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BRIC Trade Agreement: A Catalyst for Economic growth in South Africa

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Abstract

This study aims to explore the impact of the BRIC trade agreement on economic growth in South Africa over the period from 2009Q1 to 2023Q4, taking into consideration the BRIC agreements on promotion of trade and investment, and enhancement of economic growth and sustainable development. The study uses South African time-series data to estimate a Bayesian Vector Autoregression (BVAR) model with hierarchical priors as it can deal with many problems in the data without exhausting degrees of freedom. It also handles dense parameterization by giving model coefficients a structure and making them as informative as possible. The results suggest that trade agreements have a positive impact on South Africa's economy. They indicate that economic growth can be positively influenced by a 1% unexpected increase in imports, exports, and foreign direct investment from the BRIC partner countries. These findings mean that trade deals with the BRIC nations and the promotion of investment can significantly contribute to South Africa's economic development. It has also been shown that SA's government spending enhances growth and sustainable development. The positive impact of the BRICS partners' imports, exports, and FDI on South African growth highlights the need for trade and investment integration. Policymakers should reduce trade barriers, enhance infrastructure, and improve the business environment to attract more FDI from the BRIC member countries. Strengthening trade agreements within BRICS can expand market access, boost industrial competitiveness, and increase technological transfer. Long-term strategies should create stable, open economies fostering innovation, employment, and sustainable growth.

Keywords
BRIC Trade Agreement, BVAR, economic growth, hierarchical priors, South Africa.

JEL: E24, H13, O10.

Introduction

South Africa (SA) is facing numerous critical issues, such as the high rate of unemployment, especially among young people, which cause economic instability. Income inequality has increased over the past few decades, despite attempts to reduce it. This has resulted in a significant wealth gap both within and between different racial and regional groups in the country and globally (United Nations, 2020). In addition, the country has experienced stagnation, marked by a slow recovery from periods of economic downturns and political instability. While its economy has grown since the end of apartheid, it has struggled to maintain steady and robust growth.

SA became a member of BRIC in 2009. The primary goals of joining the association were to stimulate employment, foster economic expansion, and improve its competitive position in the global market. Participation in international trade through export-led growth strategies enhanced by the country's BRICS membership and e-commerce was expected to help achieve these goals (Mazenda, 2016). The decision to join the BRIC grouping was supported by growth theories by Romer (1986) and Robert (1988); it was a strategic move that was to facilitate the country's access to advanced technologies, improve production efficiency, attract foreign investment and boost international trade. However, the data show that even after joining the BRICS group, South Africa still faces difficulty achieving consistent and robust growth.

The paper analyses the parameters of South African growth, inflation, and unemployment, and compares them with those of the BRIC countries in 1991-2005, before the establishment of BRICS, and then after the establishment of BRICS in 2006-2022. Between 2001 and 2005, the growth rate of South Africa averaged 4.42%, while that of Russia, India, and China was above 6%. The inflation rates varied: in Russia and Brazil they were high, whereas in the other countries they were low, ranging from 1% to 4%. On average, the unemployment rate in South Africa was between 22% and 23%, which was higher than in the other BRICS countries.

Table 1. Mean economic growth, inflation and unemployment of the BRICS member countries

	South Africa			Brazil			China			India			Russian Federation		
	EG	Infl	UNE	EG	Infl	UNE	EG	Infl	UNE	EG	Infl	UNE	EG	Infl	UNE
2001–2005	4,42	4,45	22,56	3,42	8,69	10,62	9,80	1,34	4,33	6,47	3,98	7,65	6,14	14,90	7,99
1996–2000	2,48	6,67	22,64	2,00	7,56	9,84	8,63	1,85	3,22	6,09	7,61	7,61	1,75	39,35	11,67
1991–1995	1,94	11,31	23,01	3,33	1090,80	6,74	12,27	13,11	2,67	5,10	10,49	7,69	–8,99	275,88	6,74

Note: EG, Infl and UNE stand for economic growth, inflation and unemployment rate, respectively. The data span the period from 1991 to 2005, before the establishment of BRICS. *Source:* Author's calculation based on World Bank data (2025)

Between 1991 and 2005, growth rates in South Africa, Brazil, India, and Russia were determined by market reforms, liberalization, and globalization. China, which began reforms in the 1970s, had slower growth in the early 2000s, due to global economic slowdowns, inefficiencies, and challenges in balancing industrialization with sustainable development. After the BRICS trade agreement, South Africa's economy again performed badly compared to BRIC. The data show that, since 2006, South Africa's highest growth has been on average below 3%, with an unemployment rate of 29.35%. Inflation, however, was comparatively low, ranging from 5% to 6%. During the same period inflation in Russia was very high.

Russia was seen to recor.

Table 2. Mean of economic growth, inflation and unemployment of the BRICS member countries

	South Africa			Brazil			China			India			Russian Federation		
	EG	Infl	UNE	EG	Infl	UNE	EG	Infl	UNE	EG	Infl	UNE	EG	Infl	UNE
2016–2022	0,62	5,04	29,35	1,68	5,77	12,10	5,73	1,99	4,63	5,18	4,91	6,92	1,13	4,02	4,92
2011–2015	1,66	5,44	24,79	–0,28	6,72	7,44	7,93	2,83	4,60	6,50	8,00	7,66	1,77	8,73	5,68
2006–2010	2,64	6,16	23,04	4,51	4,69	9,02	11,33	2,97	4,52	7,03	8,68	7,62	3,72	10,26	6,99

Note: EG, Infl and UNE stand for economic growth, inflation and unemployment rate, respectively. The data span from 2006 to 2022 after the establishment of the BRICS. *Source:* Author's calculation based on World Bank data (2025)

China, India, and Russia experienced economic growth ranging from 3% to 11% on average between 2006 and 2022. Since then, however, their growth has declined. Factors contributing to this decline include global economic slowdowns, falling commodity prices, structural issues, political instability, rising inflation, China's economic rebalancing, reduced consumer spending, and increased debt levels. This raises concerns about whether SA has been able to achieve its objectives since joining the BRIC grouping. What hinders the progress towards achieving these objectives, and why is South Africa's performance so poor in comparison with that of the other BRICS member countries?

