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Full Length Research Paper

Input-output analysis on the contribution of agriculture to the economy of Limpopo Province, South Africa

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In this study, an input output table was developed, which was used to examine the empirical evidence on the strength of agricultural growth multipliers in the facets of income, output and employment. The first order multiplier effect of agriculture was 0.3481 for output, 0.0327 for income and 0.0524 for employment. It contributions to the economy of Limpopo Province was ranked ninth for output and income multipliers and eighth for employment. Trade services were ranked first in all three sets multipliers. From the study, it was concluded that more poverty could be reduced with increased investment trade services sector as it gives more returns to investments.

Key words: Input-output analysis, generation of regional input-output table (GRIT), Limpopo Province, South Africa.

INTRODUCTION

A dynamic agricultural sector in developing countries is crucial for overall national development, poverty reduction and food security (Orden et al., 2004). Limpopo Province, one of South Africa's nine provinces is predominantly rural, which made up 89% of the total population. Agriculture is a major activity of the people contributing 3.1% to the provincial GDP. The province constitutes 18% of the 40% (about 16 million) people of South Africa living in outright poverty or continuing vulnerability to being poor (Nesamvuni et al., 2003; www.til.co.za/TIL_INVESTMENT%20NODES-agric.htm).
From this, it is apparent that for any effective development strategy, more focused and thorough efforts have to be place in rural development in general and agricultural growth in particular, since the rural areas and the agricultural sector go hand in hand.

However, according to Christiaensen and Demery (2007), there has been huge debate on the extent of agricultural development in reducing poverty. They stated that, although most development practitioners acknowledge that faster economic growth leads to faster poverty reduction, they do not all agree on whether investments and policy reforms in agriculture have a higher payoff in terms of economic growth than investments and reforms in other non-agricultural sectors. They stated that those in favour of the importance of agriculture in poverty reduction argued that, poor people stand to benefit much more from an increase in agricultural incomes than from an increase in non-agricultural incomes, because many of the poor live in rural areas, and most of them earn their living in agriculture or agriculture-related activities. However, others disagree with the agriculture-first strategy, and propose that it is the non-agriculture sectors that have strong potential to push economic growth in the rural areas and pull the poor out of poverty. Meanwhile, there are others who stand on the fact that, both agricultural and non-agricultural sectors have strong potential to become the engine of growth in rural areas and hence, call for a more balanced growth strategy.

Due to diverse experts' opinions, the policy question is, should investments be directed to improve productivity in the agricultural sector or would it be more effective to invest in the development of the non-agricultural sector directly? This question was answered by Patro et al. (2005), who stated that, the amount of investment flowing to an economy normally depends on the rate of return it is likely to generate. Therefore, sectoral pattern of investment should depend on the income generating capacity of the different sectors of the economy. A backward economy characterized by capital deficiency has to carry out its investment programme in a careful manner and this requires a detailed understanding of the inter-sectoral dependence in the economy. Given the

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earlier stated premise, it is necessary to assess the impact of agriculture on the Limpopo economy.

The specific objectives of the study are to derive a regional input output table for Limpopo Province and to use the table to calculate the output, income and employment multipliers for the province. It is hoped that the results of this analysis will provide information, that will help formulate effective strategy for stimulating economic growth in the Limpopo Province and resolve the problem of poverty plaguing the province.

METHODOLOGY

Study area

Limpopo Province is one of South Africa's nine provinces found in the northernmost part of the country. It covers an area of 12.46 million hectares accounting for 10.2% of the total area of South Africa. The provincial population of 5.56 million is divided into five districts of Capricorn, Mopani, Sekhukhune, Vhembe and Waterberg. The population is predominantly rural, consisting of about 89% of the total with the main occupation of the people being agriculture. It has a dual system of about 5000 large-scale commercial farmers who occupied 70% of the prime land and 273000 small-scale farmers occupying the remaining 30% of the land. Most of these small-scale farmers are in the former homeland majority of who are women (PROVIDE, 2005; Nesamvuni et al., 2003; www.lda.gov.za).

