Input-output linkages and interdependence between countries in the southern African development community (SADC)

Phumzile Ncube and Fiona Tregenna

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Abstract

Regional industrialisation and integration form part of the policy priorities in a number of countries in southern African and those of the Southern African Development Community (SADC). Manufacturing can be seen as a key driver of domestic and regional industrialisation and growth, given its ability to exhibit high backward and forward input-output linkages. While most input-output research for African countries explores domestic input-output linkages, this paper investigates inter-country intersectoral linkages among five southern African countries for the years 2000 and 2015. We find that linkages tend to be highest in the manufacturing sector, particularly in 'food and beverages', across the countries in the study. We also find that the highest inter-country linkages are found between neighbouring countries. These findings suggest that regional industrialisation may benefit from focusing on manufacturing, especially agro-processing sectors. Regional integration may benefit from a specific focus on bilateral relationships between neighbouring countries.

Keywords: Inter-country input-output linkages, regional industrialisation, regional value chains

JEL codes: C67, D57, F15, O14

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1. Introduction

Regional industrialisation forms part of the development agenda of the Southern African Development Community (SADC 2015), as well as of a number of southern African countries. Through its 'Industrialisation Strategy and Roadmap, 2015-2063' and the recently signed Regional Protocol on Industry, the SADC has stated that regional value chains (RVCs) are an important part of their regional industrialisation strategy, with a particular focus on agro-processing and minerals value chains (SADC 2015).

The industrialisation agenda in southern Africa is informed by the need to move from a consumption- and commodity-based growth path to one that is diversified, with higher productive capacity and an ability to alleviate unemployment and poverty (SADC 2015). The commodity-based growth path was entrenched by growth accelerations in the early 2000s, during which many African countries experienced annual growth rates of between 5% and 10%, mainly from increased commodity export revenue (Leke and Barton 2016; Morris and Fessehaie 2014).

From structuralist and Kaldorian perspectives, manufacturing has been regarded as a special engine of growth, with industrialisation seen as central to developing economies 'catching up' with advanced economies. One of the key properties that sets manufacturing apart from the other sectors is strong backward and forward linkages with the rest of the economy (Hirschman 1958). Manufacturing subsectors have often been found to have stronger linkage effects on the rest of the economy than other sectors (Szirmai 2013; Tregenna 2008). As an economy industrialises, the interdependence of other sectors on the manufacturing sector also increases (Andreosso-O'Callaghan and Yue 2004).

UNSTAT (2020) data shows that manufacturing in southern African countries accounts for a relatively low share of gross value added, at approximately 6% in 2017. Moreover, most manufacturing production in the region is concentrated in a few products, particularly in the 'food and beverages' subsector (UNIDO 2019). In order to move towards an industrial growth path, the SADC has placed a key focus on RVCs. RVCs could be viewed as a potential avenue for building up technological capacity and diversifying production in southern African countries, thereby leveraging different capabilities within the region (Keane 2015; SADC 2015).

Both RVCs and regional industrialisation require strong regional ties between countries. One way of analysing the regional ties between countries is through inter-country[1] input-output (IO) backward linkages. The analysis of inter-country sectoral linkages for selected southern

[1] Although the convention is to refer to 'interregional' linkages, this term is often used interchangeably in reference to the IO analysis of individual countries, of regions within countries, and of trade blocs. Thus, this paper uses the term 'inter-country' in order to indicate that the focus is on interindustry interactions between countries in the southern African region, rather than on any of the alternative meanings attached to the term 'interregional'.

African countries, particularly in the context of regional industrialisation, makes a novel contribution to the literature. Previously, IO analysis was used to analyse the interregional spillover effects in other parts of the world, including between European countries (Dietzenbacher 2002; Dietzenbacher and Romero 2007; Van der Linden and Oosterhaven 1995), and East Asian integration (Hasebe and Shrestha 2006; Nakamura and Matsuzaki 1997).

More recently, inter-country IO analysis has sought to measure global value chain (GVC) participation rates and linkages through trade in value-added analysis (TiVA) (Del Prete, Giovannetti and Marvasi 2018; Timmer, Erumban, Los, Stehrer and De Vries 2014; UNCTAD 2013). However, as far as the authors know, there has not been an analysis of Hirschmanian backward IO linkages for African countries.

