Multi Regional Economic Multipliers

Dr. Clive Coetzee
General Manager: Infrastructure Management and Economic Services
KZN Provincial Treasury

Back Ground

A regional economic input-output approach, with its capacity for describing detailed transactions among economic units, is especially well suited to the analysis of regional economies. Essentially, input-output is a method of tracing and using information about transactions between buyers and sellers (Hirsch, 1973).

Schaffer (1999) argues that a regional input-output model traces the interactions of regional industries with each other, with industries outside the region, and with final demand sectors. Input-Output analysis essentially creates a picture of a regional economy, describing flows to and from industries and institutions

Back Ground

This paper gives details on the technique of constructing a regional input-output model for the KwaZulu-Natal (KZN) province, focusing on the five major regional economies. For this purpose, first we explore the economic structure of five regional economies. Second, describes the technique used in the construction of the regional input-output table. The third; supply a brief overview of multi regional input-output models. The forth; analyse the regional model and the multipliers calculated from the model. Finally, the results will be drawn.

Conceptualized

The five regional economies which are also the major municipal regions are:

Durban. It is the economic hub of KwaZulu-Natal and the major import/export center in South Africa.

Pietermaritzburg. It is the second largest city within KwaZulu-Natal and is the capital city of the province of KwaZulu-Natal.

Richards Bay. It is the home of manufacturing in the province, boasting two world class aluminium smelters and the world's largest export coal terminal.

Port Shepstone. It covers an area of approximately 90 km^2 of coastline, comprising of 21 beaches, not surprisingly the premier tourism destination in the South Africa.

Newcastle. Situated in the northern corner of the province, it is has significant coal deposits and agricultural land.

These five regional economies dominate the economic landscape of the province, for example:

Almost 55 percent of the provincial population resides in the five regions.

Almost 80 per cent of the provincial GDP is produced in the five regions.

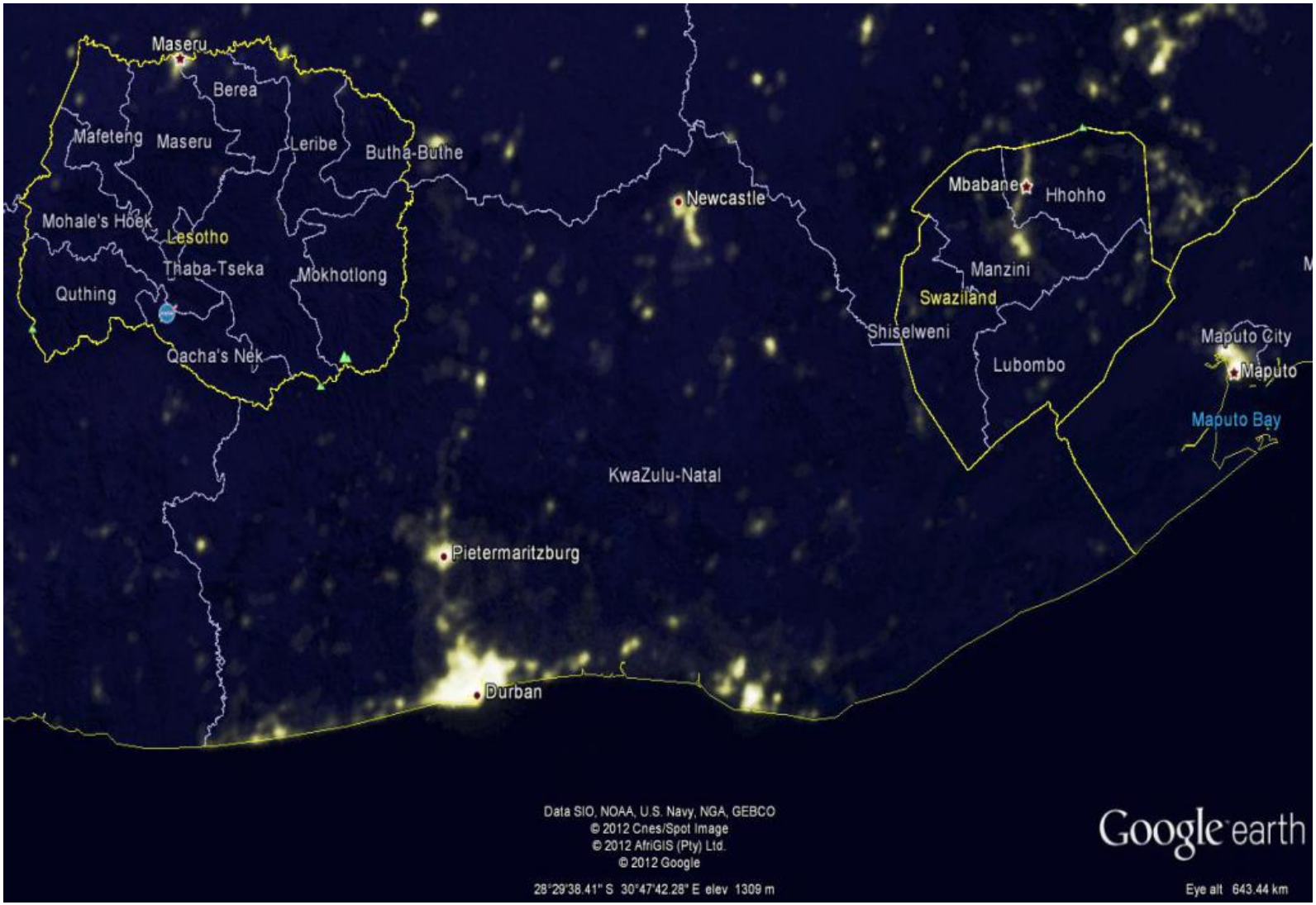
Personal per capita income is more than double in the five regions compared to the rest of the province.

