Instituto Superior de Economia e Gestão
UNIVERSIDADE TÉCNICA DE LISBOA
DESDE 1911

MASTER
ECONOMICS

MASTER'S FINAL PROJECT
DISSERTATION

THE MACROECONOMY AND AGRICULTURAL PRODUCTION IN MOZAMBIQUE

MÁRIAM ABDUL GANI ABBAS

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SUPERVISORS:

PHD CARLOS ALBERTO PESTANA BARROS

PHD JOÃO MANUEL FERREIRA DOS SANTOS MOSCA

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ABSTRACT

The agricultural sector plays a vital role in the development of Mozambique's economy, so it is important to understand the relation between the macroeconomic environment and this sector.

This master thesis examines the relationship between macroeconomic variables and agricultural production in Mozambique, adopting the classical regression model and using bootstrap, with the endogenous variable being total production, regressed in several covariates. The time horizon is from 1980 to 2012. A robust test is undertaken, estimated by a Bayesian model.

The empirical results revealed that macroeconomic variables have a significant impact on agricultural production. The variables that had the most impact on agricultural production were area harvested, labor force, interest rate, GDP and exchange rate. Policy implications are derived.

Key words: macroeconomic variables, agricultural production, Mozambique.

RESUMO

O setor agrícola desempenha um papel muito importante no desenvolvimento da economia moçambicana, sendo assim é importante perceber a relação entre o ambiente macroeconómico e o setor em causa.

Esta tese de mestrado examina a relação entre variáveis macroeconómicas e a produção agrícola em Moçambique, adotando um modelo de regressão clássica e usando *bootstrap*, tendo como variável endógena a produção total, regredida em várias co-variáveis. O horizonte temporal é de 1980 a 2012. É feito um teste de robustez, que é estimado por um modelo Bayesiano.

Os resultados empíricos mostraram que as variáveis macroeconómicas têm um impato significativo na produção agrícola. As variáveis que tiveram maior impato na produção agrícola foram a área cultivada, força de trabalho, taxa de juros, PIB (Produto Interno Bruto) e taxa de câmbio. Apresentam-se implicações de políticas.

Palavras-chave: variáveis macroeconómicas, produção agrícola, Moçambique.

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ACRONYMS

ADF	Augmented Dickey Fuller
EA	Total economically active population in agriculture
ER	Official Exchange Rate
FAO	Food and Agriculture Organization of United Nations
FDI	Foreign Direct Investment
GDP	Gross Domestic Porduct
gdppc	GDP *per capita*
gdp_perc	GDP (percent change)
GE	General government total expenditure
GEA	Government expenditure in agriculture
IF	Annual inflation
IMF	International Monetary Fund
INEmoz	Mozambique National Institute of Statistics
IR	Interest Rate
MZM	Metical
ODA	Official Development Assistance
Prod	Agricultural total production
US	United States
USD	United States Dollar
VAR	Vector Autoregressive Models
VECM	Vector Error-correction Models
WALS	Weighted-average Least Squares

1. INTRODUCTION

This master thesis seeks to verify the relationship between macroeconomic variables and the agricultural production in Mozambique. The agricultural sector plays a vital role in the development of Mozambique's economy, so it is important to understand the relation between the macroeconomic environment and this sector.

According to Ali *et al* (2010) the world agricultural economy has been substantially sensitive to the movements of macroeconomic indicators. Many researchers and economists agreed that macroeconomic policy changes, often have significant impacts on agricultural economy. So the agricultural sector should no longer be treated as a closed sector due to significant structural changes in economic environment and the dramatic integration with world markets, Schuh (1976) in Letsoalo & Kirsten (2003).

The choice of this theme was based, among other factors, on the fact that agriculture has a fundamental role on the development of Mozambique, and it is considered the basis for development and a priority sector of the economy since the country's independence. Hence, the importance of studying this sector, as well as the factors that impact on it.

A large percentage of the Mozambican population lives in rural areas, and has agriculture as their main, and sometimes, the only means of subsistence. Furthermore, this sector is a major source of employment for the Mozambican population (in 2003, employment on agriculture accounted for about 80% of total employment in the economy (INEmoz, 2011)).

At least, in the last decade, the agricultural sector was the larger contributor to GDP (Gross Domestic Product), on average about 23%, Abbas (2013a). In recent years, the

agricultural sector has been the focus of many debates, which shows a great interest and concern about the sector.

Although the agricultural sector is considered the basis of development, some inconsistencies have been observed in economic choices and political discourse. In many cases, the economic and agricultural policies are not able to perform the desired transformations and, achieve the goals assigned to the agricultural sector, Mosca (2012). It was also found that the agricultural sector in Mozambique has shown in recent years successively lower growth rates, Abbas (2013a). In addition, the poverty in Mozambique is predominant mainly in the rural areas, where about 70% of the population is located (World Bank, 2006).

The general objective of this thesis is to examine the relationship between macroeconomic variables and agricultural production in Mozambique. The specific objectives are: a) analyze the recent evolution of the agricultural sector in Mozambique; b) analyze the evolution of some macroeconomic variables between 1980 and 2012; and, c) verify the influence of some macroeconomic and agricultural variables on agricultural production in Mozambique.

This dissertation seeks to answer to questions such as: (i) has agriculture really been a priority sector of the economy?; (ii) how macroeconomic variables influence the agricultural production in Mozambique?; and (iii) has the macroeconomic environment in Mozambique been favorable to agriculture?

The current study has 8 sections, the first being the introduction, which contains a brief contextualization about the theme, a presentation of the objectives, the questions of the study, the justification and relevance of the theme and the problem statement. The second section is the contextual analysis, in which a brief description of the agricultural sector and the macroeconomic environment in Mozambique is made. The next section is

dedicated to the literature review, focusing essentially on existing studies related with the theme, their models and main conclusions. The theoretical background is the fourth section, which contains the reference theory. The fifth section is relative to the methodology used in this study for treatment of the statistical information. Section 6 contains the data analysis and results. In this section, the econometric tests, the results and an interpretation of the results are presented. The concluding remarks, limitations and future research are presented in section 7. Finally, the references are in section 8.

2. CONTEXTUAL ANALYSIS

2.1.The Agricultural Sector

The agricultural sector in Mozambique had been affected considerably during the civil war, between 1980 and 1992, World Bank (2011). After the war, the population returned to rural areas and, consequently agricultural production has increased significantly, although mainly due to expansion of cultivated areas and not to increases of productivity per hectare, World Bank (2006, 2011).

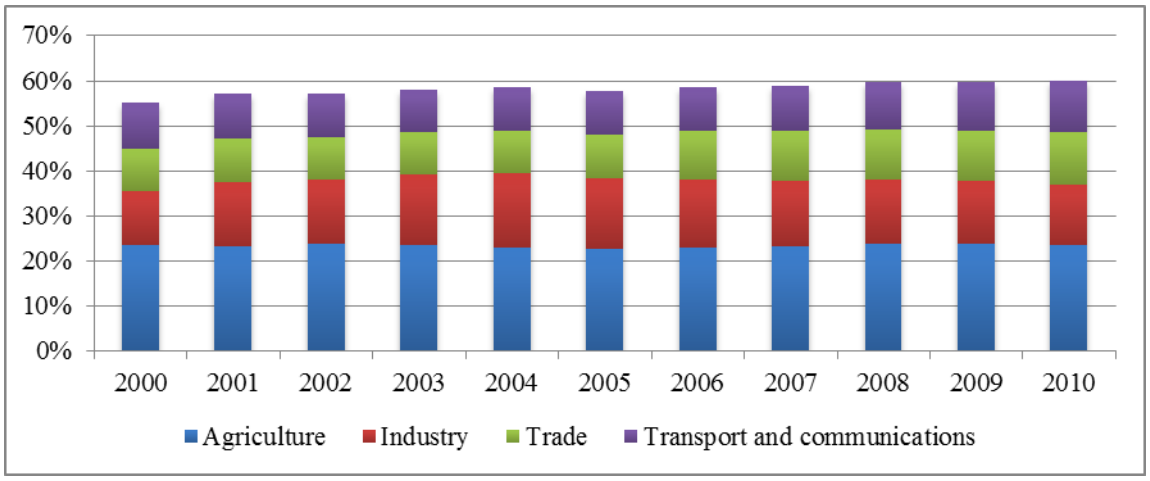
In Mozambique, agriculture is almost entirely dominated by smallholders (Abbas, 2014; World Bank, 2006, 2011). Large commercial farms were, in general, abandoned after independence in 1975, but even before that time they contributed insignificantly to food production. In recent years, some cash crops have gained weight, such as sugar, cotton, tobacco and, bananas, World Bank (2011). Cashew has traditionally been an important cash crop for smallholders, with an important role for the Mozambican economy before the independence. In the last decade the cashew production has grown, even though, slowly[1].

