THE NEXUS OF EMPLOYMENT AND TRADE: CASE STUDY OF TOMATO SECTOR IN SOUTH AFRICA (1996-2018)

BY

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[redacted]

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DECLARATION

I, Mpho Stelence Mokgolobotho, declare that the study titled **THE NEXUS OF EMPLOYMENT AND TRADE: CASE STUDY OF THE TOMATO SECTOR IN SOUTH AFRICA (1996-2018)** is my own work and all the sources used are duly acknowledged by means of complete reference. It is submitted to University of Limpopo for the Master of Science in Agriculture (Agricultural Economics) and the work has not been previously submitted by me for any degree purpose or examination at this university or any other university.

Signature:……. Date:……..……

…… ……

DEDICATION

This work is dedicated to my mother Mmapula Cate Mokgolobotho and my father Doctor M Letsoalo with the help of the LORD GOD managed to support me from the beginning of this study until at present.

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I am thankful to the LORD ALMIGHTY for granting me the wisdom, strength, and courage to embark and complete this study.

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ABSTRACT

Tomato is a significant commodity produced and traded by South Africa. The commodity plays an important role in job creation. South Africa is known as self-sufficient producer of fresh tomatoes due to its resource endowments. South Africa exports fresh tomato produce to Botswana, Namibia, Mozambique, and Lesotho. However, unjustified trade bans from neighbouring countries such as Namibia and Botswana threaten jobs in South African agricultural trade. Trade plays a vital role in employment creation and can be captured by the variable which is calculated as domestic employment in gross export. Tomato sector exports contribute to the economy and can enhance foreign exchange rates in the country.

The study aims to analyse relationship between domestic employment in gross agricultural exports and tomato sector trade from 1996 to 2018, the study focused on South Africa. The objectives of this study were to establish the causality, long-run and short-run relationship between domestic employment in gross agricultural exports and tomato sector trade in South Africa. Secondary data was employed in this study for tomato imports and exports as well as domestic employment in gross agricultural exports. The objectives were examined using a Vector auto-regressive (VAR) model and Granger causality test.

Max-Eigen and trace test from the Johansen co-integration test revealed that domestic employment in gross agricultural exports and tomato sector trade does not have a long-term co-integration. The Granger causality test revealed that domestic employment in gross export in agriculture (EMP) does not cause the amount of tomato exported (export quantity of tomato) (EXPT) in the short term. Furthermore, domestic employment in gross export in agriculture (EMP) does not cause import quantity of tomato (IMPT) in the short run. The study recommends policymakers implement short-term policies to address the deviations observed in domestic employment in gross export in agriculture and tomato trade quantities (import quantity and export quantity).

Keywords: domestic employment, gross agricultural exports, tomato sector trade, VAR model and Granger causality test

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LIST OF ACRONYMS

ADF	Augmented Dickey Fuller Test
AGMRC	Agricultural Marketing Resource Center
BLS	Bureau of Labour Statistics
CBMA	Council for Black Market Agents
CU	Cambridge University
DAFF	Department of Agriculture, Forestry and Fisheries
DALRRD	Department of Agriculture, Land Reform and Rural Development
EMP	Domestic Employment in Gross Export in Agriculture
EXPT	Export Quantity of Tomato
FAO	Food and Agricultural Organization
IMPT	Import Quantity of Tomato
ITC	International Trade Centre
NAMC	National Agricultural Marketing Council
NTB	Non-Tariff Barriers
OECD	Organization for Economic Cooperation and Development
SA	South Africa
SADAFF	South African department of Agriculture, Forestry and Fisheries
SACUA	Southern African Customs Union Agreement
Stats SA	Statistics South Africa
VAR	Vector autoregressive Model
WTO	World Trade Organization

CHAPTER 1: INTRODUCTION

1.1 Background of the study

Tomato remains the most common vegetable that is traded in South Africa among other vegetables that are traded in the country (CBMA, 2023). It is one of the vegetables that need a lot of labor in the production phase, and it creates a lot of employment due to the higher quantity demanded of tomatoes in the global market (Ibarrola-Rivas et al., 2020). Factors such as land availability, infrastructure (storage), low cost of human capital (abundance of unskilled labor), and efficient production contribute to the comparative advantage of tomato production (Esterhuizen, 2006). According to Visser et al. (2015), South Africa has a comparative advantage on tomato production due to factor endowments that favor tomato production in higher quantities.

DAFF (2019) stated that South Africa is identified as a self-sufficient in tomato production, and its tomato trade contributes positively towards economic growth and employment creation. According to Wiersinga and de Jager (2009), the tomato sector plays a vital role in global agricultural and food industries. From an economic perspective, the tomato sector influences employment generation in both rural and urban areas, providing livelihoods for farmers, laborers, and workers in processing facilities and distribution networks. Moreover, the tomato sector has significant implications for international trade, with tomatoes and tomato products being traded across borders, leading to global market integration and economic interdependence.

According to DALRRD (2020), the South African tomato sector has lots of job opportunities since approximately 22,500 people were employed with their 135,000 dependents. In the year 2016, reports by the South African Government News Agency (2016) stated that a tomato processing plant was launched, and it created a big market for tomatoes, including job opportunities. In addition, for the gross value of vegetable produce in 2009, the tomato sector contributed 19% of the gross value, whereas in 2018, its contribution to the gross value of vegetable produce was 17%. According to DAFF (2012), the biggest recipient of South African tomato exports is the African continent; therefore, those countries indicate the export share of South African tomatoes. Hence, in year 2022 South Africa was ranked number 50 in the world because of R85. 35 million that tomato export contributed to the tomato sector (OEC

report, 2024). The biggest recipients of South African tomato exports on the African continent in 2018 were Botswana (37.7% market share), Lesotho (21.1% market share), Namibia (15.7% market share), and lastly, Mozambique (14.2% market share), and the share has steadily declined (DALRRD, 2020). Observatory of Economic Complexity (OEC) report (2024) stated that main recipients of South African tomato export in year 2024 is Lesotho (27.4% market share), Mozambique (37.3% market share), Namibia (18.9% market share), Eswatini (11.7% market share), and Angola (1.66% market share).

According to DAFF (2019), it was noted that South Africa recorded a high volume of tomato exports in 2012, and this was indicated by an increase in the domestic production output of tomatoes by 9%. Tomato exports grew by 14.6% in the year 2015, despite a decrease in domestic tomato output of 8.5%. Tomato exports were more profitable in 2013-2016 due to higher export values that were recorded (DALRRD, 2020). In comparison to other years, tomato exports were less profitable due to the low export values that were recorded for exported volumes.

According to the Department of Agriculture (2007), an increase of 155% in the export quantity of tomatoes, in terms of tons, from 16737 tons to 12219 tons. Tomatoes contributed 21% to an overall of agricultural commodity value, in the years 2016-2021 tomato trade contributed 28,24% towards total agricultural production (DALRRD, 2021). Hence, DALRRD (2021) observed that export quantity of tomatoes has decreased by 11.2% tons (from 21 482 tons to 19083 tons).

DAFF (2019) and DALRRD (2020) noted that South Africa was ranked number 40 in 2018, while in 2020 it was ranked number 44 in terms of tomato exports. These inform us that neither competitiveness nor comparative advantage has been lost. A low percentage (less than 1%) of processed tomatoes are exported to other countries, such as France and Netherland, while most of raw tomatoes are predestined to be sold on the domestic market before being sold on the global market (AGMRC, 2024). However, DAFF (2019a) stated that in 2017 and 2018, the South African tomato trade contributed 27,76% of the total trade in agricultural goods, making tomatoes an important export commodity for South Africa.

Domestic employment has been threatened by the unjustified trade ban that the South African tomato sector experienced. An unjustified trade ban can be caused by tariff

barriers, mainly specific tariffs and non-tariff barriers (NTB) (Radcliffe, 2023). The neighboring countries, such as Botswana and Namibia, have employed various measures of tariffs in vegetable markets to protect their domestic markets, which is why South African fresh tomato producers felt discomfort after this resolution (DALRRD, 2020).

Further, Edwards and Stern (2007) argued that tariffs were not sufficient to reduce unemployment, and the agricultural effective rate of protection has declined to 1.7% in South Africa. The study inferred that poor consumers are not part of the formal sector due to export growth that did not create employment opportunities in agricultural trade. According to McCullough et al. (2001), agricultural trade experienced labor shedding due to cheap tariff fees that were driven by competitive gains in the trade sector.

1.2 Problem statement

According to the South African Department of Agriculture, Forestry, and Fisheries (DAFF) (2011), the tomato sector contributed approximately R1 billion to an overall of agricultural export value in South Africa. Whereas in year 2022 South African tomato sector contributed approximately R6.61 million to total export value (OCE, 2024), the contribution of tomato export value decreased due to unjustified trade ban. However, economists identified the lack of trade assimilation, which is calculated by the volume of export and import in the trade sector that leads to the realization of labor gains at various stages of tomato production including cultivation, harvesting, processing, packaging, and exporting (McDonald, 2009). Recently, South Africa has faced restrictions on the export of tomatoes destined for Botswana and Namibia (Tshitiza, 2022). This action reflects the ongoing efforts of these countries to safeguard their domestic producers.

Hence, Thukwana (2022) stated that the unjustified trade ban on exporting tomatoes has threatened employment opportunities in various stages of tomato production and negatively affected the export revenues currently in South Africa. The situation forced South African government to promote consumption of domestic goods, thus identifying alternative markets. Mohler et al. (2018) observed that economists have conflicting views regarding the nexus of trade and employment in the tomato sector, and this is complicated by the fact that specific employment trends data in South African tomato

trade are not available. This study tries to fill this gap in analyzing this specific nexus by considering the domestic employment in the gross exports variable to incorporate the analysis of nexus between tomato trade and domestic employment.

Employment in the tomato sector relies on factors such as the size of tomato sector, technological advancements, mechanization, and overall economic conditions (Schmitz and Moss, 2015)'. There are arguments in the literature (Casacuberta and Gandelman, 2010; Muendler, 2010) indicating that increased trade openness can lead to job losses rather than gains. Hence, Gasiorek et al. (2019), argued that increased trade creates loss of job and increases inequality in countries that trade. This is why it is necessary to understand the nexus of South Africa's tomato trade with employment. Unfair practices in the tomato export markets lead to a decline in domestic employment within the tomato industry, particularly in regions heavily reliant on tomato production and processing (Fan, 2020). The situation exacerbates unemployment rates and decreases the standard of living for individuals and communities dependent on the tomato industry for livelihood.

Jansen (2022) noted that the unfairness in the export of tomatoes stems from trade practices that may include price manipulation, non-tariff barriers, and unfair competition. These practices can result in an uneven playing field for domestic producers and employment opportunities, impacting overall economic growth and stability. Furthermore, Farmers Weekly (2022) stated that South Africa lost its competitiveness over Botswana and Namibia due to their low labor costs. Therefore, the study aims to fill the limited number of studies that have analyzed imports, exports, and employment by determining the nexus of domestic employment in agricultural exports and the tomato trade sector in South Africa.

The ban on exporting fresh agricultural products such as tomatoes in South Africa did not come from the farmers' bad actions (Van der Rheede, 2022). However, Botswana and Namibia wanted to protect their local producers of tomatoes. In addition, these countries continuously exported their tomatoes to South Africa; therefore, the unjustified trade ban was an indirect violation of Southern African Customs Union Agreement (SACUA), and this is regarded as unfair competition (Tshitiza, 2022).

The lack of action taken when other countries-imposed trade bans caused South African fresh tomato producers to have an uncomfortable feeling that the government

had failed them. Therefore, unfairness in tomato export practices may contribute to disparities in gross export figures, undermining the overall economic potential of the country. The study seeks to address the relationship between domestic employment in gross agricultural exports and the tomato trade sector. This necessitates a deep understanding of the trade dynamics, employment implications, and economic repercussions of unequal export practices in the tomato industry.

1.3 Rationale/Motivation

The tomato sector is identified as the sector that absorbs massive labor through the trade and industry sectors (Nkunjana and Dempers, 2020). It is stated in South African Government News Agency (SAGNA) (2016) that when a manufacturing firm seeks 15,000 tons of tomatoes to process, its sources from at least 15 commercial farmers. The firms have a potential opportunity to receive 30,000 tons, which will require 9,000 thousand laborers (Davies, 2016). The motivation of this study is portrayed from the point that trade plays a major role in domestic employment in gross exports, which ensures that tomato sector trade occurs and enhances the foreign exchange rate in the country.

