African Maize Supply Response to the World Price

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ABSTRACT

This thesis empirically examines the supply response of maize in Africa to the changes in the world price of maize. Secondary data have been analysed for eight African countries of Burundi, Cameroon, Kenya, Mali, Morocco, Rwanda, South Africa, and Togo. We have specified and estimated a fixed effect regression model, which is among the panel data model structures.

The main findings of the thesis are as follow. First, the supply response of maize in Africa depends on two factors namely; maize producer price and maize acreage. Second, maize farmers have been found to be responsive to producer price changes in the short run which means that if prices increase, farmers respond by raising maize production and acreage. This ensures that there is food security in subsequent planting seasons. Third, whereas the maize supply has been found to be inelastic in the short run (elasticity being equal to 0.162), the supply has been found to be elastic (1.12) in the long run. We conclude from our empirical findings that the maize output will increase in the long run majorly as a result of increasing output per unit area, thereby making acreage boom leading to the maize output growth in Africa.

Keywords: Maize, Africa, Supply response, Food security, Price incentives.

ÖZ

Bu tez Afrika mısır arzının dünya mısır fiyatlarına olan tepkisini ampirik olarak incelemektedir. Sekiz Afrika ülkesi Burundi, Kamerun, Kenya, Mali, Fas, Ruanda, Güney Afrika, ve Togo için ikincil veriler analiz edilmiştir. Tezde, panel veri model yapılarından olan sabit etki regresyon modeli belirlenmiş ve tahmin edilmiştir.

Tezin ana bulguları aşağıdaki gibidir. İlk olarak, Afrika'da mısır arz tepkisi mısır üretici fiyatı ve mısır ekim alanlarından oluşan iki faktöre dayanmaktadır. İkinci olarak, mısır çiftçilerinin kısa dönemde üretici fiyat değişikliklerine duyarlı olduğu bulunmuştur ki bu da fiyatların yükselmesi durumunda çiftçilerin mısır üretimini ve ekim alanlarını artırması anlamına gelmektedir. Bu daha sonraki ekim mevsimlerinde gıda güvenliği olduğunu garanti eder. Üçüncü olarak, mısır arzının kısa dönemde inelastik olduğu bulunurken (elastiklik 0.162'ye eşittir), arzın uzun dönemde elastik olduğu (1.12) bulunmuştur. Ampirik bulgularımızdan karara varılmıştır ki, mısır üretimi büyük ölçüde birim alan başına çıktı artışından kaynaklanarak artacak, ve dolayısıyla dönüm patlaması Afrika'da mısır üretim büyümesine neden olacaktır.

Anahtar Kelimeler: Mısır, Afrika, Arz Tepkisi, Gıda Güvenliği, Fiyat Teşvikleri.

To God Almighty,

The Father of Creation.

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INTRODUCTION

1.1 Background to the Study

Maize is a cereal or grain crop that is cultivated extensively throughout the world in diverse agroecological environments. Maize production is very common in Africa because it is a regular staple food in the diet or meal of many households. More grain of maize is produced every year than any other cereal crop in Africa. It was brought into the African continent in the 1500s and has since become one of Africa's main and best food crops. It is, in fact the most essential grain crop in sub-Saharan Africa as it forms a very important component of animal feeds. Maize has also been recently discovered to be an essential raw material for biofuel production.

The backbone of Africa’s economy is Agriculture which accounts for about 20% of the continent’s Gross Domestic Product. About 70% of Africa’s populace that are poor live in the non-urban areas of Africa and majorly rely on agriculture for their livelihood and day to day activities (ECA, 2004). There is an immense contribution to the African economy by Agriculture in recent years. Agriculture has supplied so many benefits to the continent in a number of ways such as providing food for the ever increasing population; creation of employment opportunities for the growing populace; adequate supply of raw inputs for industries as well as the generation of foreign exchange earnings from international deals or transactions (Nchuchuwe and Adejuwon, 2012).

However, many sub-Saharan African countries, over the past two decades have resorted in reforming their economy through pricr levelling, control of wage as well as the deregulation of sectors which are stiffly controlled by the government. These measures of market liberalisation do not deviate from economic theory that assumes that optimum allocation of resources is highly dependent on the markets functioning properly, likewise the marketing mediums or channels too (Abdulai, 2000).

According to Alderman (1993), a straight or direct association exists between the amelioration of stabilization policies and the extent to which internal markets are consolidated. Ecological situations or conditions many at times influence variations in crop production systems in different regions. This makes the government to be keen in having knowledge of how price movements of crops are interrelated among dissimilar regions. Isolated markets can in fact carry price information that are not correct, consequently causing inefficiency in product movements in food marketing chain (Alderman and Shively, 1991).

Increased attentiveness on government pricing policies among African countries highlights the importance of detailed analysis of producer responses to price adjustments. This is particularly true in the case of Zambian maize production. Maize is the most essential crop grown in Zambia. Maize, which is a regular food crop in Zambia is heavily depended on for domestic consumption as it makes up a large percentage of their diet. 80% of the worth of maeketed food crops is accounted for by maize in Zambia (Foster and Mwanaumo, 1995).

The yearn for the liberalisation of agricultural markets by government in low-income is somehow constrained as a result of the concerns and fear for negative impacts on staple food price fluctuations. In the short run, high transactions costs for indigent consumers can result from such price fluctuation and worst still, low growth could happen in the long run.

The effects of liberalization on the agricultural sectors of developing countries have been disastrous over the years. Uncompetitiveness and crashing farm gate prices have made small scale farmers to exit agricultural production. The collapsing trend of rural livelihoods as a result of liberalisation of the agricultural sector have resulted into unemployment in the urban centres because a lot of farm workers have migrated to the urban centres where most jobs are strictly meant for highly skilled professionals. However, the government have also developed a measure to check falling farm gate prices by subsidizing agricultural inputs in the likes of seeds, fertilizers, pesticides, etc thereby decreasing the production cost of farm products. The profitability of farmers is increased and this has led into the reduction of the rate at which farmers migrate to urban centres.

However, past government efforts directed towards stabilizing prices of food crops have been very expensive. By using a dynamic programming optimization model, it could be observed that different types of policy regime could actually decrease the variability in price when compared to what would happen in the liberalised market condition which could be achieved at relatively low cost. Some official price flexibility as depicted by this policy era could be allowed when production and world price adjustment are taken into consideration. This has the advantage of holding lower stocks when compared with the past policy regimes (Pinckney, 1993).

This proposition supports that poverty is not just dependent on agricultural productivity growth as well as international trade openness. Consensus that was reached by the World Trade Organization on Agriculture also focused her attention at setting standards and rules that conform to trade policies that would give the desired stimulus to agricultural growth thereby resulting into higher efficiency in different nation states of the world.

The rules which were formed purposely to provide a fair and equal opportunity for countries to succeed were unfortunately tilted towards protecting the interest of agriculture in developing nations. The rich and the powerful nations of the world keep on strengthening their agricultural sectors under the pretence of helping to eradicate poverty of small scale farmers in developing countries (Sharma, 2005).

1.2 Objectives of the Study

This research primarily focuses on the supply response of maize in Africa to the world price between 1991 and 2012. Specific objectives are:

1. To examine the trend in maize production in Africa.
2. To assess the supply response of maize to change in world price.
3. To estimate the relationship between output and price of maize produced in Africa within the time frame.

Chapter 2

LITERATURE REVIEW

Wodon and Zaman, (2010) while concentrating on Africa, reviewed the proofs or evidences of the possible effect which soaring prices of food can have on poverty. He also examined the extent to which policy responses have the capability of protecting the poor. The upsurge in prices of food stuff throughout the globe in 2008 resulted in the increment of food stuff prices in developing nations. This depics that escalated food prices will eventually lead to a higher rate of poverty in Africa because the negative effect on net consumers exceeds producer benefits thereby resulting in low food security.

It was made clear by a recent survey that in African nations, decreasing the food taxes was the most popular policy response while the most popular policy response measure outside Africa were subsidies. A higher degree of food-based safety net programs were also set up by some sub Saharan countries which help them to respond to escalating food prices. This brings the suggestion that the gains from import tariffs that were reduced on staple crops are possible able to benefit the rich. It can be concluded that there is potency in safety net programs but targeting other investments geographically ensures that future crises affects only fewer people.

International prices of cereal (in US dollar terms) have been rising since 2003, but it is known that domestic prices influence food production and consumption. Dawe

(2008) in his paper analyzes, for seven large countries in Asia, the extent to which domestic prices have risen since 2003 and present some deductions. The data show that the escalations in world cereal prices go together with a real depreciation of the US dollar. This means that increase in real domestic rice prices, through the end of 2007, resulted in a rise in real US dollar in world market prices of rice by one-third. Producer or farm gate prices for the specific cases analyzed in Asian countries have changed by approximately the same percentage as consumer prices. Thus, domestic markets appear to be imparting price changes between farmers and consumers rather efficiently.

Much of the public review of the food price crisis has focused more on the sharply increased use of food commodities for bio fuel production that has created much debate between food and fuel terms. Raw food commodities are now processed into biofuel thereby driving food prices to increased levels. Consumers now buy food stuffs at nearly international price level. However, it is highly imperative for consumer effects to be measured correctly so as to properly apportion the causes of current high prices in a bid to search for appropriate policy response (Dawe, 2008).

When the baseline projections of international prices for the major food commodities for 2008–2017 was synthesized, it was noticed that that a high level of price volatility is characteristic of world food commodity markets even when annual averages are observed. Prices are typically quick to respond to short-run shocks to either supply or demand probably because of delays between production decisions and output and the resulting gradual adjustment of quantities to price changes. High prices today will not last because prices will come down slowly as some of the factors driving them (transitory factors) will disappear. The response of demand and supply also contributes to the disappearance. Price signals, in particular are also expected to bring about productivity growth in order to regain its pace with demand growth. The main factors that resulted into a hike in food commodity prices are; high petroleum prices, overuse of grains as well as oilseeds which are used for the production of bio fuels, among many other factor (Dewbre et al., 2008).

Prices of agricultural products are subject to observable fluctuations or variations on international and local market platforms. Many reasons are responsible for the fluctuations. Merchandising contracts that are also known as forward contracts have been developed in order to hedge against this price risks. There is a quick response of agricultural commodity prices to expected changes in demand and supply conditions as large price and income fluctuations has been a common feature of the agricultural sector. This is because demand and supply of farm products, especially basic grains, are comparatively price-inelastic and thus commodity prices generally are known to have a high volatility.

However Volatility increases the risk of paying higher prices for a particular commodity. Given the significance of South Africa as a regional supplier of maize and price discovery mechanism, the South African Futures Exchange (SAFEX) is never unsusceptible to this volatility as inquiry into the volatility of maize price are not only imperative, but also necessary if all parties involved are to manage this risk (Geyser and Cutts, 2007).

