Impact of Trade Liberalisation on Economic Growth:

South Africa's automotive perspective

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DECLARATION

I, Nomfundo Vanessa Libazi, hereby declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university. I authorise the University to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

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ABSTRACT

This study examines the impact of trade liberalisation policies on the economic growth of South Africa's automotive industry within the context of international trade. The study aims to investigate the effects of trade openness policy on the automotive industry's development and economic growth. The study uses the Vector Error Correction Model (VECM) to examine the relationship between trade liberalisation and economic growth.

Time series data from Q1 1992 to Q4 2021 is used for the study to reshape conventional theories and inspire further research. The findings reveal a negative correlation between trade openness and economic growth in the long-run despite increased exports due to liberalisation policies. Even when the study adjusts the lagged results from 6 to 2, the impact is the same. This correlation is attributed to workforce limitations and an underdeveloped local supplier base. Results are validated through diagnostic tests, displaying significant and robust evidence. Given the divergence in the findings, further research is needed to better understand the results.

Policymakers should concentrate on skills and human capital development to improve the technical and absorption capability of the local market. Skills and human capital development ensure that industry benefits from technological diffusions flowing from international trade. Supportive industrial policies aligned with long-term liberalisation strategies can upgrade and capture a greater value-added share within value chains.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
AfCFTA	African Continental Free Trade Agreement
AIC	Akaike information criterion
AIEC	Automotive Industry Export Council
AIS	Automotive incentive scheme
APDP	Automotive Production and Development Programme
ARDL	Autoregressive distributed lag
BRIC/BRICS	BRIC countries Brazil, Russia, India, China
CBU	Completely build up
CCG	Capital compensation growth
CEE	Central Eastern Europe (includes Czech Republic, Hungary, Poland, Slovakia and Slovenia)
CKD	Completely Knocked Down
CWI	Cable and Wireless International
DIL	Direct investment liabilities
DTIC	Department of Trade, Industry and Competition
ECM	Error correction model
ECT	Error-correcting test
EFA	Exploratory factor analysis
ELGH	Export-led growth hypothesis
EMs	Emerging markets
FDI	Foreign direct investment
FPE	Final Prediction Error Criterion
GATT	General Agreement on Tariffs and Trade
GDP	Gross domestic product
GMM	General method of moments
GVCs/GPN	Global value chains/global production networks
HQ	Hannan-Quinn information criterion
HTIs	High-technology industries
ICT	Information and communications technology
IEC	Import-export complementation
IFIs	International finance institutes

ILGH	Import-led growth hypothesis
IMF	International Monetary Fund
IPs	Industrial policy
IPAP	Industrial Policy Action Plan
IRCC	Import rebate credit certificate
ISI	Import substitution industrialisation
JIS	Just in sequence
JIT	Just in time
KMO	Kaiser-Meyer Olkin test
LR	Likelihood ratio
MIDP	Motor Industry Development Programme
MNCs	Multi-national companies
MPN	Manufacturing production networks
NAACAM	National Association of Automotive Component and Allied Manufacturers
NAAMSA	National Association of Automobile Manufacturers of South Africa
NAFTA	North American Free Trade Agreement
NICs	Newly industrialised countries
OECD	Organisation for Economic Co-operation and Development
OECD TiVA	Organisation for Economic Co-operation and Development Trade in Value Added
OEM	Original equipment manufacturers
OLS	Ordinary least squares
PP	Phillips–Perron (methods)
R&D	Research and development
SA	South Africa
SC	Schwarz information criterion
SSA	Sub-Saharan Africa
SAAM	South African Automotive Masterplan
SARB	South African Reserve Bank
USA	United States of America
VECM	Vector error correcting model
VIF	Variance inflation factor
WTO	World Trade Organisation

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 BACKGROUND OF THE STUDY

Historically, developing countries' widely accepted trade strategy embraced policies centred on protectionism to promote economic growth. The macroeconomic landscape of emerging markets was characterised by the import substitution industrialisation (ISI) approach, which imposes high tariffs and import restrictions to protect newly formed domestic industries and promote their development and growth. However, ISI proved ineffective, with local market concentration leading to high costs and limiting competitiveness in global markets (Colistete, 2003; Rodrik, 2011; Barnes & Black, 2013; Mendes, Bertella & Teixeira, 2014 & Asfaw, 2017). Consequently, multilateral institutions recognised the importance of outward-oriented strategies for growth and urged developing nations to embrace trade liberalisation to drive development, drawing from successful examples in East Asia. Nations interested in promoting industrialisation objectives, such as integrating into global markets, initiated a trade liberalisation process by removing trade barriers and adopting trade agreements.

Increased participation in the global economy directly results from liberalised international trade policies. This phenomenon is driven by the belief in a positive correlation between economic growth and trade openness, as supported by traditional growth theories. As such, prominent international finance institutions (IFIs) such as the World Trade Organisation (WTO), International Monetary Fund (IMF) and World Bank strongly advocate for trade liberalisation, especially for developing and emerging markets. In some instances, the financial support of these institutions has been contingent on a country's perceived openness to international trade (Zahonogo, 2017). This correlation, however, remains contentious and the subject of debate and controversy (Yanikkaya, 2003 & Akpan & Atan, 2016). Some scholars argue that trade openness, particularly in high-technology industries (HTIs), facilitates knowledge diffusion and technological catch-up necessary for local economies through the inflow of foreign direct investment (FDI) (Almeida & Fernandes, 2008; Asongu, Nnanna & Ache-Anyi, 2020). Other scholars and empirical evidence, especially from developing countries, present different and often mixed perspectives which contend that sustainable growth requires more than attracting expertise and technological know-how (Ribeiro, Corseuil, Santos, Furtado, Amorim, Servo, & De Souza,2004.; Chamsuk, Fongsuwan & Takala, 2017 & Zahonogo, 2017). Instead, they argue, it requires investing in human capital, driving innovation through research and development (R&D) and improving absorption capability to assimilate technological diffusion and knowledge transfer (Fernandes, Kee & Winkler, 2020).

Since the 1990s, the economic landscape in South Africa (SA) has witnessed a shift in policy reform, with the government's strategic focus moving from an isolated economy towards a free export-orientated market (Barnes & Morris, 2008). Table 1.1 presents a graphical representation of key changes in South Africa’s economic trends from 1995 to 2020. Despite various policy reforms and increased FDI, growth rates have not significantly changed. Unemployment persists at an approximated rate of 34% (Maza, 2021). The trade openness index, which measures trade as a ratio of GDP by combining imports and exports, has steadily risen from 54% to 63% between 1995 and 2015, indicative of the country’s integration into global markets and increased international trade. However, from 2005, the trade balance declined, representing import growth over export growth. This decline is despite the Department of Trade, Industry and Competition’s (DTIC) objective to build industries and domestic suppliers that can compete against imports and support the drive for the competitiveness of the export manufacturing sector (DTIC, 2014).

Table 1.1: The dynamics of South Africa’s economic growth

Measurement	1995	2000	2005	2010	2015	2020	trend on average
	South Africa	South Africa	South Africa	South Africa	South Africa	South Africa	SA
GDP at constant 2015 R billions	2,222.31	2,578.36	3,127.83	3,635.48	3,998.47	4,242.24	↑
GDP per capital at constant 2015 R	50,523.07	55,077.49	63,811.00	70,203.47	71,559.11	75,921.74	
GDP growth annual %	3.1%	4.2%	5.3%	3.0%	1.3%	-6.3%	↓
Exports of goods and services constant R billion	683.24	873.36	1,009.36	1,061.59	1,225.16	1,072.63	
Import of goods and services constant R billion	508.49	573.65	838.61	1,020.00	1,280.00	1,070.00	
Trade Balance	174.75	299.71	170.75	41.59	(54.84)	2.63	↑
Trade to GDP ratio	0.54	0.56	0.59	0.57	0.63	0.51	
Foreign direct investments (net inflow) Current billion USD	4,5	6.16	42.27	26.62	22.07	50.40	↑

Trade to GDP ratio is an indicator of relative importance of international trade for a country **Ratio (exports + imports) / GDP**

Source: Author’s own with information from the South Africa Reserve Bank and Department of Trade, Industry and Competition (2023).

It is possible to interpret and draw conclusions from the data for South Africa's economic performance and manufacturing industry. The SA government began to transform the manufacturing industry due to the industry's stagnation and shortcomings noted under the ISI strategy (Black & Bhanisi, 2006). The transformation was initiated by adopting tactics formed in East Asia, such as establishing core industries to promote export-oriented manufacturing. The automotive industry was selected as one of these core industries. Trade liberalisation strategies significantly contributed to increased exports and integration into global markets. Despite a significant flow of FDI, increased production volumes and contribution by the sector to gross domestic production (GDP), questions still arise as to whether embracing trade openness strategies has supported sustainable economic growth. Additionally, consideration has been given to whether the flow of FDI and capital investment supports the development of the domestic market and increased value-addition capacity in high-technology industries in South Africa.

This study examines the significance of trade openness on SA's economic growth building. To do so, it observes hypothesised theories tested in empirical studies under the assertion that embracing trade liberalisation principles by opening markets to international trade brings about increased production due to market access expansion, efficiencies from economies of scale and profitability (Baldwin & Gu, 2004 & Kim, 2011). Additionally, it brings knowledge and technological diffusion through imports and foreign direct investments (FDI) to support economic growth. Using quantitative analysis measures discussed in the literature reviewed, the study examines the relationship between trade openness and economic growth for SA's automotive industry.

Fundamental principles discussed in trade liberalisation literature promote international trade. Classical theories for international trade provide core reasoning for promoting division of labour and specialisation according to countries' endowments (Afonso, 2001; Gallardo, 2005 & Schumacher,2013). This promotion leads to the flow of technological innovations and managerial know-how by sharing necessary expertise for increased productivity and economic growth (Afonso, 2001; Gallardo, 2005). Classical growth theory believes economies (1) achieve global economic efficiency through the division of their work and (2) rely on each other through international trade based on their comparative advantage. David Ricardo, in Schumacher (2013), introduces the concept that countries should focus on comparative advantages with the least inefficiencies, allowing countries to trade with each other while optimally allocating their scarce resources.

Empirical evidence from studies shows limitations to the classical assertions (Chang, 2006; Toone, 2013; Gammoudi, Cherif & Asongu, 2016). For example, in Latin America, two issues arise: (1) despite opening economies to international trade and exploiting comparative advantages, Latin America shows limited evidence of economic growth (Cimoli & Correa, 2002 & Rivera-Basques, 2022); and (2) as argued by Chang (2006) focusing on comparative advantage ignores the development of potential industries for which a country does not yet have a comparative advantage. The mindset of classical assertions that support the division of labour and specialisation according to countries' endowments can thus create low growth, entrapping disparities and further widening income inequalities amongst countries. Pugel (2007), Kiely (2010), and Siddiqui (2015) argue that competitive advantage assertions can create undue dependence on developed nations, exposing developing nations to vulnerabilities that could restrict future growth. Chang (2006) adds that these assertions undermine the growth objectives of developing markets and contradict historic practices once adopted by now-developed countries when they defied comparative advantage assertions to promote the development of their infant industries.

The acquisition of technological expertise in high-technology industries is a valuable means of promoting growth, with scholars such as Humphrey & Schmitz (2002), Kummritz, Taglioni & Winkler (2017) and Zahonogo (2017) emphasising this objective for developing countries. The endogenous growth theory, however, argues that the attraction of foreign investment alone is insufficient for growth. Human capital development must be prioritised alongside sound infrastructure, stable macroeconomic frameworks and investment in research and development (R&D). The success of 'Asian Tigers' is an example of the benefits of these structural factors. However, scholars such as Easternly (2001) and Lin (2012) note that implementing or measuring this growth framework might prove challenging.

Promoting trade openness and its correlation with economic growth is a well-studied phenomenon in economic growth literature. Empirical studies show evidence of a positive and significant relationship between the two concepts for a majority of developed and developing countries (Chang & Lin, 2009 & Kim, 2011); however, other scholars dispute this notion, noting a negative and mixed correlation (Musila & Yiheyis, 2015; Ulaşan, 2015; Wani, 2022) instead. Rodríguez & Rodrik (2001) further note challenges when measuring the relationship between trade openness and economic growth, attributed mainly to trade openness metrics being highly connected to economic development and other growth factors.

Regarding South Africa, scholars show considerable interest in determining whether trade liberalisation policies result in the anticipated economic growth for the country. Many studies support the existence of a positive correlation; however, this is noted for South Africa as a whole and not for high-technology industries, such as automotive (Sakyi & Egyir, 2017 & Banday, Murugan & Maryam, 2021). Burange, Ranadive and Karmik (2018) show a negative correlation between trade openness and economic growth for SA, whilst Masondo (2018) specifically notes that the globalisation of SA's automotive industry has led to a 'nanny state'. Given inconclusive results and limited research focused on high-technology industries like automotive, this study aims to provide a better understanding of economic growth experienced by South Africa during the period 1992 to 2021 as a result of trade openness following government incentives under programs such as the Motor Industry Development Programme (MIDP).

1.2 RESEARCH PROBLEM

Despite mixed and often inconclusive results, empirical studies acknowledge the advantages of trade liberalisation. A key limitation, however, is that countries and sectors do not receive these benefits automatically and equitably (Marcato, Baltar, & Sarti 2019). There are significant gaps in current growth literature concerning how some countries and industries successfully derive economic benefits from trade openness while others, similarly comparable, cannot. South Africa's automotive industry illustrates how international trade can have contradictory effects on different countries and regions. South Africa lags behind Brazil, India, China and Thailand's auto industries, which enjoy growth. Some researchers suggest this discrepancy is due to measurements employed in studies that do not consider certain structural characteristics of a country, such as investments in R&D, skills and human capital development (Zahonogo, 2017 & Fernandes et al., 2020).

Additionally, there is inadequate discussion on countries' efforts to steer their own development agendas, such as investment in research and development, strategic trade protectionism, skills and human capital development and drive for increased innovation (Banga, 2022). Despite Aggarwal, Chakraborty and Bhattacharyya (2021)'s research into the impact of the technical competency of the domestic work force on the ability of a nation to benefit from trade openness, little attention is given to how technological accumulation and absorption capability impact economic growth. Developing countries are encouraged to adopt trade openness to benefit from technological diffusion, but studies that explicitly show how this can be done are limited.

Following industrial policies implemented by the government to support the automotive sector and notwithstanding structural constraints such as a restrained domestic and regional market, lower production and export volumes, lack of sound technical skills and a limited local supplier base (Gossel & Biekpe, 2013; Wuttke, 2021). The current study investigates the correlation between trade openness and the industry's economic growth in SA. This is to understand the impact of development and the industry’s ability to mature into a sustainable sector despite limiting factors.

1.3 RESEARCH QUESTION AND OBJECTIVE

Based on the background of the study, the research problem and the gap identified, the guiding question of the study is as follows:

1. Has trade liberalisation of South Africa’s automotive industry led to economic growth for the country from 1992 to 2021?

The main objective of this research is to analyse the impact of trade openness on the economic growth of South Africa’s automotive sector. The focus on the high technology industry (HTI) assesses how benefits from technological advancements resulting from increased foreign direct investment (FDI) contribute to sustainable economic growth. Additionally, it evaluates how investments in research and development (R&D) and government spending on education influence the dissemination of knowledge for industry from trade openness and the impact on economic growth. The following hypothesises are used to research the phenomenon:

The study wishes to test the following hypotheses

> **$H0_1$:** There is no correlation between trade openness and economic growth for South Africa’s automotive industry.
>
> **$H1_1$:** There is a correlation between trade openness and economic growth for South Africa’s automotive industry.

The following sub-hypotheses are built on the study's main hypothetical focus and detail the study's proposed focus.

H0 $_{1.1}$**:** There is no correlation between fdi in the context of trade openness and economic growth.

H0 $_{1.2}$**:** There is no correlation between capex in the context of trade openness and economic growth.

H0 $_{1.3}$**:** There is no correlation between labour in the context of trade openness and economic growth.

H0 $_{1.4}$**:** There is no correlation between R&D in the context of trade openness and economic growth.

H0 $_{1.5}$**:** There is no correlation between gov spend on education in the context of trade openness and economic growth.

H1 $_{1-5}$**:** There is a correlation between fdi, capex, labour, R&D and government spending on education in the context of trade openness and economic growth.

1.4 FOCUS AND LIMITATION OF THE STUDY

The study notes examples of successful economic growth experienced by developing countries due to trade openness and assesses these growth-inducing mechanisms for South Africa's automotive industry. The focus is on reviewing the impact of trade openness on South Africa's automotive industry from 1992 to 2021. This period was chosen due to trade reforms and industrial policies introduced in 1995 by the government, specifically in the automotive industry, to promote manufacturing exports for the sector, notwithstanding the abnormality that could be evident in 2020 due to COVID-19. Given SA's success in the mobile telecommunication industry, the study looks to understand what could limit its growth and expansion speed within high-technology industries such as automotive. This question is critical when considering the performance of SA in comparison to the success of its peers in Thailand, East Asia, Central Eastern Europe and Latin America. Due to time constraints and data availability, the study will not consider inequality and other socio-economic factors relevant to growth analysis (Maza, 2021).

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1.5 JUSTIFICATION OF THE STUDY

Existing research on the correlation between trade openness and economic growth in Sub-Saharan African countries predominantly focuses on overall national economies, with limited focus on specific high-technology industries like the automotive sector (Sakyi & Egyir, 2017 & Banday, Murugan & Maryam, 2021). In South Africa, the automotive is one of the strategic industries positioned to create "a globally competitive and transformed sector that actively contributes to the sustainable development of South Africa's productive economy, creating prosperity for industry stakeholders and broader society" South Africa's Automotive Industry Master Plan 2035 (SAAM, 2018). Additionally, it significantly contributes to GDP, employment rate and export production outputs (AIEC,2022). Studying the impact of its trade openness on SA's economic growth is justified owing to its deliberate position and contribution to the country's overall economic health.

Additionally, owing to the implementation of industrial policies in support of automotive in SA, it is essential to assess their effectiveness in relation to trade openness and economic growth. The study's findings provide a valuable outlook for fulfilling the policy mandate of the Department of Trade, Industry and Competition (DTIC) and other stake holders which support the automotive manufacturing exports, sector competitiveness and the promotion that encourages the growth of local supplier bases and domestic value-added creation, contributing to insightful policy reforms decision making (DTIC, 2014) (SAAM, 2018) (AIEC, 2022). The practical implication of this study aids policymakers and strategic partners in realising the industry visions (SAAM,2018). Structural limitations of the sector in SA, such as the limited domestic and regional market, restrained technical capability of the local supplier base and low production and export volume, justify the need for a more in-depth study to unlock what hinders industrialisation and global competitiveness of the sector. Understanding these constraints from the context of trade openness is crucial for providing insights into industry challenges and understanding the drive for future competitiveness of the sector. The study contributes to the body of knowledge as it provides depth in sector-focused analysis of trade openness for developing African countries.

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1.6 ORGANISATION OF THE STUDY

This study is organised into five chapters: Chapter 1 introduces the study, providing an overview of the research topic. This introduction includes a background on trade openness and economic growth. The chapter identifies the study's questions and areas of interest and provides an overview of the research problem, objective and motivations driving the research in this industry. Chapter 2 includes the literature review, concentrating on foundational theories and empirical studies. The literature review examines theoretical constructs and empirical findings, particularly emphasising critical assumptions, causal impacts, noteworthy limitations in existing research, and gaps within the current body of literature. Chapter 3 encompasses the research methodology, outlining the research design, econometric models and statistical tools chosen for the investigation while justifying the selected research approach. This chapter establishes a precise scope and definition of the dataset and essential variables to answer hypotheses and address the study’s key objective. Chapter 4 interprets the results and discusses the research inquiries into South Africa’s automotive industry context. Finally, Chapter 5 concludes the study by emphasising key findings and formulating recommendations tailored for policymakers and other vital stakeholders.

CHAPTER 2: THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discusses trade liberalisation growth theories. The aim is to evaluate whether trade openness promotes economic growth for South Africa's industries, especially high-technology ones. Classical economic growth principles are examined in discussing trade openness (Afonso, 2001). In their promotion of openness, these theories contend that international trade allows for division of labour, which promotes the flow of technological innovations managerial know-how and increases productivity and, thus, economic growth (Afonso, 2001; Gallardo, 2005). David Ricardo's theory of comparative advantage builds on the justification for increased openness, asserting that utilising abundant economic resources by promoting international trade and open economies leads to better long-term development than if countries remained closed (Schumacher, 2013). These assertions are met with contrasting empirical findings, especially among developing nations, leading some scholars to question their validity using arguments centred on infant protectionism, ethical grounds and dependency theory (Toone, 2013; Gammoudi, Cherif and Asongu, 2016).