This paper builds on several previous studies, such as that by Mazeda et al. (2018) who examined the implications of South Africa's trade alliance with BRICS and SADC for the South African economy using autoregressive modelling on quarterly data from 2005 to 2017. They revealed that the South Africa-BRIC trade has made a negative contribution to the South African economy, while the contribution of the South Africa-SADC trade was positive. This paper contributes to the existing literature by investigating the impact of the BRICS Trade Agreement on the South African economy. The novelty of this study lies in its investigation of whether the South African economy benefits from the BRICS trade agreement, with a focus on export and import trade, as well as Foreign Direct Investment (FDI). It differs from those that have been documented in the literature, as the analysis goes deeper by looking at the BRIC trade inflow and outflow of export and import share, and the FDI share from the BRIC member countries. The BRIC trade share refers to the exports or imports share

of the BRIC member countries to South Africa, and the FDI share is the FDI share of the BRIC member countries to South Africa. The study adopted the Bayesian Vector Autoregression (BVAR) with priors and Bayesian Generalized Method of Moments (BGMM) for the model robustness, covering the period 2009Q1–2023Q4. The BVAR uses hierarchical priors to address two measurable defects: uncertain data quality and frequent short observations. This allows for prior selection, which adjusts for these flaws. Bayesian approaches also improve the accuracy of the impulse response function. Banbura et al. (2010) pointed out that Bayesian Vector Autoregression (BVAR) was beneficial for large dynamic models due to its credibility, structure analysis, dynamic relationship, uncertainty accounting and flexibility. The GMM was capable of effectively handling endogeneity problems using instruments and did not require strong assumptions about error term distributions (non-parametrically). This study seeks to use the BVAR model to test the following hypotheses: (i) The BRIC trade agreement has no positive impact on the South African economy, (ii) the BRIC export share makes no contribution to South African growth, (iii) the BRIC import share has a negative impact on South African growth, (iv) the BRIC FDI share has no significant impact on the South African economy, and (v) the exchange rate is more beneficial to South African growth.

The paper is organized as follows: an overview of the literature on the subject is presented in section 2. Section 3 provides a description of the BVAR model used in this study, while sections 4 and 5 detail the results, conclusions, and policy recommendations.

Empirical literature on the impact of trade and economic growth

Theoretical literature

The concept of trade as a driver of growth has been debated for centuries, with the first consistent theories developed by the classical school of thought emerging in the late 18th century. Smith (1776) and Ricardo (1817) laid the foundation for modern economic theory with their ideas about comparative advantage. In their view, countries benefit from specializing in goods based on their comparative and absolute advantages. This leads to efficiency and mutual benefits through free trade, which enhances resource allocation and promotes economic growth. Nations can then focus on their strengths, allowing them to achieve greater success. Ricardo's theory of comparative advantage was the first to explain how trade could improve societal well-being and promote economic growth through specialization.

The argument from the classical school of thought was further developed by the neoclassical trade theory in the 20th century. Prominent scholars, including Samuelson (1948), extended the comparative advantage theory of Ricardo to incorporate factors such as capital and labour. Samuelson's theory integrates the

factors of production into the Ricardian model by suggesting that trade leads to more efficient allocation of resources and increased productivity. Hecksher and Ohlin refined the Ricardo model of comparative advantage by considering differences in labor, capital, and natural resources between countries. This became known as the Heckscher-Ohlin model. According to this model, countries export goods using their abundant factors of production extensively, and this results in greater efficiency and economic growth. Neoclassical theory posits that international trade promotes competition and specialization, leading to technological innovation and increased economic growth.

Recent studies from the 1980s and 1990s introduced a new dimension to trade theories, as documented by scholars such as Romer (1990) and Roberts (1988). Their Endogenous Theory emphasizes that economic growth is driven not only by resource allocation but also by knowledge spillovers and technological innovation. They further argued that countries, which produced trade benefits from diffusion of new technology, experienced enhanced productivity, leading to sustained economic growth. These models suggest that trade promotes technological innovation and increased returns to scale, creating a direct link between trade and long-term economic development.

The scholars Bhagwati (1988) and Irwin (1996) emphasize the importance of trade liberalization. They show that trade liberalization promotes specialization, enhances productivity, and encourages more investment, resulting in higher national income, increased exports, and faster economic growth.

Empirical literature

Studies on the mixture of economics

The impact of trade on economic growth has been a subject of great concern among scholars. However, conclusions regarding this impact are far from straightforward. Different results have been reported in the literature, as researchers use various proxies for exports to measure trade in their studies. Some studies use exports and imports (Malefane & Odhiambo, 2017, Dhea et al. 2023, Ningsih and Harningtias, 2022, Adinda et. al., 2021, Event and Jordaa, 2004); others favor trade openness. Even among import-export research, conflicting results have been reported, with some documenting a positive correlation (Malefan and Odhiamba, 2016) and others negative (Ningsih & Harningtias, 2023).

Back in 2007, an empirical study by Awokusa into the causal relationship between exports, imports, and economic growth in transition countries showed that trade stimulated economic growth of their economies. Eleven years later, in 2017, Malefane and Odhiambo took the argument further, focusing on South Africa's economy. They documented that South Africa had been economically transformed from an inwardly-oriented import-substitution trade regime to an open, export-driven trade regime.

The study by Malefane (2018) found that trade openness had a positive impact on the economic growth of South Africa and Botswana but had no significant impact in Lesotho. The findings of Malefane and Odhiambo (2017) and Awokuse (2007) are supported by a study conducted by Adinda et al. (2023) in Batam, Indonesia, using a quantitative approach. A study by Ningish and Harningtis (2023) presents a different finding. Their research indicates that while exports play a positive role in Indonesia's economic growth, imports do not contribute significantly and even have a negative effect. This conclusion contradicts the conventional belief that both exports and imports are crucial for economic expansion. Dhea et al. conducted a similar study in 2023 on the Indonesian economy. Their findings showed that in the short term, exports and imports had little effect on economic growth. However, over the long term, their influence became substantial and statistically significant..

Event and Jordaan (2024) applied the Toda-Yamamoto augmented Granger non-causality approach to different countries. The study revealed a mixed causality relationship between exports, imports, and GDP per capita in Botswana, Eswatini, Namibia, Lesotho, and South Africa. The export-led growth hypothesis was supported in Botswana, while the import-led hypothesis was confirmed in Namibia. Growth-led exports were found to apply to Lesotho and South Africa.

Studies focusing on BRICS countries

Papers exploring the impact of the BRICS organization on its member countries have produced different findings. Ncube and Cheteni (2015), Dingela and Ncwadi (2022), and Sithole and Hlongwane (2023) found that the BRICS membership was beneficial for these countries. Other studies, however, suggest that it may have a negative impact on its members (Mazeda et al., 2018; Maphaka, 2020; Mazenda & Masiya, 2021).

The study conducted by Ncube and Cheteni (2015) examines the impact of the BRICS alliance on South Africa's economic growth using the vector error correction model (VECM) approach for the period from 1980 to 2012. The findings of this study suggest that international trade significantly contributed to high rates of economic growth in the BRICS countries over recent decades. However, a study by Mazenda in 2016, which used an ARDL model to analyse data from 1990-2014 found that the effect was insignificant, and therefore could not explain a long-term relationship between South African trade, foreign direct investment and growth. Mbangata and Kanayo (2017) conducted a study on the significance of BRICS as an institution after ten years of its existence, using an interdisciplinary approach. Their study found that the BRICS countries suffered from both internal and domestic problems. Later, Mazenda et al. (2018) investigated the implications of South Africa-BRIC-SADC's trade alliances for South Africa, using the autoregressive redistributive modelling on quarterly data from 2005 to 2017. The findings contradict those obtained by Ncube and Cheteni (2015), who documented that South Africa-BRIC trade had a negative impact on the South African economy, whereas South Africa-SADC trade had a positive impact on South

Africa's economy. Similar findings regarding the impact of BRICS on South Africa were reported by Maphaka (2020). The study investigated whether BRICS supported or undermined South Africa's attempts to move away from the periphery of global politics and economics, using an Afrocentric qualitative research approach. The results suggest that South Africa does not derive advantages from BRICS in a mutually beneficial way.

