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Government intervention in the maize market in the Democratic Republic of Congo

By

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DECLARATION

I declare that the thesis/ dissertation, which I hereby submit for the degree Master of Commerce (MCom), Agricultural Economics at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

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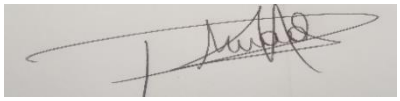

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ABSTRACT

Political economics concentrates on the specific set of social relations organised around the power or the ability to control other people, process and things even in the face of resistance. It commonly refers to interdisciplinary studies in economics, law and political science in explaining how political institutions, the political environment and the economic system influence each other. Important amount of money is spent in agricultural support in the world as well as in The Democratic Republic of Congo each year. This is increasing the pressure on government intervention in price and trade. The DRC as a member of GATT must quantify all forms of agricultural support levels in their schedule of concession. Over the years several instruments were developed to quantify the effect of government policy changes on the economy. These instruments play a significant role in displaying the impact of the intervention and policy on the market as well as advising strategic decision regarding agricultural industries.

The aim of this study was to evaluate the impact of government intervention on the maize market in the DRC within a partial equilibrium framework, according to well defined principle of price formation (price discovery). It will enable identification and analysis of the best policy practice for solving the problem concerning market failure in the maize sector. Additionally, it will evaluate the efficiency of the role played by government interventions in the maize sector, concerning issues relating to increased food security and reduction of poverty in the Democratic Republic of Congo which is one of the Millennium Development Goals.

The key findings of the study are:

- An increase in the yield has a positive impact on the production, therefore, this has led to a decrease in the wholesale price of maize. The area harvested decline as well as the consumption increased due to the lower price of maize;
- The government should promote the production of smallholder farmers and encourage agricultural innovation: given the low yield for most crops;
- The production is there but it has many problems to have access to the market, especially big cities like Kinshasa and Lubumbashi, therefore the import more;

- The government should not only stabilize the exchange rate as it has an important influence on food price but also include an effective implementation of decentralization for strategies better adapted to local realities.

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CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

The DRC is a vast country with an agricultural character where most of the population lives in rural areas, depending primarily on agriculture, livestock and fisheries. Despite the fact that the agricultural sector employs more than 70% of the rural population, most of the production trends for the various agricultural businesses have either stagnated or been in decline since 2011 (WTO, 2011) even though many policies have been undertaken to support the sector. The main food crops are cassava, maize, rice, yam and plantain. The sector, essentially subsistence agriculture, is unable to ensure food independence for the country and to generate sufficient income and sustainable jobs. Production is growing by 2% per year, compared to a population growth of 3.2% and the food deficit is estimated between 20 and 32%, according to the provinces. The contribution of agriculture to the GDP, which stood at 40% in 2009, declined to 17.4% in 2014 and 8.7 % in 2016, because of the resurgence of mining activities (ANAPI, 2016).

Maize is the most important cereal produced and consumed in the country. Despite a huge potential to produce maize, the DRC remains in deficit and continues to import rising volumes to meet local demand. According to the World Food Program, despite the huge agricultural potential of the country, the population remains poor; with a population of about 6.3 million people in acute food insecurity. Malnutrition is a serious public health issue in all the provinces of the country. The DRC's Demographic and health survey (2013-2014) states that 43% of children under five are chronically undernourished, and 23 % are acutely malnourished (World Food Program, 2015). In 2016 the UN estimated that 7.5 million people in the DRC, or 9% of the population, were in need of food and other humanitarian aid. The DRC average rate of Global malnutrition is 10.7% with some territories having a gram above the emergency edge (World Health Organisation, 2016). Despite the fact that the agricultural sector employs more than 70% of the rural population, agricultural production has decreased more than 40% since 1990 (USAID, 2016).

In most African countries the production of food and agricultural products is of great importance, both economically and politically. As a result, one often finds a high level of government intervention in various forms in the agricultural sector (Eberdnezer, 1994). African leaders have committed to support the revolution of agriculture through the Comprehensive Africa Agriculture Development Programme (CAADP), developed under the

African Union's New Partnership for Africa's Development (NEPAD). In the East African region, the support is demonstrated by the formulation of the Agriculture and Rural Development Strategy for the East African Community. Trade linkages inside the region will offer many growth opportunities, and will work to increase cross border trade (Ministry of Agriculture and Animal Resources (Rwanda), 2013). During the United Nations General Assembly in September 2000, the socio-economic development problems have been identified by the international community within the Millennium Declaration, adopted by 189 UN Member States, including the Democratic Republic of Congo. This statement gives a collective vision of the future: a world partially freed from poverty, hunger and disease, greater survival for mothers and their infants, primary education for all, gender equality and opportunities for women, improving the physical environment and partnership between the developed and the developing countries. This statement contains a set of eight development goals: Millennium Development Goals (MDGs), to be achieved by 2015, that have been replaced by the Sustainable development goals (2015-2030). The reduction of poverty and inequalities between different socio-economic groups which touched the agricultural sector thus remains a central concern for many developing countries, international institutions and non-governmental organizations in order to achieve the Millennium Development Goals (MDGs) (Document de Stratégie de Reduction de la Pauvreté , 2013).

The Democratic Republic of Congo is not an exception and each year spends a significant amount of money on agricultural support. There has consequently been an increasing tendency for government to intervene in price and trade. The DRC, as a member of General Agreement on Tariffs and Trade (GATT), must quantify all forms of agricultural support levels in their schedules of concessions. The DRC government wants to extend its policy by setting up, up to 21 agro-industrial parks throughout the country. It reaffirmed this commitment at the Strategic Troika meeting held in September 2016. The first experiment with the agro-industrial park in Bukanga-Lonzo has however not yet been subjected to any evaluation. Therefore, many doubts and questions rose about its importance, its results, its added value, its impact on communities and family farming.

Options based on a variety of approaches, procedures and methods are available to simplify better decision making (Strauss, 2005). These include modelling and simulation procedures and methods, which can be applied to diverse agricultural industries, on micro and macro levels, in order to have a better understanding of the impact(s) of government intervention on the exogenous and or endogenous changes. This improved comprehension of the agricultural

system will lead to an understanding of agricultural systems which in turn is likely to lead to a deeper understanding of the dynamics and risks that characterize each system and sub system, as well as improve the decision making regarding business strategies and government policy.

According to Meyer (2002), the development of commodity models and their applications began appearing in economic literature in the mid-1970s. Consequently, economists and policy analysts have become increasingly aware of the value that these models can add to the understanding and the prediction of movements in commodity prices, as well as estimations of the quantities demanded and supplied. Commodity models have been noted as being one of the most powerful methodological tools that provides a great analytical instrument for examining the complexities of commodity markets, giving a systematic and comprehensive approach to analysing and forecasting market behaviour (De Beer, 2009).

Several instruments have been developed to quantify the effect of government policy changes on the economy. These instruments play a significant role in displaying the impact of the intervention and policy on the market, as well as advising strategic decision regarding agricultural industries. The domestic industry's lack of competitiveness is equally important as a measure to quantify government intervention; however, agricultural sector modelling based on partial equilibrium principles of supply and demand has become a standard approach in most agricultural market analysis and policy impact studies (Kotevska, 2015).

The aim of this study was to evaluate the impact of government intervention on the maize market in the DRC within a partial equilibrium framework, according to well defined principles of price formation (price discovery). It will enable identification and analysis of the best policy practice for solving the problem regarding market failure in the maize sector. Additionally, it will evaluate the efficiency of the role played by government interventions in the maize sector concerning issues related to increased food security and reduction of poverty in the Democratic Republic of Congo, which is one of the Millennium Development Goals.

1.2 PROBLEM STATEMENT

1.2.1 General problem

In recent years, the increase in price volatility on global agricultural markets has been followed by a rise in the variability of food price inflation in developing countries. Price volatility is difficult to predict and hurts both consumer and producer. In the DRC, price volatility's magnitude varies according to products and areas. But most importantly, food prices follow the rate of the dollar (USD). The increase of food prices is justified by the depreciation of the local currency against the American dollar (USD). On the monetary market, 1 USD equalled 1400 FC in 2016. Since the beginning of 2016, the local currency has been losing its value. The Congolese Franc has experienced a depreciation of 920 to 1,400 FC against the USD within few months. This depreciation has had an important impact on the daily life of the Congolese household, as well as on their food basket. Food prices on the market followed the movement of the dollar exchange rate as well as the current political and socio-economical condition of the country. A 50 kg bag of wheat flour which was trading at 36.650 FC in September, rose to 45.700 FC within two months. A kg of maize flour has gone from 600 CF to 1000 CF in Kinshasa. A 100kg bag of corn, sold in July at 72,500 FC, rose to 100,000 FC in August. A bag of 50 kg rice sold at 34,000 FC, rose to 50,000 FC. On the other hand, imported rice went from 45.050 CF to 45,500 FC. 50 kg of cassava flour that was trading at 49.750 FC in the province of Congo-Central was sold for 53,750 FC. There was a 52 % increase in the price of one kg of maize flour and 23% in the price of one kg of cassava flour on the Lubumbashi market in December. However, after a spectacular surge in prices on the market in Goma in November (the price of 1 kg cassava flour increased 14 percent from October and 100% compared to November 2015), as a result of armed clashes between rebels of the M23 and the FARDC, the prices on this market began in December at a relative decline compared to the previous month as a result of the improvement of the security situation and the resumption of supplies (Matininfo.net, 2016). Many other factors can contribute to high volatility such as unpredictable harvest, exchange rate shifts, low levels of global food stocks and financial speculation (FAC/CAADP, 2013). The impact on consumers depends on the extent of price pass-through from agricultural commodity prices to retail prices and this transmission is usually not complete, limiting the impact of food price volatility (Gilbert and Morgan, 2010). Therefore, consumers will not purchase. On the other hand, volatility of food prices impact on the producer when income becomes too low to

provide for the viability, as well as the operational needs of the farm. The level of food stock decrease leads to an unpredicted supply shortfall of food production while on the demand side, an unexpected rise. Volatile spot price levels across several commodities have raised concerns over the role of factors that are related as well as unrelated to market fundamentals in price formation. Exogenous factors, such as greater interaction with the financial system and supply constraints in the freight markets, as well as government intervention policies and measures, have become increasingly important over the last decade (Centre for European Policy Studies, 2013). In major developed countries, agriculture is deeply subsidized and protected but the harmful effects of protection fall most heavily on the poorest countries. The reason was low income. Households have to spend the highest proportion of their budget on necessities such as basic food products and it was in those areas that protection was most common and intense for the exporting countries (GATT, 1993). The major objective of the Uruguay Round was to eliminate trade distortion created by domestic agricultural policies, in order to improve the world market and reduce the necessity for domestic support (Van Heerden, 1992 in H.W Eberdnezer, 1993).However, free price formation in the market economy will only occur if the State uses consistent and correct policies for their regulation.

Policy and institutional innovations can encourage appropriate growth and engage the private sector to develop markets and supply chains. However, political leadership and vision, a coordinated strategy, and a long-term commitment are also essential (African Union conference centre, 2013). Several countries are demonstrating how sound agricultural policy and implementation can result in remarkable growth rates (5 to 7 % as opposed to a 3.8 average for Africa). Several countries are showing that productivity improvements can have major impacts on food and nutrition, security, and poverty alleviation, while also conserving land and resources (African Union conference Centre, 2013).

The DRC is the third largest country in Africa and is awarded with agro-climatic diversity, favourable rainfall and numerous rivers and seas that allow it to produce a range of crops (Agricultural Ministry, DRC. 2010). Despite the natural resource potential, food prices, and more specifically maize meal prices, have remained very high due to a combination of factors linked to low production levels, poor infrastructure and lack of transparent market information. The DRC has the potential of producing maize for the entire central African region, yet maize is imported. This begs the questions: Why is production of maize

insufficient for the country to meet the local demand and, what is the impact of government policies on the volatility of prices that affect producers and consumers.

1.2.2 Specific problem

Globally, policy reaction to food prices has been prompt and governments in many countries, especially in developing countries, have initiated a number of measures to offset domestic increases of prices (FAO, 2010). The government of the DRC has also engaged in a range of policy interventions in an attempt to curb high food prices by providing support to the producer and consumer. Government intervention concerning the regulation of the maize price on the market constitutes an important issue in the DRC. Agricultural resources are slow to adjust to the changing market conditions due to structural, biological, climatic, economic, political and other constraints. Hathaway (1987) commented that in the meantime, the instability of prices with low returns to resources would lead to claims for support by farmers (Hathaway, 1987).

Regarding the price policy and distribution of inputs and credits, some African countries, particularly the DRC, advocate a subsidy policy for the main agricultural inputs to encourage the use of inputs such as fertilizer, improved seeds, grow equipment or improvement in mechanisation, in order to increase the yields and the area harvested. The input subsidies generally are associated with a distribution system based exclusively on organisations (national or international) and government agencies. The DRC has adopted this by providing improved seeds to the farmer (case of maize in Katanga, DRC), for free or on credit that will be refunded at harvest time. In 2012 there was a proposal for suspending the collection of customs duties and value added tax on corn flour to help the consumer cope with increased prices of maize meal. The suspension was affected No. 012/2012 of 21 September 2012.

The Tariff Commission proposed that suspension of tariffs would be brought about through the following measures.

- Strengthening mechanisms to control prices and inventory by the Ministry of Economy and Commerce;
- Creation of a fund for economic revival in particular to facilitate the provision of resources for the rehabilitation of rural roads;

Other measures were undertaken with respect to imported food such as the lowering of import taxes, for example, a 50% reduction over 12 months on imported products such as sugar, chicken, meat, wheat and wheat flour. Other measures included strengthening the mechanism of price control, establishing of control mechanisms of stocks to avoid speculation and the exemption of agricultural inputs imported by lowering import taxes by 50%. Additionally, the Tariff Commission believed that beyond the solutions of a fiscal nature, actions should be undertaken to improve the domestic supply of corn by promoting the agricultural sector.

These are just a few examples of typical interventions that the government has been involved in. However, the success of these government programmes is questionable, given the fact that staple maize prices in the DRC are amongst the highest in the region. Having a clear understanding of the impact of government intervention in the maize sector can inform the process of policy making and the general efficiency of the local market, local policies and the maize sector overall.

1.3 THE OBJECTIVES OF THE STUDY

It is important to identify and quantify the different policy instruments that have been used in the DRC, in order to determine and evaluate the support by government for the production of maize. The objectives of this study are to:

- Provide a comprehensive overview of the maize sector in the DRC, which includes a validated database on the key fundamentals of the industry such as prices, the level of production, consumption and trade.
- Provide a comprehensive review of price formation in the maize sector, which will underpin the structure of the partial equilibrium simulation model.
- Provide a comprehensive overview of current policy trends in the DRC maize sector
- Understand the structure of the maize industry in the DRC by using economic theory and econometric modelling techniques within a partial equilibrium framework.
- The partial equilibrium model is applied to develop a baseline against which a range of policy options can be evaluated to optimise policy decisions. .

- Provide recommendations for a policy framework that will lead to improved investment in agricultural production, with a specific focus on price formation in the maize industry.

1.4 HYPOTHESES

The following hypotheses form the basis of this study:
Government interventions and policies do not support the sustainable production of maize over the long run and therefore do not achieve the goal of providing affordable and equitable access to staple food for consumers

Even if there are measures that have been undertaken by government, their influence on the improvement of the sector is not yet visible as the supply side is not meeting the increasing demand.

1.5 METHODOLOGY AND CONCEPTUAL FRAMEWORK

In order to achieve the objectives, the study will firstly provide a comprehensive overview of the maize industry in DRC, including a detailed analysis of the price discovery mechanisms and to what extent domestic prices are linked to international prices. The study will also assess the government's intervention on the maize market. First, it will unpack the historic trend, then run market integration test and make use of the partial equilibrium to run a combination of scenarios where government intervention is simulated. Econometric modelling has become one of the most frequently used techniques employed in the study of agricultural policy (Sckokai, 2001). When trade occurs between two markets, according to the law of one price, the markets are integrated and the difference in the price equals the transactions costs to move the goods between those markets in the long run (Goodwin et.al, 1990). The formation of prices, also referred to as the equilibrium pricing condition (Barrett, 1999), in a specific market changes as the market shifts between different trade and policy regimes. The equilibrium price in the smaller market can be estimated as a function of the equilibrium price in the dominant market, the exchange rate and the transaction costs. The maize industry model will be evaluated by examining the performance of equations, comparing the values that will be projected and the observed values of the dependent variables. Based on the results of this evaluation, the equations will be identified by the

determination of the appropriate specification based on econometric theory (Calceterra, 2002).

The data used in this study are secondary data, sourced from the Statistics National institute of the DRC, the IRES, the World Bank, and the Ministry of Agriculture of the DRC. The individual equations will be estimated using the Ordinary Least Square, which is a classic econometric technique, as well as its associated statistics such as the R2 for evaluation the goodness to fit, the t-test for significance of parameters, and the F-test for test on groups of parameters (Stckokai, 2001). Following the assumptions of the ordinary least squares, the individual equations are linear in parameter with absence of cross equation restrictions. The equations which satisfactorily explain the structure as well as the behaviour of the market will be therefore be introduced to the model. They will then form the system of equations in the following way; the model will simulate and solve to form part of the recurrent system of equations. It should be also noted that the maize model will use scenario and outlook analysis, meaning that there is a trade-off between the number of variables and detail that can be included in the model and the availability of data series.

1.6 OUTLINE OF THE STUDY

This study is organized into six chapters. The first chapter introduces the problem statement, the objectives, the hypotheses, the methodology and the conceptual framework. The second chapter provides an overview of the agricultural industry in the Democratic Republic of Congo as well as an overview of government intervention in the maize market. Chapter three will present a review of intensive policies undertaken on the study of government intervention. In order to understand the framework of the maize market, chapter four will present a partial equilibrium model of the maize industry in the DRC. Chapter five represents the baseline of the scenario and the policy simulation analysis. A summary of the study and concluding remarks are given in chapter six.

CHAPTER 2: AN OVERVIEW OF THE AGRICULTURAL SECTOR AND THE MAIZE SECTOR IN THE DEMOCRATIC REPUBLIC OF CONGO

2.1 INTRODUCTION

The DRC has enormous agricultural potential. The total area of the country covers 2.35 million square kilometres but only approximately 3 per cent is used for agriculture. It is, however, important to have a good understanding of the key challenges that influence survival of the sector. It is also necessary to point out how past and current developments, supported by government interventions, have solved the country's shortfall in agricultural production and price increases of food commodities.

The agricultural sector in the DRC in general, and the maize sector in particular, are vast and complex industries. Therefore, it requires a conceptual understanding of the economic and political environment within which they operate.

In this chapter, a basic understanding analysis of the agricultural sector as well as the maize industry is performed with a historical understanding of how government intervened in the overall agricultural sector. The aim of this chapter is to provide a general overview of the agricultural sector, the maize industry and government intervention in the market.

2.2 AGRICULTURAL SECTOR

Between the end of the colonial period and the beginning of the 1970s, the Congolese economy boomed. However, the 1970s saw the beginning of an economic crisis which continued for more than 30 years. This crisis was marked by economic recession and monetary instability, mainly resulting from a severe decline in food production, a decline in household income and investments, and extremely high government debt (Ministry of Agricultural and fishery and rural development, 2009).

The DRC is the third largest country in Africa. It is also the fourth most populous country in Africa and the nineteenth most populous country in the world. It possesses diversity in its various zones with characteristic interrelationships between agronomy, farming systems and

climate. These agro-climate features allow it to produce a diverse range of crops (Ministry of Agricultural and fishery and rural development, 2010).

Agriculture is the second largest sector in the economy of the Democratic Republic of Congo, after mining. The DRC, with its 75 million arable hectares, agricultural production possible throughout the year, large agro-climatic diversity, abundance and regularity of rainfall, a high density of the hydrographic network etc., offers strong agricultural potential. However, this sector, despite its potential, fails to capture the funding of financial institutions since the majority of the actors are small farmers cultivating areas of less than 2ha scattered through rural areas, often difficult to reach because of roads in poor condition.

The DRC's agricultural potential has been estimated at 80 million hectares of arable land, of which only 10 million hectares are used for cultivation and pasture, or approximately 1.5 hectares per agricultural household (Ministry of Agriculture and livestock, DRC. 2010). Nationalization and two wars fought since 1990, caused a severe decline in the economy, particularly in agricultural activities. Despite recent political and economic progress, many rural communities live in poverty with little access to markets. Agriculture grew 18.6 % in 2010 because of the high production of timber goods (+89.8%) and coffee (+12.2%) with better world prices (Ministry of Agriculture and FAO, 2012).
Agriculture value added in 2009 was US$ 4 549 million, an increase from the 2006 value of US$3 702 million. The average growth rate for 2006–2009 was 3 %.The sector employed 70 % of the total work force; however it contributes to less than 50 % of GDP. Agriculture's contribution to GDP has decreased, mainly because the mining sector was recently reintegrated into the legal economic cycle. In 2009, the Agricultural sector accounted for 43% of the GDP, 23.12% in 2012 and in 2015 it accounted for 20.6% of the GDP (World Bank database 2012-2016).

The main activity practised by all households in DRC is agriculture. That is, 92.6% of families are involved in agricultural production or in the value chain of the agriculture sector. Most of the arable land is in the plateaus of the Katanga region in the south-eastern part of the country.
The main agricultural products in terms of value are: cassava, maize, plantains, game meat and fruit. Agricultural output has not recorded substantial growth, and its contribution to export is declining continuously - from about 40% in 1960 to less than 10% in 2010. (IMF

working paper, 2004). The value of agricultural exports in 2008 was US$56.55 million, increasing from US$33.92 million in 2005. The average growth rate of export from 2005 to 2008 was 19.1 % (FAO, 2010). The main agricultural exports were unmanufactured tobacco, green coffee, sugar raw centrifugal, bran of wheat, natural dry rubber as well as forestry produce.

Table 2.1: DRC Macroeconomic development (2014-2016)

Macroeconomic Development	2014	2015(e)	2016(p)
Real GDP growth	9,2	7,7	7,0
Real GDP per capita growth	6,0	4,5	3,8
CPI inflation	1,0	0,8	2,1
Budget balance % GDP	0,5	-0,5	-0,7
Current account % GDP	-9,2	-8,7	-10,8

Source: African Economic Outlook.

