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Determinants of clove exports in Zanzibar: Implications for policy

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Determinants of clove exports in Zanzibar

Implications for policy

Samwel J. Kabote and Jires Tunguhole*

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Abstract: This paper analyses factors for the declining trend in clove exports in Zanzibar using time series data that were collected between 1980 and 2020 and analysed using the vector error correction model, complemented with qualitative analysis. Clove production, producer price, world price, gross domestic product, and the exchange rate showed positive statistically significant impacts in the long run at the one per cent level, while foreign direct investment, population growth rate, rainfall, and gross capital formation showed significant negative association. Inflation had no impact. Some factors affected clove exports indirectly through production. Extension services were poor while the local price of cloves was low and not stable. We can conclude that clove exports were determined by many interlinked factors. We recommend an *integrated policy approach* that takes on board, comprehensively, all determining factors to improve and sustain clove exports.

Key words: cloves, exports, vector error correction model, Zanzibar

JEL classification: C22, Q01, Q11, Q17

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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 per cent of the foreign exchange of Zanzibar (Hervé et al. 2014; Bakar 2015; URT 2016; Temba n.d.; 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 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 with increased foreign exchange earnings, share of agriculture in gross domestic product (GDP), and employment in the clove industry. This translates into 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, 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 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, and a lack of participation of the private sector and poverty, external problems are mainly concerned with monopoly of the market.

1.1 Problem statement

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 of 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 number 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 an 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.

1.2 Limitations of the study

The limitations of the study on which this paper is based are that it was difficult to enter in the quantitative model cross-sectional variables raised during interviews with clove stakeholders. These variables include clove diseases, clove tree management, harvesting practices, extension services, laws of land ownership, and the monopoly nature of the market system, which can be addressed in future research. Putting it differently, including cross-sectional variables in the time series model was not feasible within the scope of this paper because of data limitations.

This paper consists of six sections. The next sections are organized as follows. Section 2 discusses previous studies as a literature review on the clove industry in Zanzibar. It also captures theoretical perspectives. Section 3 describes the empirical approach for this paper, and Section 4 presents the results, which are discussed in Section 5. The paper presents conclusions and policy recommendations in Section 6.

2 Literature review

2.1 Theoretical determinants of exports

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 1933) and New Trade Theory (Krugman 1979; Helpman and Krugman 1986). 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 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 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 that a low absorptive capacity of foreign markets in terms of accommodating imports from developing countries affects growth of agricultural exports. The second school of thought focuses on supply-side factors, which are basically internal. According to this school of thought, production of primary agricultural commodities determines exports, and increased production stimulates growth of exports (Boansi 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 on determinants of agricultural export

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 (2003) 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, 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.

Agasha (2009) used the vector error correction (VEC) model to analyse the determinants of the export growth rate in Uganda. That study used quarterly data from 1987 to 2006. The factors that showed positive and significant impact on export growth rate were GDP, real exchange rate, and terms of trade. 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 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.

Based on the foregoing theoretical and empirical literature, it is apparent that relevant factors that determine exports are many but differ by countries 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 an 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).

2.3 Clove industry in Zanzibar

The history of clove production and exports in Zanzibar dates back to the 18th century when the Arabs established large clove plantations through a slave labour system (Martin 1991). Since the 1960s, cloves have been the economic basis of Zanzibar, contributing 50 per cent to the GDP (Bakar 2015). The major importers of cloves from Zanzibar include the European Union

(EU), the United States of America (USA), Japan, India, Singapore, Hong Kong, and the United Arab Emirates (UAE).

After the 1964 Zanzibar revolution, clove plantations were nationalized, and a three-acre policy¹ on land ownership by indigenous farmers was introduced. By the 1970s, Zanzibar produced an average of 16,000 tonnes of cloves per year (Juma 2010). This production by volume is considered the highest in the history of clove production on the Island. Notably, after the 1970s, clove production started to decrease, and by the 2000s it ranged from an average of 1,500 to 3,500 tonnes per year (Temba n.d; Juma 2010; Hilal 2013). Clove exports are also showing a decreasing trend (Juma 2010; Moh'd et al. 2017).

In 1968, the Revolutionary Government of Zanzibar established a state corporation, namely the ZSTC, as a legal buyer and exporter of cloves and related products from the Island. The corporation is also supposed to provide extension services to clove growers. It is important to note that ZSTC came with abolition of clove growers' associations. To that effect, farmers do not play a role in setting the price of cloves. There is inadequate support of extension services and decreasing private investment in the clove industry due to fear of market control by the state (Temba n.d; Juma 2010). This questions the effectiveness of ZSTC in enhancing clove production and exports in Zanzibar, something which needs further investigation.