Poverty levels are almost half in the five regions compared to the rest of the province.

The five regions cover only about 8.5 per cent of the total provincial land cover.

Population density levels are more than 12 times higher in the five regions compared to the rest of the province.

The five regions accounted for about 93 per cent, 86 per cent and 78 per cent of all new Office & Banking Space, Shopping Space and Industrial & Warehouse Space from 2001 to 2008.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Newcastle
Mbabane
Hhohho
Manzini
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Lubombo
Maputo City
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Maputo Bay
KwaZulu-Natal
Pietermaritzburg
Durban
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28°29'38.41" S 30°47'42.28" E elev 1309 m
Google earth
Eye alt 643.44 km

	Provincial	Durban	Pietermaritzburg	Richards Bay	Newcastle	Port Shepstone
2002	9 098 473	3 066 491	599 779	526 707	301 183	387 994
2003	9 203 777	3 100 874	610 353	532 468	305 195	391 552
2004	9 314 126	3 135 938	621 216	538 570	309 387	395 531
2005	9 430 105	3 171 904	632 419	545 075	313 768	399 950
2006	9 550 057	3 210 688	644 108	551 632	318 266	404 620
2007	9 674 667	3 250 440	656 066	558 369	322 908	409 692
2008	9 803 621	3 291 265	668 326	565 380	327 704	415 158
2009	9 937 725	3 333 336	680 955	572 727	332 684	421 057
2010	10 077 996	3 376 806	694 053	580 529	337 898	427 482
2011	10 223 270	3 422 487	707 714	588 647	343 316	434 373
2012	10 373 800	3 469 797	721 712	596 897	348 882	441 674
2013	10 530 745	3 518 477	736 127	605 553	354 674	449 556
2014	10 694 434	3 568 897	750 992	614 510	360 669	457 915
2015	10 919 077	3 621 022	766 370	623 908	366 915	466 871

The regions differ significantly in terms of their population size as well, especially when compared to Durban. Coetzee (2015), however, indicates that the size distributions of the five regions have not changed noticeably over the period. This suggests that the relative population distributions for the five regions have stayed fairly constant over the period.

