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Trade linkages and growth in South Africa: an SVAR analysis
by

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Abstract

This paper investigates the vulnerability of South Africa to the shocks that originate from its major trading partners over time using a structural vector autoregressive framework. We examine the impact of shocks emanating from the EU, the US, China, Japan, India and Brazil on South Africa's output growth through both direct and indirect trade linkages, by considering the changing trade patterns from 1996 to 2017. The results suggest that the South African economy has become more integrated with emerging economies. Furthermore, China has increased its impact on the output growth of the other sample economies through trade linkages, which implies that developments in China are of increasing importance to other economies. The US and the EU are still dominated in propagating shocks despite their declining impact on the output growth of other economies in this sample.

Key words: Trade linkages; South Africa; SVAR model; output shocks

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1. Introduction

The effects of the Asian currency crisis of 1997 and the turmoil of the global financial crisis that originated from the United States (US) in 2007 influenced most other economies within a short period of time, resulting in relatively widespread economic recessions. It has been suggested that trade linkages are one of the main channels through which shocks are transmitted across countries, where such linkages include direct bilateral-trade effects and other indirect effects (i.e. through changes to the supply chain and other third market connections). Research into the effects of the bilateral-trade linkage include the work of Goldstein (1998:4), Claessens, Dornbusch and Park (2001:20) and Claessens and Forbes (2001:6), who suggest that direct bilateral-trade flows are particularly important when determining a country's vulnerability to a crisis. However, Glick and Rose (1999:604) and Forbes (2004:68) suggest that direct trade linkages can only explain a small portion of the global effects of crises and shocks, while indirect trade linkages are potentially more important. In addition, Abeysinghe and Forbes (2005:372) show that a shock to one country can have a large impact on other countries that are relatively minor trading partners due to the various indirect effects .

In this paper, the two linkages mentioned above will be used to assess the impact of external shocks on South Africa. As a small open emerging economy, South Africa has strengthened its economic relationship with both developed and developing countries. For instance, as a percentage of total exports, South African exports to the European Union (EU) have experienced a substantial decrease, from 40% in 2000 to 20% in 2012. This is partly due to the increasing importance of the trade linkage with China over this period of time. Although the EU (as a bloc) is still South Africa's largest trading partner, China has become South Africa's largest single-country trading partner (Bezuidenhout and Classen, 2013:227). This is not surprising, as the substantial domestic demand in China boosted trade with South Africa, which is rich in natural resources. In addition, the growth in trade volume with China far exceeds the growth of South Africa's trade volume with other fast growing emerging economies, such as India and Brazil. However, trade between these countries has seen a significant increase over the last few decades, mainly due to the different comparative advantages of products produced in these countries. In addition, following the conclusion of the IBSA¹ and BRICS² trade agreements, these countries are expected to become more integrated over time through stronger trade and investment relationships.

Given this background, this paper seeks to address three primary research questions:

¹ IBSA represents the India, Brazil, South Africa Dialogue Forum.

² BRICS is the acronym for Brazil, Russia, India, China and South Africa.

- How has South African growth responded to shocks from traditional trade partners, which include the EU, the US and Japan?
- How have these responses changed as a result of becoming more integrated with other emerging economies like China, India and Brazil?
- How has the output growth co-movements among South Africa, India and Brazil changed over time?

A structural vector autoregressive (SVAR) model that employs the identification strategy that is described in Abeysinghe and Forbes (2005:356) is used to answer these questions. This model allows for the measurement of how shocks that may originate in China, the EU, the US, Japan, India or Brazil affect the South African business cycle, through either direct or indirect effects. In addition, the model can also be used to show how these impacts may have changed over time.

This paper makes use of time series data from 1996Q1 to 2017Q4, which is used to estimate the model parameters and generate the various impulse response functions. The results suggest that while there is increased interdependence among Brazil, India and South Africa over time, this is overshadowed by the degree to which China has increased its impact on the output growth of other sample economies. Due to this fact, the relative importance of the impact of output fluctuations from the US and the EU (on South Africa output growth) have declined over time. However, shocks from these developed world economies are still the dominant source of international shocks. Hence, when considering the results for this sample period, it is noted that while South Africa has become more integrated with other major emerging market economies, it is still highly vulnerable to shocks that emanate from the EU and the US.

Previous studies that examine the role of indirect trade linkages in the transmission of global fluctuations, which utilise this identification strategy, are mainly focused on trade within the ASEAN-4³, NIE-4⁴, and Latin America regions. To the best of our knowledge this is the first paper that is focused on the indirect trade linkages of South Africa and its relationship with other major BRICS nations. Therefore, this study seeks to make a valuable contribution to this literature, in which includes related fields of research.

This paper is structured as follows: Section 2 reviews the relevant literature; Section 3 analyses the trade patterns of the sample economies. Section 4 describes the data that is used for the estimation of the model parameters; Section 5 describes the empirical methodology, which includes the specification of the SVAR model; Section 6 contains the results of this study that are displayed with

³ The ASEAN-4 economies are Indonesia, Malaysia, Philippines and Thailand.

⁴ The NIE-4 economies are: Singapore, Hong Kong, South Korea and Taiwan.

the aid of impulse response functions and the accumulative response functions; while Section 7 concludes.

2. Literature review

2.1. The role of trade linkages in transmitting economic shocks

According to economic theory, the main channel for the transmission of economic disturbances across countries may arise through those transactions that are recorded in the balance of payments, which include both current account transactions in goods and services and financial account transactions that are primarily concerned with capital flows (Huffman and Lothian, 1984:456). A substantial part of the literature on the transmission of shocks from one country to another has focused on role of current account and direct trade links as this channel is relatively transparent and changes to it would have important macroeconomic effects (Canova and Dellas, 1993:24). For example, an economic shock in one country, which may take the form of either a demand shock or a productivity shock, can cascade through direct trade linkages to effect the economies of other countries. Such economic shocks may be transmitted through a competitiveness effect and/or an income effect. The competitiveness effect arises when one country devalues its currency. The relative price of that country's exports will be reduced and the demand for goods will be shifted away from countries that are competing with those exports, resulting in a negative impact on these countries. In contrast, an income effect arises when a shock impacts on an economy's income level and/or growth rate, which will further affect the economy's demand for imports. Other economies that export directly to the shock-originated country will also experience a change in demand for their goods, where the sign of an income effect could be positive or negative (Forbes, 2001:4).

Although the role of trade linkages in the transmission economic disturbances has been extensively analysed, the exact role of trade linkages as a transmission mechanism remains a topic of debate. This is partly due to the fact that different countries may be affected by external shocks that are perpetuated through trade linkages in a different manner, which implies that it is difficult to generalise when considering the significance of trade linkages as a transmission mechanism. In particular, a number of studies have shown that country pairs with stronger international trade links tend to have more correlated business cycles. This finding has not only been confirmed among developed economies (Koo and Gruben, 2006:65), but also among developing economies (Calderon, Chong and Stein, 2007:2). Moreover, the studies exploring the sources of crises during 1971-1997 demonstrate that trade linkages are one of the most crucial channels for crisis propagation (Glick and Rose, 1999:617).

When considering the importance of trade linkages in the South African context, Cakir and Kabundi (2013:4698) make use of a global vector autoregressive (GVAR) model to study the importance of trade linkages for the transmission of shocks between South Africa and the BRIC countries during the course of 1995Q1 - 2009Q4. The results show that shocks from each BRIC country had a real impact on SA's output. In this instance, a real impact means that there was significant evidence of synchronization between South Africa and the BRIC countries over the business cycle. Similarly, Annari and Renee (2016:557) investigate the impact of economic shocks in the rest of the world on South Africa by estimating a GVAR model over the time period 1979Q2 - 2009Q4. In this study, 33 countries that count for 90% of the world's GDP represented the rest of the world. These results suggest that the increased trade with China makes South Africa more vulnerable to output shocks from the Chinese economy and less vulnerable to output shocks from the US economy.

Several studies have also considered the role of trade intensity as a possible facilitator for a more integrated business cycle. Frankel and Rose (1998:1025) found that trade intensity increases correlation among industrial countries, however, Firdmuc (2004:230) demonstrated that increased trade by itself does not necessarily lead to business cycle co-movement. In addition, he also suggests that intra-industry trade is positively and significantly related with co-movements in business cycles for the OECD countries between 1990 and 1999. Similarly, after estimating a business cycle co-movement equation, using data between 1976 and 1997, Shin and Wang (2004:213) conclude that intra-industrial trade, rather than inter-industrial trade, is the major channel through which the business cycle of twelve East Asian economies became more synchronised. Following this study, Rana (2008:271) made use of a similar specification that was estimated with the instrumental variable approach (as opposed to the OLS method that was employed in the previous study) over an extended sample period, to produce similar findings. This result also supports the view of Anastasiou and Zervoyianni (2009:79), who concluded that international economic disturbances are mainly transmitted through intra-industry trade linkages. Giovanni and Levchenko (2012:1132) have also shown that trade openness plays a vital role in amplifying the transmission of fluctuations instead of mitigating it. This result was further confirmed by Feldkircher (2014:19). Together these studies suggest that countries with more extensive trade links display higher output co-movement, which suggest that trade linkages would facilitate the transmission of economic fluctuations.