Food crop commodities whose examples are wheat, maize and rice are very important in Macedonia as it is not a coincidence that a huge portion of poor household income is spent on these food stuffs and their derived products making more than a fourth of the Macedonian population to live below the poverty line. Food crop commodity prices have been on the rise since 2006. The increase has been prevalent, but wheat, rice and maize have seen price increases that are far greater than other commodities. Food crop production has been dwindling since the1990s as a result of the disused planning system that has made price increases not to be sufficient enough to increase production (Petreski, 2014).

Commodity price developments in developing nations might have huge effects on the real incomes of poor families' resident there but, little information is obtainable on actual impacts on the poor, despite some concerns expressed in the literature (FAO, 2011; World Bank, 2008). The net impact of commodity price increases on the welfare of the poor depends on whether the gains to poor producers exceed the adverse effects on poor consumers, on the order and response of household income, and also on the response of policy used. It has however been widely claimed that these impacts are quite diverse and country-specific (Hertel and Winters, 2006).

However, Petreski (2014) in her study to analyse the welfare implications of increasing prices of wheat, maize and rice and those of agricultural subsidies on household welfare in the past Yugoslav Republic of Macedonia used the 2011 Household Budget Survey data and non-parametric methods to estimate these impacts on household welfare along the segments of the income distribution. Results of the analyses suggest that increasing prices of wheat, maize and rice exerted positive welfare impacts on male-headed rural households only, but the impacts on female-headed rural households and all urban households were generally negative, mainly because of the different production patterns. Also, the welfare effect of the government subsidy programme for maize as well as wheat production was positive for all rural households.

Chabane (2002) in his paper provided a clue to the supply chain of maizewhile assessing the evolvement of how maize is produced and distributed right from the producers (farmers) and maize processors (millers) since the time of liberalisation in South Africa. Maize production, storage and milling were concentrated upon while the flow of trade and local demand and supply relationship were examined also. The determinants of prices were examined on this basis. Concerns about competition were also evaluated before brief recommendations were made.

In 1996, the maize marketing board was abolished, which led to the liberalisation of the maize market in South Africa. As a result of this, production decisions and prices now respond to market forces. This has birthed the restructuring of key players at several levels of the maize supply chain at the same time and relatively high levels of concentration. We may consider the abolition of the Maize Board as the main reason why both local and international conditions are causing fluctuations in the maize price.

Another important change that has taken place since liberalisation is that the main agents with each level of the maize supply chain has been restructured. This has had an impact on the concentration levels of the market. In recent times many factors have influenced the maize price negatively. To name a few, Rand has sharply depreciated against the dollar and other currencies; drought has hit most of the Southern Africa, most notably in Zambia, Zimbabwe and Malawi while the small yield of crops in Zimbabwe is as a result of the political instability there. However, evidence seems to negate the claim that the large increase in price has been due to the local and international supply and demand conditions when we look at the trends in the maize price in the past few years. This denotes that it not possible to neglect the high levels of concentration appearing in all levels of maize production (Chabane, 2002).

A sustained increase in staple food production is majorly constrained by price uncertainty. Farmers in many of the industrialised nations as well as Latin American and Asians nations have their dependence on a range of market-based instruments of price movement under public support programs. This has resulted in an increased grain production in these nations over the years. In contradiction to this development in industrialised nations, a weak market based services of production and increased dependence on food crops have been the order of the day in many African nations.

Efforts of market stabilisation have not been effectively managed in sub-Saharan Africa and food insecurity has remained a major problem at both household and national levels. Farmers in developed countries (with few exceptions) have access to a range of public support programmes and trade protection schemes as well as instruments that manage price risks. Grain productivity and production has improved consistently and real prices of grains have decreased in the long run as a result of this. These nations have built a viable commercial farming sector and achieved a prolonged production increase.

Better incentive which increases grain production is given by state-led stabilisation efforts that use private sector operations which examines missing markets. This serves as an instrument to augment market-based risk. However, a more organized market stabilization strategy is needed in the long run because many long-term structural factors like climate change, biofuel production, escalated prices of oil, degraded soil conditions, water scarcity among other structural factors. Also, financial markets speculation also shows more volatility in grain prices (Demeke et al., 2012).

Chapter 3

DATA AND METHODOLOGY

3.1 Study Area

The study area of this thesis is Africa. After Asia, Africa remains the second largest, widest and most populous continent in the world. The African continent has 54 sovereign states which include Madagascar and other Islands. Africa is a massive continent, which makes up to about 14.72% of the whole universe population of humans and 61 territories that contains almost 1 billion people (Sayre and Pulley, 1999). In order to account for the African maize market, this study is carried out in 8 African countries namely; Burundi, Cameroon, Kenya, Mali, Morocco, Rwanda, South Africa, and Togo. These countries have been selected on the basis of data availability.

3.2 Source of Data

Secondary data have been collected and analysed for this study. Data have been obtained from the FAOSTAT database of the Food and Agricultural Organization of the United Nations. The empirical data span the period of 1991-2012.

3.3 Descriptive Statistics

South Africa is internationally renowned for massive maize production. In South Africa, maize is the most important cereal crop which is grown under different environmental conditions. According to Figure 1 below, it is evident that South Africa has the largest share of maize output in Africa. There are several factors responsible for this occurrence as successful production of maize is highly dependent on the correct usage of inputs that sustains massive agricultural production as well as the environment.

Such inputs should consist of improved varieties of maize seeds, increased maize plant population, effective and efficient maize soil tillage practices. It is also crucial that both organic and inorganic fertilizers be correctly formulated and applied to cultivated maize plants to ensure high crop performance. Adequate and efficient insect, weed, and disease control also ensures high crop performance.

Modern harvesting techniques as well as marketing and financial resources should also be made readily available for farmers through cooperative societies, government agricultural input subsidy programs, etc. The massive hectares of land apportioned to maize production are also a contributing factor responsible for the exceptionally high maize output in South Africa. This can also be observed in Table 1 below. Figure 1 displays the mean level of maize production (tons) in each African state as compared with other African states within the time frame of 1991- 2012.

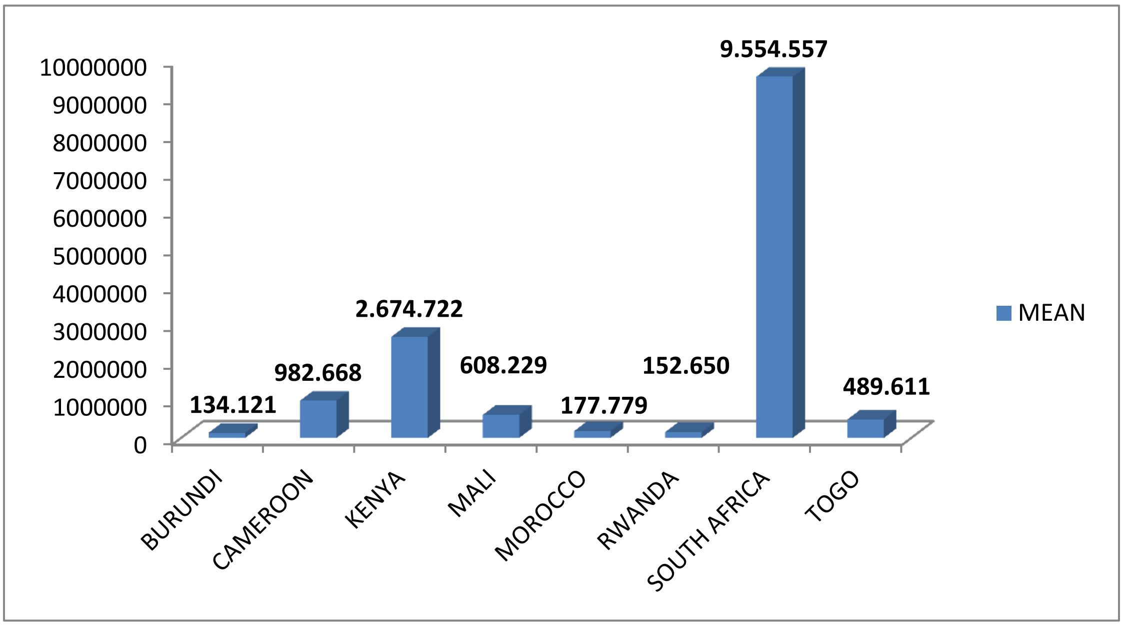

Figure 1: Average Maize Output in Africa (Tons)

Table 1: Average Output of Maize Plants in Africa (Tons)

COUNTRY	MEAN	SD	MINIMUM	MAXIMUM
BURUNDI	134,121.1	18,825.19	115507	176300
CAMEROON	982,667.7	408,870	495,000	1,749,976
KENYA	2,674,722	447,048	2,089,000	3,600,000
MALI	608,228.5	451,528.4	192,530	1,713,729
MOROCCO	177,779	93,133.95	50,120	374,460
RWANDA	152,650.2	155,024.8	54,912	573,038
S. AFRICA	9,554,557	2,583,052	3,277,000	1.33e+07
TOGO	489,611.4	141,747.9	231,400	825,710

According to Figure 2 below, South Africa is also observed to allocate the largest hectares of land to maize production among the selected African states. The economic and human need for maize production has most likely made South African farmers to allocate such a large expanse of land for maize production.

White maize is essentially consumed as food by people in South Africa while the economic benefits derived from maize cultivation domestically cannot be underscored. Also, favorable soil and climatic conditions in South Africa is well suited for maize production. This is an imperative reason why a large expanse of land is allocated for maize cultivation in South Africa on annual basis. Figure 2 shows the mean number of hectares (ha) allotted for maize production in each African states as compared with other African states within the time frame of 1991- 2012.

