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Efficiency and integration in the Zambian sugar market: analysing price transmission, price formation and policy

By

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Submitted in partial fulfilment of the requirements for the degree of
MSc Agric. (Agricultural Economics)

in the

Department of Agricultural Economics, Extension and Rural Development

Faculty of Natural and Agricultural Sciences

UNIVERSITY OF PRETORIA

PRETORIA

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DECLARATION

I Brian Chisanga declare that the thesis, which I hereby submit for the Degree of MSc. (Agric) 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

Signature ----------

Date ----------

DEDICATION

This thesis is dedicated to my dear wife Mweshi Mwamba Chisanga, my lovely daughter Natasha Temwikwa Chisanga, my parents, brothers and sisters.

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I would like to express my heartfelt gratitude to my supervisor Dr Ferdinand Meyer for the time, commitment and wise counsel during the production of this thesis. I also wish to acknowledge my co-supervisor Lulama N. Traub from the University of Stellenbosch, Prof. Johann Kirsten and all the members of staff of the Department of Agricultural Economics, Extension and Rural Development at the University of Pretoria.

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ABSTRACT

Efficiency and integration in the Zambian sugar market: analysing price transmission, price formation and policy

By

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Degree: MSc. Agric (Agricultural Economics)
Department: Agricultural Economics, Extension and Rural Development
Supervisor: Dr Ferdinand Meyer

Zambia ranks as one of the lowest cost producers of sugar. However, Zambia's domestic sugar price has been high and volatile and is substantially higher than the world price. This has raised concern among stakeholders and further raises questions about the efficient functioning of the market.

The study sought to determine and explain efficiency and integration in Zambia's sugar value chain by analysing price spreads, price formation, and price transmission through a price transmission and partial equilibrium model. The study hypothesised that the Zambian sugar market is both inefficient and it is not integrated with the world market. This was tested through the price transmission and partial equilibrium models.

Price transmission is conceptually premised on the Law of One Price (LOP) which postulates that in a frictionless undistorted market, the difference between markets spatially separated should only be explained by transaction costs. To test the hypothesis long-run equilibrium between prices was tested through a series of cointegration tests and an Error Correction model (ECM) was built for cointegrating price series. Model simulations were run and tests for asymmetry for cointegrating price series were conducted. A partial equilibrium framework was developed to determine price formation for Zambia's sugar market from a number of behavioural equations.

The study establishes cointegration in the spatial price transmission (between world sugar prices and Zambia's wholesale prices) and vertically (between the domestic wholesale prices and sugarcane prices). The ECM for the spatial price transmission reveals low integration and efficiency evidenced by the low speed of adjustment, the Error Correction Term (ECT) of -0.09 and the model simulation, which shows that it takes approximately 3 years for the markets to revert to long run equilibrium after experiencing a price shock. The study also establishes that the spatial price adjustment is asymmetric. The vertical price transmission analysis reveals that it is relatively more integrated and efficient as it has a higher speed of adjustment (ECT of 0.199) which is twice that of the spatial price transmission. The model simulation reveals that it takes about 1 year and 6 months to revert to long run equilibrium after experiencing a shock. The vertical price adjustment is also found to be symmetric. A negative short-run elasticity of -0.29 is found for the spatial price transmission while the long-run transmission is found to be inelastic (0.91) which is close to unitary elasticity. The short-run vertical transmission is found to be very inelastic (0.009) while the long-run transmission of 0.94 is similar to the spatial transmission (inelastic but close to unitary).

Farm to Retail Price Spreads are found to be widening with growing volatility owing to the volatile nature of the Retail Value. While the Farm Value has been increasing, recent spikes experienced in the Retail Value have resulted in an overall widening of the Farm to Retail Price Spread.

The partial equilibrium analysis indicates that the price formation in Zambia's sugar market is determined by the world price through the export parity price, domestic demand, supply conditions as well as policy. The elasticity between Zambia's sugar price and the export parity price is found to be unitary (1.09). The price space analysis reveals that although Zambia's domestic price is correlated with the export parity prices it is trending closer to the import parity price. This suggests that there are distortions in the sugar market, which may include high transaction costs, high concentration in the market structure as well as inappropriate policies such as high taxation, high interest rates and a policy requiring fortification of all sugar with Vitamin A, which are driving the domestic price upwards to exceed the export parity price. The sugar baseline for Zambia is generated for 2012 to 2015 based on a number of assumptions in the exogenous variables.

Sugar production domestic use and exports are on the rise while the domestic price rises in 2011, falling between 2013 and 2014 then rising in 2014 to 2015. Model simulation of the removal and/or modification of the policy requiring sugar fortification reveals that there is an increase in the flow of imports to about 25,000 tons per year. This results in a 3.2 per cent loss in production and a 6.1 per cent gain in exports while the domestic sugar price falls by 23.9 US Cents/kg (18.8 per cent). Thus Zambia gains in terms of increased consumer welfare and producer welfare because production losses are offset by revenue gains through exports since the world price also increases.

The study recommends that transaction costs which include transportation costs, energy, taxation which are pushing the domestic price upwards need to be lowered. The study emphasises the need to promote investments in the sugar industry especially for smaller emerging sugar mills by lowering interest rates and taxes as well as a need to strengthen competition laws governing the industry which will protect consumers,would-be-investors and cane producers from uncompetitive pricing. It further recomments the lifting and /or modification of the barrier on imports of unfortified sugar but stresses that government can allow raw sugar imports which can be fortified in Zambia. A more open and undistorted sugar market in Zambia will result in a competitive, efficient and integrated market governed by market dynamics.

Key words: price transmission, price formation, efficiency, integration

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LIST OF ACRONYMS

ACF	Autocorrelation Function
ACP	Africa Caribbean and Pacific
ADF	Augmented Dickey-Fuller
ARDL	Auto Regressive Distributed Lag
BFAP	Bureau for Food and Agricultural Policy
BOTT	Board on Tariffs and Trade
CCAA	The Competitive Commercial Agriculture in Africa
CSO	Central statistical Office
DF	Dickey-Fuller
DoP	Division of Proceeds
DRC	Democratic Republic of Congo
DTI	Department of Trade and Industry
ECM	Error Correction Model
ECT	Error Correction Term
ERS	Economic Research Services
EU	European Union
FAO	Food and Agriculture Organisation
FDI	Foreign Direct Investment
FOB	Free on Board
FTRPS	Farm to Retail Price Spreads
GDP	Gross Domestic Product
KASCOL	Kaleya Smallholder Scheme
LDC	Least Developed Countries
LOP	Law of One Price
NAMC	National Agriculture Marketing Council
NTB	Non-Tariff Barriers
ODI	Overseas Development Institute
OLS	Ordinary Least Squares
PBM	Parity Bound Model
RV	Recoverable Value
SA	South Africa

SACU	Southern African Custom Union
SECM	Switching Error Correction Model
TAR	Threshold Auto Regressive Model
USD	United States Dollar
USDA	United States Department of Agriculture
VAT	Value Added Tax
VECM	Vector Error Correction Model
WTO	World Trade Organisation
ZCC	Zambia Competition Commission
ZIC	Zambia Investment Centre

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The sugar industry is undoubtedly one of Zambia's most important economic sub-sectors. Although it is not strictly essential in people's diet, sugar is one of the most successful non-traditional export sectors. The sugar sub-sector accounts for 1per cent of the national Gross Domestic Product (GDP) and 4 per cent of total merchandise exports. Sugar in Zambia generates over USD 45 million in gross export revenue annually which has doubled from the mid-1990s when export earnings stood around USD 25 Million (World Bank, 2007). The sugar sub-sector is an important employer, creating employment for over 8,000 permanent and seasonal workers (Zambia Sugar Plc, 2011; Mulikelela & Muganya, 2010).

Zambia ranks as one of the lowest cost producers of sugar (World Bank, 2007; USDA, 2007). However, Zambia's domestic sugar price has been high and volatile and is substantially higher than the world price (Ellis & Singh, 2010). The high and volatile price has been attributed to a number of factors including macroeconomic fundamentals such as inflation, exchange rates, high cost of inputs including fertilizers, chemicals, high operation costs including high transport (fuel) costs and electricity labour costs among others (Chulu,2009) .

The high domestic price relative to the world price is an indication that the world price transmission to the domestic market may be low with price formation hampered by a multiplicity of policy and transaction cost variables. Government policies on sugar in Zambia include legislation on fortification of sugar (which limits imports), import tariffs and a high tax regime. Liberalisation and privatisation policies of the early 1990s resulted in increased Foreign Direct Investment (FDI) flows, increased exports and imports as well as a temporal fall in the domestic price, which has risen since the year 2000. Liberalisation of the sugar market seems to have done little to alter the structure of the market, as it remains concentrated with only three sugar millers; one miller holding 90 per cent market share. Some analysts have seen the policy on fortification of sugar enacted in

2000 by the Zambian government on sugar as an impediment for would be investors and as a barrier to imports which affects the domestic price (Serlemitsos & Fusco, 2002). Domestic taxes such as the Value Added Tax (VAT) also increase the domestic price, as Zambia's VAT is higher than most countries (Chulu, 2009).

Zambia Sugar Plc is the largest sugar producing company owned by the South African based sugar company Illovo (Illovo, 2009). The other two companies are Kafue Sugar and Kalungwishi Estates. Zambia Sugar Plc currently has a total estate of 24,940 hectares following the expansion which brought about 10,500 hectares, including 438 hectares that comprise the Magobbo and Manyonyo smallholder outgrower scheme (Palerm, Sierevogel & Hichaambwa, 2010). Kafue Sugar has an estate of around 5,000 hectares under cane, and Kalungwishi Estates has about 500 hectares under cane. Other cane producers include Kaleya Smallholder Out grower Scheme with about 2,164 hectares under cane (Mulikelela & Muganya, 2010; World Bank, 2007).

Sugar production at Zambia Sugar Plc is expected to increase to 440,000 tons (World Bank, 2007, Illovo, 2009). With Zambia's domestic sugar requirement of about 150,000 tons per year the expansion is clearly targeting the export market (Chulu, 2009). Zambia's export destinations of sugar include the European Union, Democratic Republic of Congo, the Great lakes region, the Southern African Customs Union (SACU) and more recently Zimbabwe (World Bank, 2006; Agritrade, 2010). The European Union (EU) is Zambia's most lucrative export market. Recent changes to the EU quota regime have increased Zambia's quota (Zambia can supply the EU market with up to 250,000 tons of sugar annually) and provide duty-free access, however this is offset by lower guaranteed prices (World Bank, 2009).

Considering the dynamic Zambian sugar market described in this section, a comprehensive study of the market efficiency and integration is important because it will generate indicators essential for directing the policy focus towards creating a well-function and predictable sugar market. Hence, this study undertakes to determine efficiency and integration in Zambia's sugar market by analysing price transmission and price formation. Conforti, (2004:1) broadly defines price transmission as "…the extent to which a price shock at one point affects a price at another point [which] can broadly indicate whether efficient arbitrage exists in the space that includes the two points". Price transmission can be vertical price transmission, which is the transmission of prices among

producers, wholesalers, and retailers, or spatial price transmission, which is transmission of world prices to domestic prices.

Price formation or equilibrium price condition is the manner in which the market price is determined based on the interaction between demand, supply conditions, and other factors such as policy and transaction costs. Price formation differs depending on the level of trade, which in turn affects the level of price transmission or spatial arbitrage. In the absence of trade, price formation or equilibrium price conditions depend on domestic supply and demand. In the presence of trade, price formation depends on the equilibrium price in the dominant market (world market), exchange rate and transaction costs (Sexton, Kling & Carmen (In Meyer, 2006)). Zambia is a net exporter of sugar, thus price formation theoretically should be determined by the world price, the exchange rate, transaction costs and specific policies. An indicator of value chain efficiency is the complete pass-through of price changes throughout the value chain. In a perfectly competitive market, prices should "pass through" or transmit fully and rapidly from one market to the other (Conforti, 2004).

Price formation also varies significantly under different market structures. Purely competitive market structures represent an extreme point on the continuum with demand and supply conditions determining the price while monopoly is on the other end. In a purely competitive market, market forces determine the equilibrium price. In oligopolistic or near monopoly types of markets, agents have considerable power over pricing, thus they affect both the equilibrium price and price transmission. Structural issues can affect price transmission. In Zambia, for example, one sugar processing company accounts for about 90 per cent of the market share while the other two account for only 10 per cent combined (Illovo, 2009). The sugar value chain in Zambia is a typical case of a vertically co-ordinated value chain with centralised management and co-ordination of activities from the field to the finished product.

Previous studies on Zambia's sugar industry focussed on the industry's cost of production, competitiveness, trade liberalization and its impact (World Bank, 2007; World Bank, 2009; Tyler, not dated; Nyberg, 2006; FAO, 2004). These and other studies did not focus on price transmission or price formation in Zambia's sugar value chain. Attempts to calculate export parity prices through studies conducted by the World Bank (2007) and World Bank (2009) were compounded by scanty data but a rough estimate export parity was found. It was further found that that the production cost and hence the domestic price is was USD 11.81 higher than the export parity price implying an

anomalous price formation and transmission in the sugar market in Zambia. The export parity estimate was, however, only a snapshot for a single year rather than a time series for a number of years and the analysis could not show the relationship between the domestic price and export parity price in Zambia over time. Greater effort, however, should be put into calculating export parity data series as opposed to a snapshot.

1.2 PROBLEM STATEMENT

Since liberalization policies began in most commodity markets in Zambia, prices of commodities have shown marked volatility. The sugar domestic price in Zambia exhibits similar tendencies in addition to being high. How these prices shocks are transmitted between different supply chain stages (i.e. producers, processors, and retailers) and the spread in prices from farm to retail remain largely unknown. Furthermore, the level of integration with the world market and the price formation process remain unknown.

Zambia's sugar exports have been growing since the mid-1990s, and this increase in trade has implications on how prices are formed (equilibrium price conditions), which in turn affects spatial transmission or integration with the world sugar market. Thus, transaction costs, policies and market structure parameters that affect trade and price should be investigated.

Some experts have questioned why domestic prices of sugar are high in Zambia when Zambia is among the world's lowest cost producers (Ellis & Singh, 2010).This further raises concerns of possible widening price spreads in the sugar value chain from farm to retail, which in turn is likely to affect transmission of prices in the value chain. Low price transmission and high price spreads are indicators of an inefficient market where factors other than price signals determine market outcomes.

1.3 RESEARCH OBJECTIVES

The study attempts to determine and explain efficiency and integration in the sugar value chain in Zambia by analysing price spreads, price formation, and price transmission through a price transmission and partial equilibrium model. Efficiency and integration are both key for the sugar market in Zambia. In order to analyse efficiency and integration in the Zambian sugar market, the

study attempts to provide an overview of the Zambian sugar market. This provides insight on the value chain actors, and the policies that affect the market. The structure of the market and the policy environment are both insightful as they affect and regulate the conduct of agents in the market subsequently affecting both transmission and formation of prices. A clear understanding of the market is necessary for the study to formulate accurate variables for the price transmission and partial equilibrium model, which should in-turn generate reliable estimates to determine efficiency and integration.

The specific objectives of the study are as follows:

- To provide an overview of the Zambian sugar market ;
- To discuss the sugar market structure in Zambia;
- To determine the farm to retail price spreads in Zambia;
- To develop a vertical and spatial price transmission model for the Zambian sugar market; and
- To develop of partial equilibrium framework for sugar price formation process in the Zambia sugar market.

1.4 STATEMENT OF THE HYPOTHESIS

High and volatile volatility in the world, high transaction costs, market structure and policy affects the domestic price (Serlemitsos & Fusco, 2002; Ellis & Singh, 2010). The recent growth recorded in Zambia's sugar trade particularly exports (since imports are restricted through non-tariff barrier) has major implications on price transmission and price formation. This study analyses efficiency and integration in the sugar market in Zambia. To facilitate this analysis, a number of hypotheses have been formulated.