South Africa exports fresh tomato produce to Botswana, Namibia, Mozambique, and Lesotho (DAFF, 2019). South Africa is identified as the major exporter of tomato in Africa but not in the world (McKinsey, 2015)". However, tariffs applicable to tomato exports were increased in 2009 by 37% at WTO-bound rates, including imports (ITAC report, 2012). The South African agricultural tariff quota rate is 37.1% at WTO bound rate in year 2023, especially fruit and vegetable WTO-bound rate is 15.9% (WTO, 2024). Enabling downstream processors to import tomatoes in bulk is a requirement to help domestic processors meet their needs.

DurSots-All (2016) reports that tomato processing companies reduce domestic unemployment due to the number of laborers needed to process certain commodities, like tomato paste. Hence, Hoogerwerf report (2024) stated that tomato processing value chain is essential for job creation and tomato commodities such as tomato paste are highly demanded. This ensures that domestic employment in gross agricultural export increases, especially when there is no unjustified trade ban that occurs among countries.

Between the years 1996 and 2018, the South African tomato sector showed steady growth in tomato production, which led to a market share with neighboring countries like Zimbabwe and Botswana (FAO, 2019). In 2010, the market share of South African tomato exports to Mozambique and Zimbabwe was 68% and 14%, respectively (NAMC, 2012), but there was a decline in 2019 of market share in terms of exports. Based on comprehensive literature (Balogh and Jámbor, 2020), there are limited studies that focus on the relationship of tomato trade and domestic employment in gross agricultural export. There is a gap in the current literature with the details of the interlinkage of employment in agricultural trade and tomato sector trade. Therefore, the study aims to fill the gap by determining the nexus of domestic employment in an agricultural trade and tomato sector trade in South Africa. The study will also draw recommendations that will help policymakers in the formulation of relevant policies that are necessary to ensure fair trade and employment creation in agricultural trade.

1.4 Scope of the study

1.4.1 Aim

This study aims to examine the nexus between domestic employment in gross agricultural exports and tomato sector trade in South Africa from 1996 to 2018.

1.4.2 Objectives

The objectives of the study are:

i. To determine the long-run and short-run relationship between domestic employment in gross agricultural exports and tomato sector trade in South Africa.
ii. To determine the causality relationship between domestic employment in gross agricultural exports and tomato sector trade in South Africa.

1.4.3 Research hypotheses

i. There is no long-run and short-run relationship between domestic employment in gross agricultural exports and tomato sector trade in South Africa.
ii. There is no causality between domestic employment in gross agricultural exports and tomato sector trade in South Africa.

1.5 Structure of the study

This study contains five chapters: chapter 1 entails a background of a study and introduction. Chapter 2 entails the theoretical and relevant literature. Chapter 3 involves the methodology including an analytical tool of the study. Chapter 4 entails the empirical analysis and result discussion. Finally, chapter 5 involves conclusion, research summary, and policy recommendations.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This section gives an appraisal of national and international literature about the nexus of employment and trade. The study provides information on the relationship between domestic employment in gross agricultural exports and the tomato trade sector. The literature review highlighted how previous studies enlightened the relationship between domestic employment in gross agricultural exports and the tomato trade sector, which is a similar concern to this study.

2.2 Definition of concepts

2.2.1 Employment in export

Employment in export refer to an act of providing employment opportunities to individuals or groups within a country's workforce specifically to engage in international trade activities (Johnson and Noguera, 2012). It involves the hiring of people in various positions and sectors to actively participate in production, distribution, marketing, sale of products and sale of services that are intended for export to other countries. This can include roles such as manufacturing workers, logistics coordinators, sales representatives, marketing professionals, and trade negotiators. Employment in exports not only contributes to the growth and profitability of export-oriented industries, but it also plays a crucial role in generating income, increasing foreign exchange reserves, and creating economic opportunities for a nation (Hessels and van Stel, 2011).

2.2.2 Domestic employment in gross exports

Domestic employment in gross exports refers to the total number of jobs generated within a country's borders because of its export activities (Llop, 2022). It measures the employment opportunities provided by industries engaged in exporting goods or services to foreign markets.

2.2.3 Tomato sector

The tomato sector refers to the entire industry that is involved in the production, processing, distribution, trade of tomatoes and tomato-based commodities (Lotti and Bonazzi, 2018). The sector encompasses a wide range of activities (UNIDO, 2009), including ‘’the cultivation of tomatoes in agricultural settings, the harvesting and

processing of tomato into value added commodities such as sauces, tomato pastes, and canned products'', as well as the distribution and marketing of these products to consumers both domestically and internationally (Kozlova et al., 2020 and AGMRC, 2024).

2.2.4 Trade sector

The trade sector is an industry where the exchange of products and services happens. When trade happens among parties within the country, this is known as domestic trade, and it can happen among countries; this is known as international trade (Hayes, 2024). While macroeconomics refers to the trade sector as international trade, this entails that the exchange of commodities and services happens on a global market, where the systems of export and import connect global markets (Ricardo, 1817). When goods are sold and services are rendered to the global markets by a country, this process is known as an export, whereas the goods and services bought from the global markets by a country are known as an import. Trade is typically a commercial transaction between people or countries, meaning an action of buying and selling takes place (Hayes, 2024).

2.3 Review of studies in South Africa and international literature

2.3.1 Review of Studies in South Africa

There are a limited number of studies that have analyzed imports, exports, and employment in South Africa's tomato sector. Baiyegunhi et al. (2018) carried out a study on tomato market integration of fresh produce in South Africa. The study used cointegration, ECM model, and the Augmented Engle-Granger (AEG) test for the causality test. The findings of the study were that the fresh produce market (the tomato market) was competitive in South Africa. AEG analysis was used to test cointegration, and findings indicated that the Durban tomato market and the Johannesburg tomato market were interconnected. Additionally, an error correlation model was applied to establish a potential causal link between the Durban tomato market and the Johannesburg tomato market. The findings indicated that the Durban market plays a crucial role in elucidating a percentage adjustment on average monthly tomato prices within the Johannesburg tomato market. In a different study in the vegetable sector, which included tomatoes, Sanganza (2021) also analyzed the competitiveness of the tomato sector. The quantitative methods used in the study are relative comparative

advantage, net export index, and relative trade advantage. One of the conclusions was that the vegetable did not have a comparative advantage, and it was also confirmed that the tomato is a net export.

Mandizvidza (2013) carried out a study in South Africa about the price transmission of tomato markets. The study used a Granger causality test to test whether wholesales price and retailers' price were caused by farmers gate price. In conclusion, the study found that there is independent causality between the prices. The Houck and error correction (ECM) approaches were also used to investigate the price transmission in a tomato market. Kargbo (2011) analyzed agricultural exports and imports in South African agricultural trade sector. The study used Engle-Granger (EG) single equation, VECM model, ARIMA model, and vector autoregression (VAR) for an analysis. The findings of the study are that ARIMA and VAR outperform VAR and VECM. The conclusion was that VAR outstrips the VECM in predicting South African agricultural exports.

Molepo et al. (2021) carried out a study in South Africa about an effect of international trade towards employment within the orange sector. The study used a VECM model and a multivariate co-integration method for an analysis. The findings of VECM revealed that aggregate of employment and the export output had a positive influence on each other in the long-term, whereas import output had a negative influence on aggregate of employment. The Granger causality test revealed bidirectional causal influences among output of export and aggregate of employment in the long-run, whereas output of import and aggregate of employment had no causal relationship. The inference of the study was that output of export had a positive influence on aggregate of employment, whereas import output had a negative influence on aggregate of employment within the orange sector.

Megbowon et al. (2017) carried out a study in South Africa about a connection between employment in the agricultural sector and output of agro-processing in the sub-sector. The study used the ARDL test and ‘’Toda-Yamamoto-Dolado-Lutkephol ‘’ causality test for an analysis. The finding revealed that there is a negative relationship between employment and output of agro-processing in the long-term. The study found that agro-processing output had a unidirectional causal relationship with agricultural sector employment. The conclusion of the study recommended stimulation of agricultural

export to increase employment in agriculture sector. None of the reviewed studies conducted have analyzed the relationship among import of tomato, export of tomato, and domestic employment within the South African tomato sector. This is the gap in the research that the current study is trying to address.

2.3.2 Review of Studies in the tomato sector internationally

Perez et al. (2017) examined an effect of trade and agricultural policies in the US tomato sector. The variables analyzed for the study included quantities and prices of imports and exports as well as domestic production. The study used structural breakpoint analysis and causality tests in its analysis. The study found that trade pricing policies and inventions in infrastructure affected trade. Tahir et al. (2012) carried out a study about tomato comparative analysis in Pakistan. The variables analyzed for the study are global tomato production and export trends. The quantitative method used in the study revealed comparative advantage. One of the conclusions is that tomato exports were negligible and there was no comparative advantage in tomato trade.

Capobianco-Uriarte et al. (2021) carried out a study about the export competitiveness in a European tomato market. The study used a quantitative approach and perpetual market share to examine the variation in tomato export and tomato competitiveness. One of the conclusions is that the European tomato market is competitive. In a different study on the tomato market, Kumar and Rai (2007) also analyzed the competitiveness, performance, and the determinant of tomato export in India. The export performance ratio and OLS techniques were used to analyze the export competitiveness of tomatoes in the study. One conclusion is that there is instability in tomato exports and competitiveness in the international market.

The study in Italy by Lombardi et al. (2016) analyzed the competitiveness and development of trade in the Italian tomato sector. The study used indexes of market shares for analysis. One of the conclusions is that the Italian tomato sector failed to anticipate the new international trade conditions and lost its export competitiveness in the tomato market. Kang (2015) carried out a study about agricultural exports, specifically rice, in Korea. The study used ECM model and vector auto-regression model to examine the dynamic association between economic growth variable and agricultural export variable. The findings of the study revealed that economic growth

and agricultural export had a causal correlation. In a different study in the agricultural export sector, Abolagba et al. (2010) analyzed the factors that influenced agricultural exports. The study used ordinary least squares regression (OLS) for analysis. The results of the analysis revealed that cocoa and rubber in agricultural exports are significantly influenced by domestic production.

Bayramoğlu (2014), also analyzed the study in Turkey about the rise in agricultural product prices having an impact on employment. The study used a vector auto-regressive model and a Granger causality test for analysis. The findings of the study revealed that employment and agricultural product prices have a causal relationship. One of the conclusions was that the rising price of agricultural commodities had significant influence on employment in the agriculture sector. Karabulut (2020) studied the influence of imports on exports in Turkey. The study used an Engle-Granger test, Dynamic Ordinary Least Squares, and Fully Modified Ordinary Least Squares. The study found that cointegration have been identified between exports and imports, suggesting that exports are significantly reliant on imports for long-term analysis. There is a bidirectional causal observed between export and import, indicating influence in both directions. None of the reviewed studies conducted internationally have analyzed the imports, exports, and employment relationship internationally for the tomato sector. This is the gap in the research that the current study is trying to address.

2.3.3 Review of studies on exports, imports and employment in agriculture

Otopoba (2016) carried out a study about the causal correlation among employment, loans, imports, and exports in the Kyrgyzstan agricultural industry. The study used the vector autoregression model for an analysis. The findings of the study revealed that there is a unilateral causal connection between export and import in the agricultural industry exists. One of the conclusions was that there is a unilateral causal correlation between imports, loans, and employment. In a different study on the agricultural sector, Sessu (2015), also analyzed the relationship between investment, production, export, and import in Indonesia's agricultural sector. The study used correlation and multiple regression models for the investigation. The outcomes of the study were that the import and export are significantly correlated with employment (workers absorbed). The study concluded that a reason for trade to correlate with employment is because the increased employment is encouraged by trade variables.

In a different study in the agricultural sector, Ervani (2013) also analyzed the export and import performance in Indonesia. The study used the trade balance index approach for analysis. The results of the study revealed that agricultural products had a positive influence on export volume-import volume and export value-import value. The conclusion was that Indonesia specializes in exporting agricultural products due to its positive influence on the agriculture industry. Verter and Bečvářová (2016) carried out a study in Nigeria about an influence of agricultural export towards economic growth. The approaches that were used for analysis in the study are Granger causality, impulse response, variance decomposition, and OLS regression. The findings revealed that agricultural exports led to economic growth. The conclusion is that agricultural trade should be encouraged in the country whereas agricultural import products should be discouraged due to the point that the country can produce those goods cheaply.