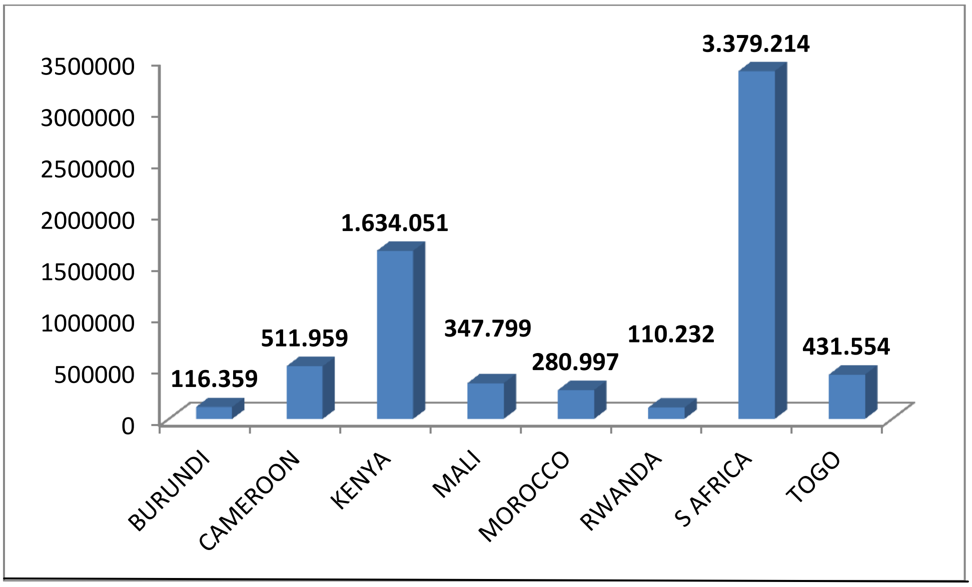

Figure 2: Average Maize Acreage in Africa (Ha)

Table 2 contains further descriptive statistics of the maize acreage in the selected African states.

Table 2: Average Acreage of Maize Plants in Africa between 1991 and 2012 (Ha)

COUNTRY	MEAN	SD	MINIMUM	MAXIMUM
BURUNDI	116359	6386.84	100000	128000
CAMEROON	511959.4	203901.1	250000	1020303
KENYA	1634051	246883.6	1310000	2159322
MALI	347799.4	173960.8	161053	924850
MOROCCO	280997.3	82799.77	117960	453600
RWANDA	110231.9	54836.9	40000	253698
S AFRICA	3379214	687161.7	2032446	4661000
TOGO	431553.5	93644.18	255400	693035

Figure 3 below shows that Burundi has the highest maize price among the African states analysed in the thesis. Increasing fuel prices between 1991 and 2012 in Burundi are a major driving force behind the rising food prices. Both input prices and transport costs have been affected through this. Soaring petroleum prices have had its contribution to the increase in prices of many agricultural crops. This happens by raising input costs on one hand and the other, by increasing demand for agricultural crops that are used as feedstock and biofuel production since grains are now important raw materials in biofuel production.

High fuel costs have also led to doubling of freight rates, contributing to further increases in food import bills. In Burundi, the few households in the project zone who were both producers and sellers have now substantially reduced their sales. They tend to gear their production towards home consumption thereby shifting away from market-oriented production, and producing food crops for home use under lower-input and lower output production system. Figure 3 displays the mean price level of maize (USD/ton) in each African states as compared with maize prices in other African states within the time frame of 1991- 2012.

Figure 3: Average Producer Price of Maize in Africa (USD/TON)

Table 3: Average Price of Maize in Africa (USD/Ton)

COUNTRY	MEAN	SD	MINIMUM	MAXIMUM
BURUNDI	286.63	73.77	181.5	425.70
CAMEROON	263.42	98.28	111	472.40
KENYA	204.99	77.14	74.40	401.80
MALI	168.04	63.87	99.1	360.60
MOROCCO	249.95	53.07	185.8	398.70
RWANDA	255.55	86.29	123.90	409.80
S AFRICA	141.78	41.24	78.50	240.50
TOGO	216.28	83.80	111.70	406.40

3.4 Analytical Procedure

We have specified and estimated a fixed effect regression model, which is among the panel data model structures. The maize output function estimated in the thesis is shown in equation (1) below. It is important to determine how responsive maize output is to price, and acreage changes as this would determine the appropriate policy to use to ensure high production continuity, hence providing food security in Africa. The maize output function expresses the total supply response to changes in price as they influence the acreage planted. The output supply function is specified as follows;

$$\ln Q_i = \beta_0 + \beta_1 \ln Pm_i + \beta_2 \ln H_i + u_i \qquad (1)$$

Where,

$\ln Q_i$ = Natural logarithm of the quantity of maize produced during the period in metric tons.

$\ln Pm_i$ = Natural logarithm of the real maize producer price per metric ton.

$\ln H_i$ = Natural logarithm of the maize acreage (Kg/Ha)

u_i = Error term.

Chapter 4

EMPIRICAL ANALYSES AND RESULTS

4.1 Preliminary Analyses

Prior to estimating the model, there are some preliminary tests, which must be conducted. Here we explain these tests.

4.1.1 Unit Root Test

It is very important that the variables used in the study are stationary. This is a requirement in order to avoid having a spurious regression analysis. The Augmented Dickey Fuller (ADF) panel unit root test results are displayed in Table 4[1]. We have obtained the results with the specifications of level and individual intercept and trend. According to the test results, where probabilities are less than the 1% and 5% significance levels, we reject the null hypothesis (H_0) that there is a unit root. This implies that the series have no unit root, i.e. they are stationary at level, or I(0).

Table 4: Augmented Dickey Fuller Panel Unit Root Test for lnoutput, lnprice and lnarea.

Variable	***Statistic***	***Probability *****
lnoutput (Level)	46.0107	0.0001
lnprice of maize (Level)	27.6284	0.0350
lnarea (Level)	40.2168	0.0007

[1] Further details of the test results are presented in Appendix B of the thesis.

4.1.2 The Pooled Regression Analysis

The pooled regression analysis, just like the fixed effect (FE) and random effect (RE) panel data estimation techniques, is applicable to panel data having observations for different cross sections and over time. In this analysis the country specific observations for the variables used in the model are ordered one after another, and the pooled variables are used in the standard ordinary least squares (OLS) estimation technique.

In order to test the poolability of our data, we follow Kunst (2009) and conduct the simplest poolability test procedure where the null hypothesis is the OLS estimation of the pooled model, and the alternative hypothesis is the fixed effect model. That is to say, we test whether the individual effects are zero (suggesting the pooled regression – restricted model) or different than zero (suggesting the fixed effect – unrestricted – model). See Appendix C for the estimation results of the null and alternative models.

The *F*-statistic of the test is calculated as follows.

$$F = \frac{(RSS_R - RSS_U)/(N-1)}{RSS_U/((T-1)N-K)}$$

where, RSS_R is the residual sum of squares of the restricted (pooled) model, RSS_U is that of the unrestricted (FE) model, N and T are cross-section and time-series dimension of the data set, and K is the number of explanatory variables excluding the constant. The *F*-statistic is distributed as F with $(N - 1, (T - 1) N - K)$ degrees of freedom, which is (8 – 1, 21*8 – 2).

Given our restricted and unrestricted model estimations, we calculate the *F*-statistic as 24.82, which is greater than the critical value of 2.3948. We therefore find out the presence of individual effects, i.e. the FE. This makes it necessary to further test which panel data model is to be fit to our data set.

4.1.3 The Hausman Test

In order to test for the most appropriate panel model to adopt, i.e. random effect or fixed effect; the Hausman Test was carried out on the data set. The null hypothesis (H_0) states that random effect is the most appropriate panel data method to use while the alternative hypothesis (H_1) states that the fixed effect is the most appropriate data method to use. Results according to Table 5 below show a probability value of 0.0783 that makes us reject the null hypothesis (H_0 – random effect) at 10% significance level. Although, rejection is common at 5% level of significance, we can also reject at 10% level of significance because our sample is small. Therefore, the fixed effect is the most appropriate panel data method of estimation to use for our data set.

Table 5**:** The Hausman Test

Test Summary	**Chi-Sq. Statistic**	**Chi-Sq. d.f.**	**Prob.**
Cross-section random	5.094623	2	0.0783

4.2 Empirical Results

Table 9 displays our empirical findings. The R^2 shows that 95% of the variations in the maize output are accounted for by that in the explanatory variables, namely maize acreage and maize price. The regression results demonstrate a good fit as justified by the high value of (adjusted) R^2. The p-value also shows that the model is overall jointly statistically significant.

Table 6: Regression Analysis Results of Maize Output

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.218727	1.103423	0.198226	0.8431
LNPRICE_MZ	0.161543	0.088749	1.820218	0.0705
LNAREA	0.939527	0.093035	10.09863	0.0000
		Effects Specification		
Cross-section fixed (dummy variables)				
R-squared	0.952182	Mean dependent var	13.25516	
Adjusted R-squared	0.949589	S.D. dependent var	1.524625	
S.E. of regression	0.342314	Akaike info criterion	0.748964	
Sum squared resid	19.45169	Schwarz criterion	0.929105	
Log likelihood	-55.90880	Hannan-Quinn criter.	0.822028	
F-statistic	367.2756	Durbin-Watson stat	1.469321	
Prob(F-statistic)	0.000000			

Alternatively, we can display our estimation results as follows, where the numbers in parenthesis are the t-statistics of the coefficients.

$$\ln Q_i = 0.219 + 0.162 \ln Pm_i + 0.940 \ln H_i + u_i \qquad (2)$$

(0.20) (1.820)*** (10.10)*

Where, *, **, *** represent the significance level of 1%, 5% and 10%, respectively.

According to our estimation results, the maize price and acreage are found to be statistically significant at 10 percent and 5 percent levels of significance respectively.

The producer price or farm gate price at which maize grains are sold in the previous harvest season directly affects the output of maize in the next harvest season. The combination of this fact and our empirical findings suggest that 1 percentage increment in maize grain price will lead to increased output by 0.162 percent. This is in line with our priori expectation that there is a positive relationship between the maize price and the output level. Maize farmers might have taken advantage of the high price incentive probably through planting more improved maize varieties, hiring more experienced or skilled labour and the procurement of more hectares of land and other agricultural inputs that enhance increased maize production.

It can also be noted from our estimations results that there is a positive and statistically significant relationship between the acreage planted and the maize output. According to our empirical findings, 1 percent increase in maize acreage (ha) results in a substantial increase in maize output by 0.940 percent, almost 1 percent. Through this credible increment, farmers are expected to expand their production capacity by cultivating more hectares of land. The high price incentive must have given farmers the financial viability to purchase more farm inputs that would cater for the newly expanded portion of land.

4.3.1 Price Elasticities of Maize Output

Our estimation methodology allows us to estimate short run and long run price elasticities of maize output. Table 4.3.2 below presents this price elasticity of maize output in Africa.

Since the model is in logarithm form, the coefficients β_1 and β_2 automatically become the short run elasticity of maize output to maize price and acreage, respectively. Following Otim and Ngategize (1993), the long run price elasticity of maize output is calculated in the following manner. First, let us recall our model and the estimation results:

$$\ln Q_i = 0.219 + 0.162 \ln Pm_i + 0.940 \ln H_i + u_i \qquad (2)$$

(0.20) (1.820)*** (10.10)*

According to our empirical findings, the short run price elasticity of maize output is 0.162. In order to calculate the long run price elasticity of maize output, we use the formula suggested by Otim and Ngategize (1993) that;

Long run price elasticity of maize output = β_2/λ, where $\lambda = (1- \beta_1)$.