Endogenous growth theory advocates a moderate approach, balancing the dependency and classical schools of thought. The theory contends the assertions of technological diffusion benefits and suggests that sustainable economic growth can only be achieved under certain conditions and when combined with policies and frameworks that drive productivity and innovations (Zahonogo, 2017). The theory emphasises the crucial role of skills development, human capital investment, and R&D in promoting technological innovation to drive economic growth (Ribeiro et al., 2004). Cimoli and Correa (2002) and Monteils (2002) argue that a blanket approach to the theoretical principles does not guarantee a positive correlation as a country's structural factors and profiles differ. The current study assesses South Africa's automotive industry's trade openness and whether it contributes to economic growth.

Empirical evidence shows that the impact of trade openness on economic growth varies substantially across countries and industries, even when structural characteristics are similar. These empirical research findings motivate this study's interest in determining what prevents SA and other developing countries from increasing their sustainable contribution to economic growth while also examining East Asian countries' successful approaches towards the sustainable growth and development of its automotive industry in order to model suitable strategies for promoting this within SA.

This study aims to review theoretical studies and empirical evidence in a way that reflects and explains theory in the unique context of SA, focusing on commonalities, key variables and critical limitations. The ultimate objective is to enhance an understanding of factors that constrain the derivation of economic benefits from trade liberalisation for SA's high-technology industries. The research phase of the study formulates hypotheses concerning limitations and knowledge gaps in existing theory and empirical studies for subsequent testing. The primary goal is to evaluate the relationship between trade liberalisation and economic growth for SA's automotive industry.

2.2 THEORETICAL LITERATURE REVIEW

The correlation between trade openness and economic growth is a highly debated phenomenon in development growth literature (Yanikkaya, 2003). After the import substitution industrialisation (ISI) strategy failed in the 1980s, mainstream consensus recognised international trade as a core catalyst for growth and development (Colistete, 2003 & Rodrik, 2011). This consensus led international finance institutes (IFIs), such as the IMF, World Bank and WTO, to strongly advocate for trade openness, citing success stories in East Asia, where economic growth was reportedly experienced through trade liberalisation strategies (Akpan & Atan, 2016). However, empirical research yields conflicting results, showing that benefits have not accrued equally for other developing countries as they did for East Asia (Siddiqui, 2015). Some researchers support the existence of a positive relationship (Chang & Lin, 2009; Kim, 2011), whilst others dispute this notion (Musila & Yiheyis, 2015; Ulaşan, 2015; Wani, 2022). The ambiguity in studies led to a perception that success claims made for East Asia could be exaggerated and that, at best, an intricate and complex relationship exists between trade openness and economic growth in developing countries (Akpan & Atan, 2016).

The theoretical foundation of this correlation between trade openness and economic growth traces back to Adam Smith's classical theory, which argues that as countries grow and specialise through the division of labour and international trade, they promote the flow of innovations and managerial knowledge necessary to increase productivity and economic growth (Afonso, 2001). The growth observed is expounded in neoclassical theory to include non-economic factors, such as the flow of capital, labour productivity and exogenous technological advancements that create access to technological diffusion and know-how, thus driving productivity and economic growth over time (Gallardo, 2005). A key assumption is that government policies have no bearing on economic growth and that market forces regulate optimal production permitted under the production-possibility frontier. This regulation leads the market to reach the most efficient level that maximises economic growth on its own. While many support the classical school of thought, others contend that it perpetuates dependencies and promotes global inequalities (Toone, 2013; Gammoudi et al., 2016). In the context of developing countries, empirical studies make it evident that moderating theory to include government policies and other interventions aimed at promoting productivity and innovation can help developing countries achieve economic growth (Zahonogo, 2017).

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Trade liberalisation is a system that strives to eliminate trade distortions by lowering barriers and other constraints to encourage the exchange of goods and services and the flow of foreign capital (Dava, 2012; Maza, 2021). Due to differing trade policies and laws between countries, there is significant variance in applying this definition (Shafaeddin, 2005). This variance leads to complexities in measuring trade openness and economic growth amongst nations (Rodríguez and Rodrik, 2001). Despite this, developing nations view classical theory assertions as a means of driving industrialisation strategies through the free flow of goods and services and the sharing of capital and technical know-how for economic development (Gurgul & Lach, 2014). This view resulted in the adoption of liberalisation policies to benefit from dissemination, driving the development of export strategies aimed at utilising abundant resources and promoting participation in the global economy (Gallardo, 2005). The assumption is that an export-geared growth strategy significantly increases production levels through market expansion, economies of scale and profitability (Baldwin & Gu, 2004 & Kim, 2011). This strategy is believed to lead to advantageous elements for promoting economic growth and development, including the promotion of exports and the stabilisation of foreign exchange polices, accumulation of foreign exchange and the relief of import shortages through better resource allocation (Gossel & Biekpe, 2013). Despite the cited benefits of liberalising trade restrictions, empirical research demonstrates inadequate and ambiguous success stories of how well this strategy supports the development of emerging nations (Siddiqui, 2015), with studies showing that even though exports have increased, the value-added element for some developing countries is limited (Lin, Hsu, Liou & Chang, 2016) and that reforms and intervention policies aimed at driving sustainable growth from a developing country context are essential (Zahonogo, 2017).

Another branch of classical ideology is the comparative advantage model, which provides theoretical justification for free trade, illustrating how the efficient use and optimal allocation of abundant resources is necessary to drive economic growth (Schumacher, 2013). In this theory, David Ricardo, in Schumacher (2013), laims that open economies have a better chance of long-term success than closed economies, based on the argument that specialisation in sectors of comparative advantage increases efficiency and productivity and enables an improvement in the overall global economy (Keho, 2017). The theory’s point of departure is that some countries perform economic activities more optimally and efficiently due to their resource endowment; therefore, specialisation in producing and exporting goods and services should be endorsed where countries have a relatively lower opportunity cost (Landsburg, 2008).

This theory led to widespread international trade and laid the foundation for major institutes and trade agreements like the WTO (Lamy, 2010). This idea embedded a tenacious view among economists that countries expand more quickly as they open and liberalise their economies to trade (Kim & Lin, 2009).

The key assumption of the theory asserts that countries using trade openness can allocate scarce resources to optimal operations or sectors where countries have a strong comparative advantage. This results in economies of scale from increased production in areas of specialisation, improving overall efficiencies and productivity and allowing countries to share in the derived advantages (Zahonogo, 2017). This outcome assumes that each country fully utilises its factors of production (labour and capital); thus, international trade creates a win-win solution for the world economy. However, when consideration is given to the underutilisation of production factors, additional demands can be addressed using readily available, unconstrained resources without the need to trade internationally, which negates the arguments for international trade (Siddiqui, 2015). Additionally, the assumption of global immobility of labour and capital is not supported by current international labour migration, bringing into question the justification asserted for the theory.

Some scholars oppose comparative advantage theory on ethical grounds. Chang (2002) and Chang & Lin (2009) contest that, even though Ricardo's comparative advantage theory is useful in the short-term for optimal resource allocation, it is not appropriate in the medium- and long-term (Chang & Lin, 2009). The theory overlooks the developmental objectives of emerging countries, which might not have a comparative advantage but have potential and ambition (Chang, 2002). Chang and Lin (2009) contest that ignoring developmental objectives perpetuates systemic inequalities, keeping poor countries poor and rich countries rich. This mindset is not ideal for developing nations to mature, upgrade their industries, and achieve sustainable growth (Chang & Lin, 2009). Historically, the world's wealthiest economies developed their industries through infant industry promotion, thereby refusing to accept comparative advantage theory's main argument for specialising in a country's industry of least efficiency (UNECA, 2015; Rassekh, 2015). This stance allowed rich economies to learn and develop industries which the theory believes they should have ignored, thus strategically positioning their economies for sustainable economic growth (UNECA, 2015).

Dependency theory is founded on the principles of Marxism and provides a critical perspective to classical theory. The theory argues that international trade results in unequal exchange between developed and developing nations, perpetuating emerging markets' entrapment in poor economic growth conditions (Kiely, 2010). Contrary to the classical mainstream, which emphasises trade policy liberalisation to increase economic growth for developing nations, study findings show weak evidence of benefits for developing nations (Pugel, 2007). Siddiqui (2015) contends that this system increases emerging countries' reliance and vulnerability on foreign financial resources. As the 2009 financial crisis shows, this reliance can harm developing countries. Additionally, this reliance undermines the economic independence of developing countries, creating dependency traps that limit economic growth and development.

The core tenet of dependence theory examines how FDI inflows are frequently motivated by capitalistic objectives, with multi-national companies (MNCs) searching for ways to optimise operations, boost profitability and strengthen their competitiveness (Tang et al., 2018). These MNC goals are typically accomplished by moving the manufacturing process to nations with large markets and low production costs. The argument is made that because MNCs' main goal is capitalistic in nature (creating profit for the shareholder), economic growth in host countries can be negatively impacted (Asongu et al., 2020). The following arguments support this negative impact: (i) Advantages derived from FDIs do not accrue equally between MNCs and local countries, with benefits skewed in favour of MNCs. Foreign companies exploit the developmental objectives of emerging countries, bringing foreign investments and utilising labour (and other resources) that could have met the development objectives of host countries, only to later repatriate profits by declaring dividends to developed economies where the MNCs originate (Ghosh & Rajan, 2019; Jensen, 2008). (ii) Taylor and Thrift (2013) argue that MNCs bring an international infusion that changes homegrown orientation and preferences, distorts local culture, and undermines indigenous industries.

Advocates for dependency theory assert that developing countries remain stuck and underdeveloped as trade drains them of their primary resources in favour of manufactured goods from industrialised regions (Naseemullah, 2022). This is detrimental for developing countries as it creates dependency, especially in high-technology industries like automotive, where the technological know-how and engineering expertise are concentrated in a few core regions, such as Germany, Japan and the USA (Toone, 2013; Gammoudi et al., 2016). To participate in trade activity, countries rely on importing technology, critical components and technical expertise from the core regions (technological dependency), restricting contributions from indigenous suppliers (Asongu et al., 2020). The reliance on imports in favour of technological diffusions limits a country's ability to add significance to the production of high-value goods, which can slow economic growth. However, Kneller, Morgan and Kanchanahatakij (2008) assert that the significance of imports cannot be overstated in the correlation between trade openness and economic growth. The study of Kneller et al. (2008) focusses on 37 countries and notes positive economic growth when imports are used to manufacture goods meant for export rather than consumption; this is especially true when countries combine imported technology with higher levels of R&D. Nevertheless, notwithstanding the assertions of the dependency theory, empirical evidence from East Asia's industrialisation success shows development possibilities that can be derived from trade liberalisation backed by government policies designed with the intent of attracting growth inducing FDI through technology diffusion as a means of learning and developing indigenous industries and suppliers (Wuttke, 2021).

The theoretical impact is considered the same for industries outside of high-technology: countries providing primary goods remain trapped in an inefficient export-oriented mindset, creating vulnerabilities to trade shocks (Keho, 2017). For example, nations like Côte d'Ivoire and Ghana export cocoa beans as a raw material, accounting for around 65% of worldwide cocoa output, yet only generating 6% of the world's chocolate sales. This enforces an export dependency that entraps these countries in non-value-adding processes whilst their exported cocoa beans are imported back to them as chocolate by advanced countries with the expertise and know-how to derive the most benefit, such as Switzerland and the USA (Ismail, 2017). Siddiqui (2015) argues that logical justification for how some emerging nations might eventually industrialise and export high-value-added goods remain unclear, necessitating governments and policymakers to define clear developmental policies to support the transition towards improved export value-add. Empirical evidence shows a positive correlation between exportation and economic growth over time, as export revenue supports industrialisation objectives (Lin, 2016).

Contrary to conventional classical theories that view external factors (such as capital investments, labour and natural resources) as core drivers of economic growth, the endogenous growth theory contends that internal factors within an economy (such as the development of skills, human capital and investment in R&D) lead to higher productivity levels which increase output and income, thus boosting long-term economic growth (Ribeiro et al., 2004). Various scholars purport that a country's capacity to absorb technological and intellectual advancement, together with sound institutional policies aimed at promoting R&D, education and innovation, play a crucial role in determining the depth and pace of international trade benefits over time

(Chamarbagwala, Ramaswamy & Wunnava, 2000 & Van Pottlesberghe & Guellec, 2001). Critics of the theory argue against the usefulness of a blanket application due to variations in business practices, resource endowment, levels of development, and stability of financial and political frameworks across countries. Moreover, nations benefit differently from distinct forms of human capital development across industries; for example, returns from investment in education in France were found by Monteils (2002) to have a negative correlation with economic growth, whilst investments in science, technology and research centres in China facilitated learning and indigenous innovation which allowed the ICT sector to leap forward and progress towards the successful establishment of brands like Xiaomi and Huawei that lead in the global market (Grimes & Sun, 2016). Cimoli and Correa (2002) argue that trade and export strategies cannot be a transformative vehicle for growth if the domestic market is inadequately developed to absorb the benefits. Nations contribute to economic growth by spending money on education, R&D and infrastructure services to support capacity building and technical competency development (Zahonogo, 2017).

The endogenous growth theory gives academics a theoretical framework for investigating and analysing the relationship between trade openness and economic growth. However, studies still show mixed results when describing the precise mechanism through which trade influences economic growth for different economies and across different industries. Despite this limitation, endogenous growth theory is widely used in empirical research, with its devised variable, development of skills, human capital and investment R&D, providing a valuable framework to explore the relationship between knowledge and technological diffusion within the high-technology sectors of various countries and economic growth. As this study focuses on high-technology industries, endogenous growth theory is suitable to empirically test if the hypotheses hold true for the automotive industry within SA. Due to skills constraints and limited investments in R&D in SA, the study assesses how the development of skills, human capital and investment in R&D influence economic growth.

2.3 EMPIRICAL REVIEW

In a comprehensive cross-country analysis spanning three decades (1970-1997), Yanikkaya (2003) actively investigates the correlation between trade openness and economic growth. Utilizing various trade openness measures, including trade intensity ratios and trade barriers, Yanikkaya employs regression analysis to reveal a positive and significant correlation between trade intensity variables (trade share, import penetration ratio, exports as a share of GDP) and economic growth. The findings support theoretical expectations that emphasize the facilitative role of trade openness in economic growth. However, Yanikkaya underscores the complexity of the relationship, noting mixed results due to varying descriptions of trade openness for different countries.

Sakyi and Egyir (2017) investigated the correlation between trade openness, exports, FDI, and economic growth in 45 African countries (1990-2014). Using an endogenous growth model and a dynamic system GMM technique, the study concludes a positive relationship, supporting channelling FDI towards African nations for export-oriented growth. Control variables indicate positive impacts of local investments and government spending on economic growth, while institutional quality and inflation lack such correlation. Banday et al. (2021) similarly find a long-term positive correlation between FDI, trade openness, and economic growth in BRICS countries (1990-2018) using the ARDL model. Key findings support the idea that exports drive increased output and economies of scale, fostering comparative cost advantages. Using the ECM, Akinlo (2004) distinguishes FDI in Nigeria to conclude that extractive FDI insignificantly affects economic growth compared to export-centric manufacturing FDI (1970-2001). Results highlight the labour force and investments in human capital's substantial impact on economic growth, supporting arguments that manufacturing FDI, backed by education policies promoting skills and human capital development, drives technological transfers and efficiency escalation. In a study focusing on 50 African countries from 1980 to 2009, Gui-Diby (2014) argues that FDI has had a positive impact on economic growth in Africa despite limited levels of human capital, particularly from 1995 to 2009.

Akinwale et al. (2012) utilizes the least square method (LSM) to scrutinize the impact of R&D, innovation, labour, and capital on Nigeria's economic growth (1977-2007). The study identifies a positive correlation between labour and capital and economic growth, underscoring the stronger influence of labour (Muhammad, Usman & Zafar, 2016). It recommends governmental dedication to funding R&D, fortifying institutions, fostering academia-industry links, and implementing a robust science, technology, and innovation policy for economic diversification and growth. Fankem & Oumarou (2020) employ the generalized moment method (GMM) to assess trade openness's impact on economic growth in 40 Sub-Saharan African nations (1989-2012). Findings suggest trade openness contributes to economic growth but may be insufficient without support for human capital development, infrastructure, physical capital investment, and R&D. Hiroyuki, Nguyen, and Pham (2018) advocate greater investment in education to expedite technological advancements, akin to East Asia and Thailand. The study underscores the significance of skills and human capital development, R&D investment, and increased domestic value added for sustainable economic growth.

Daumal and Özyurt (2011) investigate trade openness and economic growth across 26 Brazilian regions, incorporating control variables: human capital development, income level, physical capital investments, and workforce growth rate. Covering 1989 to 2002, the study, using the GMM estimator, concludes that states with high initial income levels per capita and abundant skilled human capital benefit the most from trade liberalization. Kong et al. (2021) affirm this advantage in China, attributing it to the absorption capacity of a trained and skilled workforce compared to an unskilled one. Scholarly investigations into East Asia and Thailand provide robust evidence of achieving economic growth through investments in skills, human capital development, R&D programs, and export-oriented strategies. Asada's (2022) research explores the relationship between economic growth and channels of technology diffusion, such as trade openness, FDI, and human capital development, focusing on the absorption capacity and human capital development in the Thai automotive industry. Using an ARDL model, the study finds a positive correlation between trade openness and, human capital development and economic growth.

Kong et al. (2021), employing the ARDL model in a study on China (1994-2018), reveal a positive correlation between trade openness and economic growth. These studies find similar results to past research identifying a positive correlation between China's trade openness policies and economic growth. The study by Kong et al. (2021) argues that regions with established infrastructure and skilled human capital show more significant and positive correlations than less developed regions. The government's deliberate emphasis on infrastructure development and investment in science and technology are the main factors influencing growth in the case of China. This supports the theory that such policies aid in disseminating technological advancements, crucial for enhancing productivity factors and fostering economic progress (Hiroyuki, Nguyen & Pham, 2018).

Wuttke's (2021) examination of Thailand's automotive industry underscores how government-supported international trade policies empowered Japanese Tier 1 suppliers to elevate technical education and ignite the growth of local suppliers, fostering practical skills and propelling economic growth. Purposeful initiatives nurtured human capital, driving the successful advancement of Thailand's automobile sector. Aligning with strategies in East Asian nations, Thailand strategically enhances technological capabilities through a guided framework and cultivating collaborative relationships with foreign investors. This joint effort encompasses skills training, institutional coordination, and industrial cluster programs by tier 1 MNC Japanese suppliers and tier 2 domestic suppliers, resulting in increased technical capability through active learning, ensuring sustained sector growth (Monaco et al., 2019). China mirrors this approach in its ICT industry strategy, forging strategic partnerships with local learning institutes and establishing special economic ICT zones to facilitate R&D, bolstering innovation and ensuring sustained sector growth. Prioritising policies that promote increased efficiencies and higher domestic value added is crucial for emerging economies Hiroyuki, Nguyen and Pham (2018). In their study, Hiroyuki, Nguyen and Pham (2018) advocate for greater investment in education to foster skill development, which can accelerate technological advancements, as seen in East Asia and Thailand. Despite structural constraints, developing markets can gradually improve their productivity through these catch-up mechanisms for capacity building.

Despite evidence from studies showing a positive correlation between trade openness and economic growth, Cimoli and Correa (2002) analyze Latin America's case, focusing on the post-trade reform period (1970-1999) in seven countries. Despite adopting export-promoting strategies, these nations failed to achieve growth comparable to the ISI phase, indicating that liberalization did not deliver promised growth benefits. The study examines variables like the balance of trade, technological diffusion effects on productivity, and import-export development and observes that the balance of trade is declining despite adopting export promotion policies, leading to average export growth. Despite export promotion, the declining trade balance suggests heavy reliance on imported technology with limited local absorption or development. Latin American countries' inability to fully benefit from trade liberalization and FDI flow results from the nature of the industry and limited R&D investment, hindering growth and widening productivity gaps between local and international markets. The study supports the idea that trade and export promotion alone cannot drive industrialization or economic growth. Structural reforms, including investments in human capital, skills, R&D, and the development of domestic markets, are essential for sustained long-term growth.