Data sources

The study was derived from the 2002 supply and used tables (SUT) produced by Statistics South Africa. Also, data on employment at the national and regional level identical to the nine major divisions were used. Additional socio-economic indicators used include, Mid-year population estimate and Producer Price index. Apart from the SUT, all the earlier stated data were for 2006, produced by Statistics South Africa (www.statssa.gov.za).

Description of the input output model and it assumptions

Input-output analysis is widely used as a quantitative model for national and regional economic analysis. A useful way to study an economy and the interactions between sectors of that economy is through the use of an input-output model. An input-output model provides a detailed view of the economy at a particular point in time. The input-output model is a double accounting matrix that describes the interrelationship between sectors within the economy and the relationship of these sectors to economic activities outside the economy. Input-output models, enable us to derive sets of multipliers that are disaggregated, recognizing that the total impact on income (output, employment) will vary according to which sector experiences the initial expenditure change. Manipulation of the Input-output table allows the analyst to estimate different types of multiplier depending on whether he is interested in output, income or employment effects (Ruiz-Mercado, 2006).

Data manipulation

In national accounts and economic analysis two kinds of input-output tables referred to as:

Supply and use tables (SUT),

1. Symmetric input-output table (IOT).

The major differences between a SUT and IOT are that SUT has two tables; supply table and use tables. In the SUT product by industry matrices, both industry and commodity classifications are used. The SUT is often referred to as rectangular input-output tables, while the input-output tables are converted from supply and use tables as product by product or industry by industry tables. An IOT rearranges both supply and use information in a single table and uses either a product or an industry classification for both rows and columns.

Supply and used tables (SUT)

Supply table

Table 1 shows a summarised form of the supply table, which shows the origin of the resources of goods and services, depicting products in rows and industries in columns. In the rows, the various types of products are presented according to a product classification. An additional row is added for the adjustment of direct the output of each industry according to an industrial classification, imports, taxes less subsidies on products and trade and transport margins are shown. Furthermore, in the supply table, goods and services produced in the economy are measured at basic prices.

Use table

The summarised use table (Table 2) shows the uses of goods and services and supplies information on the cost structures of the various industries. In the rows, the various types of products are presented according to a product classification. Additional rows are added for the adjustment of direct purchases by South African residents abroad and direct purchases in the domestic market by non South African residents. The table is divided into three different sections, the intermediate consumption at purchasers' price, the components of final demand and, an elaboration on the production costs of producers other than intermediate consumption expenditure.

Symmetric input-output tables

This is a derivation from the supply and use tables. The intermediate part of a symmetric input-output table (IOT) is square: the number of rows is equal to the number of columns. It is simply called the input output table. The dimension can be either product-by-product or industry-by-industry. The square IOT is important for input-output analysis. Compiling input-output tables is an analytical step. For the transformation of supply and use tables into symmetric input-output tables, various assumptions are used and sometimes adjustments are required. Table 3 shows a summarised IOT.

Transformation of the supply and use tables into the symmetric input output table

There are four basic assumptions for the transformation from supply and use tables into product-by product input-output tables or industry-by-industry input-output tables (Eurostat, 2008; Lee and Mokhtarian, 2004):

1. Product technology assumption (model A), this states that every

Table 1. Supply table.

Supply of products	Total supply at purchasers' prices	Taxes less subsidies on products	Trade and transport margins	Total supply at basic prices	Industry: Agricultural products	Mining	Manufacturing	Energy	Construction	Trade services	Transport	Finance	Community	Total industry	Imports	c.i.f./ f.o.b. adjustment
Agricultural products	Total supply at purchasers' prices (q)	Valuation items		Total supply at basic prices	Output by product and by industry (V^T)									Total industry	Imports	
Mining																
Manufacturing																
Energy																
Construction																
Trade services																
Transport																
Finance																
Community																
Total supply at purchaser's price																
c.i.f./f.o.b. Adjustment																
Direct purchases abroad by residents																
Total supply at basic price					Total output by industry (g)											

good produced by a certain industry has no quality distinction, and is regarded as equal and homogeneous;
2. Industry technology assumption (mode B), this states that if the output produced by a certain industry were to increase or decrease by x percent, the inputs required by that industry also rise or fall by the same percentage;
3. Fixed industry sales structure assumption (model C), this implies that all companies within a certain industry produce goods or services in the same way, that is, requiring the same proportions of each input;
4. Fixed product sales structure assumption (model D), this means that no technological improvement is generated at least during the analysis period.