Given our findings that $\beta_2 = 0.940$, $\beta_1 = 0.162$, we calculate λ to be equal to 1-0.162= 0.838. Therefore, we estimate the long run price elasticity of maize output in Africa to be equal to;

$$\beta_2/\lambda = 0.940/0.838 = 1.12.$$

Our findings suggest a slow supply response of maize (0.162 percent) to the price changes in the short run. The inelastic maize supply could be as a result of the length and complexity of maize production process. It should also be noted that agricultural produce are generally inelastic in the short run. Maize farmers cannot immediately (i.e. in the short run) respond to price changes because of the time it would take to prepare the land for planting. However, in the long run, it is expected and also supported by our empirical findings that the maize supply is elastic (1.12) due to the flexibility of all factors of production. Maize acreage is therefore expected to increase as farmers would respond to the high price incentive by procuring more hectares of land and providing necessary inputs needed for a successful production season.

Chapter 5

CONCLUSION

This research examines the supply response of maize in Africa in the year 1991-2012. Secondary data from the Food and Agriculture Organization's database was used for this study. Supply response of maize to its output was dependent on two factors namely; maize producer price and maize acreage. The regression result of the dependent and independent variables conforms to our apriori expectations.

Several conclusions derive from this research work reveals that Maize farmers are responsive to producer prices, which mean that if prices increase, farmers respond by raising maize production and acreage thereby increasing maize grain export and also ensuring that there is food security in the home country. The Price elasticity results indicates that output will increase in the long run majorly as a result of increasing output per unit area making acreage boom to lead to output growth. Since farmers respond positively to price incentives by increasing their production capacity, any measures deemed fit to ensure that African farmers get continuous price incentives would bring about the much anticipated economic growth which translate to development.

Strategies towards getting African agriculture to the highest horizon are imperative since 80% of the African population depend on farming. African leaders should maintain the momentum of increased budget allocation into agriculture and look for other options of increasing domestic financing for investments in the agricultural sector.

The productivity constraints faced by small holder maize farmers can be addressed through the deployment of agricultural technologies. This can be achieved by the collaboration of both governmental and non-governmental organizations in Africa. Over the years, it has been proved that the medium through which agricultural growth and development can happen is research and technology. If research institutions in Nigeria are left unimproved, they will continue to drain government resources and funds. Agricultural extension services are highly needed to bring about the much anticipated agronomic improvements needed in maize production like improved maize seeds. In essence, the new restructuring should incorporate the activities of extension agents.

Policies and programmes designed to address problems confronting agricultural development in Africa should touch human growth and development, infrastructure availability, issues in ecology and water resource management. Agro-allied industries are developed through these programs, especially in the storage and processing of maize grains. The provision of incentives for procurement of agricultural inputs as well as the development of effective mechanisms that facilitate movement and improvement of maize grains would bring about the desired results in agricultural production.

Agricultural funding should also be established in order to facilitate medium scale maize production for exporting. On the average, credit facilities are not made available to small scale or medium scale farmers because banks and other financial institutions doubt the ability of the farmers to pay back the money lent with corresponding interest. This is because of the duration of the loans as well as the risks involved. Hence, the government should call for the reappraisal of incentives which enables banks to grant credits to farmers. The incentive to the banks must go beyond agricultural insurance. However, policies on interest rate, taxation, security funds and liquidity should be included as part of such design. Advisory services, tax exemption, price incentives among others should be enjoyed by maize farmers in order to increase maize output thereby increasing food security in Africa.

The government should help maize farmers to have a probable estimation of food crop prices that are to be expected from their production activities. This could be achieved through adequate provision of storage facilities which ensure that maize supply is guaranteed beyond the harvesting period. This is very important because maize cobs are brought into the market in large quantity during harvesting period, thereby driving down prices. Access to adequate storage facilities of excess maize grains in the course of harvesting will make sure that prices are stable and that will also proper future maize production plans.

Also, liberalisation of the agricultural sector in developed nations should not be done in the short run as it might result in unemployment in developing countries. Since the competitiveness of farmers in those developing countries is relatively low, they will be affected negatively from liberalisation of the food markets because of cheap imports. So, liberalisation should be done in the long run as the competitiveness gradually increases.

Finally, future research that examines the supply response of key African food crops would go a long way in making sure that there is food security in Africa. Food crops like yam, cassava, wheat, potato, rice, sorghum, vegetables, among other prominent African crops constitute the daily diet of Africans. Ensuring the sufficient availability of these food crops in and out of season and making sure that they are supplied at prices good for farmers (producers) and consumers, would help check poverty and many other problems faced in Africa today.

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APPENDICES

Appendix A: Time Series Plots of the Data Used in the Analyses.

Figure A1: Trend Statistics of Maize Output (Tons) in Burundi

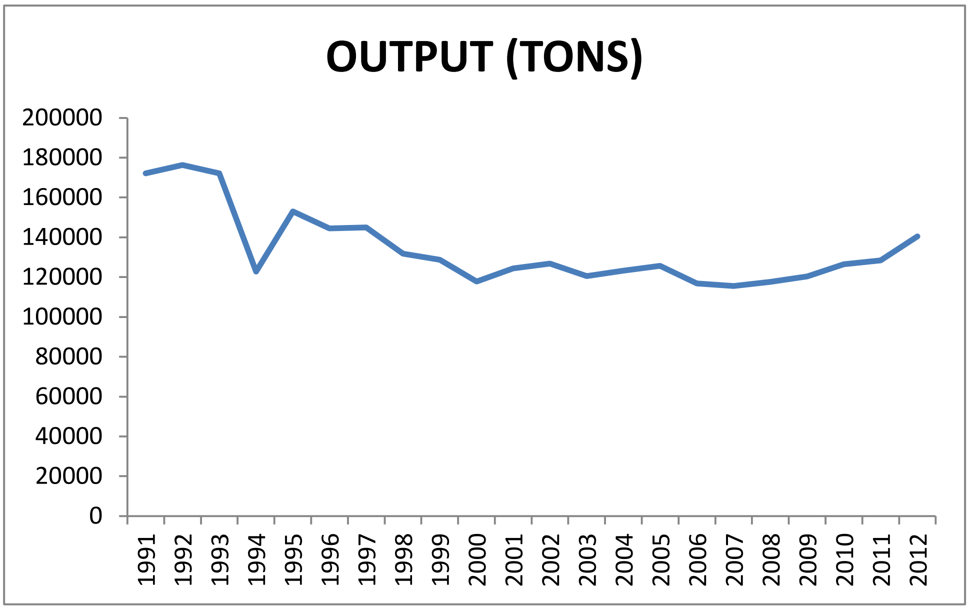


Figure A2: Trend Statistics of Maize Acreage (Ha) in Burundi

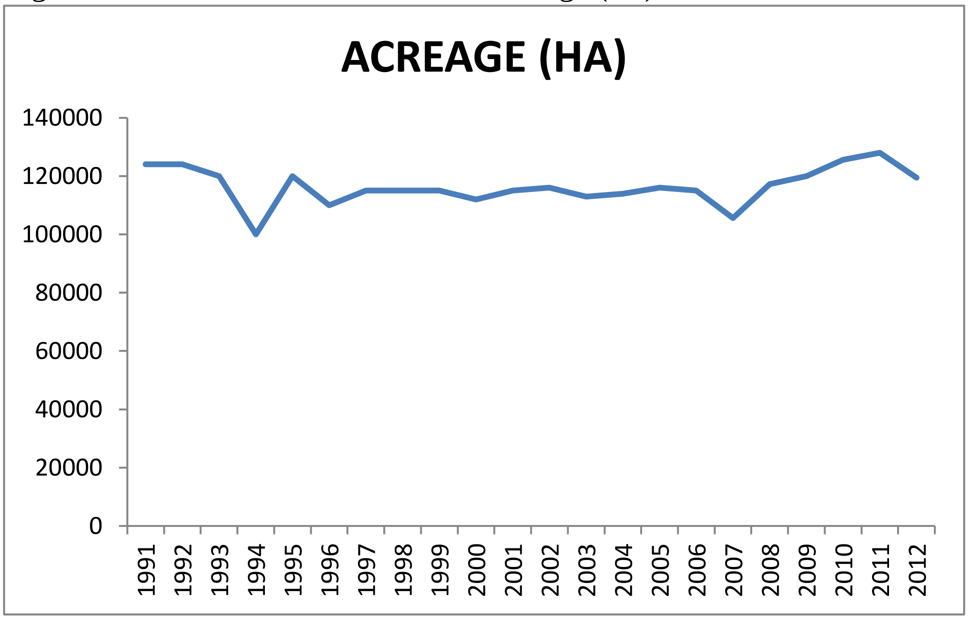


Figure A3: Trend Statistics of Maize Price (USD/Ton) in Burundi

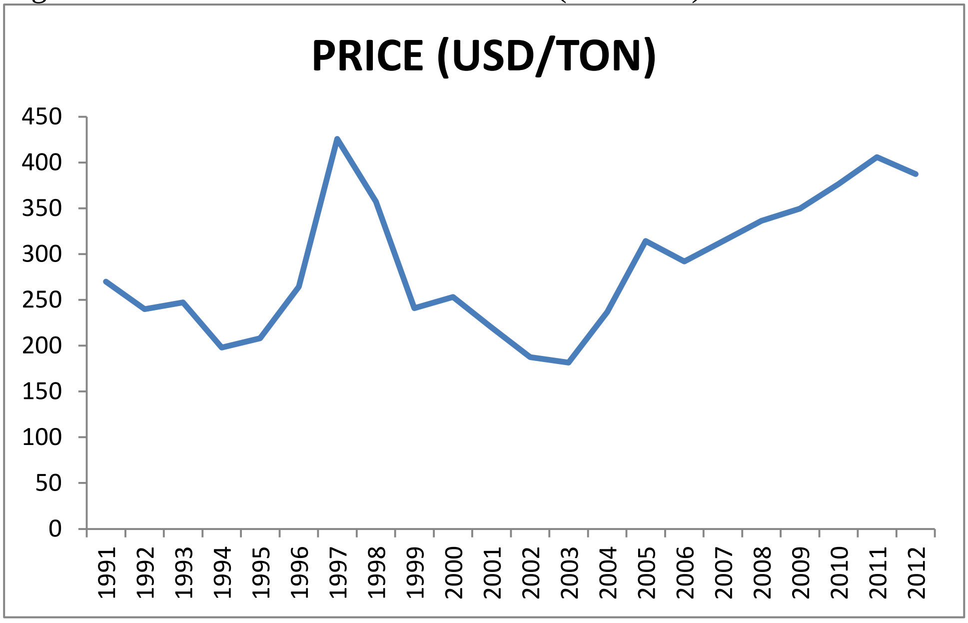


Figure A4: Trend Statistics of Maize Output (Tons) in Cameroon.