> Mozambique's food production, largely carried out in small land plots, is dominated by roots and tubers (especially cassava), cereals (maize, millet, sorghum and to some extent rice), groundnuts and pulses. Most food staples are for own consumption; only marginal surpluses are sold in local markets.
>
> In World Bank (2011), pp. 26.

[1] For a more complex study about the cashew subsector in Mozambique see Abbas (2014).

Agricultural growth was high during the mid-1990s: according to World Bank (2006) the Mozambican agriculture had one of the highest growth rates in the region[2]. Despite, the agricultural sector has shown low growth rates since 2000, due to climatic shocks (floods in 2000) (World Bank 2006, 2011). The contribution of the agricultural sector to the GDP has decreased from 30% in 1997 to 23% in 2003, Mosca (2012). However, it is the sector that has contributed the most to GDP in Mozambique in the last decade, on average 23% a year between 2000 and 2010 (see figure 1), Abbas (2013a).

Figure 1. Sectorial share of GDP

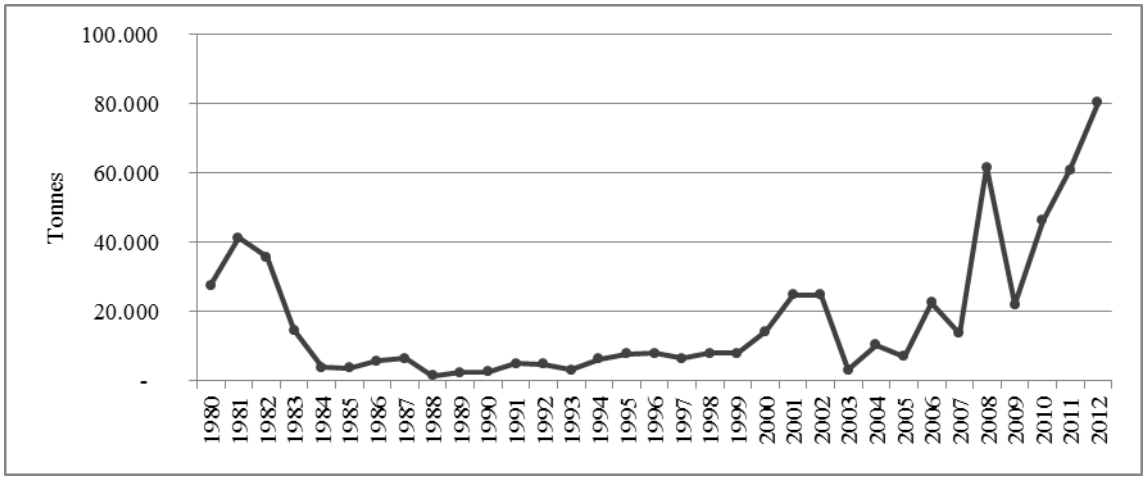


Source: INEmoz (2011).

The use of fertilizers is considered low; however, it can be noted through the figure below, an increasing trend in fertilizer consumption since 2004.

[2] Area expansion was Mozambique's main source of agricultural growth, and growth of the labor force also contributed to agricultural expansion, World Bank (2006).

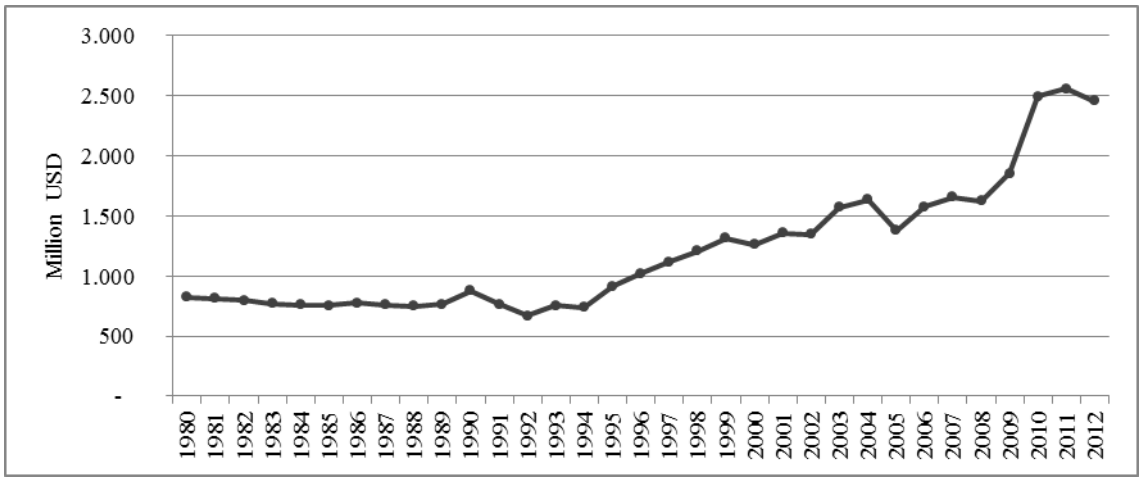
Figure 2. Fertilizers consumption



Source: FAO (2013).

World Bank (2006, 2011) confirmed that the use of chemical fertilizers, pesticides and improved seeds is very low. This study also considered that land productivity in Mozambique is low (even by regional standards) and, labor productivity has not improved (over the period 1997-2007) (Mather *et al*, 2005; World Bank, 2006). However, total production has increased over the years (see figure 3). This can be justified by increasing cultivated areas, number of farms and increase in the labor input (see figure 4).

Figure 3. Agricultural total production



Source: FAO (2013).

As is known, poverty in Mozambique is concentrated mainly in the rural areas, where it is located about 70% of the population, which has agriculture as the main, and sometimes sole, means of subsistence (World Bank, 2006)[3]. So the agricultural sector has an important role on reducing poverty in Mozambique. World Bank (2006) confirms: "Rural poverty has declined substantially over the last decade as the agriculture sector has shown remarkable improvements".

This sector is also very important as a source of employment: Mosca (2012) refers that the agricultural sector provides employment and economic support to more than 70% of the economically active population.

An increase in productivity in the agricultural sector, due to increased use of machinery, fertilizers and others, could lead to reduced acreage and labor force, as a result of agricultural modernization, pursuant to market demand.

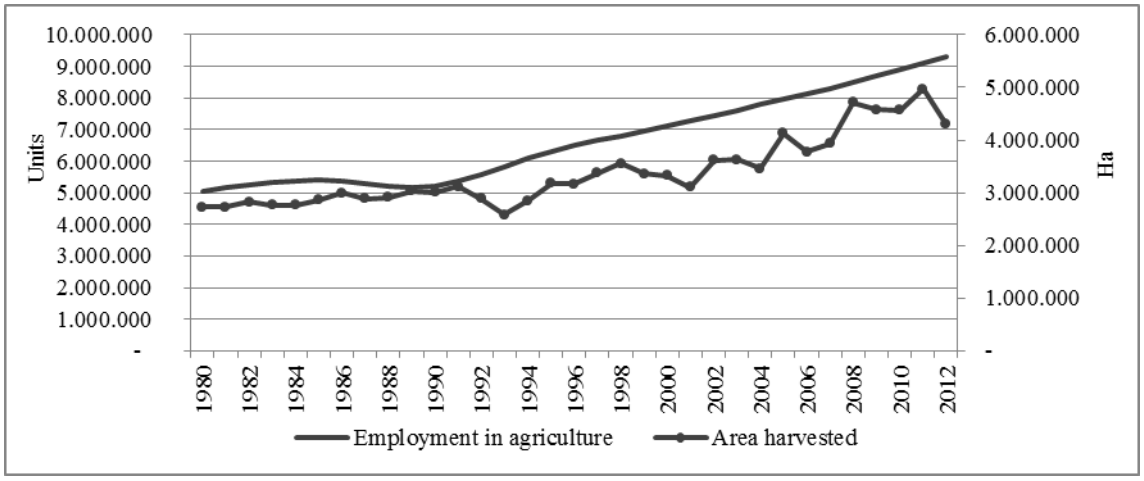
Macroeconomic policies that encourage increased agricultural production would have a positive impact on the agricultural sector. This would be so, if there is a simultaneously agricultural and industrial growth. So, the labor surplus generated in the agricultural sector would be transferred to the industrial sector.