The first two assumptions are applied to compile product by product input-output tables. The transformation of SUT to symmetric industry by industry input-output tables is based on assumptions on the salesstructure. All inputs in product by product IOT are allocated to homogenous units. Product by product IOT is believed to be more homogenous but further away from statistical sources than industry by industry IOT. Inputs in industry by industry IOT are allocated to industries. Industry by industry IOT is less homogenous but closer to statistical sources and actual observations than product by product IOT. Models A and C may have negative values after transformation from supply and use tables to input-output tables. To solve negative problems, hybrid technology and Almon's procedure can be used for removing negative values. But, models B and D do not have negative values.

The supply and use tables of the study were transformed into a 94 X 94 input output table, using the Industry technology assumption (mode B). The transformation was brought about by feeding values from the SUT into Matlab software, using the algebraic Formulae (1):

$$T = inv(diag(g)) * V$$

$$A = U * T * inv[diag\ (q)]$$

$$R = W * T * diag\ (q)$$

$$q = inv\ (I - A) * y$$

$$S = U * T$$

$$E = W * T$$

$$Y = Y \qquad (1)$$

Regionalization of the input output table

According to Imansyah (2000), for the regionalization of the IOT, three common approaches are used for impact models analysis. The first is the pure survey approach that is costly and therefore rarely used at the regional level. Secondly, pure synthetic or non-

Table 2. Use table.

		Industry														Final uses					
Supply of products	**Total supply at purchasers' prices**	**Taxes on products**	**Subsidies on products**	**Total supply at basic prices**	**Agricultural products**	**Mining**	**Manufacturing**	**Energy**	**Construction**	**Trade services**	**Transport**	**Finance**	**Community**	**Total industry**	**Exports**	**Households consumption expenditure**	**General government consumption expenditure**	**Fixed capital formation**	**Changes in inventories**	**Residual**
Agricultural products					Intermediate consumption by product and by industry (U)										Final uses by product and by category (Y)					
Mining																				
Manufacturing																				
Energy																				
Construction																				
Trade services																				
Transport																				
Finance																				
Community																				
Total																				
Purchases by residents															Adjustment items					
Direct purchases abroad by residents																				
Total																				
Compensation of employees					Value added by component and by industry (W)															
Taxes less subsidies																				
Gross operating surplus / mixed income																				
Total output at basic price					Total output by Industry (g)										(y)					

survey approaches rely on regional adjustments to the coefficients from a model of larger political boundary. The third method combines these techniques and is called a hybrid approach. The approach has grown out of the limitations of non-survey approaches and the prohibitive costs of pure survey approaches**.** He added that there seems to be general agreement in input-output analysis, that the hybrid method is the most feasible method for constructing regional input-output tables. The hybrid method appears to be the most cost-effective and well within the range of acceptable accuracy. The third method is the approach used in this study. A regional input-output table for 2006 was derived using the Generation of Regional Input-output Table (GRIT) Approach. Using the stated approach, the following was done;

The 94 X 94 national 2002 input output table produced in the study was updated to 2006 national input output table, using the 2006 producer price index. The national table was then aggregated into a 9 X 9 table and the regional output was estimated for each industry using their share of full-time employment by industry. The national table was then transformed into the technical coefficient matrix (Xij/Xj) and the self-sufficiency of every industry will be estimated by calculating the simple location quotients (SLQ):

$$(SLQj = (Xrj/Xr)/(Xnj/Xn) \qquad (2)$$

Where, X = represents number employed individuals; r = regional; n = national, and j = row sector.

