

PAPER DETAILS

TITLE: Determinants of Clove Exports in Zanzibar: Implications for Policy

AUTHORS: Samwel J KABOTE,Jires TUNGUHOLE

PAGES: 127-147

ORIGINAL PDF URL: <https://dergipark.org.tr/tr/download/article-file/2671692>

Determinants of Clove Exports in Zanzibar: Implications for Policy

Zanzibar'da Karanfil İhracatının Belirleyicileri:Politika Önerileri

Samwel J. KABOTE

Assoc. Prof. Dr., Sokoine University of Agriculture

sjkabote@sua.ac.tz

<https://orcid.org/0000-0002-6429-041X>

Received : 26.09.2022

Revised : 19.12.2022

Accepted : 26.12.2022

Type of Article : Research

Jires TUNGUHOLE

Mr., Sokoine University of Agriculture

jetunguhole@gmail.com

<https://orcid.org/0000-0001-9531-0295>

ABSTRACT

Keywords:

Cloves,
Exports,
Vector Error
Correction Model,
Zanzibar

Jel Codes:

C22, Q01, Q11

Clove is one of the high value spices that have supported the economy of Zanzibar for many decades since the 18th Century. However, clove production and exports have been declining significantly and consistently since the 1980s. The declining of the clove exports most likely jeopardizes the Zanzibar efforts to improving human development with positive changes in living standards. This paper analyses factors for the declining trend in clove exports using time series data that were collected between 1980 and 2020 and analysed using the vector error correction model, complemented with qualitative data collected from 39 key informants. The time series results show that clove production, producer price, world price, Gross Domestic Product (GDP), and Exchange Rate had positive and statistically significant impact on clove exports in a long-run at 1% level of significance; while Foreign Direct Investment, human population and Cross Capital Formation showed significant negative impact. Only inflation showed insignificant negative impact. Based on qualitative results, there were two major determinants: (i) factors that affected clove production, and (ii) low and fluctuation of the clove price. The time series results coincided with qualitative information. We conclude that some factors affected clove exports indirectly through clove production. Other factors affected exports through fluctuation of clove price. Therefore, we recommend an integrated policy approach that aims at improving clove production and price stabilization in order to rectify the decreasing trend in clove exports.

ÖZET

Anahtar Kelimeler:

Karanfil,
İhracat,
Vektör Hata
Düzeltilme Modeli,
Zanzibar

Jel Kodları:

C22, Q01, Q11

Karanfil, 18. Yüzyıldan bu yana onlarca yıldır Zanzibar ekonomisini destekleyen yüksek değerli baharatlardan biridir. Ancak, karanfil üretimi ve ihracatı 1980'lerden bu yana önemli ölçüde ve sürekli olarak azalmaktadır. Karanfil ihracatındaki düşüş, Zanzibar'ın yaşam standartlarında olumlu değişikliklerle insani gelişmeyi iyileştirme çabalarını tehlikeye atmaktadır. Bu çalışma, 1980 ve 2020 yılları arasında vektör hata düzeltme modeli kullanılarak analiz edilen zaman serisi verilerini kullanarak karanfil ihracatındaki düşüş eğiliminin faktörlerini analiz etmekte ve 39 önemli bilgi kaynağından toplanan nitel verilerle tamamlanmaktadır. Zaman serisi sonuçları, karanfil üretimi, üretici fiyatı, dünya fiyatı, Gayri Safi Yurtiçi Hasıla (GSYİH) ve Döviz Kurunun karanfil ihracatı üzerinde uzun vadede %1 önem düzeyinde pozitif ve istatistiksel olarak anlamlı bir etkiye sahip olduğunu göstermektedir. Doğrudan yabancı yatırım, insan nüfusu ve brut sermaye oluşumu ise önemli ölçüde olumsuz etki göstermiştir. Sadece enflasyon önemsiz negatif etki göstermiştir. Analiz sonuçlarına göre i) karanfil üretimini etkileyen faktörler ve (ii) karanfil fiyatının düşük ve dalgalanması iki ana belirleyicisidir. Buna karşın diğer faktörler, karanfil fiyatındaki dalgalanma yoluyla ihracatı etkilediği tespit edilmiştir. Bu nedenle, karanfil ihracatındaki düşüş eğilimini düzeltmek için karanfil üretimini iyileştirmeyi ve fiyat istikrarını hedefleyen bütünlük bir politika yaklaşımını öneriyoruz.

1. INTRODUCTION

This paper analyses the determinants of the declining trend in clove exports in Zanzibar. The clove is one of the most common spices on the Island of Zanzibar. It contributes to about 60 percent of the foreign exchange of Zanzibar (Hervé et al. 2014; Bakar 2015; URT 2016; Suda et al. 2020), suggesting that it has significant potential in driving economic growth and development on the Island. Studies like Juma (2010) demonstrate an association between Zanzibar's economy, livelihood, and performance of the clove industry. The same study shows that the economy of Zanzibar and the livelihood of the clove growers improve during periods of rising clove prices in the international markets and vice versa. For instance, the increase in clove prices in the international markets is accompanied by increased foreign exchange earnings, the share of agriculture in the gross domestic product (GDP), and employment in the clove industry. This translates into an improvement in economic growth and social welfare in Zanzibar.

The Island of Zanzibar comprises two sister islands of Unguja and Pemba. In the previous years, Zanzibar was considered a hub for international trade between USA, France, Britain, and India. The Island has fertile soil, arable land, and good climatic conditions for agricultural activities (Moh'd et al. 2017). With that, the economy of Zanzibar mainly depends on the agricultural sector, particularly on exports of cloves and seaweed. Cloves are an essential cash crop and have remained important since the colonial period. This crop is a principal source of revenue in Zanzibar. Nevertheless, the dependence of the economy on clove and seaweed exports implies that there are few commodities for export on the Island. In addition, the clove industry has been affected by recurring and common problems that decrease production and productivity, and some are concerned with the inefficiency of the clove marketing system. According to Hervé et al. (2014) and Moh'd et al. (2017), the problems encompass poor agricultural extension services, the decreasing farm size of cloves, inadequate use of clove processing firms, low producer prices, lack of funds, poverty, monopoly of the Zanzibar State Trading Corporation (ZSTC), increased clove production in other parts of the world, a limited market for Zanzibar clove products, and a lack of involvement of the private sector. Authors like Moh'd et al. (2017) categorize the problems into internal and external problems. While internal factors include price, production-related factors, inadequate funding, a lack of participation in the private sector and poverty, external problems are mainly concerned with the monopoly of the market.

The contribution of traditional agricultural crops to export earnings in the United Republic of Tanzania (URT), of which Zanzibar is a part, fell dramatically from 50 per cent in the 1990s to about 20 per cent in the 2000s (Akyoo and Lazaro 2007). Cloves are not an exception. For instance, between the 1960s and 1970s, the earnings from cloves were high, and therefore, the Island financed the Zanzibar Development Budget by over 80 per cent. However, currently, the clove industry in Zanzibar shows a significant and consistent decrease in production and world market price. For instance, the annual clove production in tonnes declined by 84.4 per cent in the period between the 1970s and 2000s. Similarly, export volumes fell by 60 per cent between 2003 and 2009 and by 89 per cent between 2003 and 2018. Although the world market demand for cloves increased, exports by volume fell from 90 per cent in the 1940s to about 6 per cent in the 2000s, 0.5 per cent in 2012, and 0.12 per cent in 2016 (Masoud 2017; REPOA 2018). This state of affairs has implications on the amount of cloves exported and export earnings, therefore affecting the economy and livelihood of clove growers.

This paper contributes to the international literature on the debate 'why clove exports are showing a decreasing trend in Zanzibar'. This is an area with inadequate information about Zanzibar. The results will help clove stakeholders, including policy makers, to improve the clove industry. Moreover, while considering quantitative analysis as a major empirical approach, the study contributes to innovation of complementing qualitative analysis with time series results. This helps to explain factors that cannot easily be quantified and entered in the regression model.

2. LITERATURE REVIEW

2.1. Theoretical Review

One of the frequently used theoretical arguments in development economics includes Ricardian hypothesis, which advocates the importance of technological change as the major source of comparative advantage, and Heckscher-Ohlin, which argues for the importance of relative factor endowments as a prime source of trade competitiveness. According to the Ricardian theory, the relative efficiency of producing goods and services determines the direction and magnitude of trade between two countries. In contrast, the Heckscher-Ohlin factor endowment theory predicts that countries with an abundance of one or more of the factors of production (land, labor, and capital) will specialize in commodities that require much of the abundant resources.

The increasing influence of policy on openness to the external world has led to numerous theoretical and empirical studies. Free trade is vindicated in different theories like the theory of absolute advantage (Smith 1776) and comparative advantage (Ricardo 1817). Others include neo-classical models like the Heckscher-Ohlin (Heckscher 1919; Bertil 1935) and New Trade Theory (Krugman 1979; Helpman and Krugman 1987). The free trade policies have been used to support policies of liberalization in developing countries (Sen 2010) as an alternative to the import-substitution policy after the 1970s. Export orientation has been credited for the remarkable economic transformation of many developing countries (Elbadawi 1998). According to Balassa (1990) and Edwards (1993), outward-oriented thinking is critical for economic transformation compared to inward-looking thinking. This implies the development of traditional agricultural exports and diversification into non-traditional exports, particularly in agrarian countries like those in sub-Saharan Africa including Tanzania.