The contemporary effort of the Revolutionary Government of Zanzibar to improve the poorly performing clove industry is clearly seen through launching the Zanzibar Development Vision 2020 in 2000 (Moh'd et al. 2017). This vision focuses on improving the agricultural sector and eradicating absolute poverty to attain sustainable development. In addition, the government has been implementing reforms to improve the clove industry. There are two major reforms. First, the Clove Market Law, implemented from 1981 to 2010. During that period, ZSTC was the sole legal buyer and exporter of cloves on the Island. The second reform is the Clove Development Strategy, implemented from 2011 to 2020. During that particular period, ZSTC was given additional roles including establishment of modern buying centres, provision of interest-free loans to the clove farmers, provision of free clove seedlings, provision of training to the farmers, rehabilitation of road infrastructure in clove-producing areas, and increasing producer prices (ZSTC 2018). Despite all these measures implemented by the government to improve the clove industry in Zanzibar, clove exports are declining. This paper provides answers to the question 'why are clove exports showing a decreasing trend in Zanzibar?'

3 Methodology

3.1 Geography of clove production in Zanzibar

The study on which this paper is based was conducted on Zanzibar Island. According to the Zanzibar Revolutionary Government (2003), the mean annual rainfall in Unguja, which is located at 6°S, is 1,628 mm and in Pemba, which is located at 5°S, is 1,963 mm of rainfall per year. On average, Unguja experiences 26.7°C of temperature annually, while the annual temperature in Pemba is 26.1°C. In order to grow better, cloves require deep fertile soil and heavy and reliable rainfall between 1,500 and 2,000 mm per annum while the temperature should range between 27°C and 30°C (Chami 2020). Cloves grow well when humidity is between 70 and 80 per cent. In terms

¹ The impact of this policy on clove production and exports is not the aim of this paper, despite it not being well understood.

of climatic conditions, Zanzibar has favourable weather for clove farming. The western parts of Unguja and Pemba have deep fertile soils, while the eastern parts have poor soils that do not favour clove farming.

We selected Zanzibar for this study because it is a chief producer and exporter of cloves in the URT, hence potential for Zanzibar's economy. Most of the cloves are produced in Pemba compared to Unguja, which only produces cloves in the northern parts (Zanzibar Revolutionary Government 2003).

3.2 Data, research design, and analysis

We used a time series analysis quantitative approach by adopting cointegration and VEC models, as specified in Equation 1, to estimate clove export response from 1980 to 2020 in Zanzibar. From Equation 1, $Zexp_t$ is clove exports² from 1980 to 2020; X_t^k denotes a set of explanatory variables, both demand- and supply-sides; ε_t is an error term; and a_k is a model parameter.

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

The study used cointegration and VEC models to test short-run and long-run equilibrium relationships of the time series data. 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 include the world price of cloves, the producer price, and the real exchange rate. The supply-side factors are clove production, FDI, GDP growth rate, population, inflation, climatic factors such as temperature and rainfall, and gross capital formation. A detailed variable description is shown in Appendix Table A2. Quantitative data were mainly secondary, which 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. Detailed descriptions on each variable and the specific sources are shown in Appendix Table A1.

Because time series data exhibit trending behaviour or non-stationarity in the means and standard deviations, our empirical approach began by testing the order of integration using the Dickey and Fuller (1981) technique (Equation 2 shown in Appendix Table A4). This showed that the series were integrated at the same order, suggesting that they had a long-run equilibrium relationship or they were cointegrated.

Second, we tested long-run and stable relationships, guided by the maximum likelihood approach developed by Johansen (1988) using cointegration techniques (Equations 3, 4, 5, and 6 shown in Appendix Table A4). This test concluded presence of the long-run equilibrium relationship between the series.

Third, we determined short-run and long-run impacts of the independent variables on clove exports using the VEC model (Equations 7, 8, and 9 shown in Appendix Table A4), as used by Maddala (1992) cited in Ahmed (2000). This approach is superior to OLS modelling because it involves de-trending or differencing the series to attain stationarity before estimating the relationship between time series data and therefore avoiding spurious regression results [Robert et al. 2012; Granger (1986) cited in Gujarati (2004)]. This also has been used in previous studies by

² The units of measurement for clove exports and explanatory variables are shown in Appendix Table A2.

various scholars like Ahmed (2000), Bashir (2003), Pacheco-López (2005), Agasha (2009), and Allaro (2010, 2012).