The study hypothesises that the Zambian sugar market is both inefficient and it is not integrated with the world market. This is tested through the price transmission and partial equilibrium models. To determine price transmission, a long run cointegration relationship must be determined, thus six hypotheses for cointegration will be tested as summarised in table 1.1 below:

Table 1.1: Hypotheses to test for cointegration between price series

	Price Series	Price Series	Hypothesis to be tested
Vertical Price Transmission	Producer	Wholesale	H_0 : No cointegration
	Producer	Retail	H_0 : No cointegration
	Wholesale	Retail	H_0 : No cointegration
Spatial Price Transmission	Wholesale	World	H_0 : No cointegration
	Retail	World	H_0 : No cointegration
	Sugarcane	World	H_0 : No cointegration

The partial equilibrium framework for determining price formation and effects of policy requires a system of behavioural equations to be specified which makes it difficult set hypotheses. However, it is worth stating that the correctly specified partial equilibrium framework for Zambia's sugar market can simulate and predict endogenous variables.

By testing these hypotheses, the study generates useful information to facilitate efficient functioning of the sugar market by pin pointing the relevant parameters for industry players to improve the predictability, stability, and efficiency of the sugar industry in Zambia as well as creating a framework for analysing other commodities' value chains.

1.5 PURPOSE STATEMENT

This study aims at determining efficiency in Zambia's sugar value chain by econometrically modelling price transmission along the sugar value chain vertically and spatially. Price formation is analysed by a partial equilibrium model to understand what determines sugar prices in Zambia and to what extent. Also of interest to this study is the spread in prices between what the farmer receives and what the consumers pay for sugar also referred to as farm to retail price spread (Hahns, 2004). The study also attempts to link price transmission, price spreads, price formation, and discovery in the value chain as a holistic approach towards understanding price movements in the sugar value chain in Zambia.

1.6 LIMITATIONS OF THE STUDY

The study has a number of limitations related to the context, constructs and theory. Firstly, the study is limited in context to a single product, which is sugar. It does not therefore, analyse price

transmission in other products. No distinction is made between the direct (consumer) and indirect (industrial) sugar price as the price is averaged out. The study ignores the sugar by-product markets such as molasses, alcohol, and electricity generation among others.

Secondly, the study is limited in terms of constructs. The main interest of the study is the transmission of prices vertically and spatially, price spreads and price formation. Spatial transmission between regions in Zambia is not analysed instead only transmission between domestic and world prices is modelled. The levels in the supply chain are limited to producers, wholesalers, and retailers.

Thirdly, theoretically the study extensively applies time series econometric modelling, price theory, supply chain (value chain) analysis, and partial equilibrium analysis.

1.7 ASSUMPTIONS

The study makes a number of assumptions in order to build the price transmission and partial equilibrium framework for Zambia's sugar market as summarised below:

- The study assumes that sugar is homogeneous, thus it does not make a distinction between brown sugar, white sugar, refined or raw sugar;
- The study also assumes that the quality of sugar is constant across time and space;
- The models developed assume rationality of economic agents who respond rationally to changes in economic variables;
- The study assumes that Zambia is a small market and the world market is the dominant market, thus Zambia is a price taker while the world market is the price maker; and
- The study assumes stationary transaction costs and constant and linear error correction due to the lack of transaction costs data.

1.8 ORGANISATION OF THE THESIS

The thesis is organised in six chapters. Following this introductory chapter is chapter 2, which presents an overview of the Zambian sugar market including a review of domestic and international policies affecting the sugar market in Zambia. Chapter 3 is a literature review of price transmission

and price formation. Previous studies and approaches are also reviewed in Chapter. In Chapter 4, the price transmission methodology is presented and the vertical and spatial price transmission results are discussed. Chapter 5 presents the methodology for price formation and discusses Zambia's price formation mechanism using a partial equilibrium framework. Chapter 6 gives a summary, conclusions, and recommendations for the study.

CHAPTER 2

THE ZAMBIAN SUGAR MARKET OVERVIEW

2.1 INTRODUCTION

This Chapter seeks to present an overall picture of the sugar market by discussing the sugar value chain in Zambia, its actors and various dynamics affecting pricing in the value chain. A review of policies implemented in the Zambian sugar market provides insight on how they can affect price transmission and formation. An overview of international policies and dynamics affecting world pricing and trade in sugar is presented in order to provide the regional and global context in which the Zambian sugar market operates.

2.2 AN OUTLINE OF THE ZAMBIAN SUGAR VALUE CHAIN

The sugar supply chain in Zambia typically consists of input suppliers, sugarcane farmers, sugar millers (processors) and refineries, local and export markets, wholesalers, retailers and consumers. Input suppliers include suppliers of fertilizers, chemicals, sugarcane cuttings, irrigation equipment among others. The sugar millers, out grower schemes (usually small and medium scale farmers) and independent farmers (usually commercial farmers), produce sugarcane.

Figure 2.1 represents the value chain and industry structure of the sugar market in Zambia. The sugar value chain in Zambia schematically presented in the figure shows a highly concentrated (oligopolistic) market structure in which the market is determined mainly by one firm. This concentration can be observed even from sugarcane production. Zambia Sugar Plc produces 60 per cent of cane milled while 40 per cent is sourced mainly from out grower smallholders organised under the Kaleya Smallholder Scheme (KASCOL) and independent sugarcane farmers (Zambia Sugar Plc, 2011). These farmers enter into a contract to supply the sugar millers with a specific quantity and quality of sugarcane. The price is based on the sucrose percentage in the cane delivered and not on the total quantity of cane delivered. Kafue Sugar and Kalungwishi Estates produce 100 per cent of all their sugarcane requirements.

Sugar millers crush the cane and convert it to refined or raw sugar for the domestic and export markets. Refined sugar is sold into all markets, that is, domestic, regional and international export markets. Raw sugar is exported into the international market mainly the EU where it is processed further. According to Zambia Sugar Plc, (2011) the export market is significant (59 %) even exceeding the domestic market (41%) which averages around 150,000 tons per year. Of the 41 per cent sugar sold in the domestic market 76 per cent is sold to the direct sector (i.e. for consumption) while 24 per cent is sold to the industrial sector for the manufacture of foodstuffs and beverages

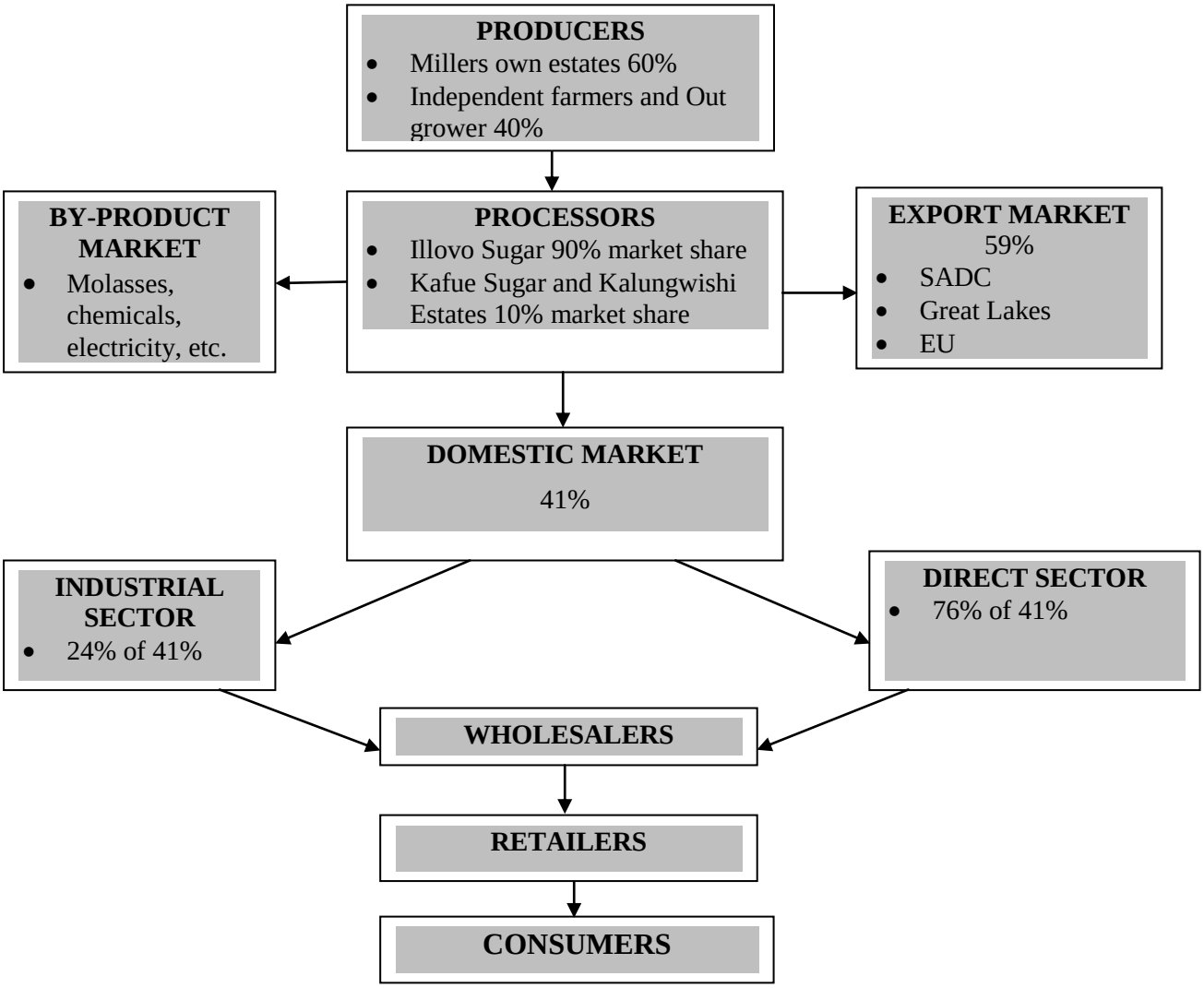

Figure 2.1: The Zambian sugar value chain

Source: Zambia Sugar Plc, 2011; interviews with key informants

Wholesalers and retailers are the main channels through which sugar reaches the consumers. Appendix 2 shows details of the domestic value chain from the farm value up to the retail value from 2005 to 2010.The export market value chain components from the world sugar price to the export parity price are also presented in Appendix 2.

Based on the data collected during this study, it was revealed that in 2009/2010 season, about 78,500 tons representing about 66 per cent of local sales for Zambia Sugar Plc were delivered to wholesalers and agents. Each of the wholesalers or agents delivers an average of 7,000 tons. Zambia Sugar Plc also delivered refined sugar directly to retailers including Shoprite, Spar and Pick n Pay. In 2009/2010, this amounted to about 11,000 tons representing about 9 per cent of local sales; on average of 250 tons was delivered to each retailer. Sugar companies are not in competition with their wholesaler clients when they supply the retail market with refined sugar. Sugar companies supply sugar to large retail outlets such as Shoprite while the allow wholesalers and agents to distribute sugar to various small and medium retail outlets.

As already referred to, the structure of the sugar market in Zambia is highly concentrated. Table 2.1 shows the structure of sugar markets in five comparable countries, which were part of a study by the Overseas Development Institutes (ODI). Apart from Ghana, which does not have any sugar milling company and relies entirely on imports, Zambia has the least number of sugar milling firms and the highest level of concentration in the sugar market.

In Zambia's sugar market, there is no state ownership in sugar production or processing as opposed to all the other sugar-producing countries in the ODI study. Due to some restrictive policies such as Vitamin A fortification requirement pursued by the Zambian government, Zambia does not record any imports as opposed to all the countries in the study as shown in table 2.1.

Table 2.1: Sugar market structures across five cases study countries

Country	Number of firms 2008	State ownership	Market share of leading firms	Import as percentage of domestic consumption
Kenya	7	Yes, the state owns nearly all mills	54% (firms with most private sector participation)	15%
Zambia	3	No	93%	0%
Ghana	0	N/A	N/A	100%
Vietnam	40	Yes, high degree of state ownership	9%	4%
Bangladesh	16 Mills & private refiners	Yes state owns nearly all mills	47%	10%

Source: Ellis & Singh, 2010

2.3 SUGAR PRICING IN THE ZAMBIAN SUGAR VALUE CHAIN

The wholesale (mill door) sugar price in Zambia is determined by mark-up pricing. Sugar companies determine their costs of production and arrive at a wholesale price that covers all the costs and margins, which is always announced publicly. For example, Zambia Sugar Plc allows 8 per cent margin for wholesale or commission for agents. Retailers are allowed an average of 3 per cent margin. The sugarcane price is a contract price negotiated between the company and farmers. It is calculated based on formula that includes retail price, mill efficiency, sugar quality, and division of proceeds (DoP) (World Bank, 2009:19).

Millers and sugarcane suppliers' representatives meet every year in April to set the sugarcane price. April is the beginning of the sugar harvest period that takes about 34 weeks through to December annually. The sugar value chain in Zambia is governed by contractual arrangements between millers and sugar farmers, wholesalers and retailers. These are legally binding contracts usually valid for a year. Sugarcane producers are offered quotas for the supply of cane and these are awarded based on a three year rolling average of cane supplied by a farmer. Quotas are determined based on the milling capacity of the sugar millers and are determined by the milling company. Farmers deliver sugarcane to the millers' door to share transport and transaction costs. Most farmers have gone into out grower arrangements and predominant among these is KASCOL consisting mainly smallholder

farmers. The outgrower company provides farmland, inputs, management to farmers who in turn provide the labour**.** The farmer is paid for the value of the cane less the value inputs.

Figure 2.2: shows the prices of sugar (cane) across the supply chain in Zambia. Generally, a common trend in the prices can be observed in the three price levels especially between the wholesale and retail prices. The cane price (which is determined through annual negotiations between sugarcane growers and millers) remains constant throughout the year, whereas the wholesale and retail prices fluctuate on a monthly basis.

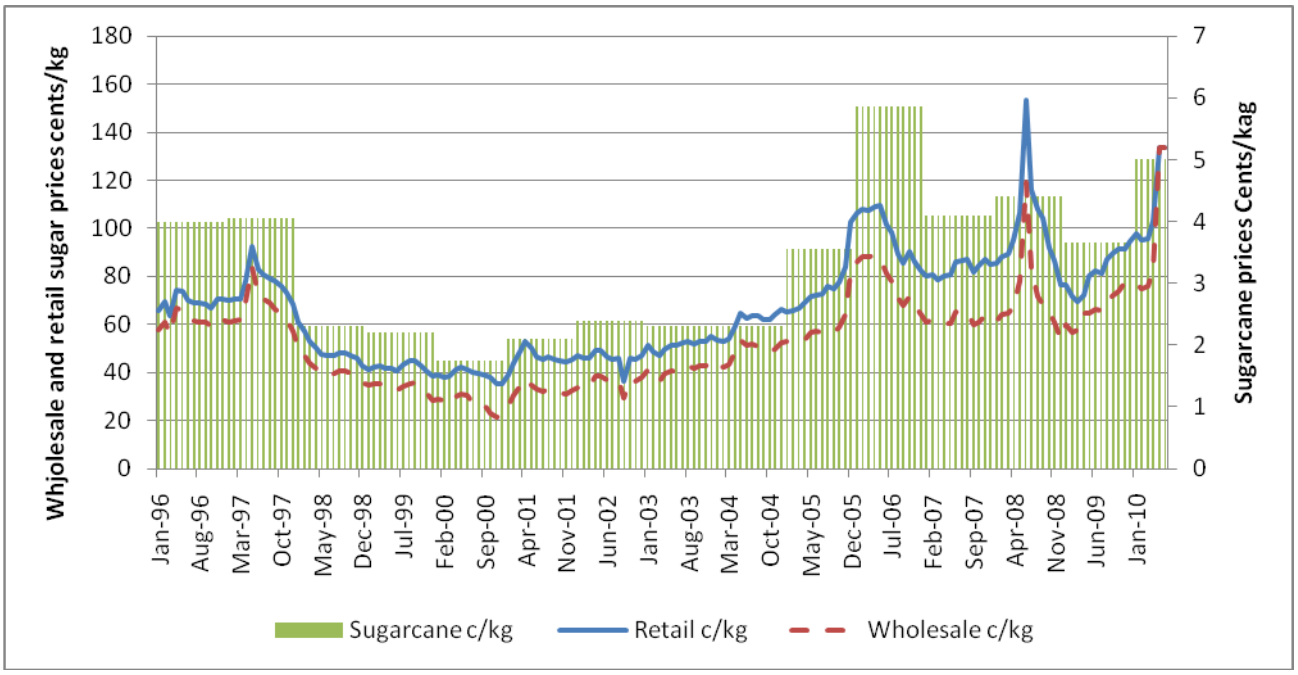

Figure 2.2: Zambia's sugar prices across the sugar value chain: 1996-2010

Source of data: Central Statistical Office Zambia database; Zambia Sugar Plc and Kafue Sugar

While Zambia has been allocated an export quota to the EU of 250,000 tons per year, there is no quota allocated for the domestic market. The export price to the EU is a guaranteed price determined by the EU while the domestic sugar price is determined by sugar producing companies themselves. Each sugar producing company determines how much to supply to the domestic and export markets.