Table 2.2: Current account (percentage of GDP at current prices)

	2007	2012	2013	2014	2015(e)	2016(p)	2017(p)
Trade balance	5,4	0,6	0,9	0,3	1,7	1,8	-2,0
Exports of goods (f.o.b.)	37,6	31,0	31,5	33,6	31,5	30,9	30,2
Imports of goods (f.o.b.)	32,1	30,3	30,6	33,3	29,8	29,1	32,1
Services	-7,5	-7,3	-6,6	-7,8	-7,3	-7,1	-6,9
Factor income	0,0	-3,8	-8,7	-8,5	-8,2	-8,5	-7,9
Current transfers	5,3	4,2	3,7	6,8	5,1	3,0	2,8
Current account balance	3,2	-6,2	-10,6	-9,2	-8,7	-10,8	-13,9

Source: African Economic Outlook

Initially projected at 10.3%, in 2015 economic growth was 7.7%. The main sectors that maintained the growth was the extractive and manufacturing industries, transport, and telecommunications. Inflation was held at 0.8% and the exchange rate of the Congolese franc (CDF) to the United States dollar (USD) only fluctuated by 0.2% in 2015. Furthermore, the reduction in government spending and the decline of the mining sector have weighed heavily on economic growth in 2015. Economic activity was expected to slow slightly to 7.0% in 2016 before climbing to 8.0% in 2017, due to a recovery of mining prices, expected from 2017, and the positive effects of structural reforms and the rebuilding of infrastructure. But the first quarter of 2016 was characterized by the mining sector's poor performance due to the impact of the economic slowdown in China. This was felt by way of a decrease in Chinese demand for the DRC's exports, as well as decreased investments originating from the Asian giant. The country's economic activity was also impacted by the election period

(KPMG, 2016). To strengthen the economy's stability and resilience to shocks, in January 2016 the government adopted 28 urgent measures, and as part of the strategic national plan for development (PNSD) currently being drawn up, it decided to diversify the country's economy and to broaden the value creation chain.

Real GDP growth was 9.2% in 2014, but declined to 7.7% in 2015 and 7.0% in 2016. This was due to the fact that commodity prices decreased, structural shortcomings in the supply of electricity to mines as well as the temporary suspension of production at some mines weighed heavily on growth expectations. Copper prices were expected to continue to trend lower in 2016, putting pressure on profit margins in the industry and on government revenue. The reduction in government spending has heavily impacted on the economic growth, mainly with businesses that depended on government infrastructure projects and services bearing the brunt of the cutbacks.

2.2.1 Food crop

The food crop consists mainly of root crops and tubers, cereals, fruit and vegetables. In the last five years the food crop occupied on average 5 235 596 ha with agro-industrial or family plantations such as coffee, cocoa, tea and palm oil that occupied 272 753 ha. In 2006, their estimated production provided 19 million tonnes for food, 880 000 tonnes of fruit and 1.15 million tonnes of agro-industrial plantation products, including 1.1 million tonnes of palm oil (PSNA, 2009).

With an annual growth rate of production lower than demographics, all food crops, except cassava and vegetables, are unable to meet the needs of the population. Cash crops, since the 70s, are still regressing, depriving the country of significant revenue for export and raw material for local businesses. Practiced on small family farms which annually cultivate less than two hectares, agriculture is inefficient, in its rudimentary equipment, materials and poor access to modern agricultural inputs (healthy seeds, fertilizers and pesticides), technology and financing.

2.2.2 Animal production

The DRC has significant strengths for livestock production that takes place on 87 million hectares of plains, savannah grasses and treed areas. Those areas are in a variety of climates including tropical and temperate regions. The total number of livestock was estimated at about 7 million head, comprising of 11% cattle, 74% small ruminants and 15% pigs. Over time, the numbers of stock have declined by 30% and production dropped by 20%. The available statistics showed that in 2001 only 70 000 tonnes of meat for domestic consumption was produced in the country. Unfortunately, the production only provided an average intake of 1.3 kilograms of meat per capita per year, compared with a minimum allowance of 13 kilograms per head of population specified by FAO (FAO / WHO, 2010). The ministry of Agricultural and Rural Development in its report estimated the total meat production in 2010 at 157 855 tonnes (Ministry of Agricultural and Rural Development, 2012).

The livestock sector has a certain duality in the systems of production. On one side there are modern businesses but on the other side, production is carried out by semi-intensive production systems practiced by farmers on small areas using traditional farming systems. There are multiple constraints associated with the traditional system. They include:

- Lack of quality genetic material, with poor sanitary conditions and the absence of several years' routine immunization against animal diseases.
- Lack of staff and veterinary infrastructure for monitoring herds and curative treatment, hygiene and poor habitat.
- Absence or poor infrastructure for the preparation and marketing of livestock products.

2.2.3 Fisheries and forestry production

The DRC, with its 40 km of sea shore, the Congo River and its lakes, rivers and other waterways, could potentially provide an estimated 707 000 tonnes of fish per year. This potential is largely under-utilized and the current production is estimated at 220 000 tonnes, which corresponds to an annual average availability of 5.2 kilograms per capita per year. Although there are industrial and semi-industrial fisheries, production occurs mostly through the artisanal mode of fishing that remains very rudimentary. This method does not pay due to environmental considerations. Despite the age of the activity and because of the absence of infrastructure throughout the country, the supply of fish cannot satisfy the level of demand of

the population. Constraints in the sub-sector are numerous. They fall within the technical weakness of production systems (lack of boats, engines, gear and catch means), poor fishing practices related to lack of training and supervision in fishing and fish farming (quasi-, non-qualified people in the fishing services), lack of infrastructure and equipment (fishing docks, cold storage facilities, roads and pathways carts) and access to inputs and finance.

Formal forestry production in the DRC remains very low compared to its potential. Normally it is around 500,000 m^3 of timber annually but is estimated at between 6-10 million m3 of annual opportunities. During the troubled period of 1992 to 2002, the volume of exports was valued at 1,197,415 m3, representing an annual average of about 108 856 m3 per year but with a very large disparity observed annually from 330,300 m3 to 44,000 m3 per year-equivalent logs. The share of export of timber is approximately 70%, indicating a low internal valuation of output.

2.2.4 Types and operating modes of farming

According to Leete , in 2010 the yield of crops per hectare were 8.11 tonnes for fresh roots of cassava, O.78 tonnes for maize, 0.76 tonnes for rice, 0.78 tonnes for peanuts, 4.28 tonnes for plantain, 6.76 tonnes for palm oil, 0.39 tonnes for coffee and 0.30 tonnes for cocoa (Leete et al, 2013).

Yields are low due to, among others:

- system-burn shifting cultivation generally practiced, accompanied by deforestation and reduction of soil fertility;
- reducing the length of fallow, especially around the extra centres (often customary, subject to certain demographic pressure);
- primary use of traditional varieties (or local) leading to (very) low productivity;
- the use of seeds or cuttings of low quality from farmers' own fields (grain or seeds of maize, paddy, groundnut, etc. normally intended for consumption used as seed)
- non usage of organic and chemical seeds;
- the low density of different cultures particularly related to the practice associated with predominant crops in the country;

- the water supply for planting crops being dependent on rainfall (rain fed or dry land crops) or unexploited resources for crop irrigation in a country crossed by countless rivers;
- sowing or planting generally done haphazardly, which makes it difficult to work (e.g. weeding) and does not allow effective and efficient process of the area cultivated;
- the presence of stumps and trunks of trees not excavated, reducing the available space;
- the density of plants in planting hole (due to planting more grains / seeds per hole) which is accompanied by a significant competition between plants for soil nutrients, light, ventilation, etc.. ;
- the fact that operators use only small agricultural tools (machetes, hoes, axes, etc.) to clear limited areas, not attempting to use relatively more efficient equipment such as tillers, chainsaws and animal traction;
- the limitation of the labour force represented essentially (often only) by hand - family labour.

2.2.5 Technical production and harvesting

Extensive or shifting cultivation is practiced in different ways, including intercropping, crop rotation and monoculture. The National Extension Service has produced guides and fact sheets for production since 1991 for food crops, vegetable crops and small livestock. Therefore, the production techniques and harvest depend on speculation, on whether it is located in forests, savannah, mountains, plateau or plain. These technical paths, whether in or out grower plantations organized are generally known to farmers.

2.2.5.1 Monoculture

Monoculture is a form of production carried out in the DRC, particularly in traditional agriculture. In the traditional sector, cotton is still grown using monoculture. Additionally, monoculture is frequently practiced on corn in Katanga, Kasai Oriental and Kasai Occidental, rice and soybeans in Equateur, and rice in Kinshasa. The choice of monoculture is probably related to several factors: the importance attached to speculation (need for

consumption or for the market); the response for introducing new crop; driving technique of culture.

2.2.5.2 Combination of species

The combination of species is the predominant mode of farming in the country. Farmers combine two, often three and sometimes even four species on the same plot. Generally the combination of species is justified by the fact that farmers are limited by a small labour force and few tools and therefor tend to grow different crops together on the same small area of land. This practice makes it very difficult to estimate the yields of different crops. However, it has been shown that this type of production is better than employing monoculture farming practices which tend to permit the build-up of pathogenic organisms in the environment. (Mukamba, 2007)

For the peasant farmer, the combination of species is also justified by being able to improve food security and dietary diversity. The reason is that factors such as damage by pests or disease are reduced, as well as the risks of losing everything due to adverse environmental effects on the production of crops

Combinations of different crops are determined by:

- the needs of consumption and marketable surplus,
- effect on soil fertility ,
- marketing opportunities (especially for perishable products such as plantain),
- length of the growing season,
- agricultural traditions.

2.2.6 The ownership of land

Under the Constitution and the DRC's 1977 Expropriation Law (Law No. 77-001), the state owns all land in the DRC and can expropriate land under concession and held by local communities, as it deems necessary, for public use or in the public interest, subject to payment of compensation.

This law (the Law of 20 July 1973, amended and completed by the Law of 18 July 1980) was based on customary rights and stipulated that the chief of the "owner" clan must consent to any registration of usage or ownership rights to the land by the relevant administrative authority (Ministry of land property,2000). During "Zairianisation" (1973), agricultural businesses that belonged to foreigners were transferred to citizens of the DRC. Later, many properties were purchased by the state. Many of the new owners did not continue to farm their land. The result was that many arable areas became inaccessible and suffered from soil degradation.

At the same time, frequent displacements of the population led to the formation of a marginal group of "small-scale farmers without land" who were forced to rent property. Lease agreements, which were not officially regulated, were often made without a written document for periods of six months to one year, with a renewal option. The consequence was that agricultural investments became very risky. Furthermore, significant restrictions were imposed regarding improvements to property such as the construction of terrace systems, water facilities and measures aimed at improving the fertility of soils.

Investments by foreigners were also jeopardized. During the period of nationalization, previous practices of providing concessions for periods of five to 25 years, with options for renewal, were not honoured. There was therefore a general lack of confidence amongst foreign investors. The harmful effects were particularly apparent in investments in long term projects in the forest industries.

2.2.7 Production system

Food production in the DRC is provided by rain-fed agriculture, organized by peasant farmers and is still mainly undertaken for subsistence purposes. The small subsistence farms are spread over approximately 5 million hectares and are organized mainly by farm households. They are the traditional and present systems of food production. Recently a new production system has been observed namely the group or intermediate system of production.

2.2.7.1 Traditional farming agriculture

The traditional farming or itinerant system has been and is still being used today by subsistence farmers on small holdings for the production of food crops for consumption by their households. Their efforts, although low yielding, represent 80 per cent of food produced in the DRC (Ministry of Agriculture and Fishery, 2013). Subsistence farms produce cassava, maize, rice, vegetables and fruit. Industrial crops of cotton, coffee and palm oil can be grown on small pieces of land too. Thus, the traditional production system is often called "polyculture". The number of subsistence farmers engaged in traditional systems of farming comprises of around six million households over an area of six to eight million hectares (Ministry of Agriculture and FAO, 2010-2014). Their farming area is 1 to 1.5 hectares, using mainly household labour. In general, they do not use fertilizers or improved plant material in their traditional systems of production.

2.2.7.2 Modern productions system

The Modern system of production was used by large agribusiness companies, operating on large commercial farming areas. It was characterised by the use of tractors for mechanized farming, various types of machinery and equipment for the processing of agricultural products, effective agricultural inputs including fertilizers, pesticides, and improved animal and plant material. Irrigation technology was often used with labour being performed by hired labour. Production was mainly for export of sugar cane, coffee, cocoa, palm oil, and cinchona bark, while rubber was produced for the local industry. Modern systems of production were used in major areas for the breeding of cattle. Unfortunately, this type of production system has suffered through the political chaos that marked the recent history of the DRC. Thus, most of the industrial production that was once the pride of the country has experienced many delays, commencing with ‘Zairianisation’ in 1973 and the tragic events of the late 1990s.

2.2.7.3 Group intermediate production system

The Intermediate system is structured in association with and ensured in practice either by religious organizations and cooperatives or by some private societies in rural areas. Farmers make use of animal traction in some parts of the country. The use of animal traction increases according to the area planted. There is a reduction in the number of hours that are worked and an improvement in the mode of transport. As a result of poorly organised routes for export,

farmers now direct most of their production internally to supply large parts of the country's urban areas in spite of enormous production and sales difficulties.

The sluggish trade of produce within the country must also be seen in the light of poor road conditions. In particular, rural areas can sometimes be accessed only with great difficulty. The isolation of rural areas brings about the following consequences:

- Farmers cannot sell their products, causing a decline in income;
- Local products cannot be transported to urban centres without difficulty, causing an increase in food imports.
- Family labour is generally sufficient for most operations on the small scale farm except for weeding and harvesting operations where hired labour is used to supplement family labour.

2.3 GOVERNMENT INTERVENTION IN THE AGRICULTURAL MARKET

Government intervention has been a very controversial issue in the economy of the DRC over the past century. Pursuant to the provisions of Article 91 of the Constitution of 18 February 2006, the Government defines, in consultation with the President of the Republic, national policy and assumes the implementation of the Ministries at the end of Article 93 of the Constitution, responsible for the department of agriculture and rural development. Under the direction and coordination of the Prime Minister, a government program has been established. The program was based on the document, Strategy for Growth and Poverty Reduction (DSRP), approved in July 2006 (DSRP, 2006). Agriculture and rural development, mining, energy, environmental protection and forestry, and the transport infrastructure were amongst the sectors driving growth in the DRC.

The Government formulated planning documents such as the 'National Plan of Action for Environment' and for other sectors, including the 'National Strategy and Action Plan for Biodiversity', the 'National Biosafety Framework', and 'Plan for Agricultural and Rural Development', the Director Plan for the Fishing sector and industry (DSRP, 2006).
Government initiatives, supported by external partners, have however not yet significantly improved the life style of the majority of Congolese. In fact, the rate of poverty is estimated at 70 % (DSRP, July 2006) which is one of the highest in sub-Saharan Africa. It is

particularly pronounced in rural areas where over 80% of the population live on less than a dollar a day (World Bank, 2010).

Food insecurity and malnutrition affect over 70% of the population who become weakened by pandemics of malaria and HIV / AIDS. This is slowing the achievement of the "Millennium Development (MDGs)", which include halving, by 2015, the number of undernourished and that of the poorest in general (DSCRP, 2011). Among the commitments which the Government has undertaken in the Declaration of this meeting include the updating of the Master Plan of the agricultural and rural sector that was devised in 1991, and services restructuring of the Ministry of Agriculture, Fisheries and Livestock (Ministry of Agriculture, 2010).

In light of the results of the review and recommendations of experts from the World Bank, the Ministry of Agriculture has decided to develop a policy for planning, with interventions, directed at the agricultural and rural sector. Additionally, the government of the DRC has intervened to prepare appropriate policies for managing the food crisis and improving sustainability of the nation's population.

The government is aiming to reduce volatility of prices in the market by encouraging all operators in the economy to respect prices that are fixed by the Ministry of Economy. The government of the DRC wants to improve its integration into world trade and undertook, with the aid of the World Bank, a diagnostic study to draw up its trade policy (World Bank.2012). To help the government cope with increases in the price of food, the agricultural commission proposes to strengthen the implementation of the inter-ministerial decree concerning action taken under Act No. 11/022 of 24 December 2011. Such action by the Ministry of Economy and Commerce is embedded in the fundamental principles relating to agriculture, with the aim of strengthening the mechanisms for controlling prices and inventory (Ministry of Economy and Commerce, 2011).

The government has also intervened to assist in reviving the economy by creating a fund for improving the provision of resources for the rehabilitation of rural roads. Other measures include the exemption of taxes on imported food. This would include sugar, chicken, meat, wheat and wheat flour. In addition to these interventions, the government has established an

agricultural park in the Bandundu province to attract new investors, with the goal of improving food security and reducing rural poverty.

2.4 MAIZE SECTOR

Maize is the main cereal produced in the DRC. Its consumption is especially important on the savannah in the north of the country and in the southern provinces of the Katanga and the two Kasais, as described in Figure 1 below. It is produced in the whole country, but four provinces represent nearly 70% of the national production: the Katanga (23%), the Bandundu (17%), the Kasai oriental (17%) and the Kasai occidental (13%) (World Bank, 2012). Maize's local production does not cover national needs therefor there has been an ever increasing import over the years of beans and maize flour (160 tonnes in 2006 to 6348 in 2009) .Approximately ½ to ¾ of the maize on the Kinshasa market comes from the former province of Bandundu, specifically Kwilu. However, current maize production in the province of Bandundu is still rudimentary; the use of fertilizers and mechanization is very rare. This is not only due to the unavailability of these inputs but also the lack of producers and a proper support or financing system. Yields per hectare are around 0.8 tonnes/ha and may go up to 3 tonnes/ha with the use of quality inputs (seed and fertilizer). The gross margin for maize producers in these conditions is actually negative because they do not account for their labour.

Transformation of maize remains very rudimentary in most of the provinces in DRC. Maize is essentially transformed in flour or semolina for human consumption in Kinshasa. The major constraints in maize production among small producers are not only the lack of improved seeds and inputs but also very limited storage. Mastering the maize storage problem is essential, not only for food security but mostly for access to lucrative markets.

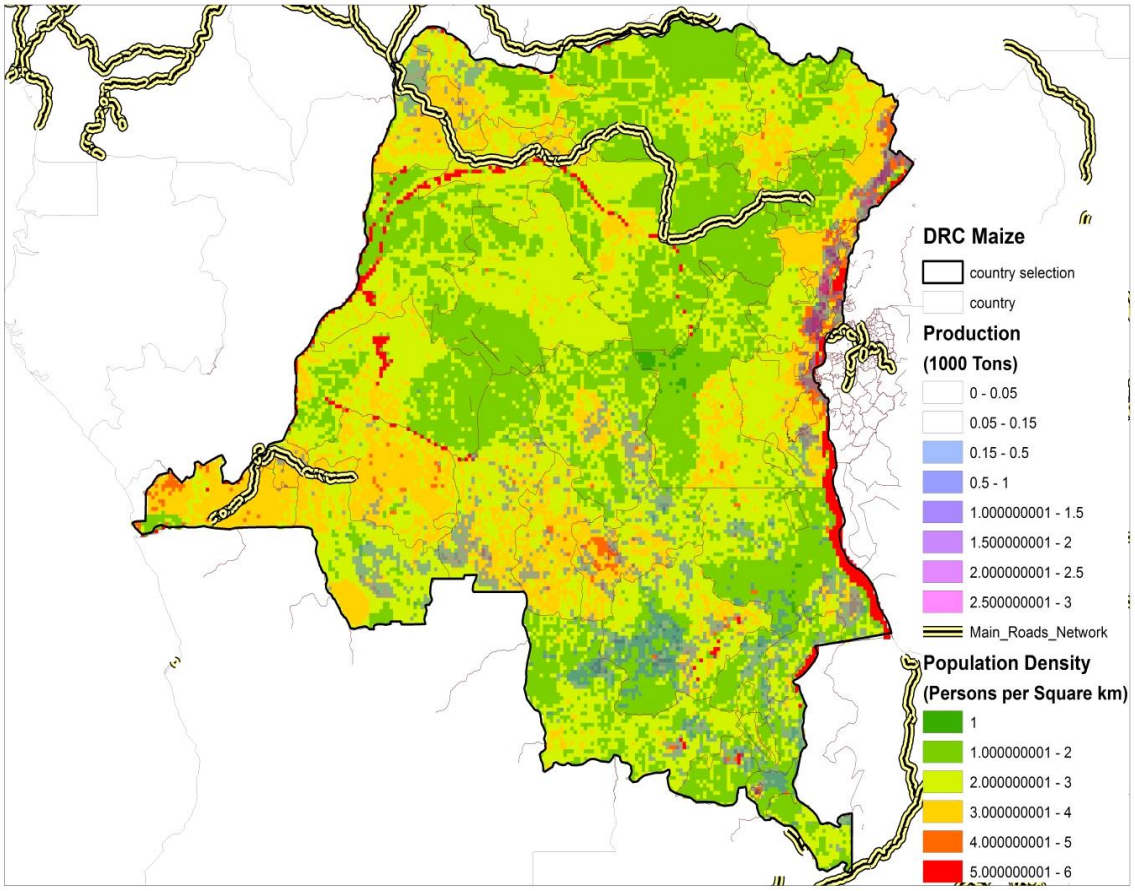


Figure 2.1: DRC population density and maize production

Source: Map mac

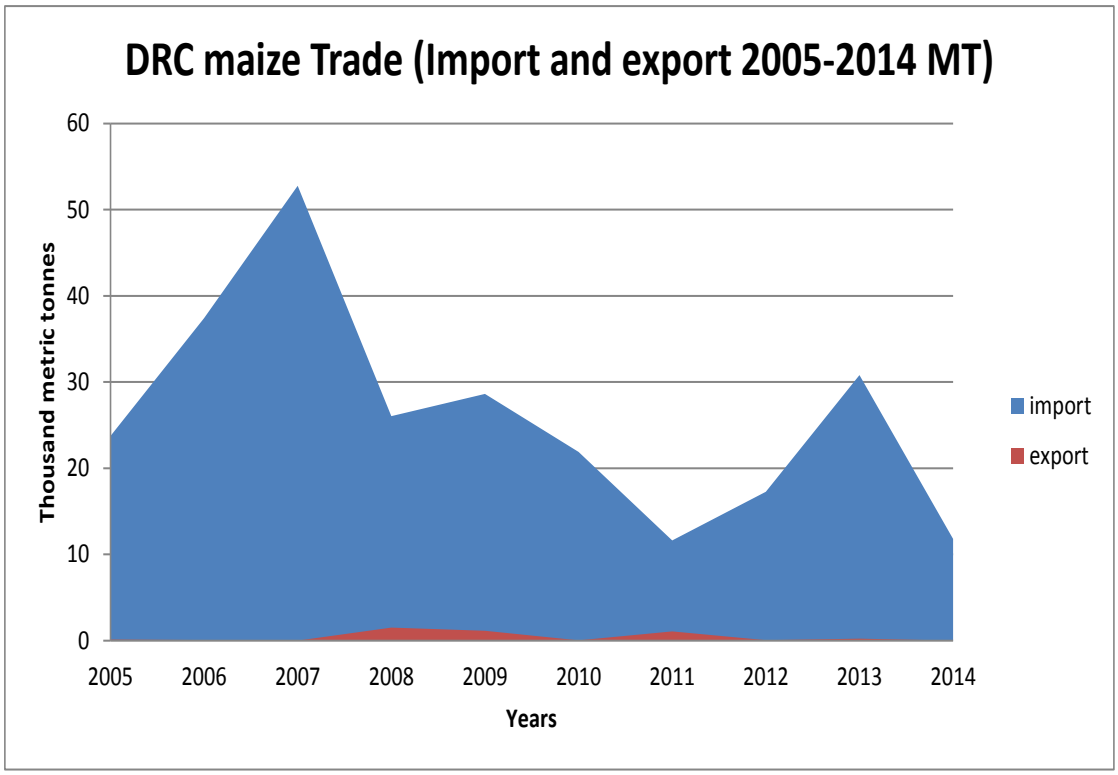
Maize is produced mainly by subsistence farmers on small holdings using basic traditional methods. The total area used for producing maize was estimated at 1.5 million hectares with an average yield of 0.8t/ha (Chausse et al. 2012). Maize production in 2012/13 remained relatively stable compared to 2011/12, increasing by only 0.02%. However, domestic production remains below the consumption requirement and imports still constitute a significant share of domestic maize consumption. The southern provinces of Katanga and Kasai are intensive consumers of maize but local production cannot reach local demand. The country therefore needs to import large quantities of maize, mostly from Zambia and South Africa.