In a different study in the agricultural export, Zhai et al. (2022) also analyzed how export restriction imposed on grain by farmers affects the economy. The study used the Global Trade Analysis Project model to examine the effect of export restriction on global food security in a grain sector. The findings revealed that export restriction misrepresent global grain price in the market, grain production and grain consumption hinder farmers which might cause food insecurity. The conclusion of the study was to resolve the export restriction by tightening world trade organization regulations and ensure food security is governed. Hamidi et al. (2024) carried out a study about trade restriction and its effect on global export in Malaysian palm oil sector. The study used trade index of restrictiveness for analysis of palm oil exporters and the gravity model was also employed to explore an effect of palm oil trade restriction. The findings of study revealed negative effect of trade restriction on export of palm oil in Malaysia but significant. The conclusion was to ensure steps that are proactive on a country that import the palm oil.

In a different study of the agrarian sector, Smutka and Abrham (2022) analyzed the effect of import ban in Russia on EU export. The study used quantitative approach for analysis. The results revealed that ban of food import in Russia had a major effect in EU export countries. The conclusion was that import restriction reduce dependence of food import in Russia and promoting food security in the country. Chen et al. (2012) analyzed domestic value added and export creates employment in the Chinese

agriculture sector. The study used a quantitative approach for analysis. The findings revealed that export cause less domestic value and employment compared to output of domestic used in agriculture. The conclusion is that the total domestic demand and domestic value added of export have converged. None of the reviewed studies conducted in agriculture has analyzed the imports, exports, and employment relationship in the international tomato sector. This is the gap in the research that the current study is trying to address.

2.4 Chapter summary

The chapter explained literature reviewed for this study by considering various studies conducted in both South Africa and internationally. The concepts were defined and briefly explained to enlighten certain terminology on the topic of the study. Other studies used vector regressive analysis where long-run relationships between variables existed whereas short-run relationships did not exist. The other studies checked the causality among variables and result showed that there is causal relationship between variables and vice versa. Hence, this study intended to examine the nexus between domestic employment in gross agricultural exports and tomato sector trade in South Africa from 1996 to 2018.

CHAPTER 3: RESEARCH

3.1 Introduction

This chapter outlines the information about the study area, data, and data collection methods, and lastly gives details on the analytical techniques that were employed to address the objectives of the study.

3.2 Study area

This research was conducted in South Africa, which is in the southern part of the African continent. The neighboring countries of South Africa are Zimbabwe, Botswana, Mozambique, Namibia, Swaziland, and Lesotho (Figure 3.1). In addition, South Africa consists of nine provinces, mainly Limpopo, Gauteng, Mpumalanga, the Free State, the Eastern Cape, Kwa-Zulu Natal, the Western Cape, North West, and the Northern Cape, and 11 official languages, mainly Afrikaans, English, Sepedi (Northern Sotho), Xitsonga, Tshivenda, IsiZulu, IsiXhosa, Ndebele, Swati, Tswana, and Southern Sotho (Statistics South Africa, 2021).

The provincial tomato exporters in South Africa are in Kwa-Zulu Natal, Gauteng, and the Western Cape, and these provinces are known as exit points for tomato exports (DAFF, 2012). Larger quantities of tomato exports are from Gauteng (DAFF, 2015); this does not imply that tomatoes are mostly produced in that province. Limpopo produces lots of tomatoes, and it has been identified as having significant tomato export value. The Department of Agriculture, Forestry, and Fisheries (2019) indicates that Botswana, Lesotho, Namibia, and Mozambique are recipients of South African tomato exports.

Figure 3.1: illustrates the South Africa map, which consists of nine provinces.

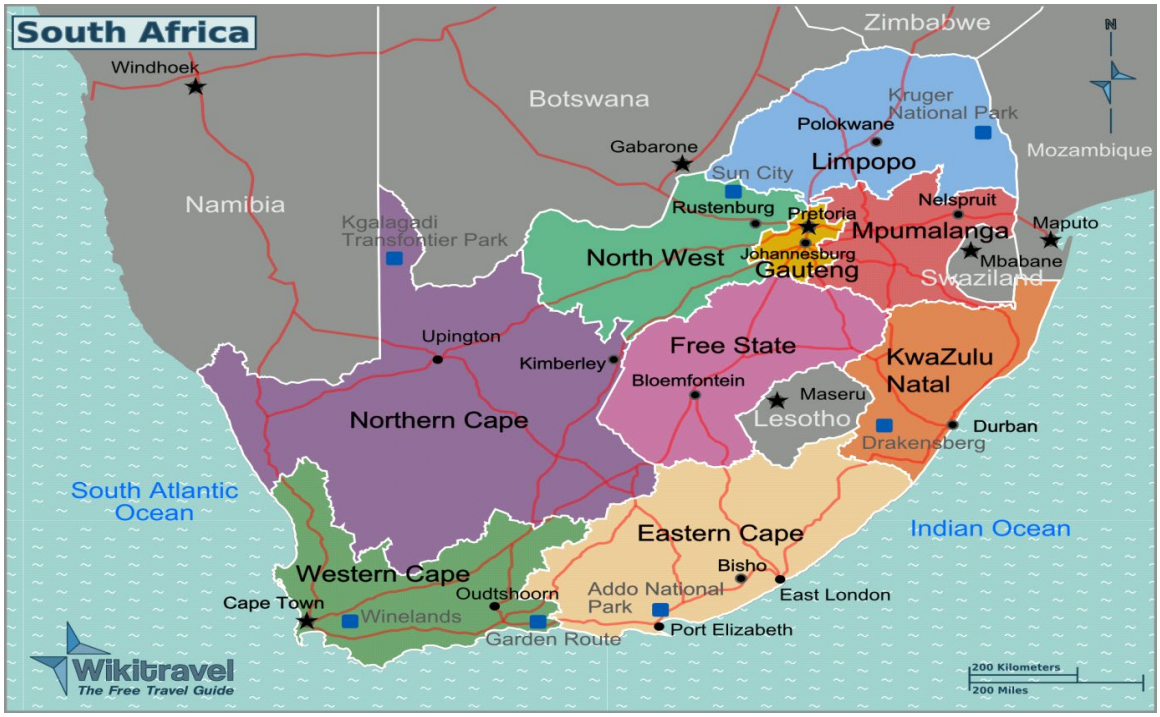

Figure 3.1: South Africa Map

Source: South Africa regions map (2009)

3.3 Data and data collection methods

The study employed secondary data for analysis. The secondary data was collected from the Food and Agricultural Organization (FAO), and Organization for Economic Cooperation and Development (OECD) databases. The study focused on domestic employment in the gross export and tomato sector trade in South Africa from 1996 to 2018. The period was chosen based on the availability and accessibility of data. Moreover, a change in trade affected the South African employment rate from 1996–2018 (DALRRD, 2020; DAFF, 2019).

3.4 Analytical techniques

3.4.1 Augmented Dickey-Fuller test

The Augmented Dickey-Fuller (ADF) test is a tool used to check the stationary and non-stationary nature of the data. This is also known as a ‘’unit root test’’. ADF testing aims to verify whether time series data is stationarity or non-stationarity before running the vector auto-regression model. The study employed Augmented Dickey-Fuller (1979) to check stationarity of variables, such as export value of tomato, export quantity of tomato, import value of tomato, import quantity of tomato, and domestic

employment in gross agricultural export. The null and alternative hypotheses were formulated to generate an outcome of the variables. The null hypothesis states that the data has a unit root (non-stationary), and the alternative hypothesis states that the data do not have a unit root (stationary). Non-stationary data is identified when the t-statistics value exceeds the ADF value, and the probability value exceeds 0.05% at a significance level (Brownlee, 2020).

3.4.2 The lag order selection of the VAR model

The lag length criterion was used to explain selection of maximum lag that a VAR model must be established on. The lag order selection consists of five components, mainly: the Hannan-Quinn information criterion (HQ), the Akaike information criterion (AIC), the final prediction error (FPE), the Schwarz information criterion (SC), and the sequential modified LR test statistic (each at a 5% significant level).

3.4.3 Vector Autoregressive (VAR) Model

To address the first objective and second objective, the study employed the vector autoregressive model. The utilization of the Johansen procedure was made possible in the study through the implementation of a vector auto-regression (VAR) model. The procedure enabled testing the objective of this study using the Johansen co-integration procedure since VAR model is analyzed based on the co-integration test (Li et al., 2019). Furthermore, a co-integration test was conducted to establish if there is a correlation among time series in the long-term. The VAR model was utilized to analyze and establish a long term and short run connection between domestic employment in gross exports and tomato sector trade in South Africa. Furthermore, VAR model will be also used to infer an impulse response model. The study followed the steps of a VAR model by Toda and Yamamoto (1995).

According to Neusser (2016), the VAR model formula is as follows:

$$X_{(k)} = C + \sum_{i=0}^{p} Ai\, X_{(k-i)} + et \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (1)$$

Where:

$p =$ lag length value

$i = 0, 1, 2, 3, \ldots, M$

$X_{(k)} =$ Endogenous variable vector

$X_{(k-i)} =$ Exogenous variable vector

$C =$ Constant vector

$\sum =$ Positive definite matrix

$Ai =$ Coefficient matrix

$et =$White noise vector

Model specification:

$$X_{(k)} = A + \sum Ai * T_{(k-i)} + et \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots .. (2)$$

$$EMP_{(k)} = A + \sum Aexpt * EXPT_{(k-i)} + \sum Aimpt * IMPT_{(k-i)} + et \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3)$$

$$EXPT_{(k)} = A + \sum Aimpt * IMPT_{(k-i)} + \sum Aemp * EMP_{(k-i)} + et \ldots \ldots \ldots \ldots \ldots \ldots .. \ldots \ldots .. (4)$$

$$IMPT_{(k)} = A + \sum Aemp * EMP_{(k-i)} + \sum Aexpt * EXPT_{(k-i)} + et \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (5)$$

Where:

A = Constant Vector

$EMP_{(k)}$ = Endogenous variable vector, which is employment in agricultural trade.

$IMPT_{(k)}$ = Endogenous variable, which is import quantity.

$EXPT_{(k)}$ = Endogenous variable, which is export quantity.

$EXPT_{(k-i)}$= Exogenous variable, which is the export quantity.

$IMPT_{(k-i)}$ = Exogenous variable, which is the import quantity.

$EMP_{(k-i)}$ = Exogenous variable, which is the domestic employment in gross export

$Aexpt$ = Coefficient matrix of export quantity.

$Aimpt$ = Coefficient matrix of import quantity.

$Aemp$ = Coefficient matrix of domestic employment I gross export

et = white noise vector

3.4.4. Johansen co-integration test

The Johansen co-integration test utilizes two methods, a maximum eigenvalue, and a trace test, to ascertain the quantity of co-integration vectors (Asari et al., 2011). The maximum eigenvalue test is a method used to verify a null that the number of cointegrating vectors is r against an alternative of r +1, while the trace statistic test is a technique used to verify a null that the number of cointegrating vectors is less than or equal to r against an unspecified alternative (Hamilton, 1994). The Johansen co-integration test is observed as a multivariate generalization of an Extended Augmented Dickey-Fuller test (Dwyer, 2015). Study used the Johansen co-integration analysis to determine a long-term relationship between domestic employment in gross exports and tomato sector trade series at different levels (Wei, 2006).

The general formula was well-defined by Johansen (1988) as:

$$Y_k = C_k + A_1 Y_{(k-1)} + A_2 Y_{(k-2)} + A_{AT} Y_{(K-AT)} + et \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots .. (6)$$

This may be rewritten as:

$$\Delta_{EMP} = A_{\ k} + A_{impt} IMPT_{(k-1)} + A_{expt} EXPT_{(k-2)} + et \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots .. (7)$$

The two ratios of Johansen proposed as follow:

Trace statistics test.

$$\lambda trace = -\mathrm{T} \sum_{i=r+1}^{g} \ln(1 - \lambda_{r+1}\ ) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (8)$$

Maximum eigenvalue test

$$\lambda maximum = -\mathrm{T}\ln(1 - \lambda_{r+1}) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (9)$$

T = number of observations, λ= the $\mathrm{I}\ th$ a largest recognized correlation $\triangle_{\mathrm{EMP}}$ = Indicates adjustment in domestic employment in gross export, tomato sector trade= Coefficient of lagged value and et = Error term.