2.4 LOW COST OF SUGAR PRODUCTION; HIGH DOMESTIC PRICE

Zambia is one of the lowest cost producers of sugar in the world. It has been ranked as the world's sixth lowest cost producer after Brazil, Malawi, Zimbabwe, Australia and Swaziland in that order (World Bank, 2006). The Economic Research Services (ERS) of the United States Department of Agriculture, USDA (2007) revealed that the cost of production for these least cost producers (including Zambia) for the raw cane was USD8.69 cents per pound while the world average was 12.39 cents per pound. A recent study by the ODI revealed that sugar production in Zambia is very efficient. They stated that the average cost of production in Zambia is USD169 per ton compared to the world average of USD 263. The study compared Zambia's costs to three other sugar-producing countries, Kenya, Vietnam and Bangladesh. Figure 2.4 shows the amount of refined sugar produced by each of the countries in the ODI study in 2007 (in thousands of tons), divided by the number of hectares of sugar cane under cultivation in each country. The study showed that Zambia's private sector led sugar industry was the most efficient, with Vietnam, Bangladesh and Kenya, which all have state led sugar industries, lagging behind by some margin (Ellis & Singh, 2010). A similar indicator for South Africa's sugar production works out to be 5.5 tons/hectares, which is three, time lower than Zambia and only comparable to that of Vietnam.

The reason for the high sugar yields in Zambia is that climatic conditions in certain localized areas are ideally suited to sugar, including a virtually frost-free winter, more than 2,800 hours of sunshine per year and a mean summer temperature of 25°C. As a result of these factors, Zambia enjoys very high yields by world standards along with low field costs (World Bank, 2007).

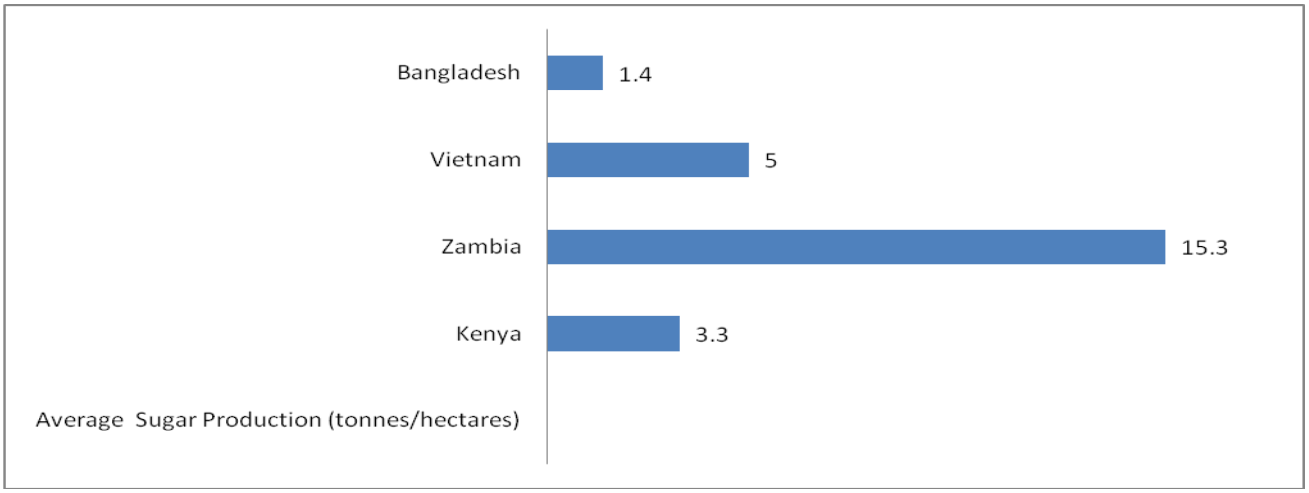

Figure 2.3: Average sugar production (tons/hectare) in case study countries 2007 harvest (or closest harvest for which data available)

Source: Ellis & Singh, 2010

The report went on to state that domestic prices of sugar in Zambia were high despite the low costs of production (Ellis & Singh, 2010). Zambia's domestic price was compared with four countries Kenya, Ghana, Vietnam and Bangladesh.

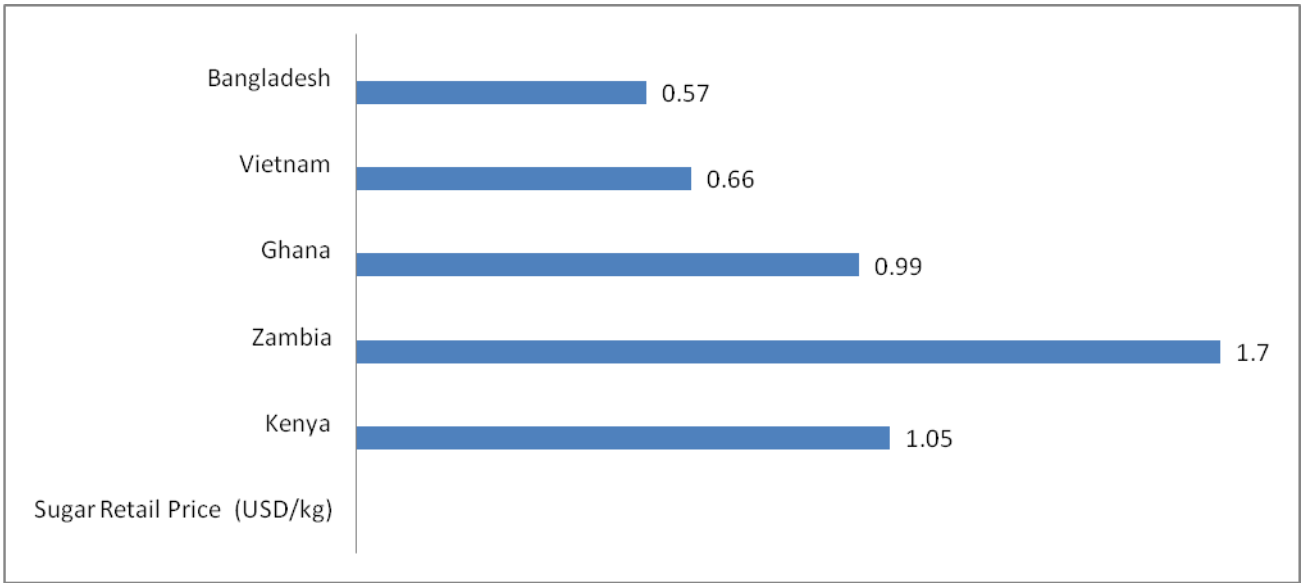

Figure 2.4: Sugar retail price: 2008

Source: Ellis & Singh, 2010

Zambia's domestic retail price was found to be higher than all the other countries as shown in figure 2.4. Notwithstanding cross-country comparisons, conventional knowledge would suggest that if the cost of the main input in the production of a commodity is low, so would the price of the final

product. This is however, not happening in the sugar market in Zambia, which indicates that a number of factors may be responsible for the cost build up from the cane to processed refined sugar. This difference between what the farmers receives for the cane and what consumers pay for the refined sugar (Farm to retail price spreads) is further investigated in the study. Other players in the industry have contended that the reported costs of production do not represent all the costs incurred to produce and take the commodity to the consumers. They argue that high taxes, high fuel, electricity, and transportation and distribution costs, cane payments, high wages and inflation rates contribute to the costs and increase the domestic price of the commodity (Chulu,2009;Boriyo, 2010). These factors increase the costs of production in the sugar industry as well as other industries.

Figure 2.5 shows the fuel and sugar prices. As with all other bulk industries, fuel is one of the drivers of sugar pricing due to the transportation (distribution) requirement for sugar (cane) throughout the sugar value chain. Sugarcane has to be transported from the farm to the processor gate and the refined sugar has to be distributed to warehouses (depots) and from there to the wholesale or retail outlets.

Fuel further enters the production costs in sugar production as it affects the price of fertilizers, chemicals and other inputs used in sugar production. Fuel costs on the other hand also protect the domestic sugar industry against imports.

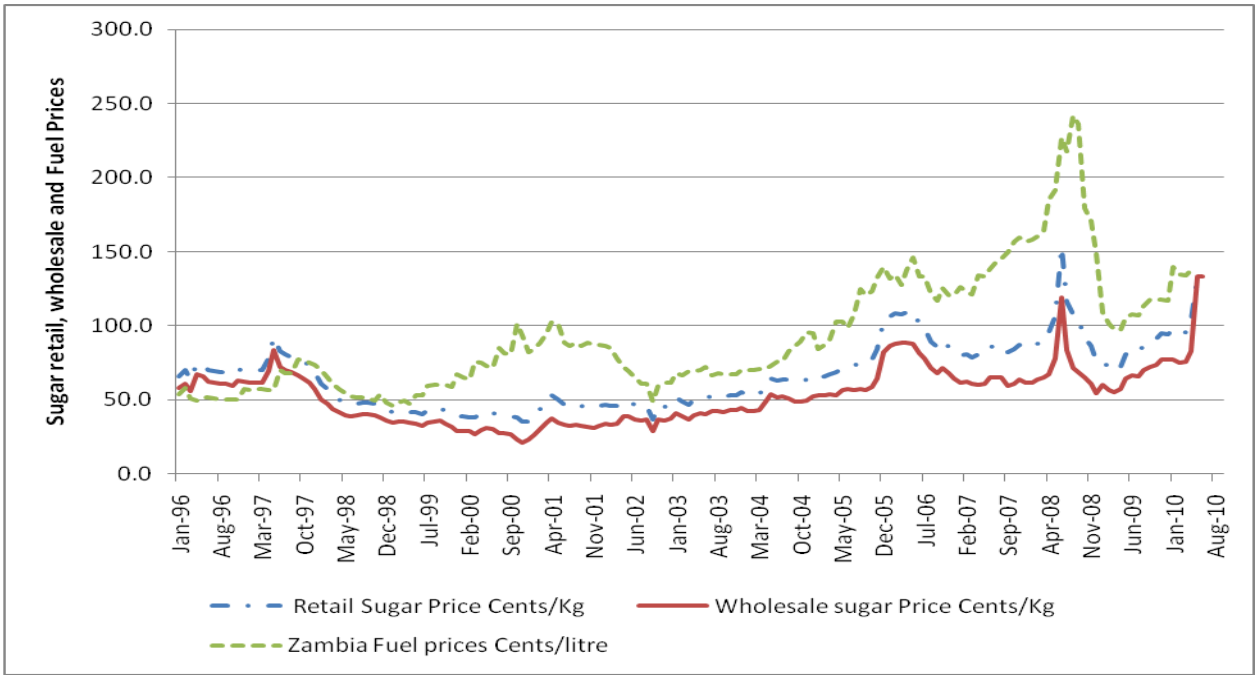

Figure2.5: Fuel and refined sugar prices: 1996 to 2010

Source of data: Central Statistical Office Zambia; Zambia Sugar Plc; Kafue Sugar; Energy Regulation Board Zambia

Figure 2.5 shows that there is co-movement in the fuel and sugar prices in Zambia implying that fuel is a major driver of sugar prices. Thus, sugar prices are susceptible to local and international fuel price changes.

2.5 SUPPLY AND DEMAND FOR ZAMBIA'S SUGAR

Total sugar supply is determined by production and imports as defined in Chapter 5. Sugar production in Zambia has been increasing steadily since 1990 after economic liberalisation while imports have been at the bare minimum due to restrictions both in pre and post liberalisation periods (See figure 2.6).

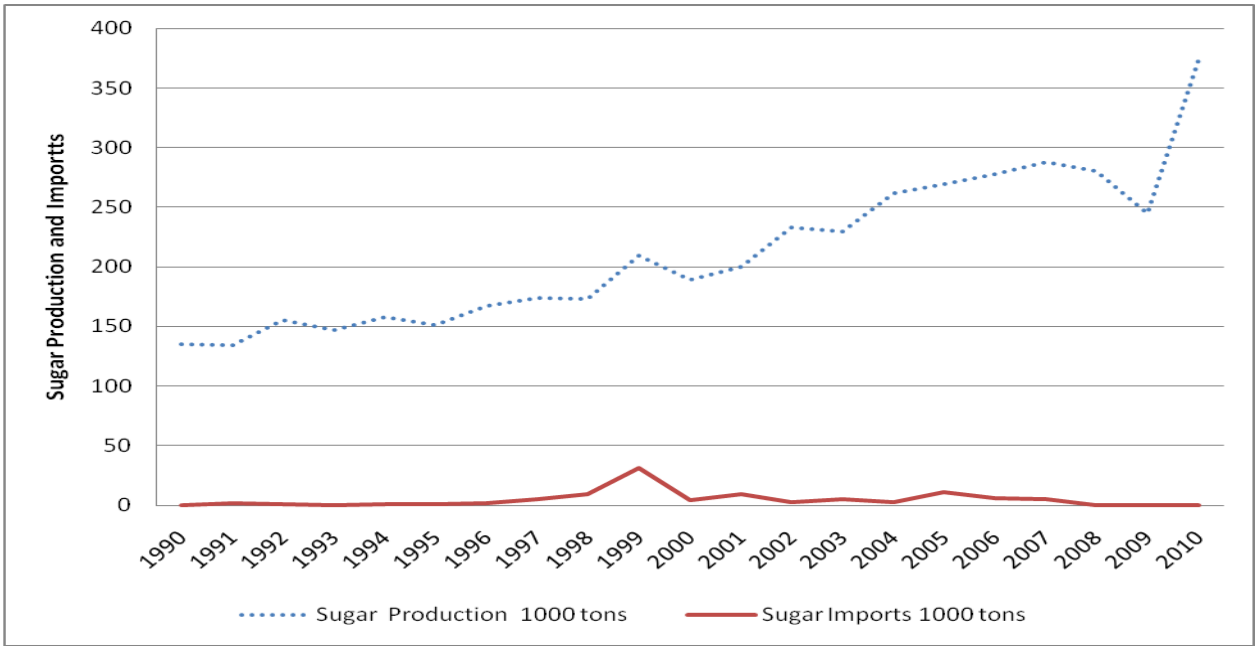

Figure 2.6: Sugar production and imports: 1990 to 2010

Source of data: FAO statistics

A significant rise in production recorded since the 2010 season has been due to an expansion project embarked on by Illovo. In the first year of operation following the expansion of the factory, record sugar production of 315,000 tons was achieved, representing a 62 per cent increase in tonnage compared to the previous season. The expansion project resulted in the development of an

additional 10,500 hectares of irrigated cane fields by the company and its supplying growers, along with the expansion of the factory's milling capacity, has increased annual sugar production from around 200, 000 tons to 450,000 tons (Zambia Sugar Plc., 2010).

Demand for sugar has been growing both in the local and export markets. Since liberalisation, exports have spiralled from close to zero to about 176,000 tons. The opportunities created by the new EU policies regime have been among the major drivers of the expansion project in Zambia. Domestic consumption has been growing but at a more stable rate compared to exports. With a relatively stable domestic demand, the sugar market in Zambia is more responsive to changes in export rather than domestic markets. The export price is more elastic compared to the domestic sugar price in the Zambian sugar market.