Six provinces produce more than they consume and export to the major cities. They are the provinces of Bas-Congo, Bandundu - both located in the south-west of the country, Equateur in the north east, Province Oriental in the North-West, Maniema and North Kivu in the East. The biggest volume of maize production is based in the Eastern part of the country (Nord-

Kivu, Sud-Kivu and Maniema), where there also is the greatest population density. The population density of the northern part of the DRC is explained by the fact that the population is mostly constituted of fisherman and living by the sea is considered being better than in the forest (Forest equatorial).The deficit in the import was estimated at 71000 tonnes in 1995, and would have reached over 800 000 tonnes in 2010 according to the Ministry of Agriculture of the DRC (2010).The main regions of consumption are the provinces of Katanga, Kasai and Kinshasa where the annual consumption per head increases yearly. The southern provinces represent more than two thirds of the national annual consumption of maize with Katanga at 34%, Kasai Oriental at 18% and Kasai Occidental at 16% (Ministry of Agriculture and Fisheries and Rural Development, 2012).Despite the small production volume, the quantities produced in these provinces remain bigger than the Eastern part of the country but they are highly unprofitable, especially Katanga. In the past, the major mining companies had large commercial farms, especially in Katanga (old farms of settlers). However, because of successive wars, all these companies ceased to operate, except for some that continued at the request of the government. Apart from consumption for food, some maize is used for the manufacturing of artisanal beer as well as for animal feed. Maize, as an important foodstuff, is sold as flour or grain. The farmers on small holdings sell most of their production of fresh maize at local markets, while the remainder is sold in large cities.

In 2000 the maize production was at 1 184 000 tons but decreased consequently to 1 169 188(1.25%) in 2001 and to 1 154 776 (2.47%) tons in 2002. Between 2007 and 2011, maize production increased from 1 155 540 tons to 1 156 106 tons (or 0.5%) (SNSA), but still production was not sufficient to cover local demand which was relatively high. Although the total available arable land is estimated at over 120 million hectares, only 10 % is currently used (3 % for agricultural and 7 % for breeding) (ANAPI). Despite the fact that the DRC has agricultural potential and available land, the country has to resort to imports to cover the shortage of maize.

Figure 2.2 : DRC maize Trade (Import and export 2005-2014 MT)



Source: FIEWSNET

Imports of maize increased considerably from 2005 to 2006 and decreased in 2008 (Renapri, 2014). Total exports are very low and quasi-non-existent, increasing from 2007 to 2009 and then going back to zero. Trade inside the country is dominated by the main road located between Kinshasa, Bas-Congo and Bandundu, from the Equateur province to the Province Oriental and Province Occidental. The Congo River also plays an important role in the trade sector as trade between Equateur, Province Oriental, Province Occidental and Kinshasa is conducted via the river. The biggest port in the country, Port de Matadi, is where the country import and export from.

The price of maize is highly volatile across the country, mostly on the principal market. On the other hand, there is a quasi-non-existent export of maize from the country. The price of the maize for the producer varies from one area to the other and is strongly related to the degree of isolation of these areas of production. There is no stability in the maize price. The price declines in the period of abundance and increases in period of scarcity. The formation of the price on the market depends on the supply, mostly as the demand increases yearly. The most important price increase was observed in Katanga with 54 % in the 2010-2012 period and 90% in the 2012-2013 period. This was due to high cost and infrastructure limitations related to trade as well as the fact that a large amount of land was used by mining companies.

Table 2.3: Average yearly price (Franc Congolais (CDF)/kilo)

Years	Maize flour retail (Fc/Kg)	Maize grain wholesale (Fc/Kg)
2005	228	154.5
2006	251.3	156.3
2007	348.8	219.8
2008	476.8	315.9
2009	635.2	418.2
2010	643.3	400.5
2011	890.5	574.3636
2012	930	574.4
2013	890.5	613.2

Source: Ministry of Agriculture (Kinshasa, DRC)

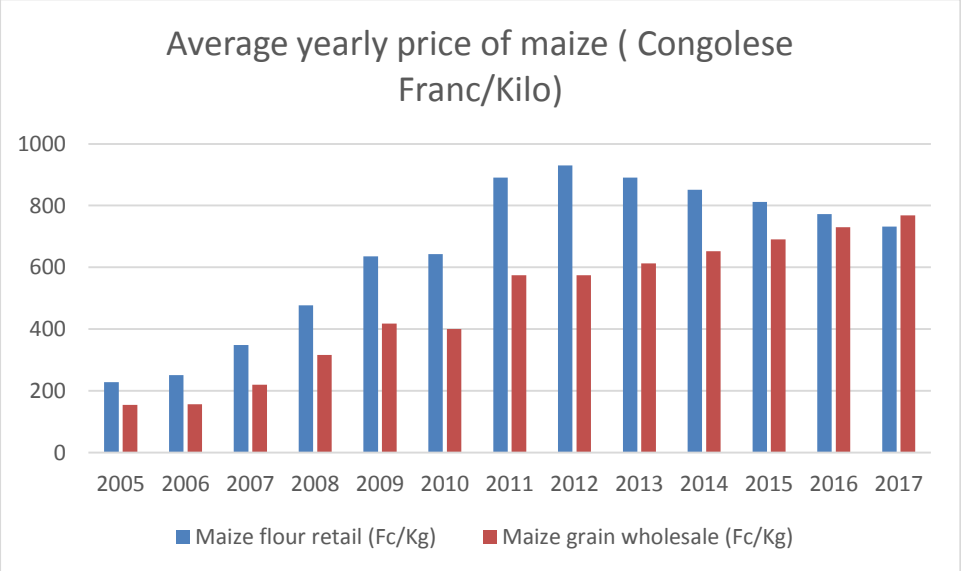


Figure 2.4: Average yearly Maize price (Franc Congolais/kilo) retail and wholesale

Source: Ministry of Agriculture (Kinshasa, DRC), service national des statistiques agricole.

On the Congolese market the price of maize, as with other staple food, is volatile. Most of the transactions take place through individual negotiation. Sellers and buyers meet in person and agree to trade at a certain price. According to the secretary of the Ministry of Economy, price fixing in the DRC has been liberalised since 1980. For individual transactions to be effective, the market price must be efficiently determined and represent all of the supply and demand forces at work in the economy or in the market (Ministry of Agricultural and rural development, 2010). From 2006 the price has increased due to the slow increase of the GDP. In 2007 the GDP was at 6.3% and should have increased to 10 % in 2010 but in the second semester the international financial crises, as well as the civil war in the east of the country, affected economic activity in the country. That has slowed down economic activity and management of the public and finance sector became challenging. Forker (1994) stated that the terms of the transaction, including the price, might be informally agreed upon or might be in the form of a formal written contract. Congolese market transactions are informal as there is no contract between buyers and sellers; the transactions are not taxed or monitored by any form of government policies or measures. The increase of the maize price is influenced, firstly, by the transportation cost from the farm to the market, the taxes and fees that the buyers must pay at toll gates and the storage cost of the grain. Secondly, by natural events like floods and droughts that occur in producers' locations, mostly from September to December and the archaic techniques and methods used in production. The supply of maize meal, produced in Zambia, justifies the prohibition of exports. Lack of information from the Congolese market does not provide buyers and sellers with information about the market condition and prices. Indicative price formation in agriculture represents the process of price formation on products and services as the result of supply and demand interaction based on non-directive, advising, recommending intervention of the government at different administrative levels (Kundus 2004).

2.5 SUMMARY

DRC has an abundance of natural resources and it could therefore be argued that it has a greater potential than many of its African neighbours to lift its population out of extreme poverty. However, its agricultural sector needs wholesale reform with the support from both the public and private sector. Since the early 1990s the growth rate of food production, at an annual average of 2%, remained below the population growth rate (3.3%) (PDDA, 2011).

Despite being an agricultural exporter prior to independence in 1960, the agricultural sector in the DRC has gone through long periods of stagnation and decline. In general, domestic food production is 20 million tons below current food needs, determined at 25 million tonnes per year. Exports such as palm oil, coffee, cocoa and rubber crops have always been exploited by agro-industrial enterprises. Currently, the agricultural sector is growing at 2% per year, but this is slower than the increase in population. The International Food Policy Research Institute (IFPRI) has blamed the government's lack of support for agriculture for continuing food insecurity in the country (FAO, 2009). Many farmers are struggling to have access to credit and despite the government's intervention with international partners such as FAO and World Bank, there is only a slight improvement of both public and private investment in agriculture, as well as in the country's energy and transport infrastructure. Additionally, the availability of data regarding the trade market is very challenging due to the far distance between provinces and low infrastructure which causes an increase in the informal trade market.

CHAPTER 3: COMPREHENSIVE REVIEW OF AGRICULTURAL POLICY IN THE DRC AND THE THEORETICAL FOUNDATION FOR ITS EVALUATION

3.1 INTRODUCTION

Crop production and animal husbandry generate the bulk of food consumed in the world today. Therefore, in most countries of the world agricultural production in general, and food production especially, is of great importance economically and politically (Helm, 1994). As a result, governments of all countries in the world attach a great importance to the guidance of agriculture. That occurs mostly through a wide variety of mechanisms that have been developed to influence prices in order to achieve their goal.

The rationale for government intervention stems from the belief that uncontrolled market forces would not enhance food security and would lead to hardship as well as political pressure to both raise and stabilize farm income. In the process of supporting prices, guidance policies became involved with side issues of food prices, supply security, trade patterns and the desire for protection against foreign competition. In this regard, both political and economic considerations tend to be the determining factor in decision making (Eberdnezer, 1994).

In most cases government intervention has resulted from a complex set of regulations concerned with marketing that necessitates a sizable bureaucracy with considerable funding. Unfortunately, the result has been a tendency to inhibit change (Josling et al., 1983).

In the DRC, since 1990, the government has undertaken a series of uninterrupted policies of reform aimed at progressively liberalising the economy and opening up international competition. A review of trade policies of the DRC with the WTO will be discussed within the context of government macro-economic policies to provide the country with a world class business climate. These were designed to help open up diversity in the economy on the basis of a coherent trade policy (WTO, 2012).

Government intervention may target a wide variety of objectives. The policies that result in high subsidies to producers in industrialised countries and cheap food in developing countries

may favour powerful special interest groups, even though they are motivated by important social and economic concerns (Mohanty et al, 2012).

The purpose of this chapter is to consider the importance of government intervention in agriculture. The first step will be to analyse why government intervention is necessary. The second will identify the policies used by the government and the third step will be to analyse the partial equilibrium tool that will be used to design the maize sector model of the DRC.

3.1 RATIONALE FOR GOVERNMENT INTERVENTION

Since 1970, several events have occurred in the international economy along with an increase in government intervention and protection in the economy. The result has strained trade relations and complicated agricultural policies. During this period, the world frequently experienced simultaneous food shortages and surpluses so that countries that used to be importers of base commodities became exporters together with a reduction in the purchasing power of countries that should be buying more food (Groenewald, 1986).

Government intervention has been a very controversial issue in the economy in the past century. According to Strauss (1987), government intervention in agriculture was determined, firstly by socio-economic and strategic considerations and secondly, by specifics characteristic of agriculture. Others will argue that governments need to intervene in their economies through industrial policy, regulation and a wider variety of monetary tools (Stiglitz, 2009). Most of small open economies often set their prices in dollars, therefore international markets set the prices of commodities, which in turn determine local prices. The result is that inflation targeting is really only effective against a ¼ of prices typically set in the local economy, such as the price of labour. An example is the effective industrial policy implementation behind Korea's successful shift from rice farming to technology and industry based economy (Chris Blaine, 2009). The economic theory of regulation was developed from attempts to explain the effect of government regulations on industries. In his theory, regarding a model market for government intervention in the economy, Peltzman (1976) stated that politicians, especially public regulatory agents, behaved as if they were breakers, clearing the market but allocating direct and indirect transfer payments among high and low bidders in the political market (Peltzman, 1976: 211).

According to the Organisation for Economic Co-operation and Development (OECD), the principal reason for government intervention is to provide a safe, secure and sufficient supply of food for consumers at reasonable prices, while guaranteeing a satisfactory and equitable standard of living to farmers. Therefore, the motivation for government intervention in the agricultural sector can be summarised as follows:

First, to manage the long-term trend in prices that should be stabilised. As a result, the policy making decision process has often been expropriated by agricultural interests under the guise of price stability. In fact, it has imposed price support policies at a level of support to ensure price stability on domestic markets. In most cases, stability was achieved through public storage by maintaining the storage costs as low as possible. These price stabilities with an end to unpredictable competition reduce the risk of investing in agriculture (Tyres et al, 1992).
Second, if the income elasticity of demand was relatively low and positive and varied according to the product among the different incomes of consumers, the indication was that with growth in consumer income coupled with relative smaller national income, in the long term would result in higher expenditure on agricultural products. That would be dependent on how growth in income affected price and consumption and how producers reacted to the changes in the income (Lucas et al., 1979).

Third, government could intervene in order to reach socio-economic strategies and objectives. Government could try to keep a certain level of the population in rural areas and seek to achieve that purpose by supporting agriculture (Strauss, 1987).

3.2 SOME POLICY REVIEW

In order to establish an effective and more competitive economy, the government has continued to adopt measures designed to reform the trade policy. In addition, it wanted to liberalise economic activities and improve its dialogue and partnership with the private sector and civil society through management of the economy as well as establish a competitive environment in various sectors (WTO, 2010). The WTO, through the trade policy review body meeting, has provided a summary of reforms that have been undertaken by the DRC (WTO).

3.2.1 The trade area

In the trade area the following points are important to note:

- The simplification of the customs regime by introducing a four-system band of support which is zero, 5%, 10% and 20%;
- The elimination of quantitative restrictions on imports, licences and other export authorisations;
- The prevention and suppression of anti-competitive trade practices;
- The introduction of measures designed to guarantee fairness in commercial transactions, in particular through metrology and crackdown on discriminatory sales, refusal to sell, holding of stocks for speculative purposes and conditional sales;
- The implementation of legalisation on government procurement;
- The implementation of the computerized customs management system (ASYCUDA) and the establishment of a single window for customs in Matadi and Kasumbalesa.

3.2.2 The legal and institutional framework for business

The Government has put into place a legislative and regulatory framework that is liberal, attractive, and geared to promote an environment of competition and competitiveness. The government also secured in 2002, through adoption by the National Assembly, the new Investment code, the New Mining code, and the New Forestry Code. These different codes will strengthen the advantages and legal guarantees accorded to companies wishing to invest in the DRC.

3.2.3 The taxation sector

The government introduced a Strategic Plan for the Reform of Government Finances (PSRFP) with two principal objectives:

- To present the vision of the government with regards to government finances and the main reforms it intended to introduce by 2012;
- To provide a useful reference for domestic actors (public sector, private sector, civil society) and for development partners so that their respective contribution can be made in a coherent framework conducive to synergy.

In accordance with the Breton Woods partners and the private sector, the government held the adoption by Parliament of a new Custom Code, which was already in effect following its promulgation by the head of state on 20 August 2014. The customs code has been completely adapted to the International Convention on the Simplification and Harmonisation of Customs Procedures (the revised Kyoto Convention). Its objective was to rationalize custom control beginning in 2003 following the promulgation, in accordance with the WTO agreement on Customs Valuation of Law no. 009-2003 on customs valuation. However, developing countries together with the DRC has adopted for a simplified tariffs policy and relatively low tariffs.

The import tariffs structure involves four rates: zero per cent, 5 per cent, 10 per cent and 20 per cent; therefore, the tariff peak is considerably lower than the WTO bound level. The tariffs are the only form of protection of domestic production.

The export tariffs policy is based on the principle of non-taxation of goods. The applied rate is fairly low, and varies from 1 per cent to 10 per cent for an exclusive list of products. According to the guide lines of the Enhance Integrated Framework validated in June 2010, all these duties have been eliminated, particularly in the case of agro- industrial products.

3.2.4 Agriculture sector

The DRC's agricultural and rural policy has aimed to reduce by 50 per cent the proportion of the population whose income is less than 1 dollar per day and the proportion of the population suffering from hunger by 2015 (DSRP, 2010). It also aimed to achieve sustainable agricultural development so as to preserve its productive assets, which form the foundation of its economic recovery.

The agricultural sector policy has 5 main objectives:

- To improve market access and the value added by the country's agricultural production;
- To improve productivity in the agricultural sector: food crops, fruit, vegetable, fisheries and livestock;

- To promote decentralized financial systems that are in keeping with the nature of activities in the agricultural sector;
- To build up the technical and organizational capacity of support for institutions involved in public and private production;
- To encourage the development of a self-management structure and support promotion of culture.
- To improve access to basic social services such as health, education, and clean water and improve basic socio-economic infrastructure.

In order to reach those objectives, the government launched the following reforms: Restructuring of the central and regional services of the Ministry of Agriculture, Fisheries and Livestock; reform of the legal framework with the adoption of the Agricultural code; drafting of the phytosanitary law and veterinary law; decentralization of the agricultural services with the transfer of skills to the provinces; the agricultural Policy Note and an in-depth study of the agricultural sector with the support of the African Development Bank.

3.3 RATIONAL FOR INTERVENTION

The only rationale for considering intervention in the operation of an entity is that it is functioning poorly. Poor functioning may be defined as wrong or insufficient output or excessive wastefulness in the way the output is produced (reference). Market failure refers specifically to the causes of problems by the mechanisms through which the market works. When markets are not efficient, then the government should intervene. Therefore, the interventions demonstrate that a market failure exists and should be corrected. This will depend on how significant the failure is and on the ability of the public sector to design and implement an effective intervention. Public sector intervention is more likely to be effective when it addresses the cause of the market failure, and where it seeks to improve the functioning of the market rather than replacing it. “Government intervention” is used here as shorthand for “government intervention in the operation of the economy”. Since the economy is one of the mechanisms by which a society moves to satisfy its objectives, intervention is usually triggered by dissatisfaction with the way the economy is performing in this regard. To identify all the categories of justifications for intervention, and to specify the dimensions across which the impact of interventions should be judged, it is necessary to contemplate that

subset of social objectives whose degree of satisfaction is susceptible to plausible differences in the way the economy operates (Vic Wright, 2009).

In all countries, the government regulates economic processes, which include agriculture. Government intervention in agriculture is varies from country to country and is dependent on various factors. Since the independence of the DRC, the international financial partner of the government has implemented many agricultural development plans and programs. The study of the agricultural sector conducted in 2009 by TECSULT-AECOM has listed at least 22 plans.

The objectives, rarely achieved and rarely or ever evaluated, were most often transferred to the following programs, with little success. It was also widely acknowledged that these multiple national and provincial sector strategy documents were too broad, with no priorities and no realistic and simple monitoring opportunities. The reasons for the failures of these multiple programs compared to what was happening elsewhere in the Democratic Republic of the Congo. Priority in the agricultural and rural sector development was given to emergency operations without a real medium- and long-term strategy. Thus, for a very long time, the approach remained based on short-term, poorly initiated and budgeted projects that eventually became permanent administrative structures without any real impact on the ground. The main strategic orientations of the government for the medium term were the following: Benchmarks are found either in the documents designed by the development partners, in the speeches of the Head of State which take the form of force of law, or in the declarations made at the end of the advisory committee meetings or the Round Tables. “Several agricultural and rural policy documents designed by donors or inspired by them contain the reflections that follow others, unassuming and with the same content "(Makala Nzengu 2009).

Parallel to all these initiatives, the Agricultural Policy and Rural Development Note (NPADR), was a program designed to contribute to achieving food security and to the sustainable and effective improvement of the rural population’s life. This new outline of agricultural policy is of high quality, comprehensive, relevant and remarkable (Kitsali 2013).

The actions undertaken by the government and donors are still disparate, dis-concerted and weakly supported in their implementation. Many projects exist, but without being integrated into a robust and equitable sectoral policy, the impact of these interventions remains low. The

increase of rural poverty is a cynical but glaring demonstration of the weakness of the intervention.