Empirical evidence on inter-country interindustry linkages between southern African countries is important, as it can provide a better understanding of the effect of southern African countries on one another. IO analysis is used in this paper to identify which sectors have the highest linkages between southern African countries. This paper analyses the relative strength of inter-country backward linkages between sectors across five southern African countries – Mozambique, South Africa, Tanzania, Zambia and Zimbabwe. As with domestic linkages, strong inter-country linkages within a region suggest that the growth of final demand in one sector within a specific country may have economy-wide effects in another country (Miller and Blair 2009).

Previously, research of this nature would not have been possible for countries in the southern African region due to a lack of IO data. However, IO data has recently become available through the Eora multiregional IO database (hereafter 'Eora MRIO') (see Section 4.1 for a fuller discussion of this data). In 2018, the SADC had the highest level of intra-regional trade in Africa, at US$34 billion (UNCTAD 2019a). Therefore, analysing the countries in the southern African region is important in the context of regional industrialisation.

This paper is organised as follows: it begins with the literature review in Section 2. Section 3 provides the relevant empirical background, presenting descriptive data on trade for the five countries being analysed. Section 4 sets out the methodology, particularly the model specification. The results are given in Section 5, while Section 6 presents the discussion and conclusions.

2. Literature review: Overview of IO analysis

The level of interdependence of an economy, whether domestic or regional, is an important consideration for industrialisation, growth and development. The more interdependent an economy, the more likely that the growth of one sector will have a stimulatory effect on the other sectors (Albala-Bertrand 1999). Of key interest in the analysis of interdependence are backward and forward linkages.

Backward linkages, which are a demand-side feature, refer to the economy-wide output change stemming from a one-unit increase in final demand from the purchasing sector (Miller and Blair 2009). Forward linkages, which are a supply-side feature, represent the effect on the economy from a one-unit increase in the supply of primary inputs from a given sector (Miller and Blair 2009).

The use of forward linkages in IO analysis has been challenged, however, because their presence is a result of demand originating from existing backward linkages (Jones 1976). An important distinction has thus been made in the literature between 'causal' and 'permissive' linkages, where the latter characterise forward linkages (Jones 1976). Dettmer and Fricke (2014) made a similar distinction by referring to growth-inducing industries (via backward linkages) and growth-enabling industries (via forward linkages), arguing that high forward linkages are still an important indicator of growth-enabling sectors.

Overall, a greater degree of importance has been placed on backward linkages, particularly in terms of growth-pulling properties across sectors. Studies have found that sectors with high backward linkages per unit of output have higher pulling power on the economy as a whole, and on employment generation, than do sectors with high forward linkages (Clements and Rossi 1991).

Although the IO framework has been challenged because of its strict assumptions and what is said to be the oversimplification of complex economic relationships (Dorfman 1954; Miller and Blair 2009), as discussed further below, it provides a simple means to understand the interdependence of countries in southern Africa. Next, we highlight some key issues with regard to inter-country IO linkages and the findings of some applications of inter-country IO linkage analysis.

The integrated nature of global production means that many activities have both global and domestic linkages (Durongkaveroj 2019). With the prominence of regional trade agreements (RTAs), understanding sectoral interdependence between various countries is important, because increases in final demand for a sector's products in one country are likely to create ripple effects in other countries (Van der Linden and Oosterhaven 1995; Miller and Blair 2009).

Just as with domestic IO analysis, it is possible to measure the effect of a sector in one country on the sectors found in other countries through estimating inter-country backward and forward linkages. Inter-country backward linkages refer to the output effect in one country resulting from a one-unit increase in final demand in a purchasing sector in a different country (Temursho 2018). Conversely, inter-country forward linkages are the effects on sectors in one country arising from the increase in supply of primary inputs from a given sector in another country (Miller and Blair 2009).

The literature generally shows that larger economies in a region have a greater influence on other countries in the region than do smaller economies. For instance, studies of the East

Asian region find that dependence on Japan is relatively high (Hasebe and Shrestha 2006; Nakamura and Matsuzaki 1997). Similarly, studies of European interdependence find that the strongest interdependencies have been exhibited mainly by large countries such as Germany (Dietzenbacher and Romero 2007; Dietzenbacher, Van der Linden and Steenge 1993; Van der Linden 1999). Concomitantly, growth trends in the largest economies have disproportionate effects on the rest of the region. In addition, there was a tendency among the European countries for neighbouring countries to have higher dependencies on each other than on countries in other regions (Dietzenbacher and Van der Linden 1997).