	National	Provincial	Durban	Pietermaritzburg	Richards Bay	Newcastle	Port Shepstone
Agriculture, forestry and fishing	2.44	4.34	1.18	4.25	2.89	2.06	7.66
Mining and quarrying	6.87	1.81	0.27	0.43	8.77	1.22	1.99
Manufacturing	16.39	21.32	21.06	12.81	39.03	31.49	12.24
Electricity, gas and water	2.09	2.24	2.44	2.77	0.58	2.10	1.69
Construction	2.46	2.34	2.52	2.29	1.93	1.90	4.05
Wholesale & retail trade; hotels & restaurants	12.07	12.43	14.15	11.05	6.00	8.72	16.67
Transport, storage and communication	8.37	11.18	13.05	10.71	9.77	7.72	9.19
Finance, real estate and business services	18.51	15.63	18.06	19.07	9.44	13.37	18.71
Personal and General Government Services	19.77	17.70	16.30	26.69	9.85	20.44	17.04

These five regions also differ significantly in terms of their economic structure. Table displays the annual average (2002 to 2015) contribution rates for each economic sector for each of the five regions. The structural differences are fairly evident, for example Richards Bay and Newcastle are "production" economies whilst Pietermaritzburg and Port Shepstone are "consumer" economies. Durban has a much more diversified economy which is fairly similar to the national economy.

	SA	KZN	Durban	Pietermaritzburg	Richards Bay	Newcastle	Port Shepstone
2002	2 093 469	322 651	183 390	25 734	19 857	9 785	9 084
2003	2 157 045	331 504	189 731	26 624	20 544	10 123	9 398
2004	2 251 739	346 179	198 131	27 803	21 453	10 571	9 814
2005	2 366 783	365 775	209 346	29 376	22 667	11 170	10 369
2006	2 491 296	385 398	220 577	30 952	23 884	11 769	10 926
2007	2 624 841	408 910	234 033	32 841	25 341	12 487	11 592
2008	2 708 601	424 640	245 609	33 589	27 805	12 578	11 995
2009	2 666 940	418 879	235 790	35 344	24 206	13 237	11 871
2010	2 748 008	433 846	247 805	35 259	26 787	13 272	12 284
2011	2 838 257	449 826	256 758	36 703	27 738	13 769	12 732
2012	2 901 078	461 604	262 330	38 042	27 879	14 279	13 073
2013	2 968 682	472 217	269 210	38 608	28 931	14 502	13 370
2014	3 017 037	482 953	275 156	39 563	29 513	14 851	13 674
2015	3 055 192	489 208	278 552	40 127	29 801	15 067	13 852
Average	2.97	3.27	3.30	3.49	3.33	3.39	3.32
St Dev	1.91	2.00	2.67	1.92	5.73	1.96	1.92

The GDP (R'm 2010 constant prices) and economic growth rates of the five the regions has also been fairly varied. Table displays the per annual GDP and average economic growth rate of each of the regions and the national and provincial economies. It seems evident that the differences in total economic output are very big and substantial although the economic growth rate disparities are marginal.

Input-Output Approach

An input-output model in its basic form consists of a system of linear equations, in which each equation describes the distribution of an industry's economy. It is constructed from observed data for a specific economic area. The economic activity in the area must be divisible into a number of segments or producing sectors. These inter-industry or inter-sectoral flows are measured for a particular time period and, in monetary terms, in what is known as a transaction table

Input-Output Approach

The main body of the transaction table consists of a collection of industries and sectors and shows the inter-sectoral flows, providing many links between different sectors and industries within the economy. An input-output table is made up of rows and columns; rows representing sectoral output and the columns representing sectoral purchases. The figures entered in each column of the table describe the input structure of the corresponding sector, whereas each row shows what happens to the corresponding output sector (Bazzazan et al, 2005).

Input-Output Approach

An input-output table also consists of final demand and value added sections, as in an economy, there are sales to purchasers who are more external or exogenous to the industrial sectors that constitute the producers in the economy, e.g. households, government, and foreign trade. The demand for these units and the magnitudes of their purchases from each of the industrial sectors are generally determined by considerations that are relatively unrelated to the amount being produced in each of the units.

Input-Output Approach

The demand from these external units is generally referred to as final demand. Final demand covers total consumption (private or public), capital formation, and exports. The row sum of intermediate demand and final demand equals the gross value of production. Similarly, the column sums of intermediate demand plus value added also equal the gross values of production of an industry (Bazzazan et al, 2005).