3.4.5. Granger casualty test

The second objective employed Granger causality to examine the influence of domestic employment in gross agricultural exports on the tomato sector trade variables in South Africa and vice versa. ‘’Granger causality refers to a statistical tool

that is used to determine whether a time series is useful to forecast another time series in a long run (Okafor et al., 2021). It helps to explain the linear relationship that one variable can cause the output of another variable''. The test is used to determine the occurrence of a variable before another, including assisting in prediction, and can lead to challenges where bad choice sampling periods are used (Sorensen, 2005). Granger (1969) stated the Granger causality test formula as follows:

General model as:

$$Y_i = \sum \mathrm{bi} * A_{(k-1)} + \sum \mathrm{ci} * A_{(K-i)} + \mathrm{et} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . \ldots . (10)$$

While the model specification:

$$EMP = \sum bimpt * IMPT_{(k-i)} + \sum cexpt * EXPT_{(k-i)} + et \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . . . \ldots (11)$$

$$EXPT = \sum bimpt * IMPT_{(k-i)} + \sum cemp * EMP_{(k-i)} + et \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . (12)$$

$$IMPT = \sum bemp * EMP_{(k-i)} + \sum cexpt * EXPT_{(k-i)} + et \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . . (13)$$

Table 3.1: The description of variables

	Variable codes	Name of Variables	Measurement in unit	Data Source
Y	EMP	Employment in Agricultural trade	1000 person	Organization for Economic Cooperation and Development
X_1	EXPV	Export value trade for tomato	1000US$	Food and Agricultural Organization
X_2	EXPT	Export quantity trade for tomato	Tonnes	Food and Agricultural Organization
X_3	IMPV	Import value trade for tomato	1000US$	Food and Agricultural Organization
X_4	IMPT	Import quantity trade for tomato	Tonnes	Food and Agricultural Organization

Source: Author's Compilation (2023)

Domestic employment in gross agricultural export, import quantity of tomato, and export quantity of tomato plays a vital role in the economy of a country. Trade

independent variables are the driving force of the economy and create employment in the domestic gross agricultural export. These variables promote foreign exchange, ensures that the economy run smoothly, and improve the livelihood of the surrounding area where tomato trade activities take place(Stojanov et al., 2024).

3.4.6 Impulse response function

The impulse response traces a dynamic effect of shocks within systems input dependent variables (Peterson, 2020). The impulse response function is employed to assess and understand how regressand variables react to a shock in the disturbance term affecting one or more equations within the vector autoregressive model. Therefore, the impulse response function recognized by Lutkepohl (2008) is valuable for examining the relationships among multiple variables in a vector autoregressive model. An impulse response function is utilized to analyze and monitor how a system responds to a shock. In this study, an impulse response was utilized to explore behavior of variables following regressors shock over time.

3.5 Chapter summary

This chapter discussed methodology of the study used to determine a relationship between domestic employment and trade in the South African tomato sector. In this chapter, the focus was on the explanation of the study area, data and data collection, and analytical techniques. The significance of testing properties of time-series data before undertaking the nexus of trade and employment was noted. The vector auto-regression model was presented as the most suitable model for this study.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

This chapter explains the results of two objectives mentioned in Chapter 1. The first is about the long-run and short-run connection between domestic employment in gross agricultural exports and tomato sector trade in South Africa. This chapter first describes the stationary and non-stationary variables. Therefore, if variables are found to be non-stationary at levels, then 1st difference applies to find a stationarity of the data, if the stationarity is not identified at 1st, then 2nd difference applies to find a stationarity of data for all variables.

After determining stationarity, the VAR is described based on the results. The second objective is about the causal relationship between domestic employment in gross agricultural exports and tomato sector trade in South Africa. Therefore, the causality of all variables is described in the results below. In general, empirical outcomes were obtained using E-view software based on econometric procedures, and details of the research methodology are shown in Chapter 3.

4.2 Augmented Dickey-Fuller test results

The null and alternative hypotheses were tested to give the results in Tables, 4.1, and 4.2.

Null hypothesis (H_n): series is non-stationary.

Alternative hypothesis (H_a): series is stationary

‘’Condition to reject null hypothesis: ADF statistic test must be greater than critical values and p-value less than 0.05, to reject the null hypothesis. This means that time series or variables of the study are stationary (Vijay, 2023). Therefore, an alternative hypothesis is accepted, and significance of the variables are based on a P-value that is below 5% ’. The data must be stationary to avoid spurious regressions.

Table 4.1: Augmented Dickey-Fuller Test Results at Levels

Variables	Test equation	ADF test statistics value	Critical value test at 5%	Probability value (P-value)	Result
Employment	Intercept	-1.488379	-3.040391	0.5163	Non-stationary
	Intercept and trend	-4.173843	-3.658446	0.0188	Stationary
	None	-3.437038	-1.961409	0.0018	Stationary
Export value	Intercept	1.278359	-3.020686	0.9974	Non-stationary
	Intercept and trend	-1.174037	-3.658446	0.8885	Non-stationary
	None	2.435341	-1.959071	0.9943	Non-Stationary
Export quantity	Intercept	0.838066	-3.020686	0.9921	Non-Stationary
	Intercept and trend	-1.689420	-3.658446	0.7179	Non-stationary
	None	2.115196	-1.959071	0.0001	Stationary
Import value	Intercept	3.855534	-3.040391	1.000	Non-Stationary
	Intercept and trend	2.218447	-3.690814	1.0000	Non-Stationary
	None	4.583042	-1.961409	0.999	Non-Stationary
Import quantity	Intercept	-0.425374	-3.004861	0.8883	Non-Stationary
	Intercept and trend	-0.252938	-3.658446	0.9862	Non-stationary
	None	0.127313	-1.957204	0.7127	Non-stationary

Source: Author's Compilation (2024)

The augmented Dickey-Fuller test was employed at levels in Table 4.1. Domestic employment in gross exports (1000 persons) accepted the H_n (null hypothesis) at the intercept because the ADF statistics value (-1.488379) was below the critical value test (-3.040391), and the probability value (0.5163) was insignificant because it was exceeding the 5% of a significance level. The H_n was accepted at the intercept for domestic employment in gross exports (1000 persons). This implies that domestic employment in gross exports is non-stationary, based on the conditions. The ADF statistic value (-4.173843) at intercept and trend exceeds the critical value (-3.658446), and the probability value (0.0188) was significant because it was below the 5% of the significance level. The conditions rule led to the H_n (null hypothesis) rejection, which

suggests that the H_a (alternative hypothesis) is accepted. The probability value (0.0018) is below 0.05 (5%), and the ADF statistics value (-3.437038) exceeds the critical value (-1.961409) at none. Based on the condition rule, which assumes that time series data is stationary, and H_a (alternative hypothesis) was accepted.

Value of export ($1000 USD) accepted the H_n (null hypothesis) at intercepts because the probability value (0.9974) was insignificant which exceeds the 5% (0.05) of the significance level and the ADF statistics value (1.278359) was below the critical value test (-3.020686). This suggest that export value is non-stationary based on the conditions. The ADF statistic value (-1.174037) at the intercept and trend is below the critical value (-3.658446), and the probability value (0.8885) was insignificant because it exceeded the 5% of the significance level. The decision rule led to an acceptance of H_n, implying the rejection of H_a. At none, the p-value (0.9943) exceeds 5%, while the ADF statistics value (2.435341) exceeds critical value (-1.959071). The condition rule, which indicates that time series data is stationary, and the variable is insignificant, led to an acceptance of the alternative hypothesis.

Export quantity (tons) accepted the H_n (null hypothesis) at intercept because the ADF statistics value (0.838066) was below the critical value test (-3.020686) and the probability value (0.9921) was insignificant because it exceeded the 5% (0.05) of the significance level. This suggests that an export value is non-stationary based on condition rule. The ADF statistic value (-1.689420) at the intercept and trend is below the critical value (-3.658446), and the probability value (0.7179) was insignificant because it exceeded the 5% of the significance level. Based on condition rule, the H_n was accepted, indicating that the H_a is not supported, and the data is non-stationary, this implies that an analysis is spurious. The ADF statistics value of 2.115196 is significantly above a critical value (-1.959071), and probability value (0.0001) which is below a 5% significance level. The H_a (alternative hypothesis) was accepted according to the condition rule, which implies that time series data is stationary.

The import value of tomatoes (1000 US$) rejected the H_n (null hypothesis) at intercept because the ADF statistics value (3.855534) exceeds the critical value test (-3.040391), and the probability value (1.000) was insignificant because the probability value exceeded 5% (0.05) at the significance level. According to the conditions, this implies that the import value is stationary, and the analysis is robust. At the intercept

and trend, the ADF statistic value (2.218447) is below the critical value (-3.690814) and the probability value (1.0000) was insignificant because the probability value exceeded 5% at a significance level. The H_n was accepted based on the conditions; this implies that data is non-stationary, and an analysis is spurious. At none, the ADF statistics value (4.583042) exceed the critical value (-1.961409), and the probability value (0.999) exceed 0.05 (5%), which is non-significant. The H_a (alternative hypothesis) was accepted according to conditions, which implies that the data is stationary.

The import quantity of tomatoes (tons) rejected the H_n (null hypothesis) at intercept because the ADF statistics value (3.855534) exceeds the critical value test (-3.040391), and the probability value (0.8883) was insignificant because p-value exceeded 5% (0.05) at a significance level. According to the conditions, this implies that the import value is stationary. At intercept and trend, the ADF statistic value (-0.252938) is below the critical value (-3.658446) and the probability value (0.9862) was non-significant since p-value exceeded 5% of a significance level. The H_n was rejected based on conditions; this implies that data is non-stationary. At none, the ADF statistics value (0.127313) is below the critical value (-1.957204), and the probability value (0.7127) exceeded 0.05 (5%), which is insignificant. This implies that H_n was accepted according to conditions, which implies that time series data is non-stationary.

In conclusion, H_n is not rejected because domestic employment in gross agricultural exports and tomato sector trade was non-stationary at levels (intercepts, none, intercepts, and trends). This implies that the non-stationary data can cause the analyses of the study to be spurious. The time series is not stationary at levels; therefore, first differences were analyzed (Wang, 2016). To identify stationarity of a time series, and the results are given in Table 4.2.

Table 4.2: Augmented Dickey-Fuller Test Result at 1st difference.

Variables	Test equation	T-statistics of ADF test	T-statistics of critical value test at 5%	Probability value	Result
Employment	Intercept	-6.716940	-3.040391	0.0000	Stationary
	Intercept and trend	-6.503362	-3.690814	0.0003	Stationary
	None	-4.859183	-1.961409	0.0001	Stationary
Export value	Intercept	-6.002699	-3.020686	0.0001	Stationary
	Intercept and trend	-7.3930575	-3.658446	0.0000	Stationary
	None	-1.750350	-1.960171	0.0761	Non-stationary
Export quantity	Intercept	-2.260451	-3.052169	0.1944	Non-stationary
	Intercept and trend	-6.863052	-3.658446	0.0001	Stationary
	None	-1.011253	-1.961409	0.2681	Non-stationary
Import value	Intercept	-0.221042	-3.052169	0.9184	Non-stationary
	Intercepts and trend	-1.912186	-3.710482	0.6045	Non-stationary
	None	0.273954	-1.962813	0.7535	Non-stationary
Import quantity	Intercept	-4.654938	-3.020686	0.0016	Stationary
	Intercept and trend	-5.931643	-3.658446	0.0006	Stationary
	None	-1.750350	-1.960171	0.0761	Non-stationary

Source: Author's Compilation (2024)

Table 4.2 shows the results of an augmented Dickey-Fuller test at 1st difference, and the study rejected the null hypothesis because domestic employment in gross export in agriculture, export quantity of tomato, and import quantity of tomato are stationary at intercept and trend level. The domestic employment in gross export in agriculture, export quantity of tomato, and import quantity of tomato are integrated of order I (1), and will be used in the Johanson co-integration test, impulse response and Granger causality test. Therefore, the values of imports and exports are dropped out of the analysis given that the import value is not integrated of order I (1); trade will be

represented by import quantity and export quantity. Ramos (2001) observed that a real export and real import were stationary at the first difference, suggesting that a real export and real import are integrated of I (1), thereby corroborating the findings of this study.

Figure 4.1 illustrates the export quantity of tomato, export value of tomato, import quantity of tomato, import value of tomato, and domestic employment in gross agricultural exports in South Africa at levels values.