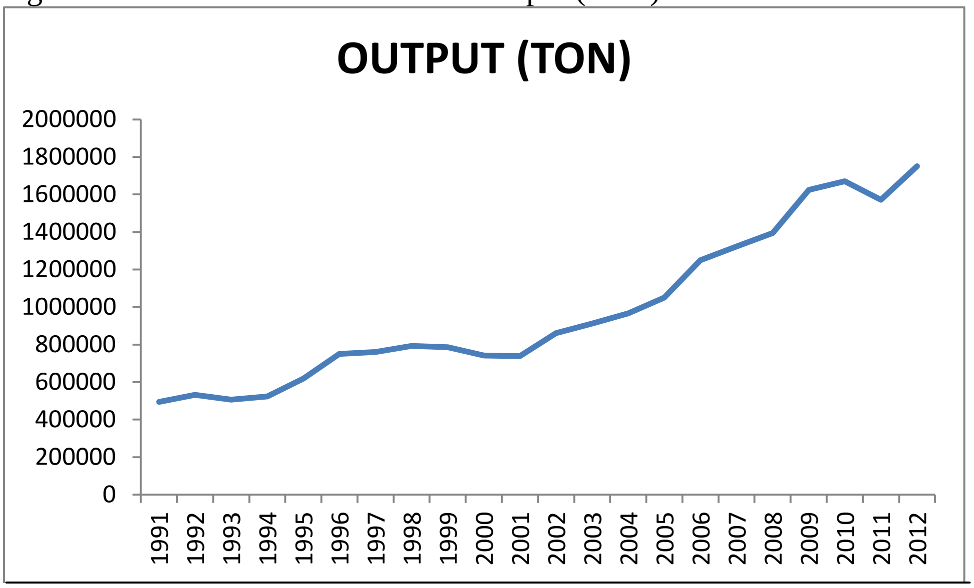


Figure A5: Trend Statistics of Maize Acreage (Ha) in Cameroon.

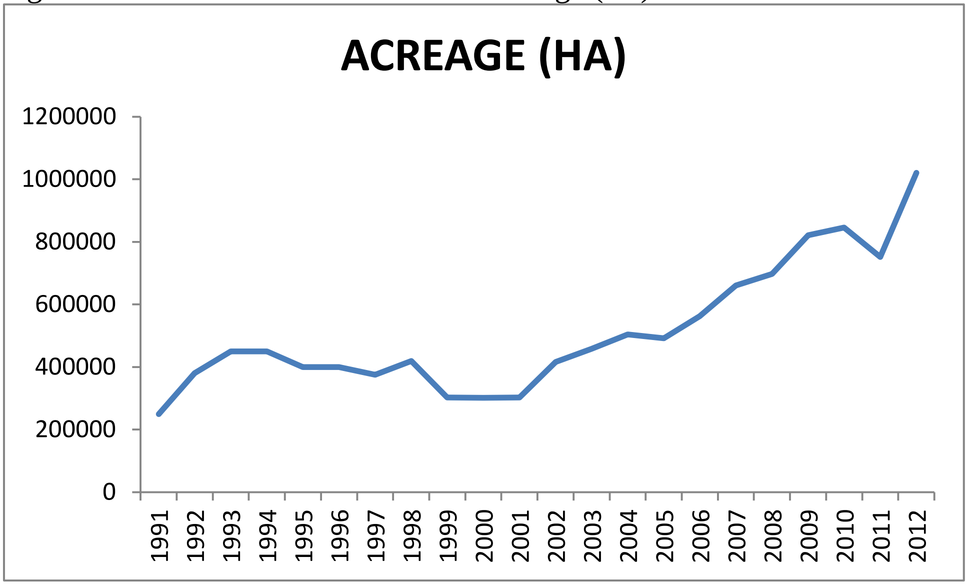


Figure A6: Trend Statistics of Maize Price (USD/Ton) in Cameroon.

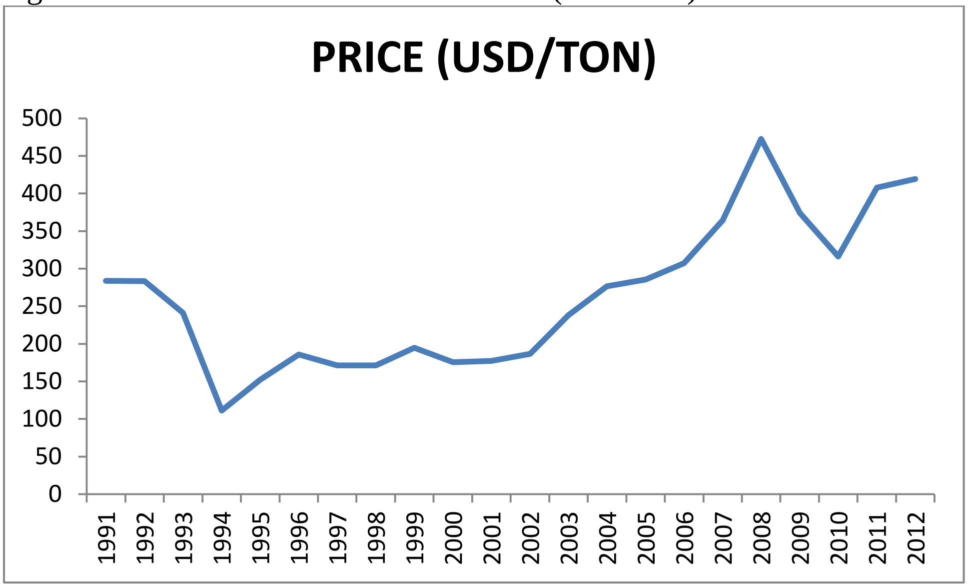


Figure A7: Trend Statistics of Maize Output (Tons) in Kenya.

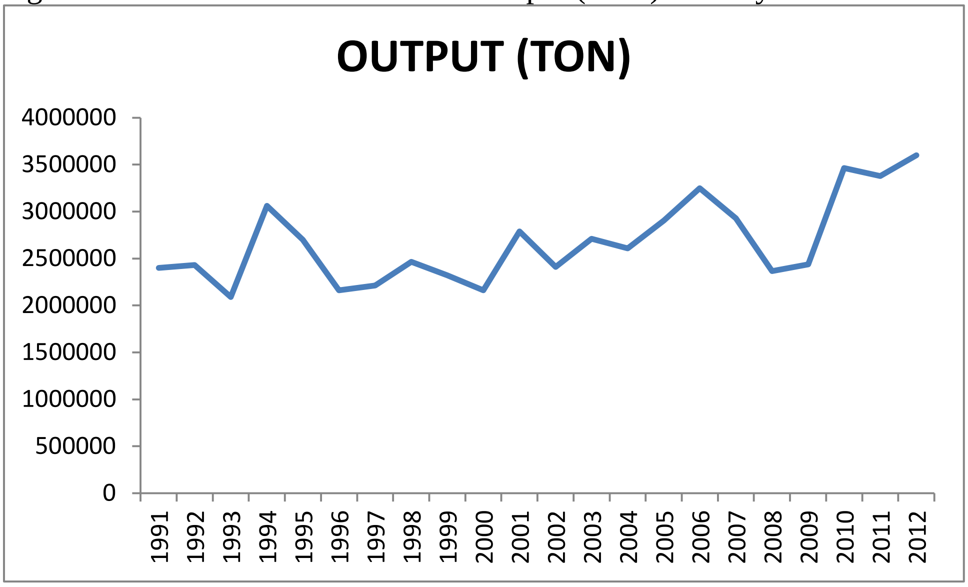


Figure A8: Trend Statistics of Maize Acreage (Ha) in Kenya.

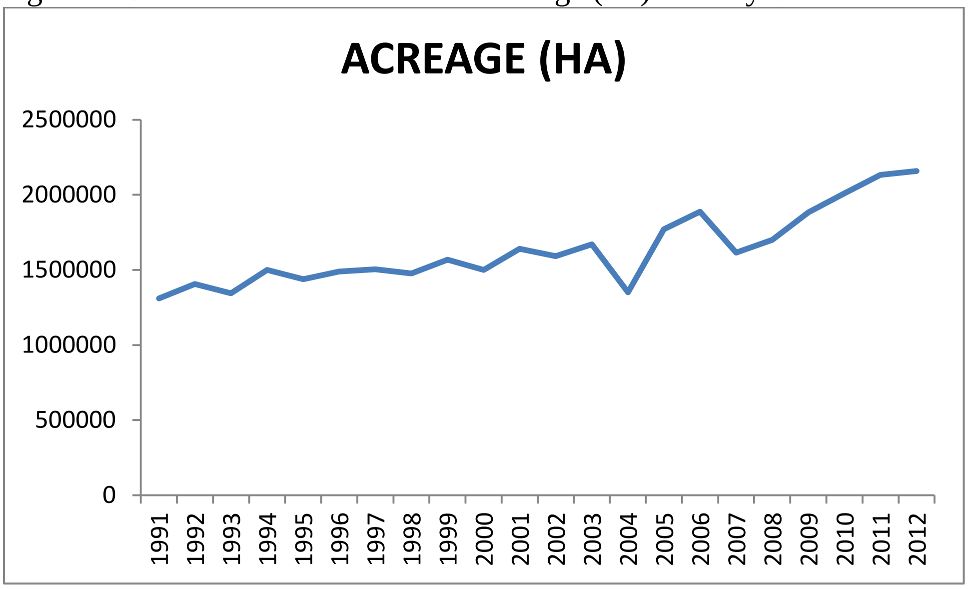
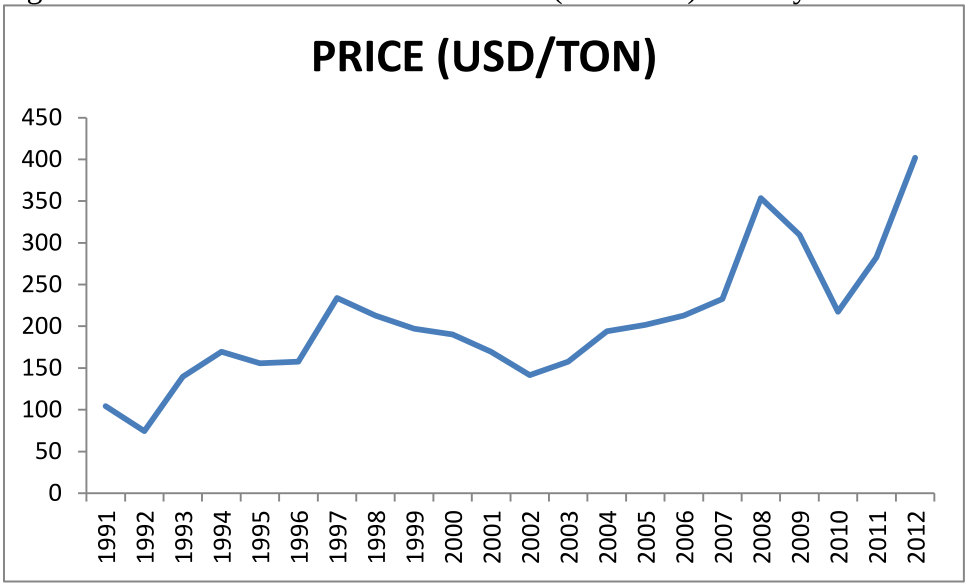


Figure A9: Trend Statistics of Maize Price (USD/Ton) in Kenya.