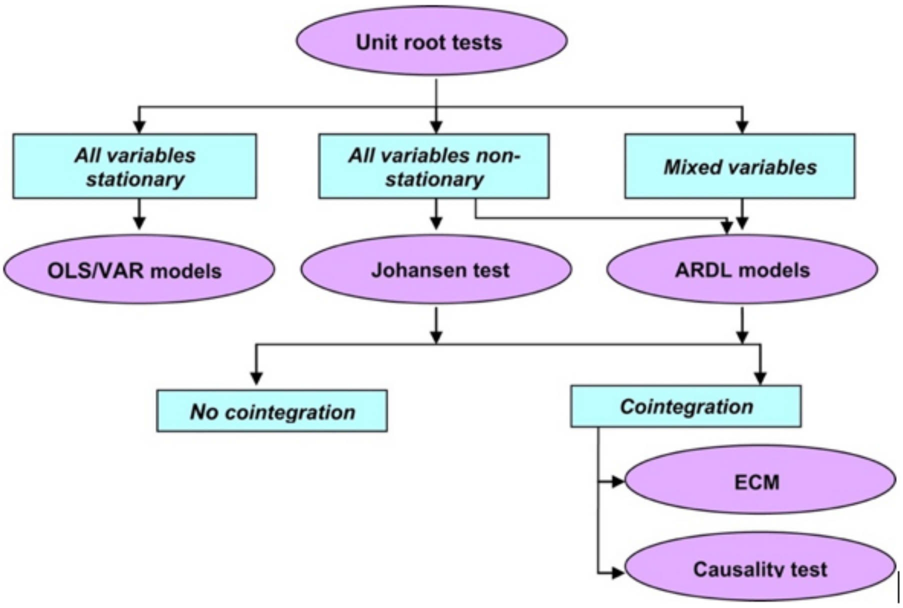
Kim (2011) employs the instrumental threshold regression technique on data from 61 developed and developing countries spanning 1960 to 2000. The study clarifies reasons why low-income or developing countries struggle to fully capitalize on the benefits of trade openness. This struggle is attributed to less-developed financial systems, distorted government policies, weak institutions, and a lack of capacity to absorb technological diffusion. Kim (2011) concludes that developing countries experience a negative correlation between trade openness and the economy, whereas high-income countries demonstrate a strong positive correlation. Durfrenot et al. (2009) contradict Kim's (2011) assertion, noting mixed correlations and that the impact is more significant for low-growth countries as opposed to high-growth ones, justifying trade openness for developing countries. However, the study concludes that the correlation differs by country and level of economic development. Unique elements of each country, such as resource endowment, skill level, and competence of its domestic market and trade policies, influence economic growth.

A study conducted by Zahonogo (2017) analysed the data from 42 developing SSA countries from 1980 to 2012 using the pooled mean group (PMG) technique. The findings reveal a non-linear U-shaped relationship between trade openness and economic growth in SSA countries. Zahonogo (2017) emphasizes the existence of a critical threshold, below which inadequate investment in human capital and dysfunctional structures hinder technological advancement and absorption capacity, impeding the progress of developing countries in deriving benefits from trade openness and FDI inflows. Similarly, they provide a major take away that inadequate investment in human capital and dysfunctional structures can hamper technological advancement and absorption capacity, hindering progress made by developing countries to derive benefits from trade openness and FDI inflows.

Wani (2022) investigates the relationship between trade openness, capital formation and economic growth in India from 1993 to 2019. The study uses the ARDL technique to reveal a negative correlation between trade openness and economic growth in the short and long term. This finding contradicts theoretical frameworks that assert that trade liberalisation and export-promoting strategies induce economic growth, especially for developing countries. The findings by Wani (2022) are consistent with those of Kumari, Soomro and Kumar (2022), who identify no long-term correlation between FDI, trade openness and economic growth in India from 1985 to 2018.

Rodríguez and Rodrik (2001) challenge the difficulty of comparing trade openness correlations across nations, citing discrepancies in definitions, varied trade policies, data quality issues, and methodological differences. However, Yanikkaya (2003) finds the argument by Rodríguez and Rodrik (2001) unpersuasive. Despite methodological issues, there is no compelling evidence that trade openness is detrimental to economic growth. Ulasan (2015) additionally introduces an averaging technique to address data quality issues, while Shrestha and Bhatta (2018) present a methodological framework for robust data and correlation analysis (see Figure 2.1).

Figure 2.1: Method to select an appropriate model for time series data



At Level I (0)

Method selection for time series data. OLS: Ordinary least squares; VAR: Vector autoregressive; ARDL: Autoregressive distributed lags; ECM: Error correction models.

Source: Shrestha and Bhatta (2018).

Evidence from empirical studies, however, shows that the benefits from international trade are not automatic nor equal for all countries. Benefits require a conducive environment that promotes overall economic development. For developing nations, the key insight is prioritizing high-value processes in pursuing sustainable development and industrialization. Simply exporting without a clear goal to enhance value-added contribution limits economic impact. Despite mixed findings, this study demonstrates that trade openness fosters global market integration, supporting economies of scale and economic growth. While not all countries uniformly benefit from relaxed trade policies, most studies affirm a positive correlation between trade openness and economic growth, with disparities in impact assessments (Chang & Lin, 2009; Kim, 2011; Kumari et al., 2022; Wani, 2022).

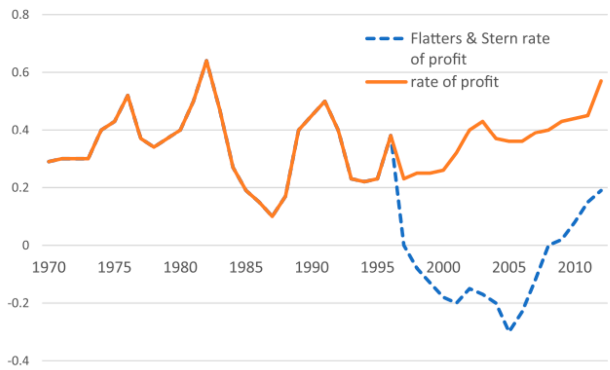
Gossel and Biekpe (2013) examine the trade, capital inflows, and economic growth relationship in South Africa from 1995 to 2011, using the Toda-Yamamoto and Dolado-Lutkepohl (TYDL) test. They argue that South Africa's economic growth is predominantly driven by trade, especially exports and fixed investments, indicating a positive correlation. Ajmi et al. (2015) support this, finding a positive correlation between South Africa's exports and economic growth through a granger nonlinear causality test. Despite export increases, challenges persist due to past distortions from the Import Substitution Industrialization (ISI) strategy. Gossel and Biekpe (2013) reveal that South Africa's education system negatively affects labour efficiency, limiting industrial productivity and innovation progress. Additionally, higher labour costs result in capital instead of labour-intensive manufacturing. When examining imports, Gossel and Biekpe (2013) find a weak correlation between imports and long-term economic growth, contradicting the idea that importing high-technology goods accelerates economic development through technological diffusions, as Kneller et al. (2008) proposed.

Low production levels historically characterise the automotive industry in South Africa, as well as limited local value-added content and high costs (Lamprecht, Rudansky-Kloppers & Strydom, 2008). These traits were due to the assembly of various models and the government's implementation of an inward-oriented import substitution strategy to reduce dependency on foreign markets. This strategy, not unique to South Africa, aimed at reducing dependency on foreign markets but proved unsustainable due to stagnant local market growth, restrictive trade policies, and uncompetitive production techniques. Post-democracy, the government shifted focus towards a manufacturing export approach, intending to integrate the country into global markets and drive growth through value-added exports (Barnes & Morris, 2008; DTIC, 2014).

The 1995 introduction of the Motor Industry Development Programme (MIDP) marked a strategic shift, gradually integrating the sector into international markets (Lamprecht et al., 2008). MIDP aimed to incentivize increased vehicle and component production, stimulate exports, and contribute to economic development. Measures included eliminating minimum local component quotas, reducing import duties, and introducing tradable rebate credit certificates. While resulting in increased production and exports, scholars argue the reforms may have been too drastic, with export performance falling short of expectations and failing to address ISI strategy inefficiencies (Mosikari, 2013; Wuttke, 2021).

Masondo (2018) contends that South Africa's automotive industry, marked by trade openness, transformed into a 'nanny' state rather than a development state. Assessing the sector from 1995 to 2010, Masondo (2018) cites evidence such as the General Agreement on Tariffs and Trade (GATT), reduced local content requirements, tariff reductions, and government incentives as indicators of trade openness. Despite improved export and investment performance under the Motor Industry Development Programme (MIDP), Masondo (2018) argues that the integration into global markets has imposed significant financial burdens on the state, with estimates suggesting over R100 billion in industry support from 1995 to 2008 in the form of import rebates and investment grants. This income results in assertions that the sector would not have made a profit between 2000 and 2008 if not for MIDP (see Figure 2.2.) (Flatters and Stern, 2008).

Figure 2.2: Automotive industry rate of profit without MIDP



Source: Masondo (2018).

Barnes, Black and Techakanont (2017) outline several challenges facing South Africa's automotive industry, including its unfavourable location, limited local market growth, insufficient technical skills, an undiversified components market, and heavy foreign ownership. These factors place the industry at a significant disadvantage compared to global competitors. Despite government efforts outlined in the South African Automotive Masterplan 2035, the country lags behind Thailand in production and export volumes and industry localization. While South Africa attracted substantial multinational investment at the tier 1 level, the failure to establish a robust locally owned sub-supplier base, as seen in Thailand, results in low production volumes and a weak domestic supplier market, undermining the intended competitiveness of the manufacturing export sector (DTIC, 2014).

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Like other developing countries, trade openness in SA supports the sector's integration into the international market, as evidenced by a significant inflow of automotive FDI and an increase in exports (Barnes & Black, 2013). However, export growth does not fully translate into local suppliers' development as the government intended (DTIC, 2014) or economic growth (Masondo, 2018). Despite the inflow of FDI and technological diffusions, the domestic market remains constrained by limited skills and technical competency to absorb technological diffusions (Barnes et al., 2017), calling into question the significance of international trade benefits on the sustainable development of the industry in SA.

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2.4 SUMMARY OF LITERATURE REVIEWED

The literature review and empirical studies reveal a complex and multifaceted relationship between trade openness and economic growth. While a complex relationship exists between trade openness and economic growth, the classical growth theory provides a foundational framework for how trade openness can help nations achieve economic growth. Trade openness is essential in facilitating the flow of FDIs in developing markets. This opens new market avenues for developing countries, improving their productivity, innovation and economies of scale. Importing high-technology industries has been a dominant strategy for developing countries, resulting in a diffusion of knowledge and skills transfer, which supports the learning economic growth of sectors and/or countries. However, achieving economic growth through trade liberalisation is not automatic and requires a multi-faceted approach from policymakers that incorporates innovation, productivity and value-added strategies that embrace the unique structural characteristics of each country and its developmental needs. The development of skills, human capital and increased investment in R&D has the most potential for sustainable growth in the long-term and should be prioritised in policy reforms.

Since the benefits from trade openness have not accrued automatically or equally across developing countries, its measurement concerning economic growth is complex. Empirical studies demonstrate that the degree to which developing countries improve their level of education, R&D, sound governance and infrastructure impacts the technical competency of the local market. Countries that concentrate investments in skills development and learning centres accelerate their development and ability to absorb foreign technology, showing stronger evidence of the economic growth that this study seeks to measure for SA using an inexhaustive list of variables used in empirical studies due to the absence of a theoretic framework.

Through a review of theory and analytical frameworks, this study hypothesises a specific question that investigates the impact of trade liberalisation on economic growth of SA's automotive industry. The study examines the correlation between trade openness and economic growth, with the research design aimed at determining whether post-1994 changes in the trade policy environment of SA's auto industry, specifically the sector's increased openness to global market influences, have impacted SA's economic growth. The Empirical evidence suggests several metrics to measure the relationship between trade openness and economic growth. These include trade openness variables, the impact of fdi on export-oriented growth, the role of imports in the manufacturing process, R&D, human capital development and technical capability and absorption skills contribution to technological advancements. Though these variables are not exhaustive, they form a basis for our research study.

The main challenge cited in empirical studies as a constraint to trade openness is the complexity of establishing a direct link between trade openness and economic growth. This is due to trade openness metrics being highly correlated to economic development factors and other growth-promoting policies (Rodriguez & Rodrik, 2001). To mitigate this, the study employs control measures to eliminate the effect of other determinants of economic growth and holds them constant alongside its assessment of the relationship between economic growth and trade openness. Using theories and hypotheses, this study seeks to validate that economic growth (dependent variable) changes in response to changes in trade openness, the inflow of foreign direct investment and capital investments (independent variables) when other auxiliary variables are controlled, such as research and development investments, government spending of education as a proxy for human capital development and labour productivity. This study makes a fundamental assumption that such a relationship exists and can be observed over a period of time.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter specifies the methods and frameworks used by the study to address the research questions and hypotheses, along with the rationale for their selection and any evident limitations. The following subsections expand on the literature review by recapping the main focus of the study, outlining the research approach, and justification for the strategy and design used. The collected data variables built into the econometric models and analytical framework are described in detail, as are the sample size and period. An explanation of the estimation technique employed, its robustness, limitations and the control measures used to improve data reliability is also given. This chapter details the research methodology and justification for the data-collection and analysis methods and assesses the validity and appropriateness of conclusions drawn from the research findings.

3.2 RESEARCH APPROACH AND STRATEGY

The main objective of this quantitative regression study is to establish a relationship between trade openness and economic growth by addressing whether trade liberalisation of South Africa's automotive industry led to economic growth for the country between 1992 and 2021. This question serves as the foundation of the research and influences its approach and strategy. To address this question, the study uses the vector error correcting model (VECM) as used by (Keho, 2017; Wani, 2022). Given the drawbacks of using a qualitative method for causal extrapolation and correlation analysis, this study uses a quantitative approach based on secondary data as a descriptive plan for the research. A quantitative approach is further justified by its deductive[2] strategic approach to testing theoretical and analytical frameworks through numerical analysis and its attempt to clarify and answer the research questions using a hypothesised economic model based on empirical studies. The next section details the modelling framework and describes key variables already explored in the empirical research.

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[2] According to Bradford (2017), a study is considered deductive when it focusses on evaluating theories and hypotheses in order to draw a conclusion of validity.

3.3 MODEL AND VARIABLE SPECIFICATION

Using the foundation principles of the new growth theory and the Cobb-Douglas production function of the automotive manufacturing sector in SA, economic growth is assumed to be a function of capital flows, labour productivity and technological advances (Muhammad et al., 2016). The following formula represents the study's measure of economic performance:

$$Y = A\ (L, K) \qquad (1)$$

Where:

Y is the aggregate output;

A represents technological advances or the total factor productivity;

L is labour; and

K is capital inputs.

The Cobb-Douglas production function is expanded to reflect how the dependent variable *(y)* changes in response to deviations in independent variables (A, K, L) represented by *(x)* measured over a period of time. To adapt the model to represent those used in empirical studies, the study considers variables (denoted by z) that might influence fluctuations of y and controls for them. The following regression model is an expansion of equation (1) and is denoted by:

$$y_t = \beta_0 + \sum_{i=1}^{p} \delta_{1i} y_{t-1} + \sum_{i=0}^{q} \beta_{1i} \bigtriangleup x_{t-1} + \sum_{i=0}^{q} \beta_{2i} \bigtriangleup z_{t-1} + \mathcal{E}_t \qquad (2)$$

Where:

$y_t =$ represents the dependent variable

$\beta_0 + \sum_{i=1}^{p} \delta_{1i} y_{t-1}$

$=$ represents the value of y, when the value of X and Z is 0 (y − intercept)

$\beta_{1i} - \beta_{2i}$

$=$ represents the degree to which a change in Y is a result of a unit change in X or Z

$\bigtriangleup x_{t-1} =$ represents the change in independent variables that are used to explain changes in Y

$\bigtriangleup z_{t-1}$

$=$ represents the change in control variables that are used to explain the change in Y

$\mathcal{E}_t =$ represents the error term in predicting Y

From empirical studies, technological advancements (denoted by A) represent diffusions that flow as a result of trade openness (Cimoli & Correa, 2002; Gallardo, 2005) and foreign direct investments (Asada, 2022). Capital assets and labour (denoted by K and L) significantly impact economic growth. Alongside technological advancement, these factors constitute the independent variables in the model, as highlighted by Zahonogo (2017) and Keho (2017). Additionally, the model considers control variables, which include investment in R&D, as measured by Kong et al. (2021) and government spending on education, which is used as a proxy for skills and human capital development, as measured by Sakyi and Egyir (2017), as these are believed to influence economic growth as a result of trade openness. This study thus expands equation (2) by adding variables into the statistic equation. Additionally, the study uses logarithmic conversion of parameters to correct for any data skewness and a better understanding of estimated elasticities.

$$y_t = \beta_0 + \sum_{i=1}^{p} \delta_{1i} LAuto\ GDP_{t-1} + \sum_{i=0}^{q} \beta_{1i} \Delta Ltrade_{t-1} + \sum_{i=0}^{q} \beta_{2i} \Delta LFDI_{t-1} + \sum_{i=0}^{q} \beta_{3i} \Delta Lcapex_{t-1} + \sum_{i=0}^{q} \beta_{4i} \Delta Llabour_{t-1} + \sum_{i=0}^{q} \beta_{5i} \Delta Lgovexp_{t-1} + \sum_{i=0}^{q} \beta_{6i} \Delta LR\&D_{t-1} + \varepsilon_t \quad (3)$$

Where:

y_t = represents automotive Gross Domestic Product (our dependent variable)

trade = represents trade openness

FDI = represents foreign direct investments

capex = represents capital expenditure (investment in assets)

labour = represents labour productivity

govexp = represents government spending on education

R&D = represents spending on research and development

With L = represents the logarithmic conversion of the parameters

Equation three represents the final model used in the study to measure the correlation between trade openness and economic growth. Similar studies use comparable models to examine the existence and significance of a correlation between trade openness and economic growth, such as Keho (2017), Kong et al. (2021), Udeagha and Ngepah (2021) and Wani (2022), for Cote d'Ivoire, China, South Africa and India respectively. This study follows a similar approach and assesses the model's suitability.

The dependent variable in the model is gross domestic product (GDP), measured in millions of rands and based on 2015 constant values seasonally adjusted to quantify the sum of a country's value-added in a particular year. For this study, real GDP has been adjusted to reflect auto GDP. This is calculated by multiplying real GDP with the automotive industry's broad share of GDP. The SARB database is used to obtain real annual GDP data for the period Q1 1992 to Q4 2021, with the percentage contribution of GDP attributed to the automotive industry collected from various National Association of Automobile Manufacturers of South Africa (NAAMSA) and Automotive Industry Export Council (AIEC) reports and secondary data from Mashilo's (2019) study based on the same reports.

The study considers the independent variable of trade openness (denoted as *trade* in the model), which measures the growth rate of exports and imports as a percentage of GDP per quarter. The information is presented as a ratio and reflects automotive industry exports and imports. The study uses automotive GDP and multiplies it by exports and imports as a percentage of GDP. The information for imports and exports as a percentage of GDP is sourced from the World Bank open data for 1992 to 2021, using an adjustment applied to the automotive GDP to gain a quarterly automotive approximation. Studies have used quarterly data from the Department of Trade, Industry and Competition's (DTIC) harmonised system codes for the automotive industry and reports by NAAMSA and AIEC for various years. However, the study opted for the approximation due to substantial missing data in the case of imports and exports from 1992-2008. The trade openness variable i expected to show a positive or mixed correlation with economic growth.

The other independent variable is foreign direct investments, presented in millions of rands and denoted by *fdi*. FDI is measured using information sourced from the World Bank open data, net FDI inflow as a percentage of GDP, and applied to automotive GDP to get an automotive industry FDI approximation. Gossel & Biekpe (2013) use databases for direct investment liabilities (DIL) over real GDP and gross capital formation; however, DIL or gross capital formation values often reflect results for SA as a whole, and this could not be moderated for the automotive industry. FDI is expected to positively correlate with economic growth, owing to the flow of technological diffusions.

The next independent variable is capital expenditure, which represents investments in capital assets and is denoted by *capex*. This is measured in millions of rands. The information is sourced using NAAMSA and AIEC reports (AIEC 2022) of various years and secondary data from research conducted by Barnes and Morris (2008) and Mashilo (2019), also based on NAAMSA and AIEC reports. Capex includes physical and intangible asset investments made by component and vehicle manufacturers in the industry and used to produce goods or services. Capex is expected to have a positive correlation with economic growth.