When considering the literature that specifically considers the effects of trade linkages in the transmission of shocks that arise during periods of crisis, it is noted that most findings suggest that an increase in trade would not necessarily constitute an important channel for the mitigation of such shocks. In particular, trade linkages are found to be both weakly significant (Canova and Dellas, 1993:24) and insignificant as a transmission mechanism (Harrigan, 2000:79). According to Schmitt-

Grohé (1998:283), from a theoretical perspective, trade interdependencies cannot sufficiently explain the observed output integrations between the US and Canada, despite immense trade interdependencies. Similarly, Selover (1999:57) found almost no empirical evidence presenting output-shock transmission across major trading regions, which included North America, Japan and East Asia, and Europe. Similarly, in the aftermath of the 2007/2008 global financial crisis, Rose and Spiegel (2011:309) found that countries with strong export dependence on the US market suffered less than many of the other countries, which implies that trade linkages with the US market may have mitigated the transmission of the sub-prime crisis. Similarly, Berkmen et al. (2012:42) did not find statistically significant evidence linking the degree of trade openness with the sub-prime crisis transmission to emerging markets. Blanchard, Das and Faruqee (2010:304) also noted the lack of such a transmission.

The results of the above studies suggest that while trade linkages may have resulted in an increase in co-movement of business cycles on aggregate, it is not necessarily the case that they are responsible for an increase in the transmission of economic shocks that may have arisen during period of crisis. However, it is important to note for the purposes of this study that the trade statistics used in all of the above research would have only captured the effect of direct trade linkages to measure the degree of trade dependency.

2.2. Direct and Indirect trade linkages

The direct trade effect captures the impact of one country's economic fluctuation on that of another, through the bilateral trade links between them (i.e. imports and exports). However, with the development of international production networks, the composition of trade has changed significantly, which would allow for foreign shocks to be transmitted via indirect trade linkages, specifically through upstream/downstream linkages to other industries that are trading with a foreign country (Cheewatrakoolpong and Manprasert, 2014:102). For example, it has been noted that more than half of the 30,000 components in an average British-made motor vehicle are produced in other countries (Financial Times, 2017). Moreover, each one of these components may incorporate materials that are sourced in a number of other countries. Hence in this case, industrial action in a distant part of the supply chain for underlying components may affect the British motor vehicle production process, through indirect linkages.

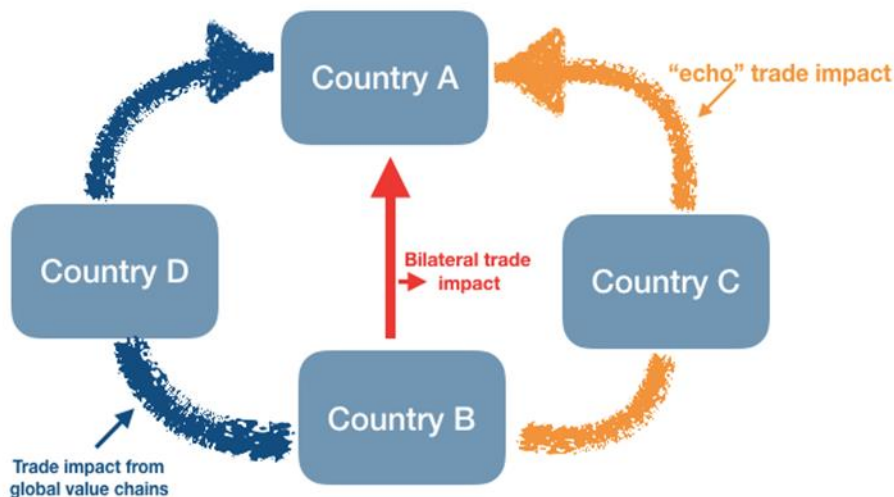


Figure 1: An illustration of the transmission of demand shocks through trade

Source: European Central Bank (ECB) - The role of cross-border production chains (2016:13)

Note: The figure illustrates a demand shock that originates in country B and its impact through the various trade channels on country A

Figure 1 illustrates how direct and indirect trade linkages work. Other indirect linkage such as flows of foreign direct investment, trade competition in the third market are not captured in the above illustration. Figure 1 displays a simple scenario using a four-country example, which considers the partial first-round trade effects of a demand shock. In this example, country A and C export directly to country B, and country A also exports directly to country C. Moreover, country A can export indirectly to B through Country D.

Several trade channels should be considered when processing the impact of a demand shock in country B on country A. First, the demand for country A’s exports to country B will change due to the bilateral trade impact (red arrow). Second, following the demand shock in country B, the demand for country C’s exports to country B could change, resulting in a change in country A’s exports to country C. More specifically, a slower growth in country B reduces exports from country C, which in turn reduces growth in country C and its demand for exports from country A. Thus, country A is influenced by this “echo” effect, which is presented by the yellow arrow in Figure 1. Third, given that country D processes value-added products from country A and exports these to country B, the shock in country B would also affect country A through this part of the global value chain, which is displayed by the blue arrow in Figure 1. This example shows that both direct trade linkages, such as those from bilateral trade, and indirect trade linkages such as the “echo” and global value chain effects, should be considered when analysing the possible impact of a foreign disturbance. In other

words, shocks in one economy can influence other economies through complex supply chains and third market connections, despite weak direct trade linkages.

In order to understand the role of direct and indirect linkages in the international transmission mechanism in a real-world scenario, various models have been developed to study the transmission of shocks that may relate to specific countries and regions. To examine the transmission of crisis shocks from the US to Thailand, Cheewatrakoolpong and Manprasert (2012) constructed a computational general equilibrium (CGE) model and divided international trade transactions into direct and indirect linkages. The results suggest that due to the contraction of demand for intermediate goods in the US, Thailand's economy was affected more significantly through indirect channels. In a subsequent study Cheewatrakoolpong and Manprasert (2015:385) made use of the same model to demonstrate that Thailand is highly exposed to shocks from advanced economies when both linkages are considered. More specifically, its economy is also particularly vulnerable to financial crises through various indirect trade linkages.

To consider the potential importance of indirect trade linkages, Abeysinghe and Forbes (2005:373) make use of a unique identification strategy that is employed in a SVAR model to capture the separate direct trade and the indirect-multiplier effects that are represented by a trade-weight matrix. After estimating the model parameters, they are then able to generate a series of impulse response functions that show how a shock to one country can affect others, through either bilateral-trade linkages between two countries or indirect multiplier effects. Their results suggested that the indirect effects in their sample of countries are relatively large. Saldarriaga and Winkelried (2013:13) made use of this model structure in a later paper to show how the shocks from large developed and emerging economies have affected the growth rates of Latin American countries through bilateral trade linkages over the period of 1989Q1 - 2011Q2. When using time-varying trade weights, this paper found that the indirect effects of changes to China's growth rate can account for most of the changes in the growth rates in Latin American countries during the latter part of this sample. Dungey, Khan and Reghavan (2018:118) have also made use of this trade-linked SVAR model to investigate the effects of shocks that emanate from China, the EU and the US, on other Asian markets over the period 1978Q1 - 2015Q4. The results showed the growing importance of China as a source of shocks to other Asian countries.

3. South Africa's relationship with its main trading partners

South Africa has increased its total exports to the rest of the world by more than threefold during the period of 1998 - 2017. Being a resource-rich country, its stronger engagement in trade with the world has made its economy more sensitive to external shocks. This section provides an overview of South Africa's trading trends and trade linkages with its main trading partners.

According to the South African Revenue Service (SARS), South Africa's top export products in 2018 are gems and precious metals (17.5% of total exports), followed by ores, slag and ash (12.5%). Vehicles are the third largest export product, which accounts for 11.4% of total exports. Exports of mineral fuels and iron rank fourth (10.6%), while exports of steel follow with 6.7% of total exports.. As can be seen, the structure of South Africa's merchandise exports is largely focused on commodity goods, which make up more than 40% of total exports. Table 1 displays the top 5 categories that South Africa exports to each of its main trading partners. It shows that South Africa mainly exports raw materials to both developed and emerging economies.

Table 1: South Africa's top 5 export categories to trading partners in 2018

Rank	US	China	India	Japan	Brazil	Germany
1	Gems, precious metals	Ores, slag, ash	Mineral fuels	Gems, precious metals	Mineral fuels	Vehicles
2	Iron and steel	Iron and steel	Ores, slag, ash	Ores, slag, ash	Gems, precious metals	Gems, precious metals
3	Aluminium	Copper	Wood pulp	Vehicles	Plastics	Machinery
4	Ores, slag, ash	Wool	Iron and steel	Iron and steel	Aluminium	Ores, slag, ash
5	Vehicles	Wood pulp	Machinery	Wood	Car engines	Other chemical goods

Source: Trade Map, International Trade Centre

Figure 2 illustrates shows how South African merchandise exports to its trading partners have grown over time. The US, EU (mainly Germany and the United Kingdom) and Japan are the main traditional trading partners of South Africa. During the period of 1998 - 2011, South African exports to these developed economies increased at a steady rate, despite a sharp fall after the 2007/2008 global financial crises, after which it recovered back to the pre-crisis level in 2011. The strong trade relations with these developed economies are due to a number of reasons. First, South Africa qualifies for preferential trade benefits under the African Growth and Opportunity Act (AGOA) signed in 2000,

which allows South Africa to export significant quantities of manufactured goods to the United States (Rolfe and Woodward, 2005). In addition, a Trade and Investment Framework Agreement was signed in 1999 and was amended in 2012 to improve the trade relations between these countries. Second, following the RSA-EU Trade, Development and Co-operation Agreement signed in 1999, a Free Trade Area (FTA) has been set up to cover around 90% of trade between South Africa and the EU. Under the FTA, South African exports to the EU have been largely liberalized (Lee, 2010:81).