Some opportunities for change have started to take shape, but are still very fragile. These include the recent promulgation of the Agricultural Code and the effective establishment of the CARG (Rural Agricultural Management Board) in various provinces. These changes have materialized through the implementation of the fundamental principle relating to agriculture that ended the legal vacuum and set out a number of principles to promote the development of agriculture in the DRC, integrating social and environmental factors such as family farming, for the first time defined and recognized as the cornerstone of the Congolese economy. An agricultural cadastre is created, agricultural products are exempt from export duties and this has led to the creation of a national fund for the development of agriculture.

3.4 MODEL STRUCTURE

Modelling approaches in agricultural policy analysis can be time series models or market equilibrium models such as the partial or general equilibrium models that implement policy impact analysis with a more understandable level of aggregation (Tongeren et al., 2000). The use of the time series model is generally applied to help with the forecast of the future on the basis of extrapolation of historical data. The time series model put more interest on the statistical behaviour of the data than on the behavioural economic theory. In the other hand, the market equilibrium model involves the response of economics agents to the change of price in the market. This model determines the equilibrium prices and quantity on a set of market. The determination of the market equilibrium depends on the producer and consumer demand and supply behaviour in the market that involves income, price and elasticity (Tongeren et al., 2000).

In quantitative policy analysis, a domestic product can be represented by a single market model, a selected set of multi-markets systems, or as a wide economic equilibrium model, for a more complete representation of national economies. Econometric commodity models provide a strong quantitative policy analytical tool for examining the complexities associated with the agricultural commodity market. It is used to analyse and project the effect of the policy, to discuss and evaluate policy alternative. Econometric models as a tool of the quantitative policy analysis are used to describe the main economic mechanisms of a national

or sub-national economic system. Using regression analysis with different estimation methods, it is possible to estimate a model's parameters, coefficients and elasticities from available data at the micro or macro level (FAO, 2009). Furthermore, econometric models can be a single equation or set of equations establishing relationships among institutional, definitional and behavioural variables. Additionally, structural agricultural econometric model building is the process of building an economic model of a particular commodity or set of commodities for a particular country or region. Policy makers use these types of models to simulate the impact of alternative policies, macroeconomic events, weather events, and technologies on their agricultural sector. These models can also be designed to measure the aggregate impact on consumer and producer well-being. Econometric modelling involves a combination of estimated and synthetic behavioural equations combined with basic identities to form the basis of a system of simultaneous equations (World Agricultural Economic and Environment Services, 2012).

Partial equilibrium models, as one of the tools used in econometric modelling, consider a particular market or sector as closed and without linkage to the rest of the economy, for example the agricultural sector that is affected by the rest of the economy but which has no direct effect on the said economy. The effects of the rest of the world and the local economy on the sector are treated as exogenous (De Beer, 2009). The partial equilibrium model includes behavioural equations, which represent the responses of an economic agent making supply and demand decisions. This model is mainly applied to policy analysis of a specific product (Calceterra, 2002). Partial equilibrium models are widely used in sector specific analyses and have found numerous applications in the context of economic policy analysis in agriculture. Models establish equilibrium within the sector by solving the various behavioural equations simulation so that total supply equals total demand at a specific price. This maize market analysis can be described using flow charts which reflect a causal ordering of the supply utilisation price structure, and the price and quantity space (P-Q).

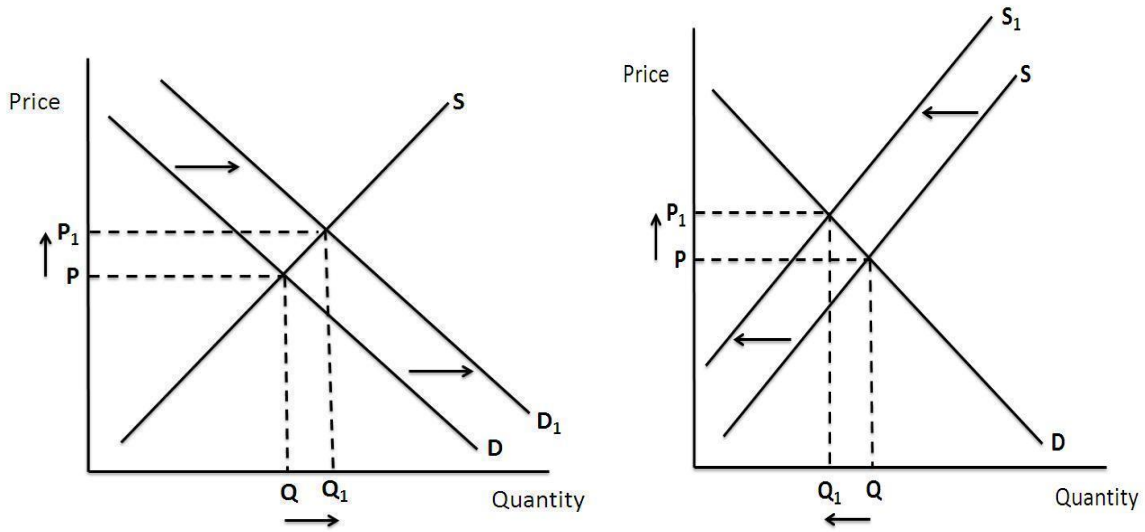


Figure 3.1: P-Q for a commodity market

The figure above expresses a change in demand and supply through a shift in the relevant supply or demand curve. The change in demand is due to changes in various other factors such as change in income or a change in consumer's tastes and preferences. A shift in demand occurs when there is a change of one of the factors of demand while keeping price at constant. For instance, an increase in a consumer's income will lead to an increase in the demand for his preferred goods; shifting his demands curve to the right. This will lead to a higher quantity being consumed at a given price *ceteris paribus.*

The shift in the supply curve occurs when one of the factors of supply change such as a change in the price of input production like labour or capital; a change in production technology and its associate productivity change, then there is a corresponding change in the supply curve. For example, if there is an improvement in worker productivity due to some human capital or technology investment, then the cost of production decreases. This has a positive effect on the supply curve, shifting it to the right where new market equilibrium is at a higher quantity and a lower price, holding everything else constant. There can also a negative shift that moves the supply curve to the left with higher price and lower quantity, *Ceteris paribus*.

For this particular study, the partial equilibrium model is appropriate because there is only one commodity that is modelled, which is maize. The maize market model will facilitate understanding of the nature of the economic and statistical relationship amongst the variables

that influence supply and demand, whilst also explaining how policy and other relevant variables influence production and consumption of maize.

3.5 PRICE DISCOVERY PRINCIPLE

In his paper Barrett (1999) stated that the market equilibrium price was a function of the domestic supply and demand factors in each market respectively. Therefore, when the difference in the market prices becomes less than the transaction costs, trade is discontinued and the markets are no longer integrated (Sexton et.al., 1991). The domestic price is therefore set by the country specifics policies and trade thus will establish how the domestic price is incorporated in the world price (Meyer et al, 2006). Market integration measures the degree to which markets at separated locations (from different countries) share long-run price or trade information on a homogenous commodity (Amikuzono, 2010). Therefore, the price transmission process from markets geographically separated, will depend: firstly, on the volume of trade; this means that the quantity of trade (import or export) as well as the size of the market and the existing transport capacity has an impact on the price transaction. Secondly, the transfer costs can vary significantly over time; therefore, considering these costs as constant or as varying following a smooth trend will edge the capacity that price transmission analysis have to offer meaningful policy conclusion; Thirdly, by government behaviour (Myers and Jayne, 2010). For example, during the food crisis food prices have doubled and increased by 85% from 2007 to 2008. The United Nations and the governments minimized the potentially dangerous implications of food hoarding through restrictions or bans on food exports (UNCTAD, 2008).

It is argued that government tariffs and licensing requirements, together with the unpredictable, unrestricted imports by the government itself, will lead to a discouragement for the private sector to play an effective role in the organisation of imports, as well as to promote appropriate price transmission (Tchirley and Jayne, 2010). Government, as well as policy decision makers, must increase their interest on the higher global prices being transmitted into the local commodity market in order to protect domestic producers and consumers. The dynamics of price formation has received attention across a wide range of commodities; therefore, it has developed a partial equilibrium model to explain the characteristics of price movement and future markets for storable commodities (Zapata, 2005).

In a partial equilibrium price formation, net trade is modelled as a function of the world price and the exchange rate. Price discovery is an important and common function of markets. Competition in trading plays an important role in the price discovery process. The competition process is at the same time the price discovery process in a transaction. Under the import and export parity regimes, the domestic price is modelled as a function of the import and export parity price respectively, with the exchange rate factored into those prices as well as into the international supply and demand situation and international prices (World Food Program, 2008). The law of one price advises that the correlation between the world price and the local price equals one.

3.6 PARTIAL EQUILIBRIUM MODEL

3.6.1 Introduction

Modelling in the agriculture sector of a specific country or region is the process of structural and economic modelling of a particular commodity or set of commodities that reflects changes in a policy or policies that take place over time. Quantitative modelling is therefore a well know method used in agricultural policy because it provides understandable and real results by quantifying the impact of policy on the wellbeing of the country or region (Davids, 2013). Stanley Johnson emphasized the role of econometric modelling in support of decision making and argued that models ought to be both theoretically sound and have predictive accuracy (Johnson, 2006). Models are simplified representations of real situations that identify the key factors and relationships between them, thereby providing a suitable method for analysing and solving real problems (Lee & Olson, 2006; Howitt, 2005; Garforth & Rehman 2006). In agriculture, techniques in econometric models are used to make a baseline projection regarding the supply and demand of commodities and for analysing the impact of various policies on macroeconomic settings for a country or a region. Econometric models are considered to be an analytical representation of one or more statements about economic behaviour, which representation relies upon statistical implementation for the purposes of hypothesis testing, parameter estimation, or use in prediction or simulation circumstances (Wolka, 2007). During the past decade, econometric models have come in for increasingly widespread use by government (for policy analysis and forecasting), by industry (largely as a forecasting tool), and by universities (for instructional

use and a wide variety of research purposes). Despite the growing importance of such models in various decision-making situations, the process of systematic model evaluation has, with some noteworthy exceptions, seriously lagged behind the process of multi-model proliferation. Within the past few years however, a handful of significant attempts have been made, in respect to large scale econometric models, to conduct serious cross-model comparisons. On the other hand, simulation models are being described as the parameter values estimated using statistical techniques. Simulation models may be used to formulate economic question in dynamic stochastic model in order to avoid biased answers to some applications where data on the real system are either completely missing or scarce. When missing data, a study can still consider qualitative knowledge, and, in order to obtain qualitative knowledge, the analyst may develop a simulation model. In simulation models, parameters are typically drawn from a variety of sources and some are calibrated (Kleijnen, 1998).The simulation of the model is a way to capture the richness of a model at a variety of levels of the forcing processes, impulses and parameters, as well as to understand properties of a complex model (Hansen and Heckman, 1996).

Several approaches have been frequently applied to assess policy impacts, such as Value Chain Analysis (VCA), Multi-Market Models (MMM), Computable General Equilibrium (CGE) and Partial Equilibrium models.

The Partial Equilibrium model is chosen for this study because it allows the analysis of a high level of disaggregation of data that face African countries. Developing countries, including African countries and particularly the DRC, do not have enough data; therefore, the Partial Equilibrium model is the most appropriate tool used where there is a lack of availability of data. The main area of application of Partial Equilibrium models is detailed trade policy analysis of specific products which represent only a small portion of the activities of the economy of the country. This condition implies that policy-induced changes on the rest of the economy (outside the farm sector) are so small that they can safely be ignored. The Partial Equilibrium model has been used in the analysis to determine the impact of the southern African customs union agreement on Botswana's import. Because of the lack of data, the Partial Equilibrium appears to be the appropriate tool for the analysis (American journal of economics and business administration 5, 2013). The advantage of using the Partial Equilibrium approach to Market Access Analysis is because of its minimal data requirement.

In fact, the only required data is the trade flows, the trade policy (tariff), and a couple of behavioural parameters (elasticities). Another advantage (which follows directly from the minimal data requirement) is that it permits an analysis at a fairly disaggregated (or detailed) level (World Bank, 2010). Data is lacking at times in Africa, particularly in the DRC, therefore the Partial Equilibrium model is the most suitable method to analyse agricultural commodity market policy.

Partial equilibrium is a condition of economic equilibrium which takes into consideration only a part of the market, ceteris paribus to attain equilibrium. Stigler defined partial equilibrium as 'one which is based on only a restricted range of data. That means that we only consider the price of a single product, the prices of all other products being held fixed during the analysis

Partial equilibrium modelling in the agricultural sector is a standard approach in determining the outlook for markets and studies the impact of various policies within the sector. The ability to capture the detail related to salient market features and policy inclusion, points to a partial equilibrium model being the most appropriate for the purpose of this study. As a more comprehensive market model, the Partial Equilibrium framework (model) describes and analyses in detail the equation supply and demand, price formation, interdependency of agricultural inputs and outputs between different product lines, policy impact on supply and producers' income for sub-sectors or groups of agricultural sub-sectors. It considers a particular market or sector for a specific agricultural sector that is not directly linked but does not extend its influence without linkages to the rest of the economy (Tongeren, 2001). That means that the agricultural sector is affected by the rest of the economy but has no direct effect on the economy (Calceterra, 2002). Partial Equilibrium modelling in agriculture uses economic theory to provide a theoretical concept for supply and demand of commodities by analysing the behavioural decision of producers and consumers. A market equilibrium model can be for a single or multi-commodity market system that focuses on the response of the economic agent to changes in prices and other shifts in supply and demand (Calceterra, 2002). The linear equation for demand and supply of a commodity is illustrated as:

Demand: QD= a-bP (a, b> 0);

Supply: QS= -c+ dP (c, d>0);

Equilibrium condition: QD= QS
Where:

QD: the quantity demanded

QS: the quantity supplied

P: the price

a, b, c: the coefficient

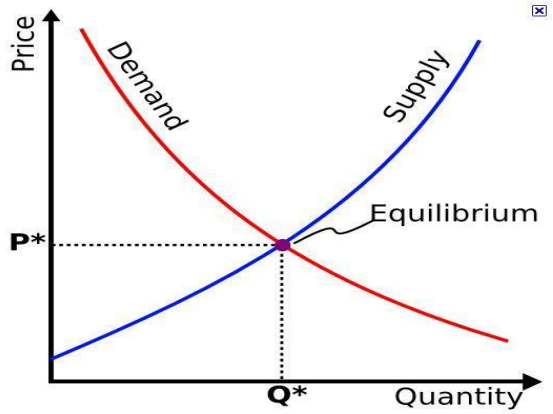


Figure 3.2: Total supply and demand

The above supply and demand model is a partial equilibrium model where the clearance on the market of some specific goods is obtained independently from prices and quantities in other markets. In other words, the prices of all substitutes and complements, as well as income levels of consumers, are taken as a given.

The supply block consists of total production, import and beginnings stock. The area harvested is influenced by the lagged real price of maize and the maize yield which constitute the real Gross return of maize and the competing crop price such as rice prices, also influencing the area harvested. Area harvested multiplied by yield gives maize production and it is an identity.

The demand block consists of the total domestic use, export and ending stock. The food consumption (food demand) for maize responds to the real price of maize, the population and the income. The per capita food consumption is specified as the total food consumption divided by the total population

The various parts of the framework of a partial equilibrium model are displayed in the Figure below:

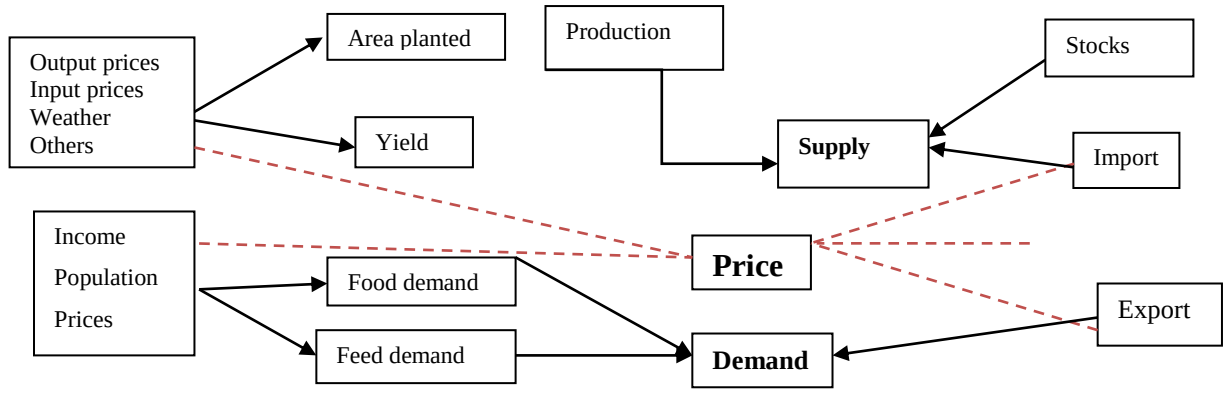


Figure 3.3: Partial equilibrium model framework

3.6.2 Supply system

The agricultural producer's behavioural analysis, based on the neoclassical theory of the firm, assumes that producers maximize profit or net return subject to technical and institutional constraints. According to Varian, the technical constraints are based on the physical relationship between factor demand and the maximum output level for the given technology per unit of time, called the firm production function (Varian, 1984). Institutional constraints relate to market structures as determined by the economic environment in which the firm operates (Calceterra, 2002).

Consider a firm that uses land (A); labour (L) and other input capital (K) in production. The production function for a particular good (Q) is determined by the maximum amount of goods that can be produced, using alternative combinations of land (A), capital (K) and labour (L). This can be written as:

$$Q = F(A, L, K),$$

The marginal physical product is defined as the additional output that can be produced by employing one more unit of that input while holding other inputs constant. Factor inputs have non negative marginal contribution to output.

$$MPA = \frac{\partial Q}{\partial A} \geq 0;$$

$$MPL = \frac{\partial Q}{\partial L} \geq 0;$$

$$MPK=\frac{\partial Q}{\partial K} \geq 0$$

The production technology structure requires that the second derivatives be greater than zero. Let the price (p), which is the output price and c the input cost takes into consideration. Let r be the rental cost for land (*A)*, w the cost of labour (L) and k the cost of capital (K). The neoclassic theory states that output level and output prices are random variables independently distributed and that the firm is neutral. A firm's main objective, as a single decision maker, is to maximize the expected profit. This can be illustrated as below:

Max π (p,r,w,k, TFC)= Max{pQ-rA-wL-kK-TFC}, where :

pQ: is the expected revenue (R)

rA : is the cost of land

wL: is the cost of the labor

kK: is the cost of capital

And TFC: is the total fixed cost

The necessary condition for choosing the level of *Q* that maximizes the profit can be found by setting the derivate of the profit π function with respect to each input equal to zero. The first order condition can be written as:

$$p\frac{\partial Q}{\partial A} - r = 0$$

$$p\frac{\partial Q}{\partial L} - w = 0$$

$$p\frac{\partial Q}{\partial K} - k = 0$$

The three equations state that the partial derivatives of the production function with respect to the input are the marginal product of these inputs.

Globally the first order condition for the profit equation is illustrated as below:

$$\pi'(Q) = \frac{\partial \pi}{\partial Q} = \frac{\partial R}{\partial Q} - \frac{\partial C}{\partial Q} = 0$$

Therefore: $\frac{\partial R}{\partial Q} = \frac{\partial C}{\partial Q}$

This equality emphasizes that the farmer will maximize profit by producing output levels where the expected value of the marginal revenue is equal to the marginal cost. The marginal profit must be decreasing at the optimal level of the output *Q*. The second order condition

requires concavity of the production function, which ensures convexity of the profit function to input and output prices. The second order condition can be illustrated as follows:

$$\frac{\partial \pi^2}{\partial A^2} < 0$$

$$\frac{\partial \pi^2}{\partial L^2} < 0$$

$$\frac{\partial \pi^2}{\partial K^2} < 0$$

As the production function is invertible, the optimum input demand can be expressed as a function of input and output price. The input prices must exhibit sufficiently diminishing marginal productivities so that marginal cost increases as output expands:

A(p, r, k, w);*

L(p, r, k, w);*

K(p, r, k, w)*

The input demand functions are obtained from solving the first order condition equations. The input demand functions are homogenous of degree Zero input and output prices. The output supply function is therefore yield by substituting input demand into the production function and must also be homogeneous of degree Zero in input and output prices. This can be shown below:

$$Q^* = f(A^*, L^*, K^*)$$

The supply function is upward sloping and the input demand functions are downward, following the profit function property. It also follows that the marginal effect of a rise in input price P on input demand is equal to but of opposite sign to the marginal effect of an increase in the corresponding input price.

The theory duality has been a method in the recent advance in the empirical analysis of static production theory (Diewert, 1974). It can also be used to solve the input demand. Lopez has described the advantages of the duality as that the simultaneous equation bias is avoided since profit and input demand function are expressed as a function of exogenous variable and that the duality method can be used to compute the mutatis mutandis elasticity, associated with supply and demand (Lopez, 1982). Substituting the factor input and the output level, gives us the indirect profit function illustrated as follow:

Π (p, r, k, w) = p (A, L*, K*) - rA-wL- kK,*

This is a function of the output and input prices. Taking the partial derivatives of the indirect profit function with respect to output and input prices by using the envelop theorem, gives us the output supply and input demand function.

3.6.2.1 Elasticity of supply and input demand

The elasticity measures the responsiveness of the independent variable to a change in price. The concept of price elasticity applied to supply is defined as the response of the quantity supplied to a change in the price.

Mathematically, it is defined as: $\varepsilon = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{p}} = \frac{\Delta Q}{\Delta P} * \frac{P}{Q} > 0$.

Similarly, the elasticities for the input prices are defined as the percentage change in output given a 1% change in one of the inputs. These can be expressed as:

$$\varepsilon A = \frac{\Delta Q}{\Delta r} * \frac{r}{Q} < 0$$

$$\varepsilon L = \frac{\Delta Q}{\Delta w} * \frac{w}{Q} < 0$$

$$\varepsilon K = \frac{\Delta Q}{\Delta k} * \frac{k}{Q} < 0$$

This means that the increase in all the input prices by the same percentage output quantity should not be affected as the negative effect of input price increases will be offset by the positive effect of own price increases. The marginal change in the level of output Q, due to the change in the price of an input, is equal to a negative value of the marginal change in input use following a marginal change in output price. Mathematically this can be illustrated as follows:

$$\frac{\Delta Q}{\Delta A} = -\frac{\partial A}{\partial P}$$

$$\frac{\Delta Q}{\Delta L} = -\frac{\partial L}{\partial P}$$

$$\frac{\Delta Q}{\Delta K} = -\frac{\partial K}{\partial P}$$

This will lead to a symmetric relationship between the input demands: $\frac{\partial k}{\partial r} = \frac{\partial A}{\partial K}$ similarly for all inputs

3.6.2.2 Dynamic supply

Most agricultural supply analysts recognize that farmers must commit resources to production before product prices, which are subject to change through time, are known with certainty. Producers are not in a position to totally adjust their input or output use in one period (Calcaterra, 2002). Agricultural production takes place with less than perfect certainty, where decision-making for adding sequential inputs is based on its biological nature, and because input use is a function of time (Meyer, 2006). Therefore, it is important to take price into consideration as it provides various ways for the firm to adjust its inputs, hence the movement from one equilibrium point to another. The adjustment is not immediate due to price uncertainty, fixity, and non-divisibility for factor input (Calcaterra, 2002).