Labour productivity, denoted as *labour*, refers to the value-added contribution by the automotive industry workforce to automotive GDP. The information is presented as a ratio, calculated as the automotive GDP over the number of those employed in the sector. The number of people employed in the sector represents the workforce used in the production process to achieve economic benefits and is a quarterly equivalent of monthly averages for the period Q1 1992 to Q4 2021. The information is sourced from NAAMSA and AIEC reports (AIEC 2022) of various years, with secondary data from Barnes and Morris (2008) and Mashilo (2019), which is also based on NAAMSA and AIEC reports.

The study considers two control variables based on empirical findings and data availability. These include research and development (R&D) and government expenditure on education. Research and development (denoted by *r&d*) measured the sum of all expenditures incurred by the government, research centres, academic institutes and companies. This variable represents values in millions of rands and is calculated using percentage allocations obtained from the World Bank open data for R&D as a percentage of GDP multiplied by the auto industry GDP. The information is sourced from annual figures moderated to support the research time series of Q1 1992 to Q4 2021. R&D is expected to have a positive correlation with economic growth, based on the empirical literature.

The final control variable is government spending on education, denoted by *govexp*. This variable serves as a proxy for skills and human capital development. Govexp is measured as a logged value in millions of rands and sourced from the World Bank's open data. This variable is calculated using government spending in education as a percentage of GDP multiplied by auto industry GDP. Govexp is expected to positively correlate with economic growth, as evidence from empirical studies shows. Table 3.1 summarises all variables, their data source and their correlation to economic growth. All values are logged to adjust for data skewness and departures from a normal distribution, allowing for more trustworthy statistical analysis and interpretations.

3.4 DATA COLLECTION, SAMPLE PERIOD AND SELECTION

The study utilises secondary data from South Africa's automotive industry to evaluate the correlation between trade openness, domestic value added through participating in GVCs and economic growth and to answer the hypotheses and research questions. The quarterly time series data is collected for Q1 1992 to Q4 2021 and uses a sample size of 120 observations. This period was selected due to the introduction of MIDP in 1995: a trade liberalisation policy aimed at transforming the automotive industry; as well as the availability of data for the variables of interest. Variables were selected based on empirical studies and theoretical frameworks already discussed in the literature review. The variables are summarised in the tables below.

Table 3.1: Measurement and definition of variables used in assessing trade openness and economic growth

No.	Variable	Measure	Description	Expected Correlation	Source
1	Economic Growth (Rmillion, 2015 constant)	**Auto GDP**	Measured as real GDP* percentage of the broader contribution to GDP by the automotive industry, resulting in **auto GDP**.	Dependent variable being measured	SARB*, AIEC/NAAMSA**, Mashilo (2019)
2	Trade Openness Ratio	**Trade**	Measured as (exports + imports)/automotive GDP. Exports and imports represent automotive equivalents.	Positive, Mixed[3]	World Bank open data*** and SARB* AIEC/NAAMSA** Mashilo (2019) *calculated by author*
3	Foreign Direct Investment Rmillion	**FDI**	Measured as auto GDP* net FDI inflow as a % of GDP.	Positive	World Bank open data*** and SARB* AIEC/NAAMSA** Mashilo (2019) *calculated by author*
4	Capital Input Rmillion	**Capex**	Measured as capital expenditure. (Investment on physical and intangible assets).	Positive	AIEC/NAAMSA** Barnes & Morris (2008) Mashilo, 2019
5.	Labour Productivity Ratio	**Labour**	Measured as auto GDP / total labour in the automotive industry (value added per worker).	Positive	SARB*, AIEC/NAAMSA** Barnes & Morris (2008) Mashilo, 2019
6	Research and Development Rmillion	**R&D**	Measured as auto GDP* R&D expenses as a % of GDP.	Positive	World Bank open data*** and SARB* AIEC/NAAMSA** Mashilo (2019) *calculated by author*
7	Government spending education Rmillion	**Govexp**	Measured as auto GDP* government spend in education as a % of GDP.	Positive	World Bank open data*** and SARB* AIEC/NAAMSA** Mashilo (2019) *calculated by author*

**South Africa Reserve Bank. **NAAMSA/AIEC annual reports (AIEC, 2022). ***World Bank Open Data.*

Source: Mashilo (2019) and Barnes and Morris (2008).

[3] Given that the correlation between trade openness and economic growth in studies remains mixed, the expectation was hoped to be positive as per theoretical assumptions can also be mixed.

3.5 PRELIMINARY OF THE REGRESSION ANALYSIS

The preliminary regression results are organised around the abovementioned research questions. The following structure is used for the results of each question of interest: a descriptive statistical analysis, correlation review, multicollinearity assessment using variance inflation factor (VIF), unit root test, lag selection, cointegration assessment, main regression review and diagnostic tests.

3.5.1 Descriptive statistics, correlation and multicollinearity

The data is presented in a logged form to correct any data skewness and to normalise the data. Additionally, the data is subject to descriptive statistical analysis, correlation and variance inflation factor (VIF) to access multicollinearity. Upon examination of the descriptive statistics, as detailed in the results in Chapter 4, the regression model commences with an evaluation of the linearity among the variables using a correlation table. According to Kim (2019), a[a] correlation range in excess of a 0.8 threshold signals the existence of multicollinearity among the variables. Correlation exceeding this threshold indicates a high intercorrelation between independent variables, rendering the matrix unreliable and distorting the regression model's results. Given that the results of the correlation table show the interconnectedness of the variables above 0.8, the variance inflation factor (VIF) is used to measure the extent of multicollinearity, as depicted in Table 4.4 and Appendix A. Variables with a centred VIF value in excess of 10 are considered problematic. The current variable assessment shows evidence of multicollinearity, necessitating the removal of highly correlated metrics from the model. To address this, a process of elimination was applied to remove the variable with the highest centred VIF, calling for the [a]removal of FDI and govexp from the model, which have a measure of multicollinearity exceeding 10. Removal of govexp allows the analysis to proceed, using an adjusted model as follows:

$$y_t = \beta_0 + \sum_{i=1}^{p} \delta_{1i} LAuto\,GDP_{t-1} + \sum_{i=0}^{q} \beta_{1i} \Delta Ltrade_{t-1} + \sum_{i=0}^{q} \beta_{2i} \Delta Lcapex_{t-1} + \sum_{i=0}^{q} \beta_{3i} \Delta Llabour_{t-1} + \sum_{i=0}^{q} \beta_{4i} \Delta Lr\&d_{t-1} + \mathcal{E}_t \qquad (4)$$

After adjusting the model per the results of multicollinearity, analytical tests are performed to justify the model selection. The study tests for stationarity using the unit root test to determine if the variables are stationary at level I (0) or first difference I (1). If any variable is stationary at I (2), the VECM model cannot be used. Evidence from studies shows that the bounds test, Augmented Dickey-Fuller (ADF), and the Phillips-Perron (PP) tests are the most commonly used models to assess Unit Root. After confirming the stationarity of the variables of the same order, the optimal lag level is determined. Following this, a cointegration test is performed to assess the presence of a long-run relationship between the variables. Depending on the results of the cointegration model, the study proceeds with the model estimation using the VECM in both the short and long term.

The literature section shows various methods the study can employ to investigate the relationship between trade openness and economic growth. The results of the stationarity and cointegration tests confirm justification for the selected model. The appropriate model is subject to a diagnostic and stability test performed using Microsoft Excel and EViews software to verify robustness, accurate specification and stability.

3.5.2 Unit root test

It is imperative to test the dataset for stationarity before applying a regression model, as failure to test for stationarity tends to lead to spurious results, meaning the model fails to give the correct analysis (Banga, 2022). A recommended statistical approach is the unit root analysis, which should be performed before further analysis. Various techniques are available for unit root analysis, with the bounds test, Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) methods most prominent in the literature. The null hypothesis of the unit root test asserts the existence of a unit root indicating non-stationary when the probability value exceeds 5% significance level. Rejection of the null hypothesis indicates that variables are stationary at a significant level of less than 5%. In this study, all the variables for trade openness and economic growth analysis are found to be non-stationary at level 1(0) using the ADF tests but become integrated at first different 1(1), justifying the use of the VECM model. This is discussed further in the results section. These results justify the use of the Johansen cointegration test to assess the long-run relation between variables. These results are discussed in detail in the results section, with raw data in Appendix B.

3.5.3 Lag selection

The lag length of the unrestricted VAR model is determined using five (5) different lag selection criteria, including the likelihood ratio (LR), final prediction error criterion (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ). The selection of lags is influenced by the maximum criteria, using the selection methods mentioned above (Sharp, 2010). Though this contradicts the results of the AIC, to preserve the degree of freedom however and balance the goodness of fit as suggested by the HQ criteria, a lower lag selection of 2 will also be reviewed, albeit on a high level. The results of the lag selection are discussed in Chapter 4.

3.5.4 Cointegration testing: Johansen cointegration test

The Johansen cointegration test is valuable for analysing the long-run relationships among multiple time series variables. The test results determine whether cointegration exists and provide information about the number of cointegrating vectors, which can be crucial for economic modelling. After verifying the stationarity of variables, the next step is to establish a cointegration correlation between them. This aids in determining whether any variables share a common trend and provides evidence of short- and long-run information among them (Nkoro & Uko, 2016). The aim, in this case, is to evaluate whether the dependent variable economic growth is integrated in the long run with independent variables, such as trade, capex, labour and R&D. As variables are integrated of the same order, i.e. are not of a mixed order of integration I(0) and I(1), the Johansen test of cointegration will be used to evaluate the long-term correlation , where the null hypothesis states that at:

$\boldsymbol{H_0}$: **no cointegrating exists** or $\boldsymbol{H_1}$: $\boldsymbol{H_0}$ **is not true**.

Based on the decision criteria for Johansen cointegration tests, the null hypothesis is rejected if the trace and maximum-eigen statistics values are less than or equal to 5% critical value and conclude that a long-term relationship exists and can be tested for in this model. Regarding trade openness and economic growth, the Trace and Max-eigen statistics are confirmed as less than the 5% critical value. This result is based on the Johansen test using EViews, having determined the appropriate lags to use for the model using Akaike information criteria (AIC), sequential modified LR test (LR) and final prediction error (FPE). Therefore, the null hypothesis is rejected. However, when 2 lags are selected, only the Trace shows evidence of cointegration, thus long-term relationship. The existence of co-integration among the time-series data provides grounds for employing the VECM. As discussed in empirical studies, various methodological frameworks exist to aid the selection process of an appropriate regression model; however, this analysis is guided by Shrestha and Bhatta (2018).

Owing to the existence of a cointegration reflected in the results of the Johansen cointegration test and using the framework depicted in Figure 2.2 in the empirical studies, the study wishes to assess the long-term relationship. The VECM is used to assess the correlation between trade openness and economic growth and to determine the speed at which errors are corrected back to equilibrium, thus the dynamic error correction capabilities of the model (Wani, 2022). Using the formulas discussed above, the model is adjusted to assess the correlation using the VECM and ensure that error-correcting dynamics are incorporated.

Short-Run

$$y_{t} = Y_0 + \sum_{i=1}^{p} \delta_{1i} LAuto\ GDP_{t-1} + \sum_{i=0}^{q} \beta_{1i} \vartriangle Ltrade_{t-1} + \sum_{i=0}^{q} \beta_{2i} \vartriangle Lcapex_{t-1} + \sum_{i=0}^{q} \beta_{3i} \vartriangle LLabour_{t-1} + \sum_{i=0}^{q} \beta_{4i} \vartriangle Lr\&d_{t-1} + \varepsilon_t \qquad (5)$$

Long Run

$$y_{t} = Y_0 + \sum_{i=1}^{p} \delta_{1i} LAuto\ GDP_{t-1} + \sum_{i=0}^{q} \beta_{1i} \vartriangle LOPEN_{t-1} + \sum_{i=0}^{q} \beta_{2i} \vartriangle LCAP_{t-1} + \sum_{i=0}^{q} \beta_{3i} \vartriangle LLabour_{t-1} + \sum_{i=0}^{q} \beta_{4i} \vartriangle LR\&D_{t-1} + \beta_{5i}\, ECT_{t-1} + \varepsilon_t \qquad (6)$$

where: $\beta_{5i}\ ECT_{t-1}$ = represents the error-correcting term

The VECM model is used to assess correlation in both the short- and long-term, and its coefficient is represented by demonstrating the model's adjustment speed when correcting or returning to equilibrium. A negative error correcting test (ECT) indicates a convergence, which is the ability to adjust to equilibrium, whereas a positive coefficient indicates divergence, which is the deviation from equilibrium (Nkoro & Uko, 2016). This is significant because it prevents misleading correlations caused by non-stationary data and blends short-term dynamics with stable long-run data without compromising information (Shrestha & Bhatta, 2018). Results from the VECM model are discussed in detail in Chapter 4.

3.5.5 Diagnostic tests

The final step in VECM models is to perform diagnostic tests to check for the model's robustness, properties and validity. These tests ensure correct model specification. The diagnostic test results confirm various aspects of the VECMs, such as normality, heteroskedasticity and serial correlation. The test of normality mandates that errors follow a pattern of normal distribution, signifying unbiasedness in the estimation of parameters. This mandate is essential to confirm model credibility, as most statistic models assume that datasets conform to a normal distribution. Allende-Alonso et al. (2019) asserts that when data has a sample size greater than 30 or 40, the violation of normality is not considered a major problem, and parametric procedures can still be performed. Heteroskedasticity relates to variances that are neither constant nor equal across observations in the error terms of a regression model, which is problematic for any regression model as it renders the model invalid and underestimates the t-statistics values. Serial correlation tests for evidence of autocorrelation and describes errors that show reliance across time. Evidence of autocorrelation in a model can affect the accuracy and dependability of predictions of a model. If these assumptions do not hold, wrong inferences can be made about the data (Brooks, 2019). In summation, diagnostic tests are applied to determine the fit of the models employed and to assess whether model parameters remain stable across various data samples. Preliminary results show stable and robust models.

The preliminary results for trade openness (discussed in Chapter 4) show no evidence of autocorrelation or heteroscedasticity. The Jarque-Bera test of normality shows that the assumption of normal distribution should be rejected. However, owing to the large observation size for this research at 120 being greater than 30 or 40, and the results of skewness and kurtoses tests for each variable as contained in descriptive statistics, it can be assumed data follows a normal distribution and, if not, that the impact on statistic procedures will be insignificant.

3.6 METHODOLOGY LIMITATIONS

Due to limited data availability, specifically quarterly data, a statistic tool is applied to convert annual datasets into their quarterly equivalents. This conversion is achieved by applying the percentage share of GDP for variables representing South Africa to the equivalent quarterly automotive share of GDP obtained from the SARB databases. The percentage share for SA used as a proxy for the sector could slightly limit data accuracy from a sectoral perspective, though this is mitigated by applying the percentage share to automotive equivalent GDP. In cases of missing data for the period under study (Q1 1992 to Q4 2021), an averaging approach is adopted to recalculate the data; this could limit the study's ability to conclude the research questions for the automotive sector as a whole and to give 100% study accuracy due to the averaging adopted to standardise the time series. Given the industry's size in SA, justification is drawn that it is a significant contributor and that the study's findings will resemble the sector's current situation. Another limitation is the data quality, as the reliability and consistency of information collected from different databases cannot be confirmed at 100% accuracy, given that the study uses secondary data. However, this limitation is mitigated by the data sources' reputability. The study attempts to address the relationship between economic growth and trade openness. This measure of both variables presents some complexities due to the multidimensional element of the research and limited investigation in the field in the context of South Africa. These limitations restrict the use of some variables addressed in empirical studies due to the availability of data.

CHAPTER 4: RESULTS, DISCUSSION AND INTERPRETATION OF FINDINGS

4.1 INTRODUCTION

Chapter 4 correlates with the research objectives established in Chapter 1 and presents findings through a brief overview of descriptive statistics for all models employed. For the regression models, a review and discussion of results from the correlation matrix, unit root test, lag selection and cointegration follow. This review and discussion are followed by a review of findings from the models. To conclude the results section, diagnostic evaluations are performed to confirm the model's suitability in terms of theoretical frameworks.

4.2 DESCRIPTIVE SUMMARY

Table 4.1 below summarises the descriptive statistics for the datasets used in this study's evaluation of trade openness and economic growth – 120 observations are made covering the period Q1 1992 to Q4 2021. Samples of at least 120 observations are generally considered sufficient to represent the data distribution; however, the period covered could have been extended were more information readily available. The statistic measures calculated include the mean, minimum, maximum, standard deviation, skewness and kurtosis. The mean measures the centrality of the dataset and indicates the average of all variable values for the period Q1 1992 to Q4 2021. Another measure of centrality is the median, used in descriptive statistics to assess the central tendency unaffected by data skewness and outliers, giving a good idea of the stability of the mean value in a dataset. The standard deviation explains the spread of the dataset, where the standard deviation seems moderately lower than the mean for all variables, indicating that relatively the spread of the variables shows data as centred around the mean, so the dataset can be considered reliable. The kurtosis and skewness measures are observed to determine if the data is normally distributed (Hair et al., 2010). Kurtosis assesses flats or peaks of the graph in relation to a normal distribution, whereas skewness describes the angle at which the data is tilted (where right equals negative skewness, and left equals positive skewness). All variables match the criterion Hair et al. (2010) set that critical values for skewness and kurtosis fall within the range of +- 3, indicating that the dataset can be considered normally distributed.

Table 4.1: Descriptive statistics summary – trade openness and economic growth

Statistics	Auto GDP	Trade	FDI	Capex	Labour	R&D	Govexp
Mean	4.69	1.09	3.66	2.97	3.28	1.90	2.80
Median	4.72	1.10	3.76	2.96	3.26	1.98	2.78
Minimum	4.51	0.93	2.99	2.57	3.11	1.62	2.62
Maximum	4.82	1.22	4.10	3.39	3.39	2.09	3.04
Standard Deviation	0.10	0.07	0.37	0.24	0.09	0.16	0.13
Skewness	-0.32	-0.56	-0.31	-0.01	-0.17	-0.53	0.31
Kurtosis	-1.41	-0.38	-1.45	-1.14	-1.51	-1.37	-1.43
Observations	120.00	120	120	120	120	120	120

Source: Author's own calculation using MS Excel (2023).

Table 4.1 shows a mean value of 1.09 to 4.69, representing the average data points. The mean closely approximates the median, representing an average of about 98% of the median. This indicates that the dataset has a degree of relative symmetry and limited evidence of skewness, which strongly indicates data stability. Data stability and centrality with limited evidence of data abnormality are indicated through no evidence of outliers and a minimum and maximum range between 0.93 and 4.82. The observed standard deviations indicate data points grouped around the mean. As the average standard deviation is low, the dataset indicates less dispersion and instabilities. The values for skewness and kurtosis fall within the range of -3+3, signalling the centre and normality of the data. Both skewness and kurtosis values are in the -3 to +3 range, indicating that the data is centred and follows a normal distribution. The skewness value displays a negative tail, verifying the symmetry of the data. The close proximity of the skewness value to zero supports the symmetry of the data distribution, emphasising that the mean is 98% less valuable than the median. In summary, the descriptive statistics analysis reveals a dataset with consistent central tendency, moderate variability and symmetrical distribution characteristics. The consistency of numerous indicators increases trust in the dataset's reliability for further analysis and interpretation.

4.3 CORRELATION AND MULTICOLLINEARITY

The correlation of the independent variables ranges from 0.57382 to 0.98057, as shown in Table 4.2. According to Kim (2019), a correlation range above a 0.8 threshold signals the existence of multicollinearity amongst the variables. With correlation values above 0.8, a multicollinearity test was conducted using the VIF. Appendix A shows that FDI and govexp were removed from the trade openness model as they have a centred VIF value in excess of 10 with 42.19863 and 15.98084, respectively. Once adjusted for fdi and govexp, the model was tested with the new variables.

Table 4.2: Correlation table – trade openness and economic growth

	Auto GDP	Trade	FDI	Capex	Labour	R&D	Govexp
Auto GDP	1.00000						
Trade	0.85439	1.00000					
FDI	0.98057	0.79192	1.00000				
Capex	0.79574	0.57382	0.83102	1.00000			
Labour	0.95010	0.79278	0.93057	0.66124	1.00000		
R&D	0.94271	0.87468	0.89248	0.69739	0.86794	1.00000	
Govexp	0.93405	0.69364	0.96245	0.86306	0.88978	0.78615	1.00000

Source: Author's own calculation using MS Excel (2023).