According to Gbetnkom and Khan (2002), there are two schools of thought emanating from classical and modern theories of international trade that explain the determinants of agricultural export growth. First, agricultural exports are mainly determined by demand-side factors such as world market price and exchange rate. These are basically external factors to the exporting country. Thomas and Nash (1991) contend that developing countries' exports essentially comprise primary agricultural products. To that effect, export growth in developing countries depends on industrial growth in developed countries. This can also be interpreted as a low absorptive capacity of foreign markets in terms of accommodating imports from developing countries affects the growth of agricultural exports. The second school of thought focuses on supply-side factors, which are basically internal. According to this school of thought, the production of primary agricultural commodities determines exports, and increased production stimulates the growth of exports (David 2013). In this study, both classical and modern theories of international trade are used as the guiding theories. The premise that we put forward is that Zanzibar has favourable natural ecological and climatic conditions, and therefore, it should specialize in producing cloves for export. Moreover, the international trade of cloves attracts and fosters an environment for Zanzibar to continue producing and exporting cloves.

2.2. Empirical Literature

Export trade is one of the most important sources of foreign exchange in a country. Some scholars like Rivera-Batiz and Romer (1991) and Kingu (2014) succinctly support this premise. They argue that export trade stimulates economic growth and development through improvement of balance of payments deficit, enhancing diffusion of technologies, stimulating external demand for domestic products, increasing domestic production and efficient allocation of resources. Empirical literature confirms this premise in countries like Pakistan, Fiji, Vietnam, Tanzania, Turkey and Gabon (Suleiman et al., 2018). Others like Krugman and Venables (1995) contend that export trade tends to kill domestic infant industries particularly in developing countries where the industries cannot compete with those in developed countries. The current study considers export trade as a key for socio-economic development in the sense that the argument of the opponents of export trade can be addressed by an import-substitution strategy using foreign exchange earnings from exports (Rodrigues, 2010).

Studies on determinants of agricultural exports are not conclusive; the findings differ depending on the context. On one hand, Sharma (2001) and Babatunde (2009) determine factors for export performance and show that the exchange rate is a major factor affecting export performance in India and sub-Saharan Africa. In addition, Ahmed (2000) in Bangladesh, Bashir (2003) in Pakistan, and Santos-Paulino (2006) in the Dominican Republic show that export performance is determined by trade liberalization. On the other hand, using co-integration analysis, Menji (2010) shows that export performance in Ethiopia is determined by terms of trade, real effective exchange rate, and foreign direct investment (FDI). In addition, determinants of export in Africa include income per capita, the share of manufacturing in GDP, and FDI (Mold and Prizzon 2008). Other scholars like Kumar (1987) have reported GDP and level of production as determinants of export performance in India.

Gasheja et al. (2017) used the vector error correction (VEC) model to analyse the determinants of Rwanda exports. That study used data from 1976 to 2013. The factors that showed positive and significant impact on export growth rate were GDP, FDI, Industrial Value Added and Savings. Abdulai and Rieder (1995) and Abolagba et al. (2010) in Nigeria show, using ordinary least squares (OLS), that export of cocoa is determined by rainfall whereas the export of rubber is determined by domestic production, producer price, exchange rate, domestic consumption, and interest rate.

The Bank of Tanzania (2005) shows that determinants of agricultural exports include 'extension services, seasonal variation due to climatic changes, decreasing of clove farm size, underutilization of capacity of processing firms, and low farm gate price'. With regard to the importance of clove exports to Zanzibar's

economy, Kingu (2014) revealed that clove exports generate maximum earnings in the long run when the real exchange rate and world market price are taken into consideration.

Other studies have confirmed that differences in productivity and factor endowment explain a small part of trade performance variations over time and across countries (Bergstrand 1990; Bernstein and Weinstein 2002). Moreover, recent evidence suggests factor endowment has greater relative importance over productivity or technology in explaining international trade performance (Amoroso, Chiquiar, and Ramos-Francia 2011). The role of infrastructure in enhancing trade has also been widely discussed in policy circles and in the literature (Bougheas, Demetriades, and Mamuneas 1999; Francois and Manchin 2013; Bouët, Mishra, and Roy 2008; Moïsé et al. 2013). Empirical studies have generally confirmed positive and significant effects of infrastructure quality on trade values in exporting countries.

Both developed and developing countries provide financial and technical support to their agricultural producers for different reasons. Empirical studies assessing the link between domestic subsidies and trade have revealed mixed results depending on the type of commodity and support. Many have argued that the removal of European Union (EU) and U.S. agricultural subsidies could have a significant effect on the world prices of some commodities, such as cotton, tobacco, and soybeans (Bouët et al. 2005; Bureau, Jean, and Matthews 2006). However, the impact of domestic subsidies Global food, financial, and oil markets are increasingly interconnected (Tadasse et al. 2016). Shocks to any of these markets is likely to affect the nature and extent of agricultural trade. The 2007/2008 food price crisis, for example, caused many countries to impose export barriers and relax import restrictions on food products, which further aggravated the problem of price spikes and adversely affected agriculture lower than other cross-border measures (Hoekman, Ng, and Olarreaga 2004; Anderson and Martin 2005). Developing countries do also provide technical, financial, and institutional support to smallholder producers to boost productivity and improve market efficiency, thereby enhancing agricultural exports (Benin, Mogues, and Fan 2012).

A study by Staatz and Dembélé (2007) indicates that agriculture's capacity to contribute to growth and poverty alleviation in Africa has been greatly constrained in the past by underinvestment and miss-investment, in both physical and human capital, resulting in a huge cost to Africans in terms of foregone well-being. Helleiner's (2002) as cited in Bacchetta (2007) also found that FDI has not as yet made a particularly important contribution to African non-traditional export expansion. Oyejide (2007) investigated the critical of African investment codes which place heavy reliance on fiscal and other incentives which may be largely ineffective in attracting FDI and are at the same time quite costly in terms of lost revenue.

Degree of openness of the countries determines the export of primary commodities. Babatunde (2009) empirically investigates the effect of productive capacity (proxy by GDP of SSA countries) on its export by using both random and fixed effect regression of export supply model. The result reveals that GDP has highly significant positive impact on export volumes and export volumes appear to be lower when manufacturing share in GDP is higher. Traditionally, economists have argued that more open economies grow faster. This idea was largely based on the argument that openness improves resource allocation. According to Rodrik (1997) high levels of trade restrictions have been an important obstacle to exports, and their reduction can be expected to result in significantly.

Based on the foregoing theoretical and empirical literature, it is apparent that relevant factors that determine exports are many but differ by country and context. They include supply, demand, and institutional and climatic conditions. Importantly, while Zanzibar's economy substantially depends on clove exports, there is inadequate evidence on the factors that determine clove exports on the Island. In addition, most of the studies that have been done on exports have used OLS modelling, which is a weak estimation method; therefore, the results are not reliable. The reason is that most of the time series data trend over time, so regression between trended series using OLS techniques may produce erroneous but significant results with a high coefficient of determination (Granger and Newbold 1974). The cointegration methods employed by Menji (2010) have the ability to avoid this problem (Engle and Granger 1987). Cointegration methods offer a need for using the error correction model (ECM) for the same reason. Other studies that have used cointegration methods are Mustafa et al. (2016) and Soontaranurak and Dawson (2015).

3. METHODOLOGY

3.1. Data and Research Design

We used a trend analysis quantitative approach complemented by a qualitative approach in order to produce robust results for policy implications. The quantitative analysis utilises the vector error correction (VEC) model as specified in equation 1 to estimate clove export response from 1980 to 2020 in Zanzibar.

$$Zexp_t = a_0 + \sum_{k=1}^{k=n} a_k X_t^k + \varepsilon_t \quad (1)$$

Where: $Zexp_t$ is clove export from 1980 to 2020; X_t^k denotes a set of explanatory variables, both demand and supply-side; ε_t is an error term and a_k 's are model parameters.

The study used cointegration and VEC model to estimate the short-run and long-run effects of different determining factors on clove exports. The paper used demand- and supply-side factors to model clove exports. Using clove exports as our dependent variable, we used typical independent variables from international trade theories and empirical studies, particularly from Sharma (2001), Babatunde (2009), Bashir (2003), Abdulai and Rieder (1995), and Abolagba et al. (2010). The demand-side factors used include the world price of cloves, the producer price, and the real exchange rate. The supply-side factors used are clove production, FDI, GDP growth rate, population, inflation, climatic factors such as temperature and rainfall, and gross capital formation. Quantitative data were mainly secondary and were collected from different sources including the Office of the Chief Government Statistician of Zanzibar (OCGS), ZSTC, World Bank, United Nations–World Population Prospects, and World Development Indicators. A detailed description of the definition, units of measurement and data source for each variable used in the ECM model is shown in Appendix Table A1.

A qualitative approach was employed to collect information from key clove stakeholders in Mkoani, ChakeChake and Wete districts in Pemba; and Zanzibar North and Zanzibar West districts in Unguja. This was meant to complement the time series data in explaining the main factors for the decline of clove export. A total of 39 key clove stakeholders were selected using a snowballing sampling technique. This sampling technique enabled to capture of clove stakeholders with knowledge and experience in the clove industry. The stakeholders included 30 clove farmers, 20 from Pemba and 10 from Unguja; 2 officials from ZSTC; 3 officials from the Ministry of Agriculture, Natural Resource, Livestock and Fisheries; 3 officials from the Ministry of Trade and Industry; and 1 official from Zanzibar Investment Promotion Authority. Detailed information on the list of key informants is shown in Appendix A2.