At the sectoral level, the literature shows a high degree of heterogeneity across sectors. In an East Asian study, the 'interdependence structure [was] entirely different across individual production sectors' (Hasebe and Shrestha 2006:1723). Dietzenbacher (2002:126) found that sectoral backward linkages show considerable variation, with manufacturing sectors having 'larger backward output multipliers, larger import multipliers and larger intercountry spillover effects' than services sectors.

Most of the inter-country IO analysis in the extant literature has not included African countries, much less inter-country linkages between sectors in different African countries. However, a few studies have undertaken some form of inter-country IO analysis for African countries. Analysing the growth linkages between South Africa and other countries, Nin Pratt and Diao (2008) used a regional computable general equilibrium (CGE) model and found that, while growth in South Africa leads to increased demand for agricultural exports from smaller SADC countries, it is necessary for these countries to increase agricultural productivity growth if they are to take advantage of this increased demand. Thus, if South Africa, as the largest country, could indeed be used as the anchor in the region, smaller countries would have to increase their productivity in order to take advantage of demand from South Africa.

Another, more recent, study analysed GVC participation by African countries through a trade in value added (TiVA) analysis, using Eora MRIO (2018) data. In their analysis of the GVC participation of North African countries, Del Prete et al. (2018) found that, although North African countries have low participation in GVCs, TiVA is increasing, as their exports rely heavily on GVC-related trade through imports of intermediate goods.

These studies do not analyse the inter-country sectoral linkages among various African countries, as data was not previously available for this purpose. Thus, the availability of the Eora MRIO (2018) database allows this paper to contribute to fill a gap in the literature by analysing inter-country IO linkages for five southern African countries in the SADC region. This can shed light on both the strength of linkages between countries, and on variation across sectors. Understanding the nature of this interdependence is pertinent to regional integration and industrialisation.

3. Empirical background: SADC trade

Although trade figures mainly reflect trade in both final and intermediate goods, thus not necessarily reflecting the effects seen in IO linkages, this section provides some background on intra-SADC trade dynamics.

Beginning with exports, total intra-SADC exports increased from US$5 billion in 2000 to US$37 billion in 2018 (UNCTAD 2019b). However, intra-SADC trade only made up 20% of the SADC's total trade (both exports and imports) in 2018. This intra-regional trade figure is still relatively low when compared to other regions, such as America[2] and Europe, which range between 50% and 60% (UNCTAD 2019a).

Table 1 shows the proportion of total SADC merchandise trade accounted for by each of the five countries included in this study.[3] South Africa accounts for over half of intra-SADC exports. This is not surprising, given that it is the largest and most diversified economy in the SADC region.

Table 1: Share of total SADC merchandise trade, selected countries (%)

		2000	2018
Mozambique	Exports	2	3
	Imports	7	6
South Africa	Exports	57	59
	Imports	4	18
Tanzania	Exports	1	2
	Imports	3	2
Zambia	Exports	4	7
	Imports	7	14
Zimbabwe	Exports	8	4
	Imports	13	8

Source: Authors' calculations, based on UNCTAD (2019b)

South Africa's main exports to the SADC region are manufactured goods, such as 'machinery and equipment' and 'food and beverages'. The 'machinery and equipment' exports are destined mainly for the mining and construction sectors in Zambia, Zimbabwe, Mozambique and the DRC (Arndt and Roberts 2018; Fessehaie 2015). The 'food and beverages' exports could be related to the spread of South African supermarkets in the region. Exports to South African-owned supermarkets in other parts of the SADC region are largely because of generally low capabilities and scale among local suppliers in countries such as Zambia, Botswana and Zimbabwe (Das Nair and Chisoro 2017). These observations suggest that these

[2] America denotes North and Latin America and the Caribbean.
[3] Unless otherwise specified, the analysis of trade and sectoral trade patterns is derived from the UNCTADStat data portal in UNCTAD (2019b).

sectors, especially the machinery subsectors, are likely to be important for inter-country forward linkages.

However, what is of more interest for inter-country backward linkages are the intra-SADC imports. In contrast to exports, intra-SADC imports are not dominated by South Africa. In 2018, South Africa and Zambia accounted for the highest proportion of imports among the countries chosen, at 18% and 14% respectively. The five countries combined accounted for 48% of intra-SADC imports in 2018.