In Mozambique, the Lewis Model is not verified. Instead, the opposite takes place, because there are no macroeconomic policies considered agricultural friendly and, there is no productivity growth, and hence there is no labor surplus in the agricultural sector and, the income is low. In addition, there is no structural transformation.

Increases in production in Mozambique are a consequence of increase in labor input and cultivated area, as can be seen in figure 4. World Bank (2006, 2011) confirms.

[3] According to World Bank (2006) rural households are predominantly smallholders who provide about 95% of agricultural GDP.

Figure 4. Employment in agriculture and area harvested



Note: The right scale corresponds to the area harvested.

Source: FAO (2013).

2.2.Macroeconomic Environment

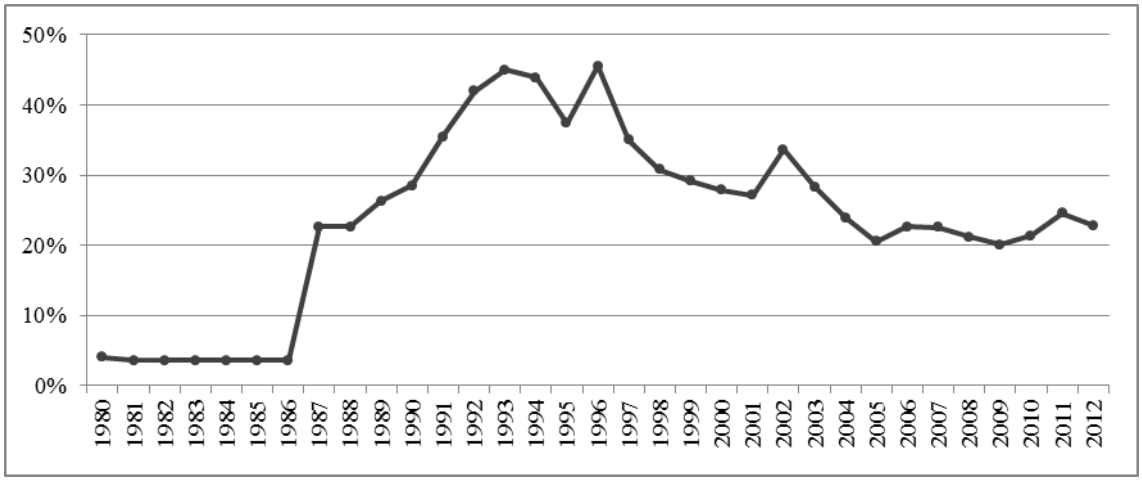
According to World Bank (2003, 2006), in 2004, agricultural expenditures were 0.6 percent of GDP and 3.3 percent of total government expenditures, and donor funding dominated investment in agriculture. Based on that information, it can be said that even though the agricultural sector is considered the foundation of development in Mozambique, in practice, this is not the case.

Mosca *et al* (2013a) emphasized that between 2001 and 2012, on average, only 1% of total public current expenditures at central level were directed to the agricultural sector. In relation with investment expenditures, the agricultural sector benefitted, on average, with only 4% of total public investment expenditures, between 2001 and 2012, Mosca *et al* (2013a).

One of the constraints to the agricultural sector in Mozambique is the lack of rural finance, which is due to several structural factors, such as, high and volatile real interest rates, (Mosca & Dada, 2013; World Bank, 2006). The interest rate in Mozambique has

been quite volatile, with a tendency to increase until 1996, and then it has experienced some declines, although remaining high (see figure 5). According to Cassamo (2012) in Mosca & Dada (2013), the agricultural sector received, on average, only 8% of total credit to the economy (between 2001 and 2011).

Figure 5. Interest rate, percentual annual average

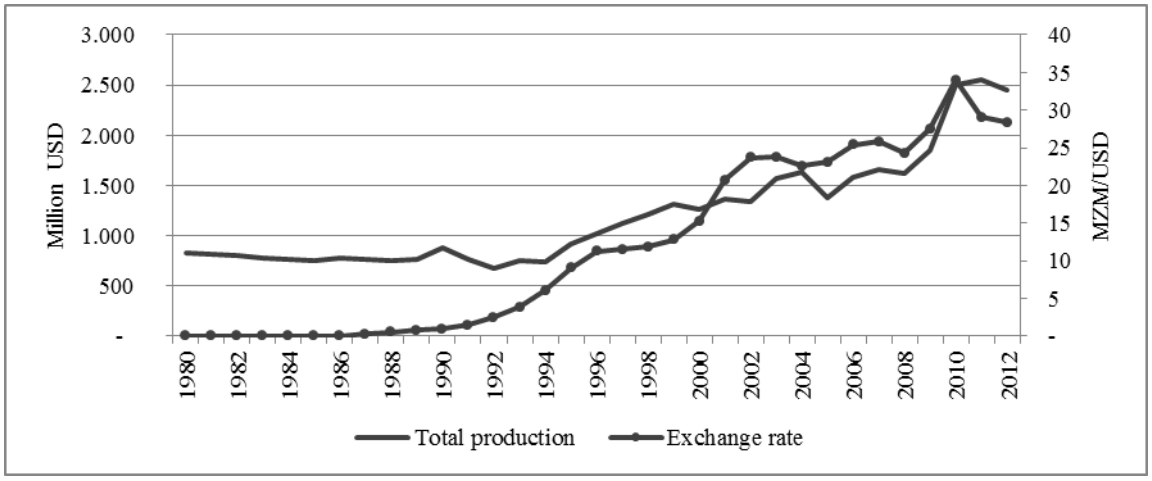


Source: Bank of Mozambique (2013).

In relation with investment in agriculture, Abbas (2013b) analyzed the distribution of investment by sector, and concluded that agriculture is one of the sectors that had the lower participation of Mozambican capital (only 3%, on average, between 2001 and 2010), with almost 30% of Foreign Direct Investment (FDI), and the remaining in loans.

The exchange rate had increased over the period 1980-2010, that is, the Metical has been constantly depreciated in the last three decades, except for 2011 and 2012, where a slightly appreciation was noted. According to the figure below, a positive relationship between exchange rate and agricultural production is expected.

Figure 6. Total production and exchange rate

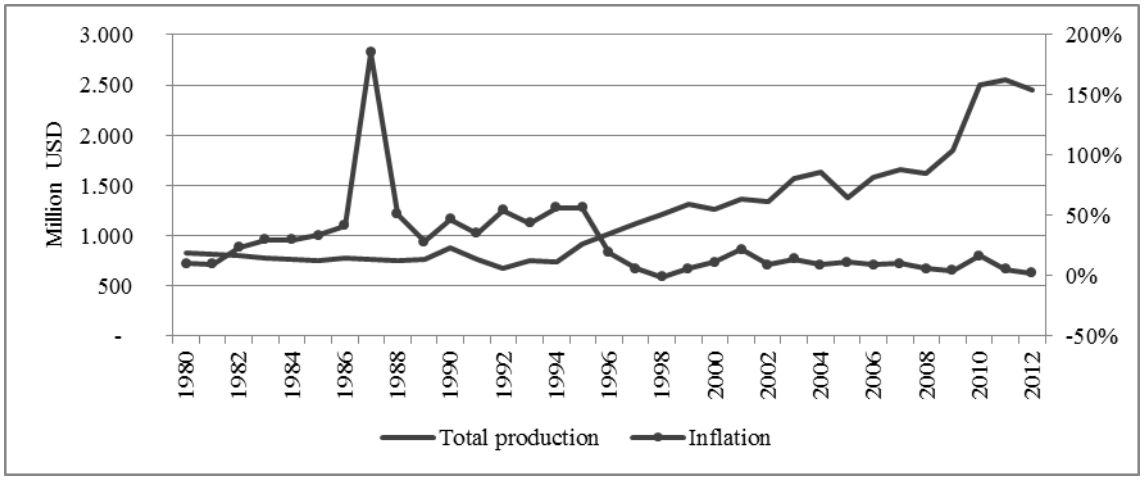


Note: The right scale corresponds to the exchange rate.