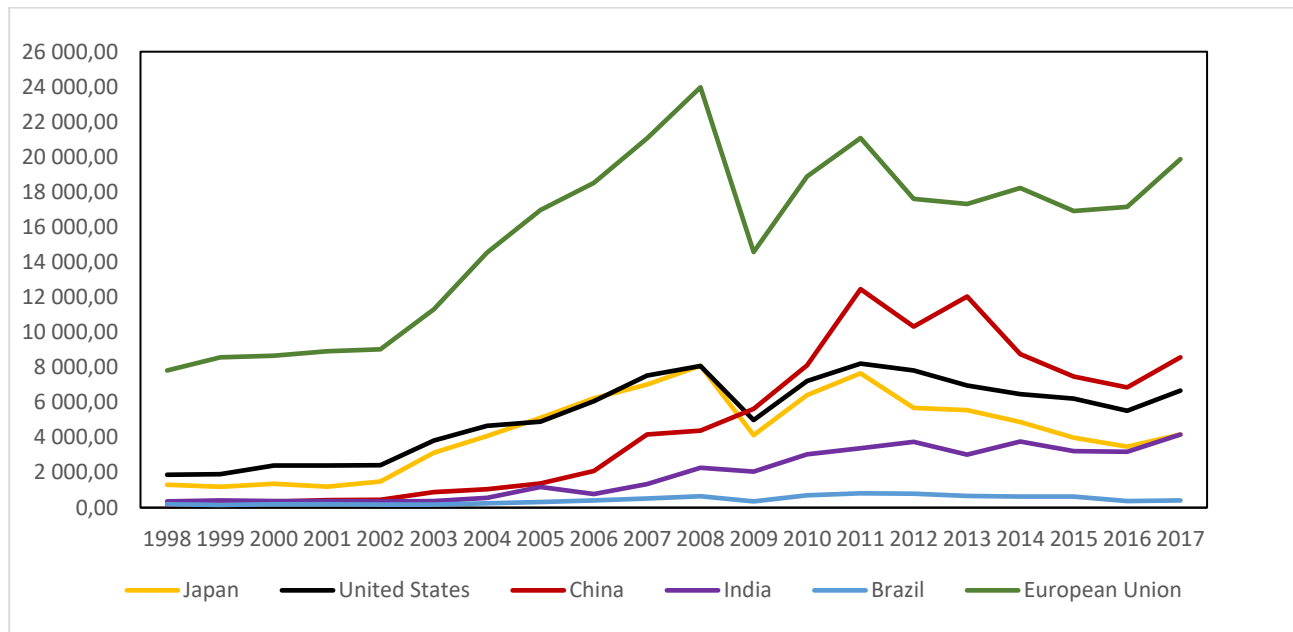


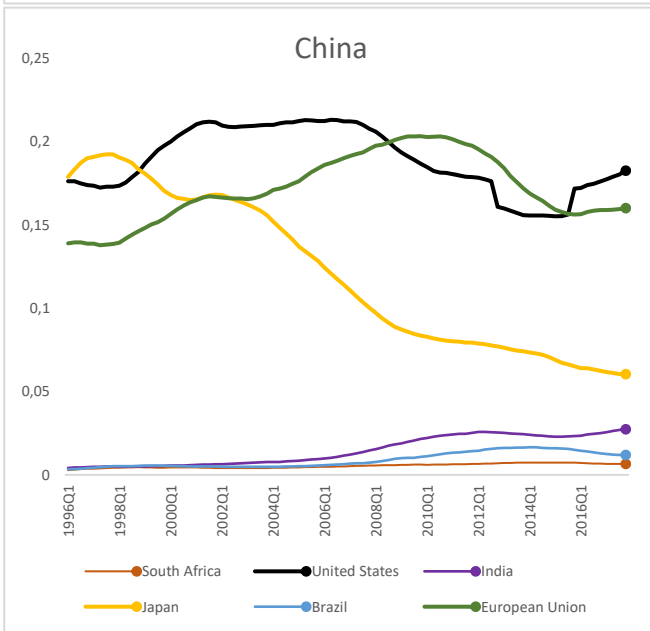
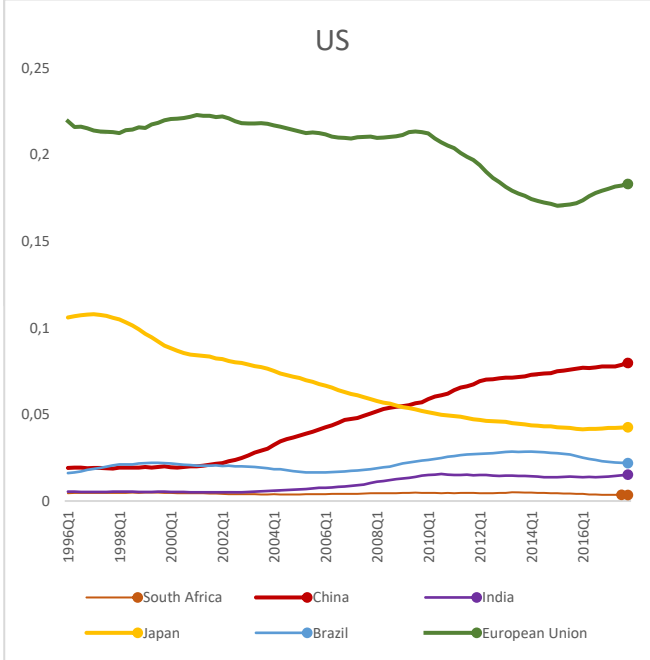
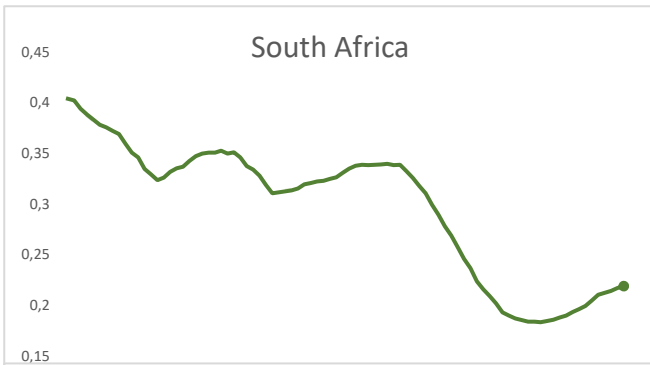
Figure 2: South African merchandise exports to its trading partners 1998-2017 (US Dollars, Millions)

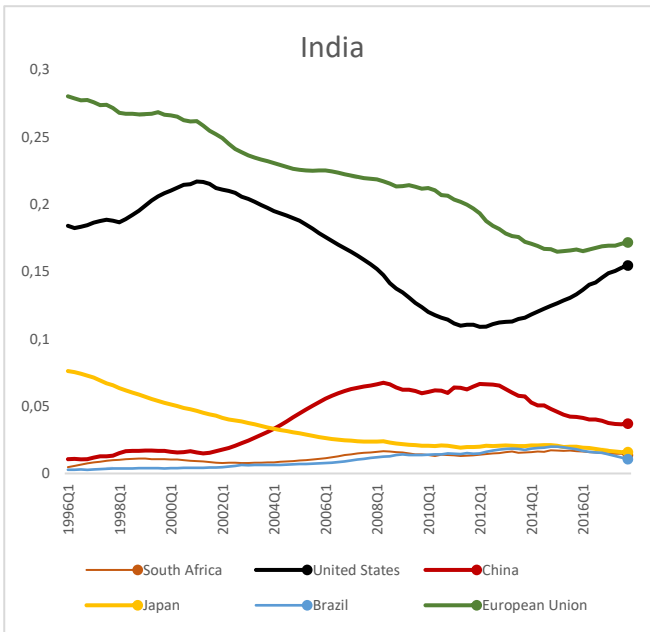
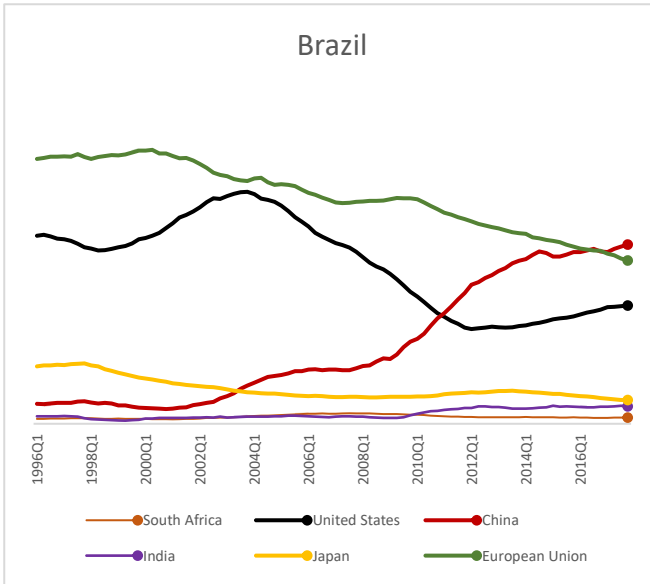
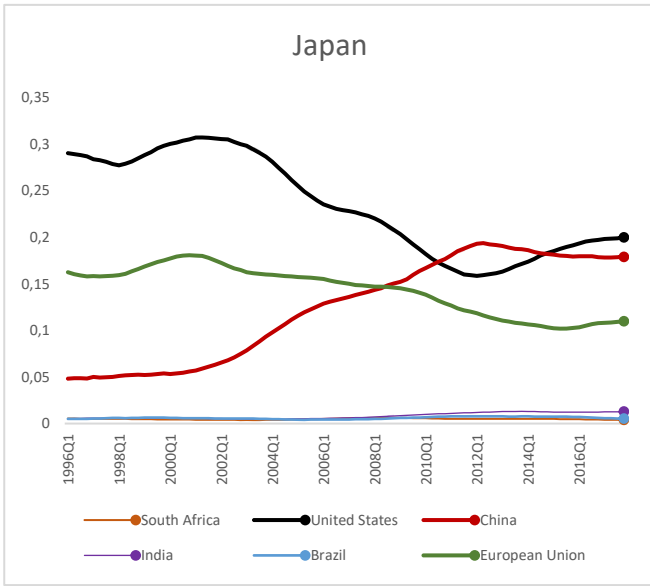
Source: Direction of Trade Statistics (DOTS)