4.4 UNIT ROOT TEST

The unit root test results using the Augmented Dickey-Fuller (ADF) test indicate that all variables are non-stationary at the level (see Tables 4.3 and 4.4). As their respective p-values exceed 5%, the null hypothesis that states the existence of a unit root and thus non-stationarity cannot be rejected. As expected, each variable becomes stationary at first, differencing as all variables are now below the 5% significance level, leading to the rejection of the null hypothesis. This means that these results would need to be used after differencing for statistical analysis. Additionally, these findings confirm that the variables are integrated of order one 1(1) and of the same order, i.e., not mixed. This means that the Johansen cointegration test can be used as a measurement basis for cointegration.

Table 4.3: Unit root test – trade openness and economic growth

Variables	ADF test results				Order***
	Level	Probability	First difference	Probability	
Auto GDP	-0.9555	0.767	-15.218	0.0000	1(1)
Trade	-2.235	0.195	-10.989	0.0000	1(1)
Capex	-1.467	0.552	-13.360	0.0000	1(1)
Labour	-1.097	0.715	-14.515	0.000	1(1)
R&D	-1.647	0.455	-14.925	0.000	1(1)

All variables include unit root tests with constant *** order of integration.
Source: Author's own calculation using EViews (2023). (See Appendix B).

Table 4.4: Unit root test – trade openness and economic growth

Variables	ADF test results				Order***
	Level	Probability	First difference	Probability	
DVA	-1.030	0.7408	-11.9632	0.000	1(1)
K	-1.522	0.519	-13.341	0.000	1(1)
R&D	-1.647	0.455	-14.925	0.000	1(1)
Lskills	-1.095	0.716	-11.074	0.000	1(1)

All variables include unit root tests with constant *** order of integration.
Source: Author's own calculation using EViews (2023). (See Appendix B).

4.5 LAG SELECTION

The number of lags used in the model must be determined before performing the cointegration test. The optimal lag selection is derived for the cointegration model using an unrestricted VAR model. The selection is made using the Akaike information criterion (AIC), sequential modified LR test (LR) and final prediction error (FPE). Appendix C shows that the best lag length for trade openness is 6, as it has the majority of selections. However, to preserve the degree of freedom and balance the goodness of fit as suggested by the HQ criteria, lag selection of 2 was also considered. The impact of selecting 2 lags though similar to the 6 lags selected has been included in the results of the lag selection in Appendix C.

4.6 JOHANSEN COINTEGRATION TEST

The Johansen cointegration test assesses the long-run equilibrium correlation of variables.

The null hypothesis asserts that $\boldsymbol{H_0}$: **no cointegrating exists** whilst the alternative argument states that $\boldsymbol{H_1 : H_0}$ ***is not true***. Based on the results shown in Tables 4.5 and 4.6 for trade openness, the trace and maximum eigenvalue tests reject the null hypothesis that no cointegration exists. The trace and max-eigenvalue tests indicate that at least one cointegration exists at a 5% level. However, when 2 lags are used only the trace test shows evidence of cointegration (see appendix d). This confirms a long-term relationship between trade openness variables and economic growth. Owing to the correlation range of cointegration vectors, the VECM model is assessed for trade openness.

Table 4.5: Unrestricted cointegration rank test (trace) – trade openness

Hypothesised number of CE(s)	Eigenvalue	Max Eigen Statistic	5% Critical Value	Prob. **
None*	0.265284	35.14288	33.87687	0.0287
At most 1	0.14563	17.94216	27.58434	0.3996
At most 2	0.12013	14.58983	21.13162	0.1692
At most 3	0.09599	11.50438	14.26460	0.1047
At most 4	0.03860	4.48726	3.841465	0.0431
Max-eigenvalue test indicates 1 cointegration eqn(s) at the 5% level. *** Denotes rejection of the hypothesis at the 0.05 level.**				

Source: Author's own calculation using EViews (2023).

Table 4.6: Unrestricted cointegration rank test (maximum eigenvalue) – trade openness

Hypothesised number of CE(s)	Eigenvalue	Trace Statistic	5% Critical Value	Prob. **
None *	0.269831	88.35721	69.81889	0.0008
At most 1	0.154964	52.50654	47.85613	0.0172
At most 2	0.138986	33.31162	29.79707	0.0189
At most 3	0.101193	16.25211	15.49471	0.0384
At most 4*	0.035239	4.089752	3.841465	0.0431
Trace test indicates 5 cointegration eqn at the 5% level.				
*** Denotes rejection of the hypothesis at the 0.05 level.**				

Source: Author's own calculation using EViews (2023).

4.7 VECTOR ERROR CORRECTING MODEL (VECM)

The VECM model is applied owing to evidence of stationarity of the same order and cointegration or long-term relationship between the variables. The results with six lags are shown in Table 4.7. Results detail trade openness's short- and long-run impact on economic growth. In the long run, the measurement variables of trade, capex, labour and R&D have a negative and significant correlation to economic growth. The significance of the relationship is denoted by a t-statistic absolute value in excess of 2. These findings differ from expectations based on empirical studies; however, they are consistent with findings by Wani (2022) and Kumari et al. (2022) in their study of a correlation between trade openness and economic growth. Detailed explanations of the correlation for each variable are recorded below. The lag results include differencing of the variables and capturing the short-term dynamics of the model. In the short run, the impact and significance of lagged results vary for the observed lagged period (lag 1-6). When 2 lags are selected, the results show an insignificant relationship in the short term (see appendix E when 2 lags are selected). The coefficient of the ECT, as shown by CointEq1, is -0.243580 with a t-statistic value of -2.27, implying that the system corrects its prior period errors at a correction speed of around 24.3%. This means that after one period, over 24.3% of the divergence from the long-run equilibrium is smoothed. The ECT signals the model's strong tendency to adjust back to equilibrium. The sign of the CointEq coefficient is negative and significant, as expected.

Table 4.7: Vector error correcting model (VECM)

Cointegrating Eq:	CointEq1
AUTOGDP(-1)	1.000000
TRADE(-1)	-0.213874 (0.07933) [-2.69597]
CAPEX(-1)	-0.092272 (0.01730) [-5.33227]
LABOUR(-1)	-0.264006 (0.06980) [-3.78241]
RD(-1)	-0.299717 (0.04110) [-7.29160]
C	-2.751039

Error Correction:	D(AUTOGDP)	D(TRADE)	D(CAPEX)	D(LABOUR)	D(RD)
CointEq1	-0.243580 (0.10713) [-2.27359]	0.074041 (0.23396) [0.31647]	3.572743 (0.95946) [3.72370]	-0.402447 (0.12719) [-3.16421]	-0.018976 (0.24430) [-0.07767]
D(AUTOGDP(-1))	-0.094925 (0.19341) [-0.49079]	-0.165317 (0.42238) [-0.39140]	-1.567285 (1.73214) [-0.90482]	-0.016033 (0.22962) [-0.06983]	-0.195841 (0.44104) [-0.44404]
D(AUTOGDP(-2))	-0.115318 (0.18515) [-0.62284]	-0.240151 (0.40433) [-0.59394]	-2.487280 (1.65814) [-1.50004]	-0.013993 (0.21981) [-0.06366]	-0.146617 (0.42220) [-0.34727]
D(AUTOGDP(-3))	-0.083351 (0.16175) [-0.51531]	0.118697 (0.35323) [0.33604]	0.182878 (1.44857) [0.12625]	-0.173217 (0.19202) [-0.90206]	-0.083768 (0.36883) [-0.22711]
D(AUTOGDP(-4))	-0.216810 (0.16343) [-1.32660]	0.563970 (0.35690) [1.58017]	1.200752 (1.46365) [0.82038]	-0.314422 (0.19402) [-1.62054]	-0.236857 (0.37267) [-0.63556]
D(AUTOGDP(-5))	0.012342 (0.16976) [0.07270]	0.486414 (0.37073) [1.31206]	0.727067 (1.52033) [0.47823]	-0.171345 (0.20154) [-0.85019]	0.032925 (0.38711) [0.08505]
D(AUTOGDP(-6))	-0.001012 (0.16398) [-0.00617]	-0.044486 (0.35809) [-0.12423]	0.541123 (1.46852) [0.36848]	0.172590 (0.19467) [0.88658]	0.265767 (0.37392) [0.71077]

D(TRADE(-1))	-0.004065	-0.084408	0.585912	0.044712	0.039923
	(0.06030)	(0.13169)	(0.54006)	(0.07159)	(0.13751)
	[-0.06741]	[-0.64095]	[1.08490]	[0.62454]	[0.29032]
D(TRADE(-2))	0.060801	0.126280	0.949271	-0.012151	0.103981
	(0.05998)	(0.13099)	(0.53717)	(0.07121)	(0.13678)
	[1.01366]	[0.96406]	[1.76716]	[-0.17063]	[0.76023]
D(TRADE(-3))	0.008634	-0.103122	0.209856	0.009452	0.018156
	(0.05429)	(0.11855)	(0.48617)	(0.06445)	(0.12379)
	[0.15905]	[-0.86986]	[0.43166]	[0.14666]	[0.14667]
D(TRADE(-4))	-0.092759	-0.342511	-1.168772	0.210542	0.068767
	(0.05296)	(0.11566)	(0.47432)	(0.06288)	(0.12077)
	[-1.75138]	[-2.96133]	[-2.46410]	[3.34850]	[0.56939]
D(TRADE(-5))	0.023037	-0.136238	0.304783	-0.002296	-0.071614
	(0.06666)	(0.14558)	(0.59701)	(0.07914)	(0.15201)
	[0.34557]	[-0.93583]	[0.51051]	[-0.02902]	[-0.47111]
D(TRADE(-6))	0.005740	0.035737	-0.172290	0.003685	0.087675
	(0.06580)	(0.14369)	(0.58927)	(0.07811)	(0.15004)
	[0.08724]	[0.24871]	[-0.29238]	[0.04718]	[0.58434]
D(CAPEX(-1))	-0.028753	-0.009161	0.072126	-0.042784	-0.034979
	(0.01394)	(0.03044)	(0.12483)	(0.01655)	(0.03178)
	[-2.06287]	[-0.30097]	[0.57781]	[-2.58559]	[-1.10053]
D(CAPEX(-2))	-0.020243	0.029718	0.234577	-0.039789	-0.010668
	(0.01402)	(0.03061)	(0.12554)	(0.01664)	(0.03197)
	[-1.44404]	[0.97076]	[1.86849]	[-2.39087]	[-0.33374]
D(CAPEX(-3))	-0.021100	0.026666	0.029767	-0.005272	-0.010619
	(0.01228)	(0.02682)	(0.11000)	(0.01458)	(0.02801)
	[-1.71785]	[0.99411]	[0.27060]	[-0.36153]	[-0.37912]
D(CAPEX(-4))	-0.005712	-0.010185	0.042070	-0.054788	-0.006821
	(0.01226)	(0.02678)	(0.10984)	(0.01456)	(0.02797)
	[-0.46575]	[-0.38029]	[0.38301]	[-3.76285]	[-0.24390]
D(CAPEX(-5))	-0.014550	-0.010462	0.139710	-0.029633	-0.021646
	(0.01354)	(0.02956)	(0.12122)	(0.01607)	(0.03086)
	[-1.07496]	[-0.35393]	[1.15256]	[-1.84415]	[-0.70132]
D(CAPEX(-6))	-0.011281	0.031803	0.221732	-0.022310	-0.017864
	(0.01326)	(0.02896)	(0.11878)	(0.01575)	(0.03024)
	[-0.85057]	[1.09805]	[1.86680]	[-1.41692]	[-0.59068]

D(LABOUR(-1))	-0.271557	-0.109856	0.676764	-0.345094	-0.346072
	(0.13309)	(0.29065)	(1.19195)	(0.15801)	(0.30350)
	[-2.04033]	[-0.37796]	[0.56778]	[-2.18405]	[-1.14029]
D(LABOUR(-2))	-0.261707	0.028800	2.353175	-0.418625	-0.479341
	(0.13028)	(0.28450)	(1.16670)	(0.15466)	(0.29707)
	[-2.00888]	[0.10123]	[2.01695]	[-2.70676]	[-1.61358]
D(LABOUR(-3))	-0.156656	-0.092357	0.929144	-0.183912	-0.068243
	(0.10372)	(0.22651)	(0.92889)	(0.12313)	(0.23651)
	[-1.51036]	[-0.40775]	[1.00028]	[-1.49359]	[-0.28854]
D(LABOUR(-4))	-0.186125	-0.786349	0.438698	0.112219	-0.666452
	(0.10289)	(0.22469)	(0.92144)	(0.12215)	(0.23462)
	[-1.80898]	[-3.49971]	[0.47610]	[0.91872]	[-2.84058]
D(LABOUR(-5))	-0.074504	-0.149545	0.850008	-0.088614	-0.245605
	(0.12172)	(0.26582)	(1.09011)	(0.14451)	(0.27756)
	[-0.61207]	[-0.56258]	[0.77974]	[-0.61322]	[-0.88486]
D(LABOUR(-6))	0.077490	0.265308	1.085376	0.070292	0.190374
	(0.11875)	(0.25933)	(1.06348)	(0.14098)	(0.27078)
	[0.65255]	[1.02307]	[1.02059]	[0.49861]	[0.70305]
D(RD(-1))	-0.120737	0.021328	0.386723	-0.275605	-0.347674
	(0.07140)	(0.15593)	(0.63947)	(0.08477)	(0.16282)
	[-1.69091]	[0.13678]	[0.60476]	[-3.25127]	[-2.13531]
D(RD(-2))	-0.063942	-0.024372	0.352744	-0.062690	-0.128808
	(0.07449)	(0.16266)	(0.66708)	(0.08843)	(0.16985)
	[-0.85844]	[-0.14983]	[0.52879]	[-0.70894]	[-0.75836]
D(RD(-3))	-0.047698	-0.088380	0.853134	-0.038750	-0.034048
	(0.06539)	(0.14281)	(0.58565)	(0.07763)	(0.14912)
	[-0.72938]	[-0.61887]	[1.45673]	[-0.49913]	[-0.22833]
D(RD(-4))	0.143549	0.232097	1.216668	-0.030986	0.399490
	(0.06437)	(0.14057)	(0.57649)	(0.07642)	(0.14679)
	[2.23000]	[1.65106]	[2.11047]	[-0.40547]	[2.72158]
D(RD(-5))	0.086815	0.067727	0.894453	0.189136	0.432148
	(0.06962)	(0.15203)	(0.62346)	(0.08265)	(0.15875)
	[1.24705]	[0.44549]	[1.43466]	[2.28848]	[2.72226]
D(RD(-6))	-0.010232	-0.041941	0.925772	-0.013231	0.016025
	(0.07205)	(0.15734)	(0.64523)	(0.08553)	(0.16429)
	[-0.14202]	[-0.26657]	[1.43480]	[-0.15469]	[0.09754]
C	0.006422	0.002047	-0.021788	0.006835	0.007143
	(0.00163)	(0.00356)	(0.01460)	(0.00194)	(0.00372)
	[3.93897]	[0.57502]	[-1.49230]	[3.53143]	[1.92149]

R-squared	0.400680	0.317201	0.303822	0.542845	0.432504
Adj. R-squared	0.171311	0.055882	0.037383	0.367884	0.215314
Sum sq. resids	0.007165	0.034171	0.574687	0.010099	0.037258
S.E. equation	0.009405	0.020539	0.084231	0.011166	0.021447
F-statistic	1.746879	1.213847	1.140307	3.102667	1.991364
Log likelihood	385.7828	297.5221	138.0544	366.3946	292.6363
Akaike AIC	-6.261642	-4.699505	-1.877069	-5.918489	-4.613031
Schwarz SC	-5.489284	-3.927148	-1.104711	-5.146132	-3.840673
Mean dependent	0.002566	0.001770	0.006726	0.002124	0.003186
S.D. dependent	0.010332	0.021139	0.085851	0.014044	0.024211

Determinant resid covariance (dof adj.)	2.87E-18
Determinant resid covariance	5.43E-19
Log likelihood	1574.530
Akaike information criterion	-24.94743
Schwarz criterion	-20.96496
Number of coefficients	165

Note: Standard errors are in ( ) and t-statistics are in [ ].

Source: Author's own calculation using EViews (2023).

4.8 TRADE OPENNESS

As shown in Table 4.7, a negative long-run relationship exists between trade openness and economic growth. This contradicts theoretical frameworks that assert that trade openness should lead to economic growth. This negative correlation within SA's automotive industry can be explained by the sector's declining trade balance, coupled with a consistent rise in imports and limitations in the domestic supplier base and its absorption capacity, as highlighted by AIEC (2020) and Wuttke (2021) (refer to Appendix F). The trade coefficient value of -0.21% signifies the estimated impact of a 1% increase in trade on automotive GDP. More specifically, it suggests that for every 1% increase in trade, the automotive GDP is expected to decrease by approximately 0.21%, given that other factors remain constant. With a t-statistic more than the absolute value of 2 at 2.695, the correlation is significant in the long run. Trade openness and economic growth results are mixed and insignificant over the observed lag period 1-6. This signals that the impact of trade openness on economic growth might require time to materialise. In the short term, it is mixed, consistent with expectations. However, owing to an insignificant t-statistic, the results show limited evidence of robustness. This indicates that trade openness does not have a strong impact on economic growth in the short term.

4.9 CAPEX

Findings show that capital has a negative and significant correlation to economic growth. As explained in Chapter 5, this contradicts established theoretical frameworks but aligns with Masondo's (2018) argument that government cash incentives for capital expenditures may negatively impact economic growth. This is reflected by the coefficient of -0.09 and a t-statistic absolute value of 5.33. A 1% increase in capital expenditure results in a 0.09% decrease in automotive GDP, provided all other factors remain the same. In the short run, capex shows evidence of a negative correlation with economic growth. In lagged period 1, this evidence is strong, as reflected by a significant t-statistic of 2.06. However, this becomes statistically insignificant over the remaining observed period. This could indicate that capex values in lagged period 1 have the most negative and significant impact on economic growth than during other lagged periods and that no significant relationship exists in the short term.

4.10 LABOUR

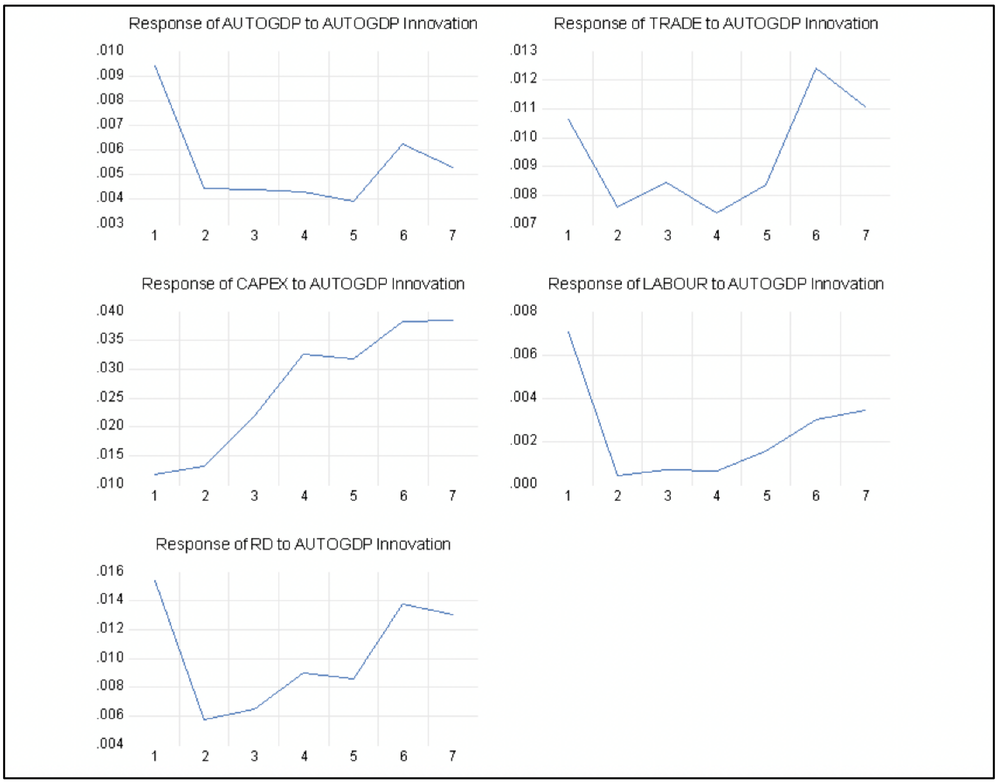
Typically, labour productivity has a positive correlation with economic growth. However, results in the long run show a negative and strong correlation between labour productivity and economic growth. This contradicts theoretical expectations but supports empirical evidence that high-tech industries face limited benefits from technological diffusion when there is insufficient local skills and human capital development, as highlighted by Cimoli and Correa (2002). This negative correlation is depicted by a coefficient value of -0.26%, signaling that a 1% increase in labour results in a 0.26% decrease in automotive GDP. Similar to capex, labour productivity shows a consistent negative correlation with economic growth in the short run, however only lag period 1 and 2 show significant results, all other periods are insignificant and thus not interpreted.