Source: FAO (2013) for total production and World Bank (2013) for exchange rate.

The inflation in Mozambique had been quite high and volatile during this period. However, in the last years, it can be noticed a downward trend, and in 2012 the inflation rate stood at 2% (the lowest rate since 1980).

Figure 7. Total production and inflation (percentage)



Note: The right scale corresponds to inflation.

Source: FAO (2013) for total production and IMF (2013) for inflation.

According to the figure above, it is expected a negative relationship between inflation and agricultural production. Ali *et al* (2010) and Brownson *et al* (2012), in their studies, also found a negative relation between those two variables.

The World Bank (2006) considers that a stable macroeconomic is one of the necessary conditions for a strategy to promote growth of smallholder agriculture. That is, the Government needs to ensure both price stability and fiscal control. "Inflation must be kept under control and the exchange rate should be competitive for Mozambican exports", World Bank (2006).

3. LITERATURE REVIEW

3.1.Macroeconomic Linkages with the Agricultural Sector

"The macroeconomics of agriculture involves the relationship between the general domestic economy and the agricultural sector, and the world economy and the domestic agricultural sector" Knutson *et al* (2000) in Letsoalo & Kirsten (2003).

The growth of the agricultural sector is directly linked to the performance of the whole economy. However, economic growth does not always imply growth in the agricultural sector, although, historically, both are associated.

Several studies have been conducted relating macroeconomics and agriculture, in the last decades. These are studies that examine the impact of changes in macroeconomic variables on the agricultural sector. According to Choe (1989), since 1973, after the collapse of the Bretton-Woods agreement and the allowance for a floating US dollar, agricultural economists have considered the relationship between agriculture and the macroeconomy. Gil *et al* (2009) confirm the existence of several studies analyzing the relation between macroeconomic variables and the agricultural sector since the mid-seventies.

The study by Schuh (1974) is considered, by many authors, as the starting point of studies emphasizing the relationship between exchange rate and agricultural variables[4] (Chambers & Just, 1981; Choe, 1989; Gil *et al*, 2009).

Johnson (1975) in Karbasi & Tavana (2008) referred that inappropriate policies leave farmers in disadvantage in making effective use of their resources. Rausser *et al*

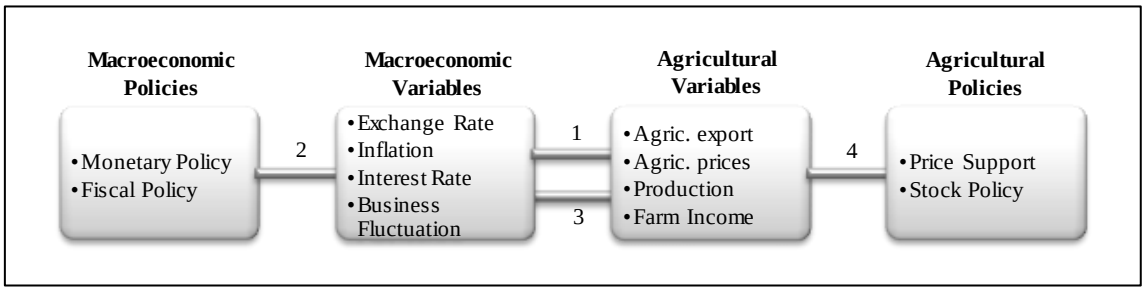
[4] However, this study neglects the possible effect of exchange rate changes on other macroeconomic variables, and vice-versa, (which can influence agriculture prices and exports indirectly), and also the effects of other macroeconomic variables on agricultural variables, Gil *et al* (2009).

(1986) added that sector-specific policies would be irrelevant if macroeconomic policies were appropriately designed, Karbasi & Tavana (2008) (Choe, 1989).

Alagh (2011) considered that macroeconomic policy changes affect agricultural economy through their impacts on interest rates and inflation (Snell *et al*, 1997). "Changing interest rates influences variable production costs, long-term capital investments, cash flow, land values, and exchange rates, while inflation affects input prices, commodity prices, real interest rates and land prices", Alagh (2011).

According to Choe (1989) the macroeconomic environment influencing agriculture is done through four mechanisms (exchange rate, rate of inflation, interest rate and the demand effect of business cycle fluctuations) through which events and policies in the macroeconomy may be transferred to agriculture.

Figure 8. Forward and backward linkages between the macroeconomy and agriculture



Source: Choe (1989), p. 11.

> Schuh (1974, 1981, 1983) argued that the exchange rate would affect food prices relative to other prices, the amount of land used, employment in agriculture, farm incomes, and productivity… An increase in the exchange rate would increase agricultural factor prices relative to output prices, agricultural imports, and farm

migrations. Schuh (1981, 1983) also confirmed the negative impact of exchange rate changes on agricultural income and inventories.

In Choe (1989), p. 21.

Several authors supported and agreed with this statement (Chambers & Just, 1981; Johnson *et al*, 1977; Snell *et al*, 1997).

In relation to the relationship between rate of inflation and agriculture, Choe (1989) referred that Tweeten (1980) formulated and tested the proposition that general inflation contributes to the cost-price squeeze in agriculture, and found that "the general increment in overall price level increases nominal farm product prices and farm demand in proportion to the general price level but leaves real farm demand, and hence real demand price unchanged"[5]. According to Choe (1989), Penn (1979) also supported this hypothesis.

According to Choe (1989), Ruttan (1979), in an attempt to link productivity growth in agriculture to general price level changes, found that general inflation dampens productivity growth in the agricultural sector in the U.S.

However, some authors did not found any real impact of general inflation on agriculture, and others only found an insignificant impact (Gardner, 1981; Johnson, 1980; Lee,1980; Schluter & Lee, 1981).

Choe (1989) considered that the interest rate has become one of the most important factors affecting agriculture. Chambers (1984), in Choe (1989), argued that there is a

[5] "Farmers may consider inflation to be beneficial in the short run due to higher farm commodity and land prices. However, in the long run, prices of other goods, including farm inputs, become more flexible and may increase more than farm prices", Snell *et al* (1997).

negative relationship between interest rate and agricultural prices[6]. On the other hand, for Snell *et al* (1997), changing interest rates also influence the price of farmland and agricultural wealth.

Some authors argued that fluctuations in general macroeconomic activity are an important factor causing instability in agricultural prices and the farm economy (Choe, 1989; Schultz, 1945).

Even though macroeconomic variables have significant influence on agriculture variables, Gil *et al* (2009) considered that, in general, changes in agricultural variables have no significant effects on macroeconomic variables (except for shocks in agricultural prices that have an effect on inflation).

According to Ali *et al* (2010), in Malaysia, since 1990, as the global environment deteriorated, the growth of GDP for the agricultural sector was relatively unstable and declined, as well as the share of agricultural sector to GDP. These authors emphasized that macroeconomic indicators have been considered one of the significant factors affecting agricultural economy in Malaysia.

Ali *et al* (2010), in their study, used the co-integration regression model which, in their opinion, is the most favored approach and the most widely used in similar studies.