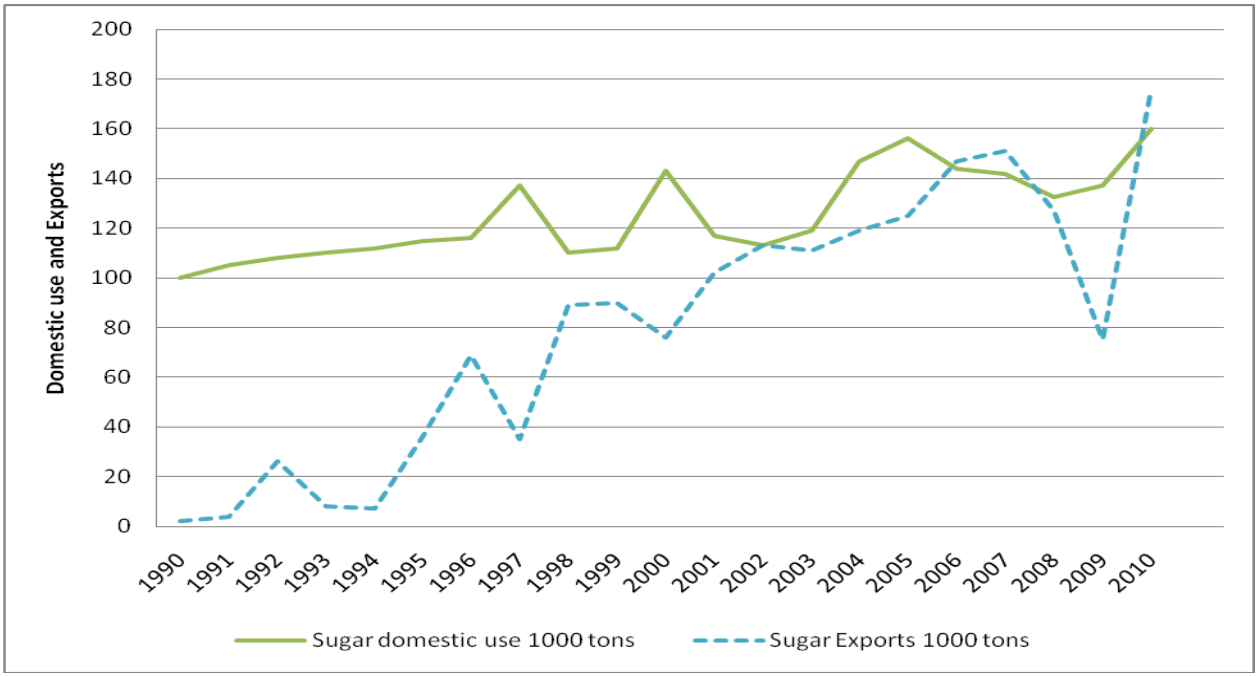

Figure 2.7: Sugar consumption and export: 1990 to 2010

Source of data: FAO Statistics

Figure 2.8 shows the export destinations for Zambia's sugar. Regional export markets including the Democratic Republic of Congo, Rwanda and Zimbabwe have offered Zambia's sugar a great opportunity for export growth. Given the proximity and the attractive price, Zambia has been able to serve these markets competitively. With the opportunities in the EU, Zambia's exports have been growing and are poised to grow further with the market access granted. Exports to SACU however have plummeted and Zambia has lost that export market. The reason for the loss of the SACU

market is that Illovo supplies these markets through South Africa and Swaziland, which are part of SACU and hence benefit from preferential trade agreements. Zambia is not a member of SACU and therefore concentrates on serving other markets mainly in COMESA and the EU.

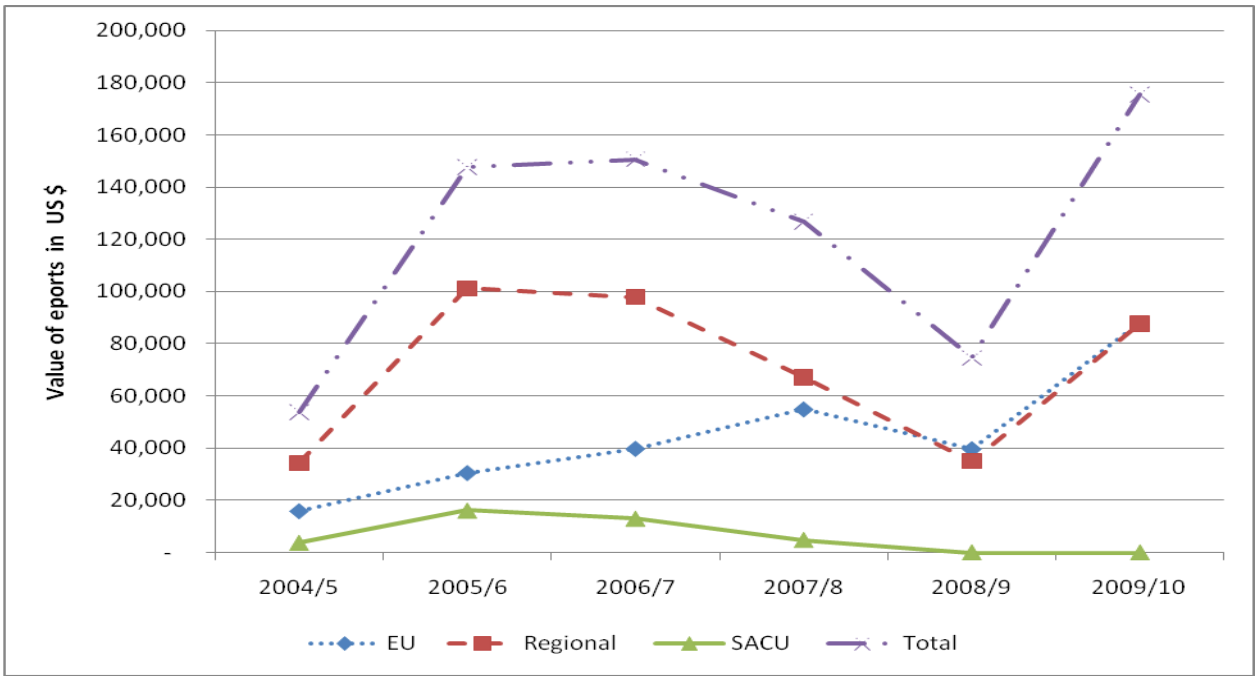

Figure2.8: Zambia's export markets for sugar: 2004 to 2010

Source of data: Zambia Sugar Plc; Kafue Sugar

2.6 POLICIES IMPLEMENTED IN THE ZAMBIAN SUGAR MARKET; WHAT ARE THE IMPLICATIONS ON THE PRICE FORMATION AND TRANSMISSION?

If a country is a net exporter of a commodity, the domestic price of the commodity should be at or near the export parity price while in a net importing country the price should be at or near the import parity. Further if a country does not engage in any trade with the rest of the world the price is determined purely by local demand and supply forces. Despite being a net exporter of sugar, the Zambia's sugar domestic (wholesale) price is much higher than the world reference price for sugar as shown in figure 2.9 below.

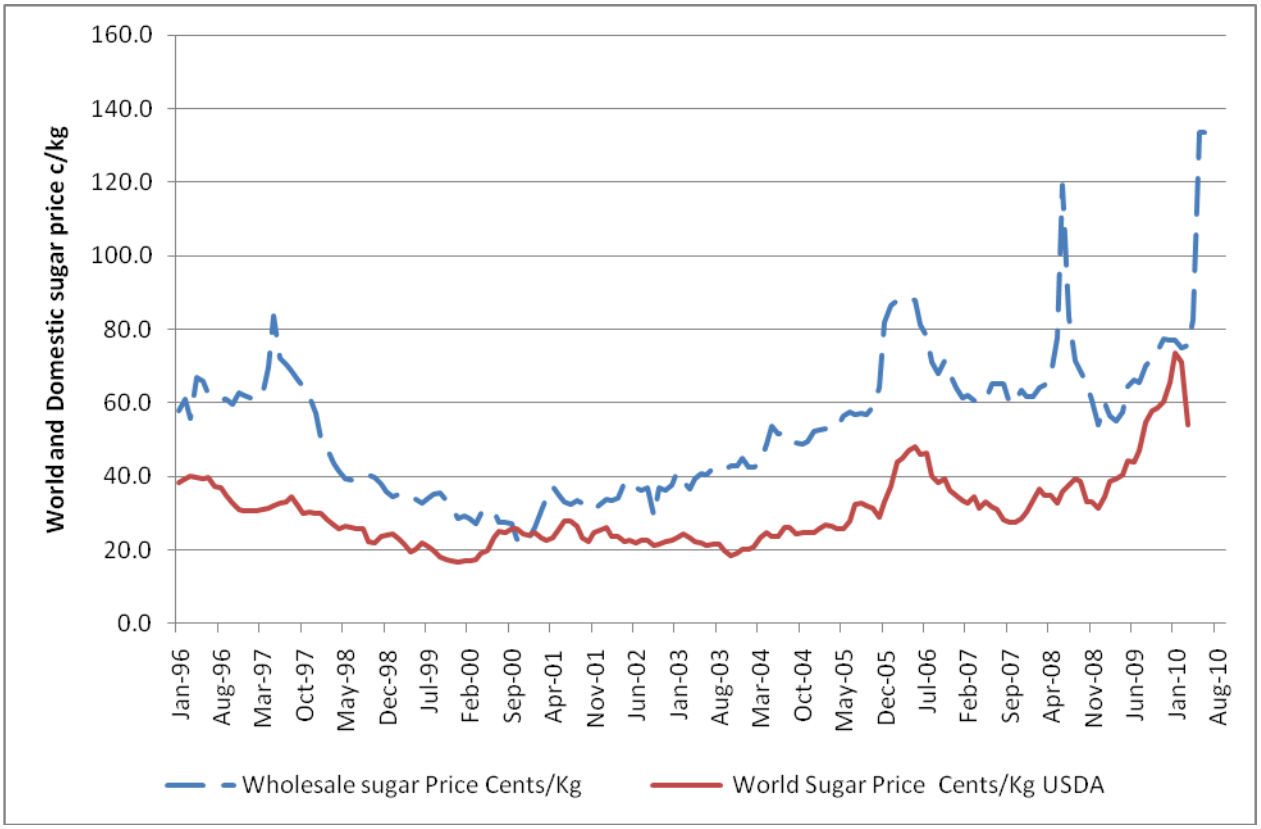

Figure 2.9: Domestic (wholesale) and World sugar prices: 1996 to 2010

Source of data: Zambia Sugar Plc, Kafue Sugar; USDA

This suggests that there is something going on with either policy or structure thus altering price formation in the market. However, a common trend in prices can be observed in the retail, wholesale and world prices. Chapter 5 provides a detailed analysis of the Zambia sugar domestic price, export and import parity prices.

Price transmission plays an important role in price formation especially in a trade regime where price formation in a market not only depends on local demand and supply but on world prices as well (Meyer, 2006). The level of price transmission would thus affect the equilibrium price conditions in the domestic market as changes in the world market price are transmitted to the domestic market through trade. Thus in the absence of trade, there will be no transmission of world prices to the domestic market and price formation is determined by domestic demand and supply conditions and government policy.

Since Zambia began pursuing policies of liberalisation in 1991, the pricing of most commodities including sugar have been left to the market. Due to the above mentioned, a free market pricing

regime controls most commodities, which has increased most markets' susceptibility to price shocks. Zambia is a relatively open economy and this began with liberalisation policies in the early 1990s. During the economic reforms, the government introduced a uniform, lower rate tariff regime and a reduction in the average tariff level. Subsequently, tariffs were set at a minimum of 20 per cent and maximum of 40 per cent by 1993. The import licence fee of 10 per cent was also abolished. Further, discretionary waivers and exemptions on import taxes were also revoked in preference for incentives provided under the new investment Act of 1991 that created the Zambia Investment Centre (ZIC) for the purpose of investment promotion in the country. The maximum tariff is at 25 per cent, which is applied to manufactured goods for final consumption. Most of the tariff lines are clustered around the zero-rated goods, which are followed by the tariff lines between 10-19 per cent. The applied tariff on sugar is 25 per cent while the bound tariff rate is 125 per cent (WTO, 2007; UNCTAD, 2006).Despite the negative effects that have been associated with liberalisation, such as the collapse of the manufacturing industries, the country's trade has more than doubled since liberalisation (WTO, 2007). In the case of sugar, exports have more than doubled (see figure 4) and this implies more integration with the international market. The implication of this policy change was that liberalisation opened up sugar trade with the rest of the world which meant which increased volumes of trade thus altering the price formation mechanism from that of autarky (absence of trade) to import or export parity.

Zambia Sugar Plc was privatised in 1995 when Tate and Lyle bought 51 per cent of the shares. In 2001, Illovo bought 50.8 per cent shares from Tate and Lyle (Serlemitsos and Fusco, 2002). Since privatisation, Zambia's sugar production has been increasing from around an average of 150,000 tons to around 350,000 tons. Exports also grew from 2000 tons per year to an average of 130,000 tons per year (FAO Stats, 2010; Illovo, 2009). The implication of privatisation was that the market received more investments through foreign direct investment that resulted in increased efficiency and thus more output and exports. Concerning investment, Zambia has deliberate policies to FDI in all sectors of the economy including the sugar industry. Due to this open policy, Zambia has a sugar industry that is characterised by corporate ownership of the industry value chain. Corporate ownership in the sugar industry has been identified as one of the determinant of competitiveness coupled with low costs of production (Garside, Hills, Marques, Seeger & Thiel, not dated: 12). Zambia has attracted investments from big corporate organisations such as the South African Illovo which has resulted in reduced costs of production due to economies of scale (Garside et al. not.dated:12). While Zambia has attracted FDI from large corporate organisations, the high

investment costs prevents growth of smaller sugar companies, which subsequently affects the market structure of the sugar market.

The Zambian government introduced controls with regard to sugar imports. According to Zambia's legislation, all sugar in Zambia that is meant for direct consumption is to be fortified with vitamin A in specific quantities. This implies that all domestic and imported sugar should meet specific fortification requirements. This legislation does not exist in other countries which means all sugar coming from outside cannot be imported into Zambia. In effect, this policy affects sugar imports, as it is Non-Tariff Barrier (NTB) on sugar imports. Coupled with this there is an administrative barrier to sugar imports where potential importers are required to obtain import permit from the government which is often not transparent and often delayed. This has limited imports, which had soured to around 25 per cent of total domestic consumption in 1999 at the time the law was put in place (Serlemitsos & Fusco, 2002).This affects the equilibrium price conditions or price formation in the domestic market since imports do not move as freely as exports do. Subsequently this also has an impact on the transmission of prices as world prices cannot easily pass through due to the barrier to trade. The law on fortification also increases the cost of producing domestic sugar which is pushed onto consumers increasing the farm to retail price spreads. It also crowds out the sugar market as it is a significant barrier to entry for potential entrants as the cost of fortification machinery is high (Ellis & Singh, 2010).

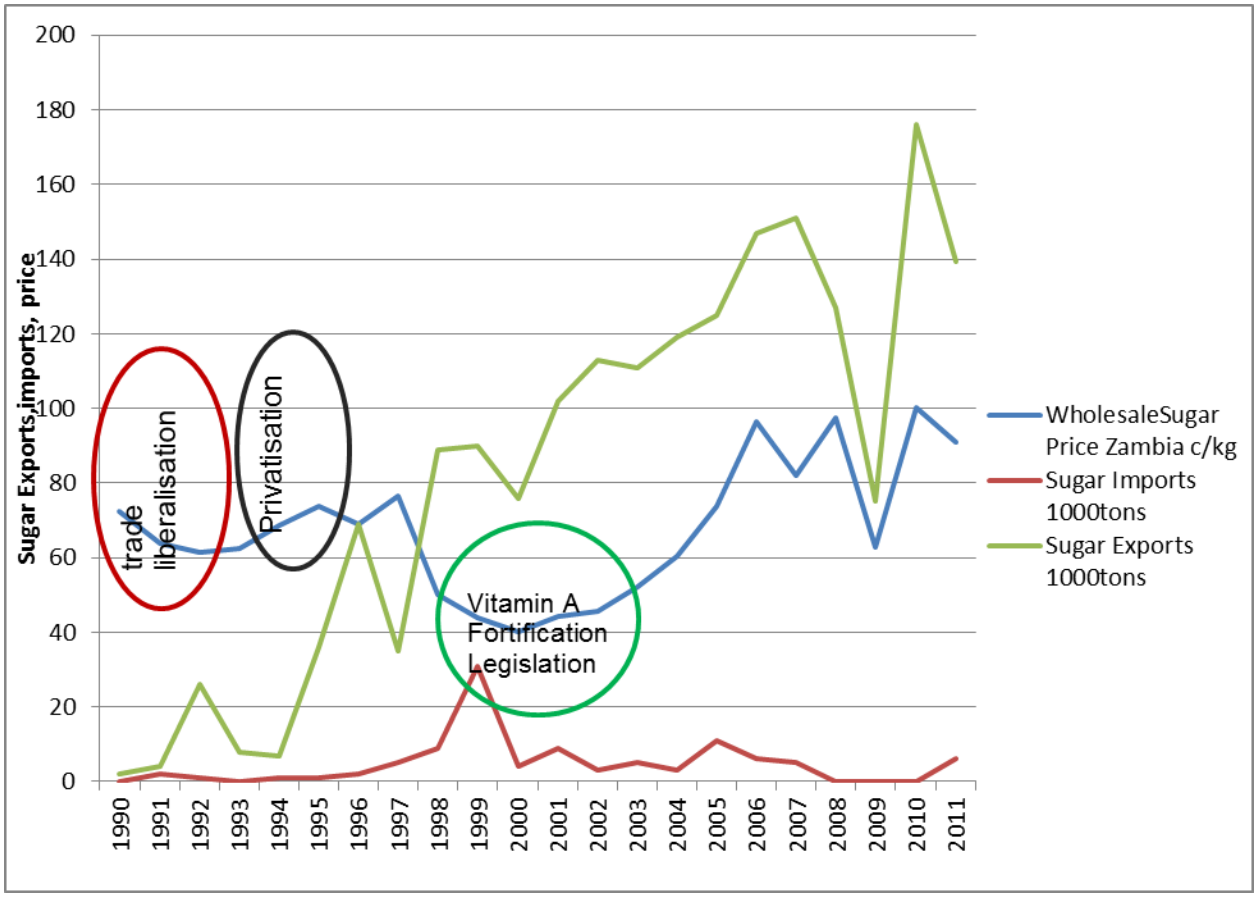

Figure 2.10: Zambia's sugar policies, trade and the domestic price: 1990 to 2010

Source of data: Zambia Sugar Plc., Kafue Sugar; FAO Statistics,

Figure 2.10 shows how domestic policies in the sugar market in Zambia have affected trade and the domestic price formation. When trade liberalisation policies began in the early 1990s, exports increased rapidly but the domestic prices remained high. Imports on the other hand remained low and close to zero. When the sugar industry in Zambia was finally privatised in 1995, there was high flow of FDI, which probably resulted in economies of scale gains and subsequently domestic price dropped rapidly. Imports also increased in the same period. A government policy intervention on fortification of sugar with Vitamin A, which limited imports, saw a steady increase in prices and exports and a drop in imports.