Dingela and Ncwadi (2022) examined the behaviour of the South African economy towards inflows of foreign direct investment (FDI) from the BRIC member countries using the fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) techniques. The findings are that the FDI from BRIC is beneficial to the South African economy. Similar findings were obtained by Gopano (2023), who examined the regional economic integration on stock market linkages in the BRICS economic bloc. The study used BERK-MGARCH and panel data models to analyse South Africa's total trade, BRICS existence, BRICS experience, and average distance. The results show that bilateral trade, as a proxy for economic integration, increases stock market integration, especially during surplus trade episodes. This positive relationship began three years after the formation of BRICS and continues to grow. Sithole and Hlongwane (2023) adopted the PMG estimator and Granger causality model, focusing on the financial mechanisms and project portfolio impacting the BRICS member countries. The results reveal a positive, bidirectional, statistically significant relationship between broad money and economic growth in BRICS. A different approach was used by Malik and Sah (2024), who studied the relationship between foreign direct investment (FDI) and economic growth in the BRICS countries from 1990 to 2020. They used panel threshold autoregressive and panel smooth transition autoregressive models to measure trade openness and inflation rate. The findings showed that trade, domestic investment, and human capital positively influenced economic growth above the estimated thresholds, indicating that attracting FDI is crucial for improving growth.

Methodology and data adopted in this study

Justification of variables

The question of whether the establishment of BRICS is beneficial for its member countries has been the subject of debate. However, in the existing literature, the effects are still unclear, since studies reveal conflicting results regarding the impact of the BRICS trade agreement on the member countries of the group. Studies use such variables as exports, imports, openness to trade, and foreign direct investments as proxies for trading. Unlike what has been done in the literature, this study uses the BRIC import share, the BRIC export share and the net inflow of foreign direct investment (as a percentage of GDP) in South Africa to capture the impact of BRIC

trade on the South African economy. To achieve the objectives of the study, the researchers adopted the BVAR model using prior information, following the work of Malla and Pathranarakul (2022). Variables that form the trade-growth mechanism are reported in Table 3. Three variables were used to capture intra-BRICS trade. The BRIC export share represents the proportion of South Africa's exports that go to the BRIC countries. The BRIC import share, on the other hand, refers to the percentage of South Africa's imports that come from these same countries. BRIC FDI (foreign direct investment) inflows indicate the investment made by the BRIC countries in South Africa. To strengthen the argument about trade and economic growth, the author takes into account monetary policy and fiscal policy. To support the trade-growth link in the model, the author includes variables such as house prices to reflect monetary policy and the central government's debt to represent the fiscal stance.

Table 3. Variables employed for hypothesis testing

Theoretical framework variables	
Variable(s) code	Description
Dependent variable	
Growth	GDP growth (annual %)
Dependent variable	
BRICimp	Import partner share (%) (BRIC)
BRICexp	Export partner share (%) (BRIC)
BRICFDI_Inflow	BRIC Foreign direct investment, net inflows (% of GDP)
Fiscal policy variable	
CGD	Central government debt, total (% of GDP)
Monetary policy variable	
BRM	Broad money (% of GDP)
Control variables in the model	
Emp	Employers, total (% of total employment) (modeled ILO estimate)
REEXC	Real effective exchange rate index (2010 = 100)
Infl	Inflation, consumer prices (annual %)

The rationale behind using the housing market prices is that monetary policy affects interest rates, which in turn influence mortgage rates and subsequently trigger housing demand and price dynamics. This would obviously affect household wealth, leading to reductions in investment and consumption, i.e. the main channels through which the benefits of trade can be amplified or shocks can be magnified. Central government debt reflects fiscal space available for responding to trade

opportunities arising from the BRICS agreement. The potential economic benefits of the agreement may be hindered due to high debt levels, which could constrain public investment. A direct influence on exchange rates, interest rates, and macroeconomic stability is witnessed for both monetary and fiscal policy, which are believed to trigger the trade flows. The model is designed to accurately analyse the impact of the BRIC trade agreement on economic growth by capturing these policy interventions and preventing confounding effects caused by policy-driven macroeconomic fluctuations. The study further controls for Employers, total (% of total employment) (modelled ILO estimate), Real effective exchange rate index (2010 = 100), Inflation, and consumer prices (annual %). Controlling for these factors is essential because they influence economic stability and competitiveness. Employers' share reflects labour market dynamics; the real exchange rate has an impact on export competitiveness and import costs; inflation affects purchasing power and price stability, which in turn influence trade balances. Accounting for these factors ensures a more accurate understanding of trade flows, economic performance, and external competitiveness in global markets. The selection of variables was guided by theoretical underpinnings and empirical research that substantiated the relationships under study.

Model specification

To achieve the objective of this research, the author adopted the VAR model, incorporated with the Bayesian econometrics, known as the BVAR model. Let us consider the following VAR(p) model:

$$y_t = \alpha_0 + A_1 y_{t-1} + \ldots + A_p y_{t-p} + \in_t \text{ with } \epsilon_t \sim N(0,\Sigma) \quad (1)$$

where Y_t denotes the endogenous variable which is 7×1, while the vector constant is α_0. The matrix coefficient is denoted by A_p which is 7×7, and the vector of endogenous shocks is ϵ_t or a 7×1. In the model, $7 \times 7_p^2$ is the number of coefficients to be estimated, which rises drastically with the number of included variables and/or lags. The curse of dimensionality — a problem in frequentist estimation — can be overcome by incorporating prior beliefs about model parameters in a Bayesian framework. This allows for the use of larger models, which can lead to improved prediction accuracy. (Bańbura et al., 2010).