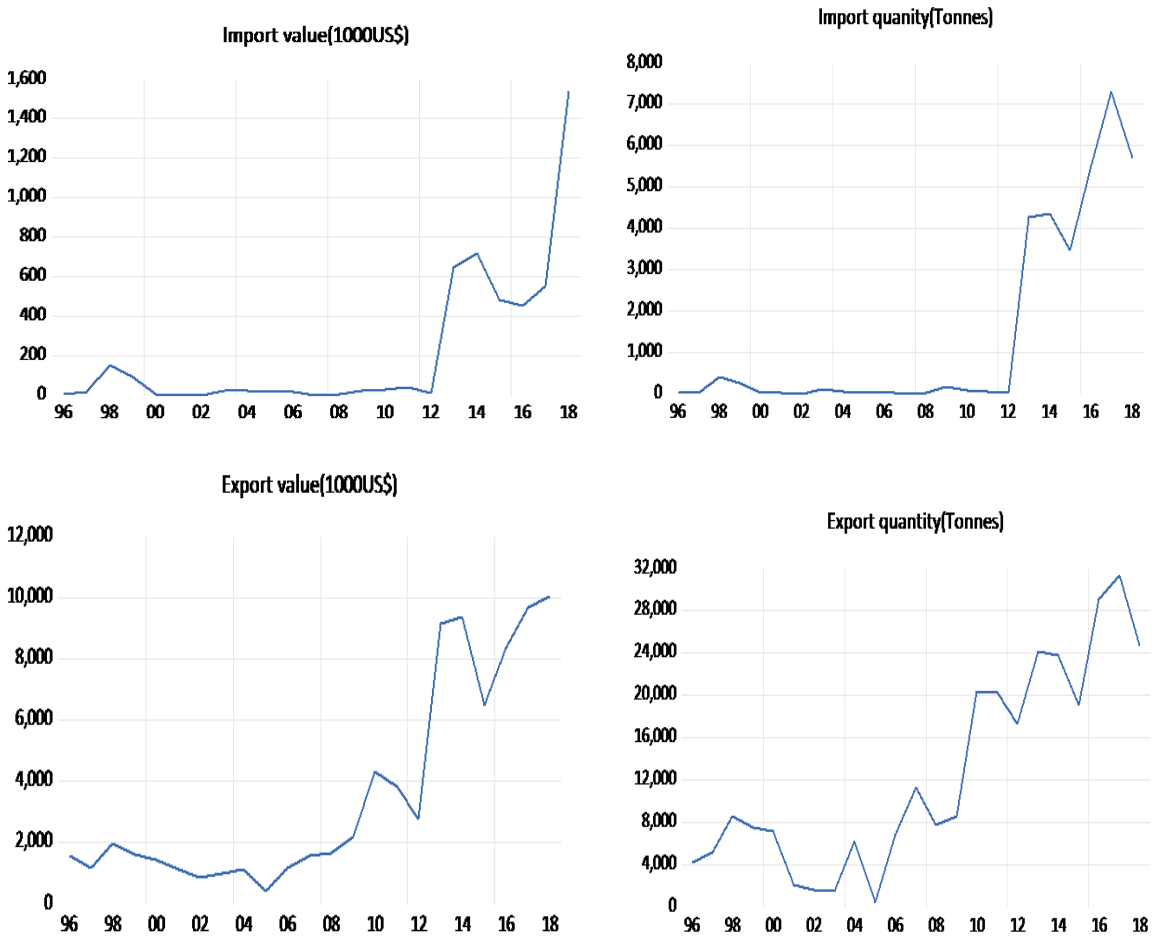

Figure 4.1: Tomato trade and domestic employment in gross agricultural exports at levels for the period of 1996 to 2018.

Source: Author's Compilation (2024)

The results in Figure 4.1 revealed that domestic employment in gross agricultural exports portrays a fluctuating trend. Initially, the fluctuating trend was growing and declining throughout the years 1996–2018. Whereas import quantity and import value revealed that the 1996–1998 graphs showed a growing trend, then suddenly there was a declining trend from 1998–2000. From 2000 to 2012, there was a constant trend, and graphs showed a growing trend from the year 2000 to 2018. Lastly, export quantity and value portray the fluctuating trend that keeps growing from 1996 to 2018. These trends could be driven by tomato exports that was neglected and no comparative advantage in tomato trade (Sanganza, 2021). Zhai et al. (2022) indicate that export restriction distorts market prices, production, consumption that hinder farm productivity which might cause food insecurity and unemployment. Hence, these graphs indicate a clear trend in the time series, implying the necessity for the series to be made stationary through the differencing method as per the ADF test (Iordanova, 2022).

4.3. The vector autoregressive (VAR) lag length criteria

The process of selecting the lag order is a critical aspect of constructing models. In this study, an information criteria approach was employed to determine the suitable lag order. The selection of lag order is essential for various analyses in this study, including cointegration analysis, estimating vector autoregressive models, conducting

Granger causality tests, and performing impulse response analysis. The study followed the maximum lag order decision rule by Zhang et al. (2020).

Table 4.3: Lag structure-lag length criteria selection

	Lag Order	Selection	Criteria			
Lag	VAR	LR	FPE	AIC	SC	HQ
0	-527.1834	NA	1.72 e+17	48.19849	48.34727	48.23354
1	-496.9859	49.41409*	2.53e+16*	46.27145*	46.86656*	46.41164*

The asterisk sign (*) represents lag order selected by criterion.

‘’HQ: Hannan-Quinn information criterion, AIC: Akaike information criterion, SC: Schwarz information criterion, FPE: Final predication error, and LR: Sequential modified LR test statistic (each at 5% level).’’

Source: Author’s Compilation (2024)

Table 4.3 shows the results of the lag length criterion, showing that AIC, HQ, SC, FPE, and LR denoted that the first (1) lag was appropriate to be used for employment and trade. The rule of condition states that lag order selection with an ‘’asterisk (*)’’ led to the best result due to the low value of lag order. Based on the decision rule, the lag order selection with a lower value with an ‘’asterisk’’ led to the best result. Therefore, maximum lag order of 1 was used in the analysis.

4.4 Vector autoregressive (VAR) model for domestic employment in gross agricultural exports and tomato sector trade.

Table 4.4 shows the findings of vector auto-regressive model, and findings are used to infer an impulse response function results in figure 4.3. Domestic employment in gross exports in agriculture is represented by EMP, the export quantity of tomatoes is represented by EXPT, and the import quantity of tomatoes is represented by IMPT in tables 4.4 and figure 4.3. The model is a good fit because R^2 of the variables were above 0,50 (50%). This revealed that the export quantity of tomatoes and the import quantity of tomatoes had variability observed in the domestic employment in gross export in agriculture. The R^2 values of the study were 0.584926, 0.820394, and 0.822118, respectively. The numbers that are in round brackets are the standard error of the variables whereas numbers in the square brackets are t-statistics of the variables. The findings of this study in Table 4.4 show that there is a significant

relationship between the import quantity of tomatoes and 1 lag of the import quantity of tomatoes at a 5% significance level.

Table 4.4: The vector autoregressive estimation model

Variables	EMP	IMPT	EXPT
EMP (-1)	0.512234	-1.310522	-67.37022
	(0.27234)	(9.57732)	(38.2085)
	[1.88087]	[-0.13684]	[-1.76323]
EMP (-2)	0.086575	-8.749825	-38.43070
	(0.31935)	(11.2306)	(44.8042)
	[0.27110]	[-0.77911]	[-0.85775]
IMPT (-1)	-0.000235	0.756342	0.270298
	(0.00934)	(0.32859)	(1.31090)
	[-0.02520]	[2.30178]	[0.20619]
IMPT (-2)	-0.002981	-0.074850	-0.015901
	(0.01023)	(0.35963)	(1.43472)
	[0.29151]	[-0.20813]	[-0.01108]
EXPT (-1)	-0.001635	-0.024467	0.370865
	(0.00238)	(0.08375)	(0.33411)
	[-0.68649]	[-0.29215]	[1.11000]
EXPT (-2)	0.000262	0.073779	0.115994
	(0.00211)	(0.07408)	(0.29554)
	[1.01712]	[0.99593]	[0.39247]
C	76.85591	1786.906	24385.32
	(75.5625)	(2657.30)	(1060.12)
	[1.01712]	[0.67245]	[2.30024]
R-squared	0.584926	0.820394	0.822118
Adj. R-squared	0.407037	0.743420	0.745883
Sum sq. resids	17098.25	21145544	3.37E+08
S.E equation	34.94716	1228.982	4902.993
F-statistics	3.288151	10.65807	10.78398
Log likelihood	-100.1709	-174.9331	-203.9899
Akaike AIC	10.20675	17.32696	20.09428
Schwarz SC	10.55493	17.67514	20.44246
Mean dependent	159.233	1515.593	13306.27
S.D. dependent	44.61616	9651.840	2389.172
Determinant.resid	covariance (dof adj.)	2.77E+16	
Determinant,res.	covariance	8.2E+15	
Log-likelihood		-474.1571	
Akaike (AIC)		47.15731	
Schwarz criterion		48.20193	
Number of	coefficients	21	

No brackets represent the coefficient, (…) represents the standard error or standard deviation, and […] represents t-statistics. Lastly, * represents the statistical significance at 95%.
Source: Author's Compilation (2024)

This means that a one-unit increase in 1 lag import quantity of tomatoes increases the import quantity of tomatoes by 0.75 unit of import quantity of tomatoes. The rest of the analyzed relationships among the variables show no significance at the 5% level. Djara et al. (2022), found that there is a significant relationship between 1 lag import and import at a 5% significance level in Indonesia, thereby corroborating the findings of this study. Moreover, the findings meant that a one-unit increase in 1 lag import increases imports by 0.90 units of import products.

The implication of this study is that consumers benefited from lower prices of tomatoes due to increased import of tomatoes which can lead to higher consumption of tomatoes. However, the situation can sabotage production of tomatoes and employment in the tomato sector. The study suggests that South African tomato sector should diversify by producing value-added products from raw tomatoes for employment opportunities.

4.5 Verification of the VAR Model

Figure 4.2: illustrates the distribution of AR roots of export quantity of tomatoes, import quantity of tomatoes, and domestic employment in gross agricultural exports in South Africa on first difference.

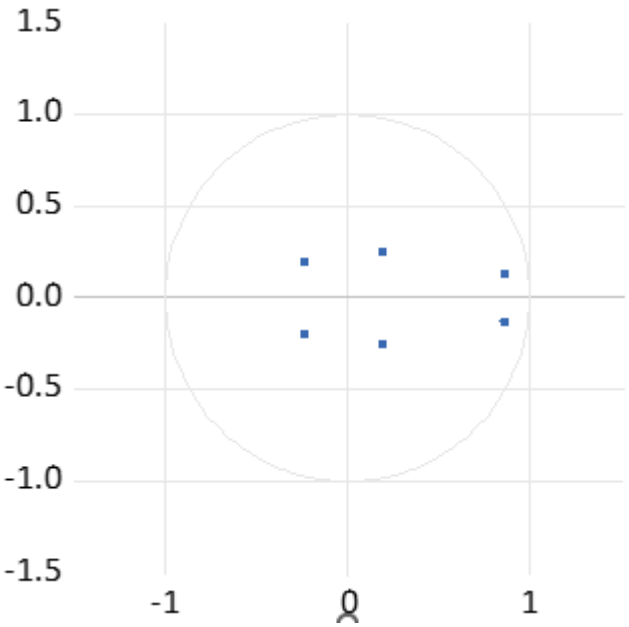

Figure 4.2: The distribution of AR roots of export quantity of tomatoes, import quantity of tomatoes, and domestic employment in gross agricultural exports.

Source: Author's Compilation (2024)

The five points on a unit circle in Figure 4.2 were (-0.24; 0.20); (-0.05; 0.13); (0.94; 0.35); (-0.20; -0.20); (-0.00; -0.13); and (0.99; -0.14). The main point of the unit circle of domestic employment in gross agricultural exports and tomato sector trade is because of the AIC (Akaike information criterion) in the VAR. This revealed the modulus of all unit roots and reciprocals for domestic employment in gross agricultural exports and tomato sector trade. Furthermore, the VAR model is stable and satisfies the stability assumption because circles do not contain roots outside them (Figure 4.2). The value of the modulus of the root is below the value of 1, indicating that the system is stationary.

4.6 Johansen co-integration test results

It is significant to determine the presence of co-integration in short-run and long-term relationship among variables. The study conducted Johansen co-integration test to investigate the presence of a short term and long-term cointegration relationship between domestic employment in gross agricultural exports and the tomato trade sector. The results of this test are presented in Table 4.5. The study formulated a null hypothesis (H_n) suggesting the absence of a co-integration relationship and an alternative hypothesis (H_a) suggesting a co-integration relationship among variables. Therefore, the H_n was rejected because probability value was below 5% significance level and accepted when the probability value exceeded the 5% significance level. In other words, the maximum and trace t-statistics values must be less than the critical t-value.

Table 4.5: Trace test and Maximum eigenvalue test.