The main results of Ali *et al* (2010) was that money supply has a positive relationship with agricultural exports and income, that is, an increase in credit availability for farmers or producers strongly influences the agricultural income in Malaysia. On the other hand, both exports and income were negatively related with interest rate. In relation to the influence of inflation rate, Ali *et al* (2010) concluded that

[6] That is, "an interest rate increase causes farm stocks to be released to the market, since interest costs are an important component of the total costs of carrying stocks. Therefore, the price of agricultural products will fall", Choe (1989).

inflation has a positive relationship with agricultural commodity prices, while presenting a negative relation with agricultural exports. Meanwhile, depreciation in the Malaysian currency tends to lower commodity prices, which increase the competitiveness of Malaysian agricultural products in foreign markets.

In general, Ali *et al* (2010) concluded that money supply and interest rates play a crucial role in influencing agricultural performance in Malaysia, and that exchange rates and inflation are the major factors leading to the variability of agricultural commodity prices.

A study by Brownson *et al* (2012) established the relationship between value of agricultural GDP, as the ratio of total GDP (as a proxy for agricultural productivity) and, key macroeconomic variables in Nigeria, using short and long run model methodologies. In this study, the short-run and long-run elasticity of the agricultural productivity with respect to some key macroeconomic variables were determined using the techniques of co-integration and error correction models.

According to Brownson *et al* (2012), variations in agricultural productivity (in Nigeria) are mostly induced by changes in macroeconomic variables.

Brownson *et al* (2012) found that "some key macroeconomic fundamentals in Nigeria's economy interact in each period to re-establish the long-run equilibrium in the agricultural productivity following a short-run random disturbance".

> The empirical result from the estimation of the long run agricultural productivity equation in the country revealed significant inelastic relationship with respect to the total export, external reserve, inflation rate, and external debt; while industrial capacity utilization rate and nominal exchange rate of naira to US dollar have significant positive relationship. On the other hand, short run model for

> agricultural productivity reveals significant negative inelastic correlation with respect to total export, external reserve, external debt and inflation rate; while *per capita* real GDP, industrial capacity utilization and nominal exchange rate have a positive inelastic influence.
>
> In Brownson *et al* (2012), p. 124.

In general, industrial capacity utilization rate, real GDP *per capita* and interest rate are the most important factors that affect agricultural productivity both in the short and long run in Nigeria, Brownson *et al* (2012).

Another paper from Letsoalo & Kirsten (2003) examined the importance of macroeconomic and trade policies on the agricultural sector in South Africa. Letsoalo & Kirsten (2003) considered that some macroeconomic and trade variables such as government expenditure, money supply, exchange rate and import tariffs affect agricultural performance.

According to Penson & Gardener (1988) and Knutson *et al* (2000) in Letsoalo & Kirsten (2003) "domestic macroeconomic variables that are most important for agriculture are the rate of inflation, real rate of growth in Gross National Product, interest rate and exchange rate".

The major assumption of Letsoalo & Kirsten (2003) was that macroeconomic and trade policies will affect the agricultural sector through output prices. "Higher output prices are expected to increase productivity, as the increased profitability would make firms allocate more resources to innovation activities and increase their investments in new technologies", Letsoalo & Kirsten (2003).

Letsoalo & Kirsten (2003) found a positive relation between money supply and agricultural domestic prices in South Africa.

Karbasi & Tavana (2008) did the same study as Letsoalo & Kirsten (2003) for Iran. However, Karbasi & Tavana (2008), found a negative relation between money supply and agricultural prices.

Baek & Koo (2010) examined the dynamic relationship between the U.S. farm income and macroeconomic variables. For that purpose, they used the U.S. net farm income as the endogenous variable.

They found a positive coefficient of the real GDP on the net farm income, which implies "that a rise in real domestic income leads to an increase in demand for agricultural goods through the increased purchasing power of U.S. consumers, thereby enhancing the farm income", Baek & Koo (2010).

On the other hand, they found that both exchange and interest rates have a negative impact on net farm income. They explained the negative coefficient of the exchange rate as follows: "the weakening U.S. dollar makes the price of U.S. agricultural goods more competitive abroad and leads to an increase in U.S. agricultural exports, thereby boosting the farm income".

Table I.Brief description of the previous research

Paper	Country	Model	Endogenous variable	Exogenous variable	Relation with the endogenous variable
Ali *et al* (2010)	Malaysia	Co-integration regression model	Agricultural exports	Real money supply (MS)	+
				Real interest rate (IR)	-
				Inflation rate (IF)	-
			Agricultural income	MS	+
				IR	-
			Agricultural commodity price	Exchange rate - ER	-
				IF	+
Brownson *et al* (2012)	Nigeria	Co-integration and error correction models	Agricultural GDP as a ratio of total GDP (proxy for agricultural productivity)	Real value of total export	-
				Real external reserves	-
				Inflation rate	-
				Real per capita GDP as a proxy of aggregate demand shock	+
				External debt as a ratio of GDP	-
				Industry's capacity utilization rate - CUR	+
				Interest rate - INR (lending rate)	No evidence
				Oil revenue (OIL) as a ratio of	No evidence
				Domestic saving as a ratio of	No evidence
				Nominal exchange rate	+
Letsoalo & Kirsten (2003)	South Africa	Two Stage Least Square (TSLS)	Degree of openess (DCO)	Trade barriers	+
				Government expenditure	-
			Real exchange rate (RER)	Terms of trade	-
				Government expenditure	+
			Relative agricultural domestic prices	RER	+
				Money supply as a proportion of GDP (MOSPTI)	+
				GDP	-
				DCO	+
Karbasi & Tavara (2008)	Iran	Two Stage Least Square (TSLS)	Degree of openess (DCO)	Trade barriers	+
				Government expenditure	+
			Real exchange rate (RER)	Terms of trade	+
				Government expenditure	+
			Relative agricultural domestic prices	RER	+
				Money supply as a proportion of GDP (MOSPTI)	-
				GDP	-
				DCO	+
Baek & Koo (2010)	US	Fully-modified cointegration technique (FM-OLS)	Net farm income	Agricultural price	+
				GDP	+
				Exchange rate - ER	-
				Interest rate - IR	-

In general, these authors established the relationship between macroeconomic variables and agricultural variables. But they focused their analysis on particular macroeconomic variables, whereas the current study is broader, as it covers a larger set of macroeconomic variables.

4. THEORETICAL BACKGROUND

The reference theory is the dual sector model of Arthur Lewis. His emphasis on dualism appeared on his work (Lewis, 1954) when neither the work of Keynes or Harrod-Domar nor the later neoclassical production function of Solow seemed relevant for developing countries, Ranis (2004).

The Lewis dual model considers a developing economy, and assumes an unlimited supply of labor[7] and two sectors: the capitalist (modern) sector and the subsistence (traditional) sector. The capitalist sector has the following characteristics: (1) uses capital; (2) uses modern technology; (3) has higher wages compared to the subsistence sector; and, (4) has high marginal productivity. In turn, the subsistence sector: (1) does not use capital; (2) uses traditional technology; (3) has low wages; (4) abundance of unskilled labor; and (5) low productivity (Abbas, 2013a).

According to Lewis (1954) "the wage which the expanding capitalist sector has to pay is determined by what people can earn outside that sector".

The Lewis model is a theory of development in which the labor surplus of the subsistence sector is transferred to the capitalist sector. As capital grows more workers can be drawn into the capitalist from the subsistence sector and their output *per capita* rises as they move from one sector to another, Lewis (1954).

> The key to the process is the use which is made of the capitalist surplus. In so far as this is reinvested in creating new capital, the capitalist sector expands, taking more people into capitalist employment out of the subsistence sector. The surplus is then

[7] "An unlimited supply of labour may be said to exist in those countries where population is so large relative to capital and natural resources, that there are large sectors of the economy where the marginal productivity of labour is negligible, zero, or even negative", Lewis (1954).

still larger, capital formation is still greater, and so the process continues until the labour surplus disappears.

In Lewis (1954), p. 412.

The link of this model with the current theme lies in the fact that macroeconomic policies, that incentive agricultural production and productivity, will have effects not only on production, but also on the sector's structural transformation; that is, changing crops to more profitable ones, increase in the use of machinery, reduction in acreage and in labor due to increases in productivity[8].