Appendix A10: Trend Statistics of Maize Output (Tons) in Mali.

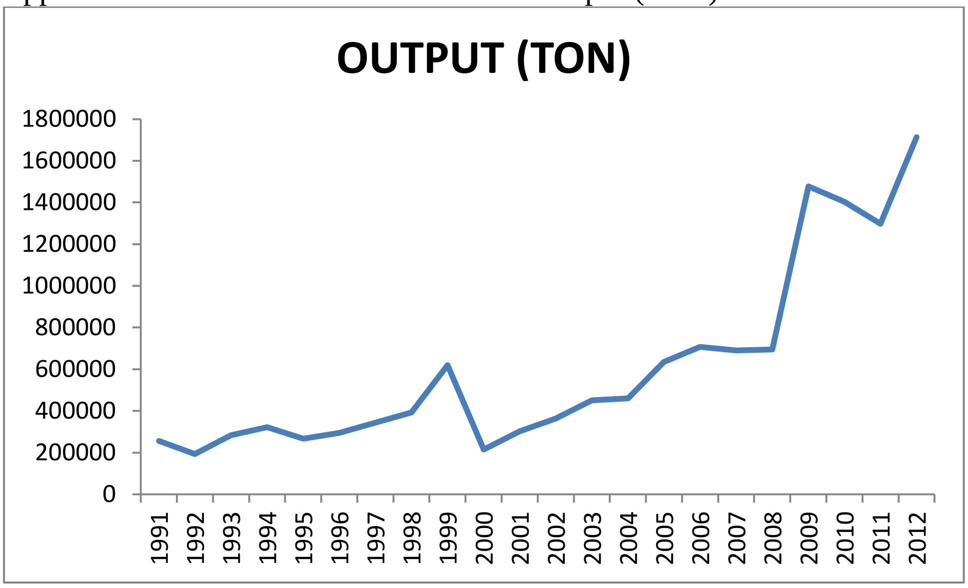


Figure A11: Trend Statistics of Maize Acreage (Ha) in Mali.

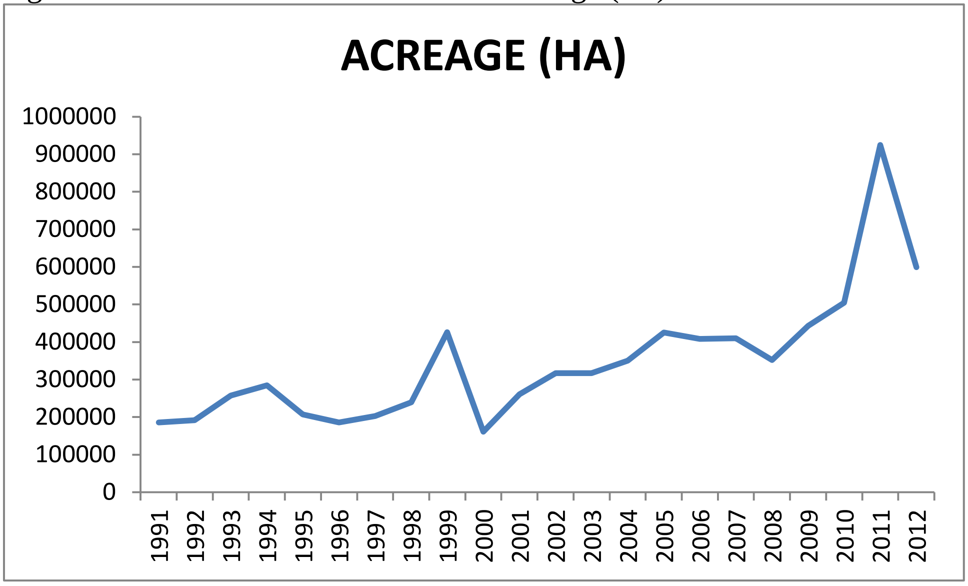


Figure A12: Trend Statistics of Maize Output (Tons) in Mali.

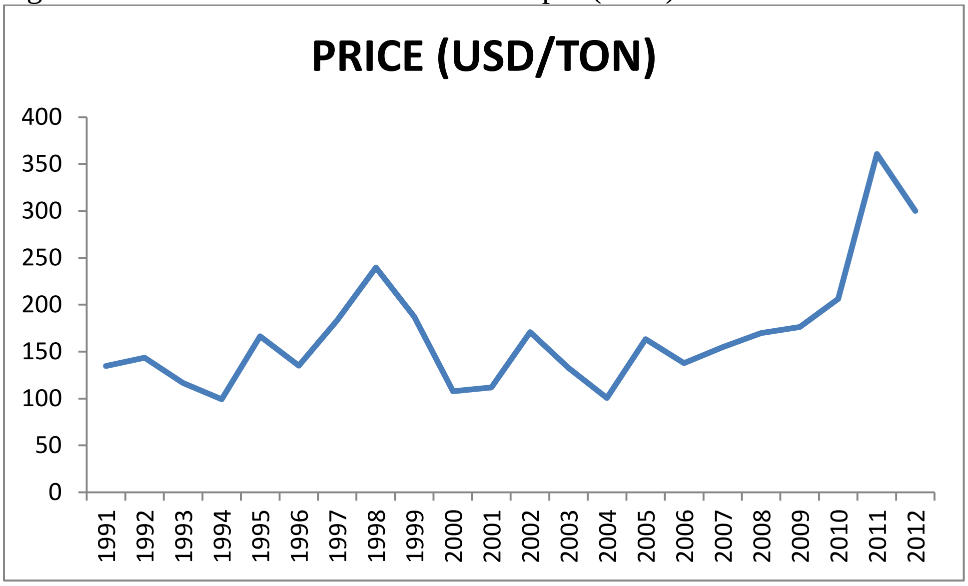


Figure A13: Trend Statistics of Maize Output (Tons) in Morocco.

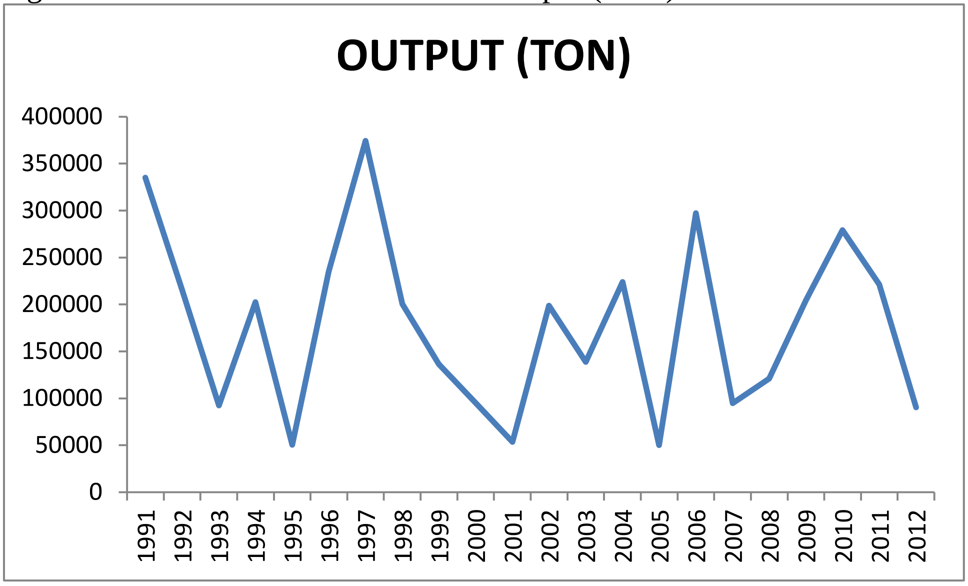


Figure A14: Trend Statistics of Maize Acreage (Ha) in Morocco.

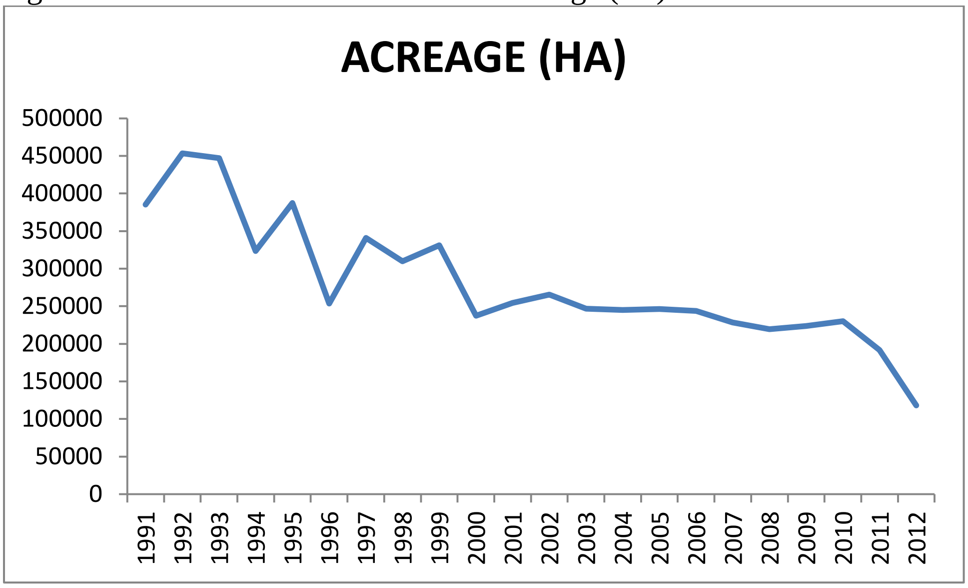


Figure A15: Trend Statistics of Maize Price (USD/Ton) in Morocco.