More complex forms of expectations involve various distributed lags. The most commonly used model through the 1950s and 1960s was the adaptive expectations model that claimed that the partial adjustment model assumed that the change in price expectations in the current period was some proportion (∂) of the error made in formulating expectation in the previous period (Nerlove, 1958).

The equation is:

$Pe_t - Pe_{t-1} = \partial (P_{t-1} - Pe_{t-1})$,

Where P_t is the normalized price of output, e is the expectation operator in respective periods and ∂ the coefficient of expectation with $0 < \partial < 1$. The same equation can be rewritten as $P_{et} = \partial P_{t-1} (1- \partial) P_{et-1}$. This means that the expected price at time t is the summation of the last period's expected price plus some adjustment factor and last period's actual price. Nerlove (1956) stated that therefore each period people revise their notion of 'Normal' price in proportion to the difference between the current price and the previous ideal 'normal' price.

The first order difference of the above equation can be expressed as follows:

$$P_{et} = \sum \partial\ (1-\partial_{Pt-1}).$$

The first order condition can be solved for P_{et} which is the weighted moving average of past and actual price where the weight declines with time. A simplified version of the output supply function is used where output is a function of the expected price and the exogenous variable Z.

$$Q_t = \gamma_0 + \gamma_1 Pe_t + \gamma_2 Z + et,$$

where

$\gamma 1$: is the long-term response, and

et: is an error term

The algebraic equation of the price and the output function yield the following output supply function:

$$Qt = \gamma 0\partial + \gamma 1 \partial Pet + (1-\partial)\ Qt-1 + \gamma 2\ [Zt - (1-\partial)\ Zt-1] + et - (1-\partial)\ \acute{v}t-1.$$

Rewrite the equation

$$Qt = \prod 0 + \prod 1 Pet + \prod 2 Qt-1 + \prod 3 Q + et$$

Where:

$$\prod 0 = \gamma 0 \partial$$

$$\prod 1 = \gamma 1 \partial$$

$$\prod 2 = 1-\partial$$

$$\prod 3 = \gamma 2$$

$$Q = Zt - (1-\partial)\ Zt-1$$

$$Et = \acute{v}t - (1-\partial)\ \acute{v}t-1$$

The estimation of the output supply function is that there is a possibility of correlation in the lag values of the dependant variable which results in the problem of multicollinearity. In the

case of multicollinearity one can state that the use of the Ordinary Least Square (OLS) estimation of the supply equation will not yield a reliable estimate, but in this study OLS is widely used in empirical work because if the model's error term is normally, independently and identically distributed, OLS yield unbiased estimators for the model's coefficients, i.e. no other technique can produce unbiased slope parameter estimators with lower standard errors. Ordinary least squares provide estimates of the model coefficients that minimize the sum of squared deviations of the actual observations and the model predictions of the dependent variable (Goodwin, 2008). However, Maximum Likelihood or instrumental variable estimation methods will lead to estimates with desired property (Meyer, 2006). In the short run, some input factors of production are fixed and some inputs may vary in response to price, whereas in the long run, all input factors can vary.

The short and long run multipliers are obtained as follow:

$$\frac{\partial Qt+1}{\partial Pt+1} = \prod 1\ (1+\prod 1+\prod 2+\prod 12+\ldots) = \frac{+\prod 1}{1-\prod 2}$$

The short run elasticity is therefore the estimated value of the coefficient γ1∂; the short run elasticity is:

$$\text{Es} = \frac{\partial Qt}{\partial Pt-1} * \frac{Pt-1}{\partial Qt} = \prod I * \frac{\overline{P}}{\overline{Q}}$$

The long run elasticity is

$$\text{EL} = \frac{+\prod 1}{1-\prod 2} * \frac{\overline{P}}{\overline{Q}}$$

where: $\overline{P}$ and $\overline{Q}$ are the mean value of price and output.

3.6.3 Demand system

Demand is defined as the quantity of goods or services people are willing and able to buy at different prices. When prices increases, the willingness and ability of sellers to offer goods will increase, while the willingness and ability of buyers to purchase goods will decrease. This means that the demand curve is downward sloping. When the market price for a product is high, the demand will be low. When price is low, demand is high. At very low prices,

many consumers will be able to purchase a product. The demand for agricultural crops can be divided into primary demand, derived demand and the inventory demand.

3.6.3.1 Consumer demand

Demand is a model of consumer behaviour. It attempts to identify the factors that influence the choices that are made by consumers. In Neo-classical micro-economics, the objective of the consumer is to maximize the utility that can be gained given their preferences, their income, the prices of related goods and the price of the good for which the demand functions are derived. Consumer theory is concerned with how a rational consumer would make consumption decisions. The consumer demand theory postulates that the quantity demanded of a commodity is a function of the price of the commodity, the consumer's income, the price related commodity, and the taste of the consumer. Therefore, the law of demand states that there is an inverse relationship between the quantity demanded and its own price.

Utility is the capacity of goods (or service) to satisfy the consumer's want. Utilitarianism is the ethical foundation of neo-classical micro-economics. Jeremy Bentham (1748-1832) formalized 'utilitarianism'. Utility is a subject evaluation of value. Bentham seemed to intuitively grasp the notions of total and marginal or incremental utility. However, it was not until 1844 that Dupuit (1804-1866) associated marginal utility with the concept of demand.

The consumer chooses a vector of goods x = (x1, ..., xn) to maximize their utility, subject to a budget constraint that says they cannot spend more than their total wealth.

This specification of food use is based upon consumer theory of utility maximization subject to a budget constraint where the consumer wants to maximize their utility function, subject to a given level of income.

The Utility Maximisation problem can be presented mathematically as follows:

$$MAX\ U(x_1, x_2, ...x_n)$$

subject to

$$I = \sum_{i=1}^{n} p_i x_i$$

$U(x_1, x_2, ...x_n)$ is the consumer's utility function.

$I = \sum_{i=1}^{n} p_i x_i$, represents the budget constraint and consists of *I*, the consumer's total available budget and p_i, the unit price of commodity x_i. The utility function is strictly quasi-concave and twice differentiable (Mas-Colell et.al., 1995). Consumer preferences are assumed to satisfy certain properties (reflexive, transitive, completeness, continuous, and weakly monotonic) (Calcetera, 2002).

The maximization problem is solved by defining an auxiliary function known as the Lagrangian.

$$L = U(x_1, x_2, ..., x_n) - \lambda(\Sigma\, p_i x_i - m)$$

The variable, λ, is called the Lagrange Multiplier since it is multiplied by the budget constraint. According to the Lagrange theorem, an optimal choice or utility maximisation must satisfy the First Order Condition (FOC), which involves the partial derivation with respect to λ.

$$\frac{\partial L}{\partial x_i} = \frac{\partial U(x_i)}{\partial x_i} - \lambda p_i = 0 \quad \text{With} \quad \text{i} = 1, 2, \ldots\ldots \text{n.}$$

$$\frac{\partial L}{\partial \lambda} = (\Sigma\, p_i x_i - m) = 0$$

The FOC simply sets the derivatives of the Lagrangian with respect to x_i and λ each equal to zero. Hence, the derivation with respect to λ is the budget constraint that is set equal to zero. Assuming the second order conditions are satisfied for a global maximum, all input is spent. Solving (n+1) FOC, the demand function of x_i is obtained and is an implicit income and price function. This implies that λ is equal to marginal utility divided by price for the commodities, which specifies the increased rate of satisfaction derived from spending an additional dollar on a particular commodity. The Lagrange Multiplier thus can be interpreted as the marginal utility of income.

The simultaneous solution of the FOC yields the demand function of x_i, which is an implicit function of own prices, the prices of complement or substitute goods, and consumers' income. The demand function of x_i can be presented as follows:

$$x_i = x_i(p_1, p_2, ..., p_i, m), \quad i = 1,2..., n$$

This demand function represents the demand for x_i of every individual consumer and is homogenous of degree zero in prices and income.

The indirect utility function is obtained by substituting the solved values of x_i into direct utility

$$U^*(P1, \ldots P_N, I) = U^*[X^*_1(P1, \ldots P_N, I) \ldots X^*_N(P1, \ldots P_N, I)$$

The indirect utility function approach allows us to derive the uncompensated or Marshallian demand function by differentiating the indirect utility function with respect to the price and income. The Marshallian demand is therefore obtained as follows:

$$\frac{\frac{\partial U*(P1,\ldots PN,I)}{\partial Pi}}{\frac{\partial U*(P1,\ldots PN,I)}{\partial I}} = X^*(P_1, \ldots P_N, I),$$ the inverse uncompensated demand is obtained by applying the Hostelling identity to the indirect utility function (Johnson *et al*, 1984).

Inverting the indirect utility function and solving for the income I in terms of U and p gives the expenditure function. Therefore, the consumer demand for a commodity can be expressed as a function of price and income:

$Q^D = F(P_m, P_s, I)$

This expresses a consumer demand function approached as an expenditure minimization problem with P_m the price of the commodity and P_s the price of the substitute or the competing and supplementary goods.

3.6.3.2 Crop inventory

Most agricultural products are produced and supplied to the market at one specific time during a crop year whereas consumption occurs throughout the whole period. According to Bressler and King (1970), the demand for stock can be decomposed into a transaction demand, precautionary demand and speculative demand. Hence the changes in stock exert a considerable influence on supply (Bressler and King 1970).

Transaction and precautionary demand are related to the domestic supply and demand. The stock behaviour specification can be expressed as follows:

$SC_t = S_t(SC_{t-1}, P_t, Q_t, Q_{t-1})$

where C is the change in stocks, P the price and Q the quantity produced.

The equation above allows a clear understanding of supply and demand for commodities and means that the change in stock is the function of the current price, current production and the production of the next period.

3.6.3.4 Demand elasticity

The concept comes from economic theory and is linked to the description of demand adjustments in a market, consumer as well as producer demand. The elasticity can be defined as a correlation between two variables, e.g. price and demand. When price increases, demand typically decreases and the size of the decrease is determined by the elasticity (Ramskov and Munksgaard, 2001).

The elasticities play an important role because they determine the size of the demand adjustments as a result of price changes in the market. The elasticities are used to examine how sensitive the demand for goods is to changes in the price of the goods itself, to changes in the price of related goods, and to changes in income (Ramskov and Munksgaard, 2001). As the demand for goods depends on more factors than the price of the goods itself, it is important to introduce different types of elasticities. The demand side in an equilibrium model is characterized by consumers maximizing their utility (U). The utility derives from consumption (C) of the goods that are included in the economy. Thus the general term of the utility function could be written as U=U (C_1, C2... Ci).This function should be maximized, provided that the consumer can afford the goods.

$$\sum_{i=1}^{n} Pi\ Ci \leq I$$

where I is the consumer income and p is the price vector. Optimally the consumer will spend his whole income on goods, unless he benefits from saving. If the consumer does not have saving opportunities, the restrictions would be indicated by "=" and not "≤" when he maximizes his utility.

3.6.3.4.1 Own price elasticity

The own price elasticity is defined as the proportionate change in the price of C_i, *ceteris paribus*. According to neo-classical theory, the own price elasticity of a demand function has a negative sign, which explains the inverse relationship between price and quantity demanded, whereas the own price elasticity of supply has a positive sign, explaining the positive relationship between price and the quantity supplied. Mathematically, the own price elasticity of demand is expressed as

$$\varepsilon_p = \frac{\partial Ci}{\partial Pi}\frac{\overline{Pi}}{\overline{Ci}} < 0$$

where C_i defines the demand for goods i and P_i defines the price of goods i. If $\varepsilon_p = 1$, the demand is defined as being unit elastic. This means that a price increase of 1% will cause a reduction in the demand for goods by 1%. The demand is defined as being elastic if $\varepsilon_p > 1$ and inelastic if $\varepsilon p < 1$. Inversely, a price decrease of 1% will cause an increase in demand of 1%. If the demand is inelastic, a price increase means that the decrease in the purchased quantity will be relatively smaller than the increase in price. So the consumer's total expense for the goods in question increases. The opposite is the case at a price increase of goods where the demand is elastic (Fog, 1992).

3.6.3.4.2 Income elasticity

Income elasticity shows the percentage increase in the demand for given goods as a result of a percentage increase in income. Formalized, the income elasticity is given as:

$$\varepsilon_p = \frac{\partial Ci}{\partial I}\frac{\bar{I}}{\overline{Ci}} = n_j$$

where I indicates the income. Generally, the income elasticity for necessities is smaller than for luxury goods. So a reduction in income will not reduce the consumption of for instance

electricity, as much as for the consumption of holiday trips. It is also the case that the income elasticity of goods decreases when income increases. In the short run, the income elasticity of the fixed part of the household budget is equal to 0, while variations in consumption of the goods which are part of the variable costs of the budget increase. In the long run, this would not be the case because several items on the budget could be varied (Fog, 1992).

3.6.3.4.3 Cross-price elasticity

Cross-price elasticity shows the percentage increase in demand for goods *i* as a result of a percentage increase in the price of goods *j*. The mathematical definition of cross-price elasticity is given as:

$$\varepsilon_{\mathrm{p}}=\frac{\partial Ci}{\partial Pj}\frac{\overline{Pj}}{\overline{Ci}}>0$$

Cross-price elasticity for goods having a close substitution or complement, would be relatively big numerically. If there is a close substitution, the cross price elasticities will be positive as a price increase of goods *i* will cause the consumers to substitute, demanding goods *j*. If *i* and j are complementary goods, the cross-price elasticity will be negative. A reduction in the demand for goods *i*, as a result of a price increase of the goods, will also lead to a decreasing demand for goods *j*. For goods that are neither close substitutes nor complementary, the cross-price elasticity will be insignificant.

In time series analysis, the measurement of various elasticities is restricted by the degrees of freedom. The demand functions have four essential properties, summarized by Tomek and Robinson (1990).

- *Homogeneity*

Many of the functions appearing from solutions of parameterized families of problems in economics are homogeneous functions. For instance, the optimal consumer bundle is a homogenous function of degree zero in prices and income (Madden 1986, Ch. 9 and Simon and Blume 1994, Ch. 20). From an economic perspective, this means that if we multiply prices and income by the same constant, then the optimal consumer bundle does not change. The sum of the own, cross, and income elasticities are equal to zero. This implies that if a commodity has many substitutes, it must have large own-price elasticity (Meyer, 2006).

$$E_{ii} + E_{iL} + ... + E_{ij} + E_{iy} = 0$$

where:

$E_{ii} = own - price\ \ elasticity\ \ for\ i$

$E_{ij} = cross\ elasticity\ \ effect\ \ of\ \ j\ on\ i$

$E_{iy} = income\ elasticity\ \ for\ i$

Cournot aggregation

This property states that the average cross-price elasticity of goods, relative to another, is proportional to its relative importance in consumer expenditure. This means that the weighted average cross-elasticity of the jth commodity, when all are weighted by their respective average budget shares, equals the negative of its average budget share. A change in price on a major item in food expenditure is likely to have a greater consequence on the consumption of a minor product than the price of a minor product on the consumption of a major product. Mathematically the Cournot aggregation can be illustrated as follows:

$$E_{ij} = (R_j / R_i) * E_{ij} + R_j * (E_{jy} - E_{iy})$$

where:

$E_{ij} = cross\ elasticity\ \ effect\ \ of\ \ j\ on\ i$

$E_{iy} = income\ elasticity\ \ for\ i$

$R_i = \exp enditures\ on\ i\ as\ ratio\ to\ total$

Engle Aggregation

This property gives the relationship between the income elasticity of all consumers' goods. It can be expressed as follows:

$$R_1 * E_{1y} + R_2 * E_{2y} + ...R_n * E_{ny} = 1$$

where:

$E_{iy} = income\ elasticity\ \ for\ i$

$R_i = \exp enditures\ on\ i\ as\ ratio\ to\ total$

The weighted sum of income elasticities of all items in the consumer's budget weighted by the relative importance of each item equals one. This means that total expenditure should increase proportionally as the consumer's income increases. The level of expenditure on an item and its income elasticity determines the change in expenditure of the item.

3.7 SUMMARY

Laubscher, (1986) states that 'although market performance appears to be an extremely broad concept, it remains the end result of what the society desires for a market'. The agricultural market remains complex to analyse due to the changes in market conditions. However, given meaningful econometric techniques and economic theories, one can understand the market structure, using the partial equilibrium model that has been presented in this chapter. This will help with the understanding and the development of the modelling of partial equilibrium on the maize market in the DRC. The DRC government has undertaken a series of reforms, designed to liberalize the economy and open it to international trade; by undergoing a review of trade policies with the WTO in order to focus on open and transparent trade, keeping the multilateral trading system.

CHAPTER 4: SPECIFICATION OF THE PARTIAL EQUILIBRIUM MODEL OF THE DRC MAIZE MARKET

4.1 INTRODUCTION

Having provided a general overview of the agricultural sector and maize market fundamentals in chapters 2 and 3, this chapter presents the specification of a partial equilibrium model to be used for simulation purposes. The aim of this chapter is to report the results of the single equation estimations of the partial equilibrium model. In chapter 2 we provided a general overview of the agricultural sector, the maize industry and the government intervention in the market. This helped in the understanding of the agricultural sector, as well as how the maize industry performed, and a historical understanding of how government intervened in the overall agricultural sector. In chapter 3 we saw that the government undertook a series of uninterrupted policies of reform, aimed at progressively liberalising the economy and opening up international competition. Following the description of the structure of the market as well as the government intervention in the maize market, this chapter will present a partial equilibrium simulation model that was applied to develop a baseline against which a range of policy options can be evaluated to optimize policy decisions prior to implementation. But firstly it will provide meaningful econometric techniques and economic theories so that one can understand the market structure. Where reasonable, statistical estimation techniques are used to estimate the equations to ascertain the relationship between endogenous and exogenous variables, the model is calibrated based on pre-imposed elasticities. The model used two principal blocks, a supply block and a demand block, as developed in the last chapter. The supply and demand were estimated using single equations. Data was limited, but still the use of a simulation model, even when based on synthetic parameters, has allowed us to gain insight prior to making decisions as opposed to evaluating the impact of decisions after they have been implemented. The price used to close the model was determined by equating the excess supply and excess demand. All the equations are explicitly linked to the local reference price. The equations are based on the period 2005-2016.

4.2 SPECIFICATION OF THE DEMOCRATIC REPUBLIC OF CONGO MAIZE MARKET

Economic and econometric modelling has become an important part of research and development across many fields of study. They are therefore appropriate to provide an overview of quantitative methods and models to help policy makers, financial and development institutions determine the rate and pattern of economic growth and to help them to adopt the most suitable policy in order to promote all the sectors in the economy of countries. The modelling of the maize market in the Democratic Republic of Congo includes a model specification which consists of a set of estimable linear equations. Additionally, the model uses econometric estimation procedures that will help in computing the desirable analytical characteristics of the equations. Statistical estimation techniques are used to estimate the equations that may help in the determination of the relationship between the endogenous and exogenous variables. The reliability of the statistics and statistical tests are easily applied to test the forecast in the case of a linear reduced form, therefore the problem of structural change and updating the model can be easily handled (Calcetera, 2002). As an econometric structural model, the maize market model will have behavioural equations and identities. The behavioural equations are based on economic theory and are estimated from historical data, using statistical techniques. On the other hand, the identities are equations that are true by definition. The two equations - the behavioural equation and the synthetics equation - explain the relationship between the different variables and their causal effect. Friedman (1968) attributes a fourth role to accounting identities by claiming that:
"... identities are useful for economic analysis because they offer useful classification of the factors at work."(p. 435).The behavioural equations contain endogenous and exogenous variables.

The equations are estimated using the ordinary least squares (OLS) method, which will help to identify the variables to be used in the behavioural equation. Suppose that y is the variable that represents the behavioural variable o. The theory may advise that the behaviour of y can be well characterized by some function (f) of the variables $x_1,...,x_k$. Then, $f(x_1,...,x_k)$ may be seen as a "systematic" component of y, provided that no other variables can further account for the behaviour of the residual $y - f(x_1,...,x_k)$. In the context of linear regression, the function f is specified as a linear function. The unknown linear weights (parameters) of the linear specification can then be determined using the OLS method (Chung-Ming Kuan, 2004

in De Beer, 2009). In a simple linear regression, only one variable x is designated to describe the behaviour of y. The linear equation can be represented as

$y = \alpha + \beta x + e\ (\alpha, \beta)$,

where α and β are unknown parameters, and $e\ (\alpha, \beta) = y - \alpha - \beta x$ represents the error of this specification. Different parameter values result in different errors. In what follows, y will be referred to as the dependent variable (regressand) and x an explanatory variable (regressor). Note that both the regressand and regressor may be a function of some other variables

4.2.1 Data

The aim of this study is to, through the use of the partial equilibrium model, study the impact of the government policy intervention on the maize market in the DRC with the use of historical data. In order to achieve the assigned objective, it is imperative to understand the structure of the maize market. Happe et al (2006) state that the objective of a quantitative analysis of the agricultural policy is to investigate the impact of agricultural policies on a range of indicators such as income, production, prices, factor allocation etc.., at different levels of scale, for instance global, national, regional farm scale (Happe et al, 2006). He emphasized that in order to do a simulation on an agricultural policy, one must understand the framework or the structure of the market on which the policy is applied by the use of modelling approaches in agricultural policies analysis (Happe et al, 2006).