Tariffs are a union matter in Tanzania; thus, there is no export tax on Tanzania exports including exports from Zanzibar. Therefore, the study did not include export tariffs for cloves as one of the determinants of the clove exports. In addition, Zanzibar does not import cloves from outside, so we did not include import tariffs in our independent variables. We did not consider destination economies' characteristics using panel data regression analysis because the study was designed to analyse time series data using a VEC model. Because the idea is feasible and interesting, we suggest that it can be considered in further studies.

The empirical approach was complemented by a qualitative approach in order to produce robust results for policy implication. Qualitative information was collected from key clove stakeholders in Mkoani, Chake Chake, and Wete districts in Pemba and Zanzibar North and Zanzibar West districts in Unguja. A total of 39 key clove stakeholders were selected using a snowballing sampling technique that enabled capturing clove stakeholders with knowledge and experience in the clove industry. Thirty clove farmers were selected, 20 from Pemba and 10 from Unguja; two officials from ZSTC; three officials from the Ministry of Agriculture, Natural Resource, Livestock and Fisheries; three officials from the Ministry of Trade and Industry; and one official from Zanzibar Investment Promotion Authority. Detailed information on the list of key stakeholders is shown in Appendix Table A3.

Analysis of the key clove stakeholders' perceptions of the clove industry

Content analysis was used to analyse stakeholders' perceptions on the important factors that explain the trends of clove exports in Zanzibar. According to Berg (2009: 338), content analysis 'is a detailed, systematic examination and interpretation of a particular body of material in an effort to identify patterns, themes, biases, and meanings'. This technique was useful in analysing verbal data collected through interviews with key stakeholders.

4 Results

4.1 Descriptive statistics of time series data

Before presenting 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 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 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	1,131,717	13,434	3,374,399
World price	30	1,144,882	1,281,899	13,529	3,770,970
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	14.89974	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	1,768.574	860	7,077
Production	10	3,804.7	2,467.634	211	8,572
Producer price	10	12,800,000	4,218,489	1,433,286	15,900,000
World price	10	16,700,000	4,106,043	10,900,000	23,900,000
Gross domestic product (GDP)	10	5.85	1.901607	1.3	7.7
Exchange rate (ER)	10	1,963.5	328.8229	1,557	2,298
Foreign direct investment (FDI)	10	2.7564	1.497598	0.76	4.69
Inflation	10	6.27	3.503665	2.7	14.7
Population	10	4.441	0.1909886	4.14	4.62
Rainfall	10	1,053.079	131.807	827.48	1,293.22
Temperature	10	22.773	0.3960371	22.08	23.22
Gross capital formation (GCF)	10	28.09914	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 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 implementation of the 10-year clove development strategy from 2011 to 2020. This shows a huge disparity in the amount 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 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 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 were integrated of the same order, we proceeded with cointegration tests. The results in Table 3 show that the series were 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 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

Variable	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
$r = 0$	327.9098	81.8926	233.13	62.81
$r = 1$	246.0172	76.5585	192.89	57.12
$r = 2$	169.4587	63.7114	156	51.42
$r = 3$	105.7473*	36.436*	124.24	45.28

Note: * denotes significance at the 5% significance level. 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

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						
Variable	Coef.	Std. err.	z	P>z	[95% C.I.]	
D_EXPORT						
_ce1						
L1.	-1.774518	0.5091784	-3.49	0.000	-2.772489	-0.7765466
_ce2						
L1.	0.1579154	0.4151245	0.38	0.704	-0.6557136	0.9715444
_ce3						
L1.	0.000422	0.0001666	2.53	0.011	0.0000953	0.0007486
export						
LD.	0.1617652	0.2890349	0.56	0.576	-0.4047328	0.7282633
PRODUCTION						
LD.	0.0956887	0.2276646	0.42	0.674	-0.5419032	0.3505258
LOCAL_PRICE						