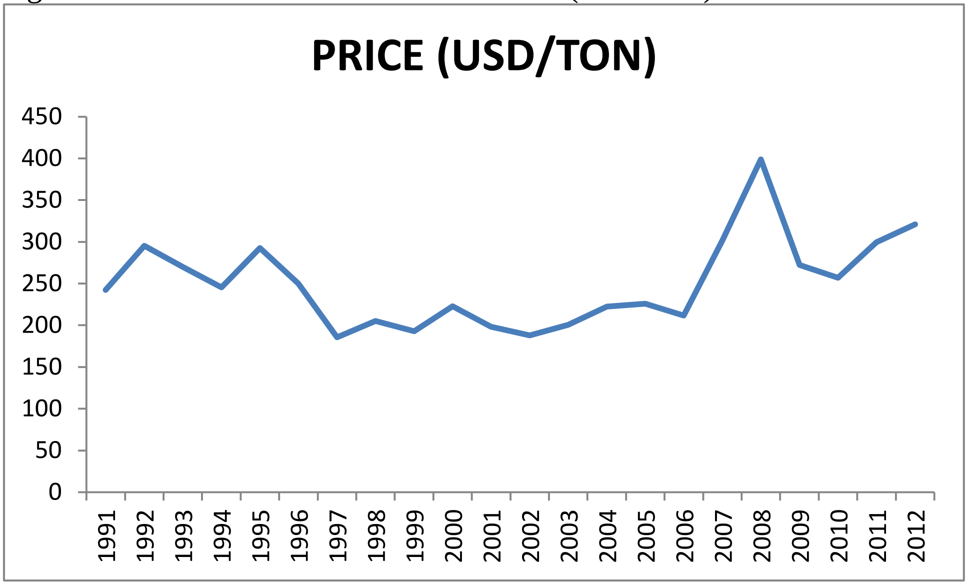


Figure A16: Trend Statistics of Maize Output (Tons) in Rwanda.

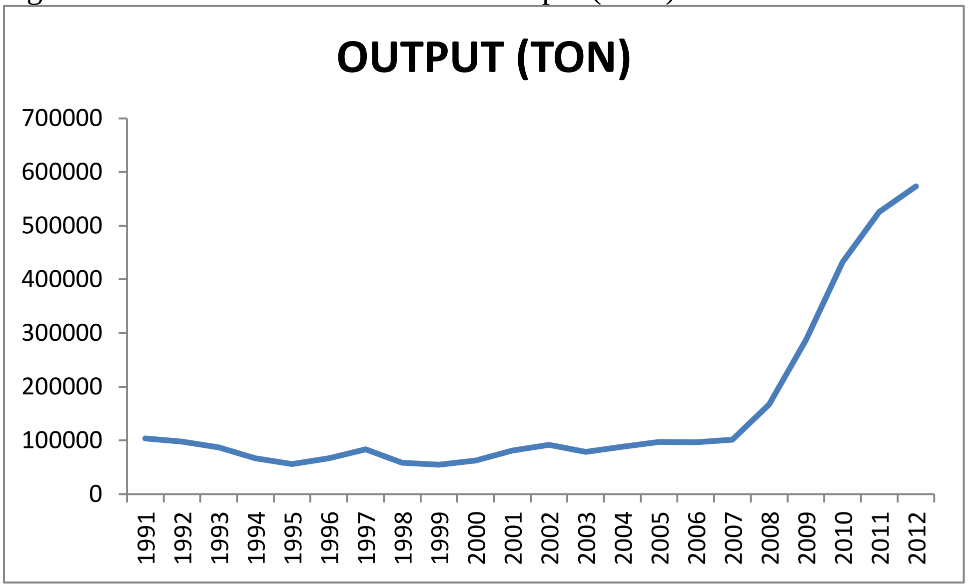


Figure A17: Trend Statistics of Maize Acreage (Ha) in Rwanda.

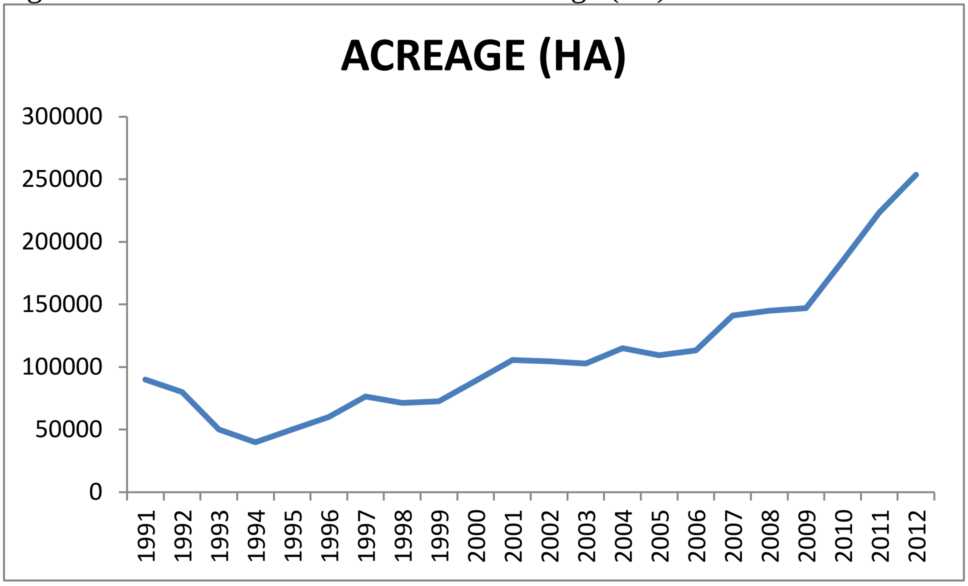


Figure A18: Trend Statistics of Maize Price (USD/Ton) in Rwanda.

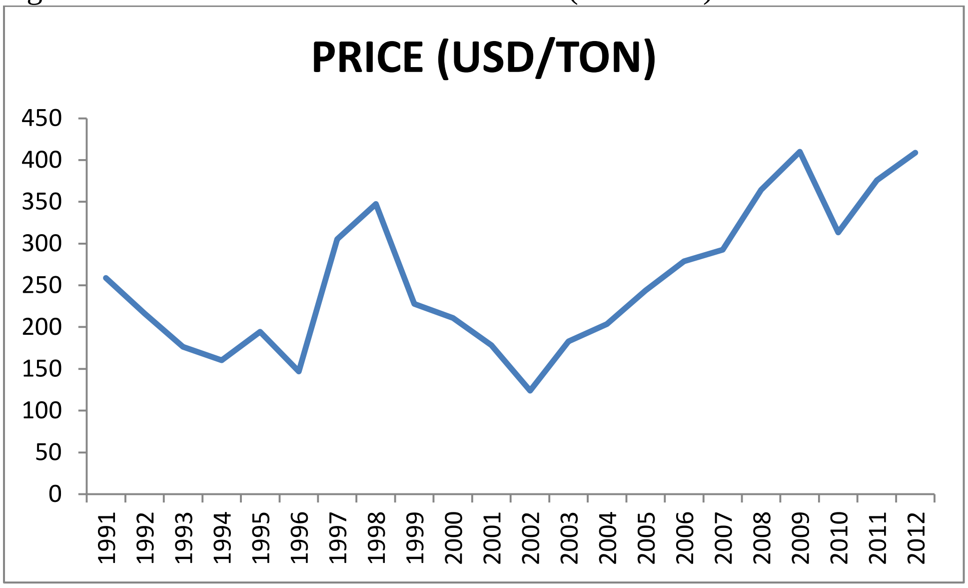


Figure A19: Trend Statistics of Maize Output (Tons) in South Africa.

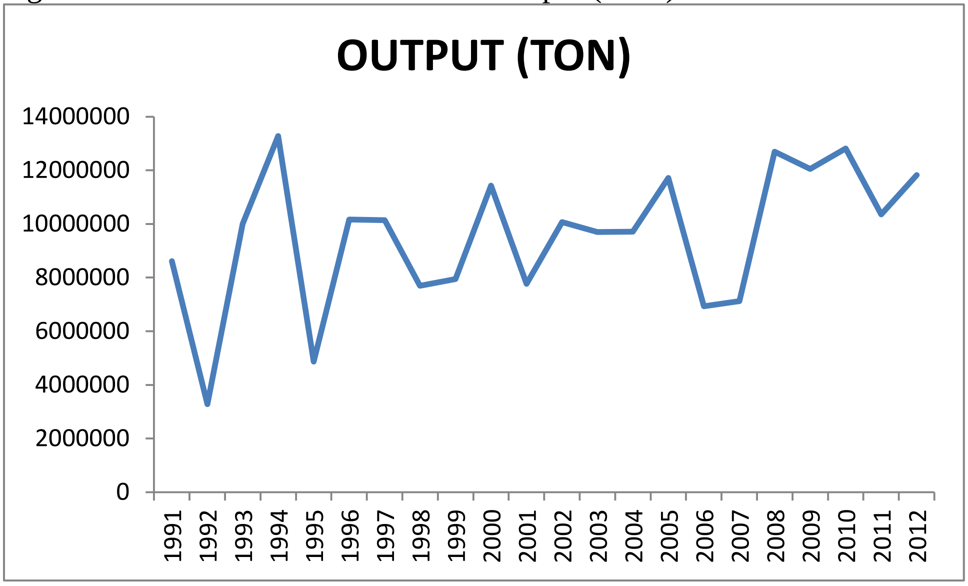


Figure A20: Trend Statistics of Maize Acreage (Ha) in South Africa.

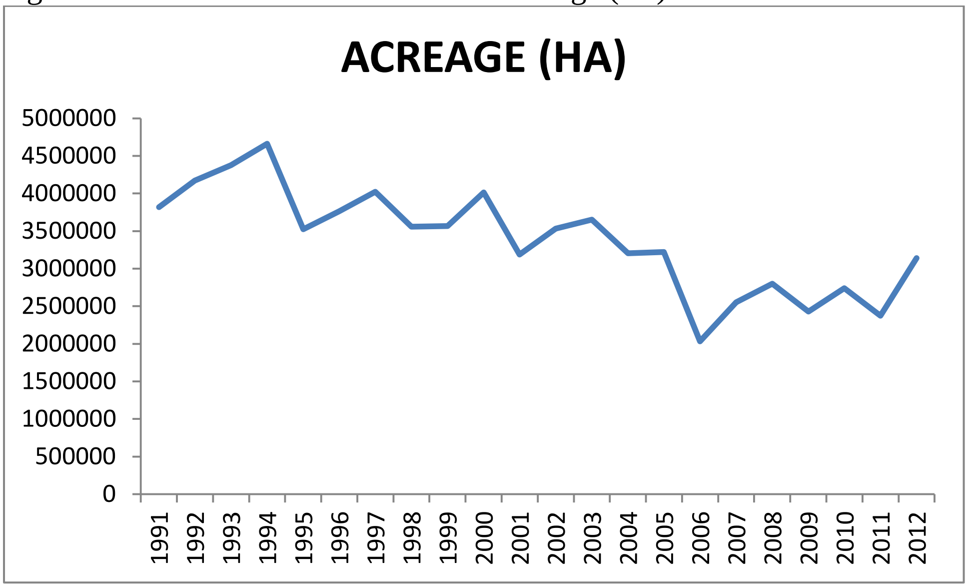


Figure A21: Trend Statistics of Maize Price (USD/Ton) in South Africa.