3.2. Estimation of the Clove Export Response Model

The study employed Vector Error Correction Model (VECM) to estimate clove export function parameters. This is similar to many other researchers like Ahmed (2000), Bashir (2003), Penélope-López (2005) Agasha (2009), Allaro (2010) and Allaro (2012). This technique is superior to Ordinary Least Square (OLS) modelling because it establishes short-run and long-run relationships amongst variables. Granger (1986) cited in Gujarati (2004) asserts that testing for unit root and cointegration of the regression residual is an imperative condition since it is a pre-test to avoid the possibility of producing spurious regression output. In this study, these procedures were taken into consideration, by first conducting stationarity and cointegration tests.

Stationarity Test

The Dickey-Fuller (DF) test developed by Dickey and Fuller (1981) was employed for testing stationarity. The DF-test requires estimating the following equation using OLS:

$$\Delta y_t = \sigma + \beta_t + (\varphi - 1)y_{t-1} + \mu_t \quad (2)$$

Equation (2) indicates that the series y_t has both stochastic and deterministic trends and can be used as a DF-equation for testing the unit root null hypothesis such as:

$$H_0: (\varphi - 1) = 0 \quad (\text{unit root or non-stationary})$$

$$H_1: (\varphi - 1) \neq 0 \quad (\text{no unit root or stationary})$$

The test statistic used to test the unit root hypothesis is the t -statistic. If the calculated t -value (t -value of the coefficient $\varphi - 1$) is greater than the critical t -value, then y_t is non-stationary.

Cointegration Test

In this analysis, we tested for cointegration among the variables using the Johansen Method of Maximum Likelihood approach developed by Johansen (1988). The rationale here was to test for the presence of long-run and stable relationships among the time series data. Johansen's methodology takes its starting point in the vector autoregression (VAR) of order p given by:

$$y_t = \mu + A_1 y_{t-1} + \dots + A_p y_{t-p} + \varepsilon_t \quad (3)$$

Where, y_t is an $n \times 1$ vector of variables that are integrated of order one, commonly denoted as $I(1)$, and ε_t is an $n \times 1$ vector of innovations. This VAR can be re-written as:

$$\Delta y_t = \mu + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \quad (4)$$

Where,

$$\Pi = \sum_{i=1}^p A_i - I; \quad \text{and} \quad \Gamma_i = - \sum_{j=i+1}^p A_j \quad (5)$$

If the coefficient matrix Π has reduced rank $r < n$, then there exist $n \times 1$ matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta'y_t$ are stationary. r is the number of cointegrating relationships, the elements of α are known as the adjustment parameters in the VECM and each column of β is a cointegrating vector. It can be shown that for a given r , the maximum likelihood estimator of β defines the combination of y_{t-i} that yields the r largest canonical correlations of Δy_t , with y_{t-i} after correcting for lagged differences and deterministic variables when present. Johansen proposes two different likelihood ratio tests of the significance of these canonical correlations and thereby the reduced rank of the Π matrix: the trace test and maximum eigenvalue test are shown in equations (6) and (7) below;

$$J_{trace} = -T \sum_{i=r+1}^n \ln(1 - \lambda_i) \quad (6)$$

$$J_{max} = -T \ln(1 - \lambda_{r+1}) \quad (7)$$

Here T is the sample size and λ_r is the i^{th} largest canonical correlation. On one hand, the trace test tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of n cointegrating vectors. On the other hand, the maximum eigenvalue test tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of $r+1$ cointegrating vectors.

Error Correction Model Estimation

An Error Correction Model (ECM) is a time series model commonly used for data where the variables are likely to have a long-run stochastic relationship referred to as cointegration. According to Engle et al. (2011), ECMs are superior in estimating short-run and long-run effects of a time series to OLS modelling. The error term considers the reality that a deviation of the last period influences its long-run equilibrium. In simpler terms, an error correction involves de-trending or differencing the series in order to attain stationarity before estimating the relationship between the variables. In this paper, ECM is preferred because of its estimation strength to address the historical declining trend of clove production and exports in Zanzibar, and specifically, it helps to observe the long-run effects of the determining factors to clove exports.

The long-run clove exports supply function is specified as follows:

$$\ln CE_t = \beta_0 + \beta_1 \ln WP_t + \beta_2 \ln CLP_t + \beta_3 \ln PP_t + \beta_4 \ln ER_t + \beta_5 \ln FDI_t + \beta_6 \ln GDP_t + \beta_7 \ln POP_t + \beta_8 \ln INF_t + \beta_9 \ln GCF_t + \beta_{10} \ln RF_t + \beta_{11} \ln TP_t + u_t \quad (8)$$

Where CE is clove exports, WP is cloves world price, CLP is clove production, PP is producer price, ER is the exchange rate, FDI is Foreign direct investment, GDP is the Gross domestic product growth rate, POP is the population growth rate, GCF is gross capital formation, RF is rainfall, and TP is temperature. u is a random disturbance term with its normal classical properties, β is a vector of coefficients measuring long-run relationships, and \ln is a natural logarithm.

If these time series variables of $\ln CE$, $\ln WP$, $\ln CLP$, $\ln PP$, $\ln ER$, $\ln FDI$, $\ln GDP$, $\ln POP$, $\ln INF$, $\ln GCF$, $\ln RF$, and $\ln TP$ are found to be unit roots, then the study required to take the first difference of the variables (as in equation (8)) in order to obtain a stationary series:

$$\begin{aligned}\Delta \ln CE_t = & \beta_0 + \beta_1 \Delta \ln WP_t + \beta_2 \Delta \ln CLP_t + \beta_3 \Delta \ln PP_t + \beta_4 \Delta \ln ER_t + \beta_5 \Delta \ln FDI_t \\ & + \beta_6 \Delta \ln GDP_t \\ & + \beta_7 \Delta \ln POP_t + \beta_8 \Delta \ln INF_t + \beta_9 \Delta \ln GCF_t + \beta_{10} \Delta \ln RF_t + \beta_{11} \Delta \ln TP_t + u_t\end{aligned}\quad (9)$$

Equation (9) above does not have any inference to long-run aspects of decision making because the process of differencing equation (8) results in a loss of valuable long-run information in the data (Maddala, 1992 in Ahmed, 2000). In dealing with the loss of valuable information, the theory of cointegration came into place to mitigate the problem. The theory of cointegration addresses this issue by introducing an error, we specified the correction (EC) term in the model. We introduce an Error-correction term (EC_t) lagged one period (EC_{t-1}) so as to integrate short-run dynamics in the long-run clove export supply function. Thus a general Error Correction Model (ECM) in equation (10) is as follows:

$$\begin{aligned}\Delta \ln CE_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta \ln WP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta \ln CLP_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta \ln PP_{t-1} \\ & + \sum_{i=1}^n \beta_{4i} \Delta \ln ER_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta \ln FDI_{t-1} + \sum_{i=1}^n \beta_{6i} \Delta \ln GDP_{t-1} \\ & + \sum_{i=1}^n \beta_{7i} \Delta \ln POP_{t-1} + \sum_{i=1}^n \beta_{8i} \Delta \ln INF_{t-1} + \sum_{i=1}^n \beta_{9i} \Delta \ln GCF_{t-1} \\ & + \sum_{i=1}^n \beta_{10i} \Delta \ln RF_{t-1} + \sum_{i=1}^n \beta_{11i} \Delta \ln TP_{t-1} + \lambda_i EC_{t-1} + u_t\end{aligned}\quad (10)$$

Where, EC_{t-1} is the error-correction term which is the lagged value of the residuals obtained from the cointegrating regression of the dependent variable on the regressors; λ_i = the speed of adjustment parameter. It is expected to be negative; β_i = Coefficients measuring short-run relationship/effects among the variables; and u = Disturbance term.

3.3. Analysis of the key clove stakeholders' perceptions of clove export determinants

Qualitative results were used to explain trends in clove exports. The content analysis was used to analyse stakeholders' perceptions of the important factors that explain the trends in clove export in Zanzibar. The content analysis technique is a careful, detailed, systematic examination and interpretation of a particular body of material in an effort to identify patterns, themes, biases, and meanings (Berg 2009). This technique is useful in analysing the large amounts of verbal data collected through interviews with key informants in this paper.

4. RESULTS

4.1. Descriptive Statistics of Time Series Data

Before presenting the analysis of time series data, we present the properties of each variable by generating summary statistics to help observe how the variables behave. Descriptive statistics are based on the reforms made in the clove industry in Zanzibar. The first was from 1981 to 2010 during the implementation of the Clove Market Law, when ZSTC was the sole legal buyer and exporter of cloves on the Island (Table 1). Second, we present similar properties from 2011 to 2020 during the implementation of a 10-year (2011–21) clove development strategy, when a role to strengthen the clove industry was played by providing incentives to the farmers to encourage better management, supplying clove farmers with free clove seedlings and raising the clove price (Table 2).