LD.	0.0000878	0.0001815	0.48	0.628	-0.0002679	0.0004436
WORLD_PRICE						
LD.	0.0000258	0.0001465	0.18	0.86	-0.0002614	0.000313
GDP						
LD.	-172.5104	317.7261	-0.54	0.587	-795.2421	450.2213
ER						
LD.	15.93811	8.773577	1.82	0.069	-1.257786	33.134
FDI						
LD.	146.0963	503.2296	0.29	0.772	-840.2155	1,132.408
INFLATION						
LD.	-11.14182	141.2111	-0.08	0.937	-287.9106	265.6269
POPULATION						
LD.	-178.5845	1,456.945	-0.12	0.902	-3,034.145	2,676.976
GCF						
LD.	18.17864	166.5542	0.11	0.913	-308.2616	344.6188
RAINFALL						
LD.	4.51787868	4.564308	0.99	0.322	-4.428012	13.46375
TEMPERATURE						
LD	132.6167	1,788.053	0.07	0.941	-3,371.902	3,637.135
_cons	-1,008.89	1,568.678	-0.67	0.504	-4,122.443	2,026.664
Long-run effects						
Variables	Coef.	Std. err.	z	P>z	[95% C.I.]	
_ce1						
EXPORT	1	.	.	.	.	.
PRODUCTION	1.317139	0.0534763	24.63	0.000	-1.42195	-1.212327
LOCAL_PRICE	0.0004496	0.0000895	5.02	0.000	-0.0006252	-0.0002741
WORLD_PRICE	0.0002902	0.0000545	5.32	0.000	0.0001833	0.0003971
GDP	188.5299	63.19344	2.98	0.003	64.67304	312.3868
ER	2.091077	0.5666581	3.69	0.000	0.9804471	3.201706
FDI	-790.5653	113.7831	-6.95	0.000	-1,013.576	-567.5544

INFLATION	-36.5714	25.63772	-1.43	0.154	-13.67761	86.82042
POPULATION	-720.6474	174.8021	-4.12	0.000	-1,063.253	-378.0417
GCF	-146.5855	25.857	-5.67	0.000	-197.2643	-95.90669
RAINFALL	-3.878556	1.272401	-3.05	0.002	-6.372416	-1.384696
TEMPERATURE	607.087	381.5521	1.59	0.112	-140.7414	1,354.915
_cons	2,372.644	.	.	.	.	.

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 practice, 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 an 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 outbreak, particularly a sudden-death disease, caused clove tree mortality. The disease was increasing in both Unguja and Pemba and had persisted for many years. The only premonitory symptom is a slight chlorosis, followed by thinning of the foliage and 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 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 expansion of urban areas.

5 Discussion of factors for the declining trends in clove exports

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, quantity of production, producers, and world market prices. Unlike during implementation of the Clove Market Law that took 30 years from 1981 to 2010, the efforts of the Revolutionary Government of Zanzibar through ZSTC partly increased producer prices during 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 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 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 quantity 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 quantity 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 towards 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). About the world price, the results are in line with findings by Edward and Golub (2004) who used South African data. Regarding 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 in development through technology transfer and employment creation, the agricultural sector attracts low FDI inflows compared to 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 possibly 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 for clove production as 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 an 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. 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. 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 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 to 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 one offered by ZSTC. However, 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 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 yellowing and thinning of foliage, followed by 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 aging of the trees. This implies that clove diseases and a decrease of 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 the smallholder farmers. According to Chami (2020), some of the 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 pull 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 that 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 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 of 1964 came with 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 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, 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 Conclusions and policy recommendations

6.1 Conclusions

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 of the world market triggers falls of the producer price. There is also 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 the clove trees. The replanting programme is not new; it was implemented in the 1960s and showed positive impact in terms of restoring 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 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 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 of the world market price causes a fall of 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 price and so not negatively affecting their income and livelihood. Second, the government should consider promoting investments in processing cloves. This needs 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 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 vigorous analysis of time series data using a VEC model, complemented with qualitative information. A mixed-methods approach helps to get more and useful insights in addition to better explanation of the factors that determine clove exports.

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Appendix A

Table A1: Types and sources of time series data recorded in the 40-year period from 1980–2020

S/N	Type of data	Source
1	Annual export of cloves	OCGS and ZSTC
2	World price of cloves	OCGS and ZSTC
3	Annual quantity of cloves produced	OCGS and ZSTC
4	Exchange rate	WDI
5	Foreign direct investment	WDI
6	Annual GDP growth rate	WDI
7	Population	UN-WPP
8	Inflation	WDI
9	Clove producer price	OCGS and ZSTC
10	Gross capital formation	WDI
11	Rainfall	https://climateknowledgeportal.worldbank.org/country/tanzania-united-republic
12	Temperature	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.

Source: authors' own compilation.