Regarding the overview of the market of the DRC in chapter 2, the market analysis model seems to be suitable for the agricultural policy analysis of the Congolese agricultural market. The study focused on one commodity, which is maize, by giving an overview of its price discovery, consumption, production and trades. Therefore, the Partial Equilibrium model as a market behavioural economic tool was used in the agricultural policy analysis. The Partial Equilibrium model is able to provide much product detail through analysing the structure of the maize market using economic theory. A Partial Equilibrium model of the maize market included linear behavioural equations that capture data on the supply and demand interrelationship in the market. The effectiveness of a Partial Equilibrium model as a tool of understanding the DRC maize market is based on the fact that the use of partial equilibrium analysis is empirically simple and the analysis approximates the real effect of trade and local policy changes on commodities and consumer and producer. It is also very useful in the case of the DRC maize market because it allows for the utilisation of widely available trade data (

Lang, 2006).In many cases the required data was not available and some of them were controversial. For almost all the African countries data is very imprecise due to several problems such as disruption in data collection caused by wars or weak statistical institutions. Another issue with the data in the region, especially in the DRC, is the dualistic character of agriculture in terms of commercial and subsistence farming. As most data does not account for subsistence farming, it is clear that by not including subsistence farming, it poses great limitation to the usefulness and accuracy of the model. In addition, data sets sourced from different organisations have different values for the same variables. It was therefore necessary to combine the data from these sources to establish an accurate data set for the model for the period used in the estimation.

The data sources are shown in the table below

Table 4.1: The data sources

Data	Data source
Area harvested	FAO data base
Production	Ministry of Agricultural and rural development data
Yield	FAO data base
Beginning and Ending stock	FAO data base
Domestic consumption	FAO data base
Feed use	FAO data base
Food use	FAO data base
Maize price	Ministry of Agricultural and rural development
Rice price	FAPRI World price projection
Word price	FAO Giews database
Total Import	International Trade Council/FIEWSNET
Total Export	International Trade Council/FIEWSNET

Table 4.2: Macroeconomics data sources

GDP	Word bank
GDP deflated	International Monetary Fund
Population	Word bank
Exchange rate	Word bank
Consumer price index	Word bank
Import tariffs	Mac map

Not enough observations were available to estimate statistically significant annual equations. So the equations were investigated for the period 2005-2014. For the equations such as ending stock as well as consumption, the lack of data had an impact on the regression, as a result it was decided to impose a synthetic formulation for the ending stock equation of the missing data to have an economic significance for some of the equations.

4.3 MODEL CLOSURE

The components of the Partial Equilibrium model consist of supply, demand, price and trade. In order to reach the equilibrium, it is necessary to get equality between the total demand and total supply (Meyer, 2006). Literature identifies several model closure techniques; however, the choice of technique depends on the structure of the market (Meyer, 2006). The two important components for the model to reach equilibrium, as well as the choice of closure technique are the price and the trade. This should be based on the equilibrium pricing conditions in the particular existent market (De Beer, 2009).

The three different market regimes are import parity, autarky and export parity. Therefore, only one can prevail in a market at any single point in time. Under each of these regimes, domestic and world prices are integrated differently. Generally econometric simulation models estimate the domestic price as a function of the world price, with the relationship between the dependent and independent variables being estimated as an average over the three regimes (De Beer, 2009). When the domestic prices are too high, it will attract import to the point where the country becomes a net importer. Therefore, the domestic price will be a function of the world price. When the domestic price is too low it will attract export, to the point where the country becomes a net exporter, thus the domestic price will be also a function the world price. A high domestic price will push the country to buy outside (import) at a lower price than the domestic, therefore the country will become a net importer. If the domestic price is too low, it will encourage the country to sell outside at higher price therefore the country will be a net exporter (Meyer, 2006). A market that is functioning under autarky is one where the domestic prices are between import and export parity (Meyer, 2006). Domestic market prices are thus expected to be closely related to the price paid in import parity countries, after the deduction of the relevant transportation costs and taxes (De Beer, 2009).

In order to understand the reality of the market structure and the price formation mechanism in the DRC, it is essential to use the model closure to determine the way in which equilibrium is achieved in the market.

In this study, the price is calculated as an identity and is used to close the model. The model will be solved by means of a price equilibrator. According to Meyer, the price equilibrator is used when the market is in autarky or near autarky (Meyer, 2006). The autarky condition refers to a situation where the market equilibrium price is determined when the total supply of the commodity is equal to the total domestic demand. Under strict autarky, no trade occurs as domestic markets fluctuate between import and export parity. The price equilibrator of the maize market in the DRC is a function of the starting price, the export surplus and the domestic surplus. The export surplus is the difference between the DRC total export and the total import. On the other hand, the domestic surplus is equal to the difference between the production plus the beginning stock and the domestic consumption plus the ending stock. In establishing the price equilibrator, the difference between the maize domestic surplus and the maize exports supply is calculated. The new market clearing price is simulated by linking the starting market price to the difference between the maize domestic surplus and the exports surplus. The new market equilibrium is reached at a point when the export surplus will equate the domestic surplus (when the demand will be equal to the supply). The solution is achieved in excel through an iterative simulation process.

Maize is an important crop in the DRC but the domestic production remains relatively stagnant. However, domestic production remains below the consumption requirement and import still constitutes a significant share of the domestic maize consumption. The DRC is therefore a net importer of maize. The FAO estimated that 6.7 million people were in a severe food insecure state in December 2013. Maize production in 2012/13 remained relatively stable compared to 2011/12, increasing by only 0.02%. Nevertheless, domestic production remains below the consumption requirement and imports still constitute a significant share of domestic maize consumption (Renapri outlook, 2014). Therefore, even if the civil insecurity as well as the absence of roads and poor infrastructure continues to obstruct access to food in conflict affected areas, maize remains an important crop in the DRC. The absence of access to government support by the maize producers, as well as the remoteness of certain production regions accessible only by poor rural roads, pose a major problem to maize production and trade inside the country. This discourages producers and other stakeholders

from investing in maize production. Despite the availability of arable land and climatic conditions ideal for maize production, particularly relevant in the Equateur province, the country finds it hard to meet local demand. Incidentally, four other provinces (Katanga, Kasai Oriental, Bandundu and Kasai Occidental) account for almost 70% of maize production in the DRC (Renapri outlook, 2014). The lack of financing represents another important challenge for Congolese agriculture. With the liquidation of the institution that has supported the Agricultural Credit Bank over the past 20 years, financial systems (banks and microfinance institutions) do not grant credit to farmers, due to excessive risks related to agriculture. Hence financing options are very limited (Renapri outlook, 2014).

The structure of the maize market in DRC can be represented as below:

Figure 4.1: Structure of the maize market in the DRC

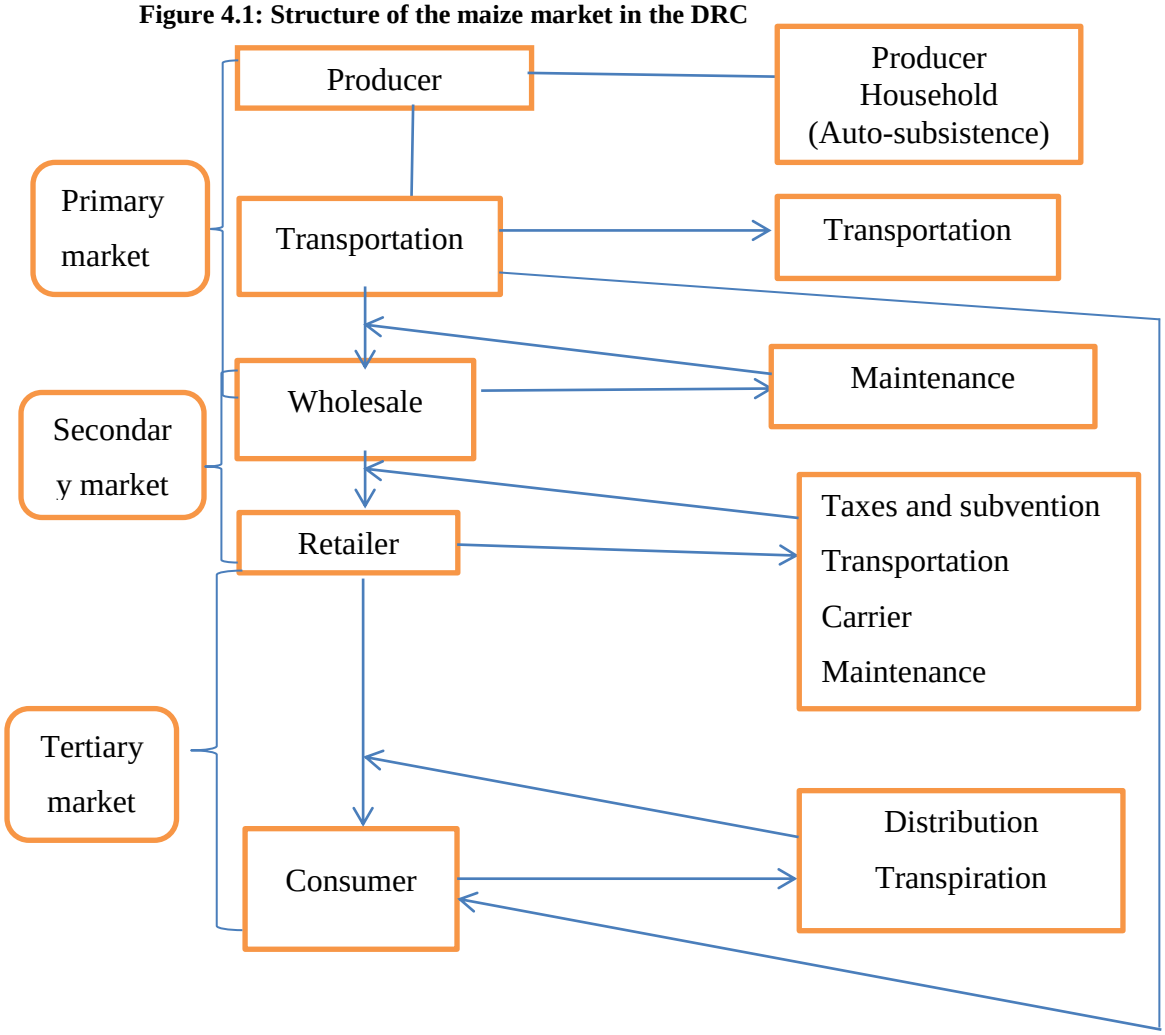


Figure 3: DRC Maize market structure
Source: Mpanzu, 2012

4.2.2 Supply and demand equations

Econometric models used for agricultural policy study can be classified as being either structural models based on a single equation, structural models based on multiple equations, or non-structural models (Sckokai, 2001).

Structural models based on single or individual equations consist of a single variable being analysed by means of a linear/non-linear relationship (in this case a linear relationship) with a certain number of explanatory variables (Sckokai, 2001).

Statistical estimation is used to estimate the equation to determine the relationship between the exogenous and endogenous variables. The statistical formulation implies the addition of an error term (residual) that represents the difference between the estimated values and the observed sample values of the dependent variable.
The equation models in the analysis of the maize market structure used the econometrics method, which is the Ordinary Least Squares, as well as associated statistic such as the R^2 for evaluating the goodness of fit, the t test for the significance of the parameters, and the F test for the tests on groups of parameters. Once the model has been solved, it will make baseline and scenario projections and conduct policy analyses. Model validation procedures are used to critically examine its performance in reflecting the realities of the DRC maize market, using the procedures described by Ferris (1998). For the method of ordinary least squares to be applicable, the assumptions that the individual equations are linear in the parameters and that there is an absence of cross equation restrictions, also need to hold. In practice, these assumptions rarely hold and the single equations may suffer from misspecifications (Sckokai, 2001; Conforti, 2001).

The total domestic supply is the cumulative sum of maize production, maize import and beginning stocks while the demand side contains the total domestic use, export and ending stock.

In this section that details the estimation results for the various equations, it should be noted that some of the equations fit the data well, while others do not.

4.2.2.1 Area harvested

The maize area harvested was estimated in a linear function, the real maize gross return and the real rice gross return. From the table below, the equation does not perform well with a R^2 value of 0.19. This means that the model is explaining only 19% of the variation in the area under production. The small value of R^2 was also found in the study of the agricultural price and commodity analyses by Ferris (2005), Meyer (2006) in his PhD thesis regarding the model closure and price formation under switching grain market regime in South Africa, as well as in a study on the evaluation of the effect of proposed tariff protection for South Africa. Therefore, the economic significance is more relevant than the statistical significance. (Agricultural Economics Research, 2015) The economic significance of the agricultural equations is more important than the statistical significance because the economic significance expresses the relationship between variables which helps one to understand the structure and behaviour of the market, the producers and consumers. Not all variables are statistically significant at 5% level. They are however maintained in the model for their overall economic significance. This is due to the poor quality of data and therefore we place greater importance on the economic significance.

The calculated elasticity of 0.3 on the maize gross return shows that a 10% increase in the real maize return would lead to a 3% increase in the area harvested and elasticity of 0.1 on the gross return in rice indicates that a 10% increase in real rice gross return would lead to a 1% decrease in the maize area harvested. The impact is not big and this might be due to the fact that most of the farmers produce for subsistence and don't need more land like industrial or commercial farmers. The production process is rudimentary; therefore, after they consume enough of what thy produce, they sell their goods at the nearest market. A large number of the poor farmers in the rural area is characterised by the existence of the agricultural activity of subsistence or near subsistence farming. Farmers sell only a small part of their harvest. The surplus production which ends up on the market is only produced by a small percentage of farmers. Therefore, an increase in the food price will only benefit the larger farmer. The increases in price will merely transfer the income from a consumer to the producer in proportion to the amount purchased and sold (Tollens, no date). Farmers will find it more

profitable to sell maize on the market as they avoid producing surplus for the market instead of simply being self-sufficient. Following the neoclassical economic point of view concerning the optimization behaviour of an individual farm, the price is the most relevant factor that influences the level of production. Therefore, an increase in the price level of the output, increases the return to factors of production by giving the producer incentives to employ more input and produce more output. But for other goods, the relative change in price will shift the production from one output to the other good (Ayinde et al., 2014). In the case of this study, as rice is the substitute cereal consumed in the DRC, a decrease in the rice return will lead to an increase in the maize and therefore an increase in the supply. The supply response concerns the output response to a change in price of the product but also in each country the supply response depends on the country's population, the preference attached to the commodity consumed mostly by the households menu, natural endowment for expanded production as well as the farm productivity of that specific commodity (Ayinde et al, 2014; Saka et al, 2005).The explanation behind the elasticity impact is that if the consumption on the market increases while the price remains the same, the farmer can increase the area on which he is producing maize. Or an increase in the price of the input production, such as seed or fertilizer, can stimulate the farmer to decrease his area from the previous year to the next.

Equation 4.1: Maize Area harvested

MAHDC= f (Real maize gross return, Real rice gross return, trend)

Table 4.1: Estimation result of the maize area harvested

	coefficient	*t Stat*	*P-value*	*Elasticity*
Intercept	1494.86	4.03	0.006*	
Real maize gross return	1.32	1.1	0.31	0.30
Real rice gross return	-0.67	-0.57	0.59	-0.10

Significance level: ***1%, **5% and *10%
F-Test (0.39) R^2 (0.19)

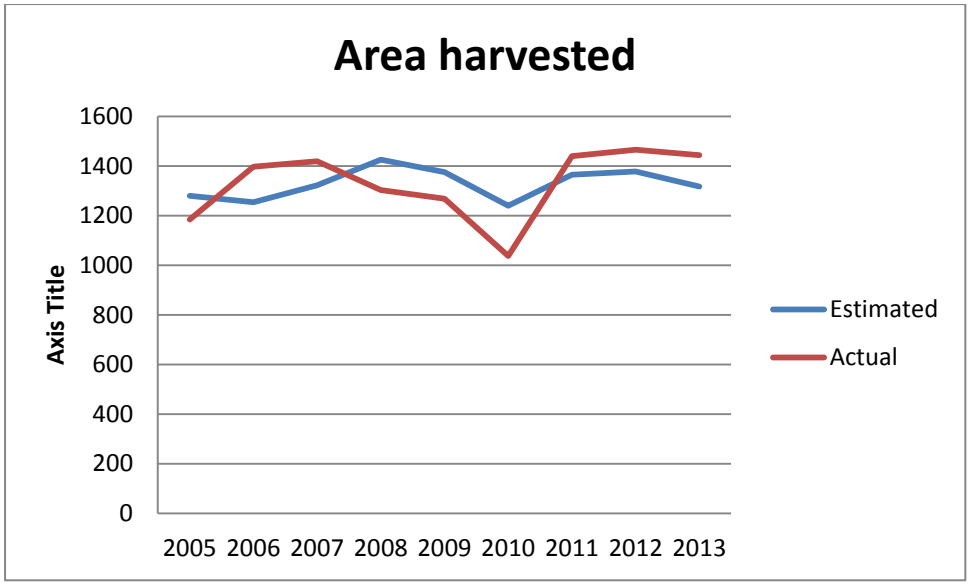
Validation can be defined as determining whether the simulation model is an acceptable representation of the real sector's structure studied, given the purpose of the simulation model

(Lawand Kelton 1991). Kleijnen (1999) presented three situations that could be distinguished in the analysis of a model:

(i) Where there is no data: In this case, the analysis may be experiment with the simulation model to obtain simulated data. Such an experiment should be guided by the statistical theory on the design of experiments

(ii) If only output data exist, then real and simulated output data can be compared through the well-known two-sample Student t statistic or certain other statistics

(iii) In case input and output data are available, then trace-driven simulation becomes possible, but validation should not proceed in the popular way (make a scatter plot with real and simulated outputs, fit a line, and test whether that line has unit slope and passes through the origin); alternative regression and bootstrap procedures are presented (Kleijnen, 1999).The validation of a model appears to consist of nothing more than the value of R^2 statistic from the fit, but given the number of observations and the data used for the model, a high R^2 value does not guarantee that the model fits the data well. There are many statistical tools for model validation, but the primary tool for most process modelling applications is graphical residual analysis. Different types of plots of the residuals from a fitted model provide information on the adequacy of different aspects of the model. Numerical methods for model validation, such as the R^2 statistic, are also useful, but usually to a lesser degree than graphical methods. Graphical methods have an advantage over numerical methods for model validation because they readily illustrate a broad range of complex aspects of the relationship between the model and the data. Therefore, for each equation, the study has plotted a graph for the estimated versus the actual variables, in order to validate the statistical performance of the equations. A good model is one where the estimated and the actual variables are moving in almost the same direction. They mostly have the same trend and variation. This shows that the model is performing well.



4.2.2.2 Production

The maize production is an identity and equal to the area harvested multiplied by the yield.

Equation 4.2: Maize production

*MProdDC= MArHarvDC*MYDC*

4.2.2.3 Yield

In order to set the production identity, the maize area harvested is multiplied by the yield. The maize yield is estimated as function of the trend variable. There are many things that could influence the trend that cannot be captured in the estimation such as advances in technology, or innovations in the production process. The table below shows that the yield is less sensitive to changes in innovations. This might be due to the large number of farmers living in the rural area who do not have direct access to agricultural innovations, therefore the trend of the maize yield is a straight, constant linear line. In order to set the production identity, the maize area harvested is multiplied by the yield. Trend analysis is a useful structure for crop yield analysis. Krus (1999) states that crop yields are determined by three major factors which are weather, autonomous technology improvement and economic factors. He noted that the weather, as a large determinant of yields, remains unpredictable and the economic factors are uncertain. Therefore, there are some difficulties to predict the yield due to, as stated above, the unpredictability of technology which changes the shape of the production

function by shifting it up and closer to the origin and secondly, data availability that faces many countries trying to estimate a changing production through time that could lead to weak parameter estimates with ambiguous signs. The alternative approach would be to consider historical growth and use it as a proxy for setting future trend (Kruse 1999). Westcott and Jewison (2013) also found that although trend analysis could examine the crop yield, the weather-related yield could cause the expected yield to deviate from the actual yield (Westcott and Jewison (2013). Shiwei Xu, 2014, states that yield trend reflects the yield adjustment by all non-natural factors such as agricultural technological progress, improvement in technology such as seed with high yield, and improvement in production such as pets integrated management and precision planting (Shiwei Xu, 2014). Due to data availability and the findings from the trend analysis above, the DRC maize yield was estimated as function of the trend. The model explains only 6% of the variation in the yield. The calculated elasticity of 0.011 means a 10% increase in the trend would lead to a 0.1% increase in the yield.

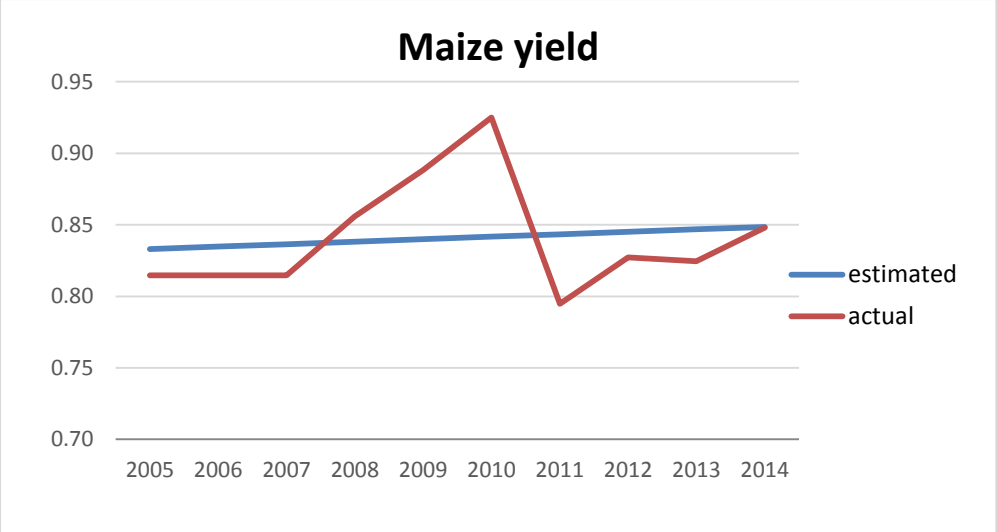
Equation 4.3: Maize yield

MYLD=f(trend)

Table 4.2: Maize yield equation

	coefficient	**T stat**	**p-value**	**Elasticity**
Intercept	0.82	26.5	4.36E-09	
Ln Trend	0.01	0.72	0.49	0.011

Significance level: ***1%, **5% and *10%
F-Test (0.5) R2 (0.06)



4.2.2.4 Maize per capita food consumption

The maize per capita consumption equation is a function of real own price, per capita gross national income and the substitute price represented by the rice price.