The bulk of South Africa's imports from the SADC region in 2018 – approximately 34% – are fuels from Angola. Another 33% are accounted for by various manufactured goods, such as chemical products from Eswatini, and textiles from Lesotho, Mauritius, Mozambique and Madagascar. Finally, 16% of South Africa's imports from SADC are food products.

South Africa's textiles imports are interesting because they could reflect the growth of the apparel RVC between South Africa and Lesotho, Mauritius, Mozambique and Madagascar (Whitfield and Staritz 2018). Given that the apparel value chain – cotton, textiles and fabric – is almost fully contained between these countries (with Zambia and Zimbabwe providing the cotton), it shows that the 'apparel' sector in the IO table may be a source of high inter-country linkages for South Africa.

Zambia's import profile is slightly different, with approximately 60% of its imports from the SADC being manufactured goods, mainly 'machinery and equipment'. With the expansion of the Zambian copper mining industry, there have been increased imports of machinery and transport equipment from South Africa (Fessehaie 2015). Even for Mozambique, Tanzania and Zimbabwe, manufactured goods, especially 'machinery and equipment', are mainly sourced from South Africa.

The inter-country interdependence structure may be low, particularly where an exporting country's production processes are more dependent on other countries for its production (Dietzenbacher 2002). Thus, while machinery and chemicals are important from an import perspective, their influence may not be as high from an inter-country linkages perspective.

In summary, while SADC countries are growing and increasingly trading with each other, this increased trade is still concentrated in a few sectors, and with mainly one country – South Africa. Consequently, as in Europe and East Asia, this preliminary finding indicates that the highest inter-country linkages are likely to be anchored by the largest country, South Africa. Furthermore, the prevalence of South African exports of food and machinery, and its dominance in the region, suggest that these sectors may have the highest inter-country impact. These relationships are explored more rigorously in the empirical analysis that follows. The next section outlines the methodology used in this.

4. Methodology

IO modelling is employed here to understand inter-country interindustry linkages. This study specifically follows the IO framework devised by Leontief (1936) and calculates backward linkages as contemplated by Hirschman (1958) between the five southern African countries and the rest of the SADC region.

4.1 Country sample and data

The five countries analysed in this study were selected taking into account both the sizes of their respective GDP and their intra-SADC import proportions. South Africa, being the largest economy in the region, was an obvious choice. It accounts directly for almost 60% of GDP in the SADC, with a larger, more diversified industrial base than the other countries in the region (based on calculations using data from UNCTAD 2019b). Also worth noting is that Zambia, Mozambique and Tanzania exhibited the highest growth among the SADC countries, of over 6% between 2000 and 2017. Finally, as noted in Section 3, these countries, combined, account for almost half of intra-SADC imports. Although not necessarily representative of SADC countries, these countries could provide interesting insights into the inter-country linkages in the region.

This study utilises the 26-sector global Eora MRIO (2018), which includes nine subsectors of manufacturing. The Eora MRIO database is constructed using the following datasets: national IO tables, UN main aggregates and official country data (for years in which there are no IO tables for a particular country) and UN Comtrade data (Lenzen, Moran and Kanemoto 2013).

There have been criticisms of the Eora database, particularly related to the reliability of the data for countries that do not produce IO tables, where missing tables are imputed through optimisation procedures drawing on national and global statistics as a base (International Monetary Fund [IMF] 2015). In order to determine the reliability of the data in the IO tables in the Eora MRIO (2018) database, diagnostic images that provide key information on the reliability and uncertainty of the data are used (Lenzen et al. 2013). This information, available on the Eora MRIO website, allows a user to reach an assessment of the overall consistency of the raw data used in the construction of the IO tables (Lenzen et al. 2013).

The IO analysis in this study was carried out for two points in time, 2000 and 2015. The year 2000 is the starting point because most of the current SADC member states had joined the regional bloc at that point (SADC 2012). In addition, and as mentioned previously, the year 2000 is the base year of the Eora MRIO database, as it had the best data availability for national IO tables (Lenzen et al. 2012). The year 2015 is the latest year for which data is available in the Eora MRIO database. For Zimbabwe, the second time period is 2010 instead of 2015, because it is the last year for which meaningful data is available.