Table 1. Implementation of the Clove Market Law (1981–2010)

Variable	Obs	Mean	Std. dev.	Min	Max
Export	30	4,411.192	3,384.201	12	12,000
Production	30	4,905.935	4,369.707	41	16,052
Producer price	30	810,007.7	1,131,71	13,43	3,374,39
World price	30	1,144,88	1,281,89	13,52	3,770,97
Gross domestic product (GDP)	30	4.346774	2.160189	0.5	8.17
Exchange rate (ER)	30	567.4248	483.3378	8.2	1,453.54
Foreign direct investment (FDI)	30	1.956677	2.023286	0.0	5.77
Inflation	30	19.54265	11.42925	4.73	36.14
Population	30	4.604194	0.672794	3.15	5.49
Rainfall	30	996.5097	104.8457	792.04	1,198.55
Temperature	30	22.70333	0.2847059	22.15	23.23
Gross capital formation (GCF)	30	21.95787	5.035915	14.899	32.84936

Note: number of observations: 30.

Source: authors' own computation using data from WDI, OCGS, and WB

Table 2. Implementation of the 10-year (2011–20) Clove Development Strategy

Variable	Obs	Mean	Std. dev.	Min	Max
Export	10	2,932.21	1,768.57	860	7,077
Production	10	3,804.7	2,467.63	211	8,572
Producer price	10	12,800,00	4,218,48	1,433,28	15,900,00
World price	10	16,700,00	4,106,04	10,900,00	23,900,00
Gross domestic product (GDP)	10	5.85	1.90160	1.3	7.7
Exchange rate (ER)	10	1,963.5	328.822	1,557	2,298
Foreign direct investment (FDI)	10	2.7564	1.49759	0.76	4.69
Inflation	10	6.27	3.50366	2.7	14.7
Population	10	4.441	0.19098	4.14	4.62
Rainfall	10	1,053.07	131.807	827.48	1,293.22
Temperature	10	22.773	0.396037	22.08	23.22
Gross capital formation (GCF)	10	28.099	2.466925	25.04924	33.24036

Note: number of observations: 10

Source: authors' own computation using data from WDI, OCGS, and WB

The findings in Tables 1 and 2 show that, on average, Zanzibar exported 4,411.192 tonnes of cloves during the implementation of the Clove Market Law in the period between 1981 and 2010, but it exported, on average, 2,932.21 tonnes of cloves during the implementation of the 10-year clove development strategy from 2011 to 2020. This shows a huge disparity in the number of clove exports between the two reform periods. Clearly, the Clove Market Law was characterized by higher exports, while exports declined during the 10-year clove development strategy. Similarly, clove production showed a decreasing trend while producer price showed an increasing trend during the implementation of the Clove Market Law and following the introduction of the 10-year clove development strategy. The clove prices show a significant improvement after the implementation of the 10-year clove development strategy, although part of the improved prices, both producer prices and world market prices, may capture inflation and exchange rates of the Tanzanian Shilling. The rest of the variables are not directly related to the two major clove reforms.

4.2 .Estimation of Clove Export Supply Response Model

Unit root test results

In order to carry out cointegration tests, the study tested the order of integration of the time series data. When the series was integrated in the same order, we proceeded with cointegration tests. The results in Table 3 show that the series was non-stationary at levels but became stationary at first differences. This is because, at levels, the Augmented Dickey and Fuller (ADF) statistic values are less than ADF critical table values, while in the first difference the ADF statistic values become greater than ADF critical table values. This shows that the series were integrated of the first order. Therefore, the unit root test results suggested that the existence of cointegration relationships between the series had to be tested (Table 4).

Table 3. ADF Unit Root Test Results

Variables	Level	First difference	Critical value (5%)
Export	-1.914	-5.145	-2.97
Production	-1.957	-5.607	-2.97
Producer price	1.943	-2.99	-2.97
World price	-1.376	-2.98	-2.97
Gross domestic product (GDP)	-2.554	-3.009	-2.97
Exchange rate (ER)	1.924	-2.99	-2.97
Foreign direct investment (FDI)	-1.951	-3.62	-2.97
Inflation	-1.375	-2.987	-2.97
Population	-2.824	-3.019	-2.97
Rainfall	-2.579	-14.214	-2.97
Temperature	-1.421	-3.213	-2.97
Gross capital formation (GCF)	-1.344	-5.379	-2.97

Note: model with constant for variable series. Number of observations: 41

Source: authors' own computation using data from WDI, OCGS, and WB

Cointegration test results

We continued by testing if there was cointegration between the series—that is, testing if the variables had long-run and stable dynamics. We employed the Johansen Co-integration Test by performing cointegration tests with a constant with no trend. Table 4 shows the results from the Johansen likelihood ratio tests for cointegration. The two common likelihood ratio tests—the trace and maximum Eigen value (λ -max)—were used to determine the number of cointegrating relations in the time series. The hypothesis of no cointegration between the series was rejected at the five per cent level of significance based on both the trace and maximum Eigen statistics. The results indicate that there existed a long-run equilibrium relationship between the series.

Table 4. Johansen Cointegration Test

Hypothesis	Statistic		Critical values (5%)	
	Trace	Max	Trace	Max
$r = 0$	327.90	81.89	233.13	62.81
$r = 1$	246.01	76.55	192.89	57.12
$r = 2$	169.45	63.71	156	51.42
$r = 3$	105.74*	36.43*	124.24	45.28

Note: * denotes significance at the 5% significance level. The number of observations: 41.

Source: authors' own computation using data from WDI, OCGS, and WB.

Vector error correction model results

The results from the VEC model presented in Table 5 show that the R-squared was 0.8706, indicating that 87.1 per cent of the variations in clove exports were explained by the variables entered in the model. The F-statistic probability of 0.0408 implies that the model, as a whole, was statistically significant at the five per cent level of significance. The coefficient of the error correction term in the first cointegration equation measured the speed of adjustment. The -1.77 indicates that about 177 per cent departure from long-run equilibrium was corrected in each period. Put differently, the previous period's deviation from long-run equilibrium was corrected in the subsequent

period at an adjustment speed of 177 per cent. The p-value of 0.000 shows that the speed of adjustment was statistically significant at the 0.1 per cent level.

Table 5. Vector Error Correction Model Results

Table 3. Vector Error Correction Model Results

Model summary				
R-squared =0.8706		F-statistic =4.4832		Durbin-Watson =1.6738
Adj.R-squared= 0.6764		Prob (F-statistic)=0.0408		
Short-run effects				
Variables	Coefficient	Std. err.	t-statistic	Prob.
D(EXPORT(-1)	0.1617	0.2890	0.56	0.576
D(PRODUCTION)	0.0956	0.2276	0.42	0.674
D(LOCAL_PRICE)	0.00008	0.0002	0.48	0.628
D(WORLD_PRICE)	0.00002	0.0001	0.18	0.86
D(GDP)	-172.50	317.722	-0.54	0.587
D(ER)	15.938	8.7735	1.82	0.069
D(FDI)	146.096	503.229	0.29	0.772
D(INFLATION)	-11.141	141.211	-0.08	0.937
D(POPULATION)	-178.584	1,456.95	-0.12	0.902
D(GCF)	18.1786	166.554	0.11	0.913
D(RAINFALL)	4.5178	4.5643	0.99	0.322
D(TEMPERATURE)	132.616	1,788.05	0.07	0.941
ECT(-1)	-1.7745	0.50917	-3.49	0.000
Long-run effects				
Variables	Coefficient	Std. err.	t-statistic	Prob.
EXPORT	1			
PRODUCTION	1.317139	0.0534763	24.63	0.000
LOCAL_PRICE	0.0004496	0.0000895	5.02	0.000
WORLD_PRICE	0.0002902	0.0000545	5.32	0.000
GDP	188.5299	63.19344	2.98	0.003
ER	2.091077	0.5666581	3.69	0.000
FDI	-790.5653	113.7831	-6.95	0.000
INFLATION	-36.5714	25.63772	-1.43	0.154
POPULATION	-720.6474	174.8021	-4.12	0.000
GCF	-146.5855	25.857	-5.67	0.000
RAINFALL	-3.878556	1.272401	-3.05	0.002
TEMPERATURE	607.087	381.5521	1.59	0.112
cons	2,372.64			

Note: number of observations: 41.

Source: authors' own computation using data from WDI, OCGS, and WB.

The results for short-run and long-run impacts are shown in Table 5. The lagged value of clove exports is a proxy for the existing capacity of Zanzibar's clove exports. In the short run, all variables were not significant at any level of significance. In the long run, the quantity of clove production, clove local price, world price, GDP, and exchange rate showed a positive significant impact on clove exports at the one per cent level of significance. Furthermore, the results show that FDI, population growth rate, gross capital formation, and rainfall had significant negative long-run impacts on the level of clove exports in Zanzibar at the one per cent level of significance.

4.3. Qualitative Findings

This section presents the stakeholders' views of the factors determining the decreasing trend of clove exports in Zanzibar. The factors raised during the interviews are clove price fluctuation, extension services and farming practices, government policies, climate and disease factors, and urbanization.

Price fluctuation

Interviews showed that price fluctuation was one of the biggest challenges impacting clove production and exports in Zanzibar. The rise and fall of clove market prices in the international markets relate to increasingly strong competition from other clove-producing countries like Indonesia, Madagascar, and Comoros (Juma 2010). This is common in most developing countries that depend on raw agricultural commodities. Price fluctuation was a serious concern to the clove growers. It also appeared that price challenges led farmers to sell cloves through smuggling channels.