Economically, the estimated coefficient of the per capita GDP positively affects maize consumption therefore the increase of income would positively influence the consumption of maize; real maize price coefficient has a negative sign meaning that it has a negative influence on maize consumption and the positive price of the real rice price shows that there is a positive. The economic interpretation of the per capita GDP and the maize price coefficients are in line with expectations. From the estimated results, it is noted that the real maize price and the rice price are not significant variables at a 10% level of significance, the F-statistic of 1.62. The R^2 value is equal to 0.44, indicating that the model is explained at 44% of the variability of the consumption. However, the goodness of fit is not evaluated critically at this point. The estimated coefficients are in line with prior expectations, with the price of maize affecting consumption negatively and the real rice price influencing consumption positively. The calculated elasticity of -0.20 on the real maize price suggested that a 10% increase of the real maize price would lead to a decrease of 2% in the per capita consumption of maize. An increase of 10% in the real rice price would lead to an increase of 3% in the per capita consumption. The calculated elasticity of the GDP per capita expresses that a 10% increase of income would lead to 0.4% increase in maize consumption. The

income elasticity shows the impact on maize consumption of changes in income. As income increases, quantities purchased increase, but at a slower rate than income.

Equation 4.3: Maize per capita food consumption

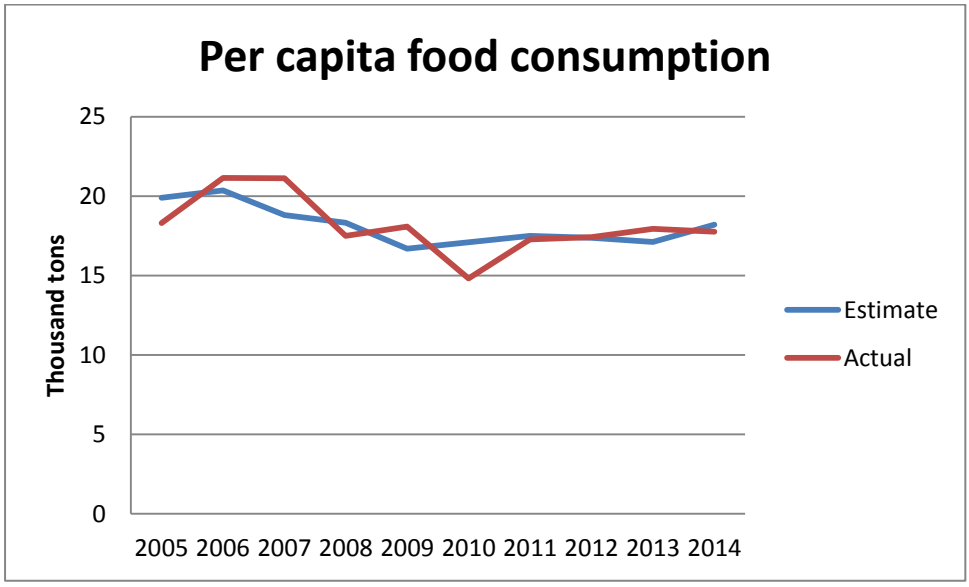
MPCCDC=ƒ (GDPPC, RMPDC, RRPDC)

Table 4.3: Estimation result of the maize per capita food consumption

	coefficient	t Stat	P-value	Elasticity
Intercept	23.61	8.41	0.0001***	
GDPPC	0.002	0.23	0.82	0.044
Real maize price	-0.01	-0.56	0.58	-0.20
Real rice price	0.01	(0.82)	0.44	0.30

Significance level: ***1%, **5% and *10%

F-Test (1.6) R^2 (0.44)



4.2.2.5 The maize food use

The maize food use is an identity and is equal to the population multiplied by the per capita food use to which is added the feed and food domestic.

Equation 4.4: Maize food use

*MFUDC= (MFPCDC*POPDC) + (MFDC+MFEDC)*

4.2.2.6 Maize real price

The real maize price is modelled as an identity as we close the model at the price. The model will include the price equilibrator as a tool for closing the model at the price.

4.2.2.7 Trade

Although the maize trade in DRC is mostly characterised by import, annual import and export data have always been very small and constitute a small share in the overall maize market. Since 2010, the average trade (import and export) have amounted to only 8 thousand tons, which represent only 1% of the domestic demand. Its small share in the total market imply that trade volumes are unlikely to have substantial impact on price levels. It is proposed to model trade as a behavioural equation, which allows markets to interact, without avoiding supply and demand dynamics in the price formation (Davids, 2017).

In market simulation models, trade flow specifications are most commonly based on the assumption of product homogeneity, resulting in trade occurring in a central pool. Thompson (1981) evaluated different approaches to model trade and concluded that most of the empirical models assume that agricultural commodities are homogenous in nature. The implications of such an assumption are that agricultural products are perfect substitutes; hence elasticity of the substitution is infinite and corresponding price ratio is constant. However, the inter industry trade where countries import and export the same agricultural commodity is the common characteristic in trade. In the other hand Grennes et al. (1978) reported several reasons for agricultural commodities to be heterogeneous. These include intrinsic heterogeneity of agricultural products, importers view products differently, cross transportation and the type of competition. Thus, trade models, such as multiple-region; non-spatial and spatial price equilibrium models that assume of homogeneity of product has limited application in modelling trade of differentiated goods.

The spatial equilibrium was first initiated by Samuelson in his paper on spatially price equilibrium in 1952 and was pointed out by Takayama and Judge who derived the model by maximizing the so called "net social payoff' subject to linear demand and supply functions in the various markets. Their study is largely conceptual due to the assumption that linear demand and supply functions are known or given. The spatial equilibrium is predicated on

the maximization of a quasi-welfare function define as the sum of producer and consumer surplus in an individual market after deducting transport and storage costs. (Davids, 2017). Thus, the price difference in each individual market cannot exceed the transport cost for a good between regions and price differences over time can't exceed the cost of storage. The price of the product *x* in the region *a* is described as

$$P_{xa} \leq P_{xb}+T_{xab}$$

Where:

- P_{xa} is the price of the product A
- P_{xb} is the price of the product B
- T_{xab} the transport cost of the product from region A to region B

The model is based on strong assumptions of price taking and perfect information (Davids, 2017), and allows for three possible regimes:

- No trade at all because prices differences are smaller than transportation costs
- Positive trade from region b to region a and Pxa = Pxb+Txab
- Positive trade from region a to region b and Pxa = Pxb+Txab

The supply function of each market may be estimated as a single regression equation independent of the supply functions in other markets and of the demand function in the same market. Change of price in one market with a higher transport cost won't have an impact on the other market but could allow a switch from one regime to another (Davids, 2017).

The Armington model is a popular specification to estimate import demand of the products differentiated not only by type but also by country of origin. According to Alston (1990), the Armington model is disaggregated which distinguishes commodities by country of origin, permits calculation of cross price elasticities between imports from all sources, easy to estimate
and flexible. The model often generates results that are judged to be successful because of both plausible parameter estimates and statistical significance.

Armington (1969) assumed that consumer utility was separable, and a single constant elasticity of substitution exists between products and across markets. He carried a two-stage procedure assuming in the first stage that a buyer decides on the total volume of imports and then in the second stage allocates total volume to individual suppliers to minimize cost.

Regarding the above, the methodology used in the study is largely based on the Armington approach. The trade flow specification considers relative prices in the domestic and regional markets. In the case of the import equation, a positive sign is expected on the price ratio variable. This would imply that, if domestic prices increase and international prices remain unchanged, it becomes relatively more affordable to procure maize outside of the DRC and hence imports increase.

Estimation however suggested that the effect of changes in there relative prices in the past has been negative. This does not align with the stated expectation as well as economic theory. Given that the estimation is based on a very short dataset, it was decided to base the trade equation on an assumption that aligns with economic theory instead. If one assumes a specific, positive elasticity, the coefficient on the price ratio variable can be derived as below. The assumed elasticity, as well as the derived coefficient, are presented in Table 4.4.

$$\text{Elasticity}=\frac{\partial y}{\partial x}\times\frac{Y}{x}$$

$$=(\text{coefficient of x})\frac{y}{x}$$

Rearranging the terms above, we get the following

$$=\text{coefficient of x}=\text{Elasticity}\times\frac{y}{x}$$

Equation 4.6: Maize import (Assumption)

MIMDC= (RMPRDC/WPR)

Table 4.4: Estimation results of maize import

	coefficient	*t Stat*	*P-value*	*elasticity*
Intercept	3.70	N/A	N/A	

Dom Price/IMPP	4.42	N/A	N/A	0.3

Significance level: ***1%, **5% and *10%

F-Test N/A R^2 N/A

By this assumption, a 10% increase in the ratio will lead to an increase in the quantity imported of 3%.

In the other hand, the export equation is expected to have a negative sign on the price ratio variable. This would imply that, if domestic prices increase and international prices remain unchanged, producers would be more inclined to sell domestically and exports would reduce. Estimation however yielded a positive sign, suggesting that higher domestic prices relative to regional prices would increase exports. This contradicts prior expectation, as well as economic theory. In order to align with the expectation as well as economic theory, exports are also based on an assumption, as opposed to estimation results. The assumed elasticity, as well as the implied coefficient, is presented in Table 4.5. The elasticity implies that a 10% increase in the price ratio will lead to a decrease in the quantity exported by 3%.

Equation 4.7: Maize export (Assumption)

MEXDC=f (RMPRDC/IMPP)

Table 4.5: Estimation results of maize export

	coefficient	*t Stat*	*P-value*	*elasticity*
Intercept	0.5	NA	NA	
Dom Price/IMPP	-0.07	NA	NA	-0.3

Significance level: ***1%, **5% and *10%

F-Test (NA) R^2 (NA)

As stated above, annual import and export data have been very small and constitute a small share in the overall maize market, this represents in average 1% of the domestic demand, that's the reasons of the fact that the estimation of the model were not working well, also, there is a prevalence of informal trade on the border side between DRC and Zambia.

4.4 CONCLUSION

Following the theoretical foundation describing the Democratic Republic of Congo's maize industry in Chapters 2 and 3, the purpose of Chapter 4 was the construction of a simulation model that would represent the market structure and price formation mechanisms described in Chapters 2 and 3. Despite the lack of data and the mismatch between the assumptions related to the traditional quantitative modelling techniques, a partial equilibrium was the appropriate methodology to use for this study. The use of the economics theory in the model allowed us to understand the relationship between the variables, as well as their impact on the market. With only limited data and small values on trade and stocks, it can be expected that statistical significances of some of the equations will not perform well. Therefore, the insertion of synthetic variables as well as assumption on trade equations is a must in order to get an economic significance.

The estimated coefficients of the trade parameter signs did not comply with a priori economics expectations therefore, the assumption made on the trade elasticity helped to align with the theory. This was due to the small share of trade in the market as well as the prevalence of informal trade in the maize industry. For this study, the model is closed on the price identity and then will be solved using the price equilibrator. This will be linked to the market and will be used to solve the model. The model is only solved when the demand is equal to the supply.

The baseline forecasts, as well as the policy scenario, is presented in the next chapter.

CHAPTER 5: VALIDATION AND APPLICATION OF THE PARTIAL EQUILIBRIUM MODEL FOR POLICY SIMULATION

5.1 INTRODUCTION

Based on the estimated equation of the model, the baseline scenario and the policy simulation are performed in this chapter to critically examine the performance of the model in reflecting the realities of the maize market in the DRC. The previous chapter reported the estimated parameters for the individual equations used in the maize market partial equilibrium model for the DRC. The use of the statistical test and economic theory for the individual regression using the OLS estimator was applied to report their statistical and economical significance. Validation has many forms, but I focused on validation through mathematical statistics. Statistical validation can use various tests, depending on the type of data available for the real system. The measure of the validity of a model remains an open question as it depends on the real-world aspect being analysed as well as on the type of model being used (Gass, 1983). The validation of the model tries to establish how closely the model mirrors the apparent reality of the model developed. It is used to describe the standard statistical procedures for hypothesis testing and estimation that can be used for validating a model, especially a policy model must go beyond applicable statistic test. A model is structurally valid if it not only reproduces the observed real system but also truly reflect the way in which this system operates in real life to produce this behaviour (Ziegler, 1976). Based on the estimated mode equation, simulations for plausible policy scenarios are performed in this chapter. The purpose of modelling the DRC maize market is to validate the forecasting accuracy of the estimated model by providing an impact analysis in order to validate the model; generating a Baseline outlook and evaluating different policy alternatives relative base. In order to evaluate the model performance, it is needed to compute a policy scenario or impact multiplier deterministic simulation to provide recommendations for a policy framework that will lead to improved investment in agricultural production, with a specific focus on price formation in the maize industry. The impact multiplier is the change in a dependant variable to the change induced by an exogenous shock (Ferris, 1998). The impact multipliers are calculated through the imposition of two different sets of shocks on different variables in the maize model. The maize model specification and simulation results are outlined both in table format and graphically.

The first policy scenario shock evaluated a possible increase in the yield in the DRC maize sector and the second scenario evaluated the trade policy impact on the maize market. The baseline forecast was generated for the period 2015-2020, based on several assumptions.

5.2 BASELINE

The construction of a baseline scenario is often required in analyses and future studies that aim at comparing different possible future situations (FAO, 2011). According to Meyer (2006), a baseline projection is considered as a simulation of the model of a specific period under agreed policies and specific assumptions about macroeconomic economic variables, as well as weather and technological change. In other words, the baseline scenario can be considered as a benchmark against which alternatives can be measured and understood. In order to build a baseline one must take into consideration several criteria from the socio-economic to the environmental aspects. In itself, a baseline scenario does not constitute a forecast, but it is presented as a benchmark of a set of plausible assumptions (Meyer, 2006). This means that theoretically, a baseline can rather be seen as a single plausible market scenario outlook or a benchmark of what possibly will happen under a specific set of assumptions on the maize market given a set of exogenous assumptions. It assumes policies remain unchanged; this makes things ideal to compare policy changes in order to illustrate their impact. The partial equilibrium model is also one of the tolls used for analysing the influence of various trade policies on production, consumption and trade is considered for a specific sector, while keeping other influences constant. A partial equilibrium model is used as an estimation of trade policy changes. Although it has limitations in terms of coverage in the economy, it provides a flexible, useful tool for policy analysis (AGRODEP, 2013).

5.2.1 Assumption

The main assumption regarding policy of the maize market in the DRC includes macroeconomic variables, domestic and international prices, and local trade flow. The baselines are simulated for the period 2017-2020.

In order to simulate the maize market in the DRC baseline, the study used macroeconomic variables, domestic and world price trade is endogenous. Macroeconomic variables assumptions are generally based on projections to simulate the baseline scenario. The values

of the macroeconomics projection for the DRC maize model were taken from the World Bank database and the Renapri Outlook 2014. Table1 presents the projections for macroeconomic and policy variables as well as international prices that were used to generate the baseline projections for the maize model. All the relevant macroeconomics variables were assumed to have a growth rate equivalent to the average of the last four years. In the study, we used the Zambian price as the regional price and it was assumed to grow according to the trend of the past years and finally, the tariffs were assumed to be the same during the forecast period.

Table 5.1: Macroeconomics Baseline assumption

Variables	Units	2017	2018	2019	2020
Exchange rate	USD\FC	1500.85	1848.388	2134.24	2420.1
GDP	Billions, US$	47.1	50.66	54.22	57.78
GDP per capita	USD	577.6	611.0	644.3	677.6
Population	Million	74.7	76.5	78.3	80.1
World maize price (Zambia)	$/kg	0.29	0.3	0.31	0.31
Consumer price Index	index (2010=100)	164.83	173.51	182.19	190.87
Convert to domestic currency	FC/kg	437.9	552.1	652.2	756.3
Insurance	3%FOB	13.1	16.6	19.6	22.7
Tariff	%	0.1	0.1	0.1	0.1
Import Parity Price	FC/kg	494.8	623.8	737	854.60

The macroeconomic projections presented above focus on the real GDP; Consumer Price Index (CPI); exchange rate; GDP per capita, and the population. The baseline assumes that agricultural policies remain constant. The GDP per capita is projected to increase continuously throughout the years, with a raise to USD 677.59 in 2020. This increase correlates to the population increase. The exchange rate is expected to gradually depreciate to a level of FC 2420.10 against 1USD by 2020. Throughout the projected years, inflation (CPI) is expected to steadily increase reflected in the rise of CPI from 164.83 in 2017 to 190.87 in 2020.

Table 5.2 below illustrate a baseline of the endogenous variables obtained from the estimated model. This includes area harvested, production, domestic consumption, export and import, ending stock, food use and food use, maize wholesale price, real maize price and real rice price.

Table 5.2: Baseline simulation

	Units	2017	2018	2019	2020
Maize area harvested	000 ha	1483.36	1490.91	1504.01	1519.33
Maize yield	Ton/ha	0.85	0.85	0.86	0.86
Maize production	000 tonnes	1260.85	1267.27	1293.45	1306.62
Total Maize imports	000 tonnes	12.74	12.13	11.79	11.55
Total Maize exports	000 tonnes	0.10	0.11	0.12	0.12
Maize dom. Consumption	000 tonnes	1263.13	1283.57	1303.88	1319.83
Maize ending stocks	000 tonnes	80.49	76.21	77.45	75.67
Maize feed dom. Consumption	000 tonnes	51.05	51.22	51.39	51.57
Maize food use	000 tonnes	1212.08	1232.35	1252.49	1268.27
Maize food use per capita	Kg/Capita/year	16.23	16.11	16.00	15.84
Maize grain Wholesale (Kinshasa)	FC/kg	564	600	639	690
Real Maize price	FC/kg	294	293	265	272
Real Rice price	FC/kg	347	336	326	316

Table 5.2 above presents the baseline projection of the DRC endogenous variables of maize market from 2017 to 2020. The area planted is projected to increase up to 1519,3 thousand hectares in 2020. The increase in the area planted is positively correlated to the quantity produced; hence the results show an increase in the quantity produced in 2019 to be 1293,5 thousand tons. This production is a product of the increased area planted (1504,01 thousand ha) multiplied by the yield of 0.86 tons per hectare. On the demand side, maize domestic consumption is projected to increase to 1319,83 thousand tons in 2020. The feed consumption of maize is estimated to slightly increase in 2017 and decrease from 2019 to 2020. Yield is unchanged relative to last year and is expected to stay constant over the projected period. The maize food use increases from 1212,08 tons in 2017 to 1268,28 tons by 2020. The maize import is expected to increase in 2018 by 12,13 thousand tons whereby there is a reduction in 2019 to 11,79 thousand tons and in 2020 to 11,55 thousand tons. The maize export is expected to increase in 2017 by 0,10 thousand tons then stay stagnant for all the projected year. The ending stock is expected to an increase in 201è followed by a decrease over the projected period. A higher or lower level of production implies that stock (ending) should rise or decrease.

The model indicates that maize grain whole sale price increase from 2017 to 2020. The real maize price, on the other hand, showed a decrease in 2018; it goes from 294 FC/kg in 2017 to 293 FC/kg in 2018 and by 265 FC/kg. By 2019, real maize price is expected to go up. In

DRC the political instability had have an impact on the price; the prices of the staple food such as maize, cassava, beans have increase mostly at the Center (Kasaï Central), West (Kwango), Southeast (Haut-Lomami), North (Tshuapa) and East. (North Kivu, Maniema) of the country. The Center, the East and the South-East of the country are experiencing insecurity and displacements of populations that have an impact on the availability of foodstuffs.

5.3 DRC MAIZE OUTLOOK SCENARIO 1: YIELD SHOCK

The agricultural sector of the DRC is characterised by the fact that 70% of the population depends on agriculture for survival. Since maize is among the major cereals consumed in the country, it is a staple food in most of the provinces in the DRC. It is produced in the central regions, mainly by small farmers in mixed-cropping systems, with an average national yield of around 0.85 tons per hectare. This is very low relative to global and regional norms.

The scenarios that will be incorporated in this study are market-related; and take into consideration current policies and environmental changes, including economic and political instabilities. In the scenario applied, the model is solved, and the results are compared to the initial baseline produced prior to environmental shocks in the economy, to measure the impact. Within the partial equilibrium context, any change to one variable can be quantified in terms of impact on the entire maize market.

While the purpose of this study is to quantify the impact of improved yields on the entire maize market, specifically also price, rather than the effect of specified measure in improving current yield levels, it should be noted that a number of options exist to achieve yields gains in the DRC. Possible measure for increasing yields include improvements to tillage methods to preserve soils and nutrients, which will be more beneficial than removing rain forest to open more agricultural land. Other policies might include soil testing to determine soil chemistry profiles, crop rotation, nutrient and water management, crop diversification, and interspersing crops with trees. These methods could reverse the nutrient depletion characteristic of so many cultivated soils.

The scenario conducted with an intention to evaluate the impact of increasing the maize yield by 5% in 2017 and 2018 and 10% in 2019 and 2020. Tables 5.4 and 5.5 show the possible

impacts this would have on the maize industry in different year in the country. After the shock, in 2017, the initial impact is felt whereby the increase of maize production by 3.41% (1303.8 thousand Tons). In responding to the increase in production, the maize import decrease by 3.37% in the same year (or -0.43 thousand tons). On the other side, the increase of the yield has led to an increase of the maize domestic consumption by 2.85%; the ending stock will increase and leads to an increase of export. The increase of the production led to a decrease of the maize wholesale price by 8,21%. The decrease of the price lead to a decrease of the area harvested. As the price is going down, the producers are not willing to plant in big surfaces. The decline of price leads to an increase of maize food use per capita by 2.97%.

The dynamic nature of the model also enables simulation of multi-year impacts. In 2018, production will increase by 3.06% (38.8 thousand ton). The maize domestic consumption increases by 3.13%, more than production. In responding to the 2018 lower prices, farmers reduce the areas under cultivation, therefore the maize area planted will decrease slightly more than 2017, by 2.66% (against 2.34% in 2017). The projection shows that the consumption of maize food use increases at a rate constant to the per capita maize food use consumption. Over the past years, the domestic economies experienced frequent macroeconomic, political and environmental fluctuations. The DRC population is projected to continue growing till it reaches a level of 86.7 million by 2020. This implies that the country´s available food should also increase to support this growth. The higher the population, the higher will be the food demand; this increase should be taking into awareness the per capita GDP. The price reaction in 2017 and 2018 reveals the law of demand and supply in relation to price determination of goods, whereby a higher supply will lower the price of the goods or service in question and/or vice versa. It is also evident that a change in one variable on the maize industry will affect the others as the market moves to establish equilibrium. Since 2017, the political crisis has affected the economy of the country, there has been an upward trend in food prices in recent months (2018) caused by the ongoing conflict in the Kasai and the Tanganyika regions which continue to disrupt markets for food and livestock. Countrywide, cereal prices are generally high as a result of limited supplies.