South African exports to China have increased at a growing rate from 1998 - 2011. As a result of China's prodigious economic growth over this period of time, the world's demand for commodity goods has increased (as it is the world's largest consumer of commodities). This has also placed upward pressure of commodity prices, which has contributed towards an increase in exports (by value) from South Africa and other commodity goods producers to China. It is worth noting that the global financial crisis in 2007 did not affect South Africa's exports to China to a large extent, as it did with the US, the EU and Japan. Figure 2 also shows that China has overtaken the US as South Africa's biggest export destination, during the beginning of 2009. However, more recently exports to China have been subject to a decline of 43% between 2013 and 2016. This can be partially explained by the sharp decrease in commodity prices between 2014 and 2015, and the slowdown in the Chinese economy. A number of initiatives have since been put in place to correct this downward trajectory. For example, during the China Inward Buying Mission event in 2015, China signed more than 20 co-operation agreements and contracts to the value of \$918 million with South Africa. Overall, South Africa's exports to China still remain large and are expected to increase in the future.

Besides trading intensely with industrialized economies, South Africa has also significantly improved its trading relations with other emerging economies such as India and Brazil. Brazil is currently South Africa's largest trading partner in Latin America. Although South Africa only exports a small amount of its total exports to Brazil, exports to Brazil have grown by approximately 200% over the period 1998 - 2017. South Africa mainly exports mineral products, machinery and chemical products to Brazil, while importing animal products, food and tobacco products. Due to the different comparative advantages in products produced in these two countries, there are many opportunities for trade expansion. India has also started to import a large amount of raw materials from South Africa due to the expansion of its economy. The substantial increase in exports to India can be seen in Figure 1, where there has been an increase of \$3,813 million worth of exports. In 2003, the trilateral development initiative was established between India, Brazil and South Africa (IBSA). This initiative emphasises multilateral trade liberalisations among these three countries and would contribute towards the expansion of South-South trade.

Apart from these trends, it is also important to understand the relative trade linkages between South Africa and its trading partners. In several studies export shares have been used as a measure of bilateral-trade linkages, where a positive relationship between export shares and economic growth has been found. This would imply that there is greater economic integration between these countries, which may result in greater business cycle synchronizations. In the figures that follow, the export shares are defined as the sum of country i 's merchandise exports to country j divided by the sum of country i 's total merchandise exports to the world. This allows for additional insight into the trade patterns of the US, EU, China, India, South Africa, Japan and Brazil.





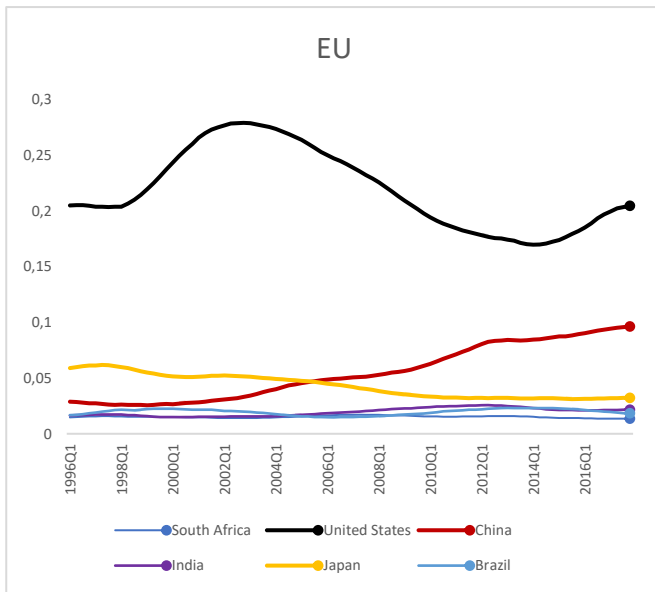


Figure 3: Export Shares (% of country's total exports)

Note: These export shares are calculated following a 12-quarter moving average process

Figure 3 displays the changes in the export-shares of the seven countries that are included in this analysis over time. Among these countries, South Africa and Brazil are small open economies, and their economic growth heavily depends on exports. This results in greater exposure of their economies to the fluctuations that may arise in international markets. South Africa has doubled its exports of goods to the EU, however its export share to the EU has shrunk from 40% to 20% between 1996 and 2017. Over this period of time, South Africa's export share to China and India has grown significantly, by 10% and 5%, respectively. In addition, its export share to the US has declined by 3%. Since 2014, the export share to China has experienced a steady decrease, while the export share to India has increased at a stable rate and was almost equal to Japan by 2017. South Africa's export share to Brazil remains steady over the sample period at about 1%. As for Brazil, its trade intensity with China has grown by a larger magnitude, when compared with that of South Africa, with 20% of its total exports going to China in 2017. In contrast, Brazil's export share to the EU, the US and Japan has dropped by 11%, 8% and 3.5%, respectively, over the sample period. In addition, the export share to India has seen a 1% increase over this period. In total, the trade patterns of both South Africa and Brazil have changed significantly over time, with their export shares moving gradually towards fast growing emerging economies.

The substantial economic expansion that has been experienced by India and China over the last two decades has ensured that their influence is of increased importance in the changing structure of global trade, especially after China joined the WTO in 2001. In addition, India's export share to China has also increased substantially, from 1% in 2001 to 6% in 2014, while India's export shares to the EU,

US and Japan have shrunk by 10%, 7% and 6% over the same period. India has also shifted its exports to South Africa and Brazil, with a 1% increase in its export shares to both these countries. Despite trading more intensely with China, India's biggest export destinations are still the EU and US. As for China, its strong economic growth has been largely driven by its growing exports to the world's major economies. The relative importance of the EU and US as destinations for China's exports remains relatively unchanged. In addition, China has also increased its exports to other emerging economies, with increasing export shares to South Africa, Brazil and India.

In general, almost all the other countries' export shares to Japan have shrunk to a large degree, while China has seen significant growth in its importance as a trading partner to all the other countries that are included in this analysis. This is particularly the case for the three smaller emerging economies, which have all developed much stronger trade-linkages with China.

4. Data Description

This study makes use of the data for six countries and one regional aggregate, which is treated as a single country for the purpose of this analysis. Hence the sample includes: South Africa, US, China, India, Japan, Brazil, and EU. Hence, we assume a seven-country world, where all the economies are able to interact with each other. This group of countries account for about 75% of the world's economy. The data for these countries that is used in the estimation of model parameters extends over the period from the first quarter of 1996 through to the fourth quarter of 2017. To calculate the 12-quarter moving average for the export shares, a longer sample for the export data is used, beginning in the first quarter of 1993.

Annualized quarterly real GDP data is used to measure economic output and merchandise exports data is used to measure trade linkages between each country. The measures of economic output were obtained from various databases, which include: Statistics South Africa (STATS SA), Bureau of Economic Analysis (for the US), National Bureau of Statistics of China, India National Statistics Office, Cabinet Office (for Japan), OECD Economic Indicators and Eurostat. All GDP data is denoted in national currencies. Measures of economic output for South Africa and the EU are reported at constant 2010 prices, Japan and India provide constant 2011 prices, the US data is measured at constant 2012 prices and China makes use of constant 2000 prices. Moreover, quarterly export data is obtained from the Direction of Trade Statistics (IMF Database). Export data is reported as Freight on Board (FOB) in current US dollars. The export data for South Africa to all its trading partners is not available at the beginning of the sample period (from 1993Q1 to 1997Q4), thus we use imports reported by its trading partners for estimates of South Africa's exports.

The final database includes 7 GDP growth rates and 36 export-share series. The GDP growth rates are transformed by using the first difference of log real GDP. Some series were available in seasonally adjusted form (the US, South Africa, EU and Brazil). Unadjusted series for China and India were seasonally adjusted using the Census X-13 procedure.⁵ Table A.1 in the appendix contains the descriptive statistics of the GDP growth rates for each country. By conducting ADF tests, all the growth series are found to be stationary, as can be seen in Table A.2 of the appendix.

To achieve the aim of measuring bilateral-trade flows, a trade-matrix (W) is calculated by constructing a 12-quarter moving average process for bilateral export shares. There are several benefits of focusing on trade weights. First, among the assessable measures, trade weights are the most consistent and its data sources are generally more available. Second, trade in goods displays an important channel for shock transmissions across countries. Third, trade flows can be used as a proxy for various cross-border linkages: linkages of goods and services, linkages of foreign direct investment, flows of migrants and workers, cultural and political linkages, etc. (Dungey, Khan and Raghavan, 2018).

5. Methodology

In order to analyze the complex linkages, which include the indirect output multiplier effects between the seven countries, a structural vector autoregressive (SVAR) model is applied to quarterly GDP data and the corresponding quarterly export shares. The identification strategy of Abeyasinghe and Forbes (2005:372) is used in the SVAR model to generate the impulse response functions (IRFs) that describe essential features of the dynamics that relate to the international transmission effects of the shocks.