Prior specification

Giannone et al. (2015) proposed setting prior parameters based on data, treating them as additional parameters. They integrate the marginal likelihood (ML) of the model and use it as a decision criterion for exploring parameter space. Their approach demonstrates accuracy in estimating impulse response functions and outperforms

standard VAR models, while performing similarly to factor models. It has been widely adopted. The researchers consider the prior distributions of commonly used Gaussian-inverse-Wishart families:

$$\beta \,|\, \Sigma \sim \varkappa\left(b, \Sigma \otimes \Omega\right) \tag{2}$$

$$\Sigma \sim IW\left(\Psi, d\right) \tag{3}$$

where b, Ω, Ψ and d are functions of a lower-dimensional vector of hyperparameters γ. The ML of a model can be efficiently computed in closed form as a function of γ due to the conjugacy of Equations 1 and 2, considering three specific priors: Minnesota (Litterman), sum-of-coefficients, and single-unit-root (Giannone et al. 2015). The Minnesota prior, a parsimonious specification that assumes random walk processes (Litterman, 1980), is effective for macroeconomic time-series forecasting (Kilian and Lütkepohl, 2017), and serves as a benchmark for evaluating accuracy.

It is characterized by the following:

$$\begin{aligned} \mathrm{E}\left[\left(A_s\right) \dot{i}_j\right] \left\| \Sigma \right| &= \begin{cases} 1, \; if \;\; i = j, s = 1 \\ 0, \text{ otherwise} \end{cases}, \;\; \mathrm{cov}(\left(A_s\right)_{ij}, \\ \left(A_r\right) \dot{k}_l \left| \Sigma \right. &= \begin{cases} \dfrac{\lambda^2}{K^2}, \;\; if \, l = j \text{ and } r = s \\ \vartheta \dfrac{\lambda^2}{K^2} \dfrac{\sigma^2_j}{\sigma^2_j}, \text{ otherwise} \end{cases}, \end{aligned} \tag{4}$$

The parameter λ controls the tightness of the prior, weighing the relative importance of the prior and data. As $\lambda \to 0$, the prior is imposed exactly, while as $\lambda \to \infty$, posterior estimates approach OLS estimates. A controls the punishment of distant observations, and Ψ controls the prior's standard deviation on other variables' lags. The Minnesota prior is refined as additional priors to reduce the deterministic component of VAR models based on initial observations (Giannone et al. 2015). The sum-of-coefficients (SOC) prior (Doan et al., 1984), implemented via Theil mixed estimation, imposes the notion that a no-change forecast is optimal at the beginning of a time series.

$$\underset{M \times M}{Y^+} = \mathrm{diag}\left(\frac{\overline{y}}{\mu}\right) + \underset{M \times (1+MP)}{x^+} = \left[0, y^+, \ldots, y^+\right] \tag{5}$$

where $\overline{y}$ is a M × 1 vector of averages over the first p observations of each variable, with the key parameter μ controlling variance and tightness. As $\mu \to \infty$, the model becomes uninformative, leading to the single-unit-root (SUR) prior (Sims & Zha 1998), allowing cointegration relationships in the data. The prior influences variables towards their unconditional mean or at least one unit root, with associated dummy observations:

$$\underset{1\times M}{Y^{++}} = \frac{\overline{y}}{\delta} + \underset{1\times(1+MP)}{x^{++}} = \left[\frac{\overline{y}}{\delta}, y^{++}, \ldots, y^{++}\right] \quad (6)$$

The key parameter δ governs the tightness of the SUR prior. The choice of prior parameters in a Bayesian model is conceptually identical to the inference on any other parameter (Doan et al. 1984; Banbura et al. 2010). Giannone et al. (2015) show that VAR models with conjugate priors can be treated as hierarchical, with the marginal likelihood of the data available in closed form. Estimating hyperparameters via maximization of the ML is an empirical Bayes method with clear frequentist interpretation.

Empirical analysis and interpretation results

The Bayesian VAR model will be used as the main model, and the Bayesian GMM will serve as a robustness check to examine the impact of the BRICS agreement on the South African economy over the period 2009Q1 — 2023Q4. Both the BVAR and BGMM are adopted because they offer advantages for studying the subject at hand, helping to incorporate prior knowledge, improve parameter estimates, and address endogeneity. The BVAR captures dynamic relationships and uncertainty, while the BGMM handles complex models, offering more reliable results for small sample sizes. This study transforms the data, following the function that has been adopted in the BVAR literature (Kuschnig & Vashold, 2019). As shown in the literature, the function deals with several transformations within the system. The ordering of variables in the VAR system is crucial, so machine learning uses a random forest algorithm to determine which variables are important. This means that the model should be specified as follows: growth, BRIC exp, BRIC imp, BRIFDII, REEXP, Infl, and CGD.

Data transformation and stationarity

When estimating both the BVAR and BGMM models it is necessary to check the rectangular numeric matrix to ensure that there are no missing values. The model we are using is a matrix, as explained in the methodology. All variables in this study have been expressed as rates, so it would be inappropriate to record the data as individual numbers. The data underwent the BVAR transformation process using code 2[1] for stationarity, following McCracken and Ng (2016) and Kuschning and Vashold (2019). The variables were tested for stationarity using the Augmented Dickey-Fuller test (ADF) and Phillips-Perron test (PP), crucial for accurate predictive models in economics, finance, and other fields. The results indicate that all the variables are non-

[1] Code 2 is used in the BVAR code to transform all variables into first differences in accordance with the results of the ADF and PP results of nonstationary.

stationary at levels and stationary after initial differencing. This is detailed in Appendix A. Given that the study used quarterly data, the length of the lag was restricted to six as a rule of thumb. Both the Schwarz Criterion and the Akaike Information Criterion were applied, leading to a lag of four based on the results from both criteria. The study spans from Q1 2009 to Q4 2023, yielding 60 observations. Lagging reduces this to 56, which leads to overfitting especially when the number of parameters is large relative to the number of observations. As proposed in the literature, the standard VAR models cannot handle short-term observations. To resolve this issue, the author uses a BVAR (Bayesian Vector Autoregression) model with a strong Minnesota shrinkage prior.

The prior setup and configuration

To handle missing data points and data of uncertain quality, the VAR econometric paradigm places a strong emphasis on prior setups. Conventional VARs lose degrees of freedom due to over-parameterization. In order to overcome these constraints, the BVAR model was used. The model is built up according to Kuschnig and Vashold's prior setting algorithm (Kuschnig & Vashold, 2019), which includes the hierarchical handling of the hyperparameters and arguments for the Minnesota and dummy-observation priors. After fitting the AR(p) models to each variable, the author may use Kuschnig and Vashold's prior setting function to set Ψ to the square root of the innovation variance. Three dummy observation priors are pre-constructed by adding a sum-of-coefficients prior to a single unit-root prior. Essential parameter hyperpriors are assigned gamma distributions similar to λ, and lower and upper limits are placed on the prior hyperparameter.

Estimation of the model and identification via sign restrictions

The BVAR model requires data preparation and transformation, with the order p as an argument, with initial iterations, burns, and draws set up. For this study the burns were set to 150000000, while the draws were set to 50000000 for model accuracy. The author set verbose true for a progress bar during the Markov chain Monte Carlo stage (Kuschnig & Vashold, 2019). Table 4 shows the posterior marginal likelihood results.

