth, and probably also a major reason for the manufacturing sectors lack of competiveness. The narrow focus of monetary authorities on inflation targeting rather than on managing the exchange rate, probably caused the latter to be left to fluctuate and strengthen to levels not conducive to the health of the trading sectors of the economy.

A third reason for the structural change is the role played by wage pressure. The average real wage in the manufacturing sector increased significantly in the 1990's, due largely to skill upgrading and capital deepening, rather than reasons related to unionisation etc., alone. Better skilled workers working with more machinery are likely to be more productive, and hence get paid more (Rodrik, 2006:15)

Rodrik (2006:19) found that both skilled and unskilled employment is significantly more sensitive to changes in relative manufacturing prices than in the case of other sectors. A percentage reduction in relative prices resulted in a comparable percentage drop in employment. It was also found that skill upgrading and changes in labour costs had significant implications for employment. Skill upgrading had particularly negative implications for unskilled employment. Productivity growth (total factor productivity) had a positive impact on output, but reduced employment.

Rodrik (2006:3-7) argues that given a number of striking similarities between South Africa and Malaysia, and the latter country's success in using its export orientated manufacturing sector as a driver for economic growth and job creation, local policy makers should learn from the Malaysian experience and adopt similar policy measures centred around the manufacturing sector. He argues that, while recognising the political expectations and realities in South Africa, rather than rely on a poorly functioning school system to produce ill equipped workers for the high-skill requirements of a service dominated economy, we need to look at measures that will make manufacturing profitable again. A vibrant, competitive and profitable manufacturing sector is an important requirement of an economy unable to create sufficient economic growth or employment opportunities for millions of semi- and low-skilled workers.

5.6 Summary

Deriving simple GDP multipliers allows the identification of a decreasing trend in the arithmetic mean and an increasing trend in the standard deviation over the period reviewed. This suggests that the direct and indirect effect have decreased marginally, while the variation amongst industries has increased, and at an increasing rate, especially over the last five-year period. It can be argued that the recession that followed the global financial crisis of 2008 affected industries disproportionately. The calculation of the simple GDP multiplier enabled the derivation of the induced effect, which is the difference between the simple and total GDP multiplier.

Investigating the sets of simple type II GDP multipliers led to the observation that a decrease in both the arithmetic mean and the standard deviation occurred over the period reviewed. This suggests that the indirect effect decreased, in relative importance, in relation to the direct effect, over the 1980-2010 period. It reveals that downstream industries added relatively less value in 2010 than they did in 1980, and suggests a change in the pattern of production.

The significant decreasing trend in the arithmetic mean of the total GDP multiplier is perhaps the single most important revelation of this investigation. It reflects the fact that the structure of the South African economy has changed over the last thirty years (Roux, 2008:59-60). It reveals the increasing openness of the economy that has followed the end of apartheid. It also shows the extent to which the structure of ownership has changed following the unbundling of the apartheid era conglomerates and the increasing foreign ownership of the economy.

The relative decrease in the arithmetic mean of the induced effect also suggests that the relative impact of households has decreased over the past thirty years. This might reflect the fact that the economy became increasingly capital-intensive in response to the increasing inability of South Africa's labour intensive industries to attract investment and create employment (Roux, 2008:61-62).

The arithmetic mean and standard deviation of the total type II multiplier follow a similar time path to that of the simple type II multiplier. It again suggests that downstream industries increasingly add value and might support the suggestion that production has become more specialized in the last 15 years.

The composition of the total GDP multiplier has also changed over the past three decades and it is evident that the relative decrease in the percentage contribution of the induced effect in both secondary and tertiary industries has been the most important cause. It is believed that the structural changes that occurred in the economy over the past three decades are behind the observed trends. The most telling trend identified was the decreasing economic impact of the manufacturing sector. The most important reason for the decrease in profitability in the South African manufacturing sector, is the increase in import competition due to the increasing openness of the local economy.

6 SUMMARY, CONCLUSION AND RECOMMENDATIONS

The most important observation is the significant decline in the arithmetic mean of the total GDP multiplier over the 1980-2010 period. It suggests that the inter-sector multiplier effect has weakened over the past three decades.

The impact of the average R 1 invested in the economy has therefore yielded a smaller return in terms of economic impact throughout the economy in 2010 than in 1980. The inter-industry links and industry-consumer links have therefore weakened.

This can reflect the increasing openness of the South African economy since the end of apartheid, and could hide the fact that the economy has become more specialized towards its comparative advantages, and hence more efficient and competitive.

It also reflects the unbundling of South Africa's apartheid era conglomerates, which formed when sanctions and foreign exchange controls forced big local companies, which were unable to expand offshore, to diversify by investing in industries other than their own.

Input-output analysis can be very useful to government, as it provides valuable information about the functioning and structure of the linkages between the industries and households in the economy and can assist policymakers in designing suitable economic policy measures. It also provides insight into what sort of return government can expect from investing in various industries, and can hence be a valuable tool in guiding the state's involvement in the economy. The gold mining industry provided an important example, where it was found that its contribution to GDP increased, even though its output was in decline.

An important insight gained in this study was the declining nature of the multiplier effect in the secondary (manufacturing) industries due to structural changes that occurred in the economy over the past three decades and have caused profitability in this sector to decrease significantly. Government needs to consider the desirability of this state of affairs, and whether creating a more favourable environment for investment in this area of the economy would contribute to economic growth and job creation.

Policy makers can look to facilitate such an environment, both through macroeconomic and microeconomic policy. In terms of macroeconomic policy, both monetary and fiscal policy measures can be used. A much more stable and competitive exchange rate environment is needed to create an environment in which entrepreneurs and investors would be confident to invest in the local manufacturing sector. This might necessitate the need for the South African Reserve Bank to broaden its involvement from inflation targeting only to a more active role in managing the exchange rate.

In terms of microeconomic policy, well targeted industrial policy needs to be well co-ordinated and focused, rather than the usual jargon-rich, politically correct, but economically meaningless social objectives often produced by expensive and time-consuming "workshops" and "task-teams". New areas in which comparative advantage can be developed should be explored and very specific strategies should be put in place to coax entrepreneurs to invest time, money and energy in such areas. More generally, good political leadership, strong effective institutions and effective collaboration with the private sector all are necessary ingredients for the successful re-vitalisation of domestic manufacturing, and hence more rapid economic growth and job creation on a larger scale.

The fact that STATSSA has published a draft input-output table and plans to publish it on a more regular basis would make multiplier analysis in the future easier, more cost effective and more accessible. This would lead to a better understanding of the relationships between industries, amongst themselves, and industries and households, as well as add to a more comprehensive body of knowledge in this field of study. Even though the calculation of employment multipliers is beyond the scope of this investigation, it would add valuable insight as to what this study has revealed, and could aid the development of a better understanding of the relationships and linkages in the economy.

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