Other policies affecting the sugar industry according to Ellis and Singh (2010) include the competition framework governed by the Zambia Competition Commission (ZCC), which regulates all industries to create a level playing field. Another policy affecting the sugar industry is a protectionist administrative non-tariff barrier, which requires all potential sugar importers to obtain import permits through a bureaucratic and non-transparent process. Imports have to be cleared by

three government departments; Ministry of Agriculture and Livestock, Ministry of Health and Ministry of Commerce, Trade and Industry. Each of the three ministries has to clear the sugar imports, which is a lengthy and tedious process. This requirement is linked to the legislation on Vitamin A fortification of all direct consumption sugar in that among other requirements, imported sugar needs to meet the specific Vitamin A fortification.

Macro level policies also affect the sugar market such as inflation, interest rates, exchange rate. These policies affect domestic pricing, export, and market structure.

2.7 INTERNATIONAL POLICIES ON SUGAR AND IMPLICATIONS ON THE ZAMBIAN SUGAR MARKET

Internationally, Zambia is also affected by the EU policy change. Under the Lomé and Contonou Agreements, Zambia has enjoyed protected, quota-based access to the European Union for a maximum of 28,000 tons per annum. This regime, however, is now set to change under the new "Everything but Arms" agreement between the EU and African, Caribbean, and Pacific (ACP) countries whereby the price for raw sugar has been cut by 32 per cent while the quota has be increased. The new trade policy permits Zambia to export a maximum of 250,000 tons of refined sugar (about 95 per cent of its current production) to the EU from 2009 until at least 2015. This change represents a significant challenge for Zambia, not least because the new policy is expected to reduce prices by 32 per cent compared to the old protected price, but also because of the vast development opportunity it offers (World Bank, 2006; World Bank, 2009).

The World Bank (2008) estimated price changes under complete trade liberalization for all commodities. The report showed an average 9 per cent increase in trade for developing countries for all agricultural commodities and a 9 per cent increase for sugar. Most of the gains in agricultural production from complete trade liberalization were estimated by the World Bank to occur in Latin America and Sub-Saharan Africa (Zambia inclusive).This Liberalisation is expected to result in the stabilization of world price, which will increase in the short to medium term. Estimates of expected price increases under full liberalisation have been as high as 70 per cent but average around 30 per cent, depending on assumptions (Reed,2004; Milner,2004 (In Garside *et al*. not dated: 10).

Zambia, which is one of Africa's lowest-cost producers (16.5 cents/kg) currently exporting negligible amounts to the EU market, is set to benefit from the EU reforms. Since it sells the majority of its production at world market prices, the country is expected to benefit from the rise in the world market price (Garside *et al*., not dated: 12). In a study to determine the effects of EU reforms on ACP countries, the dependency of the Least Developed Countries (LDCs) on the EU market was estimated. Zambia was found to have the lowest dependence on the EU market of the sixteen countries in the study. Zambia was also grouped among the countries that were low cost producers, had low exposure to the EU and/or could survive at a lower world price (LMC international in FAO, 2004).

Zambia is also affected by duties, taxes and other protectionist policies in countries where it exports sugar. This results in higher prices of sugar in these markets. However, evidence shows that the regional markets that Zambia serves offer higher returns than the EU quota based market due to high transport costs to reach overseas markets (Chulu, 2009; World Bank, 2007:89).

2.8 ZAMBIA'S SUGAR INDUSTRY PARITY PRICE

A world bank commissioned Competitiveness Analysis study for Zambia was undertaken as part of feasibility of restoring competitiveness and growth in selected African countries by identifying key commodities, production systems, and marketing arrangements capable of underpinning rapid development of commercial agriculture. The study covered cassava, cattle, cotton, maize, rice, soybeans, and sugar (World Bank, 2007).The study essentially conducted a value chain analysis for the commodities including sugar, which ranged from production, processing and exports. The study estimated the domestic value added at farm level by estimating all the costs incurred in production, mark-ups, taxes and additional costs. They also calculated what they called shipment value by adding foreign costs to the domestic value added figure. The study was constrained at the sugar processing level because of lack of data on costs.

Studies to calculate the parity price for sugar have produced varied results and have been hampered by the fact that Zambia receives different prices in different markets. The Competitive Commercial Agriculture in Africa (CCAA) project made a parity price comparison using global commodity price data. Based on the world price of USD 386 per ton on the unprotected world market, a rough FOB factory gate price was calculated by deducting USD 120 per ton for containerized road freight to Durban and sea freight to northern Europe. This gave an equivalent FOB factory gate price for

processed sugar of USD 266 per ton with international shipping equal to 45 per cent of total value (World Bank, 2007:89). The shipment value for a ton of processed sugar was calculated based on a number of assumptions and it worked out to be USD277.81 per ton, which is higher than the FOB factory gate price of USD266 per ton. The study indicated that Zambia was more competitive in the regional markets compared to the EU market due to high costs of transportation. This particular study however compared the parity price to the domestic cost of production (domestic costs plus foreign costs). The results are however, similar to the general observation that the Zambia domestic sugar price is way above the export parity price, which indicates that the price formation process is affected by factors other than the export parity and exchange rate. This is confirmed by a detailed price formation analysis in Chapter 5 of this study.

The World Bank (2009: 17) further conducted an international value chain analysis for selected value chains in Zambia including sugar. They also conducted a sensitivity analysis at varying exchange rate of the Zambian Kwacha to the US dollar. The sugar export parity prices were calculated at varying exchange rates and varying FOB prices. The results indicated that Zambia was consistently uncompetitive in sugar production even at higher FOB prices. The results underscore the importance of Zambia to concentrate on the regional market rather than markets such as the EU as the country is uncompetitive in these markets due to high transportation costs. The regime change in policy will improve competitiveness in sugar as the world reference price is set to increase. This study further underscores the point that domestic prices higher than the parity price even if the exchange rate were to depreciate.

2.9 SUMMARY

Zambia has a dynamic sugar market which is expanding rapidly. This is partly because of the low cost of production and increasing demand both domestically and internationally. The domestic price of sugar in Zambia, however, is high and this has raised questions on the structure of the market which is highly concentrated possibly giving rise to market power. The domestic price is also significantly higher than the world price and for a net exporting country this suggest that structure, policy and transaction costs (such as transport, energy and input, cost) and macroeconomic factors such as inflation in the market makes it inefficient. Zambia's total sugar output far exceeds the domestic requirement and as such, the market is becoming more export oriented. This growth in trade should ideally result in increased integration with the world market with the domestic price

trading close to the export parity price. However, growing evidence points to the fact that Zambia's domestic price is higher than the export parity and is possibly closer to the import parity. A study by the World Bank provides more evidence as the Zambian domestic price was found to be higher than the export parity price and this remains the case at various scenarios in another study. A review of the policies implemented in the sugar market in Zambia reveals that the liberalisation policies implemented in Zambia increased FDI which increased total output and exports and imports. The domestic sugar price reduced following liberalisation. To offset the effects of increased imports the government imposed a requirement for all sugar in Zambia to be fortified with Vitamin A. This policy restricted imports and the domestic price has been on the rise since then. With these policies in place, the price formation mechanism is altered in that the domestic price is determined more by local demand and supply and market structure. The opportunities arising in the EU may benefit Zambia but only if transaction costs can be lowered. The increase in exports may not even benefit consumers or cane producers as there may be little trickle down of benefits due to limited transmission of prices.

CHAPTER 3

PRICE TRANSMISSION, FORMATION AND SPREADS: A LITERATURE REVIEW

3.1 INTRODUCTION

This chapter aims at presenting relevant concepts in analysing price transmission, formation and spreads. The Chapter also reviews previous studies in terms of the approaches and main findings, which gives insight and justifies the particular approach chosen for this study. Many studies have focussed on price transmission without linking it to price formation. This Chapter devotes some attention to explain the link between the concepts by presenting approaches and findings from studies involving both transmission and formation of prices. A look at specific studies in Zambia reviews that very little work has been done in analysing efficiency and integration using price transmission and formation. The study thus reviews the few studies conducted and presents the evidence in the Zambian case.

3.2 INTEGRATION AND EQUILIBRIUM PRICE CONDITIONS

Price transmission has been widely applied to various agricultural markets since Gardner first applied it to the food economy (Meyer and von Cramon-Taubadel, 2004; Conforti, 2004; Getnet, Verbeke & Viaene. 2005; Rapsomanikis, Hallam & Conforti., 2004; Varga, 2007; Funke, 2006). In a frictionless or undistorted market, full or perfect transmission occurs while the opposite is true for a highly distorted market (Conforti, 2004; 1). Thus, the degree of price transmission is indicative of the extent of spatial and vertical market integration and whether markets are functioning efficiently in a predictable way and price signals are passing-through consistently (Abdulai, 2007:1; Conforti, 2004:,1; Krivinos & Ollareaga, 2006:9; Meyer & von Cramon-Taubadel, 2004:1). "Market integration refers to the complete pass-through of price changes from one market to another" (Rapsomanikis *et al.,* 2004:52). Oladapo and Momoh, (2008:497), with emphasis on spatial price transmission, define market integration as "… the co-movement of prices and more generally the smooth transmission of price signals and information across spatially separated markets."

Market integration is related to the concept termed as the" law of one price". "The classical paradigm of the Law of One Price, as well as the predictions on market integration provided by the standard spatial price determination models) postulate that price transmission is complete with equilibrium prices of a commodity sold on competitive foreign and domestic markets differing only by transfer costs, when converted to a common currency. These models predict that changes in supply and demand conditions in one market will affect trade and therefore prices in other markets as equilibrium is restored through spatial arbitrage (Rapsomanikis *et al.,* 2004).

Arbitrage refers to the practice of taking advantage of the state of imbalance between two markets reflected by price differentials. Arbitrage results in the convergence of prices and exchange rates in different markets. Sexton, Kling and Carmen (In Meyer, 2006) argue that arbitrage between regions differs depending on the demand and supply conditions in each region at time *t*. When regions are linked by arbitrage, the equilibrium price in one region is determined by the equilibrium price in other regions. If arbitrage does not exist, however, then price formation is determined by demand and supply conditions. The equilibrium price in the smaller market (for example domestic market) can be estimated as a function of the equilibrium price in the dominant market (for example world market), the exchange rate and the transaction costs (Meyer, 2006). Market equilibrium is a function of domestic market and supply conditions in each market respectively. Hence, the formation of prices also referred to as the equilibrium price condition changes under switching market regimes (Barret, 1999). According to Meyer (2006), the determination of domestic prices is dictated by a country's specific trade and policy regimes, which determine how domestic prices are integrated with world prices. The three regimes identified are import parity, autarky and export parity.

In most price transmission literature, market structure has been linked to the existence of market power and concentration. It is often related to asymmetric price transmission (further discussed in later sections of this literature review). Market structure can affect the transmission of world prices to domestic prices. Industry concentration and imperfectly competitive behaviour beyond the farm-gate may imply that wholesalers, or intermediaries with power over price, may exercise pricing strategies, which result in a slow and incomplete transmission of increases in the international price. On the other hand, there will be rapid and full transmission of decreases in the international price to prices upstream, as their margins are squeezed (Rapsomanikis *et al.,* 2004:55). Market structure can also affect domestic demand and supply and therefore affects the equilibrium pricing condition

(price formation). In a pure competitive market, market forces determine the equilibrium price. In oligopolistic or near monopoly types of markets, agents have considerable power over pricing thus they affect both the equilibrium price and price transmission.

3.3 WHAT IS PRICE TRANSMISSION?

The phenomenon of price transmission has attracted a lot of attention with application to a wide range of commodity markets. According to Minot (2010) price transmission refers to "the effect of price changes in one market on prices in another market." Varga, (2007:1), takes particular interest in vertical relations in food chains and defines price transmission as "transmission of value through prices". For the purpose of this study price transmission will be defined as a "the degree to which a price change at a certain point affects a price at another point".

3.3.1 Types of Price Transmission

Price Transmission can be either vertical or spatial. Vertical price transmission is the degree of adjustment and speed with which price changes are transmitted among producer, wholesale, and retail market which is indicative of actions of market participants along the market channel (Supply chain)(Abdulai,2007:1). Stated otherwise, vertical price transmission refers to interactions between prices at different supply chain stages (Jensen & Møller, 2007; 5). Spatial price transmission refers to the relationship in prices among spatially separated markets in a country, or how domestic prices adjust to international prices (Abdulai, 2007:1). For the purposes of this study, spatial price transmission will refer to price adjustment to international prices and not price relations among spatially separated markets in a country. The definition of vertical price transmission given above still holds for this study.

3.3.2 Factors Affecting the Extent of Price Transmission

Full price transmission and market integration are premised on the standard competition model which states that in a frictionless undistorted world, the Law of One Price (LOP) is supposed to govern spatial price relations. Pricing along supply chains depends entirely on production costs (Conforti, 2004:1; Cudjoe, Breisinger & Diao 2010:1; Rapsomanikis *et al.*, 2004:51). However, most markets have some degree of distortions and because of this full price transmission fails to

occur. Price transmission literature suggests that a number of factors affect the degree or extent of price transmission. These factors include transport and transaction costs, market power, increasing returns to scale in production, product homogeneity and differentiation, exchange rates, border, information asymmetry and domestic policies (Conforti, 2004:1; Minot, 2010).

3.3.3 The Four Important Questions

Vavra and Goodwin, (2005:5), with more emphasis on vertical price transmission, condense the primary focus of most price transmission studies into four fundamental questions:

- **Magnitude**: how big is the response at each level due to a shock of a given size at another level?
- **Speed**: What are the lags in adjustment and are they significant?
- **Nature**: Do adjustments following positive and negative shocks at a certain marketing level exhibit asymmetry?
- **Direction**: Do adjustments differ depending on whether a shock is transmitted upwards or downwards the supply chain?