The second shock is a 10% increase of the maize yield in 2019 and 2020. The results show an increase of maize production by 6.21%. The growth of maize production followed by the adoption of appropriate agricultural practices has resulted in farmers producing enough grain, not only for immediate consumption, but also for storage to feed the population over the year

as well as the following year. While the domestic consumption increases by 7.68%, the import decreases 4.78% due to the higher increase of maize supply (production) than the increase of domestic consumption (demand). The increase of production triggers the decrease in the maize market price by 26.82% for the maize grain wholesale and by 3.13% for the real maize price. Responding to the price reduction, the maize domestic consumption as well as the food use and per capita food use increase by 5.88%. In 2020 the production increase by 5.95%.

The results indicate that the area planted decrease in 2019 and 2020 as a result of declining maize prices. The increase in yield is however sufficient for production to increase, despite the decline in area.

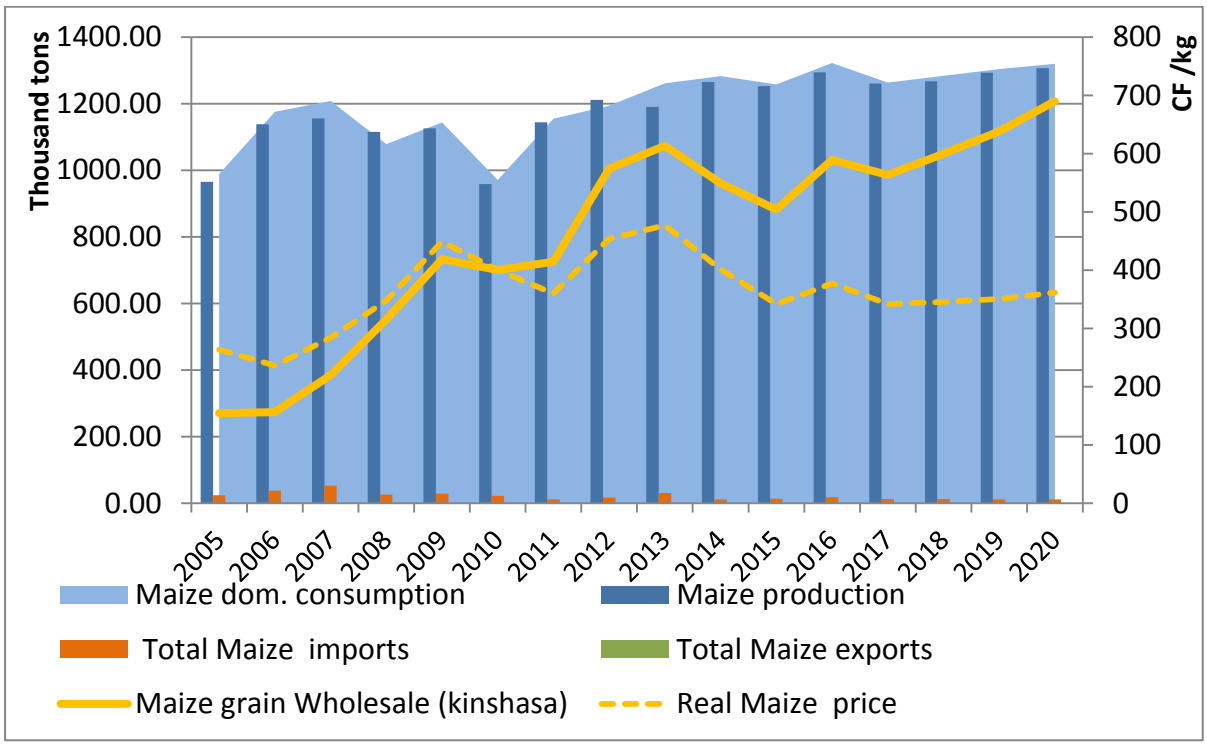


Figure 5.1: DRC Maize market Outlook: Yield Shock

Table 5.3: DRC Maize Market Baseline versus Yield Improvement Scenario: Absolute change

	Units	2017	2018	2019	2020
Maize area harvested	1000 ha	-34.65	-39.72	-73.01	-77.21
Maize yield	Ton/ha	0.05	0.05	0.10	0.10
Maize production	1000 tonnes	42.98	38.80	80.31	77.81
Total Maize imports	1000 tonnes	-0.43	-0.37	-0.56	-0.51

Total Maize exports	1000 tonnes	0.01	0.01	0.01	0.01
Maize dom. Consumption	1000 tonnes	35.94	40.21	73.59	78.84
Maize ending stocks	1000 tonnes	6.61	4.82	10.97	9.42
Maize feed dom. consumption	1000 tonnes	0.00	0.00	0.00	0.00
Maize food use	1000 tonnes	35.94	40.21	73.59	78.84
Maize food use per capita	Kg/Capita/year	0.48	0.53	0.94	0.98
Maize grain Wholesale (Kinshasa)	FC/kg	-79.30	-91.22	-171.26	-187.92

Table 5.4: Percentage change of the yield shock in the DRC Maize market

	Units	2017	2018	2019	2020
Maize area harvested	1000 ha	-2.34%	-2.66%	-4.85%	-5.08%
Maize yield	Ton/ha	5.88%	5.88%	11.63%	11.63%
Maize production	1000 tonnes	3.41%	3.06%	6.21%	5.95%
Total Maize import	1000 tonnes	-3.37%	-3.07%	-4.78%	-4.40%
Total Maize exports	1000 tonnes	6.73%	5.33%	7.68%	6.73%
Maize dom. consumption	1000 tonnes	2.85%	3.13%	5.64%	5.97%
Maize ending stocks	1000 tonnes	8.21%	6.32%	14.16%	12.45%
Maize feed dom. consumption	1000 tonnes	0.00%	0.00%	0.00%	0.00%
Maize food use	1000 tonnes	2.97%	3.26%	5.88%	6.22%
Maize food use per capita	Kg/Capita/year	2.97%	3.26%	5.88%	6.22%
Maize grain Wholesale (Kinshasa)	FC/kg	-14.06%	-15.20%	-26.82%	-27.24%

The increase in yield will therefore allow producer to produce more on less area as well as to free land to diversify their production to generate additional revenue to meet the rising demand. In the other hand, the consumer pays their staple food (maize) at a lower price and have the liberty to diversify their diet as there is availability of other food.

A study of increase in yield in Kenya by Maurice Juma Ogada1 and Wilfred Nyangena (2015) shows that improving farm technologies are meant to make agriculture more rewarding, especially in terms of increased output per unit of factor input or improved quality of output. Another same study was conducted by National Agricultural Research Institute (NARI) and International Institute for Tropical Agriculture (IITA) in Nigeria were the government attempted to increase maize production by doing extensive research works on maize yield, research focus was to develop and introduce improved maize varieties that are disease resistant and high yielding. Consequently, maize production has since the mid-1980s increased more than tripled not only in West and Central Africa including Nigeria. The development of rapid maturing varieties has empowered maize production to expand into the Sudan Savannah Zone of Nigeria because the zone has short duration of rainy season.

5.3 DRC MAIZE OUTLOOK SCENARIO 2: TRADE SHOCK

The introduction of trade in agriculture has become increasingly important as more and more countries and their farmers participate in the international market. Trade agreements in the agricultural sector has a significant effect on the national trade policy as well as on the structure and the nature of the whole system of agricultural trade and production pattern (Ching, 2013). Therefore, the national and international trade policy has a significant impact on food security. Liberalisation of the agricultural market has increased pressure on cost, promoting producers toward greater specialisation which often results in increased mechanisation and utilisation of chemicals and boosting trade (Ching, 2013). Although the arguments in favour of free trade and increased trade sincerity, agricultural trade protection is still widely practiced. The main justification given for continued trade protectionism is to protect infant industries, new technology; protect strategic industries such as energy, water, steel, armaments, and food; discourage unfair competition, such as dumping at prices below cost measure to liberalize their economy in order to improve their trade policies and by increasing their partnership with the private sector and civil society as well as to launch a competitive environment within all the sectors (Davids,2013).

Partial equilibrium is one of the most suitable tools for trade simulation, mostly for small countries where the import tariff imposed does not impact on the world price (Davids, 2013). Partial equilibrium shortcomings are the fact that the analysis of import is isolated from the rest of the economy and does not take into account long term effects such as growth or reallocation of production factors (AGRODEP, 2013). With the help of the partial equilibrium model the DRC maize model focuses on the response of the maize market to the change in the trade policies. Since 2001, the government has undertaken a series of reforms intended to liberalize the economy and to open up to international competition (WTO, 2010). In a small economy in which the volume of a traded commodity is an insignificant portion of that item in world trade, the imposition of a tariff or a quota will have a negligible effect on the country's terms of trade. Under such a condition, partial equilibrium analysis is a very useful tool to analyse the welfare effects of tariffs and quotas (Fan, 2005).

Tariffs can be defined as taxes on import of commodities into a country or a region. They are among the oldest tools used for government intervention and are widely used to protect domestic producer income from the competition. This protection does not only affect the consumer who pays higher prices for the import of competing goods but also to the whole economy through inefficient allocation of resources to import competing domestic industries. The welfare effect of the imposition of tariffs on the demand and supply of a commodity in the market can be described as:

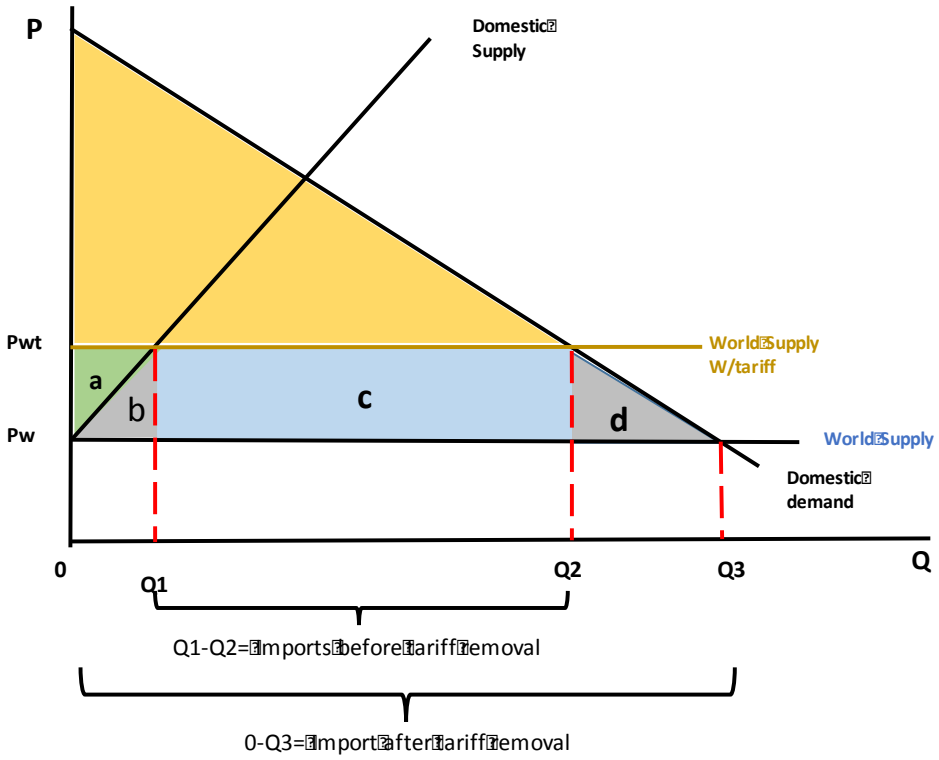


Figure 5.2: Effect of tariff on the DRC maize import market

With tariff in place, the domestic production will be Q1, the domestic consumption will be Q2, the difference between Q2 and Q1 is the sizable import. If the government remove tariff, the domestic price will decrease to Pw, while the import increase and the production will decline in this extreme case to 0. The new domestic consumption will be Q3, all of which will be imported. In response to the removal of tariff and as price declines, the consumer surplus increases by the area (a+b+c+d) while the producer surplus declines by the area a. the area c is a loss in government revenue as the tariff was removed therefore the government does not gain tariff revenue. As the area a is transferred from producer to consumers and the

area c from the government to consumer, the total net gain from the removal is represented by the area b and d.

The study was conducted with the aims at analysing the impact of maize import tariff policy changes on the production, the consumption, the import and the price of maize in DRC. To answer the purposes of this study, the following simulations were conducted by an elimination of maize import tariff. To control the importation of maize and protect domestic maize farmers, the government issued a policy of import tariffs. During the period 2005-2016, 10% import tariff was imposed. For the scenario, it was removed in 2017.

The abolishment of the import tariff policy on maize had an impact on the maize production, import and price maize imported and decreased maize price. Decreased domestic maize price was responded by maize farmer through lessing maize planted area and fertilizer input uses that had impact on the declining in maize production. The table below, shows the result of the simulation.

Table 5.5: DRC Maize Market Baseline Scenario 2: Trade shock, removal of tariff

	Units	2017	2018	2019	2020
Maize area harvested	1000 ha	1483.10	1490.78	1503.88	1519.21
Maize yield	Ton/ha	0.85	0.85	0.86	0.86
Maize production	1000 tonnes	1260.64	1267.16	1293.34	1306.52
Total Maize import	1000 tonnes	13.03	12.37	11.99	11.73
Total Maize exports	1000 tonnes	0.10	0.11	0.11	0.12
Maize dom. Consumption	1000 tonnes	1263.30	1283.66	1303.97	1319.91
Maize ending stocks	1000 tonnes	80.40	76.17	77.40	75.63
Maize feed dom. Consumption	1000 tonnes	51.05	51.22	51.39	51.57
Maize food use	1000 tonnes	1212.25	1232.44	1252.58	1268.34
Maize food use per capita	Kg/Capita/year	16.23	16.11	16.00	15.84
Tariff	Percentage	0%	0%	0%	0%
Maize grain Wholesale (Kinshasa)	FC/kg	564	600	638	690

The second scenario is conducted to evaluate the impact of tariff removal on the maize market from 2017 to 2020 as showed in table 5.5. The trade shock has express a small effect due to the small share of trade in the maize market in DRC. Tables 5.7 and 5.8 show the possible impacts this would have on the maize industry. After the removal of the tariff, there is a decline in the production by 0.02% to 0.01% from 2017 to 2020. In responding to the decrease in production, the maize import increase by 2.31% in 2017; then will slightly goes

down by 1.95% in 2018, 1.72% in 2019 and 1.56% in 2020. On the other side, the tariff removal has led to a slight increase of the maize domestic consumption while the ending stock has decrease and leads to decrease of export. The increase of the import has led to a decrease of the maize wholesale price by 0.07% in 2017, 0.03% in 2018, 0.03% in 2019 and 0.03% in 2020. This shows that, the welfare of tariff expresses that the producer is more likely to gain from the imposed tariff while the consumer loses. The price elasticity of the supply as well as the demand will determine how much the producer will gain and the consumer will lose. The greater the supply and demand elasticities are, the larger the distortion will be.

Table 5.6: DRC Maize market: Trade shock (removal of tariff): absolute change

	Units	2017	2018	2019	2020
Maize area harvested	1000 ha	-0.26	-0.13	-0.13	-0.11
Maize yield	Ton/ha	0.00	0.00	0.00	0.00
Maize production	1000 tonnes	-0.22	-0.11	-0.12	-0.10
Total Maize import	1000 tonnes	0.29	0.24	0.20	0.18
Total Maize exports	1000 tonnes	0.00	0.00	0.00	0.00
Maize dom. consumption	1000 tonnes	0.17	0.09	0.09	0.08
Maize ending stocks	1000 tonnes	-0.09	-0.04	-0.05	-0.04
Maize feed dom. consumption	1000 tonnes	0.00	0.00	0.00	0.00
Maize food use	1000 tonnes	0.17	0.09	0.09	0.08
Maize food use per capita	Kg/Capita/year	0.00	0.00	0.00	0.00
Tariff	Percentage	-0.10	-0.10	-0.10	-0.10
Maize grain Wholesale (Kinshasa)	FC/kg	-0.38	-0.20	-0.22	-0.19

Table 5.4: Percentage change of the trade shock in the DRC Maize market

	Units	2017	2018	2019	2020
Maize area harvested	1000 ha	-0.02%	-0.01%	-0.01%	-0.01%
Maize yield	Ton/ha	0.00%	0.00%	0.00%	0.00%
Maize production	1000 tonnes	-0.02%	-0.01%	-0.01%	-0.01%
Total Maize import	1000 tonnes	2.31%	1.95%	1.72%	1.56%
Total Maize exports	1000 tonnes	-4.61%	-3.39%	-2.77%	-2.39%
Maize dom. consumption	1000 tonnes	0.01%	0.01%	0.01%	0.01%
Maize ending stock	1000 tonnes	-0.11%	-0.06%	-0.06%	-0.05%
Maize feed dom. consumption	1000 tonnes	0.00%	0.00%	0.00%	0.00%
Maize food use	1000 tonnes	0.01%	0.01%	0.01%	0.01%
Maize food use per capita	Kg/Capita/year	-0.02%	-0.01%	-0.01%	-0.01%
Tariff	Percentage	-100.00%	-100.00%	-100.00%	-100.00%
Maize grain Wholesale (Kinshasa)	FC/kg	-0.07%	-0.03%	-0.03%	-0.03%

5.4 CONCLUSION

This chapter examines the ability of the maize market model to generate reliable estimates and projections of endogenous variables under what is happening in real world conditions in terms of baseline and scenario simulations. These performance measures can be seen as supplementary to the statistical validation tests reported and discussed in Chapter 3.

CHAPTER 6: CONCLUSION

Every country needs a comprehensive national food security strategy to build resilience to reduce, manage and cope with shocks and stresses, including price volatility. The DRC has a huge potential of natural resources and it could therefore be argued that it has a greater potential than many of its African neighbours to lift its population out of extreme poverty. However, its agricultural sector needs wholesale reform with the support of both the public and private sector. Despite being an agricultural exporter prior to independence in 1960, the agricultural sector in the DRC has been through long periods of stagnation and decline. Currently, the agricultural sector is growing at 2% per year, but this is slower than the increase in population. Many farmers are struggling to have access to credit and despite the government's intervention with international partners such as the FAO and World Bank, there is a slight improvement of both public and private investment in agriculture, as well as in the country's energy and transport infrastructure. The DRC government has undertaken a series of reforms, designed to liberalize the economy and open it to international trade; undergoing a review of trade policies with the WTO in order to work for open and transparent trade, also to keep the multilateral trading system. Additionally, the availability of data concerning the trade market is very challenging.

The agricultural market remains complex to analyse, due to the changes in market conditions. However, given meaningful econometric techniques and economic theories, one can understand the market structure using the partial equilibrium model that has been used in this study. This has helped with the understanding and development of the modelling of partial equilibrium on the maize market in the DRC.

Following the theoretical foundation describing the Democratic Republic of Congo's maize industry, the construction of a simulation model represented the market structure and price formation mechanisms in the maize market. Despite the lack of data and the mismatch between the assumptions related to the traditional quantitative modelling techniques, a partial equilibrium model was used in the analysis. The use of economics theory in the model allowed us to understand the relationship between the variables as well as their impact on the market. With only limited data and small values on the trade and the stocks, the statistical significances of some of the equations did not perform well. Therefore, the insertion of synthetic variables was used in order to get an economic significance. The model is closed on

the price identity and then was solved using the price equilibrator. The empirical estimation of the model showed that the maize market do respond to change in the world price of maize.

The baseline forecasts, as well as the policy scenario, examined the ability of the maize market model to generate reliable estimates and projections of endogenous variables regarding what is happening under real world conditions in terms of baseline and scenario simulations. Although the enhanced stability is useful within the context of the total sector model, the sensitivity that is lost in the maize model could lead to the underestimation of the impacts of exogenous factors. A shock on the yield leads to a decrease in the area harvested from 2017 to 2020. The maize food use per capita, as well as the domestic consumption will increase following decrease of the price. This allows the producer to increase the maize production. Although the changes are light, it is obvious that an adjustment on the yield will allow small farmers to increase the production of food. Besides this increase, the area harvested decreased due to the lack of machinery for most farmers. The area declined but production still increased due to yield – this freed up area to diversify crops. Apart from the shock in yield, the government should stabilise the exchange rate as it has an important influence on food price.

All this calls for a very strong, creative, efficient measure of policies to mitigate all the negative effects of factors like political instability, food insecurity, malnutrition and infrastructures issues that do not allow the agricultural sector to develop properly. On the other hand, a tariff removal will benefit help to increase import at a lower price, while the production will decline. As a matter of fact, the impacts of the tariff removal are very low in the local maize industry is not only due to the small share of trade in the maize market but also to the trade policies impact on local price depend not only on the local trade policy but also on the local infrastructure and transportation system and the economic structure of the market.

As a recommendation, the government as well as the investors should promote the production of smallholder farmers. Ggovernment needs to facilitate and accelerate smallholder access to seeds and fertilizer given that world prices for seeds and fertilizers are beyond the reach of small farmers. Encourage agricultural innovation: given the low yield for most crops, especially cassava, maize and rice, it is therefore essential to provide assistance to agricultural research institutions to increase their capacity to help and assist farmers in increasing their area harvested and the yield.

6.1. LIMITATION OF THE STUDY

As stated before, the DRC's agricultural data is imprecise and very poor. This was the main challenge of the study, as well as the reason behind the inability of this study to assess the total sensitivity of the maize market. The use of the partial equilibrium framework could not provide an assessment of the world economy's effect on the local maize market. Hence, future study should take into consideration the above limitations and incorporate some trade measures or restrictions on the maize market. The economic and political instability of the country, as well as the government, the study could not forecast for more than 5 years in order to keep the data accurate for future use.

Taking into the consideration the political and economic situation of the DRC and the effect of imports of food (particularly of maize) on the trade balance, the country should focus on increasing maize productivity through improved policy to enhance exploitation of comparative advantage in maize production to improve food security.

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