Extension services and farming practice

According to the interviews, extension services granted by the government were inadequate. In order to expand clove production in Zanzibar, extension service is one of the crucial factors that should be prioritized with the aim of enabling farmers to get basic farming skills. According to a study by Birkhaeuser et al. (1991), 'agricultural extension services are one of the most common forms of public-sector support of knowledge diffusion, and this can bridge the gap between discoveries in the laboratory and changes in individual farmers' fields'.

Interviews with clove stakeholders showed poor management of clove trees. This decreased clove production due to weed competition for nitrogen and other nutrients. Owners of clove trees had inherited them from their forefathers, and some did not have the passion to continue managing the trees despite their great impact on their income earnings. The government has started a programme for re-planting new clove trees, but some clove farmers are not interested in it, perhaps because of focusing on non-farm activities.

Government policies

Following the Zanzibar Revolution in 1964, the land was nationalized. According to Martin (1991), the larger Arab plantations were also nationalized, and the three-acre policy was established. By 1974, almost 22,262 tenants—residents and landless peasants—had received three-acre plots of land from the government; a considerable proportion of this would have been clove land. This caused land fragmentation of the large original clove plantations. In addition, the administrative structure of the clove market in Zanzibar shows that all powers and authority on cloves are under the government through ZSTC, something which deprives intervention of the private sector.

Climate and disease factors

Better clove production highly depends on favourable climatic conditions with moderate rainfall and temperature (Chami 2020). Interviews showed that the impact of climate change manifested through floods and drought, and increased surface temperatures have adverse consequences on clove production. Clove growers also observed increased temperature and unpredictability of rainfall since the 1990s, which led to clove trees dying and the remaining ones becoming less productive compared to the period before the 1990s.

In connection with climatic factors, interviews showed that disease outbreaks, particularly sudden-death diseases, caused clove tree mortality. The disease was increasing in both Unguja and Pemba and persisted for many years. The only premonitory symptom is slight chlorosis, followed by thinning of the foliage and a decline of the absorbing system. Death follows after a period that may vary from only a few days to many months. Death occurs from lack of water caused by disorganization of the absorbing roots, therefore reducing the tree population, followed by a decline in production. Therefore, the Government of Zanzibar established a Clove Rehabilitation Programme in 1975, which involved clove nurseries re-established between 1975 and 1985 (Revolutionary Government of Zanzibar 2003). This programme increased clove production.

Urbanization

Interviews showed that there was a process of urbanization caused by migrants from Tanzania Mainland and the rest of East Africa. Meanwhile, there has been the mobility of the population from the two islands of Zanzibar as well as rural-urban migration within Unguja Island. This has reduced the size of land for clove production since the 1960s due to the expansion of urban areas.

5. DISCUSSION

Based on the descriptive statistics presented in Tables 1 and 2, the two major reforms that took place in the clove industry in Zanzibar showed different trends in clove exports, the quantity of production, producers, and world market prices. Unlike during the implementation of the Clove Market Law which took 30 years from 1981 to 2010, the efforts of the Revolutionary Government of Zanzibar through ZSTC partly increased producer prices

during the implementation of the Clove Development Strategy in a 10-year period from 2011 to 2020. The world market price was also high during that particular reform. However, clove production and exports showed a decreasing trend when compared with the period during the implementation of the Clove Market Law. These findings imply that increasing clove exports is attributed to increased clove production in the sense that an increase in clove production increased clove exports and vice versa. Unlike expectations, an increase in price during the Clove Development Strategy (2011 to 2020) did not influence clove production, possibly because the period was too short.

A decrease in clove production during the Clove Development Strategy and failure to increase producer prices in the same period imply the failure of the Revolutionary Government of Zanzibar to improve the clove industry because the government controls the industry. In addition, there is almost no private sector investment and participation in the clove industry in Zanzibar (Moh'd et al. 2017). Therefore, the price of cloves is not left to the vagaries of the market forces.

Further analysis of the results using the VEC model showed that all independent variables had no significant impact on clove exports in the short run. In the long run, the number of cloves produced, producer price, world market price, GDP, and exchange rate showed positive and significant impacts on clove exports at a one per cent level of significance, while FDI, population growth rate, rainfall, and gross capital formation showed a negative significant impact. The variables had positive signs, implying that there was a direct positive relationship between each of them and the dependent variable—in this case, clove exports. This implies that when the variables increased, clove exports increased as well, and vice versa. For example, a unit increase in the number of cloves produced increased clove exports. The impact of clove production on the clove export supply function that was significant implies that a decision to export cloves into external markets was dependent on the producer country's capacity. Despite the government's efforts through the Clove Development Strategy to improve clove production, data on clove productivity are limited. Interventions like improving extension services to clove farmers are critical for improving productivity. The results of the impact of clove production on clove exports are in line with Jongwanich (2007) who argues that clove exports in nine countries in East and Southeast Asia are determined by factors including supply-side production capacity.

In addition, the time series results showed that improved producer and world market prices, in the long run, stimulated domestic production, which in turn influenced clove exports. This implies that producer and world market prices were together a key in enhancing exports. Importantly, this study has shown that producer and world market prices increased during the Clove Development Strategy (2011–2020) compared to the period during the Clove Market Law (1981–2010). This is a good indicator of improving the clove industry. The long-run findings about GDP imply that increased production created surplus output supplied to the international markets. In addition, exchange rate depreciation in the international market stimulated export. These results are in line with findings by Odunga (2020), Mwinuka (2010), Mwinuka and Felix (2015), Ndulu and Lipumba (1990) for Tanzania, and Fugazza (2004). Regarding the world price, the results are in line with findings by Edward and Golub (2002) who used South African data. Regarding the exchange rate, the results are in line with Sharma (2001).

The existence of a long-run negative impact of FDI and gross capital formation on clove exports implies low levels of investment in the clove industry. Despite the fact that FDI is considered potential for development through technology transfer and employment creation, the agricultural sector attracts low FDI inflows compared to the accommodation and food service sectors in Zanzibar. For instance, between 2016 and 2017, there was completely no FDI inflow into the agricultural sector, including the clove industry, whereas accommodation and food services attracted, on average, inflows of USD\$74.9 million (Zanzibar Revolutionary Government 2017). This implies that there are neither foreign nor domestic companies involved in the clove industry in production and processing. Clove production is dominated by smallholder farmers, whereas the market is controlled by the Revolutionary Government of Zanzibar through ZSTC. Processing and value addition are hardly done, although the law gives a provision for them (International Trade Centre 2014). This is possible because of the low level of technology invested in the clove industry.

About the human population growth rate, its impact has an implication on population size and the declining size of land devoted to clove production as the population increases. The statistics on the changing size of arable land are limited. But this is categorically a typical case in Zanzibar, particularly in Unguja, where most of the clove farms have been turned into residences because of increasing population size and expansion of urban areas, as reported by ZSTC (2018). According to the URT, Zanzibar's population size increased from 640 in 1978 to 675 in 1988 to 1,303,569 in 2012, growing at a rate of 3.0 per cent per annum, but from 2012 it grew at a rate of 2.8 per cent per annum. The urban population grew at 4.4 per cent in 2012, higher than the growth rate of the rural

population, which was 1.7 per cent (URT 2014), resulting in increasing urbanization. In urban areas, 44 per cent are working in the service sector compared to 41 per cent working in the agriculture sector, including clove farming in rural areas. The rest are working in the manufacturing sector. This state of affairs associated with urbanization has decreased clove production and, by implication, exports.

Based on the long-term average rainfall, the negative coefficient implies that rainfall had a negative association with clove production. For instance, between 1981 and 2010, the long-term mean was 996.5 mm per annum with a standard deviation of plus or minus 104.8 mm. From 2011 to 2020, the long-term mean increased to 1,053.07 mm per annum with a standard deviation of plus or minus 131.8 mm. Although these statistics show an increasing long-term mean in a period of 40 years, rainfall was not adequate when compared with the moisture requirement for clove production. For instance, in the eight years between 2005 and 2012, the amount of rainfall was below the normal or below the long-term mean (Appendix Table A4). This was a period of drought, so clove production was negatively affected. Moreover, the standard deviation was high implying that there was high rainfall variability, which is most problematic in affecting clove production. The graph of rainfall anomaly against time shown in Appendix Table A4 also justifies the presence of rainfall variability in Zanzibar from 1980 to 2020. Interviews with clove stakeholders showed that irrigation was not practised in clove farming in Zanzibar. This implies that drought and rainfall variability most likely decreased clove production or made it more challenging. According to the Zanzibar Revolutionary Government (2003), cloves require heavy and reliable rainfall between 1,500 and 2,000 mm per annum. The temperature did not show an impact, possibly because it remained almost constant, at a long-term mean of 22.7°C throughout the period under consideration.

Qualitative results complement the time series results in this study. Interviews with clove stakeholders show that clove exports were determined by a number of interwoven factors that collectively influenced clove exports indirectly through clove production. Some of these factors were also reported by the Bank of Tanzania (2005). The clove stakeholders argued that despite government control, the producer price of cloves was low and not stable and was controlled by the rise and fall of the world market price. Since the clove industry in Zanzibar is controlled by the government through ZSTC, Moh'd et al. (2017) are of the view that the ZSTC provides lower producer prices than the black market. Therefore, there has been an emergence of smuggling cloves into Kenya. These together frustrated stakeholders' efforts and therefore paralyzed clove production and exports as well. Some farmers sold cloves to middlemen in an effort to get better prices compared to the ones offered by ZSTC. However, the availability of middlemen was not predictable, possibly because of too much control of the state in the market system through ZSTC. These results imply that giving farmers a better and stable price could be an incentive for clove production that in turn increases clove exports. During the implementation of the Clove Development Strategy, the Government of Zanzibar, through ZSTC, improved producer prices of cloves from TZS3,500 to TZS14,000 per kg. It also pledged higher prices to farmers even if the world market price fluctuated downwards (ZSTC 2018). Nevertheless, the world price continued to dictate the producer price, implying that falls in the world price caused falls in the producer price. Moh'd et al. (2017) argue that price disparity is one of the factors for the decline in the clove industry in Zanzibar.