		Trace test			Maximum eigenvalue test		
Hypothesized No. of CE(s)	Eigenvalue	Trace t-statistic value	critical value at 0.05	Prob**	Maximum t-statistic Value	critical value at 0.05	Prob**
None	0.371083	16.34751	29.79707	0.6876	9.73885	21.13162	0.7687
At most 1	0.246958	6.608621	15.49471	0.6235	5.956328	14.26460	0.6188
At most 2	0.030584	0.652292	3.841465	0.4193	0.652292	3.841465	0.4193

Source: Author's Compilation (2023)

''The trace test and Maximum eigenvalue test indicate no cointegration at 5% (0.05) significance level.

* Represents rejection of the hypothesis at the 5 % (0.05) significance level

** represents Mackinnon-Haug-Michelis (1999) p-values''

Table 4.5 shows the result of Johansen co-integration test of domestic employment, import quantity of tomato, and export quantity of tomato. There is a non-existence of co-integration correlation at the 0.05 significance level on maximum eigenvalue and trace test. The condition rule states that in rejecting null hypothesis, indicate that there is non-existence of co-integration between domestic employment in gross export agricultural, export quantity of tomatoes and import quantity of tomatoes. The absence of co-integration (H_n) was accepted at none in the trace test because statistic value (16.34751) is below critical value (29.79707) at 5% significance level. Furthermore, the absence of the co-integration (H_n) was accepted at most 1 in the trace test because the statistic value (6.60862) is below critical value (15.49471) at 5% significance level. Furthermore, absence of co-integration (H_n) was accepted at most 2 in the trace test because the statistic value (0.652262) is below the critical value (3.841465) at a 0.05 significance level. Therefore, there is a non-existence cointegration equation confirming that three variables move away from the long-term average. In a different study of trade sector conducted by Husein (2014), it was found that export and import countries had long-term equilibrium, implying that no violation of ''international budget constraint'' in the long term and this indicates that the findings are different from this study. This implies that there is instability and fluctuation among variables in the short run due to trade policies. The implication of no co-integration is that unfair practices of tomato export markets that caused by uncoordinated trade policy led to a deterioration of domestic employment and instability within the tomato industry, especially in areas heavily dependent on tomato production.

The absence of co-integration, as confirmed by the trace test, indicates that domestic employment in gross export in agriculture, import quantity of tomato, and export quantity of tomato do not have long term co-integration. These variables are not moving together in the long run. Study suggests that in the short run, domestic employment in gross export employment, import quantity of tomato, and export quantity of tomato exhibit movements that deviate from their expected long-run average values. This implies that there is instability and short-term fluctuation in these variables. In addition, the absence of co-integration caused the unfairness in the tomato export practice which resulted in an uneven playing field for domestic producer

of tomato by impacting the overall stability in the tomato sector. In the different study of agricultural sector conducted by Ramakgasha et al. (2024) it was found that ‘’trace test’’ revealed co-integration among employment rate and which is different from this study.

The maximum eigenvalue test is 0.05 significance at 5% level, this shows a maximum t-statistic value (9.73885) is below critical value (21.13162) at none. There is no co-integration equation shown in the results. Furthermore, the maximum eigenvalue statistic value at most 1 is 5.956328, which is below 14.26460 critical value at a 0.05 significance level. There is an absence of co-integration among domestic employment in gross export and tomato trade variables. Furthermore, the maximum eigenvalue statistic value at most 2 is 0.652292, which is below the 3.841465 critical value at a 0.05 significance level. There is an absence of co-integration among variables. Therefore, null hypothesis is accepted on the maximum eigenvalue test, confirming that domestic employment in gross export in agriculture, import quantity of tomato, and export quantity of tomato moved away from the long-term average of a short run. This implies there is short-term fluctuation in the average levels of domestic employment in gross export in agriculture, the import quantity of tomatoes, and the export quantity of tomatoes. The unjustified practice of tomato export negatively impacted overall economic growth and stability in tomato sector due to short-term fluctuation among variables. This movement indicates a temporary shift in these variables from their equilibrium level. Ramakgasha et al. (2024) observed that ‘’maximum-eigen statistics’’ revealed co-integration of agricultural employment rate and which is different from this study.

4.7 Impulse response analysis of vector autoregressive

The impulse response function analysis of vector autoregressive (VAR) model allows magnitude of the shock or one standard deviation for each selected variable to be examined (Stock and Waston, 2001). The impulse response enables the evaluation of the impact of variable shocks on a specific variable, thus guiding relevant policy recommendations. Rizwan et al. (2017), describe impulse response as a transmission that takes place among variables. Figure 4.3 shows the results of the impulse response. A line above (0.0) at the middle line represents a positive effect, while a line below (0.0) at the middle line represents a negative effect.

Figure 4.3 illustrates the response of domestic employment in gross export in agriculture (EMP) to a shock in domestic employment in gross export in agriculture (EMP), export quantity of tomato (EXPT), and import quantity of tomato (IMPT) in South Africa.

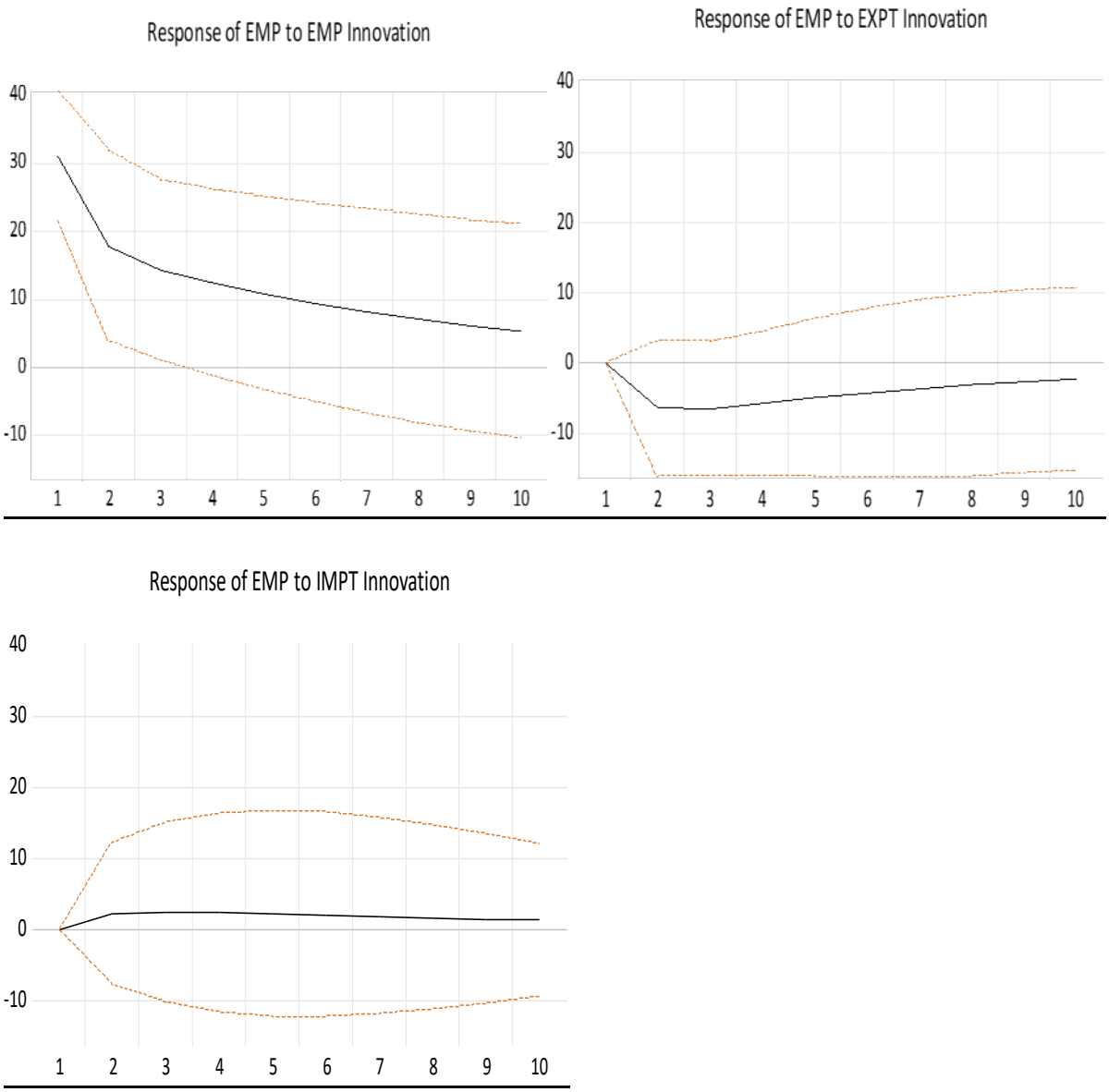

Figure 4.3: An impulse response of domestic employment in gross export in agriculture (EMP) to a shock in domestic employment in gross export in agriculture (EMP), export quantity of tomato (EXPT), and import quantity of tomato (IMPT) for period of 10 years.

Source: Author's Compilation (2024)

Figure 4.3 illustrates the re-action of domestic employment in gross export in agriculture (EMP) to a shock in domestic employment in gross export in agriculture

(EMP), export quantity of tomato (EXPT), and import quantity of tomato (IMPT). Domestic employment in gross export in agriculture (EMP) and import quantity of tomato (IMPT) responded positively, and export quantity (EXPT) responded negatively towards domestic employment in gross export in agriculture (EMP) throughout the period of 10 years. The EMP fall period of 1 to 2 remains constant, while IMPT and EXPT remain constant throughout the period.

Oluyemi and Isaac (2017) observed that import, export, and exchange rate responded positively towards import throughout the period of 10 years, with import falling in its response, whereas exchange rate responded negatively towards export throughout the period of 10 years, thereby corroborating results of this study. An impact of domestic employment in gross export in agriculture (EMP) in South Africa is closely related to tomato export restrictions. This could be that the export restrictions affected the overall employment level in the agricultural industry.

The correlation between the import quantity of tomato (IMPT) and domestic employment in gross export in agriculture (EMP) in South Africa over 10-year period showed a positive response, while export quantity (EXPT) responded negatively. This dynamic is influenced by the export restrictions placed on tomatoes in South Africa, impacting the overall employment level in the agricultural sector. The restrictions on tomato exports may lead to an increase in imports, which can have a positive influence on domestic employment. However, the decrease in export quantity due to these restrictions had a negative influence on employment level in the agricultural sector. It is important for policymakers to carefully consider an implication of export restrictions on the tomato trade to support sustainable employment in the agricultural industry.

4.8 Granger causality test

Table 4.6 shows the finding of the Granger causality analysis, and hypotheses of the study are:

Null hypothesis (Hn): There is no granger causality between domestic employment in gross agricultural exports and the tomato trade sector (domestic employment in gross agricultural exports does not lead to tomato trade).

Alternative hypothesis (Ha): There is granger causality between domestic employment in gross agricultural exports and the tomato trade sector.

‘’Condition rules: Reject the null hypothesis if p-value is less than 5% significance level, then an alternative hypothesis would be accepted (Okafor et al., 2021)’’. Additionally, the import quantity of tomato is represented by IMPT, domestic employment in gross export in agriculture is represented by EMP, and export quantity of tomato is represented by EXPT in table 4.6.

Table 4.6: The Granger causality test of domestic employment in gross agricultural exports and the tomato trade sector.

Dependent variable: EMP		
	Prob.	Decision
EXPT	0.7689	Accept
IMPT	0.9252	Accept
All	0.9345	Accept
Dependent variable: IMPT		
	Prob.	Decision
EMP	0.6749	Accept
EXPT	0.5958	Accept
All	0.3973	Accept
Dependent variable: EXPT		
	Prob.	Decision
EMP	0.0645	Accept
IMPT	0.9601	Accept
All	0.2356	Accept

Source: Author’s Compilation (2024)

IMPT do not cause EMP in the short term because the probability value (0.9252) exceeds the 0.05 significance level, signifying the absence of a causal relationship in this direction. In other words, IMPT does not lead to EMP. EXPT do not cause EMP in the short term because the probability value (0.7689) is above the 0.05 significance level. Therefore, IMPT and EXPT do not cause EMP in the short term because their probability value (0.9345) is above 0.05. The reason there is no causal relationship between IMPT, EXPT, and EMP is because of trade policies. The implication of this study is that trade policies focusing solely on regulating the import quantity of tomatoes and export quantity of tomatoes may not significantly affect domestic employment in gross export in agriculture in the short run. Nguyen and Jolly (2011) observed that domestic production of seafood and imports of seafood do not have a causal relationship in the short term, thereby corroborating the findings of this study. Whereas Karabulut (2020), found out that there is a bidirectional causal observed between

export and import, indicating influence in both directions in Turkey study which is different from this study.