4.11 RESEARCH AND DEVELOPMENT (R&D)

The study shows a negative correlation between R&D and economic growth. These results contradict expectations, similar to labour productivity, and may indicate limitations in deriving economic benefits when domestic absorption capacity and skills are constrained (see detailed explanations in Chapter 5). A 1% increase in R&D is expected to result in an approximated 0.19% decrease in economic growth. In the short run, the observed lagged period results are mixed and insignificant; however, for the lagged period 4, the results show a positive and significant impact on economic growth. This is consistent with our expectations.

4.12 IMPULSE

Table 4.8: Impulse results for VECM trade openness and economic growth



Source: Author's own calculation using EViews (2023).

As shown in Table 4.8, the impulse response depicts how each variable reacts to a one-standard-deviation shock to auto GDP over a 7-year observation period. The data analysis reveals remarkable patterns that correspond to the interpretations drawn from the VECM. In particular, a one percentage rise in auto GDP causes an early drop in trade, stabilizing and following a stable trajectory through periods two to four, with a modest peak observed in period five. Labour productivity declines significantly during the first two years but stabilises over the next seven years, with a noteworthy upturn beginning in the fourth year. R&D show similar trends to labour productivity. Capex results are steady and stable over the seven-year period, with only a minor dip in period four. These observations shed light on the intricate temporal dynamics and fluctuations of these variables in relation to economic growth shocks, offering valuable insights.

4.13 DIAGNOSTICS TESTING

Following a review of the study's findings, the next step is to subject the model to diagnostic tests to confirm its suitability and robustness. The VECM model was tested for normality, autocorrelation, serial correlation and heteroskedasticity. Results indicate that the model is suitable and can be relied on, as depicted in Table 4.9.

Table 4.9: Diagnostic tests – VECM model

Diagnostic Tests			
Diagnostic test	**Null hypothesis**	**p-value**	**Conclusion**
Jarque-Bera test of normal distribution	$H_0: data\ is\ normally\ distributed$	0.0000	Reject null hypothesis *
Heteroskedasticity	$H_0: data\ has\ no\ heteroskedasticity$	0.9983	Fail to reject the null hypothesis
Serial Correlation LM test	$H_0: data\ has\ no\ serial\ correlation$	0.9869	Fail to reject the null hypothesis

** Normal distribution violation has no significant impact on statistic tests performed.*

Source: Author's own calculation using EViews (2023). (See Appendix G).

The result of the Jarque-Bera test of normality shows a significant p-value at 0.0000, signalling that the dataset departs from normality. A sample size of 120 is sufficient for this normal distribution violation to not have a significant impact on statistic tests performed, and so this departure is not cause for concern (Allende-Alonso et al., 2019). For the purpose of this model, the normality results are accepted. The results of the heteroskedasticity show an insignificant p-value at 0.9983, meaning the null hypothesis is not rejected as the dataset and model show no heteroskedasticity. The serial correlation LM test results show no evidence of serial correlation for the model, with a p-value of 0.9869 at lag 1 and an insignificant value for all other lags. The serial correlation and heteroskedasticity results show a fairly well-behaved mode.

CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

Chapter 5 summarises and concludes the primary findings of the study. Based on these results, it recommends practical policy reforms and potential avenues for future studies. The purpose of this chapter is not only to summarise the study's key findings but also to provide useful recommendations for policymakers and researchers interested in applying these findings in their domains.

5.2 SUMMARY OF THE STUDY AND CONCLUSION

Discussion for trade openness and economic growth

In assessing the relationship between trade openness and economic growth, it is noted that while trade openness led to increased capital investments and export production within South Africa's automotive industry, a negative correlation is observed between trade openness and economic growth (Masondo, 2018). The negative and significant correlation contrasts theoretical assumptions that open economies grow faster than closed ones. These findings, however, are supported by earlier studies conducted by Kim (2011) in the case of developing countries, Kumari et al. (2022) and Wani (2022) in the case of India. The negative correlation could also be justified due to the sector's decline in the trade balance, owing to a steady increase in imports, especially imported vehicles for local consumption, over the past few years (AIEC, 2020) (see Appendix F). Kneller et al. (2008) and Huchet-Bourdon et al. (2018) argues that when imports relate to goods used in the manufacturing process rather than for consumption, they tend to contribute to economic growth through knowledge and technological diffusion rather than mere imports. Additionally, given the limited localisation of components and/or the development of endogenous suppliers at lower tiers of production, especially when compared to markets like Thailand, undue reliance is placed on imported materials without local suppliers, which limits sustainable growth (Wuttke, 2021). These results call for deep dives and a closer examination of the specific variables under investigation, especially in measuring trade openness for high-technology industries, which can help signal potential challenges for the sector. Additionally, results may aid in the adaptation of policies to address these findings effectively. Such an approach allows policymakers to craft industrial strategies that align with national priorities and aspirations, as articulated in the Industrial Policy Action Plan (IPAP) (DTIC 2014).

The negative and significant results for capex are unusual and contradict theoretical frameworks and a majority of empirical studies that argue for technological diffusions and productivity that flow as a result of capital investments and stimulating economic growth (Keho, 2017; Zahonogo, 2017; Sakyi and Egyir, 2017; Kong et al., 2021). However, an interesting observation made by empirical studies suggests that the domestic environment, government policies and structural characteristics of a country have a bearing on the correlation between economic growth and capital investments. These results support assertions made by Masondo (2018) that the auto industry in SA might have resulted in more costs for capital investments than benefits, owing to generous government incentives and foregone import duties, justifying the negative correlation between capital investment and economic growth. These findings call for additional in-depth research and analysis of the phenomenon, especially because these results carry a potential policy impact and may require further investigation to validate these.

The results for labour were also unexpected; however, the results support empirical assertions that in the case of high-technology industries, a lack of skills and human capital development in the local market tends to result in a lower absorption rate of technological and managerial know-how, limiting benefits derived from technological dissemination (Cimoli & Correa, 2002; Fortwengel, 2011; Hiroyuki et al., 2018). In the case of South Africa, Gossel and Biekpe (2013, using a study by Fedderke, 2001), argue that education levels in SA negatively affect labour efficiency and limit advancements in industrial productivity and innovation. Additionally, studies note that labour costs in South Africa are substantially higher than its peers (Gossel & Biekpe, 2013; Barnes & Black, 2013). If the impact of high labour costs is considered in light of mixed results for labour productivity, then the negative correlation with economic growth can be justified. However, these results call for additional investigation and deep dives.

The results for R&D are negative and significant and contradict theoretical frameworks and a majority of empirical studies, which calls for additional investigation. The results support the findings by Akinwale et al. (2012) that economic growth from R&D can be constrained by corruption and weak institutional infrastructure, as was the case in Nigeria. These assertions need to be tested in the case of South Africa. Cimoli and Correa (2002) argue that despite investments in R&D in Latin America, benefits were limited by insufficient absorption capacity and skill set of the domestic market. This was noted in studies in the context of SA under labour productivity.

Summary and Conclusion

This study aims to investigate the correlation between trade openness and economic growth. Using a time series dataset covering the period Q1 1992 to Q4 2021, the study looks to incorporate the impact of industrial policies to liberalise the sector post-1994. To measure trade openness and economic growth in the long run, the study employs the vector error correcting model (VECM). The long-run results between economic growth and trade openness variables, namely capex, labour and R&D, show a negative and significant correlation. These findings challenge theoretical frameworks and other empirical studies. However, other findings support the results of this study, such as Masondo (2018) in the case of a negative correlation with capex; Gossel and Biekpe (2013) in the case of a negative correlation with labour productivity; and Cimoli and Correa (2002) and Akinwale, et al. (2012) with a negative correlation assertion made for research and development. The results in the short term are often mixed and /or insignificant. Additionally, when a lag selection of 2 was selected the results in the short run were insignificant. Thus, only the long-term relationship is concluded.

Trade openness improved the inefficiencies of constrained volumes under ISI. However, the limited capacity of the domestic workforce and an inadequate supplier base restrict the absorption speed of technological dissemination and prevent the meaningful value addition the sector could provide the country. The magnitude of the positive correlation between R&D, skilled labour and human capital development has the most potential to improve economic growth from trade openness, as evidenced in empirical studies in the case of East Asia. Further deep dives into these variables could provide additional insights for policymakers.

5.3 IMPLICATION FOR FUTURE STUDIES, POLICY-MAKERS AND RECOMMENDATIONS

The unexpected negative relationship between trade openness factors has important implications for policymakers. Zahonogo (2017) notes a critical threshold below which trade openness harms economic growth. This finding underscores the need for a comprehensive investigation into the optimal trade openness level for South Africa's automotive sector and raises questions about whether the sector might currently be operating below the critical threshold. Such an inquiry can provide insights into the factors influencing the impact of trade openness on economic growth and offer guidance to policymakers on potential interventions.

The liberalisation of industrial policies for SA's automotive industry increased imports, which has driven the growing trade balance deficit over time (AIEC, 2020). Additionally, recent imports have predominantly been for consumption vehicles rather than production components, aligning with concerns raised by Kneller et al. (2008) and Huchet-Bourdon et al. (2018) that imports for consumption negatively affect economic growth. The surge in consumption-based vehicle imports, driven by trade incentives, may have, to some extent, eroded the benefits of trade openness for South Africa's automotive industry (Masondo, 2018). In light of these findings, the South African government should re-evaluate its trade policies and incentive programs, particularly concerning imports intended for consumption. This reconsideration is necessary to ensure that trade openness continues contributing positively to the growth of the automotive sector and the broader economy.

Furthermore, the government should take deliberate steps to enhance the development and growth of domestic suppliers, as outlined in the Industrial Policy Action Plan (IPAP) of 2014 (DTIC, 2014). By doing so, the government can ensure a competent domestic supplier network that can progressively facilitate the localisation of production and reduce excessive reliance on imports. This approach aligns with the sector's long-term sustainability goals. Moreover, prioritising skills development and human capital investments for the domestic workforce and local supplier base holds tremendous growth potential. This investment can significantly enhance the sector's capacity to absorb technological advancements, thereby strengthening the potential of domestic suppliers to contribute substantially to increased value addition. An illustrative example of this strategy is Thailand's success, where the Thai government and Japanese tier 1 suppliers played a pivotal role in providing technical training and fostering the development of domestic suppliers at tiers 2 and 3 (Wuttke, 2021). Such initiatives can serve as valuable models for South Africa to follow in its efforts to bolster its domestic supplier base and drive sustainable economic growth in the automotive sector. Further investigation is needed to determine whether investments in skills development and research and development (R&D) can indeed increase the absorption capacity of the domestic labour force and supplier base.

Establishing science parks and technology research centres in China facilitated the country's learning and the drive for indigenous innovation, playing a crucial role in the sustainable development of China's ICT industry (Grimes & Sun, 2016). In addition, the government in

Brazil introduced an energy diversification strategy through R&D investments that allow for the use of special flex fuel, providing opportunities for local suppliers to develop skills and expertise in flex-fuel engineering – a new industry unique to Brazilian market needs. Allowing for market penetration in the design of flexible powertrain markets results in capturing significant value-adding shares within value chains (Wuttke, 2021). Drawing from the abovementioned examples, skills and human capital training should ensure that development strategies align with global trends and address domestic needs to support indigenous innovation. In Thailand, for example, the government designated pick-up trucks as national vehicles and offered special incentives to promote their production while increasing local content. SA could adopt a similar strategy and use industry to address unique and unaddressed needs in the domestic market. A recommendation for government would be to collaborate with local OEMs to identify a distinct 'flagship car'. For instance, taxis in Southern Africa could fit such a profile, and incentive programmes and local content requirements could support their production. This would allow for local strategy development and domestic supplier integration for a vehicle mainly used for the local market. Such vehicles could help the sector leverage the country's competitive advantage while meeting the community's unique needs.

5.4 LIMITATIONS OF THE STUDY

The primary constraint faced by this study concerns the shortage of existing research measuring trade openness for the manufacturing industries in Southern Africa. A cross-country study focused on SSA could provide valuable insight for the region. Additionally, data availability necessitated the use of a proxy variable, which could fail to accurately capture the underlying assumptions in theoretical frameworks. Estimation and averaging techniques are adopted to moderate the data, thus limiting the results and conclusion, and mitigation is applied by reliable databases used in previous empirical studies. However, despite these limitations, the study addressed the research objectives presented in Chapter 1.

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APPENDIX A: CORRELATION, MULTICOLLINEARITY AND VARIANCE INFLATION FACTOR

Correlation Table - Trade Openness and Economic Growth

	Auto GDP	Trade Openness	FDI	Capital	Labour Productivity	R&D	GovEdu
Auto GDP	1.0000						
Trade Openness	0.8849	1.0000					
FDI	0.9956	0.8754	1.0000				
Capital	0.7890	0.6304	0.7997	1.0000			
Labour Productivity	0.9624	0.8331	0.9644	0.6881	1.0000		
R&D	0.9574	0.8950	0.9514	0.7146	0.8953	1.0000	
Govexp	0.9376	0.7381	0.9326	0.8203	0.9163	0.8171	1.0000

Variance Factor Analysis Table 4.2.1a Elimination Process

1. First order of eliminations

Variance Inflation Factors
Date: 06/15/23 Time: 17:14
Sample: 1992Q1 2021Q4
Included observations: 120

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
TRADE	8348.300	196.9726	4.456257
FDI	0.016337	136.4948	42.19863
CAPEX	0.135131	30.48573	6.691055
LABOUR	529637.4	306.0489	13.24915
RD	108.0371	125.3365	11.70713
GOVEXP	5.273794	372.9432	30.18276
C	1920298.	287.2288	NA

Process of elimination, starting with removing the variable with the highest centered VIF **FDI**

2. Second order of eliminations

Variance Inflation Factors
Date: 06/15/23 Time: 17:12
Sample: 1992Q1 2021Q4
Included observations: 120

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
TRADE	9287.068	195.6230	4.425724
CAPEX	0.149963	30.20364	6.629140
LABOUR	561549.7	289.6903	12.54097
RD	88.35049	91.50542	8.547118
GOVEXP	3.127739	197.4620	15.98084
C	661950.7	88.39315	NA

Process of elimination, eliminating the variable with the next highest centered VIF **GovExp**

Variance Factor Analysis Table 4.2.1b Variables Without Multicollinearity

Variance Inflation Factors
Date: 06/15/23 Time: 17:21
Sample: 1992Q1 2021Q4
Included observations: 120

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
TRADE	21293.17	194.7393	4.405733
CAPEX	0.105643	9.238251	2.027625
LABOUR	436652.0	97.80327	4.233996
RD	180.6288	81.22636	7.586997
C	1455631.	84.39495	NA

APPENDIX B: UNIT ROOT – AUGMENTED DICKEY-FULLER TEST

Trade Openness and Economic Growth

Null Hypothesis: GDP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.955546	0.7671
Test critical values:	1% level	-3.486551	
	5% level	-2.886074	
	10% level	-2.579931	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP)
Method: Least Squares
Date: 06/24/23 Time: 17:03
Sample (adjusted): 1992Q3 2021Q4
Included observations: 118 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	-0.009610	0.010057	-0.955546	0.3413
D(GDP(-1))	-0.331003	0.087644	-3.776662	0.0003
C	840.5555	520.3526	1.615357	0.1090

R-squared	0.117776	Mean dependent var	269.2288
Adjusted R-squared	0.102433	S.D. dependent var	1303.286
S.E. of regression	1234.734	Akaike info criterion	17.10019
Sum squared resid	1.75E+08	Schwarz criterion	17.17063
Log likelihood	-1005.911	Hannan-Quinn criter.	17.12879
F-statistic	7.676177	Durbin-Watson stat	2.117712
Prob(F-statistic)	0.000743		

Null Hypothesis: D(GDP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-15.21844	0.0000
Test critical values:	1% level	-3.486551	
	5% level	-2.886074	
	10% level	-2.579931	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP,2)
Method: Least Squares
Date: 06/24/23 Time: 17:05
Sample (adjusted): 1992Q3 2021Q4
Included observations: 118 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1))	-1.332950	0.087588	-15.21844	0.0000
C	355.8312	115.8853	3.070546	0.0027

R-squared	0.666284	Mean dependent var	9.122881
Adjusted R-squared	0.663407	S.D. dependent var	2127.444
S.E. of regression	1234.271	Akaike info criterion	17.09115
Sum squared resid	1.77E+08	Schwarz criterion	17.13811
Log likelihood	-1006.378	Hannan-Quinn criter.	17.11022
F-statistic	231.6009	Durbin-Watson stat	2.116977
Prob(F-statistic)	0.000000		

Null Hypothesis: TRADE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.234805	0.1953
Test critical values:	1% level	-3.486064	
	5% level	-2.885863	
	10% level	-2.579818	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TRADE)
Method: Least Squares
Date: 06/24/23 Time: 17:07
Sample (adjusted): 1992Q2 2021Q4
Included observations: 119 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TRADE(-1)	-0.065624	0.029364	-2.234805	0.0273
C	0.859411	0.368339	2.333207	0.0213

R-squared	0.040939	Mean dependent var	0.045630
Adjusted R-squared	0.032742	S.D. dependent var	0.615171
S.E. of regression	0.605016	Akaike info criterion	1.849540
Sum squared resid	42.82717	Schwarz criterion	1.896248
Log likelihood	-108.0476	Hannan-Quinn criter.	1.868506
F-statistic	4.994353	Durbin-Watson stat	1.990572
Prob(F-statistic)	0.027329		

Null Hypothesis: D(TRADE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.98187	0.0000
Test critical values:	1% level	-3.486551	
	5% level	-2.886074	
	10% level	-2.579931	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TRADE,2)
Method: Least Squares
Date: 06/24/23 Time: 17:08
Sample (adjusted): 1992Q3 2021Q4
Included observations: 118 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TRADE(-1))	-1.019580	0.092842	-10.98187	0.0000
C	0.047310	0.057249	0.826393	0.4103

R-squared	0.509724	Mean dependent var	0.002034
Adjusted R-squared	0.505498	S.D. dependent var	0.882054
S.E. of regression	0.620268	Akaike info criterion	1.899474
Sum squared resid	44.62899	Schwarz criterion	1.946435
Log likelihood	-110.0690	Hannan-Quinn criter.	1.918542
F-statistic	120.6014	Durbin-Watson stat	1.998926
Prob(F-statistic)	0.000000		

Null Hypothesis: CAPEX has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.456532	0.5522
Test critical values:	1% level	-3.486064	
	5% level	-2.885863	
	10% level	-2.579818	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CAPEX)
Method: Least Squares
Date: 06/24/23 Time: 17:10
Sample (adjusted): 1992Q2 2021Q4
Included observations: 119 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CAPEX(-1)	-0.047396	0.032540	-1.456532	0.1479
C	62.66261	39.58610	1.582945	0.1161

R-squared	0.017809	Mean dependent var	11.68529
Adjusted R-squared	0.009415	S.D. dependent var	202.7298
S.E. of regression	201.7732	Akaike info criterion	13.46883
Sum squared resid	4763354.	Schwarz criterion	13.51554
Log likelihood	-799.3954	Hannan-Quinn criter.	13.48780
F-statistic	2.121484	Durbin-Watson stat	2.353517
Prob(F-statistic)	0.147924		

Null Hypothesis: D(CAPEX) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-13.35993	0.0000
Test critical values:	1% level	-3.486551	
	5% level	-2.886074	
	10% level	-2.579931	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CAPEX,2)
Method: Least Squares
Date: 06/24/23 Time: 17:11
Sample (adjusted): 1992Q3 2021Q4
Included observations: 118 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CAPEX(-1))	-1.212197	0.090734	-13.35993	0.0000
C	14.27376	18.42353	0.774757	0.4401

R-squared	0.606096	Mean dependent var	0.295593
Adjusted R-squared	0.602700	S.D. dependent var	316.9956
S.E. of regression	199.8078	Akaike info criterion	13.44939
Sum squared resid	4631088.	Schwarz criterion	13.49635
Log likelihood	-791.5142	Hannan-Quinn criter.	13.46846
F-statistic	178.4878	Durbin-Watson stat	2.009386
Prob(F-statistic)	0.000000		