Clove tree diseases decreased the clove tree population. The main disease manifests through the yellowing and thinning of foliage, followed by the death of a clove tree. This was exacerbated by inadequate extension services offered by the government through ZSTC. Despite the clove rehabilitation programme of 1975, the problem persisted, causing a decrease in the clove tree population—low production that in turn decreased clove exports. This is also reported by Hilal (2013) and Bakar (2015). Martin (1991) shows that in a period of 50 years from the 1940s to the 1990s the clove tree population decreased by 20 per cent. The same author indicates that the problem is caused by clove tree diseases and the ageing of the trees. This implies that clove diseases and a decrease in the clove tree population have affected the industry for many decades. Other factors that had similar impacts include poor clove tree management and poor harvesting practices, suggesting poor extension services and therefore failure of the ZSTC. Disease control measures, including the use of pesticides, were hardly used because of poor knowledge among clove growers. The poor performance of the clove industry has definitely caused poor livelihoods among smallholder farmers. According to Chami (2020), some clove growers cut clove trees for firewood and charcoal to sell to earn a living. Although statistics are limited, the unimpressive performance of the clove industry suggests that the number of clove farmers has decreased.

Urbanization has increased since the 1960s. This is attributed to pulling factors, largely tourism and service industries, in Zanzibar which led to an increase of immigrants from Tanzania Mainland and other parts of East Africa. Increased urbanization coupled with poor land governance exacerbated the problem of unofficial settlements and improper land use apart from clove farming. Complex land tenure legislation has further aggravated the problem. For example, the key informants in Unguja asserted that *'we are the natives of Unguja;*

our experience is that there are many areas that were full of clove trees in the 1980s, and some were covered by natural forests, but now those areas have been changed for other uses due to urbanization, with huge construction of various infrastructures and human settlements'. Although infrastructure development is critical for development, it has decreased clove trees which in turn decreased clove production and exports. The Revolutionary Government of Zanzibar recognizes the importance of the clove industry to the people, and the economy and thus continues to support the industry at the level of laws, policies, and interventions. In addition, the government is promoting diversification into other crops like rice, cassava, banana, sweet potatoes, vegetables, selected tropical fruits, and other spices including pepper.

Other factors were the government policies, particularly the three-acre policy and the role of ZSTC. The revolution of Zanzibar in 1964 came with the nationalization of clove plantations from the Arabs. As such, indigenous farmers were given three acres to produce cloves. The government intended to restore the land to the natives and empower them economically. In addition, the three acres were restricted for agricultural use, and the government forbade the selling of the land. This caused problems in that the new owners of clove farms did not manage the farms well because of inadequate farming knowledge (ZSTC 2018). Indigenous farmers also ended up building houses or selling the land to immigrants for residential purposes, implying a weakness of the three-acre policy. This justifies the arguments put forth by Hikmany (2015) on the premise that the objectives of land acquisition contradict the constitution of Zanzibar of 1984. This also decreased land for clove production, which definitely reduced the clove tree population.

About government control of the cloves market through ZSTC, it is the sole and legal buyer and exporter of cloves in Zanzibar. Cloves are purchased from the farmers by ZSTC and then exported to the world market (Moh'd et al. 2017). This is a monopsony marketing system. Interviews with clove stakeholders indicated that the government controlled the price of cloves offered to the farmers, and the price was supposed to be constant even if the world market price fluctuated downward. Such government intervention sounds better in a situation of stabilized world market price. However, the situation was challenging when the world market fluctuated downward; it was difficult to compensate the farmers. Another option to deal with the price fluctuation is to process raw cloves into other products for export. Although information about processing cloves is limited, the processing is hardly done, and it is not well developed in Zanzibar. We urge the government to promote clove processing in addition to supporting production, ensuring good quality of cloves and marketing.

6. CONCLUSION AND POLICY RECOMMENDATIONS

6.1. Conclusion

Clove exports in Zanzibar are determined by a combination of factors. The major ones are clove production, producer price, world price, GDP, and exchange rate. Others are rainfall variability, FDI in the production and processing of cloves, increased human population, and gross capital formation. These factors determine clove exports directly or indirectly, and their impacts are considerably high. Other determinants are diseases, poor clove tree management, and poor harvesting practices, which collectively imply poor extension services. Others are urbanization, the three-acre policy, and the monopoly nature of the clove market system. These factors determine clove exports indirectly through clove production. Clove production and exports were so directly linked that an increase in production increased exports and vice versa. Therefore, the determinants of clove exports can be collapsed into production factors, those which influence clove production on the supply side, those related to market and price at the local and world market levels, the demand side, institutional factors including policies and laws, and climatic factors. The world market price controls the producer price such that a fall in the world market triggers falls in the producer price. There is also the government's institutional and policy failure to revitalize the clove industry.

6.2. Policy Recommendations

Based on the conclusions, we recommend the following policy interventions:

- (i) We recommend an *integrated policy approach*, which considers together different factors that affect clove exports. The integrated policy can coordinate different goals to address factors affecting clove exports. Some of the interventions to consider in this policy include increasing, stabilizing, and sustaining producer prices. At the government level, the interventions should include creating an enabling environment for FDI inflows into the clove industry to improve clove production. It appears that a larger number of the clove tree population results in greater production; therefore, at the grassroots level, the government should implement a replanting programme to restore the population of clove trees. The replanting programme is not new; it was

implemented in the 1960s and showed a positive impact in terms of restoring the clove tree population and production. To deal with drought and rainfall variability, the government should consider introducing an irrigation farming system.

- (ii) Because clove production and exports are directly linked, the *integrated policy approach* should aim to increase clove productivity. The intervention should include intensification of clove farming systems, introducing a high level of intercropping, new post-harvest techniques, clove farming methods, management of clove trees, control of diseases, and improvement of extension services to the clove farmers. Farmers should be trained to improve the farming skills and knowledge required for clove production and processing.
- (iii) The government has been implementing the Clove Development Strategy, and its success has indicated positive results. This paper recommends that some of the issues to consider in the *integrated policy approach* are those implemented by ZSTC through the Clove Development Strategy. These include the establishment of modern clove-buying centres, provision of interest-free loans to the clove farmers, provision of free seedlings, provision of training to the farmers, and rehabilitation of road infrastructure in clove-producing areas. When these are implemented collectively and effectively, they can revamp clove production. Therefore, the key clove stakeholders like ZSTC; the Ministry of Agriculture, Natural Resources, Livestock, and Fisheries; and the Ministry of Trade, Industry, and Marketing should consider the factors raised in this study in order to improve clove production, which appears to be affected by a combination of different factors that in turn determine clove exports.
- (iv) The existing clove marketing structure in Zanzibar is currently a monopsony controlled by the government through the ZSTC. In this system, the government is supposed to control producer prices, thereby protecting farmers from being affected by the downward price fluctuations. This is important because producer price is affected by the world market price such that a fall in the world market price causes a fall in the producer price. Therefore, this study recommends two policy issues. First, the government should compensate smallholder farmers when the world market price fluctuates downward. This will help stabilize producer prices and so not negatively affect their income and livelihood. Second, the government should consider promoting investments in processing cloves. This needs the adoption of technologies to produce products from cloves. This is critical for value addition and can enable the Revolutionary Government of Zanzibar to diversify export products instead of depending on exporting raw cloves, therefore increasing government revenue. Thus, given the increased competition of cloves in the world market that causes downward fluctuation of the producer price, the future sustainability of the clove industry in Zanzibar depends on the ability of the revolutionary government to offer good prices and protect smallholder farmers from being affected negatively by the falls of the world market price.
- (v) The Revolutionary Government of Zanzibar should promote and implement new policies that aim at reducing farmers' income dependence on cloves. This should be done by promoting diversification of other crops including other spices with a competitive advantage. Since the livelihood of the majority depends directly or indirectly on the agricultural sector, diversifying income sources besides agriculture is inevitable for improving the livelihoods of the people and economy of Zanzibar.
- (vi) In order to understand the dynamics of clove exports, researchers need to consider the vigorous analysis of time series data using a VEC model, complemented with qualitative information. A mixed-methods approach helps to get more useful insights in addition to a better explanation of the factors that determine clove exports.

AUTHORS' DECLARATION

This paper complies with Research and Publication Ethics, has no conflict of interest to declare, and has received no financial support.

AUTHORS' CONTRIBUTIONS

Conceptualization, writing-original draft, editing – SK and TJ, data collection, methodology, formal analysis – SK, Final Approval and Accountability – SK and TJ

FUNDING DETAILS

This study was originally commissioned under the UNU-WIDER project Sustainable development solutions for Tanzania – strengthening research to achieve SDGs, funded by the Ministry for Foreign Affairs of Finland.