Table 4. Posterior marginal likelihood

Bayesian VAR: For the Export model	Bayesian VAR for the Import model
Optimisation concluded. Posterior marginal likelihood: -534.113 Hyperparameters: lambda = 0.1194 |==========| 100% Finished MCMC after 3.3 hours	Optimisation concluded. Posterior marginal likelihood: -503.675 Hyperparameters: lambda = 0.2342 |==========| 100% Finished MCMC after 3.5 hours.

Source: Author's calculation results based on data from WDI (2025)

The BVA function generates a BVAR class object, including hyperparameters, VCOV matrix, VAR coefficients, marginal likelihood values, prior settings, initial hyperparameter values, and established values. IRFs are calculated using suitable shocks, following algorithms by Rubio-Ramirez et al. (2010) or Arias et al. (2018) if no restrictions are imposed.

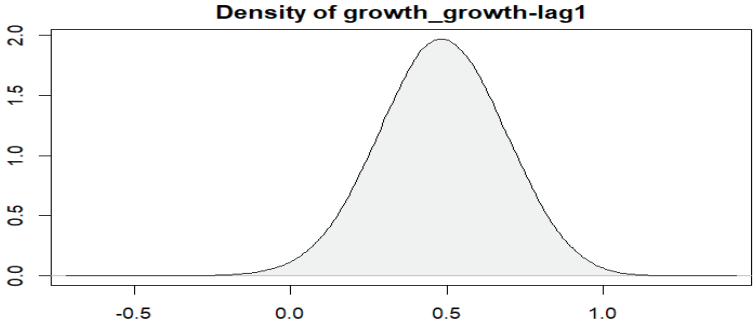

Figure 1. Density of growth plots of all hierarchically treated hyperparameters and the ml. *Source*: Author's calculation results based on data from WDI (2025)

The result of the convergence of Markov chain Monte Carlo in a BVAR model

This section provides an overview of the convergence of MCMC model estimation algorithms, which are essential for stability.

Table 5. Summary of the BVAR model

	Bayesian VAR consisting of 56 observations, 6 variables and 4 lags	
	Export model	Import model
Time spent calculating	3.3 hours	3.5 hours
HLHVP	0.1194	0.3432
Iterations (burnt / thinning):	150000000 (50000000 / 1)	150000000 (50000000 / 1)
Accepted draws (rate):	4149192 (0.515)	4843533 (0.675)

Note: HLHVP stands for Hyperparameters lambda Hyperparameter values after optimization. *Source:* Author's calculation results based on data from WDI (2025)

Table 5 provides a summary of the BVAR for export and import models, using arguments *var_impulse and var_response* for obtaining autoregressive coefficients.

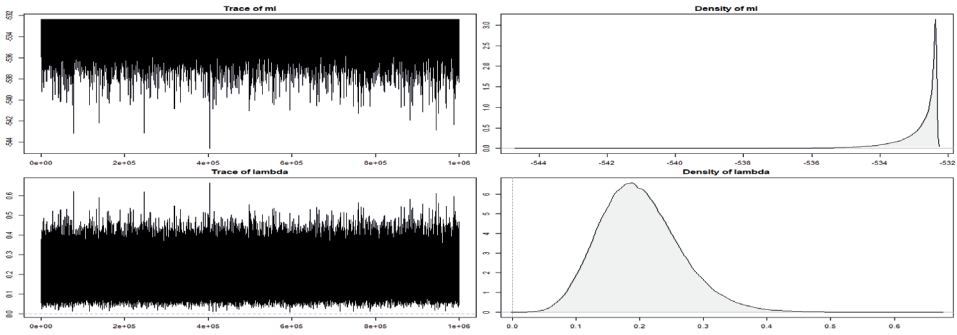

Figure 2. Trace and density plots of all hierarchically treated hyperparameters and the ml. *Source:* Author's calculation results based on data from WDI (2025)

The author chose a visualization technique for analysis, displaying trace[2], density[3], and hierarchical hyperparameter treatments. The results showed convergence in critical hyperparameters within the estimated BVAR model, and the MCMC chain effectively explored posterior distribution.

Impulse responses of the Bayesian VAR with no sign restrictions

The main aim of this study is to explore how the South African economy responded to the BRICS trade agreement covering the period from 2019Q1 to 2030Q4, using the BVAR (Bayesian Vector Autoregression) model. The study further seeks to use BGMM to quantify the impact of endogeneity in the model and control it. This investigation is crucial to understanding trade dynamics, investment flows and policy changes. It has the potential to enhance economic development, reduce inequality and promote regional integration. Figure 2 shows the impulse response functions (IRFs) from the BVAR model, using tighter hierarchical selection. The coefficients for the variables BRICexpi, BRICimp, BRICKFDII, REEXC, Infl, and EGD correspond to 16% and 84% credible sets of economic growth. Figures 3, 4, and 5 show the impact of BRIC exports, imports, and FDI on South Africa's economic growth. Figure 3 presents the combined effect of these variables on economic development without control variables. The BRIC index was used to determine how economic growth in South Africa responds to the share of exports from BRIC countries and foreign investment from these countries.

As anticipated, Figure 3 shows that BRIC exports significantly contribute to South Africa's economic growth. The maximum impact is 0.35 after a one-percent

[2] The trace plot, on the other hand, is a time series plot that displays the values of the hyperparameters as the MCMC chain progresses. It allows us to monitor how the chain traverses the parameter space.

[3] This Figure presents graphical representations of the density, trace, and hierarchical treatment of hyperparameters. The scrutiny of these density and trace plots serves as an indicator of the convergence achieved in the critical hyperparameters within the estimated BVAR model.

standard deviation shock in seven quarters, and then it converges to the steady-state region. These findings are in line with South African literature, as well as BRICS literature and other country studies (Malefane and Odhiambo 2017; Ncube and Cheteni 2015, Dingela and Ncwadi 2022). (Adinda et al., 2023). The BRIC trade agreement provides South Africa with access to larger and more diverse markets in the BRIC countries, driving demand for South African goods and services. This has been facilitated by Brazil, China, and India, which have increasingly consumed South African resources and reinforced infrastructure development, contributing to job creation. They further boost growth by increasing foreign exchange earnings and transferring technology. The BRICS trade agreement provides resilience for South Africa against global market fluctuations, stabilizing and fostering long-term economic growth.