4.2 Empirical strategy and model

This section outlines the model specification and empirical strategy of the study. We calculated inter-country backward linkages, which are similar in structure and interpretation to the more commonly used domestic backward linkages. Inter-country backward linkages measure the effect of a unit increase in final demand from a given sector in the 'destination' country on total output in the 'origin' countries (Miller and Blair 2009). To simplify the analysis, we picked the top three inter-country linkages and their sectors for each country in the study from the 26-sector model. These results are presented in Tables 2 and 3 in Section 5.[4]

Hirschmanian backward linkages were calculated for the inter-country analysis. The basic model is similar to that of the domestic IO model, which is presented as in equation (1):

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f}, \tag{1}$$

where $\mathbf{I}$ is the identity matrix, with ones on the diagonal and zeros elsewhere. The inverse is known as the Leontief inverse matrix (Miller and Blair 2009). The elements of the Leontief inverse matrix represent direct and indirect changes in total output induced by a change in final demand (Miller and Blair 2009).

For the inter-country analysis, the model is very similar to that of the domestic model presented above. However, there is a difference in the interpretation of the elements of the Leontief inverse matrix. For this part of the analysis, we followed the model used in Nakamura and Matsuzaki (1997) and Miller and Blair (2009:560). An inter-country IO model contains both inter-country and intra-country elements.

To illustrate, a representation of a bilateral inter-country IO model takes the following form:

$$\begin{bmatrix}\mathbf{x_1}\\ \mathbf{x_2}\end{bmatrix} = \begin{bmatrix}\mathbf{a_{11}} & \mathbf{a_{12}}\\ \mathbf{a_{21}} & \mathbf{a_{22}}\end{bmatrix}\begin{bmatrix}\mathbf{x_1}\\ \mathbf{x_2}\end{bmatrix} + \begin{bmatrix}\mathbf{y_1}\\ \mathbf{y_2}\end{bmatrix}, \tag{2}$$

where x_1 and x_2 are elements of output vector x, and y_1 and y_2 are elements of the final demand vector y. The numbers 1 and 2 are used to designate each country. Further, a_{11} and a_{22} are the domestic input coefficient matrices of each country, representing the intra-country element of this matrix. Matrices a_{12} and a_{21} are inter-country input coefficient matrices, where a_{12} represents the sale of intermediate inputs from country 1 to country 2 (Nakamura and Matsuzaki 1997). The matrix a_{21} shows the sale of intermediate inputs from country 2 to country 1 (Nakamura and Matsuzaki 1997).

Similarly, the inter-country analysis yields a Leontief inverse matrix, as found in the system below:

[4] The full set of results, for all 26 sectors, are not shown for reasons of space, but are available from the authors upon request.

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} L_{11} & L_{12} \\ L_{21} & L_{22} \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \end{bmatrix}. \quad (3)$$

The sub-matrices on the diagonal, L_{11} and L_{22}, are the domestic Leontief inverse matrices for countries 1 and 2 respectively. The two off-diagonal elements, L_{12} and L_{21}, represent the inter-country changes in output related to additional final demand in another country. L_{12} is the change in output in country 1 as a result of an additional unit of final demand from country 2 (Nakamura and Matsuzaki 1997).

Inter-country backward linkages are the column sums of the inter-country Leontief inverse matrices, L_{12} and L_{21}. The column sums of these inter-country Leontief inverse matrices represent the total output from the sectors in the 'origin' region required to fulfil a unit of final demand in a sector in the destination region (Miller and Blair 2009). Each element of these matrices thus measures inter-country intersectoral effects, that is, the individual multipliers between the countries and their sectors. In this instance, the total backward and forward linkages have both an intra-country and an inter-country component. The linkages are expressed as the sum of both of these elements (Miller and Blair 2009:561).

The inter-country Leontief inverse matrices are of primary interest here. This analysis only deals with inter-country backward linkages, because their interpretation is more relevant in a growth-pulling way than are forward linkages, as discussed in Section 2. We use the full 26-sector Eora MRIO (2018) to calculate backward linkages between all countries in the Eora MRIO database. From this, the Leontief inverse matrices between the countries in this study and other SADC countries were extracted in order to compute the backward linkages. The total backward linkages are the column sums between each country of interest and other SADC countries. Thus, although our analysis focuses on the results for the five selected countries, it is their linkages with the entire SADC region that are shown.