Table A2: Definition and level of measurement of variables used in the ECM model

S/N	Variable	Definition	Unit of measurement
1	Export quantity of cloves	The quantity of cloves exported to the world market from Zanzibar	Tonnes
2	World price of cloves	Price of cloves at the world market	TZS
3	Exchange rate	Rate at which TZS is converted into USD	TZS
4	Foreign direct investment	Foreign direct investment, net inflows (per cent of GDP)	Per cent
5	Clove production	Amount of cloves harvested	Tonnes
6	Producer price	Price of cloves paid to the producers	TZS
7	GDP growth rate	Annual growth rate of GDP per cent at prices of market based on constant local currency	Per cent
8	Population	Population growth rate (annual per cent)	Per cent
9	Inflation	Inflation, consumer prices (annual per cent)	Per cent
10	Gross capital formation	Gross capital formation (per cent of GDP)	Per cent
11	Rainfall	Long-term mean in millimetres per year	mm per year
12	Temperature	Long-term mean	°C

Source: authors' own compilation.

Table A3: 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
Zanzibar State Trading Corporation	Providing input services, including implements, equipment, fertilizers and chemicals, post-harvest management, and handling materials. Promoting production, marketing, processing, storage, and trade of cloves and other agricultural products. Collection, analysis, marketing, processing, storage, and trade of cloves and other agricultural products. Promoting technological advancement in cloves and other agricultural product activities. Providing assistance in the formation and support of farmers and actors, farmers' group, and cooperative organizations.	2	Managing director Marketing officer
Ministry of Agriculture, Natural Resources, Livestock, and Fisheries	Extension services to clove growers and other clove stakeholders. Agricultural research on cloves.	3	Director of agriculture and extension services Extension officer Extension officer
Ministry of Trade, Industry, and Marketing	Ensure the State Corporation fulfills their tasks efficiently and effectively. Ensure farmers have better conditions and access to services such as extension, loans, subsidized inputs, and better prices. Responsibility for the growth of the clove industry and encouraging farmers to invest in this sector.	3	Director of trade and marketing External trade officer Marketing officer
Zanzibar Investment Promotion Authority	Improving productivity and aid trade diversification of exports that meet international standards. Attracting FDI in agriculture.	1	Director of investment facilitation and project development

Source: authors' own compilation and Chami (2020).

Table A4: Econometric equations

S/N	Equation	Description
Eq. 1	$Zexp_t = a_0 + \sum_{k=1}^{k=n} a_k X_t^k + \varepsilon_t$	$Zexp_t$ is clove export ³ 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 are model parameters.
Eq. 2	$\Delta y_t = \sigma + \beta_t + (\varphi - 1)y_{t-1} + \mu_t$	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.
Eq. 3	$y_t = \mu + A_1 y_{t-1} + \dots + A_p y_{t-p} + \varepsilon_t$	
Eq. 4	$\Delta y_t = \mu + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t$	Where $\Pi = \sum_{i=1}^p A_i - I; \text{ and } \Gamma_i = - \sum_{j=1}^p A_j$
Eq. 5	$J_{trace} = -T \sum_{i=r+1}^n \ln(1 - \lambda_i)$	T is the sample size, and λ_r is the i^{th} largest canonical correlation.
Eq. 6	$J_{max} = -T \ln(1 - \lambda_{r+1})$	T is the sample size, and λ_r is the i^{th} largest canonical correlation.
Eq. 7	$\begin{aligned} \ln CE_t = & \beta_0 + \beta_1 \ln WP_t + \beta_2 \ln CLP_t \\ & + \beta_3 \ln PP_t + \beta_4 \ln ER_t \\ & + \beta_5 \ln FDI_t + \beta_6 \ln GDP_t \\ & + \beta_7 \ln POP_t + \beta_8 \ln INF_t \\ & + \beta_9 \ln GCF_t \\ & + \beta_{10} \ln RF_t + \beta_{11} \ln TP_t \\ & + u_t \end{aligned}$	CE is clove exports, WP is clove world price, CLP is clove production, PP is producer price, ER is exchange rate, FDI is foreign direct investment, GDP is gross domestic product growth rate, POP is 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 natural logarithm.
Eq. 8	$\begin{aligned} \Delta \ln CE_t = & \beta_0 + \beta_1 \Delta \ln WP_t + \beta_2 \Delta \ln CLP_t \\ & + \beta_3 \Delta \ln PP_t + \beta_4 \Delta \ln ER_t \\ & + \beta_5 \Delta \ln FDI_t \\ & + \beta_6 \Delta \ln GDP_t \\ & + \beta_7 \Delta \ln POP_t \\ & + \beta_8 \Delta \ln INF_t \\ & + \beta_9 \Delta \ln GCF_t + \beta_{10} \Delta \ln RF_t \\ & + \beta_{11} \Delta \ln TP_t + u_t \end{aligned}$	

³ The unit of measurement for clove exports and explanatory variables are shown in Table A2.