Input-Output Approach

	Industry 1	Industry 2	Industry 3	Net final demand
Industry 1	a_{11}	a_{12}	a_{13}	Y_1
Industry 2	a_{21}	a_{22}	a_{23}	Y_2
Industry 3	a_{31}	a_{32}	a_{33}	Y_3
Value added	V_1	V_2	V_3	

$$
\begin{aligned}
a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + Y_1 &= X_1 \\
a_{21}X_1 + a_{22}X_2 + a_{23}X_3 + Y_2 &= X_2 \\
a_{31}X_1 + a_{32}X_2 + a_{33}X_3 + Y_3 &= X_3
\end{aligned}
$$

Input-Output Approach

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} x \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} \cdot \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix} \cdot \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix}$$

Following the construction of the input-output table, it is possible to derive a second table of input or technical coefficients. The term "technical coefficients", according to Pissarenko (2003), refers to the quantity of inputs required from each industry to produce one monetary term's worth of a given industry's output. Because it represents the entire domain of wealth-producing activities, computation of the technical coefficients are restricted to the processing sector industries only. The coefficients can be denominated in either monetary or physical units.

Input-Output Approach

The basic formula for determining coefficients is

$$\mathbf{a_{ij} = X_{ij}/x_j}$$

where:

a_{ij} = the input coefficient of industry i into industry j

X_{ij} = the amount of industry i 's output used by industry j

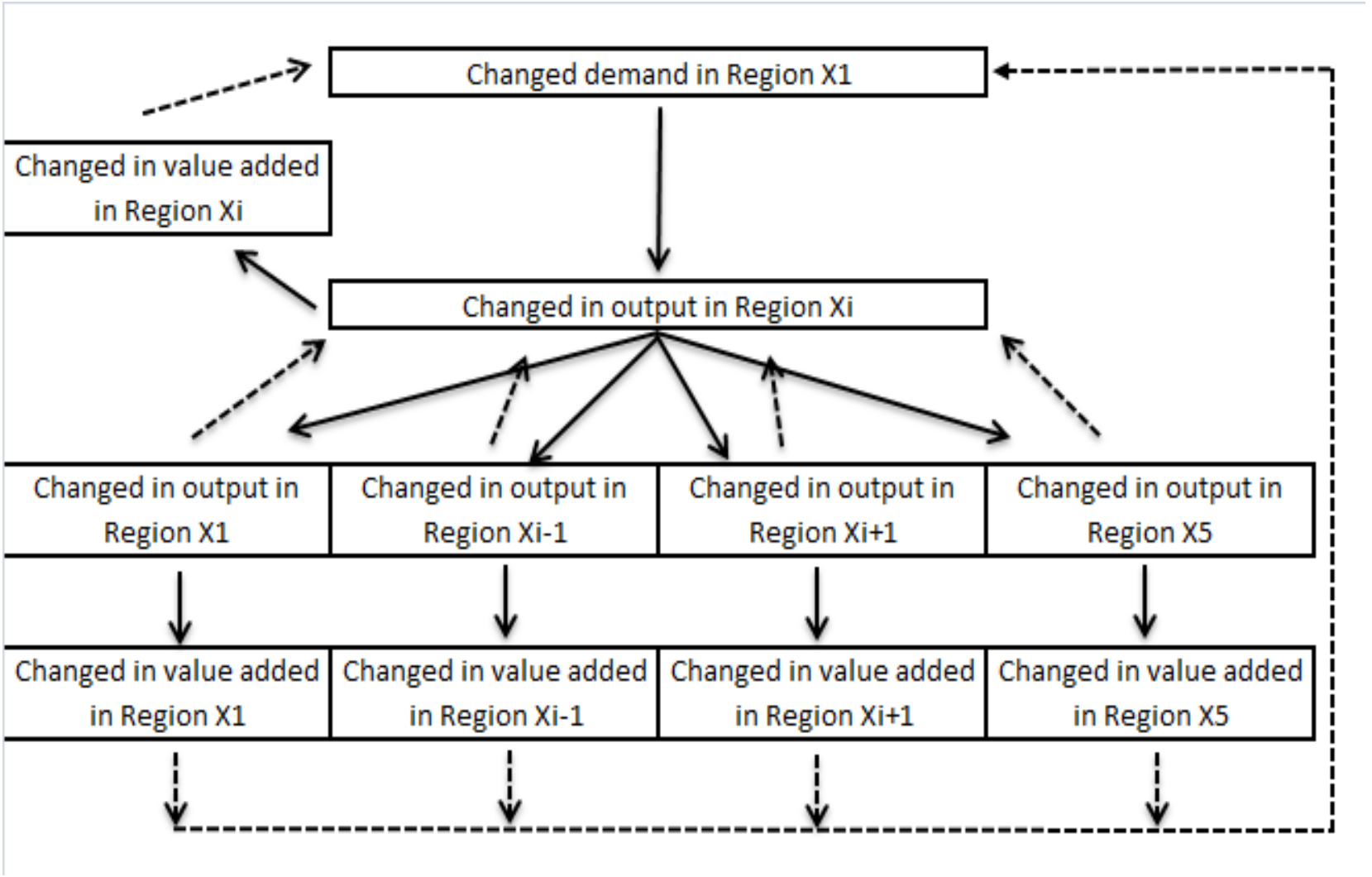
x_j = the total output from industry j

Using this formula, the coefficient $\mathbf{a_{ij}}$ can be obtained for all the industries in an input-output table. Once a transaction table of direct and indirect coefficients (or a coefficient matrix) has been obtained, several common economic analyses can be performed.

Multi Regional Input-Output Model (MRIO)

The MRIO model, according to Sargento (2009) is based on the notion that when one region increases its production, as a reaction to some exogenous change in its final demand for example, some of the inputs needed to answer the production augment will come from the remaining regions, originating an increase of production in these regions, the so called spillover effects. The remaining regions, in turn, may need to import inputs from other regions (probably including the first region) to use in their own production. These involve the concept of interregional feedback effects: those which are caused by the first region in itself, through the interactions it performs with the remaining regions (Miller, 1998).