Therefore, the agricultural sector will have labor surplus, which must be employed in other sectors, such as industrial and service sectors (which are, in principle, more efficient than the agricultural sector).

In general, if there are macroeconomic policies that encourage increase in agricultural production through increases in productivity, agricultural growth would not be a problem, because the labor surplus would be absorbed by the industrial sector[9].

[8] That is, increase in production while maintaining the same cultivated area, or even, reducing it.
[9] Considering that there is industrialization.

5. METODOLOGY

Initially, a literature review was carried out on the topic of research and subjects directly and indirectly related. Then, macroeconomic information of Mozambique was collected. Subsequently, the treatment of statistical information was done in order to understand the relationship between macroeconomic variables and agricultural production.

The sequence of the route was not linear and was subject to changes, corrections and adjustments.

The statistical information was collected in the initial phase of the work in Mozambique, so as to form a first basis for reflection and methodological guidance. As the study progressed information was added as required.

The criterion for the selection of macroeconomic variables was based on the literature review[10]. The macroeconomic and agricultural variables considered in this thesis were the following: exchange rate, inflation, GDP, GDP *per capita*, export of goods, ODA (Official Development Assistance), interest rate, government expenditure, government expenditure in agriculture, money, area harvested, fertilizers consumption and labor force in agriculture.

In order to determine the macroeconomic variables that influence the agricultural production, the classical regression model was used, where the endogenous variable was total production. Seven regressions were performed. In general the regressions can be represented as follows[11]:

[10] That is, we used variables that were most used by other authors and that theoretically are related with agricultural production and productivity.
[11] See table II for variables description.

(1) $$Prod_t = f(X_t, \varepsilon_t)$$

Where: Prod – agricultural total production; X_t – covariates; ε_t – error term, assumed to be normal distributed; t – specified period.

The time horizon was between 1980 and 2012. Since this period is very short we used bootstrap analysis to overcome the small data span. "The basic idea of bootstrapping is to approximate the distribution of the estimator via re-sampling and recalculation of the parameter of interest", Barros *et al* (2010). A robustness test was also conducted, in order to confirm the regressions results. All information were introduced and worked on a statistical program, Stata 11.

The statistical information was found on Government Budget and on official reports of national organizations, such as Bank of Mozambique and INEmoz (Mozambique National Institute of statistics). Information from international organizations was also obtained, such as FAO (Food and Agriculture Organization of United Nations), IMF (International Monetary Fund) and World Bank.

6. DATA ANALYSIS AND RESULTS

Table below provides a descriptive statistics about the variables considered for this study.

Table II. Data descriptive statistics

VARIABLE	Description	(1) Mean	(2) Std. dev.	(3) Min	(4) Max
production	Gross production value (constant 2004-2006 million USD)	1210	540.9	671	2558
areaharvested	Total area harvested (ha)	3.385e+06	651971	2.588e+06	4.967e+06
fertilizers	Total fertilizers consumption (tonnes)	18101	19879	1600	80469
ER	Official exchange rate (MZM per US$, period average)	12.02	11.50	0.0324	33.96
IF	Annual inflation (%)	27.21	33.33	-0.956	185.3
gdppc	GDP *per capita* (current prices, US$)	288.9	126.6	130.8	634.3
gdp	GDP (constant prices, millions MZM)	66828	41546	26290	163822
gdp_perc	GDP (constant prices, percent change)	5.169	6.517	-15.70	14.78
savings	Gross national savings (% of GDP)	12.09	7.058	0.462	31.54
goodexport	Volume of export of goods (percent change)	8.545	25.36	-46.20	109.7
ODA	Net ODA[12] received (% of GNI)	27.74	18.71	3.972	81.29
IR	Interest rate (annual average, percentage)	0.238	0.128	0.0361	0.455
GE	General government total expenditure (% of GDP)	26.09	4.813	14.21	35.34
GEA	Government expenditure in agriculture (Millions MZM)	522.6	771.8	1.200	2452
money	Money and quasi money growth (annual %)	31.12	19.48	0.545	85.94
EA	Total economically active population in agriculture	6.667e+06	1.384e+06	5.050e+06	9.313e+06

[12] ODA means Official Development Assistance.

The econometric procedure to analyze time series variables is to first check whether the variables have unit-roots, then check for co-integration among the variables, and finally, estimate the equation.

In order to test the existence of unit-roots the Augmented Dickey Fuller (ADF) unit-root test was used. The null hypothesis is that the variable contains a unit root, and the alternative is that the variable was generated by a stationary process. The test was performed excluding the constant term, with constant and with constant and trend, following the literature.

Table III. Results of ADF unit-root test[13]

	No constant	Constant	Constant & trend
lnprod	1.980	0.580	-2.211
lnarea	1.034	-1.031	-2.440
lnfert	0.062	-1.809	-2.556
lnER	-0.483	-1.826	-0.687
lngdppc	0.325	-0.947	-1.829
lngdp	4.320	2.035	-4.993***
lnGEA	1.395	-0.611	-2.731
lnEA	7.516	1.784	-6.253***
IF	-2.608**	-3.610**	-3.642**
gdp_perc	-2.447**	-3.361**	-3.234*
savings	-1.424**	-3.274**	-2.714
goodexport	-3.606***	-3.911***	-2.746
ODA	-1.031	-2.233	-1.869
IR	-0.214	-1.700	-1.308
GE	0.244	-3.402**	-3.128
money	-1.764*	-3.809***	-3.842**

*** p<0.01, ** p<0.05, * p<0.1

IF(inflation), gdp_perc (GDP (%)), savings and GE (government expenditure) were statistically significant at 5% (0.05), indicating stationary (means and variance of the variables do not change over time), while the lngdp, lnEA (labor force), goodexport and money were significant at 1%.

[13] Variables in natural logarithm are represented with "ln" before the variable name, such as, lnprod, lnarea, etc.

However lnprod (production), lnarea (area harvested), lnfert (fertilizers), lnER (exchange rate), lngdppc (GDP *per capita*), lnGEA (government expenditure in agriculture), ODA (Official Development Assistance) and IR (interest rate) were not statistically significant at any level. Thus, those variables were transformed into first difference variables[14]. At the first difference, all variables were significant at 1%.

These findings suggest the need to test for co-integration. So, in order to identify the number of co-integration vectors, the Johansen multivariate co-integration procedure was employed using the same set of variables defined in table IV; more precisely, the vecrank[15] command was used. In order to select the number of lags the varsoc[16] command was used. The results indicated that the variables are co-integrated, except for regression 1 (represented as reg1 in table IV)[17].

In order to analyze the effect of macroeconomic variables on agricultural production the classical regression model was used, using the bootstrap. Having as endogenous variable the total production and several exogenous variables in level or in first differences (variables with a "d", such as darea, dfert, etc., have unit roots and therefore are used in first differences). Table below shows the results obtained.

[14] In this study first difference variables are named with a "d" before the variable name, i.e. dprod.
[15] Vecrank is the command for determining the number of co-integrating equations.
[16] The varsoc command obtains lag-order selection statistics for Vector Autoregressive Models (VAR) and Vector Error-correction Models (VECM).
[17] See appendix for test results.