5. Results

This section presents the inter-country backward linkages between the five sample countries and other SADC countries. It begins with aggregate sectoral analysis, presenting the backward linkages in the aggregate sectors – primary, manufacturing, non-manufacturing and services sectors. The next sub-section presents the inter-country linkages at the sub-sectoral level. The last sub-section presents the inter-country multipliers, showing which countries exhibit the highest multipliers for each country in the sample.

5.1 Aggregate sector inter-country analysis

Table 2 presents the inter-country backward linkages by aggregate sector. The inter-country backward linkages reported in Table 2 represent the effect on output in other countries induced by a $1 increase in final demand from the reporting country. For example, Mozambique's result for petroleum in 2000 indicates that a $1 increase in final demand from

the petroleum sector in Mozambique is associated with a $0.02 increase in gross output from sectors in the other SADC countries.

The results in Table 2 show that, for each of the five countries and for both years, manufacturing exhibits the highest inter-country backward linkages among the sectors. This indicates that an increase in final demand in the manufacturing subsectors in each of these countries results in the highest output increases in other countries. Services also exhibit relatively high backward linkages, especially in Zambia and Zimbabwe. The strong linkages of manufacturing suggest that regional industrialisation efforts among SADC countries may have broader positive effects on growth in the region.

Table 2: Aggregate sectoral inter-country backward linkages by country, 2000 and 2015

		Primary	Manufacturing	Non-manufacturing industry	Services
Mozambique	2000	0.02	0.38	0.1	0.2
	2015	0.01	0.2	0.05	0.17
South Africa	2000	1.01	6.97	0.89	1.43
	2015	0.82	3.72	0.41	0.81
Tanzania	2000	0.01	0.28	0.06	0.17
	2015	0.01	0.15	0.04	0.12
Zambia	2000	0.01	0.36	0.06	0.19
	2015	0.01	0.44	0.1	0.27
Zimbabwe	2000	0.02	0.33	0.07	0.23
	2015	0.03	0.38	0.09	0.32

Source: Authors' calculations

5.2 Sub-sectoral inter-country linkages

Turning to the sub-sectoral analysis, Table 3 shows the top three inter-country backward linkages. South Africa has the highest linkages with SADC countries. This means that a $1 increase in final demand from South Africa induces higher increases in gross output from other SADC countries than is the case for the other countries in this study.

When comparing the sectoral distribution of the top three backward linkages, the results in Table 3 suggest that an increase in final demand in 'petroleum' and 'food and beverages' in each of these countries generally elicits the highest output responses in other SADC countries. While the result for petroleum could point to general trade in oil between SADC countries, the result for the 'food and beverages' sector is interesting in terms of agro-processing. As noted earlier, agro-processing RVCs have been identified as possible avenues through which southern African countries could develop further.

Table 3: Top inter-country backward linkages by country, 2000 and 2015

	2000		2015	
	Sector	**Linkages**	**Sector**	**Linkages**
Mozambique	Petroleum	0.13	Food & Bev	0.05
	Food & Bev	0.06	Petroleum	0.04
	Construction	0.06	Construction	0.04
South Africa	Food & Bev	1.32	Food & Bev	0.80
	Petroleum	1.24	Agriculture	0.72
	Metal products	1.24	Textiles	0.57
Tanzania	Petroleum	0.11	Petroleum	0.05
	Food & Bev	0.05	Food & Bev	0.03
	Education, Health and other services	0.04	Various services sectors	0.02
Zambia	Petroleum	0.13	Petroleum	0.18
	Food & Bev	0.05	Metal products	0.06
	Financial & BA	0.05	Financial & BA	0.06
Zimbabwe	Petroleum	0.08	Financial & BA	0.10
	Food & Bev	0.06	Petroleum	0.09
	Financial & BA	0.05	Food & Bev	0.06

Source: Authors' calculations

Although it is not a trend, it is also worth noting that, in 2015, South Africa's third highest inter-country backward linkages in the SADC, at 0.57, were in the 'textiles' sector, with Mauritius accounting for approximately 80% of these linkages. Although the 'textiles' sector cannot be disaggregated further, these linkages could reflect the textiles and apparel RVC found between firms in Mauritius and those in South Africa, Madagascar and Mozambique. To be precise, the textiles-apparel RVC involves the importation of cotton from Zambia and Mozambique (among other countries), the subsequent production of textiles in Mauritius, the assembly of apparel in Madagascar, and then exports to South Africa (Whitfield and Staritz 2018).