The regional coefficients for row sector j are estimated by multiplying the national coefficient by SLQj, and apportioning the difference to imports, that is, r*ij* = a*ij*SLQ*j* where SLQ*j* <= 1 This means that the region produces less than its share of national output in industry j and imports are therefore required. If the SLQ for an industry exceeds 1, then the size of the regional industry is greater in relative terms, than its national equivalent and is assumed to be capable of satisfying local demand. The SLQ technique assumes that, national and regional technologies are identical, and that there are no products or sector mix problems. The SLQ technique allows national coefficients only to be revised downwards but not upwards. The coefficients table was then converted back to transactions value.

Households' consumption was estimated by applying a population index (for example):

Population index = Region population / National population

Estimates of households' consumption for each regional sector were obtained by multiplying the population index by the national output for each sector. Other final demands were calculated as the

Table 3. Product-product input-output table.

Supply of products	Homogenous Product										Final uses						
	Agricultural products	Mining	Manufacturing	Energy	Construction	Trade services	Transport	Finance	Community	Total	Exports	Households consumption expenditure	General government consumption expenditure	Fixed capital formation	Changes in inventories	Residual	Total use at purchasers' prices
Agricultural products																	
Mining																	
Manufacturing																	
Energy																	
Construction	Intermediate consumption (S)										Final uses (Y)						(q)
Trade services																	
Transport																	
Finance																	
Community																	
Total																	
Compensation of employees																	
Taxes less subsidies	Value added (E)																
Gross operating surplus / mixed income																	
Output at basic Price																	
Imports	Import																
c.i.f./f.o.b. Adjustment																	
Imports																	
Trade and transport margins																	
Taxes less subsidies																	
Total supply at basic price	(q)										(y)						

residual, achieving the necessary row and column consistencies. A four quadrant regional matrix was then produced, from which type I multiplier was calculated.

Calculation of transaction table

The transaction table is the basic and most important table of the input-output system. A table of technical coefficients and interdependency coefficients can be obtained through mathematical manipulation of the transaction table. Output multipliers, income multipliers and employment multipliers can then be determined from these two tables. These multipliers provide criteria for measuring economic activity in a given region. In order to determine the interdependence coefficients the technical coefficients first must be calculated. Table 2 can be expressed as follows;

$X_1 = x_{11} + x_{12} + x_{13} + \dots x_{1n} + Y_1$
$X_2 = x_{21} + x_{22} + x_{23} + \dots x_{2n} + Y_2$
$X_3 = x_{31} + x_{32} + x_{33} + \dots x_{3n} + Y_3$
.
.
$X_n = x_{n1} + x_{n2} + x_{n3} + \dots x_{nn} + Y_n$

From which the technical coefficient a_{ij} can be calculated thus;

$$a_{ij} = x_{ij} / X_j \quad (3)$$

Where: x = intermediate consumption; X = Column of total gross input; i = is the row value andj = the column value.

Equation 3 in matrix form is:

$$A = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix}$$

This can be expressed in matrix equation as:

Table 4. Regional Input output coefficient matrix of the Limpopo Province.

	Agriculture	Mining	Manufacturing	Energy	Construction	Trade	Transport	Finance	Community
Agricultural products	0.0323	0.0001	0.0333	0.0001	0.0005	0.0167	0.0019	0.0021	0.0043
Mining	0.0023	0.0024	0.0524	0.1622	0.0191	0.0259	0.0011	0.0039	0.0092
Manufacturing	0.1355	0.0742	0.1550	0.0658	0.1996	0.3816	0.1365	0.0509	0.0901
Energy	0.0031	0.0096	0.0043	0.0634	0.0020	0.0214	0.0076	0.0025	0.0028
Construction	0.0027	0.0060	0.0000	0.0393	0.1707	0.0603	0.0043	0.0104	0.0053
Trade services	0.0031	0.0029	0.0013	0.0018	0.0021	0.2016	0.0292	0.0122	0.0063
Transport	0.0337	0.0877	0.0113	0.0136	0.0165	0.5256	0.0905	0.0368	0.0274
Finance	0.0095	0.0112	0.0199	0.0253	0.0419	0.5918	0.0576	0.1202	0.0415
Community	0.0146	0.0383	0.0151	0.0016	0.0111	0.0363	0.0137	0.0158	0.0713