Multi Regional Input-Output Model (MRIO)



Constructing the Multi Regional Input-Output Model

$$x_1 = \alpha_{11}x_1 + \alpha_{12}x_2 + \alpha_{13}x_3 + \alpha_{14}x_4 + \alpha_{15}x_5 + d_1$$
$$x_2 = \alpha_{21}x_1 + \alpha_{22}x_2 + \alpha_{23}x_3 + \alpha_{24}x_4 + \alpha_{25}x_5 + d_2$$
$$x_3 = \alpha_{31}x_1 + \alpha_{32}x_2 + \alpha_{33}x_3 + \alpha_{34}x_4 + \alpha_{35}x_5 + d_3$$
$$x_4 = \alpha_{41}x_1 + \alpha_{42}x_2 + \alpha_{43}x_3 + \alpha_{44}x_4 + \alpha_{45}x_5 + d_4$$
$$x_5 = \alpha_{51}x_1 + \alpha_{52}x_2 + \alpha_{53}x_3 + \alpha_{54}x_4 + \alpha_{55}x_5 + d_5$$

where:

$x_{1 \text{ to } 5}$ is the five regional economies

$\alpha_{1n}x_n$ is the input demand of the five regional economies

d_n is the final demand for its output

Constructing the Multi Regional Input-Output Model

The annual regional economic business confidence surveys that have been conducted since 2005 contain a question relating to the proportion of products and services sold by businesses in a particular regional economy to the other regional economies. The questionnaire currently contains around 25 questions, seven more than in 2005. The surveys are conducted through the various local chamber of business and other local business organizations operating in the five economic regions (only three urban centres from 2005 to 2010). The survey is an online anonymous business survey designed specifically to generate data and information on a number of local economic characteristics and trends, and the general level of business confidence in the particular urban centre

Production and Output Matrix

Regional economy of Residence	Regional economy of Production: Pietermaritzburg	Durban	Richards Bay	Port Shepstone	Newcastle
Pietermaritzburg	0.444	0.100	0.038	0.033	0.026
Durban	0.060	0.494	0.093	0.014	0.023
Richards Bay	0.037	0.059	0.617	0.007	0.048
Port Shepstone	0.040	0.116	0.018	0.416	0.011
Newcastle	0.023	0.099	0.014	0.012	0.352
Total	0.604	0.867	0.779	0.481	0.459

The yearly proportions (2011 to 2015) have been averaged in order to minimize the risk of outliers and are displayed in matrix format in the table .The totals are not equal to one hundred because it excludes the proportions of the total sales that are sold outside the five regional economies, for example to the rest of the province.