Table IV. Results (dependent variable: total production)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	reg1	reg2	reg3	reg4	reg5	reg6	reg7
VARIABLES	dprod	lnprod	lnprod	dprod	lnprod	lnprod	lnprod
IF	-0.0007	0.0015	0.0003			0.0004	
	(0.0075)	(0.0014)	(0.0013)			(0.0009)	
gdp_perc	0.0030	-0.0043		0.0063*	0.0066		0.0021
	(0.0205)	(0.0037)		(0.0034)	(0.0080)		(0.0029)
savings	0.0050	0.0068***	0.0076**		0.0010	0.0049*	0.0081**
	(0.0083)	(0.0026)	(0.0030)		(0.0048)	(0.0028)	(0.0037)
goodexport	-0.0013			-0.0015	0.0020		
	(0.0039)			(0.0012)	(0.0021)		
GE	0.0040	-0.0025		0.0038	0.0085		
	(0.0208)	(0.0060)		(0.0060)	(0.0086)		
money	-0.0005	-0.0037***					
	(0.0051)	(0.0014)					
lngdp	-0.2143	0.5267***	0.4341***	-0.0005			0.2001
	(0.8361)	(0.1725)	(0.1291)	(0.0457)			(0.2684)
lnEA	0.7638	0.5965	1.0918**				1.2881*
	(2.1022)	(0.4992)	(0.5199)				(0.7365)
darea	-0.2136						
	(0.7652)						
dfert	0.0104						
	(0.1083)						
dER	0.1608						
	(1.0704)						
dgdppc	0.1437			0.1681**			
	(0.8344)			(0.0779)			
dGEA	0.0303			0.0612**			
	(0.1662)			(0.0292)			
doda	-0.0020						
	(0.0044)						
dIR	-0.1783						
	(1.5446)						
lnER			-0.0235			0.1393***	-0.0391
			(0.0215)			(0.0228)	(0.0596)
ODA			-0.0025				-0.0020
			(0.0020)				(0.0022)
lnfert			-0.0155			0.0352	
			(0.0225)			(0.0256)	
IR					-0.3824	-0.9462***	0.2106
					(0.2656)	(0.3469)	(0.5232)
lnarea					1.8951***	0.0693	
					(0.2650)	(0.3521)	
lngdppc						0.3604***	0.0927
						(0.1114)	(0.1514)
lnGEA							0.0345
							(0.0394)
Constant	-9.7836	-8.0290	-14.7276**	-0.0959	-21.6400***	3.6514	-16.1122
	(24.6059)	(6.1611)	(7.0473)	(0.4149)	(3.8584)	(5.0037)	(10.1224)
Replications	1000	1000	1000	1000	1000	1000	1000
Observations	32	33	33	32	33	33	33
R-squared	0.511	0.966	0.974	0.295	0.869	0.956	0.975

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

As it can be seen in the table above, the macroeconomic and the agricultural variables considered account, in most cases, for a large percentage of changes in agricultural production. However, the results for variables as inflation (IF), good export, government expenditure (GE), ODA and fertilizers are not significant. Therefore, there is no evidence of the influence of these variables on agricultural production.

Although the results were inconclusive, according to the literature and the graphical analysis (figure 7) a negative impact of inflation on agricultural production is expected, because increased inflation will rise the price of agricultural commodities which could result in reduction in agricultural commodity demand and supply, Brownson *et al* (2012).

Mapila *et al* (2012) referred that to increase crop productivity, increased investment in fertilizers is essential, so a positive relationship between fertilizers and production is expected.

Considering the results for gdp_perc, lngdp, dgdppc and lngdppc, it can be said that GDP has a positive (strong) relationship with agricultural production. This can be justified by the fact that, the factors that positively influence the GDP, could have a positive effect in the agricultural sector as well. Considering, for example, an investment on infrastructure, this would have a positive effect on GDP. Furthermore, the agricultural sector benefits with improved infrastructure, that is, improved infrastructure promotes trade, which constitutes an incentive to increase production.

Savings have a positive influence on production, although it is very weak. According to Valá (2012) the Mozambican businessman tends to realize investments using their own funds, which could be the explanation for a positive (weak) relation between savings and production. It is worth noting that the volume of savings in

Mozambique is very low, on average, it is less than 5% of GDP (Mosca *et al*, 2011). The investment is mainly supported by external savings, that is, FDI, external aid and loans. Note that the agricultural sector uses a relatively small amount of credit, that is, the sector that least benefitted from credit: on average, only 8% of total credit to the economy went to agriculture, Mosca *et al* (2013b).

On the other hand, money also revealed a weak, but negative, relationship with agricultural production. This can be justified by the fact that, as mentioned before, in the last 10 years there was less access to agriculture credit. That is, the production is growing, but the credit volume that went to the agriculture sector has decreased. Moreover, the family farming does not have access to credit.

Labor force on agriculture (lnEA) and area harvested (lnarea) constitute the variables with most impact on agricultural production. Both variables have a positive strong impact on production, that is, an increase by 1% on lnEA and lnarea, individually, increases production by more than 1%. This result is consistent with the literature because, in theory, these are the two variables that are directly related with changes in agricultural production.

According to the results, increases in government expenditure in agriculture (GEA) lead to increases on agricultural production in Mozambique. That is, an increase by 1% in dGEA increases production by 0.06%. According to Casamo *et al* (2013), 80% of public expenditure in agriculture is allocated to investment. However, even though this percentage is very high, Casamo *et al* (2013) emphasizes that most of the agricultural investment is intended to components that contribute little or nothing to increase output and agricultural productivity. This fact could be a reasonable explanation for the low coefficient.

The exchange rate has a positive impact on production, that is, a change by 1% in exchange rate leads to a change of 0.14% in production. This is so, in the sense that depreciation of the national currency (that is, an increase in the exchange rate) encourages exports and, therefore, farmers tend to increase their productivity and, consequently, their production. The other possible reason for this result is that an increase in the exchange rate will constrain importation, in the sense that, a depreciation of the national currency makes imports more expensive (Brownson *et al*, 2012). So, import of food is expected to decrease, thereby promoting domestic products. But, since the agricultural sector in Mozambique is mainly composed by smallholders, who produce for their own consumption and then sell the surplus in the domestic market, this could be the reason why the coefficient is low.

In relation to the interest rate, it can be said that this variable influences negatively the agricultural production (this result is consistent with the literature). High interest rates lead to lower investment, which leads to lower demand and this, in turn, has a negative impact on production. It is important to underline that in Mozambique the financial services are available for a minor part of the population. Since agriculture is mainly practiced by smallholders (households with low incomes), these people do not have access to financial credit in formal institutions. The access to credit in Mozambique is a constraint to the development of agriculture, in the sense that the farmers can only get credit in institutions of micro credit with high interest costs (Abbas, 2014; Valá, 2012).

6.1.Robustness Test of the Results

The main purpose of the robustness test is to validate the regression results presented on table IV. This test seeks to guarantee that, despite the small sample, the results obtained are credible.

In order to test the results, it was used the Bayesian econometrics because it does not depend on the number of observations. More precisely, the weighted-average least-squares (WALS) estimator developed by Magnus *et al* (2010) was used.

"WALS is an alternative model-averaging technique that was originally introduced by Magnus & Durbin (1999) and Danilov & Magnus (2004) to investigate the statistical properties of pretest estimators", Luca & Magnus (2011). The basic idea of this estimator is computing a weighted average of the conditional estimates across all possible models because each of them provides some information about the focus regression parameters, Luca & Magnus (2011).

The results of this test showed that, despite the small sample, the Bayesian model validates the results obtained through the classical regression model (table IV). Therefore the results are robust and sound policy implication can be derived from it.