$(I - A)X = Y$

$$X = (I - A)^{-1}Y \quad (4)$$

Where: X = intermediate consumption; A= Transaction matrix; I = unit matrix, and Y = Final demand. $(I - A)^{-1}$ is known as the Leontief inverse.

RESULTS AND INTERPRETATION

The input coefficient matrix is shown in Table 4. These coefficients give an idea of what the input structure is, for a specific product if production increases by 1 Rand. Assume that the agricultural product increases by R1 million. According to the input coefficients the demand for inputs for agricultural products will increase by R 32,300 (R1 million × 0.0323), inputs from mining products will increase by R 2,300 (R1 million × 0.0023), inputs from manufacturing products will increase by R 135,500 (R1 million × 0.1355), inputs for energy product will increase by R 3,100 (R1 million × 0.0031) and so on. The input coefficients give valuable information on what the input structure is for a specific industry or product.

However, these coefficients will only give an indication of the direct requirements and it will exclude any spill over effects throughout the rest of the economy. The input coefficient matrix is the building unit for the Leontief inverse which form part of the algebraic expression in Equation 4. The main input for constructing the multipliers is Leontief inverse matrix (also known as the interdependence coefficients matrix), which shows how much of each industry's output is required, in terms of direct and indirect requirements, to produce one unit of a given industry's output. The output multipliers are gotten directly from the Leontief inverse Matrix (Table 5). They are simply the column sums of the industry part of an inverse matrix. These columns are also the essential ingredients in the calculation of the employment and income multipliers.

For example in agriculture, the output multiplier is the (1.0401 + 0.0135 + 0.1840 + 0.0051+ 0.0049+ 0.0067 + 0.0478 + 0.0246 + 0.0214 = 1.3481). This is the direct and indirect effect of investment in the product. This implies that an injection of one million into agriculture will result in 1.3481 million worth of output in the economy. In other words to increase the production of agriculture products by R 1 million, agriculture industry will have to increase their output by R 1,0401 (R 1 million × 1.0401), mining industry will have to increase their output by R 13,500 (R 1 million × 0.0135) , manufacturing industry will have to increase their output by R 184,000 (R 1 million × 0.1840), energy industry will have to increase their output by R 5,100 (R 1 million × 0.0051), construction industry will have to increase their output by R 4,900 (R 1 million × 0.0049), trade industry will have to increase their output by R 6,700 (R 1 million × 0.0067), Transport industry will have to increase their output by R 47,800 (R 1 million × 0.0478), Finance industry will have to increase their output by R 24,600 (R 1 million × 0.0246) and community industry will have to increase their output by R 21,400 (R 1 million × 0.0214).

If capacity permits, each of these industries must expand to accommodate this additional production load. At the same time, each of the industries is purchasing the additional inputs required to produce the output requested of it. This chain of purchases and production continues for all industries, until the economy is again in equilibrium. Therefore, the initial R 1 million injection into agriculture has led to money flows throughout the regional economy valued at R 1.3481 million.

Employment multiplier which is similar to the output multiplier is the ratio of direct plus indirect employment change to the direct employment change. It is calculated by multiplying the employment -output ratio with the Leontief inverse.

For all primary inputs, the following formula is used:

$$v = V (I – A)^{-1}Y \quad (4)$$

Where v = Primary input; V = Value per unit output; $(I – A)^{-1}$ = Leontief inverse; Y = Final demand.

The employment multiplier value 0.0542 for agricultural sector in Table 6 implies that, if a job is created by increase in demand in agricultural products, 0.0542 additional jobs are created elsewhere in the economy of

Table 5. Interdependent coefficients (Leontief inverse) matrix.