Notably, none of the sectors that accounted for the most intra-SADC imports in Section 2 – mainly machinery and equipment – appear among the top three linkages. This could suggest that the domestic linkages in the production of machinery and transport equipment, particularly in South Africa as the main source, are relatively low.

5.3 Inter-country multipliers by sector and country

In order to analyse the regional impact further, in the third part of the analysis we disaggregate the backward linkages in Table 3 to analyse the multipliers in the relevant Leontief inverse matrices. By doing so, we identify which sectors, in which countries, exhibit the highest output multipliers for the inter-country backward linkages identified in Table 3. The analysis in Table 4 shows the individual multipliers found in the Leontief inverse matrices between the five countries being analysed and other SADC countries. These Leontief inverse

matrices are analogous to L_{12} and L_{21}, outlined in Section 4. In Table 4, the sector following the country represents the sector exhibiting the highest effect on output. For example, for Mozambique in 2015, the increase in final demand in petroleum had its highest impact (0.04) on food and beverages in Eswatini. Where the country is denoted 'various', this indicates that there were more than four countries that exhibited the same multiplier.

The results in Table 4 show that, in general, the highest multiplier responses for the countries in this study are neighbouring countries. For Mozambique it is Eswatini, for Tanzania it is Malawi, and for Zambia it is Botswana and Zimbabwe. South Africa also induces relatively high multiplier responses in countries further than its borders, highlighting that it has a wider influence on the southern African region beyond its neighbours.

The finding that the strongest multiplier response generally is from neighbouring countries has important implications for regional industrialisation. While most regional analysis suggests that RVCs are important, the results in Table 4 suggest that the extent of the influence of each country in southern Africa may be limited to its close neighbours. Thus, policies related to promoting RVCs, and regional industrialisation in general, may need to consider that bilateral arrangements, rather than wholesale free-trade agreements, could have a larger effect on output among SADC countries.

In summary, the results in Tables 2, 3 and 4 show that increases in final demand in the South African sectors have the highest effect on output in other SADC countries. As with Dietzenbacher et al. (1993) and Nakamura and Matsuzaki (1997), this study finds that the largest economy in the region has the strongest interdependencies.

These results have also highlighted the relative importance of 'food and beverages', which may support a focus on the agro-processing sectors for industrialisation at the regional level. Finally, these results have shown that final-demand increases in these southern African countries have their highest effect on output in neighbouring countries.

Table 4: Top SADC inter-country multipliers by country, 2000 and 2015

	2000		2015	
	Country/Sector	**Linkages**	**Country/Sector**	**Linkages**
Mozambique	Eswatini/Petroleum	0.08	Eswatini/Food & Bev	0.04
	Eswatini/Food & Bev	0.04	Eswatini/Petroleum	0.02
	Eswatini/Construction	0.03	Eswatini/ Construction	0.02
South Africa	Mozambique/Food & Bev	0.49	Mozambique/Food & Bev	0.28
	Zimbabwe/Petroleum	0.46	Mozambique/Agric.	0.25
	Zambia/Metal products	0.42	Mauritius/Textiles	0.46
Tanzania	Malawi/Petroleum	0.09	Malawi/Petroleum	0.03
	Madagascar/Food & Bev	0.02	Malawi/Food & Bev	0.01
	Malawi/Educ., Health	0.02	Various/Services	0.01
Zambia	Bots. & Zim./Petroleum	0.04	Bots. & DRC/ Petroleum	0.07
	Zimbabwe/Food & Bev	0.02	Botswana/Metal Products	0.02
	Zimbabwe/Financial & BA	0.02	Bots., DRC, Malawi, SA/Financial	0.01
Zimbabwe	Botswana/Petroleum	0.03	Bots., SA, Zam/Financial	0.02
	Various/Food & Bev	0.01	Botswana/Petroleum	0.03
	Various/ Financial	0.01	Zambia/Food & Bev/ Petroleum	0.02

Source: Authors' calculations. Note: DRC = Democratic Republic of Congo; SA = South Africa

6. Discussion and conclusion

The focus of this paper was to understand which sectors have the highest backward linkages at the inter-country level among five southern African countries, namely Mozambique, South Africa, Tanzania, Zambia and Zimbabwe. Sectoral interdependence is often conducted at a domestic level. Where intercountry linkages are considered, this has mainly been through the analysis of interregional spillover effects, or the analysis of GVC participation, mainly for European and Asian countries. The recent availability of the Eora MRIO (2018), which includes individual African countries, has made it possible to conduct this analysis.