ACKNOWLEDGEMENTS

We thank Professor Joseph Semboja from UONGOZI Institute in Tanzania for constructive comments on the proposal for this study. We also thank Professor Josaphat Kweka from the Economic and Social Research Foundation (ESRF) in Tanzania, Economics Professor Svetlana Ledyeva from Aalto University School of Business, and Dr Milla Nyssölä from UNU-WIDER for useful comments on this paper.

REFERENCES

- Abdulai, A., & Rieder, P. (1995). The impacts of agricultural price policy on cocoa supply in Ghana: An error correction estimation. *Journal of African Economies*, 4(3), 315-335.
- Abolagba, E. O., Onyekwere, N. C., Agbonkpolor, B. N., & Umar, H. Y. (2010). Determinants of agricultural exports. *Journal of Human Ecology*, 29(3), 181-184.
- Agasha, N. (2009). Determinants of export growth rate in Uganda 1987-2006. *Uganda revenue authority, research and planning, Kampala, Uganda*.
- Ahmed, N. (2000). Export response to trade liberalization in Bangladesh: a cointegration analysis. *Applied Economics*, 32(8), 1077-1084.
- Akyoo, A., & Lazaro, E. (2007). *The spice industry in Tanzania: General profile, supply chain structure, and food standards compliance issues*. Danish Institute for International Studies, DIIS.
- Allaro, H. B. (2011). Export performance of oilseeds and its determinants in Ethiopia. *Journal of Cereals and Oilseeds*, 2(1), 1-15.
- Allaro, H. B. (2012). The impact of trade liberalization on the Ethiopia's trade balance. *American Journal of Economics*, 2(5), 75-81.
- Amoroso, N., Chiquiar, D., & Ramos-Francia, M. (2011). Technology and endowments as determinants of comparative advantage: Evidence from Mexico. *The North American Journal of Economics and Finance*, 22(2), 164-196.
- Anderson, K., & Martin, W. (2005). Agricultural trade reform and the Doha Development Agenda. *World Economy*, 28(9), 1301-1327.
- Babatunde, M. A. (2009). Can trade liberalization stimulate export performance in Sub-Saharan Africa. *Journal of International and Global Economic Studies*, 2(1), 68-92.
- Bacchetta, M. (2007). Releasing export constraints: The Role of governments, ERSD, WTO, available online at <https://www.africaportal.org/publications/releasing-export-constraints-the-role-of-governments/>
- Bakar, S. A. (2015). *Contribution of the Zanzibar State Trading Corporation (ZSTC) to clove production in Zanzibar* (Doctoral dissertation, The University of Dodoma).
- Balassa, B. (1990). Incentive policies and export performance in Sub-Saharan Africa. *World development*, 18(3), 383-391.
- Bank of Tanzania (2005). Operations report, dar es salaam: annual report chief of the government statistician. Zanzibar statistical abstracts (from 1984 to 2004)'. *Annual report*. Zanzibar: BoT.
- Bashir, Z., & Din, M. U. (2003). The impacts of economic reforms and trade liberalisation on agricultural export performance in Pakistan [with Comments]. *The Pakistan Development Review*, 42(4), 941-960.
- Benin, S., Mogues, T., & Fan, S. (2012). Agricultural growth and poverty reduction impacts of public investments: Assessment concepts and techniques. *Public Expenditures for Agricultural and Rural Development in Africa*. Routledge, UK.
- Berg, B.L. (2009). Qualitative research methods for the social sciences. *Long Beach*: California State University.
- Bergstrand, J. H. (1990). The Heckscher-Ohlin-Samuelson model, the Linder hypothesis and the determinants of bilateral intra-industry trade. *The Economic Journal*, 100(403), 1216-1229.
- Bernstein, J. R., & Weinstein, D. E. (2002). Do endowments predict the location of production?: Evidence from national and international data. *Journal of International Economics*, 56(1), 55-76.
- Birkhaeuser, D., Evenson, R. E., & Feder, G. (1991). The economic impact of agricultural extension: A review. *Economic development and cultural change*, 39(3), 607-650.
- Bouët, A., Bureau, J. C., Decreux, Y., & Jean, S. (2005). Multilateral agricultural trade liberalisation: The contrasting fortunes of developing countries in the Doha round. *World Economy*, 28(9), 1329-1354.
- Bouet, A., Mishra, S., & Roy, D. (2008). *Does Africa trade less than it should, and if so, why? The role of market access and domestic factors*. Intl Food Policy Res Inst.

- Bougheas, S., Demetriades, P. O., & Morgenroth, E. L. (1999). Infrastructure, transport costs and trade. *Journal of international Economics*, 47(1), 169-189.
- Bureau, J. C., Jean, S., & Matthews, A. (2006). The consequences of agricultural trade liberalization for developing countries: distinguishing between genuine benefits and false hopes. *World Trade Review*, 5(2), 225-249.
- Chami, A. A. (2020). Contemporary dynamics in Zanzibar's clove industry: prospects and challenges facing smallholder farmers in wete district, pemba, Zanzibar'. *Modern Concepts and Developments in Agronomy*, 6(1), 597-605.
- David, B. (2013). Competitiveness and determinants of cocoa exports from Ghana. *International Journal of Agricultural Policy and Research*, 1(9), 236-254.
- Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: journal of the Econometric Society*, 1057-1072.
- Edwards, L., & Golub, S. S. (2002). South Africa's international cost competitiveness and productivity: A sectoral analysis. *Report prepared for the South African National Treasury under a USAID/Nathan Associates SEGA Project*.
- Edwards, S. (1993). Openness, trade liberalization, and growth in developing countries. *Journal of economic Literature*, 31(3), 1358-1393.
- Elbadawi, I. A. (1998). Real exchange rate policy and non-traditional exports in developing countries. Helsinki, UNU-WIDER Working Paper No. 1998/46.
- Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: journal of the Econometric Society*, 251-276.
- Engle, R. F., Hansen, M., & Lunde, A. (2011). And now, the rest of the news: Volatility and firm specific news arrival. *Unpublished Working Paper, CREATES*.
- Francois, J., & Manchin, M. (2013). Institutions, infrastructure, and trade. *World development*, 46, 165-175.
- Fugazza, M. (2004). Export performance and its determinants: supply and demand constraints. *Policy Issues in International Trade and Commodities Study Series*, (26).
- Gasheja, C. A. S. H. E. J. A., Joseph, M. A., Joselyne, I. N. G. A. B. I. R. E., Napoleon, N. J., & Felix, H. A. G. E. N. I. M. A. N. A. Applying vector error correction to model export in Rwanda. *International Journal of Mathematics and Physical Sciences Research*, 4(2), 53-63.
- Gbetnkom, D., & Khan, S. A. (2002). Determinants of agricultural exports: The case of Cameroon (AERC Research Paper).
- Granger, C. W., & Newbold, P. (1974). Spurious regressions in econometrics. *Journal of econometrics*, 2(2), 111-120.
- Gujarati, N. D. (2003). Basic Econometrics 4th edition McGraw Hill United states Military Academy. *West Point*.
- Heckscher, E. (1919). The effect of foreign trade on the distribution of income 1919. *Readings in the theory of international trade*, 272-300.
- Helleiner, G. K. (Ed.). (2002). *Non-traditional export promotion in Africa: Experience and issues*. New York: Palgrave.
- Helpman, E., & Krugman, P. (1987). *Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy*. MIT press.
- Hervé, D. B. G., Amoro, G., Mahfoudh, R. S., & Constant, N. G. B. Z. S. (2014). The Determinants of export performance: The case study of Zanzibar export. *International Journal of Economics and Finance*, 6(6), 95-102.
- Hikmany, A. N. (2015, September). The Many land acquisition laws of Zanzibar: Is there an innermost objective?. In *International Conference on Advanced Research in Business and Social Sciences*.