Production and Output Matrix

		Pietermaritzburg	Durban	Richards Bay	Port Shepstone	Newcastle
Inverse matrix	Pietermaritzburg	**1.881**	**0.457**	**0.306**	**0.122**	**0.115**
	Durban	**0.279**	**2.138**	**0.553**	**0.074**	**0.129**
	Richards Bay	**0.243**	**0.425**	**2.746**	**0.060**	**0.229**
	Port Shepstone	**0.194**	**0.475**	**0.216**	**1.737**	**0.069**
	Newcastle	**0.119**	**0.362**	**0.160**	**0.050**	**1.574**

The inverse of the I-A matrix is indicated in the table. These values are also known as multipliers. This means for example that when the demand for goods and services in the Pietermaritzburg economy increases by R1, the production of goods and services in Pietermaritzburg, Durban, Richards Bay, Newcastle and Port Shepstone economies will increase on average by R1.88, R0.28, R0.24, R0.20 and R0.12, respectively (spillover effects).

An Elementary Example

Let's assume final demand in the Pietermaritzburg economy increases with a R100 for whatever reason with no change in final demand in the other 4 regional economies. Applying the regional multipliers (interdependence coefficients) (table 7) provides the estimates of both direct and indirect effects (in cents) of changes in final demands for products and services in the Pietermaritzburg economy. The new level of output in each region is displayed in the table below. The cumulative production (intra and interregional flow of final goods and services) that has taken place in the five regions combined to meet the increase in final demand is calculated at **R271.65**

	Output
Pietermaritzburg	188.119
Durban	27.914
Richards Bay	24.312
Port Shepstone	19.413
Newcastle	11.889
Total	271.647

An Elementary Example

	Pietermaritzburg	Durban	Richards Bay	Port Shepstone	Newcastle	Final Demand	Final Output
Pietermaritzburg	**83.478**	**2.784**	**0.918**	**0.636**	**0.303**	**100**	**188.119**
Durban	**11.334**	**13.790**	**2.255**	**0.262**	**0.273**	**0**	**27.914**
Richards Bay	**6.984**	**1.636**	**14.991**	**0.131**	**0.569**	**0**	**24.312**
Port Shepstone	**7.556**	**3.233**	**0.425**	**8.069**	**0.129**	**0**	**19.413**
Newcastle	**4.350**	**2.767**	**0.348**	**0.237**	**4.186**	**0**	**11.889**
Primary Inputs	**74.417**	**3.703**	**5.374**	**10.078**	**6.428**	**-**	**100.000**
Total Inputs	**188.119**	**27.914**	**24.312**	**19.413**	**11.889**	**-**	**271.647**

The rows contain the output of a region, i.e. the value of the deliveries/sales of a region to the different regions. E.g., Pietermaritzburg delivers goods and services with a value of R83 to Pietermaritzburg, goods and services with a value of R2.87 to Durban, etc and R100 of final demand. Value of total production of Pietermaritzburg is R188.12.

An Elementary Example

	Pietermaritzburg	Durban	Richards Bay	Port Shepstone	Newcastle	Final Demand	Final Output
Pietermaritzburg	83.478	2.784	0.918	0.636	0.303	100	188.119
Durban	11.334	13.790	2.255	0.262	0.273	0	27.914
Richards Bay	6.984	1.636	14.991	0.131	0.569	0	24.312
Port Shepstone	7.556	3.233	0.425	8.069	0.129	0	19.413
Newcastle	4.350	2.767	0.348	0.237	4.186	0	11.889
Primary Inputs	74.417	3.703	5.374	10.078	6.428	-	100.000
Total Inputs	188.119	27.914	24.312	19.413	11.889	-	271.647

For each region to increase their production to the new total output levels as indicated above each region has to buy intermediate goods and services (raw materials and semi-finished) from itself and from the other regions (columns). For example for a production of R188.12 Pietermaritzburg spends R83.48 in Pietermaritzburg, R11.33 in Durban etc and the primary costs (capital and labour) are R74.42. The total value of intermediate inputs purchased/spend for Pietermaritzburg is R113.70.

An Elementary Example

	Pietermaritzburg	Durban	Richards Bay	Port Shepstone	Newcastle
Pietermaritzburg	**188.119**	**45.666**	**30.557**	**12.191**	**11.487**
Durban	**27.914**	**213.759**	**55.284**	**7.411**	**12.896**
Richards Bay	**24.312**	**42.462**	**274.636**	**5.993**	**22.859**
Port Shepstone	**19.413**	**47.455**	**21.582**	**173.714**	**6.948**
Newcastle	**11.889**	**36.168**	**16.028**	**4.973**	**157.370**
Primary Inputs	**100.000**	**100.000**	**100.000**	**100.000**	**100.000**
Total Inputs	**271.647**	**385.510**	**398.086**	**204.282**	**211.561**

The table displays the comparative results of a R100 increase in final demand in each of the regions individually (ceteris paribus). The cumulative effect (total production) is the highest when final demand increase in Richards Bay and the lowest when final demand increases in Port Shepstone.