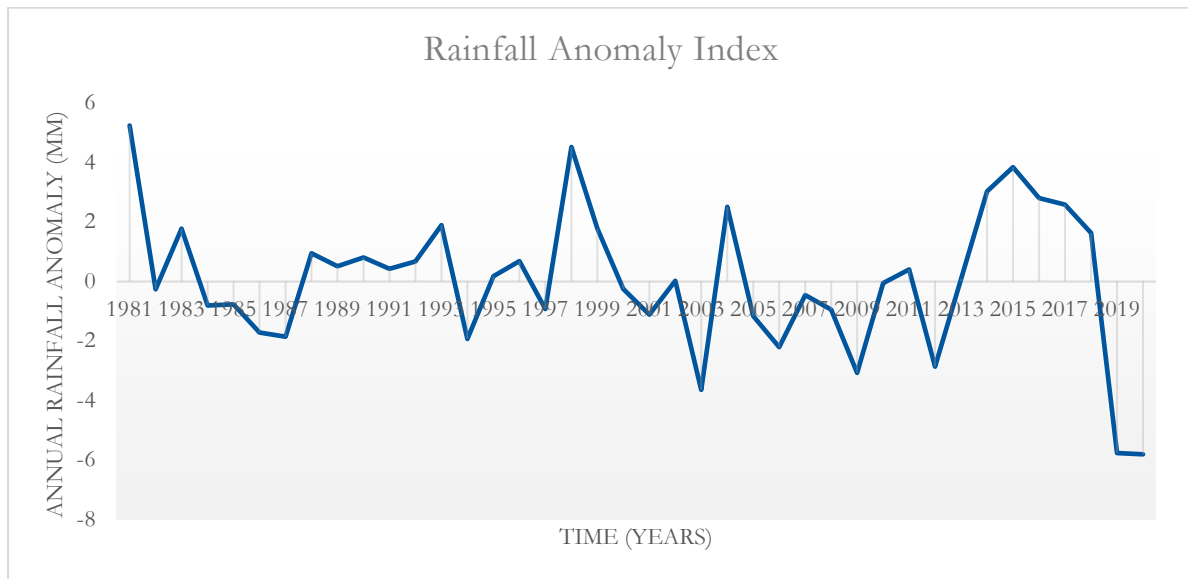
Eq. 9

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

EC_{t-1} is the error-correction term that is the lagged value of the residuals obtained from the cointegrating regression of the dependent variable on the regressors; λ_i is the speed of adjustment parameter (it is expected to be negative); β_i is coefficients measuring short-run relationship/effects among the variables; and u is the disturbance term.

Source: authors' own compilation.

Figure A1: Rainfall variability in Zanzibar between 1980 and 2020



Source: authors' own construction.

Appendix B

B1 Interview guide for clove farmers

A. Location, socioeconomic and demographic characteristics

1. District name.....
2. Shehia name.....
3. Island (Pemba/Unguja).....
4. Farmer's full name (Optional).....
5. Sex (Male/Female).....
6. AgeYears
7. What is your highest level of education?.....

B. Clove production and export

8. What best describes you as a clove farmer? (i) Certified farmer (ii) Non-certified farmer (iii) Other (specify)
9. Which one best describes you as a clove farmer? (i) Small-scale farmer (ii) Medium-scale farmer (iii) Large-scale farmer
10. How many clove trees do you own?
11. How many tonnes or kg of cloves did you harvest in the year 2019-20?
12. How many tonnes or kg of cloves did you harvest on average in the previous five years from the same farm size?
13. Export statistics show that production and exports of cloves from Zanzibar decreased over the years in the world market. In your views, what are the factors explaining this declining trend?
14. What should the revolutionary Government of Zanzibar and other stakeholders in the clove industry do to increase production and export shares of cloves in the world market?

B2 Interview guide for institutions

A. Respondents' information

1. Respondent's full name (Optional).....
2. Institution.....
3. Designation.....
4. Sex (Male/Female).....
5. Age.....years
6. What is your highest level of education?.....

B. Clove production and exports

7. What is your institution's role in the clove industry?
8. Export statistics show that production and exports of cloves from Zanzibar decreased over the years in the world market. In your views, what are the factors explaining this declining trend?
9. What should the revolutionary Government of Zanzibar and other stakeholders in the clove industry do to increase production and export shares of cloves in the world market?