- Hilal, Z. A. (2013). The Implication of prevailing marketing system in production and export: the case of clove production in Zanzibar'. *Unpublished Master's dissertation. Rotterdam, The Netherlands: International Institute of Social Studies.*
- Hoekman, B., Ng, F., & Olarreaga, M. (2004). Agricultural tariffs or subsidies: which are more important for developing economies?. *The World Bank Economic Review*, 18(2), 175-204.
- International Trade Centre (2014). *Tanzania spices sub-sector strategy*. Geneva. Available at: https://www.intracen.org/uploadedFiles/Tanzania-Spices%20Roadmap%20_final.pdf (accessed 18 December 2021).
- Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, 12(2-3): 231-54.
- Jongwanich, J. (2007). *Determinants of export performance in East and Southeast Asia*. Asian Development Bank. Available at: <https://www.adb.org/sites/default/files/publication/28367/wp106.pdf> (accessed 17 September 2021).
- Juma, A. (2010). Zanzibar clove growers association: Final clove advocacy report. Zanzibar. Available at: <http://www.best-dialogue.org/wp-content/uploads/ZAPCO-2010-07-Zanzibar-Clove-Advocacy-report-Juma.pdf> (accessed 7 February 2022).
- Kingu, J. (2014). Cloves Export response to trade liberalization in Tanzania: A cointegration analysis. *Journal Economics and Sustainable Development*, 5(1): 99-120.
- Krugman, P. (1979). A model of innovation, technology transfer, and the world distribution of income. *Journal of political economy*, 87(2), 253-266.
- Maddala, G.S. (1992). *Introduction to econometrics, 2nd Edition, Prentice Hall, New Jersey.*
- Martin, P. J. (1991). The Zanzibar clove industry. *Economic Botany*, 45(4), 450-459.
- Masoud, M. (2017). Vulnerability of clove farmers to impact of climate change and variability in pemba Island'. *Unpublished Master of Environmental Science*. Zanzibar: State University of Zanzibar.
- Menji, S. (2010). Export Performance and determinants in Ethiopia. MPRA Paper 29427. Munich: University Library of Munich, Germany.
- Moh'd, I. S., Mohammed, M. O., & Saiti, B. (2017). The problems facing agricultural sector in Zanzibar and the prospects of Waqf-Muzar'ah-supply chain model: The case of clove industry. *Humanomics*. 33(2): 189-210.
- Moïsé, E., Delpeuch, C., Sorescu, S., Bottini, N., & Foch, A. (2013). Estimating the constraints to agricultural trade of developing countries. OECD Trade Policy Paper 142. Paris: OECD Publishing.
- Mold, A., & Prizzon, A. (2008). Explaining Africa's Recent Export Performance and the Limited Gains from the Commodity Boom. Paris: OECD Development Centre.
- Mustafa, G., Latif, I., & Egwuma, H. (2016). An empirical analysis of supply response of rubber in malaysia. *American Journal of Agricultural and Biological Sciences*, 12(4), 148-156.
- Mwinuka, L. (2010). Assessment of post harvest repayment deductions on sugarcane out growers profitability: a case study of ruembe cane growers association: In. *Agricultural Innovations for Sustainable Development Contribution from the Finalists of the 2009/10 African-wide Women and Young Professional in Science Competition*, 196-201.
- Mwinuka, L., & Mlay, F. (2015). Determinants and performance of sugar export in Tanzania. *Journal of Finance and Economics*, 3(1): 6-14
- Ndulu, B. J., & Lipumba, N. H. I. (1990). International trade and economic development in Tanzania. *Trade and development in sub-Saharan Africa*. Manchester: Manchester University Press.
- Odunga, P. S. (2020). The determinants and impact of foreign direct investment (FDI) in Kenya and Tanzania: an OECD and non-OECD perspective 1996-2016. Doctor of Philosophy thesis. Wolverhampton, UK: University of Wolverhampton.
- Ohlin, B. (1935). *Interregional and international trade*. Harvard University Press, Cambridge.

- Pacheco-López, P. (2005). The effect of trade liberalization on exports, imports, the balance of trade, and growth: the case of Mexico. *Journal of post keynesian economics*, 27(4), 595-619.
- Repoa (2018). *Harnessing the Potential of Tanzania's Export*. Dar es Salaam: Research on Poverty Alleviation. https://www.repoa.or.tz/wpcontent/uploads/2020/07/Harnessing_the_potential_of_Tanzania's_exports.pdf
- Ricardo, D. (1817). On the principles of political economy and taxation. variorum edition. batoche books, ontario. <https://socialsciences.mcmaster.ca/econ/ugcm/3ll3/ricardo/Principles.pdf> (Accessed on 29 April, 2022).
- Rivera-Batiz, L. A., & Romer, P. M. (1991). Economic integration and endogenous growth. *The Quarterly Journal of Economics*, 106(2), 531-555.
- Rodrigues, M. (2010). Import substitution and economic growth. *Journal of Monetary Economics*, 57(2), 175-188.
- Santos-Paulino, A. (2006). Trade liberalisation and trade performance in the Dominican Republic. *Journal of International Development: The Journal of the Development Studies Association*, 18(7), 925-944.
- Sen, S. (2010). International trade theory and policy: A review of the literature. Working Paper No. 635. Annandale-on-Hudson, NY: Levy Economics Institute.
- Sharma, K. (2000). *Export Growth in India: Has FDI played a role?* Bathurst, Australia: Charles Sturt University. (No. 1858-2016-152730).
- Smith, A. (1998). *An inquiry into the nature and causes of the wealth of nations: a selected edition*. Oxford University Press, USA.
- Soontaranurak, K., & Dawson, P. J. (2015). Rubber acreage supply response in Thailand: A cointegration approach. *The Journal of Developing Areas*, 49(2), 23-38.
- Staatz, J. M., & Dembele, N. N. (2008). Agriculture for development in sub-Saharan Africa. Background paper for WDR report, No.41378, University of Michigan.
- Suda, M., D.G. Mhando, A. P. Maerere, and U. Tanaka (2020). Vanilla cultivation and processing in Uluguru mountains'. *The Uluguru Vanilla Project, GEF-SUA*.
- Suleiman, S. H. (2018). Exports Trade and Economic Growth in Zanzibar. *Archives of Business Research*, 6(11), 1-10.
- Tadasse, G., Algieri, B., Kalkuhl, M., & Braun, J. V. (2016). Drivers and triggers of international food price spikes and volatility. In *Food price volatility and its implications for food security and policy* (pp. 59-82). Springer, Cham.
- Thomas, V., & Nash, J. (1991). Best practices in trade policy reform. Washington, DC: *The World Bank*. Available at: <http://bit.ly/19sFj7G> (accessed 22 April 2014).
- URT (2014). Basic demographic and socio-economic profile, Tanzania Zanzibar. *Office of Chief Government Statistician Ministry of State, President Office, State House and Good Governance Zanzibar*. Available at: https://www.tanzania.go.tz/egov_uploads/documents/TANZANIA_ZANZIBAR_SOCIO_ECONOMIC_PROFILE_sw.pdf (accessed 3 November 2021).
- URT (2016). National five year development plan 2016/17 to 2020/21: Nurturing industrialization for economic transformation and human development. *Dar es Salaam: Ministry of Finance and Planning*. Available at: http://www.mof.go.tz/mofdocs/msemaji/Five%202016_17_2020_21.pdf (accessed 20 July 2019).
- Zanzibar Revolutionary Government (2003). Study on the Zanzibar clove industry. *Ministry of Finance and Economic Affairs*. Available at: <http://www.tzonline.org/pdf/studyonthezanzibarcloveindustry.pdf> (accessed 13 October 2021).
- Zanzibar Revolutionary Government (2017). Zanzibar investment report: Foreign private investments. *Office of the Chief Statistician of Zanzibar*. Available at: <https://www.bot.go.tz/Publications/Other/Zanzibar%20Investment/en/2020070616251528.pdf> (accessed 3 November 2021).
- ZSTC (2018). Zanzibar cloves magazine. *Zanzibar ZSTC*. 15 pp. <https://www.coursehero.com/file/66760261/c42pdf/> (Accessed on 6 May 2022)

APPENDIXES

Appendix A. Definition, Level of Measurement, and Data Source of Variables Used in the ECM Model

Variable	Definition	Unit of measurement	Data Source
Export quantity of cloves	The quantity of cloves exported to the world market from Zanzibar	Tonnes	OCGS and ZSTC
World price of cloves	Price of cloves at the world market	TZS	OCGS and ZSTC
Exchange rate	Rate at which TZS is converted into USD	TZS	OCGS and ZSTC
Foreign direct investment	Foreign direct investment, net inflows (per cent of GDP)	Per cent	WDI
Clove production	Amount of cloves harvested	Tonnes	WDI
Producer price	Price of cloves paid to the producers	TZS	WDI
GDP growth rate	Annual growth rate of GDP per cent at prices of market based on constant local currency	Per cent	UN-WPP
Population	Population growth rate (annual per cent)	Per cent	WDI
Inflation	Inflation, consumer prices (annual per cent)	Per cent	OCGS and ZSTC
Gross capital formation	Gross capital formation (per cent of GDP)	Per cent	WDI
Rainfall	Long-term mean in millimetres per year	mm per year	https://climateknowledgeportal.worldbank.org/country/tanzania-united-republic
Temperature	Long-term mean	°C	https://climateknowledgeportal.worldbank.org/country/tanzania-united-republic

Note: OCGS=Office of the Chief Government Statistician of Zanzibar, ZSTC=Zanzibar State Trading Corporation, UNWPP=United Nations - World Population Prospects, and WDI=World Development Indicators.

Appendix B. Clove Stakeholders' Key Informants

Stakeholders	Stakeholder's role in clove industry	Number of interviewees	Designation of interviewees
Farmers	Farm preparation, clove planting, caring, harvesting, drying, cleaning, handling, and transporting to the selling point.	30	Small and medium farmers
	Providing input services, including implements, equipment, fertilizers and chemicals, post-harvest management, and handling materials.		
Zanzibar State Trading Corporation	Promoting production, marketing, processing, storage, and trade of cloves and other agricultural products.	2	Managing director Marketing officer
	Providing assistance in the formation and support of farmers and actors, farmers' group, and cooperative organizations.		
Ministry of Agriculture, Natural Resources, Livestock, and Fisheries	Extension services to clove growers and other clove stakeholders.	3	Director of agriculture and extension services Extension officer Extension officer
	Agricultural research on cloves.		
	Ensure the State Corporation fulfills their tasks efficiently and effectively.		
Ministry of Trade, Industry, and Marketing	Ensure farmers have better conditions and access to services such as extension, loans, subsidized inputs, and better prices.	3	Director of trade and marketing External trade officer Marketing officer
	Responsibility for the growth of the clove industry and encouraging farmers to invest in this sector.		
Zanzibar Investment Promotion Authority	Improving productivity and aid trade diversification of exports that meet international standards.	1	Director of investment facilitation and project development
	Attracting FDI in agriculture.		

Source: authors' own compilation and Chami (2022)

Appendix C. Rainfall variability in Zanzibar between 1980 and 2020