EMP does not cause IMPT in the short term because the probability value (0.6749) exceeds 0.05 significance level. This indicates that there are changes in the EMP that do not precede or influence changes in the IMPT within a specific timeframe (short or long). EXPT does not cause IMPT in the short term because the probability value (0.5956) exceeds 0.05 significance level, signifying the absence of a causal correlation in this direction. The level of domestic employment in gross exports can vary among countries and industries. Therefore, EMP and EXPT do not cause IMPT in the short term because the overall probability (0.3973) exceeds the 0.05 significance level. This implies that the domestic employment in gross exports and export quantity of tomato may not significantly affect import quantity tomato due to factors such as competitiveness of the export sector, labor productivity, and the demand of exported products in foreign markets that influence EMP and EXPT. The policy implication is that export strategies for tomatoes may need to be developed independently for domestic employment in gross export agriculture. Otopoba (2016) found a unilateral causal correlation between export and import in the Kyrgyzstan agricultural industry, thereby corroborating the findings of this study.

EMP does not cause EXPT in the short term because the probability value (0,0645) exceeds 5% significance level. This means there is no unilateral relationship between EMP and EXPT, and a direction from EMP to EXPT. This implies that the employment opportunities in various stages of tomato production may have been affected by tomato export practices that affect increased domestic productivity in the short time and additionally there may be a lack of public awareness about promoting the consumption of locally produced tomatoes. The expansion in export activities is expected to lead to a new employment opportunities and retention of existing ones (Van Heerden, 2015). Molepo et al. (2021) analyzed that total employment does granger cause export output in South African orange sector, which is different from the findings of this study. An IMPT does not cause EXPT in the short term because the probability value (0.9601) exceeds 0.05 significance level, signifying the absence of causal relationship in this direction. In the same study of Molepo et al. (2021), it was found that total employment does not granger cause import in the South African orange industry, thereby corroborating findings of this study. Therefore, EMP and IMPT

do not cause EXPT in the short term because the overall probability (0.2309) exceeds the 0.05 significance level, signifying the absence of causal relationship in this direction. The reason for granger causality between EMP and EXPT is because of the labor market. The policy implication is the labor market adjustment by forming policies that enhance domestic employment in gross exports in agriculture could lead to an increase in the export quantity of tomatoes, suggesting a potential intervention in the labor market to support export growth.

4.9 Chapter Summary

This chapter explains and presents the vector auto-regressive model in the study and provides a theoretical outline for the examination of employment and tomato trade series relations. The result revealed that the data on domestic employment in gross agricultural exports and the tomato trade sector were non-stationary at the level stage. This implies that non-stationary data causes the analysis of the study to be spurious. Nevertheless, the researcher used an augmented Dickey-Fuller test to find the stationary of data at 1st difference. The findings of this study revealed that there is absence of long run relationship between trade and employment in the South African tomato sector.

Vector auto-regressive model was used to infer the relationship between domestic employment in gross agricultural exports and the tomato trade sector. The result of Granger causality test revealed that domestic employment in gross exports in agriculture (EMP) does not cause an export quantity of tomatoes (EXPT) in the short term because probability value (0,0645) exceeds 5% significance level. The import quantity of tomato (IMPT) does not cause an export quantity of tomato (EXPT) in the short term because probability value (0.9601) exceeds the 0.05 significance level, signifying the absence of a causal relationship in this direction.

CHAPTER 5: RESEARCH SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter entails a summary of the main findings of the study and a conclusion based on findings that were developed from an empirical result. A recommendation of the study is provided in this chapter, where strategies and policies that are suggested for trade policymakers, tomato traders and tomato farmers.

5.2 Research summary

The study aimed to examine a nexus between domestic employment in gross agricultural exports and tomato sector trade in South Africa from 1996 to 2018. The first objective was to determine long run and short-run relationship between domestic employment in gross agricultural exports and tomato sector trade in South Africa. The study used domestic employment in gross export agricultural, export quantity of tomato, and import quantity of tomato to analyse vector auto-regressive (VAR) model, Granger causality test, and impulse response. The variables are integrated into order 1 at intercept and trend.

The study used the Trace and Max-Eigen tests of Johansen co-integration test to check the short term and long-term relationship between domestic employment in gross agricultural exports and tomato sector trade. Therefore, the study found that there is no co-integrating connection or relationship between domestic employment in gross agricultural exports and tomato sector trade. This indicate that there is no long-term relationship among domestic employment in gross agricultural exports and tomato sector trade.

The study used vector auto-regressive (VAR) model to infer an impulse response function of domestic employment in gross agricultural exports and tomato sector trade. The study used Johansen cointegration to address first objective, which is to determine the long term and short term relationship between domestic employment in gross agricultural exports and tomato sector trade in South Africa. The study revealed absence of co-integration as confirmed by trace test and maximum eigenvalue test, which indicated that domestic employment in gross export in agriculture, import quantity of tomato, and export quantity of tomato does not have a long-term relationship.

The study used Granger causality test to address the second objective, which is to determine causal relationship between domestic employment in gross agricultural exports and tomato sector trade in South Africa. The study revealed that domestic employment in gross exports in agriculture (EMP) does not cause an increase in an export quantity of tomatoes (EXPT) in the short term. Furthermore, the import quantity of tomatoes (IMPT) and export quantity of tomatoes (EXPT) do not cause domestic employment in gross export in agriculture (EMP) in the short term. EMP do not cause IMPT in the short run. Impulse responses revealed that domestic employment in gross export in agriculture (EMP) and import quantity of tomatoes (IMPT) responded positively and export quantity (EXPT) responded negatively towards domestic employment in gross export in agriculture (EMP) throughout the period of 10 years.

5.3 Conclusion

The study entailed two hypotheses that were established or verified.

First hypothesis: There is no long-run or short-run relationship between domestic employment in gross agricultural exports and tomato sector trade in South Africa. The study accepted null hypothesis, and Johansen co-integration test revealed that domestic employment in gross agricultural exports and tomato sector trade do not have a long-term relationship in the short run. The study suggests that there is instability and short-term fluctuation in the average levels of domestic employment in gross exports in agriculture, the import quantity of tomatoes, and the export quantity of tomatoes.

Second hypothesis: There is no causality between domestic employment in gross agricultural exports and tomato sector trade in South Africa. The alternative hypothesis was not accepted in this study. The Granger causality test revealed that domestic employment in gross exports in agriculture (EMP) does not causal export quantity of tomatoes (EXPT) in the short term. This implies that the employment opportunities in the tomato sector may have been affected by tomato export practices that affect increased domestic productivity in the short time.

5.4 Recommendation

This study examined the relationship between domestic employment in gross agricultural exports and tomato sector trade in South Africa, which is a complex one with various perspectives to consider. The study recommends policymakers implement short-term policies to address the deviations observed in domestic employment in gross exports in agriculture and tomato trade quantities (import quantity and export quantity). The short-term policies such as export incentives, market access initiatives, and temporary subsidies for tomato farmers should be implemented to resolve the employment issue in the country. This intervention should aim to stabilize the variables and mitigate the implications of short-term fluctuation. However, this may involve the adjustment of short-term policy, which is a necessary resolution of fluctuation.

The second recommendation is to strengthen local production and competitiveness in the tomato sector. When the government invests in the local tomato sector, it will improve the productivity level of tomato output and enhance competitiveness in the tomato sector. This may involve supporting agricultural research, providing financial incentives, and training tomato farmers, including the adaptation of advanced farming methods or techniques. The strategy will create a job opportunity since the productivity level of tomato output will require more labourers to work in the sector.

The third recommendation is to facilitate public awareness about promoting the consumption of locally produced tomatoes, thereby increasing local demand and supporting employment in the agriculture sector. This will promote production of tomato in the country and reduce the number of imported tomatoes from other countries. Policymakers should also consider a policy coordination among governmental departments, agricultural agencies, trade organisation, and relevant stakeholders because it is essential to align policies that address the long-run relationship within the short-term deviations. The collaborative efforts streamline policy initiatives and ensure a coherent approach towards stabilizing the agricultural sector and tomato trade sector.

5.5 Limitations of the Study

The focus of this study could not be on the years 1996 and 2018 to examine relationship between domestic employment in gross agricultural export and tomato

sector trade. This was led by the limited availability of data on domestic employment in the gross agricultural exports' variable, which caused the study to range from 1996 to 2018 (a period of 23 years). Furthermore, the study referenced literature on export, import, and employment due to a lack of similar literature that relates to the nexus of domestic employment in gross agricultural exports and tomato sector trade. However, the results and conclusions of this study are rational. Furthermore, the study might add information to the scarce literature in terms of examining the specific variables of domestic employment in gross agricultural exports and tomato sector trade in South Africa.

5.6 Future recommendations for other studies

Future study can examine the diversification of export markets because this study did not examine it. This could help in exploring the diversifying of export markets in South Africa in order to minimize its dependence on one region. In addition, future study can examine the export of tomato independently for domestic employment in gross export agricultural. Furthermore, future study can do research about the employment in the tomato sector using the primary data, so that the data can be accessible for researchers who want to use secondary data for research.

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APPENDIXES

Appendix 1: Data of domestic employment in gross agricultural exports and tomato sector trade.

Years &variable	Employment (1000 person)	Export quantity (Tonnes	Export value (1000US$)	Import quantity (Tonnes)	Import value (1000US$)
1996	186.6	4149.00	1565	16.00	3
1997	184.5	5097.00	1153	19.00	14
1998	185.7	8580.00	1955	399.00	149
1999	195.0	7504.00	1637	251.00	92
2000	276.4	7096.54	1444	22.71	4
2001	202.7	2125.00	1116	1.00	0
2002	226.6	1625.00	885	0.00	0
2003	162.8	1426.00	1005	100.00	18
2004	154.6	6160.00	1148	54.00	23
2005	165.2	446.00	423	21.00	12
2006	203.4	6824.00	1154	37.00	15
2007	190.4	11254.00	1555	0.00	0
2008	178.9	7742.00	1656	4.00	1
2009	133.0	8579.00	2207	159.00	19
2010	110.6	20405.00	4296	88.00	25
2011	116.5	20216.00	3818	57.00	41
2012	116.3	17288.00	2780	5.00	8
2013	127.9	24172.00	9146	4269.00	645
2014	112.8	23767.81	9344	4362.74	720
2015	122.7	19090.29	6482	3469.93	479
2016	121.4	29073.86	8339	5491.38	454
2017	115.4	31326.49	9686	7317.40	554
2018	125.6	24730.68	10025	5718.29	1539

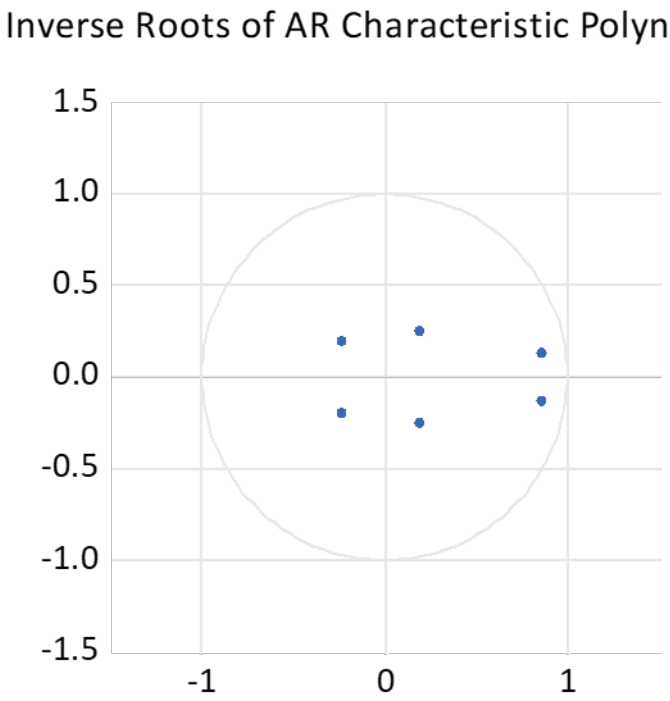
Appendix 2: VAR model estimation of domestic employment in gross agricultural exports and tomato sector trade.