5.1. SVAR framework

In comparison to the reduced-form VAR framework, an SVAR approach allows for the analysis of contemporaneous interactions between variables, which is especially important when the data is measured over long intervals, as is the case with the quarterly data that is used in this study. By adopting the SVAR approach of Abeyasinghe and Forbes (2005:372), we can examine how a shock to one country transmits to another country via either direct linkages or various indirect linkages. Following this approach, bilateral export shares are used to link business cycles across countries, which requires the construction of a time-varying trade matrix. By using this method, one is not only

⁵ The Census X-13 procedure was conducted in Eviews 8.0

able to analyze the impact of output shocks through different international trade linkages, but it would also show how the impacts of international shocks change over time, due to the varying trade patterns.

A general SVAR(p) model for this system may be structured as follows:

$$(B_0 * W_t)Y_t = c + (B_1 * W_{t-1})Y_{t-1} + \dots + (B_p * W_{t-p})Y_{t-p} + \varepsilon_t \quad (1)$$

Where Y_t , c , and ε_t are $(n \times 1)$ vectors. This generalized form contains an $(n \times 1)$ vector of country outputs. Y_t represents the countries' output at time t , c represents constants and ε_t represents white noise. Here, ε_t captures any omitted variables not included in trade linkages (Abeyasinghe and Forbes, 2005:359), these omitted variables are likely to be correlated over time as well as across equations. “*” indicates the Hadamard product giving the element-wise product of two matrices. B_j ($j = 0, 1 \dots p$) and W are $(n \times n)$ matrices of parameter and export-weight matrices, while p represents the lag length. $(B_j * W_{t-j})$ are the effective parameter matrices in the model and it is important to note that W_t is allowed to change over time, which is a fairly unique characteristic of this model structure. In addition, due to the variation of export share matrices over time, the parameter matrices will also change. By following this methodology, the changes in transmission that stem from the changing trade patterns during the course of the sample period can be identified.

The output growth equation for each country in our sample is as follows:

$$y_{it} = c_i + \sum_{j=1}^p \phi_{ji} y_{it-j} + \sum_{j=0}^p \beta_{ji} y_{it-j}^f + \varepsilon_{it} \quad (2)$$

$$y_{it}^f = \sum_{j=1}^n w_{ijt} y_{jt}$$

where w_{ijt} is the trade weight of country j for country i ($i \neq j$) and is measured by the export share from country i to country j over the total exports of country i . The sum of the export shares must equal to 1 and as noted above, the export shares change over time.

By estimating equation (2) for each of the n countries in the world, the entire system of equations can be specified. For example, if we assume $n=3$ and $p = 1$, it would imply that we have a system for three countries and one lag. The three equations that would need to be estimated simultaneously to obtain the appropriate variance-covariance matrix for the error terms could then be written as:

$$\begin{aligned} y_{1t} &= c_1 + \phi_{11} * y_{1t-1} + \beta_{01}[w_{12} * y_{2t} + w_{13} * y_{3t}] \\ &\quad + \beta_{11}[w_{12t-1} * y_{2t-1} + w_{13t-1} * y_{3t-1}] + \varepsilon_{1t} \\ y_{2t} &= c_2 + \phi_{22} * y_{2t-1} + \beta_{02}[w_{21} * y_{1t} + w_{23} * y_{3t}] \\ &\quad + \beta_{12}[w_{21t-1} * y_{1t-1} + w_{23t-1} * y_{3t-1}] + \varepsilon_{2t} \end{aligned} \quad (3)$$

$$y_{3t} = c_3 + \phi_{33} * y_{3t-1} + \beta_{03}[w_{31} * y_{1t} + w_{32} * y_{2t}] \\ + \beta_{13}[w_{31t-1} * y_{1t-1} + w_{32t-1} * y_{2t-1}] + \varepsilon_{3t}$$

The coefficients are thus measuring the trade-weighted combined influence of two countries on the third country.

The model could also be expressed in matrix form as follows:

$$\begin{pmatrix} 1 & -\beta_{01} * w_{12} & -\beta_{01} * w_{13} \\ -\beta_{02} * w_{21} & 1 & -\beta_{02} * w_{23} \\ -\beta_{03} * w_{31} & -\beta_{03} * w_{32} & 1 \end{pmatrix} \begin{pmatrix} y_{1t} \\ y_{2t} \\ y_{3t} \end{pmatrix} \\ = \begin{pmatrix} c_1 \\ c_2 \\ c_3 \end{pmatrix} + \begin{pmatrix} \phi_{11} & \beta_{11} * w_{12t-1} & \beta_{11} * w_{13t-1} \\ \beta_{12} * w_{21t-1} & \phi_{11} & \beta_{12} * w_{23t-1} \\ \beta_{13} * w_{31t-1} & \beta_{13} * w_{32t-1} & \phi_{11} \end{pmatrix} \begin{pmatrix} y_{1t-1} \\ y_{2t-1} \\ y_{3t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{pmatrix}$$

or alternatively, this form can be expressed as:

$$(B_0 * W_t)y_t = c + (B_1 * W_{t-1})y_{t-1} + \varepsilon_t \quad (4)$$

where

$$B_0 = \begin{pmatrix} 1 & -\beta_{01} & -\beta_{01} \\ -\beta_{02} & 1 & -\beta_{02} \\ -\beta_{03} & -\beta_{03} & 1 \end{pmatrix} \quad B_1 = \begin{pmatrix} \phi_{11} & -\beta_{01} & -\beta_{01} \\ -\beta_{02} & \phi_{22} & -\beta_{02} \\ -\beta_{03} & -\beta_{03} & \phi_{33} \end{pmatrix} \\ W_t = \begin{pmatrix} 1 & w_{12,t} & w_{13,t} \\ w_{21,t} & 1 & w_{23,t} \\ w_{31,t} & w_{32,t} & 1 \end{pmatrix}$$

This model is over-identified, with diagonal elements equal to 1 and non-diagonal elements in each row of B_0 and B_1 constrained to be equal. Trade weights are known elements, which allows for a relatively parsimonious framework, where equation (4) constitutes the SVAR model that is applied to the data to derive the respective model parameters with the aid of ordinary least squares (OLS), two-stage least squares (2SLS) and three-stage least squares (3SLS) estimation techniques.

5.2. Impulse response analysis

If the W -matrix is given, equation (1) can be written as:

$$Y_t = \varphi_1 Y_{t-1} + \varphi_2 Y_{t-2} + \dots + \varphi_p Y_{t-p} + \partial_t \quad (5)$$

where $\varphi_i = (B_0 * W)^{-1}(B_i * W)$, $i = 1, \dots, p$ and $\partial_t = (B_0 * W)^{-1}\varepsilon_t$

After calculating the impulse response functions, we can determine how an output shock to each country in our sample impacts other sample economies through bilateral trade linkages and indirect

output multiplier effects. For the purpose of calculating a series of impulse response functions, a moving-average expression of (5) can be written as:

$$Y_t = \sum_{i=0}^{\infty} \psi_i \partial_{t-i} = \sum_{i=0}^{\infty} \psi_i (B_0 * W)^{-1} \varepsilon_{t-i} \quad (6)$$

where the ψ_i matrices are obtained from the recursion:

$$\psi_0 = I \quad \psi_i = \sum_{j=1}^i \psi_{i-j} \varphi_j, \quad i = 1, 2, \dots \quad (7)$$

5.3. Model specification and estimation

When W is pre-determined, equation (1) with p lags can be expressed as:

$$y_{1t} = c_1 + \sum_{p=1}^n \phi_{1p} y_{1,t-p} + \sum_{p=0}^p \beta_{1p} [w_{12,t-1} y_{2t-1} + \dots + w_{1i,t-p} y_{i,t-p}] + \varepsilon_{1t}$$

...

(8)

$$y_{it} = c_i + \sum_{p=1}^n \phi_{ip} y_{i,t-p} + \sum_{p=0}^p \beta_{ip} [w_{i1,t-1} y_{1t-1} + \dots + w_{i,i-1,t-p} y_{i-1,t-p}] + \varepsilon_{it}$$

In our model, we have 7 endogenous variables for y_{it} , where $i = 1, \dots, 7$, and 88 observations. To account for any remaining seasonality in the data, we choose a lag length of 4. In addition, we also make use of four lags of each y_{it} ($i = 1, \dots, 7$) as instrument variables. We can do so in this case due to the assumption that the growth rates in each of the sample countries, except i , are treated as an aggregate trade-weighted variable as opposed to separate independent variables. Therefore, as y_{it}^f is endogenous, 2SLS is selected to estimate the above model. To ensure that these parameter estimates are robust to other estimation techniques, we also make use of OLS and 3SLS methods, which provide similar results. The approximate standard errors of the 2SLS estimates are slightly larger than those of the OLS and 3SLS estimates. However, the root mean squared error (RMSE) of the 2SLS-based forecasts are smaller than those of 3SLS-based forecasts, when forecasting over a horizon of four quarters.

In order to check the suitability of the 2SLS estimation results, we also consider the residual-correlation matrices, which are shown in Table 2. To test for the significance of non-zero correlation between these residuals, we calculate the Breusch-Pagan LM test statistics and compare them to the Chi-square critical values. We find 5 correlation coefficients that are statistically significant (bold in table 2). The existence of negative statistically significant correlations is mainly due to the quality of

the data and possibility that there may be a number of omitted variables. The omitted variables that are not captured in our model may include foreign direct investment, bank lending, third market competition, etc. In addition, the negative residual correlation between the US and Japan in Table 2 could be explained by their competition for exports in a third market. Moreover, an undesirable appreciation of the dollar will make the goods in the US more expensive, thus leading to less exports, while Japan's exports would increase due to their relative decrease in price.