Null Hypothesis: LABOUR has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.097429	0.7153
Test critical values:	1% level	-3.486551	
	5% level	-2.886074	
	10% level	-2.579931	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LABOUR)
Method: Least Squares
Date: 06/24/23 Time: 17:12
Sample (adjusted): 1992Q3 2021Q4
Included observations: 118 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LABOUR(-1)	-0.016059	0.014633	-1.097429	0.2747
D(LABOUR(-1))	-0.285019	0.088922	-3.205259	0.0017
C	42.16806	28.79895	1.464222	0.1459

R-squared	0.093618	Mean dependent var	8.787288
Adjusted R-squared	0.077855	S.D. dependent var	66.42513
S.E. of regression	63.78698	Akaike info criterion	11.17407
Sum squared resid	467909.5	Schwarz criterion	11.24451
Log likelihood	-656.2701	Hannan-Quinn criter.	11.20267
F-statistic	5.939042	Durbin-Watson stat	2.074208
Prob(F-statistic)	0.003511		

Null Hypothesis: D(LABOUR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-14.51547	0.0000
Test critical values:	1% level	-3.486551	
	5% level	-2.886074	
	10% level	-2.579931	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LABOUR,2)
Method: Least Squares
Date: 06/24/23 Time: 17:13
Sample (adjusted): 1992Q3 2021Q4
Included observations: 118 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LABOUR(-1))	-1.290118	0.088879	-14.51547	0.0000
C	11.23817	5.925004	1.896736	0.0603

R-squared	0.644933	Mean dependent var	0.339407
Adjusted R-squared	0.641872	S.D. dependent var	106.6830
S.E. of regression	63.84314	Akaike info criterion	11.16754
Sum squared resid	472809.7	Schwarz criterion	11.21450
Log likelihood	-656.8848	Hannan-Quinn criter.	11.18661
F-statistic	210.6988	Durbin-Watson stat	2.075832
Prob(F-statistic)	0.000000		

Null Hypothesis: RD has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.647410	0.4552
Test critical values:	1% level	-3.488585	
	5% level	-2.886959	
	10% level	-2.580402	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RD)
Method: Least Squares
Date: 06/24/23 Time: 16:59
Sample (adjusted): 1993Q3 2021Q4
Included observations: 114 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RD(-1)	-0.025564	0.015518	-1.647410	0.1024
D(RD(-1))	-0.388398	0.088803	-4.373720	0.0000
D(RD(-2))	-0.153718	0.094447	-1.627559	0.1066
D(RD(-3))	0.086218	0.095026	0.907316	0.3663
D(RD(-4))	0.206607	0.094262	2.191834	0.0306
D(RD(-5))	0.370409	0.089423	4.142211	0.0001
C	2.636640	1.395991	1.888723	0.0616

R-squared	0.263322	Mean dependent var	0.499211
Adjusted R-squared	0.222013	S.D. dependent var	4.907225
S.E. of regression	4.328348	Akaike info criterion	5.827686
Sum squared resid	2004.602	Schwarz criterion	5.995699
Log likelihood	-325.1781	Hannan-Quinn criter.	5.895873
F-statistic	6.374432	Durbin-Watson stat	2.073848
Prob(F-statistic)	0.000009		

Null Hypothesis: D(RD) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-14.92541	0.0000
Test critical values:	1% level	-3.486551	
	5% level	-2.886074	
	10% level	-2.579931	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RD,2)
Method: Least Squares
Date: 06/24/23 Time: 16:59
Sample (adjusted): 1992Q3 2021Q4
Included observations: 118 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RD(-1))	-1.315883	0.088164	-14.92541	0.0000
C	0.619212	0.425211	1.456247	0.1480

R-squared	0.657583	Mean dependent var	0.027288
Adjusted R-squared	0.654631	S.D. dependent var	7.825399
S.E. of regression	4.598841	Akaike info criterion	5.906289
Sum squared resid	2453.323	Schwarz criterion	5.953250
Log likelihood	-346.4711	Hannan-Quinn criter.	5.925357
F-statistic	222.7678	Durbin-Watson stat	2.091950
Prob(F-statistic)	0.000000		

APPENDIX C: LAG SELECTION

Lag Selection - Trade Openness and Economic Growth

VAR Lag Order Selection Criteria
Endogenous variables: GDP TRADE CAPEX LABOUR RD
Exogenous variables: C
Date: 06/25/23 Time: 10:08
Sample: 1992Q1 2021Q4
Included observations: 112

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3227.984	NA	8.13e+18	57.73186	57.85322	57.78110
1	-2636.900	1118.837	3.31e+14	47.62322	48.35138*	47.91866
2	-2613.836	41.59682	3.44e+14	47.65779	48.99277	48.19944
3	-2598.233	26.74945	4.10e+14	47.82558	49.76737	48.61343
4	-2575.613	36.75735	4.33e+14	47.86808	50.41668	48.90213
5	-2481.609	144.3627	1.29e+14	46.63588	49.79128	47.91612*
6	-2452.504	42.09786*	1.24e+14*	46.56258*	50.32479	48.08903
7	-2437.482	20.38735	1.54e+14	46.74075	51.10977	48.51340
8	-2416.350	26.79278	1.75e+14	46.80982	51.78564	48.82867

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Owing to the desire to preserve the degree of freedom and balance the goodness of fit of selected lags as suggested by the HQ criteria, lower lag selection using 2 was also considered. However, the comparison of the different lagged models shows no significant difference between the findings for model 1 with 6 lags and model 2 with 2 lags, with the exception of trade results. The results are interpreted using the 6 lags as discussed by Sharp (2010). Raw data for the Johansen Cointegration and results using 2 lags is also included below, under the relevant section appendix d and e.

Comparison of Lag selection – Trade Openness and Economic Growth

		Model 1 with 6 lags			Model 2 with 2 lags	
		CointEq1	T-stats		CointEq1	T-stats
Long Term	Auto GDP	1.000000			1.000000	
	Trade	-0.213874	-2.69597		0.251175	2.29307
	Capex	-0.092272	-5.33227		-0.138307	-6.77848
	Labour	-0.264006	-3.78241		-0.688280	-8.89860
	R&D	-0.299717	-7.29160		-0.207901	-3.51656

Own calculation using the reports from EViews (see appendix E)

APPENDIX D: JOHANSEN COINTEGRATION

Johansen Cointegration – Trade Openness and Economic Growth

Date: 06/25/23 Time: 10:02
Sample (adjusted): 1993Q3 2021Q4
Included observations: 114 after adjustments
Trend assumption: Linear deterministic trend
Series: GDP TRADE CAPEX LABOUR RD
Lags interval (in first differences): 1 to 5

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.269831	88.35721	69.81889	0.0008
At most 1 *	0.154964	52.50654	47.85613	0.0172
At most 2 *	0.138986	33.31162	29.79707	0.0189
At most 3 *	0.101193	16.25211	15.49471	0.0384
At most 4 *	0.035239	4.089752	3.841465	0.0431

Trace test indicates 5 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.269831	35.85067	33.87687	0.0287
At most 1	0.154964	19.19492	27.58434	0.3996
At most 2	0.138986	17.05951	21.13162	0.1692
At most 3	0.101193	12.16235	14.26460	0.1047
At most 4 *	0.035239	4.089752	3.841465	0.0431

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Johansen Cointegration – Trade Openness and Economic Growth (with 2 lags selection)

Date: 01/14/24 Time: 18:26
Sample (adjusted): 1992Q4 2021Q4
Included observations: 117 after adjustments
Trend assumption: Linear deterministic trend
Series: GDP TRADE CAPITAL LABOUR RD
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.247850	82.26325	69.81889	0.0037
At most 1 *	0.206198	48.93935	47.85613	0.0394
At most 2	0.090054	21.92157	29.79707	0.3029
At most 3	0.066489	10.88033	15.49471	0.2189
At most 4	0.023901	2.830428	3.841465	0.0925

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.247850	33.32390	33.87687	0.0581
At most 1	0.206198	27.01778	27.58434	0.0590
At most 2	0.090054	11.04124	21.13162	0.6432
At most 3	0.066489	8.049900	14.26460	0.3737
At most 4	0.023901	2.830428	3.841465	0.0925

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Evidence of cointegration using Trace test, but no evidence using the Max eigenvalue

APPENDIX E: VECTOR ERROR CORRECTING MODEL

Vector Error Correcting Model

Vector Error Correction Estimates
Date: 08/20/23 Time: 14:26
Sample (adjusted): 1993Q4 2021Q4
Included observations: 113 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
AUTOGDP(-1)	1.000000
TRADE(-1)	-0.213874 (0.07933) [-2.69597]
CAPEX(-1)	-0.092272 (0.01730) [-5.33227]
LABOUR(-1)	-0.264006 (0.06980) [-3.78241]
RD(-1)	-0.299717 (0.04110) [-7.29160]
C	-2.751039

Error Correction:	D(AUTOGDP)	D(TRADE)	D(CAPEX)	D(LABOUR)	D(RD)
CointEq1	-0.243580 (0.10713) [-2.27359]	0.074041 (0.23396) [0.31647]	3.572743 (0.95946) [3.72370]	-0.402447 (0.12719) [-3.16421]	-0.018976 (0.24430) [-0.07767]
D(AUTOGDP(-1))	-0.094925 (0.19341) [-0.49079]	-0.165317 (0.42238) [-0.39140]	-1.567285 (1.73214) [-0.90482]	-0.016033 (0.22962) [-0.06983]	-0.195841 (0.44104) [-0.44404]
D(AUTOGDP(-2))	-0.115318 (0.18515) [-0.62284]	-0.240151 (0.40433) [-0.59394]	-2.487280 (1.65814) [-1.50004]	-0.013993 (0.21981) [-0.06366]	-0.146617 (0.42220) [-0.34727]
D(AUTOGDP(-3))	-0.083351 (0.16175) [-0.51531]	0.118697 (0.35323) [0.33604]	0.182878 (1.44857) [0.12625]	-0.173217 (0.19202) [-0.90206]	-0.083768 (0.36883) [-0.22711]
D(AUTOGDP(-4))	-0.216810 (0.16343) [-1.32660]	0.563970 (0.35690) [1.58017]	1.200752 (1.46365) [0.82038]	-0.314422 (0.19402) [-1.62054]	-0.236857 (0.37267) [-0.63556]
D(AUTOGDP(-5))	0.012342 (0.16976) [0.07270]	0.486414 (0.37073) [1.31206]	0.727067 (1.52033) [0.47823]	-0.171345 (0.20154) [-0.85019]	0.032925 (0.38711) [0.08505]
D(AUTOGDP(-6))	-0.001012 (0.16398) [-0.00617]	-0.044486 (0.35809) [-0.12423]	0.541123 (1.46852) [0.36848]	0.172590 (0.19467) [0.88658]	0.265767 (0.37392) [0.71077]

D(TRADE(-1))	-0.004065	-0.084408	0.585912	0.044712	0.039923
	(0.06030)	(0.13169)	(0.54006)	(0.07159)	(0.13751)
	[-0.06741]	[-0.64095]	[1.08490]	[0.62454]	[0.29032]
D(TRADE(-2))	0.060801	0.126280	0.949271	-0.012151	0.103981
	(0.05998)	(0.13099)	(0.53717)	(0.07121)	(0.13678)
	[1.01366]	[0.96406]	[1.76716]	[-0.17063]	[0.76023]
D(TRADE(-3))	0.008634	-0.103122	0.209856	0.009452	0.018156
	(0.05429)	(0.11855)	(0.48617)	(0.06445)	(0.12379)
	[0.15905]	[-0.86986]	[0.43166]	[0.14666]	[0.14667]
D(TRADE(-4))	-0.092759	-0.342511	-1.168772	0.210542	0.068767
	(0.05296)	(0.11566)	(0.47432)	(0.06288)	(0.12077)
	[-1.75138]	[-2.96133]	[-2.46410]	[3.34850]	[0.56939]
D(TRADE(-5))	0.023037	-0.136238	0.304783	-0.002296	-0.071614
	(0.06666)	(0.14558)	(0.59701)	(0.07914)	(0.15201)
	[0.34557]	[-0.93583]	[0.51051]	[-0.02902]	[-0.47111]
D(TRADE(-6))	0.005740	0.035737	-0.172290	0.003685	0.087675
	(0.06580)	(0.14369)	(0.58927)	(0.07811)	(0.15004)
	[0.08724]	[0.24871]	[-0.29238]	[0.04718]	[0.58434]
D(CAPEX(-1))	-0.028753	-0.009161	0.072126	-0.042784	-0.034979
	(0.01394)	(0.03044)	(0.12483)	(0.01655)	(0.03178)
	[-2.06287]	[-0.30097]	[0.57781]	[-2.58559]	[-1.10053]
D(CAPEX(-2))	-0.020243	0.029718	0.234577	-0.039789	-0.010668
	(0.01402)	(0.03061)	(0.12554)	(0.01664)	(0.03197)
	[-1.44404]	[0.97076]	[1.86849]	[-2.39087]	[-0.33374]
D(CAPEX(-3))	-0.021100	0.026666	0.029767	-0.005272	-0.010619
	(0.01228)	(0.02682)	(0.11000)	(0.01458)	(0.02801)
	[-1.71785]	[0.99411]	[0.27060]	[-0.36153]	[-0.37912]
D(CAPEX(-4))	-0.005712	-0.010185	0.042070	-0.054788	-0.006821
	(0.01226)	(0.02678)	(0.10984)	(0.01456)	(0.02797)
	[-0.46575]	[-0.38029]	[0.38301]	[-3.76285]	[-0.24390]
D(CAPEX(-5))	-0.014550	-0.010462	0.139710	-0.029633	-0.021646
	(0.01354)	(0.02956)	(0.12122)	(0.01607)	(0.03086)
	[-1.07496]	[-0.35393]	[1.15256]	[-1.84415]	[-0.70132]
D(CAPEX(-6))	-0.011281	0.031803	0.221732	-0.022310	-0.017864
	(0.01326)	(0.02896)	(0.11878)	(0.01575)	(0.03024)
	[-0.85057]	[1.09805]	[1.86680]	[-1.41692]	[-0.59068]

D(LABOUR(-1))	-0.271557	-0.109856	0.676764	-0.345094	-0.346072
	(0.13309)	(0.29065)	(1.19195)	(0.15801)	(0.30350)
	[-2.04033]	[-0.37796]	[0.56778]	[-2.18405]	[-1.14029]
D(LABOUR(-2))	-0.261707	0.028800	2.353175	-0.418625	-0.479341
	(0.13028)	(0.28450)	(1.16670)	(0.15466)	(0.29707)
	[-2.00888]	[0.10123]	[2.01695]	[-2.70676]	[-1.61358]
D(LABOUR(-3))	-0.156656	-0.092357	0.929144	-0.183912	-0.068243
	(0.10372)	(0.22651)	(0.92889)	(0.12313)	(0.23651)
	[-1.51036]	[-0.40775]	[1.00028]	[-1.49359]	[-0.28854]
D(LABOUR(-4))	-0.186125	-0.786349	0.438698	0.112219	-0.666452
	(0.10289)	(0.22469)	(0.92144)	(0.12215)	(0.23462)
	[-1.80898]	[-3.49971]	[0.47610]	[0.91872]	[-2.84058]
D(LABOUR(-5))	-0.074504	-0.149545	0.850008	-0.088614	-0.245605
	(0.12172)	(0.26582)	(1.09011)	(0.14451)	(0.27756)
	[-0.61207]	[-0.56258]	[0.77974]	[-0.61322]	[-0.88486]
D(LABOUR(-6))	0.077490	0.265308	1.085376	0.070292	0.190374
	(0.11875)	(0.25933)	(1.06348)	(0.14098)	(0.27078)
	[0.65255]	[1.02307]	[1.02059]	[0.49861]	[0.70305]
D(RD(-1))	-0.120737	0.021328	0.386723	-0.275605	-0.347674
	(0.07140)	(0.15593)	(0.63947)	(0.08477)	(0.16282)
	[-1.69091]	[0.13678]	[0.60476]	[-3.25127]	[-2.13531]
D(RD(-2))	-0.063942	-0.024372	0.352744	-0.062690	-0.128808
	(0.07449)	(0.16266)	(0.66708)	(0.08843)	(0.16985)
	[-0.85844]	[-0.14983]	[0.52879]	[-0.70894]	[-0.75836]
D(RD(-3))	-0.047698	-0.088380	0.853134	-0.038750	-0.034048
	(0.06539)	(0.14281)	(0.58565)	(0.07763)	(0.14912)
	[-0.72938]	[-0.61887]	[1.45673]	[-0.49913]	[-0.22833]
D(RD(-4))	0.143549	0.232097	1.216668	-0.030986	0.399490
	(0.06437)	(0.14057)	(0.57649)	(0.07642)	(0.14679)
	[2.23000]	[1.65106]	[2.11047]	[-0.40547]	[2.72158]
D(RD(-5))	0.086815	0.067727	0.894453	0.189136	0.432148
	(0.06962)	(0.15203)	(0.62346)	(0.08265)	(0.15875)
	[1.24705]	[0.44549]	[1.43466]	[2.28848]	[2.72226]
D(RD(-6))	-0.010232	-0.041941	0.925772	-0.013231	0.016025
	(0.07205)	(0.15734)	(0.64523)	(0.08553)	(0.16429)
	[-0.14202]	[-0.26657]	[1.43480]	[-0.15469]	[0.09754]
C	0.006422	0.002047	-0.021788	0.006835	0.007143
	(0.00163)	(0.00356)	(0.01460)	(0.00194)	(0.00372)
	[3.93897]	[0.57502]	[-1.49230]	[3.53143]	[1.92149]

R-squared	0.400680	0.317201	0.303822	0.542845	0.432504
Adj. R-squared	0.171311	0.055882	0.037383	0.367884	0.215314
Sum sq. resids	0.007165	0.034171	0.574687	0.010099	0.037258
S.E. equation	0.009405	0.020539	0.084231	0.011166	0.021447
F-statistic	1.746879	1.213847	1.140307	3.102667	1.991364
Log likelihood	385.7828	297.5221	138.0544	366.3946	292.6363
Akaike AIC	-6.261642	-4.699505	-1.877069	-5.918489	-4.613031
Schwarz SC	-5.489284	-3.927148	-1.104711	-5.146132	-3.840673
Mean dependent	0.002566	0.001770	0.006726	0.002124	0.003186
S.D. dependent	0.010332	0.021139	0.085851	0.014044	0.024211
Determinant resid covariance (dof adj.)	2.87E-18				
Determinant resid covariance	5.43E-19				
Log likelihood	1574.530				
Akaike information criterion	-24.94743				
Schwarz criterion	-20.96496				
Number of coefficients	165				

Vector Error Correcting Model (with 2 lags selection)

Vector Error Correction Estimates
Date: 01/14/24 Time: 19:26
Sample (adjusted): 1992Q4 2021Q4
Included observations: 117 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
GDP(-1)	1.000000
TRADE(-1)	0.251175 (0.10954) [2.29307]
CAPITAL(-1)	-0.138307 (0.02040) [-6.77848]
LABOUR(-1)	-0.688280 (0.07735) [-8.89860]
RD(-1)	-0.207901 (0.05912) [-3.51656]
C	-1.905745