3.3.4 Asymmetric Price Transmission

Asymmetric price transmission has taken a prominent position in price transmission. Economists dedicate significant attention to asymmetry in price transmission not only because it points to gaps in Economics but also because its mere presence points to evidence of market failure (Meyer & von Cramon-Taubadel, 2004:1). The presence of market power or high concentration at any stage in the supply chain is often linked with asymmetric price transmission in most literature but this assertion is misleading because to date there is no agreement on statistical methods to prove the proposed causal relationship. Asymmetry in price transmission in food supply chains refers to the differences in the degree or speed of price adjustment, depending on whether the price change is up or downward. It is based on the idea that agents holding market power will transmit only or mostly when input prices increase rather than when they decrease (Conforti, 2004:3; Jensen & Møller, 2007:10). In short, asymmetric price transmission refers to price transmission processes for which "... transmission differs according to whether prices are increasing or decreasing."(Meyer & von Cramon-Taubadel, 2004:1).

Two types of asymmetric price transmission have been identified; namely positive and negative asymmetry by Peltzman, (2000). Peltzman (2000) explains that if a price at a given stage in the supply chain (e.g. processor) reacts more fully or rapidly to an increase than to a decrease in the price at another chain stage (e.g. farm gate), the asymmetry is termed 'positive'. Conversely, 'negative' asymmetry denotes a situation in which the price at a given chain stage reacts more fully or rapidly to a decrease in the price at another stage than to an increase.

As noted earlier asymmetry in price transmission affects the distribution of welfare. In contrast, under conditions of symmetry, price adjustments take place quicker with a greater magnitude. Hence, asymmetric price transmission changes welfare distribution from those obtainable under symmetric conditions because it alters the size and timing of welfare changes (Meyer & von Cramon-Taubadel, 2004:1).

3.4 THE CONCEPTS OF FARM VALUES, RETAIL VALUE AND PRICE SPREADS

The concept of price spreads is based on the simple idea that consumers rarely buy food directly from farmers. Thus, the price consumers pay for food is almost invariably higher than that received by farmers. This happens because as the product moves along the value chain, the product loses mostly physical mass, but always gains in value as it is processed and extra costs such as packaging and distribution are incurred (Funke, 2006:24). The farm-to-retail price spread therefore is "…the difference between what the consumers pays and what the farmer receives" (Hahns, 2004:3). Price spreads relate to issues of equity, efficiency and welfare. Producers use price spreads to measure the efficiency and equity of the food marketing system while consumers are also concerned about the efficiency and equity of the food marketing system. Consumers would prefer lower prices and producers prefer higher prices *ceteris paribus* (Hahns, 2004:3).The calculation of farm to retail price spread of a product involves the subtraction of farm value from the retail value. The farm value refers to the value of the farm products equivalent to food purchased by consumers at a given point of sale. The farm value can be viewed as "… a measure of the return, or payment, farmers receive for the product equivalent of retail food sold to the consumers whereas retail value is the average cost per Kilogram of rebuilding the commodity with products contained within the retail store" (Funke, 2006:24-25).

3.5 PRICE FORMATION; PARTIAL EQUILIBRIUM MODELS AND MODEL CLOSURE

Spatial market relationships can be described by prices, trade volumes, or both. Sometimes economists establish the appropriate aggregation of spatial units by reference to trade volumes; other times they do so using co movement among prices from spatially distinct markets. Each class of indicators has important shortcomings in isolation from the other. Analysis based on trade volumes typically cannot establish whether spatial equilibrium conditions hold, and thus whether trade exhausts all rents to arbitrage so as to ensure Pareto efficiency (Barret & Li, 2002).

Price transmission methods described above do not include information on trade except for the Switching Error Correction Model (SECM) applied in the study by Traub, Myers, Jayne and Meyer (2010). Barret and Li (2002) introduced a method that integrated trade and price information to estimate the probability of trade occurring under different regimes. More realistically, prices are determined by trade (import or export parity) and/or local demand and supply conditions and various policy variables. This study, therefore, emphasises a combination of price transmission and price formation in order to understand efficiency and integration in the value chain.

Model closure involves partial equilibrium analysis and it seeks to address the following issues:

- What makes supply equal to demand?
- Where do prices come from? Equilibrium price conditions)
- How is trade determined?
- Policies and model closure

A key accounting identity for supply=demand is stated as follows:

$$production + beginning\ stock + imports = domestic\ consumption + ending\ stock + \exp orts + wastes + statistical\ discrepancy$$

3.6 PREVIOUS STUDIES ON PRICE TRANSMISSION, FORMATION AND SPREADS

3.6.1 Price Transmission Studies

The general approach followed by most price transmission studies is based on the work of Engel and Granger who developed the technique of co integration of time series data and the Error Correction Model (ECM) (Engle and Granger, 1987). Co-integration between the price series implies that although the two prices may behave in a different way in the short run, they converge toward a common behaviour in the long run (long run equilibrium) (Conforti, 2004:3). If this property is verified, the characteristics of the dynamic relationship between the prices can be described by an ECM. The short-run adjustment parameter of this type of model can be interpreted as a measure of the speed of price transmission, while the long run multiplier can be interpreted as a measure of the degree of price transmission of one price to the other. Various modifications have been made to the above specification to take into consideration various factors and aspects in the analysis of price transmission. Most vertical price transmission studies have also devoted some time to test for asymmetric price transmission.

3.6.1.1 Price Transmission Using the (V) ECM and Granger Causality

Various modifications have been made to the original price transmission specification to take into consideration various factors and aspects in the analysis of price transmission. Most vertical price transmission studies have also devoted some time to test for asymmetric price transmission. Jensen and Møller, (2007) followed the Engel and Granger specification in analysing six food chains in Denmark but included a dummy variable to account for asymmetric price transmission and found more upward asymmetries than downward. They also found more asymmetry in the short run while in the long run prices were symmetric. Sheng, (2009) adopted approach also used by Abdulai (2000) and Meyer and von Cramon-Taubadel (2004) to test for asymmetry in Malaysian pork market. The short-run adjustment term was substituted by two separate coefficients accounting for decrease and increase in prices. This allowed testing for asymmetric price transmission in terms of rejection of the restriction that the two coefficients are equal. The study also analysed farm to retail price spreads which graphically appeared symmetric.

Conforti (2004) followed the Engel and Granger procedure to test for spatial price transmission in 48 countries and specified what is called the Auto Regressive Distributed Lag (ARDL) model. The study also used Granger causality tests to determine the direction of causality between the price series and found varying results but with general trends. For example, African countries showed less transmission of world prices to domestic prices than other countries.

Popovics (2008) also used the ARDL to test for price transmission and asymmetry in the supply chain and the direction of causality in the supply chain. The study found the presence of positive or upward asymmetry in the whole chain. The study then attributed the symmetry to oligopolistic markets structure or market power. The results of the granger causality tests also showed that the direction of causality in the chain was upstream. The studies went on to deduce that the price determination process moved upstream in the production-processing stage indicating that transmission of prices was based on the value added in production rather than the market. in the supply chain.

Getnet *et al. (*2005) also used the ARDL approach in testing for integration in the White Teff market in Ethiopia between the central wholesalers and the producers. The results indicated that the wholesale price of white Teff in the central consumer market is a major short-and long run determinant of the producer price in the local supply markets.

3.6.1.2 Price Transmission: Modifications to include Transaction Costs and Trade Flows

Due to the existence of high transaction costs in spatially separated markets, recent researchers have developed new price transmission models including the Parity Bound Models (PBM) and Threshold Autoregressive Models (TAR), which have been discussed in detail in Abdulai, (2000). In Africa, these models have been applied to test for spatial arbitrage in grain markets in Mozambique, Ethiopia, Tanzania and Madagascar. The results indicated that there was spatial price efficiency in Mozambique (Tostao & Brorsen, 2005). The Madagascan markets were efficient, Moser, Barrett and Minten (2006) and Ethiopian markets were inefficient Negassa & Myers, 2007 in (Abdulai, 2000). The Study in Tanzania emphasised on the time trend to ensure food security (Van Campenhout, 2007).

Barrett and Li (2002) developed a spatial model, also driven by transaction cost, in which, among other things, they highlighted the possibility that price transmission occurs in absence of trade

(segmented equilibrium). They further highlighted that trade takes place in absence of price transmission (imperfect market integration). The method was demonstrated using monthly soybean meal price, trade flow, and transfer cost time series for Canada, Japan, Taiwan, and the United States. The data showed that trade is commonly discontinuous and bidirectional. Furthermore, transfer costs were found to be a non-stationary. The authors showed how the new method allowed direct estimation of the probability that the relationship between two markets falls into each of the four basic conditions: perfect integration, segmented equilibrium, imperfect integration, or segmented disequilibrium (Barret & Li, 2002).

Traub *et al.* 2010 used a SECM, which uses exogenous sample separation in order to test for spatial price adjustment under differing trade regimes rather than estimation of threshold parameters. The rationale is that price transmission varies depending of trade for instance in periods of high trade we might expect the price difference to better reflect transfer costs, therefore resulting in a stronger price transmission between to the markets. Whereas, in low-import regimes, the price connection between the two markets may be broken; fundamentally altering the rate and degree of price transmission.

In this study, they identified two different trade regimes; low trade and high trade. The results of the study indicated that under the two trade regimes trading regimes, there was no evidence of a long-run relationship between Mozambican, South African maize grain prices i.e. no cointegration, and thus a SECM could not be estimated. This implies that any large deviations, within these regimes, which exceed transaction costs, could continue to grow with no tendency towards equilibrium. However, the trade volume data indicates that maize grain exports from South Africa into Mozambique in every month except for three within the sample set (Traub *et al.*, 2010).

3.6.1.3 Price Transmission Studies in Zambia's Food Markets

In Zambia, very little work has been done on price transmission. In a study that involved Zambia and Malawi, Loy and Wichern (2000), investigated both regional integration and international integration of maize markets in Zambia, using co integration techniques. The authors employed an ECM to estimate the level of market integration between regional markets within the country after reforms. Using Granger Causality tests, they further examined spatial market integration between Zambian and Malawian maize markets. The authors found that regional maize markets in Zambia

are well integrated, while some degree of integration of maize markets in Zambia and Malawi was also detected. The level of regional and international market integration, however, was quite low and did not increase significantly over time, because of high transaction costs on these markets.

A study by Minot (2010) which was motivated by soaring prices in the food crisis of 2007-2008 used the Vector Error Correction Model (VECM) to test for spatial transmission of world staple food prices increases into domestic prices. It was found that there was no long run relationship (co integration) between world prices and any of regions in Zambia (see table 3.1) although staple food prices had risen by 40-60 per cent in the crisis period.

Table 3.1: Transmission of world food prices to domestic markets in Zambia

			Unit root in domestic price?		**Long-run relationship**
			ADF Test	**Phillips-Perron Test**	**Johansen test**
Country	**Location**	**Commodity**			
Zambia	Chipata	Maize	Yes	Yes	No
Zambia	Choma	Maize	Yes	Yes	No
Zambia	Kabwe Urban	Maize	Yes	Yes	No
Zambia	Kasama	Maize	Yes	No	No
Zambia	Kitwe	Maize	Yes	Yes	No
Zambia	Lusaka	Maize	Yes	Yes	No
Zambia	Mansa	Maize	Yes	Yes	No
Zambia	Mongu	Maize	No	No	No
Zambia	Solwezi	Maize	No	No	No

Source: Minot, 2010

3.6.2 Studies on Farm to Retail Price Spreads

3.6.2.1 The Farm to Retail Price Spread in the South African Value Chain

The national Department of Agriculture of South Africa through the National Marketing Council (NAMC, 2003) conducted an analysis of food value chains including sugar. They also estimated the sugar farm to retail price spreads. They found that against a background of import tariff protection and proceed sharing between millers, and between millers and growers in the South African sugar market, the price spreads were rising.

Table 3.2 shows that during 1998/99-2002/03, the nominal farm value (cost of material from growers) rose from about R1,421/ton to about R1,856/ton (average annual rate of 6.90per cent). The nominal processing and refining spreads increased from about R1,067/ton to R1346/ton (average annual rate of 5.99per cent). The nominal transport, handling, wholesale and retail spread rose from about R973/ton to about R1,518/ton (average annual rate of 11.75per cent).The nominal retail price of sugar rose from R3,460/ton to R4,720/ton (average annual rate of 8.07per cent).

Table 3.2: Nominal farm-retail price spread for sugar in South Africa (SA), 1998/99-2002/03

Item	**Year**				
	1998/99	**1999/2000**	**2000/01**	**2001/02**	**2002/03**
	Rands/Mt				
Farm value	1,420.49	1,491.03	1,549.19	1,654.50	1,855.56
Processing & refining Spread	1,066.65	1,130.98	1,168.93	1,260.08	1,346.06
Transport, handling, wholesale & retail spread	972.86	1,097.99	1,281.88	1,335.42	1,518.38
Retail price	3,460.00	3,720.00	4,000.00	4,250.00	4,720.00

Source: NAMC, 2004

A follow up study by NAMC, 2008 found that the Farm to Retail Price Spread (FTRPS) in the South African sugar markets in 2007/2008 was R 5.51 or 76.4 per cent of the retail price, compared to R5.16/kg in 2006/07 (75.2 per cent of the retail price) (SASA (In NAMC, 2008). This spread reached a high of 82.3 per cent of the retail price in 2004/05, declining to 75.2 per cent in 2006/07. The mean farm-to-retail spread since 2000/01 was 79 per cent of the retail price

3.6.3 Studies on Price Formation

3.6.3.1 Analysing Price Formation in the Sugar Market in SA

Price formation in the sugar market in SA was analysed by NAMC (2008) where they examined various factors that affected the formation of SA's sugar price. Although the study was not based on a partial equilibrium framework the study undertook to determine the impact of local demand, government policies, market structure, the international reference price, import parity price on the SA domestic sugar price.

The study found that the Sugar Act of 1978 (as amended) and the Sugar Industry Agreement provide for three main regulatory provisions within which the pricing of refined sugar in South Africa takes place. Firstly, an import tariff that is set relative to a US dollar-based reference price. Secondly, a single channel export mechanism, and thirdly, a local market proceeds-sharing agreement whereby proceeds earned by the SA sugar industry are divided amongst growers and millers according to a set formula (about 64 per cent of the proceeds are allocated to growers). They concluded that the combination of these regulatory provisions allowed the SA sugar industry to maintain a domestic refined sugar price that is at or near the import parity price (including the tariff). The authors referred to policies such as the import tariffs imposed by the Department of Trade and Industry (DTI) and the Board on Tariffs and Trade (BOTT) which they said was due to the distorted nature of the world sugar market. Numerous studies estimate that the long-term world price of refined sugar would be 20per cent higher without market intervention
(Board on Tariffs and Trade, 2000).

The study also concluded that due to tariff protection, an oligopolistic market, and an inelastic price elasticity of demand, sugar prices had been pushed up close to import parity price. The import parity price was found to be greatly affected by the exchange rate, that is, the stronger the local currency the lower the import parity. Thus, if the import parity prices increase due to the exchange rate devaluation and prices are kept just below import parity, local sugar prices should increase when the exchange rate weakens.

Various studies on price transmission and market integration have also looked at the process of price formation in one market and the influence of a central market import and export parity prices

and a host of other factors such as policy (Oladapo &Momoh,2008;Rapsopsomaniskis et al.,2004; Sheng,2009 and Benirschka, Koo & Lou (1996). The World Bank (2007) and World Bank (2009) have also conducted studies which have analysed price formation including comparisons between the domestic price and export parity prices as well as sensitivity analysis of the export parity prices under varying exchange rates.

3.6.3.2 Analysing Price Formation in Various Sugar Markets Using a Partial Equilibrium Framework

Benirschka**,** Koo and Lou (1996), analysed world sugar market through the world sugar policy simulation model which was a dynamic, partial equilibrium, net trade model used for evaluating the effects on the world sugar economy of farm and trade policies. Eighteen countries and regions were included in the model. The country sub-models included behavioural equations for area harvested, yield, production, domestic consumption, and carryout stocks, net trade and the price linkage. Estimates of the 18 countries included regression coefficients, t-values, and R-squared for all the behavioural equations for the countries, which modelled the world sugar economy.

A study by Meyer (2006) focussed on the equilibrium pricing condition and the relevant model closure to enable the correct formation of prices under distinct trade regimes in a multi-commodity model rather than just a price transmission and market integration between distinct markets. The analysis showed that contrary to economic theory, there is some level of integration between domestic and world markets when domestic and world markets are trading at what this study refers to as near-autarky.

Flow and price-quantity diagrams were used to provide an easy guide towards the understanding of important economic and biological relationships. There was a distinction made between the Bureau for Food and Agricultural Policy (BFAP) and the redesigned regime-switching sector model. The estimated results of the redesigned price and trade equations included parameter estimates, p-values, R-squared, Durbin-Watson statistics and elasticity.