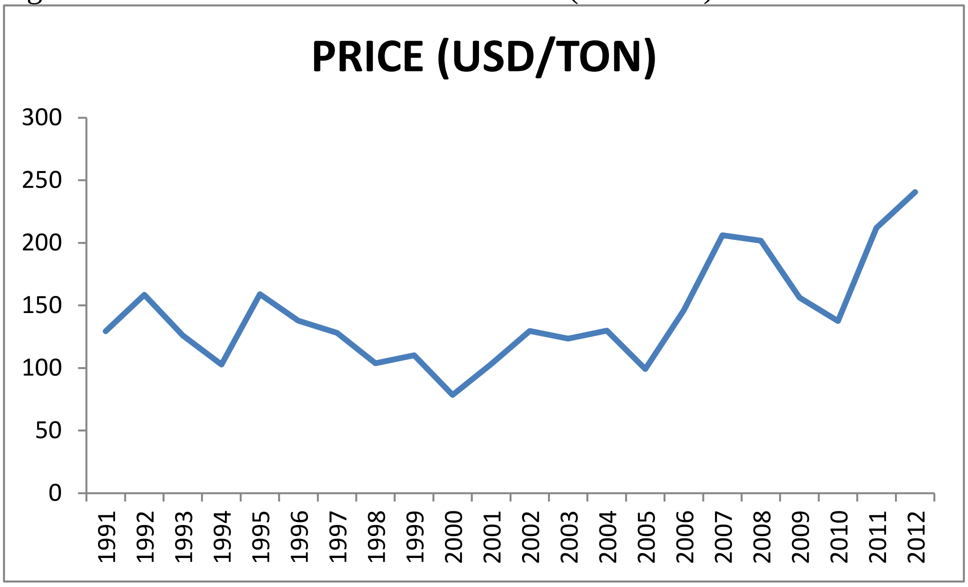


Figure A22: Trend Statistics of Maize Output (Tons) in Togo.

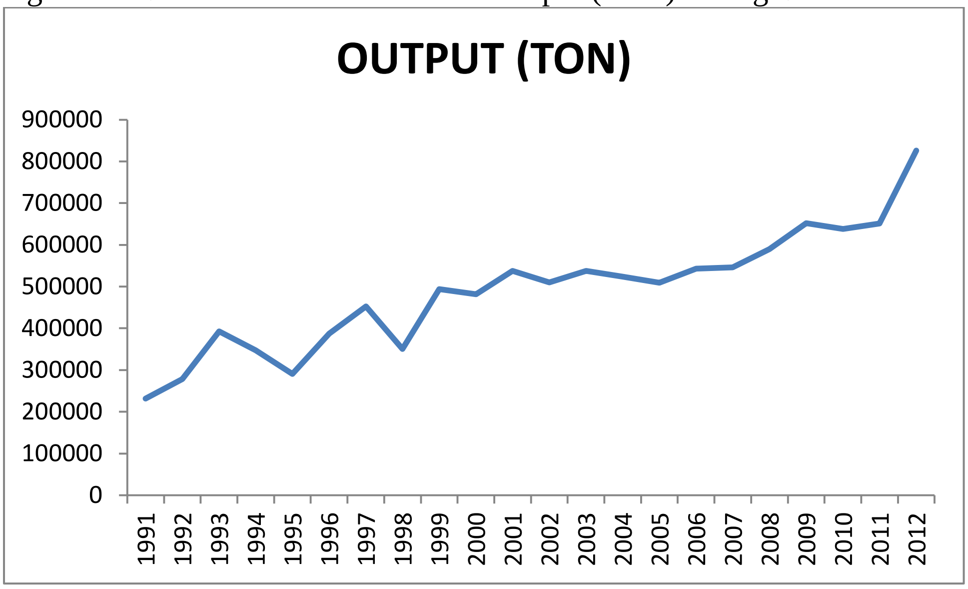


Figure A23: Trend Statistics of Maize Acreage (Ha) in Togo.

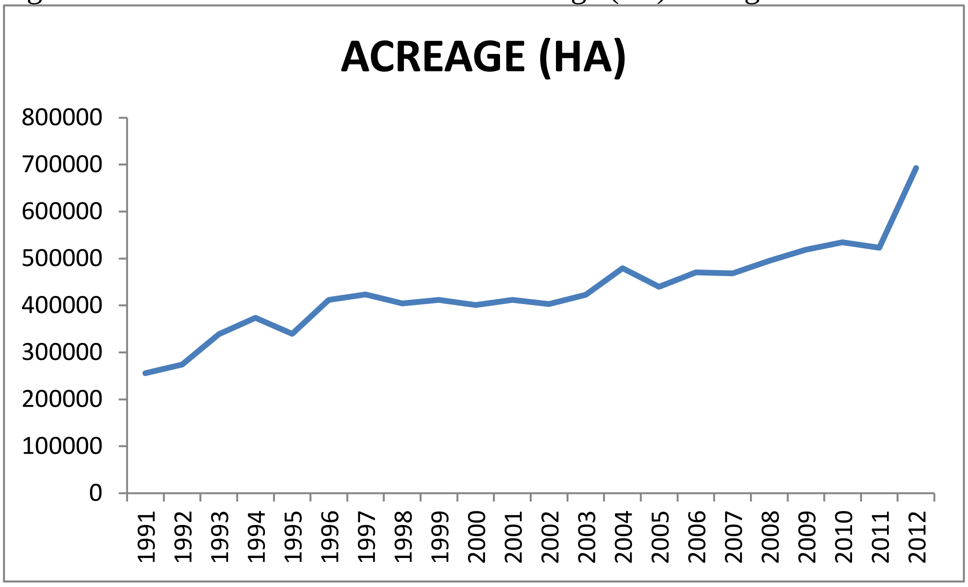
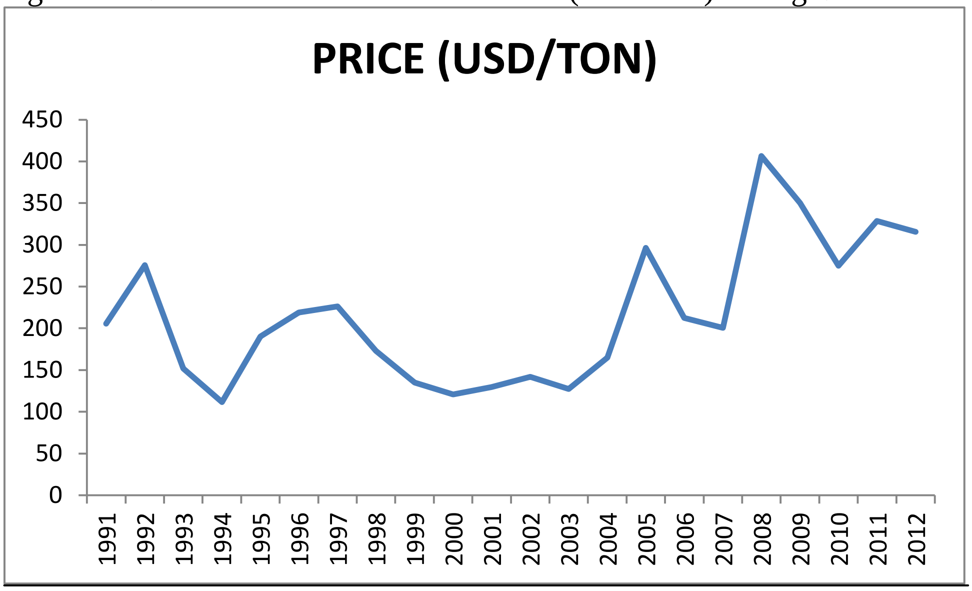


Figure A24: Trend Statistics of Maize Price (USD/Ton) in Togo.



Appendix B: Unit Root Test Results

Table B1: Lnoutput (Level, Individual Intercept and Trend)

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-3.39288	0.0003	8	160
Breitung t-stat	0.13877	0.5552	8	152
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.66941	0.0001	8	160
ADF - Fisher Chi-square	46.0107	0.0001	8	160
PP - Fisher Chi-square	83.2070	0.0000	8	168

Table B2: Lnprice_Mz (Level, Individual Intercept and Trend)

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.85249	0.0000	8	160
Breitung t-stat	-1.50402	0.0663	8	152
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-2.10869	0.0175	8	160
ADF - Fisher Chi-square	27.6284	0.0350	8	160
PP - Fisher Chi-square	21.2810	0.1680	8	168

Table B3: Lnarea (Level, Individual Intercept and Trend)

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-2.24855	0.0123	8	160
Breitung t-stat	1.12836	0.8704	8	152
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.22603	0.0006	8	160
ADF - Fisher Chi-square	40.2168	0.0007	8	160
PP - Fisher Chi-square	47.0233	0.0001	8	168

Appendix C: Estimation Results of the Null and Alternative Models.

Table C1: The Pooled Regression Analysis (Restricted Model)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNPRICE_MZ	-0.093204	0.098083	-0.950258	0.3433
LNAREA	1.228896	0.032979	37.26352	0.0000
C	-2.172305	0.779978	-2.785084	0.0059

R-squared	0.902128	Mean dependent var	13.25516
Adjusted R-squared	0.900997	S.D. dependent var	1.524625
S.E. of regression	0.479719	Akaike info criterion	1.385667
Sum squared resid	39.81258	Schwarz criterion	1.439709
Log likelihood	-118.9387	Hannan-Quinn criter.	1.407586
F-statistic	797.3119	Durbin-Watson stat	0.759343
Prob(F-statistic)	0.000000		

Table C2: The Fixed Effect Analysis (Unrestricted Model)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.218727	1.103423	0.198226	0.8431
LNPRICE_MZ	0.161543	0.088749	1.820218	0.0705
LNAREA	0.939527	0.093035	10.09863	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.952182	Mean dependent var	13.25516
Adjusted R-squared	0.949589	S.D. dependent var	1.524625
S.E. of regression	0.342314	Akaike info criterion	0.748964
Sum squared resid	19.45169	Schwarz criterion	0.929105
Log likelihood	-55.90880	Hannan-Quinn criter.	0.822028
F-statistic	367.2756	Durbin-Watson stat	1.469321
Prob(F-statistic)	0.000000		