Table 2: Residual Correlations from 2SLS Regressions, Sample period:1996-2017

	SA	US	CHINA	INDIA	JAPAN	BRAZIL	EU
SA	1.0000						
US	-0.2151	1.0000					
CHINA	0.2372	-0.4763	1.0000				
INDIA	0.1277	-0.4072	0.0228	1.0000			
JAPAN	0.1815	-0.3113	-0.1764	0.9381	1.0000		
BRAZIL	0.2792	-0.0212	0.2008	-0.1721	-0.1286	1.0000	
EU	0.0740	-0.1355	-0.1144	-0.2176	-0.0172	0.0087	1.0000

Note: Bold indicates significance at the 5% level.

This model has made an assumption that the (α_i) parameter should be time invariant, so that the model can be used for our further analysis. In this case, α_i measures the change in domestic output growth given a change in the aggregate external demand for exports, which is assumed to be constant. The expression of α_i is written:

$$\alpha_i = \sum_0^p \beta_{ji} / (1 - \sum_{j=i}^p \beta \phi_{ji}) \quad j \neq i \quad (9)$$

To check that this coefficient is indeed constant, we estimate the model using the sample period from 1996Q1 to 2010Q4 and repeat the estimation by extending the sample period to 2016Q4 and examine the recursively estimated coefficients to see if they converge on a constant value. As shown in Table 3, the coefficients for this coefficient are more or less the constant over this period.

Table 3: Recursive Estimates of Alpha Coefficients (based on 2SLS estimates)

	SA	US	CHINA	INDIA	JAPAN	BRAZIL	EU
1996-2010	0.92	0.33	0.36	0.98	1.10	0.37	1.33
1996-2011	0.90	0.22	0.37	0.98	1.14	0.29	1.39
1996-2012	0.91	0.21	0.42	0.98	1.19	0.32	1.42
1996-2013	0.92	0.26	0.43	0.99	1.20	0.33	1.42
1996-2014	0.86	0.35	0.40	0.97	1.19	0.20	1.46
1996-2015	0.80	0.35	0.45	1.03	1.20	0.25	1.45
1996-2016	0.78	0.36	0.47	1.03	1.17	0.29	1.41

6. Empirical Results

In this section, we discuss the parameter estimates and interpret the IRFs for both South Africa and Brazil. Thereafter, to show the global effects of a shock from one specific country, and to understand the dynamic form of the international transmission mechanism, we also estimate the cumulative impulse responses that demonstrate the magnitude of the output multiplier effects. Lastly, we take a closer look at the variation of economic interdependency among the IBSA countries over time.

6.1. South Africa and Brazil

To understand how the change of direct bilateral-trade linkages influence the cross-border shock transmission over time, we estimate the parameters of the model for the period 1996 - 2017 to generate the IRFs, using two different trade weight matrices. This allows for a comparison for how the different trade weight matrices may have influenced the results for the dates (i) 2000Q4 and (ii) 2015Q4. Figure A.1 in the appendix contains the IRFs for South Africa and Brazil that are used to describe the effect of a shock of one standard-deviation to economic output that arose in each of the sample economies, when using two different selected trade weight matrices. These figures demonstrate that in both cases, the effect of the shocks over twenty subsequent quarters is somewhat different when we change the trade weights.

With the fixed trade weight matrix of 2000, Figure A.1(a) shows that South Africa's response to a one-standard deviation shock in the US or EU is relatively large, and of similar magnitude, while the effect of a shock in Japan is relatively small. Similarly, the response to the shocks that originate in China, Brazil, and India are also small when using this trade weight matrix. It is also worth noting that the effects of the shocks in the EU and US decline at a fairly constant rate and are relatively persistent as they continue to effect South Africa after 20 quarters, while the effect of the shocks from

China, Brazil and India are no longer present after 20 quarters. When using the 2015 trade weight matrix, the response to shocks that emanate from the US and EU are still relatively large, but their magnitude is much smaller than in the previous case. Moreover, the response to shocks that arose in China has increased in a significant manner, while responses to India and Brazil have also increased slightly. Note also that the effect of shocks from China has become more dominant than those of Japan. In general, the impact of the shocks from the EU and US remain dominant, followed by those from China.

The impact of shocks on Brazil that originate from the EU, US and China are much larger, when compared to those of South Africa. This implies that Brazil is more sensitive to these external shocks. In this case, the effect of shocks from the EU and US are also responsible for the largest impact when using both the 2000 and 2015 trade weights. It is also worth noting that the response to a shock from the US is slightly greater than that of the EU during the first two quarters, which is not surprising given geographic location of Brazil. In addition, the response to a shock from China decline rapidly during the first two quarters, while the impact from shocks that emanate from the EU and US decrease steadily over 20 quarters. Then lastly, when comparing Brazil's response to shocks from China when using the trade weight matrices for 2000 and 2015, we note that the effect of these shocks has become more dominant during later periods of time, which is similar to the case of South Africa.

In general, Figure A.1 confirms the significance of direct bilateral-trade linkages in the transmission of shocks. Both South Africa and Brazil have become more sensitive to the shocks that originate in China. In addition, they are also more susceptible to the shocks that emanate from India, while Brazil is slightly more sensitive to shocks from South Africa.

6.2. Changes of transmission mechanism

In this section, we mainly want to explore the effect of indirect trade linkages with the aid of the cumulative IRFs. Table 3 displays the output multipliers for shocks from the five large economies of the US, China, India, Japan and EU on South Africa and Brazil during the period 1996 - 2017. These output multipliers are estimated from the accumulated influence of positive shocks of one standard-deviation. The rows in Table 4 illustrate the effect of these external shocks from the countries given in the columns, measured in terms of a change in the output growth of South Africa and Brazil. Two different trade weight matrices W-2000Q4 to W-2015Q4 are taken into consideration for the analysis of accumulated impulse responses so that the time-varying property of trade patterns can be captured.

Table 3 shows that the transmission for the respective shocks has changed over the sample period. First, the impact of output shocks arising in the US on South Africa and Brazil has decreased from 1996 to 2017, where South Africa's accumulative response to a one-standard deviation positive

output shock in the US has shrunk from 0.987 to 0.874. Further, both small economies' accumulative response to EU and Japan have also experienced a declination.

Table 4: Accumulated impact of five large economies on South Africa and Brazil

	US		CHINA		INDIA		JAPAN		EU	
	W2000	W2015	W2000	W2015	W2000	W2015	W2000	W2015	W2000	W2015
SA	0.987	0.874	0.048	0.421	0.048	0.109	0.225	0.189	1.014	0.896
BRAZIL	1.986	1.600	0.189	0.744	0.070	0.153	0.394	0.287	1.782	1.600

Note: Row indicate the responses of economies to shocks that originate in the five large economies given in the columns.

In contrast, the average impact of an output expansion of one-standard deviation in India on South Africa and Brazil has increased from 0.06 to 0.131, showing the growing importance of India for the other emerging economies. However, the impact of India is still very small when compared to other major economies. Moreover, we can see that China has substantially increased its cumulative average impact on South Africa and Brazil from 0.12 to 0.58 (i.e. by 5 times). This fact confirms the emergence of China as a major international driver for growth in these emerging economies. By looking at the cumulative responses of Brazil and South Africa, one can note that Brazil's accumulative responses to all the five economies are larger than those of South Africa over the sample period, which would imply that Brazil is more vulnerable to negative external shocks.

Table 5 and 6 demonstrate the differences that may arise as a result of changes due to indirect trade linkages, where Table 5 shows the results for the normalized output multipliers, while table 6 reports on the export shares. The normalized output multipliers are calculated by setting the countries' own effect equal to 1. They show the response of economies to positive output growth shocks of 1% that originate in the sample economies with the fixed 2015Q4 trade weight matrix. By comparing these two tables, we find that trading partners that have less export shares could have a greater impact on the output growth of the exporting country. For example, when comparing the South African export shares in 2015Q4, as shown in Table 6 we note that the share for China is larger than the US ($0.225 > 0.157$), but the shocks from the US are responsible for a larger impact on South Africa ($0.357 > 0.274$), as shown in Table 5. Similar results are provided for Brazil. Moreover, the impact from India on Brazil is greater than the impact on South Africa, but India's export shares to both countries are roughly equal. Likewise, the export shares from the US to the EU are much larger than that of China (more than twice as large), but the response of the US to shocks from these countries are more or less the same (0.355 and 0.358).

All these outcomes show that despite the weak direct linkages between the two countries, a shock to one of the countries can have a substantial influence on the other via an indirect multiplier effect,

which confirms the significance of indirect linkages in the propagation of shocks from one country to another. Hence, the need to consider the effects of both indirect multipliers and direct trade linkages when seeking to describe the transmission mechanism for international shocks.

Table 5: Normalized output-multipliers with 2015Q4 W-Matrix, Sample period: 1996 - 2017

	SA	US	CHINA	INDIA	JAPAN	BRAZIL	EU
SA	1	0.357	0.274	0.089	0.134	0.067	0.250
US	0.054	1	0.355	0.100	0.175	0.123	0.358
CHINA	0.09	0.842	1	0.160	0.276	0.169	0.540
INDIA	0.203	1.511	0.8997	1	0.433	0.329	1.030
JAPAN	0.151	1.479	1.020	0.253	1	0.277	0.892
BRAZIL	0.072	0.653	0.484	0.126	0.203	1	0.450
EU	0.124	1.070	0.676	0.200	0.320	0.223	1

Note: Rows indicate the responses of economies to 1% positive output growth shocks that originate in the given economies listed in the columns.