Vector Autoregression Estimates
Date: 05/29/24 Time: 04:05
Sample (adjusted): 1998 2018
Included observations: 21 after adjustments
Standard errors in ( ) & t-statistics in [ ]

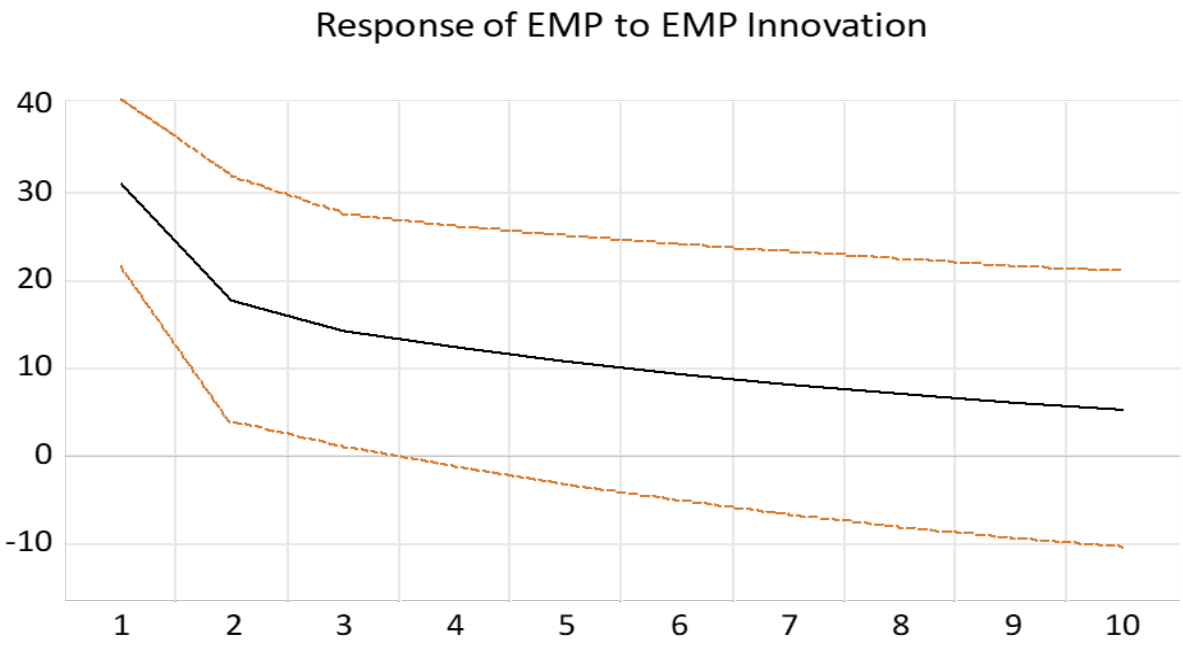
	EMP	IMPT	EXPT
EMP(-1)	0.512234	-1.310522	-67.37022
	(0.27234)	(9.57732)	(38.2085)
	[1.88087]	[-0.13684]	[-1.76323]
EMP(-2)	0.086575	-8.749825	-38.43070
	(0.31935)	(11.2306)	(44.8042)
	[0.27110]	[-0.77911]	[-0.85775]
IMPT(-1)	-0.000235	0.756342	0.270298
	(0.00934)	(0.32859)	(1.31090)
	[-0.02520]	[2.30178]	[0.20619]
IMPT(-2)	0.002981	-0.074850	-0.015901
	(0.01023)	(0.35963)	(1.43472)
	[0.29151]	[-0.20813]	[-0.01108]
EXPT(-1)	-0.001635	-0.024467	0.370865
	(0.00238)	(0.08375)	(0.33411)
	[-0.68649]	[-0.29215]	[1.11000]
EXPT(-2)	0.000262	0.073779	0.115994
	(0.00211)	(0.07408)	(0.29554)
	[0.12426]	[0.99593]	[0.39247]
C	76.85591	1786.906	24385.32
	(75.5625)	(2657.30)	(10601.2)
	[1.01712]	[0.67245]	[2.30024]
R-squared	0.584926	0.820394	0.822118
Adj. R-squared	0.407037	0.743420	0.745883
Sum sq. resids	17098.25	21145544	3.37E+08
S.E. equation	34.94716	1228.982	4902.993
F-statistic	3.288151	10.65807	10.78398
Log likelihood	-100.1709	-174.9331	-203.9899
Akaike AIC	10.20675	17.32696	20.09428
Schwarz SC	10.55493	17.67514	20.44246
Mean dependent	159.2333	1515.593	13306.27
S.D. dependent	45.38350	2426.242	9726.226

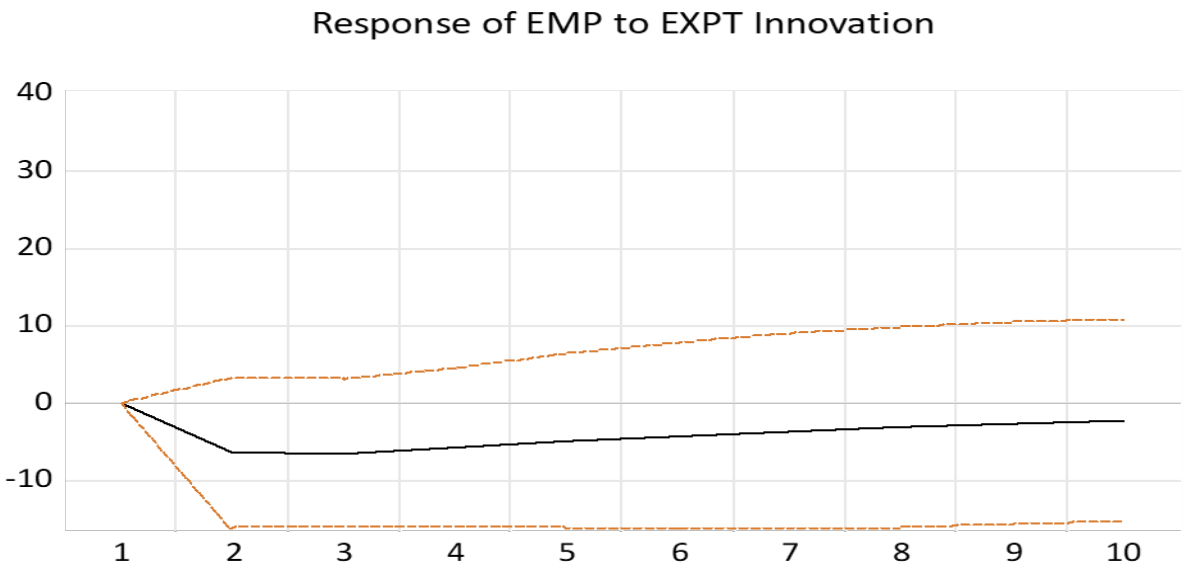
Determinant resid covariance (dof adj.)	2.77E+16
Determinant resid covariance	8.21E+15
Log likelihood	-474.1517
Akaike information criterion	47.15731
Schwarz criterion	48.20183
Number of coefficients	21

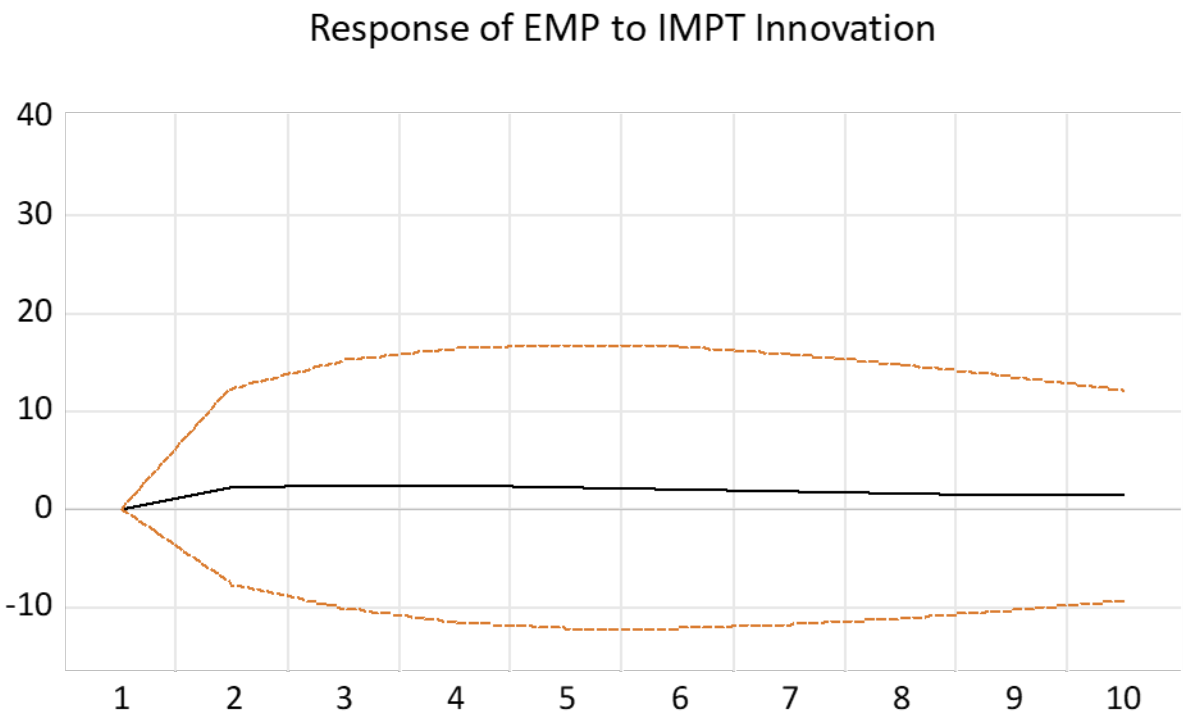
Appendix 3: VAR model verification of domestic employment in gross agricultural exports and tomato sector trade.



Appendix 4: Impulse response of domestic employment in gross agricultural exports and tomato sector trade.




Response of EMP to EXPT Innovation
40
30
20
10
0
-10
1
2
3
4
5
6
7
8
9
10


Response of EMP to IMPT Innovation
40
30
20
10
0
-10
1
2
3
4
5
6
7
8
9
10

Appendix 5: Lag Order Criterion of domestic employment in gross agricultural exports and tomato sector trade.

VAR Lag Order Selection Criteria
Endogenous variables: EMP IMPT EXPT
Exogenous variables: C
Date: 05/29/24 Time: 04:06
Sample: 1996 2018
Included observations: 22

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-527.1834	NA	1.72e+17	48.19849	48.34727	48.23354
1	-496.9859	49.41409*	2.53e+16*	46.27145*	46.86656*	46.41164*

* 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

Appendix 6: Johansen Co-integration results of domestic employment in gross agricultural exports and tomato sector trade.

Date: 05/29/24 Time: 14:06
Sample (adjusted): 1998 2018
Included observations: 21 after adjustments
Trend assumption: Linear deterministic trend
Series: EMP IMPT EXPT
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.371083	16.34751	29.79707	0.6876
At most 1	0.246958	6.608621	15.49471	0.6235
At most 2	0.030584	0.652292	3.841465	0.4193

Trace 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

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.371083	9.738885	21.13162	0.7687
At most 1	0.246958	5.956328	14.26460	0.6188
At most 2	0.030584	0.652292	3.841465	0.4193

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

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

EMP	IMPT	EXPT
0.043800	-0.000361	0.000258
0.010037	0.000612	-0.000155
-0.002054	0.000657	-2.69E-05

Unrestricted Adjustment Coefficients (alpha):

D(EMP)	-7.819125	-4.932584	4.480801
D(IMPT)	-118.5829	-501.7211	-82.45958
D(EXPT)	-2325.739	-482.0643	-440.4939

1 Cointegrating Equation(s): Log likelihood -477.4560

Normalized cointegrating coefficients (standard error in parentheses)

EMP	IMPT	EXPT
1.000000	-0.008235	0.005886
	(0.00696)	(0.00155)

Adjustment coefficients (standard error in parentheses)

D(EMP)	-0.342477
	(0.32086)
D(IMPT)	-5.193926
	(12.3179)
D(EXPT)	-101.8673
	(44.4152)

2 Cointegrating Equation(s): Log likelihood -474.4779

Normalized cointegrating coefficients (standard error in parentheses)

EMP	IMPT	EXPT
1.000000	0.000000	0.003351
		(0.00110)
0.000000	1.000000	-0.307851
		(0.08393)

Appendix 7: Granger causality results of domestic employment in gross agricultural exports and tomato sector trade.

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/29/24 Time: 14:02
Sample: 1996 2018
Included observations: 21

Dependent variable: EMP

Excluded	Chi-sq	df	Prob.
IMPT	0.155394	2	0.9252
EXPT	0.525634	2	0.7689
All	0.828811	4	0.9345

Dependent variable: IMPT

Excluded	Chi-sq	df	Prob.
EMP	0.786283	2	0.6749
EXPT	1.036315	2	0.5956
All	4.064509	4	0.3973

Dependent variable: EXPT

Excluded	Chi-sq	df	Prob.
EMP	5.481129	2	0.0645
IMPT	0.081482	2	0.9601
All	5.601921	4	0.2309