When the researcher sought to find out how economic growth responded to the BRICS FDI share in South Africa, the results were very interesting. The study reported that South Africa's economic growth responded positively, reaching its maximum impact of 0.25 after three quarters, following a one-percent standard deviation. It then converged to a steady state and died out after 12 more quarters. Similar to what was done in model 1, foreign direct investment from the BRIC countries was also included in model 2. As a result, the conclusion is the same as reported in Figure 3. However, for Figure 3b, the shock reaches a maximum impact of 0.18 after two quarters, following one percent standard deviation. It then converges to a steady state and dies out after six quarters. These findings are in line with South African literature, including Makhoba & Zungu (2021) and Makhoba (2024), and also with BRICS literature, such as Dingela & Ncwadi (2022), Kalai et al. (2024), and Malik & Sah (2024). They are also supported by other country studies (Sunde, 2017; Ahmed et al, 2023)

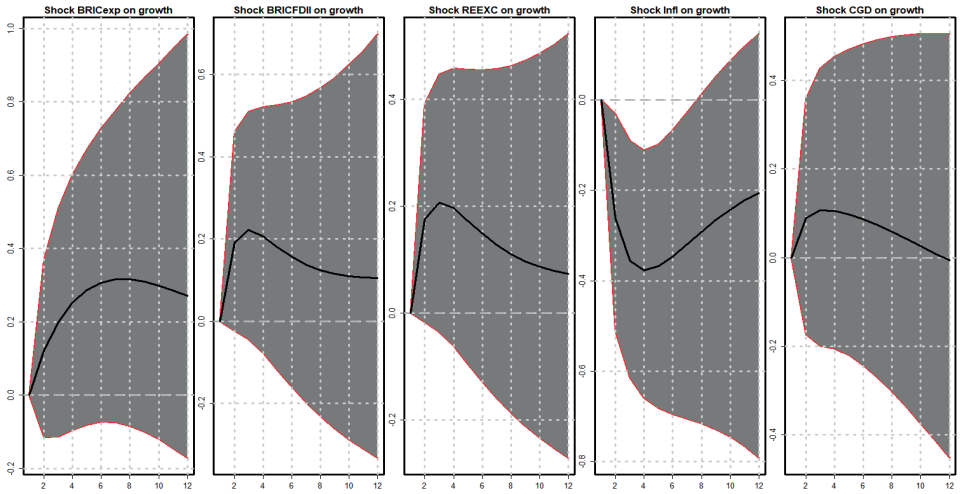

Figure 3. Generated impulse responses of economic growth to the BRIC export share from the Bayesian VAR. *Source*: Author's calculation results based on data from WDI (2025)

The positive impact of FDI from the BRIC countries on South African economic growth is driven by their technological advancements, capital investment, and expertise. These countries focus on sectors like energy, manufacturing, mining and infrastructure in South Africa. Their FDI inflows boost South African trade by improving productivity and fostering innovation and competitiveness, which further expands the growth of domestic industries. As the BRIC countries continue to invest in South Africa, the economy becomes more integrated with the global value chain, enhancing economic stability and providing long-term growth opportunities.

The second model reported in Figure 4 was estimated based on the idea that a separate model should be developed to estimate the effects of BRIC exports and import shares on economic growth in South Africa. The results of the analysis of BRIC imports reveal a significant increase in economic growth in South Africa. A positive response was observed after a 1% increase in BRIC imports. The maximum impact was reached at 0.29 percent after three quarters. After 10 quarters, the impact converged and died out. These findings are consistent with the South African literature (Malefane & Odhiambo, 2017) as well as the BRICS literature (Ncube & Cheteni, 2015; Dingela & Ncwadi, 2022) and other country studies (Adinda et al., 2023). South Africa's economic growth has been largely attributed to the increased export share of its products to BRIC (Brazil, Russia, India, China) countries, especially Brazil, China and India. This expansion of markets has given South Africa the opportunity to tap into increased demand for its raw materials, boosting South Africa's foreign exchange reserves through providing funds for job creation, infrastructure development and social programs. This is also a result of rapid growth and expansion of the middle class in those countries, which creates a steady demand for exports such as minerals, metals and energy resources. The diversification of export markets reduces the dependence on fluctuating market conditions and promotes long-term, sustainable growth, as a result of the rapid growth of the middle class and its expansion.

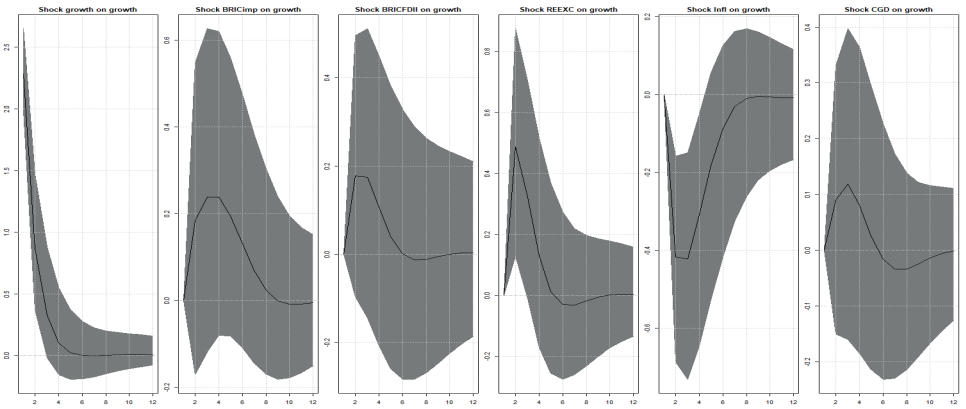

Figure 4. Generated impulse responses of economic growth to the BRIC share of imports from the Bayesian VAR. *Source*: Author's calculation results based on data from WDI (2025)

Moving forward in both models, the author controlled for exchange rates, which were captured by the real effective exchange rate index (2010=100). Inflation was measured by consumer prices (annual %), and government debt was represented by total central government debt as a percentage of GDP. Controlling for these variables is crucial because they affect external competitiveness, domestic price stability, and fiscal sustainability. This approach provides a clearer picture of the BRICS countries' direct impact on growth and enhances the reliability of results. In both models, the exchange rate has a positive impact on economic growth in South Africa. Economic growth responds positively to a 1% standard deviation shock on the REEXC exchange rate, reaching a maximum impact of 0.20 after three quarters. This impact then converges and dies out after six quarters. The maximum impact achieved is 0.50, as shown in Figure 4. These findings are consistent with the studies conducted by Seraj and Coskuner (2021) in 93 countries and Ndou et al. (2024) in South Africa. The exchange rate and economic growth in South Africa are influenced by exports, which make the country more competitive and boost demand for goods. This increases local business revenues and foreign exchange reserves, leading to more job creation and infrastructure improvements through foreign investment. These factors contribute to overall economic growth in the country. A positive exchange rate environment entices potential profits and stimulates the nation's economic growth.

This study adopted inflation as a variable (infl). In both Figures 3 and 4, the results show that economic growth decreased gradually following a standard deviation shock of 1% to inflation. The minimum was reached at -0.41 three quarters later, and then it converged and stopped after six quarters.