Table 6: Export shares at 2015Q4.

	SA	US	CHINA	INDIA	JAPAN	BRAZIL	EU
SA	1.000	0.157	0.225	0.079	0.113	0.016	0.410
US	0.012	1.000	0.228	0.042	0.125	0.078	0.515
CHINA	0.017	0.391	1.000	0.053	.0149	0.034	0.356
INDIA	0.042	0.336	0.106	1.000	0.050	0.045	0.420
JAPAN	0.012	0.385	0.360	0.029	1.000	0.015	0.206
BRAZIL	0.013	0.211	0.338	0.034	0.055	1.000	0.350
EU	0.039	0.506	0.249	0.059	0.087	0.061	1.000

Note: Rows indicate the 12-Quarter moving average of export shares from countries to its trading partners given in the columns.

6.3. Output growth Co-movements among South Africa, Brazil and India.

This section seeks to describe the evolution of economic interdependency among the IBSA countries over the sample period. Table 6 shows that these countries have a very limited impact on each other. However, the output growth co-movements amongst IBSA countries has increased over time. Moreover, with the participation of South Africa in the BRICS group of nations, their economic co-movements could potentially increase with the passage of additional time.

As can be seen in Table 7 the multiplier effect of South Africa on the output of Brazil and India has gradually increased from 1996 to 2017. This is the same for Brazil and India, indicating growing economic co-movements. In addition, Brazil and India are now more integrated with each other, seeing as they have a greater joint multiplier effect than with South Africa. Lastly, we note that South Africa's response to output shocks from both Brazil and India are roughly equal.

Table 7: Output co-movements

	SA		BRAZIL		INDIA	
	W2000	W2015	W2000	W2015	W2000	W2015
SA	1.809	1.822	0.080	0.108	0.048	0.109
BRAZIL	0.107	0.132	1.555	1.601	0.070	0.153
INDIA	0.276	0.370	0.369	0.527	1.069	1.213

Note: Rows indicate the responses of the IBSA countries to shocks that originate in other group members listed in the columns.

7. Conclusion

This paper considers the vulnerability of South Africa to shocks that originate in its major trading partners with the aid of a SVAR model that utilizes the identification strategy of Abeyasinghe and Forbes (2005:372). This allows for an investigation into the impact of shocks emanating from the EU, US, China, Japan, India and Brazil on South Africa's output growth through both direct and indirect trade linkages over the period 1996 to 2017. After estimating the model parameters, the impulse response and accumulative response functions are generated to identify potential changes in the transmission mechanism. The results suggest that South Africa is now more exposed to the shocks of the dominant emerging economies, where its vulnerability to shocks that emanate from China has increased substantially. This would also suggest that China is now potentially a major source of growth in South Africa. However, despite this change that has arisen over time, the propagation of shocks that originate in the US and EU continue to have a relatively dominant on South Africa despite the decline in their impact on the other sample economies. Furthermore, South Africa has also increased its economic interdependence with Brazil and India over time due to their tighter trade cooperation.

This paper also confirms that changing trade patterns can influence the transmission of international shocks and provides evidence to support the significance of both direct and indirect trade links in transmitting output shocks.

However, it should be noted that there are a number of limitations in this paper. First, the model assumes a seven-country world. More countries that are trading frequently with South Africa could be included in the model to hopefully reduce some of the standard errors of the parameter estimates. Second, the model examines the impact of shocks only through the analysis of direct and indirect trade linkages, while there are a number of other channels for the transmission of shocks. For example, shocks could be transmitted through financial markets or investment networks. Such a topic could be the subject for future research.

8. References

- Abeysinghe, T. and Forbes, K. 2005. Trade Linkages and Output-Multiplier Effects: a Structural VAR Approach with a Focus on Asia. *Review of International Economics*. 13(2):356-375.
- Anastasiou, A. and Zervoyianni, A. 2009. Convergence of shocks and trade in the enlarged European Union. *The Journal of International Trade and Economic Development*. 18(1):79-114.
- Berkmen, S.P., Gelos, R.G., Rennhack, R. and Walsh, J.P. 2012. The global financial crisis: Explaining cross-country differences in the output impact. *Journal of International Money and Finance*. 31(1):42-59.
- Bezuidenhout, H. and Claassen, C. 2013. South African trade hegemony: Is the South Africa–EU Trade, Development and Cooperation Agreement heading for a BRICS wall?. *South African Journal of International Affairs*. 20(2):227-246.
- Blanchard, O., Das, M. and Faruqee, H. (2010). The Initial Impact of the Crisis on Emerging Market Countries. *Brookings Papers on Economic Activity*. (1):263-307.
- Çakır, M.Y. and Kabundi, A. 2013. Business cycle co-movements between South Africa and the BRIC countries. *Applied Economics*. 45(33):4698-4718.
- Calderon, C., Chong, A. and Stein, E. 2007. Trade intensity and business cycle synchronization: Are developing countries any different?. *Journal of International Economics*. 71(1):2-21.
- Canova, F. and Dellas, H. 1993. Trade interdependence and the international business cycle. *Journal of International Economics*. 34(1-2):23-47.
- Cheewatrakoolpong, K. and Manprasert, S. 2012. *Trade concentration and crisis spillover: Case study*. Bangkok: ARTNeT. Available: <https://www.econstor.eu/bitstream/10419/64307/1/689057229.pdf> [2019 , February 10].
- Cheewatrakoolpong, K. and Manprasert, S. 2014. Trade Linkages and Crisis Spillovers. *Asian Economic Papers*. 13(1):84-103.
- Cheewatrakoolpong, K. and Manprasert, S. 2015. Trade Diversification and Crisis Transmission: A Case Study of Thailand. *Asian Economic Journal*. 29(4):385-408.
- Claessens, S. and Forbes, K. 2001. *International Financial Contagion*. New York: Springer.
- Claessens, S., Dornbusch, R. and Park, Y. 2001. *International financial contagion*. New York: Springer.

- De Waal, A. and van Eyden, R. 2016. The Impact of Economic Shocks in the Rest of the World on South Africa: Evidence from a Global VAR. *Emerging Markets Finance and Trade*. 52(3):557-573.
- Di Giovanni, J. and Levchenko, A. 2012. Country Size, International Trade, and Aggregate Fluctuations in Granular Economies. *Journal of Political Economy*. 120(6):1083-1132.
- Dungey, M., Khan, F. and Raghavan, M. 2018. International trade and the transmission of shocks: The case of ASEAN-4 and NIE-4 economies. *Economic Modelling*. 72:109-121.
- Feldkircher, M. (2014). The determinants of vulnerability to the global financial crisis 2008 to 2009: Credit growth and other sources of risk. *Journal of International Money and Finance*. 43:19-49.
- Fidrmuc, J. (2004). Migration and regional adjustment to asymmetric shocks in transition economies. *Journal of Comparative Economics*. 32(2):230-247.
- Financial Time (2017). *Brexit triggers a great car parts race for UK auto industry: EU exit will damage competitiveness if carmakers cannot source more components at home*. Peter Campbell and Michael Pooler. 30 July 2017 [<https://www.ft.com/content/b56d0936-6ae0-11e7-bfeb-33fe0c5b7eaa>].
- Forbes, K. 2001. Are Trade Linkages Important Determinants of Country Vulnerability to Crises?. Chicago: University of Chicago Press.
- Forbes, K. 2004. The Asian Flu and Russian Virus: Firm-level Evidence on How Crises are Transmitted Internationally. *Journal of International Economics*. 63(1):59-92.
- Frankel, J. and Rose, A. 1998. The Endogeneity of the Optimum Currency Area Criteria. *The Economic Journal*. 108(449):1009-1025.
- Glick, R. and Rose, A. 1999. Contagion and trade: Why are currency crises regional?. *Journal of International Money and Finance*. 18(4):603-617.
- Goldstein, M. 1998. *The Asian financial crisis*. Washington: Peterson Institute for International Economics.
- Gruben, W.C. and Koo, J. 2006. *Monetary Integration and Dollarization*. North Hampton: Edward Elgar Publishing.
- Harrigan, J. (2000). The Impact of the Asia Crisis on U.S. Industry: An Almost-Free Lunch?. *Economic Policy Review*. 6(3):71-81.
- Huffman, W. and Lothian, J. 1984. *Retrospective on the Classical Gold Standard, 1821-1931*. Chicago: University of Chicago Press.

- Lee, M.C. 2002. The European Union - South Africa Free Trade Agreement: In Whose Interest?. *Journal of Contemporary African Studies*. 20(1):81-106.
- Rana, P.B. (2008). Trade Intensity and Business Cycle Synchronization: The Case of East Asian Countries. *The Singapore Economic Review*. 53(2):279-292.
- Rolfe, R. and Woodward, D. 2005. African Apparel Exports, AGOA, and the Trade Preference Illusion. *Global Economy Journal*. 5(3).
- Rose, A.K. and Spiegel, M.M. 2011. Cross-country causes and consequences of the crisis: An update. *European Economic Review*. 55(3):309-324.
- Saldarriaga, M.A. and Winkelried, D. 2013. Trade linkages and growth in Latin America: An SVAR analysis. *International Economics*. 135-136:13-28.
- Schmitt-Grohé, S. (1998). The international transmission of economic fluctuations: Effects of U.S. business cycles on the Canadian economy. *Journal of International Economics*. 44(2):257-287.
- Selover, D.D. (2004). International co-movements and business cycle transmission between Korea and Japan. *Journal of the Japanese and International Economies*. 18(1):57-83.
- Shin, K. and Wang, Y. 2004. Trade integration and business cycle co-movements: the case of Korea with other Asian countries. *Japan and the World Economy*. 16(2):213-230.
- Shin, K. and Wang, Y. 2004. Trade integration and business cycle co-movements: the case of Korea with other Asian countries. *Japan and the World Economy*. 16(2):213-230.
- Transmission of output shocks - the role of cross-border production chains. 2016. *ECB Economic Bulletin*. (2):1-14.