Products	Agricultural products	Mining	Manufacturing	Energy	Construction	Trade	Transport	Finance	Community
Agricultural products	1.0401	0.0049	0.0419	0.0048	0.0116	0.0554	0.0109	0.0065	0.0100
Mining	0.0135	1.0119	0.0652	0.1823	0.0408	0.0927	0.0167	0.0116	0.0188
Manufacturing	0.1840	0.121	1.2078	0.1264	0.3072	0.8351	0.2194	0.0981	0.1379
Energy	0.0051	0.0123	0.0068	1.0709	0.0052	0.0444	0.0118	0.0048	0.0049
Construction	0.0049	0.0098	0.002	0.0534	1.2082	0.1144	0.0114	0.0168	0.0092
Trade services	0.0067	0.0087	0.0041	0.0058	0.0066	1.3002	0.0439	0.0205	0.0116
Transport	0.0478	0.1073	0.0275	0.0419	0.0376	0.8173	1.1353	0.0624	0.0461
Finance	0.0246	0.0316	0.0346	0.0459	0.0733	0.9601	0.1112	1.159	0.0659
Community	0.0214	0.0464	0.0242	0.0138	0.0234	0.0989	0.0249	0.0238	1.0823

Table 6. Output, income and employment type I multiplier of Limpopo Province and their ranking.

Products	Output multiplier	Output multiplier ranking	Income multiplier	Income multiplier ranking	Employment multiplier	Employment multiplier ranking
Trade services	4.3185	1	0.4853	1	1.2616	1
Construction	1.7139	2	0.0573	4	0.0998	3
Transport	1.5855	3	0.0780	2	0.1867	2
Energy	1.5452	4	0.0531	6	0.0694	6
Manufacturing	1.4141	5	0.0382	8	0.0529	7
Finance	1.4035	6	0.0551	5	0.0968	4
Community	1.3867	7	0.0616	3	0.0883	5
Mining	1.3539	8	0.0448	7	0.0513	9
Agricultural products	1.3481	9	0.0327	9	0.0524	8

Limpopo Province. Income multiplier, can be defined broadly as a measure of the total change in income throughout the regional economy, resulting from a R1 change in income in a given sector in response to a final demand change in that sector. In its calculation, income multiplier also utilizes the earlier stated formula, that is, Equation 4. The vector for income is the row of compensation of labour in the input output table. On Table 6, trade services according to the ranking were the first in all three categories of output, employment, and income. Transport was second in income and employment but third in output, with construction being second in output, third in employment and fourth in income.

On the other hand, agriculture was ranked the last (that is ninth) in output and income and eighth in employment. Also, at the bottom ranking, mining ranked ninth employment, eighth in output and seventh in income. This implies that for a more meaningful policy to alleviate poverty, trade services should be targeted, as it yields more returns for investment.

Conclusion

An input output table for the regional economy of Limpopo Province was derived from which output, income and employment multiplier were calculated satisfying the two specific objectives for the

the study. The table was regionalised from the 2002 supply and used table produced by Statistic South Africa, using the Industry technology assumption (model B) and the GRIT approach. Due to the assumed constant technologies across the country for a given industry and the arbitrary assumptions about the self-sufficiency of a region with respect to particular industries, the impact study of the generated tables may not be accurate but gives an estimate of what is happening in the economy.

Despite the fact that majority of the population of Limpopo Province are rural based, and assumed engaged in agriculture, the result shows that, agriculture gives the least return to investment when compared to the other homogenous products as indicated by the output and income multiplier; except for the case of employment multiplier where it was higher than the mining products. Therefore, going by Patro et al. (2005), who stated that the amount of investment flowing to an economy should depend on the rate of return it is likely to generate, it can be concluded that for development in the Limpopo Province either targeting output, income or employment in reducing poverty, more investment should be placed on the trade sector. However, since agriculture is a major activity in the lives of the people of Limpopo Province, promoting agriculture as a lucrative business activity can greatly improve the income of the people and consequently reduce poverty.

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