Understanding the prevalence of these inter-country intersectoral linkages is important, especially for regional industrialisation and RVCs, as these require strong regional ties between countries. Inter-country backward linkages indicate the extent to which sectors in different countries in southern Africa are interconnected, and respond most strongly to increases in final demand in other countries within the region.

The first key finding of this paper is that, across the five countries, the 'food and beverages' subsector generally has the highest inter-country backward linkages. This suggests that an increase in final demand in the 'food and beverages' subsector in the five countries studied generally has the highest effect on output in other SADC countries. This subsector generally

dominates the manufacturing profiles of most SADC countries (UNIDO, 2019). Thus, this finding underscores the importance of agro-processing – and of relevant industrial policies to support this – in paths to industrialisation and regional integration through RVCs among SADC countries. In addition, from a 'dynamic comparative advantage' perspective, it remains important to promote upgrading, both across subsectors and in the subsectoral composition of manufacturing, including through shifts to more high-tech subsectors of manufacturing.

Moreover, with South Africa generating the highest linkages, these findings support the results of recent studies on agro-processing RVCs in southern Africa which highlight that, although RVCs are still relatively underdeveloped, South Africa acts as a hub for RVCs such as the poultry value chain (Ncube 2018).

The finding that the 'food and beverages' subsector has the highest effect across the countries could be indicative of the fact that this is the main type of manufacturing found in many SADC countries. This could be a source of regional policy tension, as these countries generally make and export the same category of, and at times the same, products, which is likely to lead to heavy protection of these sectors. The manufacturing subsectors in SADC are largely undiversified (Msami and Wangwe 2016). Apart from South Africa, a great deal of the food production in SADC is tied to commodities, such as sugar (UNIDO 2019). As a result of these similar production structures, the highest levels of protection are found, according to Hartzenberg and Kalenga (2015), among the agriculture and agro-processing sectors.

The common linkages, especially for 'food and beverages', could also point to the presence of regional multinational companies that produce similar products in different countries. These companies tend to replicate their business models in these different countries. An example of this is the poultry industry, where companies have established vertically integrated domestic value chains (Ncube 2018). Another example of this is the sugar-milling industry, as a few sugar millers have operations across the SADC region (Das Nair, Nkhonjera and Ziba 2017). Thus, without effective regional policy coordination, RVCs may not necessarily be the source of growth needed because of the obstacles presented in terms of regional trade. It remains important to target export markets beyond the region, including through strategic integration in GVCs, to take advantage of larger and more diversified markets and the potential for realising economies of scale.

It is noted, however, that the prevalence of high inter-country backward linkages for mainly the 'food and beverages' sectors could in part be an outcome of the selection of countries for the study. The potentially high linkages found in RVCs such as the apparel value chain, especially in Mauritius and Madagascar, may have been more pronounced had a wider sample of countries been chosen. Indeed, the relatively high inter-country backward linkages for the 'textiles' sector in South Africa may be a reflection of the linkages in the apparel RVCs.

A second key finding of this study is that geographical proximity is important for inter-country backward linkages. Regional industrialisation requires strong regional ties across most countries in the region. However, closer analysis of the inter-country linkages reflects that the

highest linkages are usually with one country, generally a neighbouring country. The implication here is that the presence of a real regional economy may be limited. Thus, rather than fostering regional industrialisation across the region, the inter-country backward linkages highlight that any policy efforts are more likely to lead to 'shallow' regional integration and regional industrialisation between neighbouring countries, rather than across the whole southern African region.

In conclusion, this study has shown that fostering regional linkages, especially 'food and beverages', may be important, but that proximity is also a key indicator of influence. In order for regional industrialisation in southern Africa to be viable, significant policy coordination and alignment, particularly between neighbouring countries, is paramount. Alternatively, because the highest linkages are found between neighbouring countries, regional industrialisation may initially be focused on bilateral efforts between two or three countries.

Policy misalignment and restrictions on the trade of certain food products within the region undermine the possibility of scale being established, and thus the ability for agro-processing markets to become catalysts of economic growth. Thus, an important area for future research would be the analysis of regional policies, especially as they relate to inter-country linkages. This would be important for understanding whether government policies in the SADC are adequately aligned to drive regional industrialisation.

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