An Elementary Example

	Pietermaritzburg	Durban	Richards Bay	Port Shepstone	Newcastle
Multipliers	**2.716**	**3.855**	**3.981**	**2.043**	**2.116**
Final Demand	**100.000**	**100.000**	**100.000**	**100.000**	**100.000**
Total Impact	**271.647**	**385.510**	**398.086**	**204.282**	**211.561**
Domestic Impact	**188.119**	**213.759**	**274.636**	**173.714**	**157.370**
External Impact	**83.528**	**171.751**	**123.451**	**30.568**	**54.191**

The table displays some further statistics wrt the total impact derived from a R100 increase in final demand in each of the regions individually (ceteris paribus). It shows that an increase in final demand in Durban has the largest impact on the remaining four regions collectively where as an increase in final demand in Port Shepstone has the smallest impact on the remaining four regions collectively (in R value terms).

An Elementary Example

	Pietermaritzburg	Durban	Richards Bay	Port Shepstone	Newcastle
Domestic Sales	83.478	105.597	169.347	72.207	55.414
Exports	4.641	8.162	5.288	1.507	1.956
Total Sales	88.119	113.759	174.636	73.714	57.370
Domestic Purchases	83.478	105.597	169.347	72.207	55.414
Imports	30.224	79.803	44.580	11.326	16.871
Total Purchases	113.702	185.401	213.927	83.533	127.699
Value Added	74.417	28.359	60.708	90.181	85.085
Total Production	188.119	213.759	274.636	173.714	157.370

Table displays the domestic and regional trade flows, value added and total domestic production wrt the total impact derived from a R100 increase in final demand in each of the regions individually (ceteris paribus). Durban export and import the most whilst Port Shepstone export and imports the least. Value added in the most in Port Shepstone whilst being the least in Durban.

An Elementary Example

	Pietermaritzburg	Durban	Richards Bay	Port Shepstone	Newcastle
Intra Regional Flows	**70.539**	**54.554**	**77.251**	**84.909**	**74.640**
Interregional Flows	**29.461**	**45.446**	**22.749**	**15.091**	**25.360**

The table displays the percentage intra vs. interregional flows for each of the five regions. It shows that Durban is the most "open" regional economy whilst Port Shepstone in the least.

An Elementary Example

	Pietermaritzburg	Durban	Richards Bay	Port Shepstone	Newcastle
Major Sales Partner	**Durban**	**Richards Bay**	**Durban**	**Durban**	**Durban**
Major Purchases Partner	**Durban**	**Port Shepstone**	**Durban**	**Pietermaritzburg**	**Richards Bay**

Table displays each of the five regions major trading partners in terms of sales and purchases.

This paper has developed a modified MRIO model for the province of KwaZulu-Natal using the Chenery-Moses model. A diacritical feature of this study is that, unlike most other studies that construct IO models for a single country, the MRIO model was developed to link the five major regional economies in the province. A survey approach was used to construct the MRIO model. This essentially involved using primary data collected from a specially conducted survey to develop the MRIO model

The multiplier analysis found that the Richard Bay economy had the highest output multipliers whilst Port Shepstone had the smallest. The analysis of the economic relationship between the five regions found that the value of intra-trade of these five with the regions was much higher (in varying degrees) than the value of the inter-regional trade.

Durban seems to have a fairly open economy trading significantly with the other four regions followed by Pietermaritzburg and Richards Bay. Port Shepstone and Newcastle seems to be fairly closed economies trading predominantly internally. This possible explains the reason why the multiplier analysis found that the Port Shepstone and Newcastle economies had the smallest output multipliers.

- The results suggest that there is indeed some flow of final and intermediate goods and services between the five regions. Consequently, the estimated interregional spillover and feedback effects seem to be rather negligible.

Thank You

Markets serve Humanity

Humanity serve Government