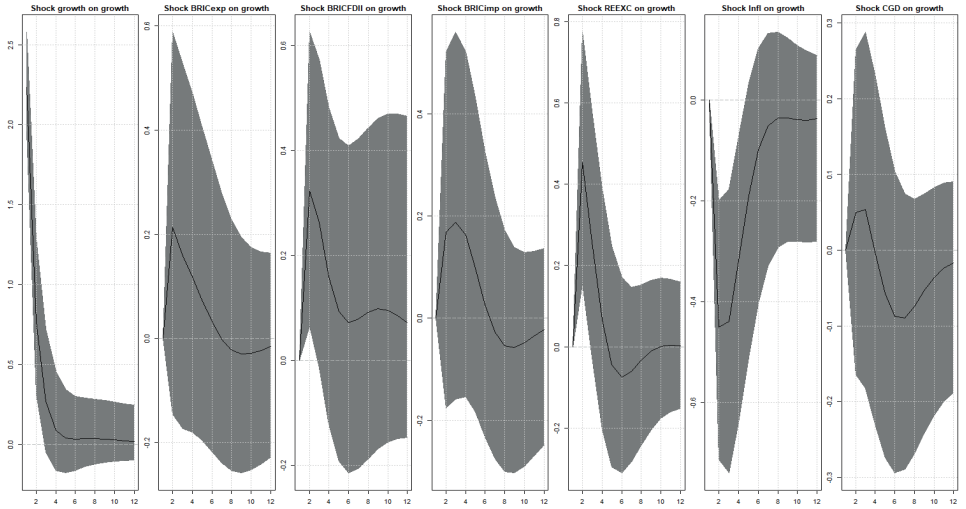

Figure 5. Generated impulse responses of economic growth to BRIC exports, imports and FDI share from the Bayesian VAR. *Source*: Author's calculation results based on data from WDI (2025)

The empirical findings do not align with the results obtained by Bittencourt et al. (2014) for SADC countries and by Ezako (2023) in Burundi. High inflation increases living costs, reducing purchasing power, and leads to slower economic activity due to decreased demand. This is because consumers spend more money on essential goods and services. Excessively high inflation can also lead to uncertainty and lower profits, as it discourages investment and increases the risk of loss.

Lastly, the author controls for government debt in both models 1 and 2, as reported in Figures 3 and 4. Figures 3 and 4 show that CGD (Controlled Government Debt) significantly contributes to economic growth, with a maximum impact of 0.15 three quarters after a 1% standard deviation shock. The impact then converges and reverses to the steady-state region. However, Figure 5 shows that the impact reaches a maximum of 0.12 three quarters later and converges to a steady state, dying after six quarters. Regarding the impact of public debt on economic growth, it can be noted that it is asymmetrical and seems to be influenced by the variables in the control group adopted in the model. The empirical findings do not align with the results reported by Ngcobo et al. (2025) for newly democratic African countries (South Africa and Namibia) and European countries (Germany and Ukraine), and by Augustine and Rafi (2023) for emerging and developing economies. Central government debt in South Africa can stimulate economic growth through financing public infrastructure projects and reducing inequality. It also enhances human capital by providing opportunities for education and training. Government debt can be a powerful fiscal policy instrument that helps to restore the economy during downturns by stimulating demand. When managed properly, it creates a favourable investment environment for the private sector and improves competitiveness.

Bayesian Generalized Methods of Moments results and discussion

For robustness purposes, the study adopted the Bayesian Generalized Method of Moments (BGMM), covering the period 2009Q1–2023Q4, to investigate the impact of the BRIC trade agreement on South African growth. The motivation for using the BGMM in this study is that it is effective in addressing various issues in the data, such as model uncertainty and endogeneity. Bayesian econometrics accounts for prior information, allowing for efficient estimation in the presence of potential relationships between trade, economic growth, and other factors. This improves robustness, especially for small samples, and makes it ideal for capturing complex economic dynamics and providing reliable estimates. The selection of instruments is crucial to the GMM because it helps address endogeneity and ensures the validity of moment conditions, which in turn maintains the efficiency of coefficients. The within-instrument approach was adopted, using lagged values for endogenous variables, with four lags chosen for the study, which deals with quarterly data. In this section, we provide further evidence to support the robustness of our findings. To assess the sensitivity of our results, we controlled for three significant variables in our model:

unemployment, monetary policy, and economic development. These factors are believed to play a significant role in the relationship between the BRIC countries' agreements and economic growth. Unemployment affects domestic consumption and productivity, while monetary policy influences investment, interest rates, and inflation. Therefore, these factors contribute to economic stability, which has a direct impact on growth and trade opportunities in the BRICS countries. On the other hand, economic development drives innovation, infrastructure and investment, enhancing South Africa's competitiveness in BRICS.

To illustrate the impact of the BRICS trade agreement on economic growth in South Africa, several models were estimated, as shown in Table 6. Models c, d, and e were estimated separately, while model f included both BRICS imports, exports, and FDI in the same model. After estimating the model, the author follows the normal procedure for checking the validity of the model using Arellano–Bond autocorrelation tests AR(1) and AR(2), and the Hansen j-test for overidentification restrictions. The results of AR(1) tests for models c, d, e, and f are -0.89 (0.548), −0.69 (0,634) −0.54 (0.458) and 0,12 (0.754) respectively, indicating that the instruments used are valid. The Hansen j test further supports this conclusion.

The results of the robustness analysis demonstrate three main findings: 1) the effect of BRICS trade agreements on South Africa's growth does not depend on any specific variable included in the analysis; 2) the results are consistent with those of the baseline analysis, regardless of which model is used; 3) when considering the magnitude of coefficients, BRICS imports (3.09%), exports (5.58%), and FDI (4.48%) have a significant impact on boosting growth.

Table 6. The BGMM effects of the BRIC trade agreement on South African growth

	Model c: Import share	Model d: Export share	Model e: FDI share	Model f: Combine
BRICimp	3.09**(0.89)			2.94**(0.60)
BRICexp		5.58**(1.33)		3.00** (1.40)
BRICFDII			4.48(2.00)	3.42**(1.03)
REEXC	2.05 ***(0.35)	1.34*(0.91)	2.00**(0.80)	1.40 **(0.23)
Infl	-2.00**(0.20)	-1.69**(0.20)	-0.89**(0.23)	-2.60* (0.76)
CGD	2.23**(0.63)	1.98*(.97)	2.94**(0.45)	2.45**(1.02)
Unmp	-2.60 **(0.30)	-2.50**(1.23)	-2.90**(1.02)	-3.50 **(0.60)
GEXP	2.84**(0.53)	3.34**(1.43)	1.43**(0.31)	2.22**(1.40)
HP	-1.34**(0.40)	-2.34 **(0.45)	-2.56** (0.42)	-3.20 **(1.13)
AR(1): z.p-	-2.85 (0.004)	-3.42(0.001)	-2.43(0.002)	-3.41(0.001)
AR(2):z.p	-0.89(0.548)	-0.69(0.634)	-0.54(0.458)	0.12(0.754)

Note: The dependent variable is economic growth. The numbers in brackets denote the standard errors. (***), (*), (*) reflect the 1%, 5%, and 10% levels of significance, respectively. Then z is the z-score, while p denotes the p-values which is the value in bracket under AR(1) and AR(2). *Source*: Author's calculation results based on data from WDI (2025)

As mentioned above, for robustness and model sensitivity, the adopted model shows a statistically significant negative impact on economic growth, with unemployment having a significant impact on all models. This indicates that, on average, a 1% increase in unemployment (Unmp) leads to a decrease in economic growth of 3.50%, the highest magnitude impact among all the models. These findings align with studies by Makarenga and Khaba (2018) in South Africa and Hajzeen et al (2021). Unemployment hinders economic growth by limiting consumer demand, reducing productivity, and decreasing tax revenue. Low disposable income results in reduced demand for goods and services, leading to lower revenues for businesses and stagnation across various sectors. High unemployment rates mean that human capital is not fully utilized, impeding innovation and economic growth. Increased government spending on social welfare programs diverts funds from investment in infrastructure, further limiting overall economic development.