Error Correction:	D(GDP)	D(TRADE)	D(CAPITAL)	D(LABOUR)	D(RD)
CointEq1	0.024340 (0.05210) [0.46719]	-0.143427 (0.11373) [-1.26117]	1.328482 (0.47902) [2.77333]	0.129394 (0.06932) [1.86653]	0.337107 (0.11807) [2.85503]
D(GDP(-1))	-0.294922 (0.15499) [-1.90287]	-0.057974 (0.33833) [-0.17136]	-0.412882 (1.42506) [-0.28973]	-0.061140 (0.20623) [-0.29646]	-0.195246 (0.35127) [-0.55584]
D(GDP(-2))	-0.182519 (0.15322) [-1.19125]	-0.213480 (0.33446) [-0.63828]	-0.756287 (1.40877) [-0.53684]	-0.097381 (0.20388) [-0.47765]	-0.281042 (0.34725) [-0.80934]
D(TRADE(-1))	0.035017 (0.05251) [0.66683]	-0.008361 (0.11463) [-0.07294]	-0.050895 (0.48284) [-0.10541]	0.025165 (0.06988) [0.36013]	0.052603 (0.11902) [0.44198]
D(TRADE(-2))	0.035858 (0.05245) [0.68359]	0.041306 (0.11450) [0.36074]	0.257706 (0.48230) [0.53433]	-0.029533 (0.06980) [-0.42313]	-0.023399 (0.11888) [-0.19683]
D(CAPITAL(-1))	-0.011567 (0.01167) [-0.99110]	-0.018743 (0.02548) [-0.73566]	-0.027970 (0.10731) [-0.26064]	-0.000104 (0.01553) [-0.00667]	0.008520 (0.02645) [0.32208]
D(CAPITAL(-2))	0.003612 (0.01145) [0.31562]	0.004761 (0.02498) [0.19057]	0.099709 (0.10523) [0.94749]	0.003602 (0.01523) [0.23653]	0.022606 (0.02594) [0.87148]
D(LABOUR(-1))	-0.057962 (0.09083) [-0.63810]	-0.163365 (0.19828) [-0.82389]	-0.029487 (0.83519) [-0.03531]	-0.149791 (0.12087) [-1.23930]	-0.148110 (0.20587) [-0.71944]
D(LABOUR(-2))	-0.010162 (0.08866) [-0.11463]	0.075789 (0.19353) [0.39162]	0.905255 (0.81516) [1.11053]	-0.090189 (0.11797) [-0.76451]	-0.053670 (0.20093) [-0.26711]
D(RD(-1))	-0.044878 (0.05872) [-0.76422]	0.009799 (0.12819) [0.07644]	-0.055768 (0.53995) [-0.10328]	-0.196722 (0.07814) [-2.51754]	-0.336905 (0.13309) [-2.53136]
D(RD(-2))	-0.007091 (0.06047) [-0.11728]	0.050092 (0.13200) [0.37950]	-0.450805 (0.55597) [-0.81084]	-0.048959 (0.08046) [-0.60849]	-0.146597 (0.13704) [-1.06971]

C	0.003929	0.002543	0.005573	0.003773	0.006052
	(0.00099)	(0.00217)	(0.00912)	(0.00132)	(0.00225)
	[3.95938]	[1.17409]	[0.61083]	[2.85780]	[2.69123]
R-squared	0.161945	0.042685	0.091397	0.201821	0.214481
Adj. R-squared	0.074149	-0.057606	-0.003790	0.118202	0.132189
Sum sq. resids	0.010082	0.048044	0.852378	0.017852	0.051789
S.E. equation	0.009799	0.021391	0.090099	0.013039	0.022209
F-statistic	1.844561	0.425612	0.960182	2.413587	2.606327
Log likelihood	381.4935	290.1560	121.9153	348.0716	285.7649
Akaike AIC	-6.316129	-4.754804	-1.878893	-5.744813	-4.679742
Schwarz SC	-6.032829	-4.471504	-1.595593	-5.461513	-4.396442
Mean dependent	0.002564	0.001880	0.003675	0.002137	0.003162
S.D. dependent	0.010184	0.020800	0.089929	0.013886	0.023840

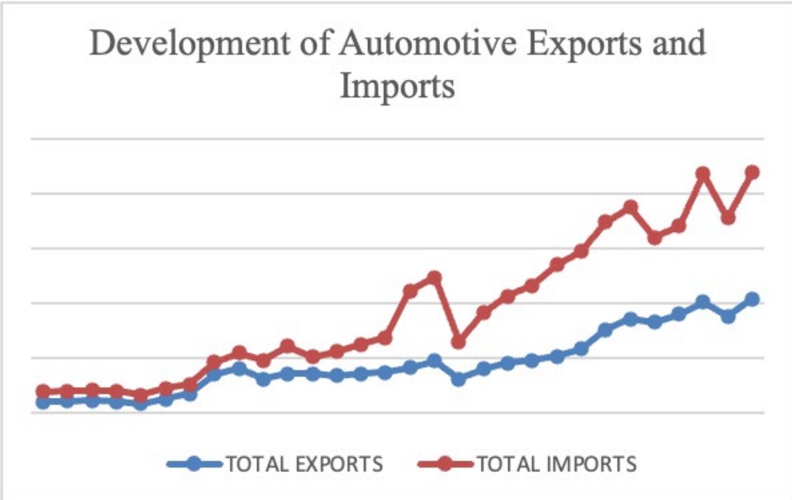
Determinant resid covariance (dof adj.)	6.58E-18
Determinant resid covariance	3.83E-18
Log likelihood	1515.969
Akaike information criterion	-24.80288
Schwarz criterion	-23.26834
Number of coefficients	65

Results for lag 1-2 show insignificant results. Affirming that the model is not suitable in the short run.

APPENDIX F: VARIABLE EXPLANATION

Trade Openness

Development of Automotive Exports and Imports



Source: Author's visualisation using DTIC information and various AIEC/NAAMSA reports.

APPENDIX G: DIAGNOSTICS

Trade Openness and Economic Growth

Jarque-Bera Test of Normal Distribution

VEC Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: Residuals are multivariate normal
Date: 08/21/23 Time: 11:28
Sample: 1992Q1 2021Q4
Included observations: 113

Component	Skewness	Chi-sq	df	Prob.*
1	-4.627473	403.2878	1	0.0000
2	-1.081169	22.01477	1	0.0000
3	-0.583502	6.412262	1	0.0113
4	-0.040961	0.031599	1	0.8589
5	0.449177	3.799816	1	0.0513
Joint		435.5462	5	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	39.03206	6112.873	1	0.0000
2	8.878827	162.7229	1	0.0000
3	9.183634	180.0341	1	0.0000
4	5.653099	33.14165	1	0.0000
5	8.191158	126.8807	1	0.0000
Joint		6615.652	5	0.0000

Component	Jarque-Bera	df	Prob.
1	6516.161	2	0.0000
2	184.7377	2	0.0000
3	186.4464	2	0.0000
4	33.17325	2	0.0000
5	130.6805	2	0.0000
Joint	7051.198	10	0.0000

*Approximate p-values do not account for coefficient estimation

Heteroskedasticity

VEC Residual Heteroskedasticity Tests (Levels and Squares)
Date: 08/21/23 Time: 11:26
Sample: 1992Q1 2021Q4
Included observations: 113

Joint test:

Chi-sq	df	Prob.
808.5990	930	0.9983

Individual components:

Dependent	R-squared	F(62,50)	Prob.	Chi-sq(62)	Prob.
res1*res1	0.551555	0.991876	0.5159	62.32567	0.4645
res2*res2	0.455824	0.675517	0.9289	51.50814	0.8265
res3*res3	0.374281	0.482389	0.9967	42.29377	0.9738
res4*res4	0.540484	0.948550	0.5814	61.07467	0.5094
res5*res5	0.533308	0.921563	0.6227	60.26375	0.5388
res2*res1	0.526012	0.894967	0.6632	59.43937	0.5687
res3*res1	0.563517	1.041163	0.4445	63.67746	0.4172
res3*res2	0.611026	1.266827	0.1944	69.04594	0.2516
res4*res1	0.547872	0.977227	0.5378	61.90949	0.4793
res4*res2	0.531640	0.915410	0.6321	60.07529	0.5456
res4*res3	0.574590	1.089253	0.3796	64.92867	0.3750
res5*res1	0.552238	0.994622	0.5118	62.40293	0.4618
res5*res2	0.557503	1.016049	0.4803	62.99779	0.4408
res5*res3	0.478803	0.740854	0.8696	54.10469	0.7521
res5*res4	0.551637	0.992205	0.5154	62.33494	0.4642

Serial Correlation LM Tests

VEC Residual Serial Correlation LM Tests
Date: 08/21/23 Time: 11:27
Sample: 1992Q1 2021Q4
Included observations: 113

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	11.96349	25	0.9869	0.468847	(25, 269.0)	0.9869
2	26.14175	25	0.4001	1.051015	(25, 269.0)	0.4010
3	16.65976	25	0.8938	0.658428	(25, 269.0)	0.8941
4	37.60621	25	0.0505	1.543753	(25, 269.0)	0.0509
5	24.13916	25	0.5113	0.966992	(25, 269.0)	0.5122
6	14.90874	25	0.9435	0.587371	(25, 269.0)	0.9437
7	16.48665	25	0.8996	0.651383	(25, 269.0)	0.8999

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	11.96349	25	0.9869	0.468847	(25, 269.0)	0.9869
2	57.20680	50	0.2252	1.158326	(50, 308.9)	0.2283
3	85.06132	75	0.2001	1.150372	(75, 301.2)	0.2079
4	97.68361	100	0.5469	0.968099	(100, 282.7)	0.5675
5	108.6210	125	0.8514	0.836162	(125, 260.8)	0.8709
6	126.5296	150	0.9183	0.793407	(150, 237.5)	0.9383
7	161.2476	175	0.7641	0.868297	(175, 213.5)	0.8341

*Edgeworth expansion corrected likelihood ratio statistic.

Serial Correlation LM Tests

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.166985	Prob. F(2,13)	0.8480
Obs*R-squared	0.500931	Prob. Chi-Square(2)	0.7784

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 08/21/23 Time: 15:10
Sample: 2017Q1 2021Q4
Included observations: 20
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
K	0.011403	0.120426	0.094691	0.9260
RD	0.008374	0.046454	0.180267	0.8597
LSKILLED	0.036135	0.773652	0.046707	0.9635
DVA(-100)	0.104463	0.417074	0.250467	0.8061
C	-0.685611	3.600823	-0.190404	0.8519
RESID(-1)	0.171434	0.330036	0.519442	0.6122
RESID(-2)	0.078616	0.303446	0.259079	0.7996

R-squared	0.025047	Mean dependent var	-1.24E-15
Adjusted R-squared	-0.424932	S.D. dependent var	0.007688
S.E. of regression	0.009178	Akaike info criterion	-6.274891
Sum squared resid	0.001095	Schwarz criterion	-5.926384
Log likelihood	69.74891	Hannan-Quinn criter.	-6.206859
F-statistic	0.055662	Durbin-Watson stat	1.831415
Prob(F-statistic)	0.999022		

Correlogram

Date: 08/21/23 Time: 15:48
Sample (adjusted): 2017Q1 2021Q4
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.117	0.117	0.3191	0.572
		2	0.063	0.050	0.4149	0.813
		3	-0.048	-0.062	0.4745	0.924
		4	-0.414	-0.413	5.1977	0.268
		5	0.015	0.130	5.2044	0.391
		6	-0.102	-0.076	5.5343	0.477
		7	-0.016	-0.041	5.5433	0.594
		8	0.332	0.230	9.5836	0.295
		9	-0.099	-0.156	9.9779	0.352
		10	-0.129	-0.277	10.712	0.380
		11	-0.217	-0.182	13.013	0.292
		12	-0.306	-0.056	18.169	0.111

*Probabilities may not be valid for this equation specification.

APPENDIX I: LOGGED RAW DATA – USED FOR TRADE OPENNESS

Period	Auto GDP	Trade	FDI	Capex	Labour	R&D	GovEdu
Q1/92	4.52	0.94	3.13	2.91	3.12	4.64	2.64
Q2/92	4.52	0.94	3.15	2.91	3.12	4.64	2.64
Q3/92	4.51	0.93	3.16	2.91	3.12	4.63	2.63
Q4/92	4.51	0.93	3.13	2.90	3.11	4.62	2.62
Q1/93	4.51	0.94	2.99	2.57	3.12	4.63	2.68
Q2/93	4.52	0.95	3.00	2.57	3.12	4.63	2.68
Q3/93	4.52	0.95	3.01	2.58	3.13	4.64	2.69
Q4/93	4.53	0.96	3.02	2.58	3.13	4.65	2.70
Q1/94	4.53	0.96	3.04	2.64	3.13	4.64	2.64
Q2/94	4.53	0.96	3.06	2.64	3.13	4.65	2.65
Q3/94	4.53	0.97	3.08	2.65	3.14	4.66	2.66
Q4/94	4.54	0.98	3.09	2.66	3.15	4.67	2.67
Q1/95	4.54	0.99	3.12	2.84	3.15	4.66	2.64
Q2/95	4.55	0.99	3.15	2.84	3.15	4.66	2.64
Q3/95	4.55	1.00	3.15	2.85	3.15	4.67	2.65
Q4/95	4.55	1.00	3.16	2.85	3.15	4.67	2.65
Q1/96	4.56	1.02	3.18	2.86	3.15	4.67	2.65
Q2/96	4.56	1.02	3.20	2.86	3.15	4.68	2.66
Q3/96	4.57	1.03	3.21	2.87	3.16	4.69	2.67
Q4/96	4.57	1.03	3.22	2.87	3.16	4.70	2.68
Q1/97	4.57	1.02	3.24	2.83	3.17	4.69	2.67
Q2/97	4.58	1.02	3.25	2.83	3.17	4.70	2.68
Q3/97	4.58	1.03	3.26	2.83	3.17	4.70	2.68
Q4/97	4.58	1.03	3.26	2.83	3.17	4.70	2.68
Q1/98	4.58	1.04	3.28	3.03	3.19	4.70	2.68
Q2/98	4.58	1.04	3.29	3.03	3.19	4.70	2.68
Q3/98	4.58	1.04	3.31	3.03	3.19	4.70	2.68

Q4/98	4.58	1.04	3.32	3.03	3.19	4.70	2.68
Q1/99	4.58	1.02	3.29	2.57	3.20	4.70	2.70
Q2/99	4.59	1.02	3.29	2.57	3.20	4.70	2.70
Q3/99	4.59	1.03	3.29	2.58	3.21	4.71	2.71
Q4/99	4.60	1.03	3.30	2.58	3.21	4.72	2.72
Q1/00	4.60	1.06	3.31	2.60	3.20	4.71	2.68
Q2/00	4.60	1.06	3.33	2.60	3.21	4.72	2.69
Q3/00	4.61	1.06	3.34	2.60	3.21	4.73	2.70
Q4/00	4.61	1.07	3.36	2.61	3.21	4.74	2.71
Q1/01	4.61	1.09	3.37	2.72	3.21	4.82	2.68
Q2/01	4.62	1.09	3.37	2.72	3.21	4.82	2.68
Q3/01	4.62	1.09	3.38	2.72	3.21	4.82	2.68
Q4/01	4.62	1.09	3.39	2.72	3.21	4.83	2.69
Q1/02	4.63	1.12	3.41	2.82	3.21	4.82	2.67
Q2/02	4.63	1.12	3.42	2.83	3.22	4.84	2.69
Q3/02	4.64	1.13	3.44	2.83	3.22	4.85	2.69
Q4/02	4.64	1.13	3.46	2.84	3.22	4.85	2.70
Q1/03	4.64	1.05	3.47	2.76	3.23	4.87	2.68
Q2/03	4.65	1.06	3.49	2.76	3.23	4.87	2.68
Q3/03	4.65	1.06	3.50	2.76	3.23	4.88	2.69
Q4/03	4.65	1.06	3.52	2.76	3.23	4.88	2.69
Q1/04	4.66	1.05	3.53	2.73	3.22	4.91	2.70
Q2/04	4.66	1.05	3.54	2.74	3.22	4.92	2.71
Q3/04	4.67	1.06	3.56	2.74	3.23	4.93	2.73
Q4/04	4.67	1.07	3.58	2.75	3.24	4.94	2.73
Q1/05	4.68	1.06	3.59	2.94	3.24	4.95	2.72
Q2/05	4.69	1.07	3.60	2.95	3.24	4.97	2.74
Q3/05	4.69	1.08	3.63	2.96	3.25	4.98	2.75
Q4/05	4.69	1.08	3.65	2.96	3.25	4.99	2.76
Q1/06	4.70	1.12	3.67	3.18	3.24	5.00	2.75

Q2/06	4.71	1.13	3.69	3.19	3.25	5.01	2.76
Q3/06	4.71	1.13	3.72	3.19	3.25	5.02	2.77
Q4/06	4.72	1.14	3.75	3.20	3.26	5.03	2.78
Q1/07	4.73	1.15	3.78	2.88	3.26	5.02	2.77
Q2/07	4.73	1.13	3.80	3.19	3.26	5.03	2.78
Q3/07	4.74	1.13	3.81	3.19	3.26	5.04	2.79
Q4/07	4.74	1.14	3.83	3.20	3.27	5.05	2.80
Q1/08	4.74	1.21	3.85	2.91	3.33	5.04	2.78
Q2/08	4.75	1.22	3.89	2.92	3.33	5.05	2.79
Q3/08	4.75	1.22	3.93	2.92	3.33	5.06	2.79
Q4/08	4.75	1.22	3.95	2.92	3.33	5.05	2.79
Q1/09	4.74	1.09	3.91	2.79	3.39	5.01	2.82
Q2/09	4.74	1.09	3.89	2.79	3.39	5.01	2.81
Q3/09	4.74	1.09	3.88	2.79	3.39	5.01	2.82
Q4/09	4.74	1.10	3.88	2.79	3.39	5.02	2.82
Q1/10	4.75	1.09	3.88	2.99	3.38	4.96	2.85
Q2/10	4.75	1.10	3.88	3.00	3.39	4.97	2.86
Q3/10	4.76	1.10	3.88	3.00	3.39	4.98	2.87
Q4/10	4.76	1.11	3.90	3.01	3.39	4.99	2.87
Q1/11	4.76	1.13	3.92	2.99	3.38	4.98	2.88
Q2/11	4.77	1.13	3.91	2.99	3.38	4.99	2.89
Q3/11	4.77	1.14	3.93	2.99	3.38	4.99	2.89
Q4/11	4.77	1.14	3.95	2.99	3.39	5.00	2.90
Q1/12	4.77	1.14	3.94	3.06	3.38	4.99	2.91
Q2/12	4.78	1.14	3.96	3.07	3.38	5.00	2.92
Q3/12	4.78	1.14	3.96	3.07	3.38	5.00	2.92
Q4/12	4.78	1.15	3.98	3.07	3.39	5.01	2.92
Q1/13	4.78	1.16	3.99	3.03	3.36	5.00	2.91
Q2/13	4.79	1.17	4.01	3.04	3.37	5.01	2.91
Q3/13	4.79	1.17	4.02	3.04	3.37	5.01	2.92

Q4/13	4.79	1.17	4.03	3.04	3.37	5.02	2.92
Q1/14	4.79	1.17	4.03	3.23	3.35	5.04	2.93
Q2/14	4.79	1.17	4.03	3.24	3.35	5.04	2.93
Q3/14	4.80	1.17	4.03	3.24	3.35	5.05	2.93
Q4/14	4.80	1.18	4.05	3.24	3.36	5.05	2.94
Q1/15	4.80	1.15	4.04	3.22	3.35	5.07	2.94
Q2/15	4.80	1.15	4.05	3.22	3.35	5.06	2.93
Q3/15	4.80	1.15	4.06	3.22	3.35	5.06	2.94
Q4/15	4.80	1.15	4.07	3.22	3.35	5.07	2.94
Q1/16	4.80	1.14	4.07	3.20	3.35	5.08	2.94
Q2/16	4.80	1.15	4.09	3.21	3.35	5.08	2.94
Q3/16	4.80	1.15	4.06	3.21	3.35	5.08	2.94
Q4/16	4.80	1.15	4.07	3.21	3.35	5.08	2.94
Q1/17	4.81	1.12	4.07	3.31	3.37	5.08	2.95
Q2/17	4.81	1.13	4.07	3.31	3.37	5.09	2.95
Q3/17	4.81	1.13	4.08	3.31	3.37	5.09	2.96
Q4/17	4.81	1.13	4.09	3.31	3.37	5.09	2.96
Q1/18	4.81	1.13	4.09	3.26	3.37	5.04	2.96
Q2/18	4.81	1.13	4.08	3.25	3.37	5.04	2.96
Q3/18	4.82	1.14	4.09	3.26	3.38	5.05	2.97
Q4/18	4.82	1.14	4.08	3.26	3.38	5.06	2.97
Q1/19	4.81	1.13	4.09	3.26	3.37	5.00	2.98
Q2/19	4.82	1.13	4.09	3.26	3.38	5.00	2.99
Q3/19	4.82	1.13	4.10	3.26	3.38	5.00	2.99
Q4/19	4.82	1.13	4.09	3.26	3.38	5.00	2.99
Q1/20	4.82	1.13	4.08	3.39	3.39	5.03	3.04
Q2/20	4.74	1.05	3.97	3.31	3.31	4.87	2.87
Q3/20	4.79	1.11	4.04	3.37	3.37	4.98	2.99
Q4/20	4.80	1.12	4.06	3.38	3.38	5.01	3.01
Q1/21	4.81	1.15	4.05	3.34	3.37	4.99	3.02

Q2/21	4.81	1.15	4.06	3.35	3.37	5.00	3.03
Q3/21	4.80	1.14	4.06	3.34	3.37	4.99	3.02
Q4/21	4.81	1.15	4.08	3.34	3.37	5.00	3.03