The study proved that the re-designed switching model is able to capture richer information on market behaviour than standard models as such the new model is able to capture more accurately the likely effects of shocks on the domestic market. The switching regime model was thus found to

be more rigorous than the previous one as it emphasises price formation and correct model closure under alternative regimes. The model was also applied to scenario planning and analysis.

3.7 SUMMARY

Various methods have been developed to test for price transmission, price formation and spreads. Price transmission studies traditionally relied entirely on price data and conclusions are drawn based on whether spatial arbitrage can be established between markets. Price formation studies establish equilibrium between demand and supply and make use of price, trade data. Although the methods have been used in isolation modern techniques have been able to apply price and trade information together. New techniques that have emerged include switching error correction models; parity bound models and switching trade regime partial equilibrium analysis. Application of the methods to specific markets reveals that results vary from market to market and this is compounded by data availability. Transaction costs and asymmetric price transmission have taken centre stage in the study of efficiency and integration in markets. Studies on price spreads in the South African markets reveal that price spreads have been increasing. In the sections that follow the methods have been applied to the Zambian sugar market to determine how efficiently the market functions and to determine the level of integration in the value chain.

CHAPTER 4

PRICE TRANSMISSION IN ZAMBIA'S SUGAR MARKET: METHODOLOGICAL APPROACH, RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter applies price transmission and price spread techniques to determine efficiency and integration in the Zambian sugar market. This is applied to both vertical and spatial price transmission. The vertical price relations include the producer price (sugarcane), wholesale and retail while the spatial price relation is the relationship between world and domestic prices. Cointegration between price series is tested using the Augmented Dickey Fuller (ADF) Tests. An Error Correction Model (ECM) is specified and asymmetric price transmission is tested. A simulation analysis of the effect of a 20 per cent price increase is one market on the other market is conducted.

4.2 PRICE TRANSMISSION; EMPIRICAL ANALYSIS

Given that prices in a spatially separated market are p_{1t} and $p_{2t,}$ the LoP and the Enke-Samuelson-Takayama-Judge model postulate that at all points of time and allowing for transfer costs *c*, for transporting the commodity from market 1 to market 2, the relationship between the prices should be as follows (Rapsomanikis *et al.*, 2004).

$$p_{1t} = p_{2t} + c \quad (1)$$

A market is said to be integrated if a relationship between two prices, such as (1), holds. However, this extreme case rarely occurs, especially in the short run. At the other end of the spectrum, if the joint distribution of two prices were found to be completely independent, then one might feel comfortable saying that there is no market integration and no price transmission.

Generally, spatial arbitrage is expected to ensure that prices of a commodity will differ by an amount that is at most equal to the transfer costs with the relationship between the prices being identified as the following inequality:

$p_{2t} - p_{1t} \leq c$ (2)

The above relationship is referred to as the weak for of the Law of One Price while the strong form is characterised by (1) Fackler & Goodwin, 2001 in (Rapsomanikis *et al*., 2004).They also emphasize that relationship (2) represents an equilibrium condition. Observed prices may diverge from relationship (1), but spatial arbitrage will cause the difference between the two prices to move towards the transfer cost (Rapsomanikis *et al*., 2004).

A number of time series techniques have been used to test each of the components of price transmission and thus ultimately assess the extent of price transmission. These are as follows:

- cointegration;
- causality;
- error correction mechanism; and
- Symmetry.

These techniques collectively offer a framework for the assessment of price transmission and market integration. If two prices in spatially separated markets (or different levels of the supply chain) p_{1t} and p_{2t} contain stochastic trends and are integrated of the same order, say I (*d*), the prices are said to be co integrated if:

$p_{1t} - \beta p_{2t} = \mu t$ (3)

is I(0)

The above relationship can be estimated using Ordinary least Squares or a Full Information Maximum Likelihood Method. Cointegration implies that these prices move closely together in the long run, although in the short run they may drift apart, and thus is consistent with the concept of market integration. Engle and Granger test the null hypothesis of no cointegration by applying unit root tests on $\hat{\mu}_t$. As $\hat{\mu}_t$ is stationary, the prices contain stochastic trends that have a long-run

proportionality, with the co integrating parameter β measuring the long-run equilibrium relationship between them. This parameter has sometimes been interpreted as the "elasticity of price transmission", when the price series are converted into logarithms (Rapsomanikis *et al.*, 2004).

Modern price transmission models build on the initial Houck approach has been expressed as follows (Rapsomanikis *et al*.,2004;Sheng,2009):

$$P_{1t} = \alpha_0 + \alpha_1 \sum_{i=0}^{M1} \Delta P_{2t}^{+} + \alpha_2 \sum_{i=0}^{M2} \Delta P_{2t}^{-} + \varepsilon_t \quad (4)$$

Where P_{1t} is the price of a commodity in the destination market such as domestic market or producer (farm-gate) price at time t

P_{2t} is the price in the originating market such as the world or retail price at time t

t =1, 2, 3..

Δ is the first difference operator

P_{2t}^{+} is a Dummy variable which is =1 if $P_{2t} \geq P_{2t-1}$ and 0 otherwise

P_{2t}^{-} is a Dummy variable which is =1 if $P_{2t} \leq P_{2t-1}$ and 0 otherwise

M1 and M2 are the lag lengths

The above model allows for testing for asymmetry where price adjustment coefficients α^{+}_{2} and α^{-}_{1} can be estimated for periods of rising and decreasing input prices, respectively. The null hypothesis of symmetric price transmission between the two markets is rejected if $\alpha^{+}_{2} \neq \alpha^{-}_{1}$.

The general price transmission model in modern studies specifies an ECM as below (Rapsomanikis *et al*, 2004; Jensen & Mϕller, 2007; Sheng, 2009):

$$\Delta P_{1t} = \alpha_1 + \theta(P_{1t-1} - \beta P_{2t-1}) + \delta \Delta P_{2t-1} + \rho \Delta P_{1t-1} + \varepsilon_t \quad (5)$$

Where:

ΔP_{1t} and P_{1t-1} are as earlier defined

θ is the error correction term or speed of adjustment representing the residual from the linear estimated relationship between market prices and transaction costs over time.

$P_{1t-1} - \beta P_{2t-1}$ is the long-run co integrating relationship

β is the long run elasticity of price transmission

δ is the short run elasticity of price transmission

This general form has been extended to test for asymmetric price adjustments by incorporating a positive and negative ECT for a rise and a fall in the price respectively.

This is specified as below (Meyer & von Cramon-Taubadel, 2004; Traub *et al.*, 2010); Sheng, 2009; Rapsomanikis *et al*, 2004) :

$$\Delta P_{1t} = \alpha_1 + \delta^+ D^+ \Delta P_{2t-1} + \delta^- D^- \Delta P_{2t-1} + \phi^+ ECT^+_{t-1} + \phi^- ECT^-_{t-1} + \varepsilon_t \quad (6)$$

Where ECT^+_{t-1} and ECT^-_{t-1} are the positive and negative error correction terms and ϕ^+ and ϕ^- are the corresponding speeds of adjustment.

The specification allows for the test for asymmetry by performing and F or the T-test on the hypothesis:

H_0: $\delta^+ = \delta^-$

4.3 DATA DESCRIPTION

The data used for the price transmission model was secondary in nature and was obtained from various sources including the UDSA, Sugar processing Companies and the Central Statistical Office of the republic of Zambia.

4.3.1 Price Series

The price transmission and price spreads analysis makes use of monthly price series vertically across the supply chain and spatially between world and domestic markets for a period of 14 years from 1996 to 2010.

4.3.2 Producer Price Series

This is the price at which sugarcane is sold by the farmers. Farmers or cane producers may be small scale, medium or commercial farmers. This price is fixed for the season thus; it is an annual price series because the price does not vary monthly.

4.3.3 Wholesale Price Series

For this study, the wholesale price is the processor gate price. This is the price at which sugarcane is sold by the processor or sugar miller. In Zambia, there are three sugar processing companies and the processor price series is an average of the prices for the three processing companies.

4.3.4 Retail Price Series

This is the price at which sugar is finally sold to consumers. This is a national average price data series as captured by the Central Statistical Office (CSO) of Zambia. Retailers buy refined sugar from wholesalers and sell it to consumers.

4.3.5 World Price Series

The sugar world price used in this study is the "London daily price for refined sugar FOB Europe spot price". From June 2006, the spot price was replaced with the average of near month for which an entire month of prices is available.

It is worth noting that the sugar retail, wholesale and world prices vary on a monthly basis while the producer (sugarcane) price varies annually. Figure 4.1 below shows the graph of retail, wholesale, sugarcane and world price series.

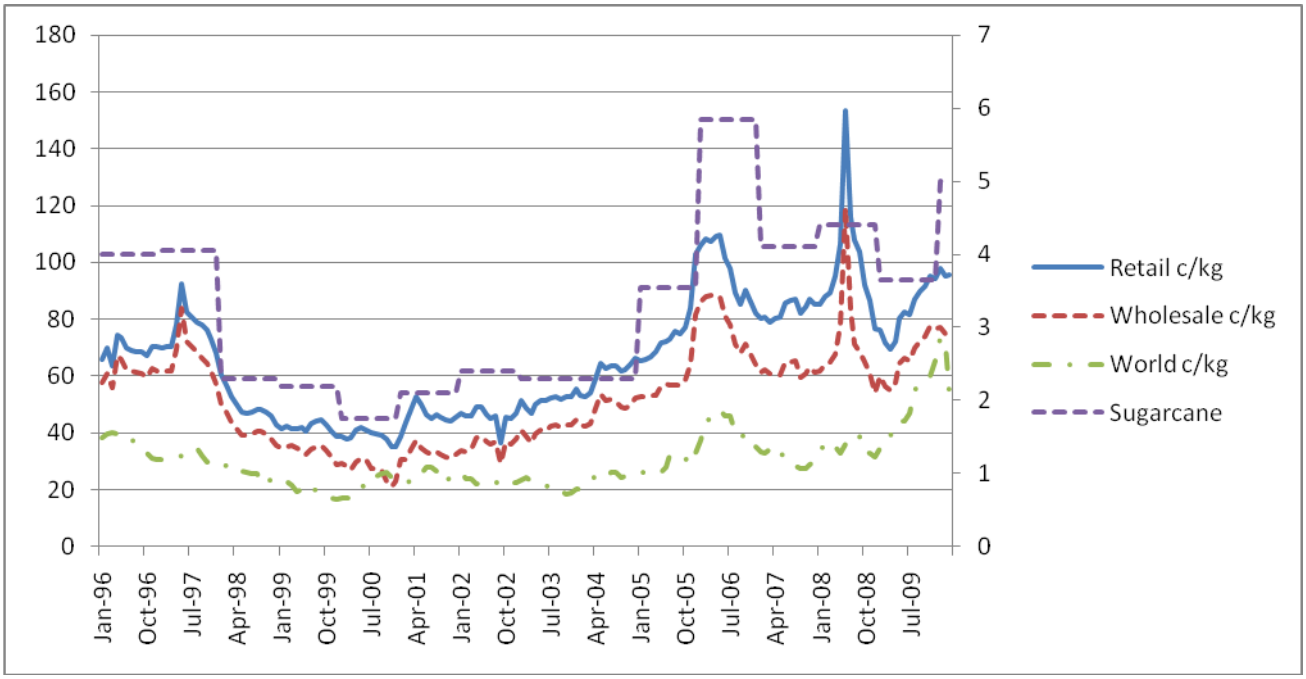

Figure 4.1: Retail, wholesale, sugarcane and world sugar price series: 1996 to 2010

Source of data: Central Statistical Office Zambia database, Zambia Sugar Plc. Plc, Kafue Sugar, USDA

4.4 STATIONARITY TESTS OF THE PRICE SERIES USING THE AUGMENTED DICKEY FULLER (ADF) TEST

The ADF test is used to determine whether a particular price series is stationary I(0) or non-stationary I(1), I(2) I(n). If non-stationary, it is also able to determine the order of integration. The procedure for Stationarity tests involves the test for unit root. For this study, this was carried out in Eviews 3.0. Three models for each data series are tested namely: trend and intercept, intercept and none (no tend or intercept). The hypothesis tested is H_0: non-Stationarity which is rejected if ADF statistic supplied by Eviews 3.0 is less than the Dickey Fuller (DF) distribution and the star (*) or significance level at which the hypothesis was rejected was shown. The underlying status of the data is checked by testing H_0: trend. The hypothesis H_0 is rejected if the F statistic is greater than $\Phi 3$ or $\Phi 1$ (without showing the star(*).Rejection of H_0 above implies the first unit root test above was based on incorrect data, therefore it should be redone (if H_0 above is not rejected, then first unit root test was correct and stop here).

The hypothesis to be retested is H_0: non-stationarity which is rejected if ADF is less than normal distribution (showing the star (*)). If a series is found to be non-stationary it is differenced and the above tests repeated.

4.5 VERTICAL PRICE TRANSMISSION MODEL

The vertical price transmission model was specified at three levels in the sugar value chain namely producer, wholesaler and retailer following the specification of equation (5) in Chapter 3.

$$\Delta P_{1t} = \alpha_1 + \theta(\Delta P_{1t-1} - \beta \Delta P_{2t-1}) + \delta \Delta P_{2t-1} + \rho \Delta P_{1t-1} + \varepsilon_t \quad (5)$$

Where:

ΔP_{1t} is the of sugar (cane) at a lower level in the value chain such as the farm gate price

ΔP_{2t} is the price sugar at a higher level in the value chain such as wholesale or retail

θ is the speed of adjustment representing the residual from the linear estimated relationship between the two different sugar (cane) price levels in the value chain

$\Delta P_{1t-1} - \beta \Delta P_{2t-1}$ is Error Correction Term, which is the residual from the linear estimated relationship between market prices and transactions costs over time

δ is the short run elasticity of price transmission between two price levels

Test for Asymmetry was also conducted amongst three price levels where the model was specified in chapter 3.

4.6 SPATIAL PRICE TRANSMISSION MODEL

The spatial price transmission model specification also follows equation (5) where:

ΔP_{1t} is the Zambian domestic wholesale sugar price

ΔP_{2t} is the world sugar price

θ, $\Delta P_{1t-1} - \beta \Delta P_{2t-1}$ and δ are defined under vertical price transmission

The table below shows a summary of the model specification for vertical and spatial price transmission.

Table 4.1: Model specification summary

	[1]Monthly Price Series ΔP_{1t}	Monthly Price Series ΔP_{2t}
Vertical Price Transmission	Producer	Wholesale
	Producer	Retail
	Wholesale	Retail
Spatial Price Transmission	Wholesale	World
	Retail	World
	Producer	World

4.7 CORRELATION COEFFICIENTS

Table 4.2 shows the correlation coefficients for the prices in the sugar value chain.

Table 4.2: Correlation matrix for prices in the sugar value chain

	RETAIL	**SUGARCANE**	**WHOLESALE**	**WORLD**
RETAIL	1.0000	0.8747	0.9743	0.7363
SUGARCANE	0.8747	1.0000	0.8834	0.7142
WHOLESALE	0.9743	0.8834	1.0000	0.7504
WORLD	0.7363	0.7363	0.7504	1.0000

There is high correlation between retail and wholesale sugar prices 0.97 and high correlation between sugarcane and retail prices 0.87 while the correlation between retail prices and world prices is moderate 0.74. The correlation between sugarcane and retail prices is 0.87, which close to the correlation between sugarcane and wholesale 0.88. The correlation between sugarcane and world prices is 0.74. The correlation between wholesale and world prices is 0.75.