However, when models for controlling government expenditure are introduced into the system in order to control fiscal policy, results show a statistically significant effect of government spending on economic growth in South Africa. The magnitude of this effect is 3.34%, following a 1% increase in government spending. This can be explained by the fact that, during an economic downturn, governments may increase spending to stimulate demand and support key sectors, such as infrastructure, education, healthcare and public services, helping to create jobs and boost economic growth. These empirical findings are consistent with the results reported by Zungu and Greyling (2022) for African emerging economies and by Kimaro et al. (2017) for sub-Sahara African low-income countries.

Such investment increases productivity and creates jobs, leading to an improvement in living standards. Moreover, if government spending is well-managed and directed towards the right channels, it may lead to an increase in economic growth. Social programs reduce inequality, resulting in increased consumer spending. Fiscal stimulus can counterbalance the effects of slow growth during economic downturns, driving short-term recovery and long-term sustained economic growth. The model further included the monetary policy variable, which featured house prices. The results showed that monetary policy reduced economic growth by 3.20% following a 1% increase in house prices. The empirical findings are not in line with the results reported by Alves and Silva (2020). An excessive increase in house prices can hinder economic growth, as it pushes consumers into debt, forcing them to spend more on mortgage payments, which reduces their disposable income for other goods and services, and slows down economic activity overall. Market instability may hinder first-time buyers, reducing market mobility and decreasing business investment. Increased cost of living also lowers consumer confidence and slows economic growth.

Conclusion and policy recommendations

This study used Bayesian VAR and BGGM techniques to investigate the impact of the BRICS trade agreement on the South African economy over the period from 2009 to 2019. The results provide insights for both researchers and policy makers by investigating the contribution of this agreement to South Africa's economic growth. Firstly, the study separated the models by examining the impact of BRIC exports and imports on the South African economy. Secondly, the study adopted a robustness model to examine the dependence of the reported results on the adopted model. To strengthen the argument, the author tested the model's sensitivity by adding more control variables to the system. This was done to see if the results were dependent on the variables included in the system. Contrary to expectations, the BRICS trade agreement has had a positive impact on South Africa's economy. An unexpected increase in exports, imports, and foreign direct investments from BRIC has led to increased economic growth in South Africa. High house prices, inflation, and unemployment have all been found to hinder the effectiveness of the BRIC trade agreement. These factors are shown to decrease economic growth. The study has also incorporated fiscal policies into the system in order to determine how government spending affected growth. The results show that government expenditure plays a critical role in improving economic growth in South Africa. As documented in the results, the BRICS trade agreement has the potential to significantly boost South Africa's economic growth. To maximize the benefits of South Africa's trade relations with the BRIC countries, it is essential to prioritize strategic sectors such as mining, manufacturing, and agriculture. These are areas where demand from China, India, and Brazil is increasing. The government and policymakers should develop policies to improve export competitiveness by reducing trade barriers, promoting local industries capable of meeting the needs of these markets, and investing in infrastructure development.

Moreover, SA should foster investments from the BRIC countries in areas like renewable energy and technology, stimulating job creation and innovation. It is also crucial for SA to address its domestic challenges that hinder economic growth, such as high unemployment rates, inflation, and high house prices. High unemployment rates limit economic productivity, since a large segment of the population is outside the workforce. This results in underutilization of human capital. Countries with high inflation have their citizens' purchasing power eroded, lowering their living standards and hindering overall demand in the economy. Lastly, rising house prices decrease affordability, leading to a decrease in disposable income and consumer spending, which can stunt economic growth. South Africa should implement policies that promote job creation by investing in skills development, infrastructure projects, and supporting small and medium-sized businesses. At the same time, it should also focus on providing affordable housing and implementing measures to control inflation in order to counteract negative factors that may hinder economic growth. Effective domestic policies, together with positive impact of the BRICS trade agreement, will foster sustainable and inclusive growth in South Africa.

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Appendix

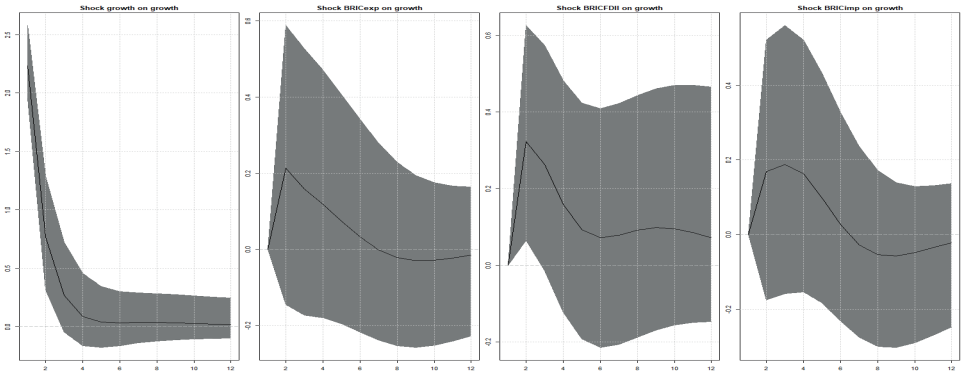

Figure 1A. Generated impulse responses of economic growth to BRIC trade agreement from the Bayesian VAR. *Source*: Author's calculation results based on data from WDI (2025)

Data Availability Statement: Publicly available datasets were analysed in this study. The data can be found at: World Development Indicators [World Development Indicators. 2025. 'World Bank, Washington, D. C. ' Available online: http://data.

worldbank.org/data-catalog/world-development-indicators (accessed on 2 February 2025)] WITS (https://wits.worldbank.org/CountryProfile/en/Country/ZAF/Year/2022/tradeFlow/EXPIMP) (accessed on 5 January 2025)] and UN trade and development (https://unctadstat.unctad.org/datacentre/dataviewer/US.FdiFlowsStock) (accessed on 27 December 2024)]. Further inquiries can be directed to the corresponding author.