Table V. WALS results

VARIABLES	(1) walsreg1 dprod	(2) walsreg2 lnprod	(3) walsreg3 lnprod	(4) walsreg4 dprod	(5) walsreg5 lnprod	(6) walsreg6 lnprod	(7) walsreg7 lnprod
IF	-0.0007	0.0016**	0.0003			0.0005	
	(0.0023)	(0.0007)	(0.0005)			(0.0006)	
gdp_perc	0.0031	-0.0043		0.0063	0.0052		0.0026
	(0.0062)	(0.0035)		(0.0039)	(0.0071)		(0.0032)
savings	0.0051	0.0064**	0.0075***		0.0009	0.0049*	0.0083***
	(0.0036)	(0.0025)	(0.0023)		(0.0045)	(0.0027)	(0.0025)
goodexport	-0.0013			-0.0015	0.0019		
	(0.0011)			(0.0009)	(0.0015)		
GE	0.0040	-0.0023		0.0037	0.0076		
	(0.0061)	(0.0044)		(0.0049)	(0.0075)		
money	-0.0005	-0.0037***					
	(0.0016)	(0.0011)					
lngdp	-0.2245	0.5938***	0.4216***	-0.0003			0.1681
	(0.2025)	(0.1205)	(0.1179)	(0.0330)			(0.2086)
lnEA	0.7953	0.3937	1.0781**				1.3434**
	(0.5764)	(0.3341)	(0.4152)				(0.5256)
darea	-0.2034						
	(0.2699)						
dfert	0.0102						
	(0.0276)						
dER	0.1478						
	(0.2918)						
dgdppc	0.1377			0.1680**			
	(0.1707)			(0.0803)			
dGEA	0.0321			0.0612*			
	(0.0437)			(0.0326)			
doda	-0.0020						
	(0.0018)						
dIR	-0.1056						
	(0.4592)						
lnER			-0.0207			0.1409***	-0.0378
			(0.0197)			(0.0196)	(0.0439)
ODA			-0.0026*				-0.0013
			(0.0013)				(0.0015)
lnfert			-0.0094			0.0351	
			(0.0164)			(0.0231)	
lnarea					1.9113***	0.0410	
					(0.2066)	(0.2218)	
IR					-0.2467	-0.9510**	0.1145
					(0.2385)	(0.3491)	(0.3922)
lngdppc						0.3675***	0.1090
						(0.1053)	(0.0988)
lnGEA							0.0359
							(0.0367)
Constant	-10.1691	-5.5786	-14.4342**	-0.0974	-21.8828***	4.0372	-16.7328**
	(6.9899)	(4.0637)	(5.5778)	(0.3043)	(3.0264)	(3.0647)	(7.0579)
Replications	2000	2000	2000	2000	2000	2000	2000
Observations	32	33	33	32	33	33	33

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

7. CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH

The study examined the relation between macroeconomic variables and agricultural production in Mozambique through the classical regression model using bootstrap.

In most cases, the data for some agricultural variables is not available for Mozambique. And when available, it does not cover a long enough period. So, the lack of data for a long period constitutes one of the limitations of this study. Thus, a robustness test was performed to validate the regression results, using Bayesian econometrics. Another constraint to the study lies in the fact that the agricultural sector was affected during the civil war, and this is not taken into account in the model.

The results obtained showed that macroeconomic variables have a significant effect on agricultural production.

Unfortunately, there was no evidence of the influence of inflation, good export, government expenditure, ODA and fertilizers on agricultural production. However, according to the literature a negative relationship between inflation and agricultural production in Mozambique, and a positive impact of fertilizers on production is expected.

Area harvested and labor force are the main source of increases in agricultural production. An increase by 1% in these two variables, individually, increases production by more than 1%.

In relation to GDP, the findings showed that it has a positive impact on agricultural production.

Both money and interest rate have a negative impact on production. This can be justified by the fact that the agricultural sector is composed mainly by smallholders, and

they do not have access to financial credit. On the other hand, higher interest rates are associated with lower investment and, consequently, lower demand, which in turn lead to lower production. Savings have a positive relationship with agricultural production, although it is weak.

As it is expected, an increase in government spending in agriculture leads to increases in production. However, this increase in production is much lower than the increase in GEA (government expenditure in agriculture).

Exchange rate has a positive impact on production, in the sense that, an increase in exchange rate encourages exports so that farmers tend to increase their production.

In general, the agricultural sector should be taken into account in the process of formulation of macroeconomic policies because some macroeconomic policies influence agricultural production. That is, the current macroeconomic environment in Mozambique is not favorable to agriculture.

Based in these results the policy implication should be the following: First, the government should promote sound and coherent policies. The macroeconomic policies should promote agricultural production by promoting agricultural trade, prices and exports. To encourage the agricultural sector the government could use instruments such as credit, public investment, fiscal benefits, exchange rate (that is favorable to domestic development) and, government participation in the modernization of agriculture (that is, construction of infrastructures, price and market policy – ensure price assurance and production quotas).

In addition to promoting agricultural growth, the macroeconomic policies must promote industrialization, in order not to generate unemployment in the economy.

In future research, the technological factor and other macroeconomic variables should be considered in the model because the technological component is a very important source of increases in productivity and, consequently, in production. Future research should also consider the effect of macroeconomic variables on agricultural prices. In this study the technological factor and the impact of these variables in agricultural prices was not considered due to lack of data.

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APPENDIX

1. Co-integration test results

Table VI. Co-integration test results for regression 2

Johansen tests for co-integration					
Trend: Constant				Number of obs = 32	
Sample: 1981 – 2012				Lags = 1	
maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	8	-422.38	.	415.19	156.00
1	23	-316.63	0.99	203.69	124.24
2	36	-281.45	0.89	133.34	94.15
3	47	-254.36	0.82	79.17	68.52
4	56	-236.34	0.68	43.11*	47.21
5	63	-227.98	0.41	26.39	29.68
6	68	-220.79	0.36	12.04	15.41
7	71	-215.02	0.30	0.48	3.76
8	72	-214.78	0.01		

***p<0.01, **p<0.05, *p<0.1

Table VII. Co-integration test results for regression 3

Johansen tests for co-integration					
Trend: Constant				Number of obs = 32	
Sample: 1981 – 2012				Lags = 1	
maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	8	-256.89	.	297.20	156.00
1	23	-201.16	0.97	185.73	124.24
2	36	-165.79	0.89	114.99	94.15
3	47	-140.95	0.79	65.31*	68.52
4	56	-125.32	0.62	34.06	47.21
5	63	-118.83	0.33	21.06	29.68
6	68	-113.56	0.28	1052.	15.41
7	71	-109.23	0.24	1.87	3.76
8	72	-108.29	0.06		

***p<0.01, **p<0.05, *p<0.1

Table VIII. Co-integration test results for regression 4

Johansen tests for co-integration					
Trend: Constant				Number of obs = 32	
Sample: 1981 – 2012				Lags = 1	
maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	7	-272.66	.	316.99	124.24
1	20	-168.28	0.990	108.23	94.15
2	31	-150.93	0.66	73.53	68.52
3	40	-134.19	0.65	40.05*	47.21
4	47	-124.05	0.47	19.77	29.68
5	52	-118.37	0.30	8.42	15.41
6	55	-114.16	0.23	0.00	3.76
7	56	-114.16	0.00		

***p<0.01, **p<0.05, *p<0.1

Table IX. Co-integration test results for regression 5

Johansen tests for co-integration					
Trend: Constant				Number of obs = 30	
Sample: 1983 – 2012				Lags = 3	
maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	105	-196.19	.	369.66	124.24
1	118	-113.94	0.99	205.13	94.15
2	129	-63.32	0.97	103.91	68.52
3	138	-35.69	0.84	48.66	47.21
4	145	-22.77	0.58	22.81*	29.68
5	150	-15.45	0.39	8.16	15.41
6	153	-12.62	0.17	2.51	3.76
7	154	-11.37	0.08		

***p<0.01, **p<0.05, *p<0.1

Table X. Co-integration test results for regression 6

Johansen tests for co-integration					
Trend: Constant				Number of obs = 32	
Sample: 1981 – 2012				Lags = 1	
maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	8	-159.01	.	234.17	156.00
1	23	-103.19	0.97	122.54*	124.24
2	36	-82.83	0.72	81.83	94.15
3	47	-69.36	0.57	54.87	68.52
4	56	-60.17	0.44	36.51	47.21
5	63	-51.99	0.40	20.13	29.68
6	68	-47.02	0.27	10.19	15.41
7	71	-43.69	0.19	3.54	3.76
8	72	-41.92	0.10		

***p<0.01, **p<0.05, *p<0.1

Table XI. Co-integration test results for regression 7

Johansen tests for co-integration					
Trend: Constant				Number of obs = 32	
Sample: 1981 – 2012				Lags = 1	
maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	10	-103.46	.	537.31	233.13
1	29	9.65	0.99	311.09	192.89
2	46	61.07	0.96	208.25	156.00
3	61	98.89	0.91	132.59	124.24
4	74	119.33	0.72	91.72*	94.15
5	85	132.86	0.57	64.66	68.52
6	94	143.5	0.49	43.39	47.21
7	101	152.63	0.43	25.12	29.68
8	106	159.32	0.34	11.74	15.41
9	109	162.84	0.20	4.70	3.76
10	110	165.19	0.14		

***p<0.01, **p<0.05, *p<0.1