Appendix A

Table A1: Descriptive Statistics of the GDP Growth series

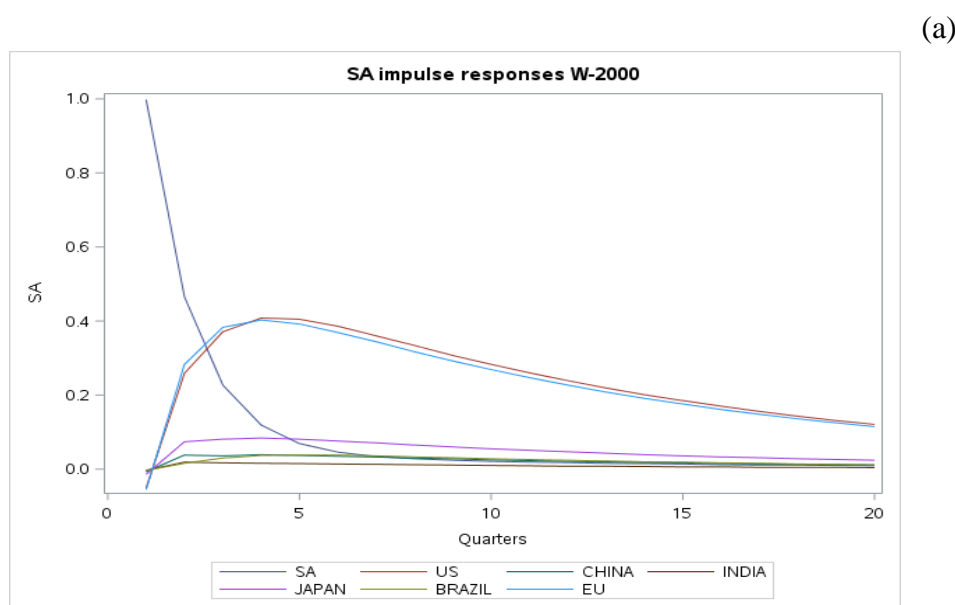
	SA	US	China	India	Japan	Brazil	EU
Mean	0.006937	0.006074	0.02157	0.016349	0.002125	0.05773	0.004451
Median	0.007391	0.006135	0.021247	0.016718	0.002602	0.007663	0.005478
Max	0.018355	0.024002	0.049326	0.045767	0.024938	0.038258	0.013193
Mini	-0.015668	-0.021876	-0.015590	-0.01951	-0.049129	-0.039604	-0.026848
Std.Dev	0.005904	0.006319	0.011715	0.0212650	0.010046	0.012091	0.005515
Obs.	88	88	88	88	88	88	88

Table A2: ADF test

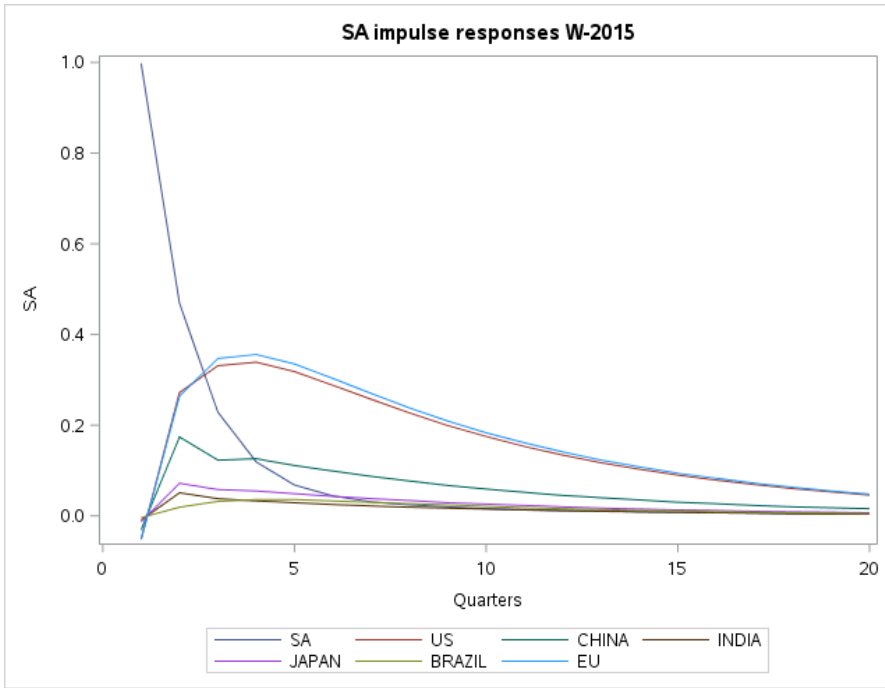
	H0	P-value	t-stat
SA	reject	0.0001	-4.893
US	reject	0.0000	-6.619
CHINA	reject	0.0001	-12.01
INDIA	reject	0.0000	-8.350
JAPAN	reject	0.0000	-8.350
BRAZIL	reject	0.0000	-6.975
EU	reject	0.0034	-3.869

Note: The null hypothesis of unit root has been rejected at 5% significance level for all the time series

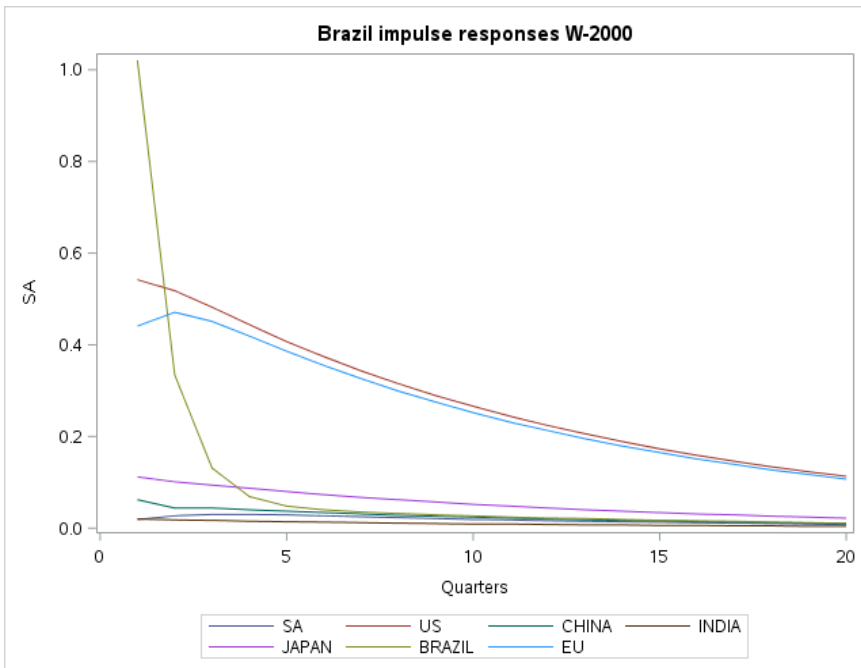
Figure A1



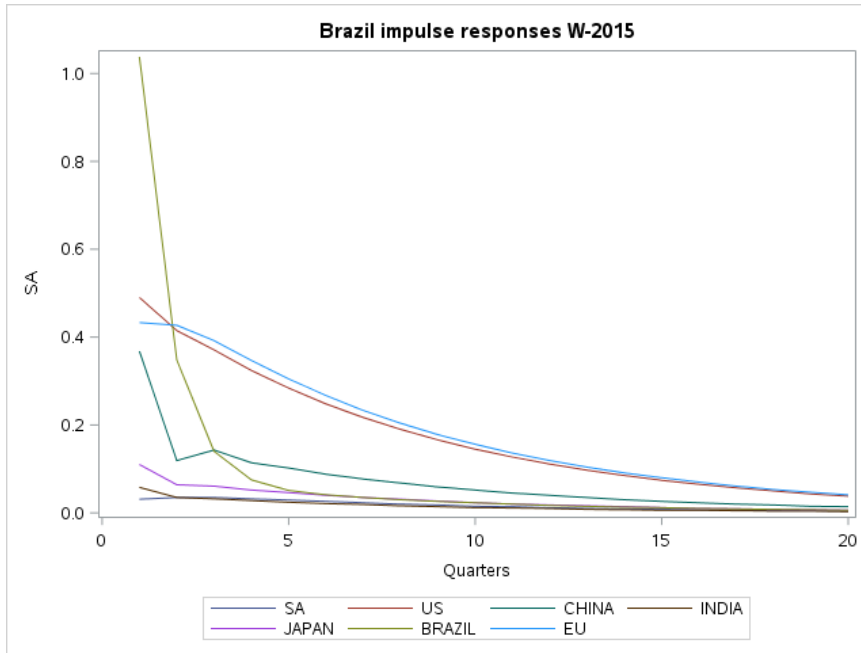
(b)



(c)



(d)



Note: Figure A1 (a) and (b) show the responses of the output growth of South Africa, whilst (c) and (d) show the responses of the output growth of Brazil.