[1] Note that while retail, wholesale and world prices vary monthly, producer prices only vary annually

The estimation of price transmission follows the procedure outlined in the figure below

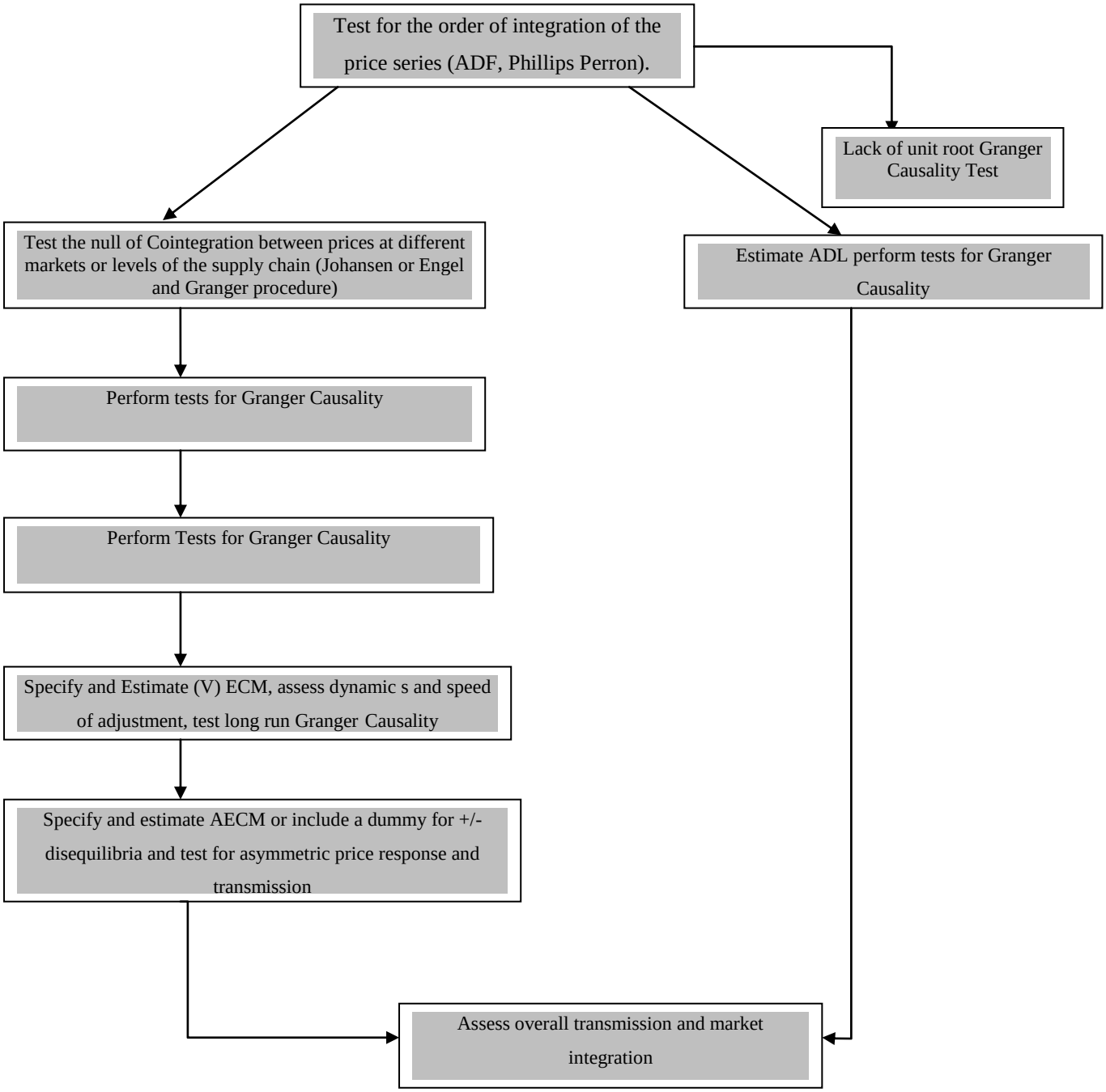

Figure 4.2: Price transmission estimation procedure

Source: Rapsomanikis *et al.*, 2008

4.8 FARM TO RETAIL PRICE SPREADS IN THE ZAMBIAN SUGAR VALUE CHAIN

The price that farmers receive is called the Recoverable Value (RV). The recoverable value is determined by the processors and the sugarcane growers at the beginning of the year. A meeting is held in April to agree on the price of the cane RV. From research the conversion rate or the extraction rate averages about 8.5 per cent.

Funke (2006) calculated the farm value for South African sugar using the following procedure:

FV=RV X EXTR

Where

FV is the farm value

RV is the recoverable value

EXTR is the extraction rate

FTRPS is calculated as follows:

FTRPS=FV-RT

Where

FTRPS is the farm to retail price spread

FV is the farm value

RT is the retail value

Figure 4.2 shows the FTRPS for Zambia's sugar value chain from the period 1996 to 2010. It can be observed from the figure that Farm to Retail Price Spreads (FTRPS) have been growing since the 1990s and they have become more volatile recently. This is because of the high volatility in the sugar retail prices. It is worth noting that the FTRPS reduced in 2006 as the farm value rose and was on increasing steadily, but increased rapidly in 2008 when the farm value remained somewhat stable.

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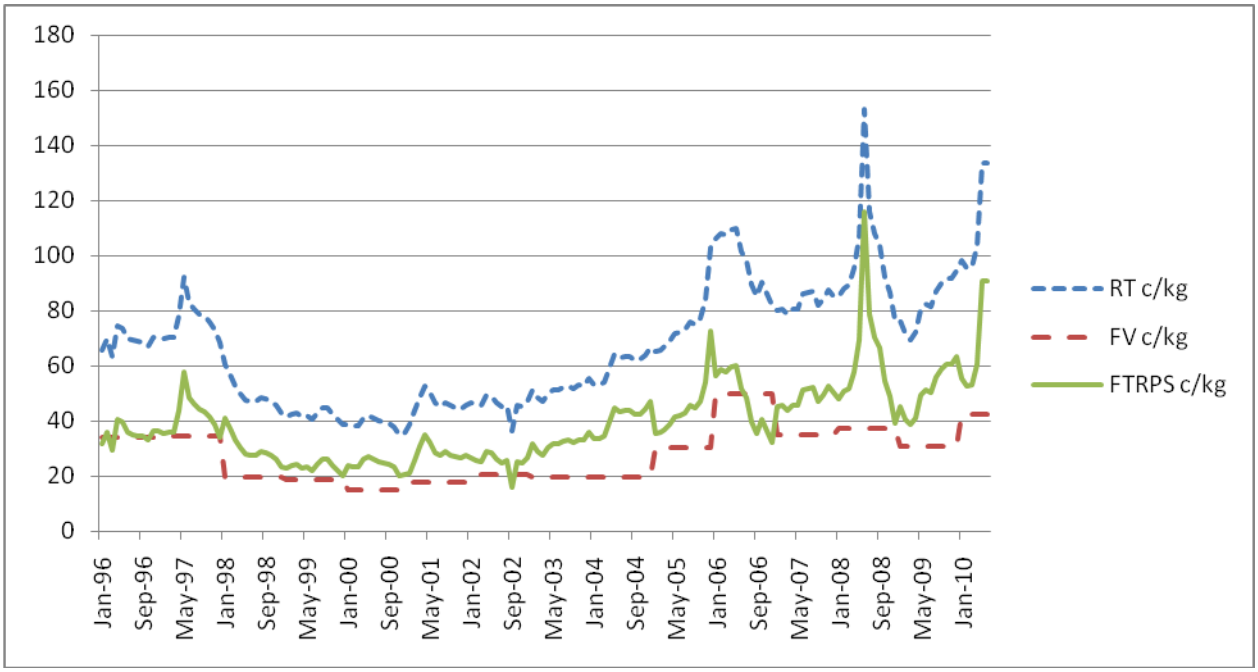

Figure 4.2: Farm to retail price spreads in the Zambian sugar value chain: 1996 to 2010

Source of data: Central Statistical Office Zambia; Zambia Sugar Plc, Kafue Sugar

In 2008, apart from the global food the domestic sugar market in Zambia experienced high prices due to flooding in the previous season. Thus while the FV remained stable due to its fixed nature the retail value rose rapidly in 2008 resulting in a spike in the FTRPS in 2008 up to May,2009. .

Table 4.3: Components of the FTRPS for sugar in Zambia: 2005 to 2010

Item	**Year**					
	2005	**2006**	**2007**	**2008**	**2009**	**2010**
	US Cents/Kg					
Farm value	30.2	49.7	34.8	37.4	31	42.5
Processing & refining Spread	28.2	28.6	27.3	34.1	36.1	33.4
Transport, handling, wholesale & retail spread	16.4	19.4	21.1	28.5	15.3	20.4
Retail Value	74.9	97.8	83.2	100	82.4	96.3

Source of data: Central Statistical Office Zambia; Zambia Sugar Plc, Kafue Sugar

Table 4.3 shows components of the FTRPS from 2005 to 2010. It can be observed that the FV has increased from 30.2 US Cents/kg in 2005 to 42.5 Cents/kg in 2010 in tandem with the RV. It can be observed that the processing and refinery spreads increased slightly in in 2006 and fell in 2007

before rising rather sharply in 2008 and 2009. The rise in the spreads corresponds with the rise in global food prices, which also affected domestic sugar prices. The transport, handling, wholesale and retail spreads have been on the increase since 2005, only fell in 2009, and later rose sharply in 2010.

4.9 STATIONARITY TESTS FOR THE PRICE SERIES

The Augmented Dickey Fuller (ADF) Stationarity tests were carried out and the results are summarised in table 4.3. Results of the test show that all the price series were non stationary until they were differenced once meaning that they were all integrated of order one I(1). All the correlograms that exhibited an Autocorrelation Function (ACF) that converged rather slowly towards zero and the graphs were not mean reverting.

Table 4.4: ADF test results for the price series

Series	Model	ADF			ORDER OF INTEGRATION
		Lags	τ_τ, τ_μ, τ	ϕ_3, ϕ_1	
WORLD PRICE	Trend & Intercept	2	-2.491549	8.867850***	I(1)
	Intercept	2	-1.682842	9.754453*	
	None	2	-0.229804		
ΔWORLD PRICE	Trend & Intercept	1	-7.320478***	19.64971***	
	Intercept	1	-7.227234***	28.26656***	
	None	1	-7.269652***		
WHOLESALE PRICE	Trend & Intercept	0	-2.441467***	2.376121	I(1)
	Intercept	0	-1.889987***	3.572052*	
	None	1	-0.357231		
ΔWHOLESALE PRICE	Trend & Intercept	0	-13.65114***	93.18104 ***	
	Intercept	0	-13.64105***	186.0781***	
	None	0	-13.67829***		
RETAIL PRICE	Trend & Intercept	0	-2.413851	3.125932	I(1)
	Intercept	0	-1.584400	2.510324	
	None	0	-0.126511		
Δ RETAIL PRICE	Trend & Intercept	0	-13.57582***	92.15575***	
	Intercept	0	-13.57196***	184.1981***	
	None	0	-13.60326***		
SUGARCANE PRICES	Trend & intercept	0	-2.087896	2.797997	I(1)
	Intercept	0	-1.439579	2.072387	
	None	0	-0.250411		
Δ SUGARCANE PRICES	Trend & Intercept	0	-12.98517***	84.30728***	
	Intercept	0	-12.92927***	167.1660***	
	None	0	-12.96318		

4.10 COINTEGRATION TESTS FOR PRICE SERIES

The possible co integrating long run relationship between price series was estimated using Ordinary least Squares (OLS) in Eviews 3.0. Residual series were generated and a line graph produced to indicate visually if it is mean reverting (stationary). Augment Dickey Fuller Tests were carried out on the residuals with the model 'none' (no trend or intercept) and with the appropriate number of lags, the ADF test statistic was generated. The hypothesis tested was:

H_0: No cointegration
H_1: Cointegration

The ADF test statistic was then compared with critical values C (p) also known as MacKinnon values calculated from the formula $C\ (p) = \phi_\infty + \phi_1 T^{-1} + \phi_2 T^{-2}$ (See Appendix for MacKinnon Values). The decision rule was to reject H_0 if the ADF statistic < C (p).

4.10.1 Wholesale and World Sugar Prices

The long run relationship between world and domestic wholesale prices was specified as: $P_{wholesale} = \alpha + \beta P_{world}$

Where $P_{wholesale}$ the sugar is wholesale price and P_{world} is the world sugar price

The estimates for the proposed co integrating relationship between world and Zambia's sugar wholesale prices are as shown in table 4.5.

Table 4.5: Estimates for the Long run relationship between Zambia's wholesale and world sugar prices

		Probability	t-statistic
α Constant	13.33006	0.0000	14.76021
β Coefficient	1.284611	0.0000	4.797449
R^2	0.563154		
Probability(F-statistic)	0.0000		

The ADF test was done on the residuals and the model for testing was specified as shown in table 4.6.

Table 4.6: Model structure for the ADF test

Variable	Model	Lags	Test Statistics
Resid	None	0	-3.453636

To test the hypothesis the ADF test statistic was compared with the C(p) and the conclusion on cointegration was made based on the decision rule.

Table 4.7: Critical values and ADF test statistics

	C(p):ADF
1%	-3.96273 < -3.453636
5%	-3.3729 > -3.453636
10%	-3.07019>-3.453636

Conclusion: World and domestic wholesale prices are co integrated at 5per cent level of statistical significance.

4.10.2 Retail and World Sugar Prices

The long run relationship between world and domestic retail prices was specified as: $P_{retail} = \alpha + \beta P_{world}$

Where P_{retail} the sugar is retail price and P_{world} is the world sugar price

The estimates for the proposed co integrating relationship between world and Zambia's sugar retail prices is as shown in table 4.7.

Table4.8: Estimates for the long run relationship between Zambia's retail and world sugar prices

		Probability	t-statistics
α Constant	18.93827	0.0000	14.14605
β Coefficient	1.560391	0.0000	5.377736
R^2	0.542143		
Probability(F-statistic)	0.0000		

The ADF test was done on the residuals and the model for testing was specified as shown in table 4.9.

Table 4.9: Model structure for the ADF test

Variable	Model	Lags	Test Statistics
Resid	None	0	-3.027891

To test the hypothesis the ADF test statistic was compared with the C (p) and the conclusion on cointegration was made based on the decision rule.

Table 4.10: Critical values and ADF test statistics

	C(p):ADF
1%	-3.96273 < -3.027891
5%	-3.3729 < -3.027891
10%	-3.07019<-3.027891

Conclusion: No cointegration between world and domestic retail prices.

4.10.3 Sugarcane and World Sugar Prices

The long run relationship between world and domestic wholesale prices was specified as: $P_{sugarcane} = \alpha + \beta P_{world}$

Where $P_{sugarcane}$ the sugarcane price and P_{world} is the world sugar price

The estimates for the proposed cointegrating relationship between world and Zambia's sugarcane prices are as shown in table 4.10.

Table 4.11: Estimates for the long run relationship between sugarcane and world sugar prices

		Probability	t-statistic
α Constant	1.530884	0.0000	13.26336
β Coefficient	0.163423	0.0001	3.891713
R^2	0.510027		
Probability(F-statistic)	0.000000		

The ADF test was done on the residuals and the model for testing was specified as shown in table 4.12.

Table 4.12: Model structure for the ADF test

Variable	Model	Lags	Test Statistics
Resid	None	0	-2.668509

To test the hypothesis the ADF test statistic was compared with the C (p) and the conclusion on cointegration was made based on the decision rule

Table 4.13: Critical values and ADF test statistics

	C(p):ADF
1%	-3.96273 < -2.668509
5%	-3.3729 < -2.668509
10%	-3.07019< -2.668509

Conclusion: No cointegration between world and domestic retail prices.

4.10.4 <u>Retail and Wholesale Prices</u>

The long run relationship between retail and wholesale prices was specified as:

$$P_{retail} = \alpha + \beta P_{wholesale}$$

Table 4.14: Estimates for the long run relationship between retail and wholesale prices

		Probability	t-statistic
α Constant	3.189697	0.0000	56.24359
β Coefficient	1.206193	0.0000	2.702839
R^2	0.949285	0.0076	
F-statistic	0.000000		

The ADF test was done on the residuals and the model for testing was specified as shown in table 4.15

Table 4.15: Model structure for the ADF test

Variable	Model	Lags	Test Statistics
Resid	None	3	-2.680153

To test the hypothesis the ADF test statistic was compared with the C (p) and the conclusion on cointegration was made based on the decision rule.

Table 4.16: Critical values and ADF test statistics

	C(p):ADF
1%	-3.96273 < -2.680153
5%	-3.3729 < -2.680153
10%	-3.07019< -2.680153

Conclusion: No cointegration between world and domestic retail prices.

4.10.5 Sugarcane and Wholesale Prices

The long run relationship between Zambia's sugarcane and wholesale prices was specified as: $P_{sugarcane} = \alpha + \beta P_{wholesale}$

Table 4.17: Estimates for the long run relationship between sugarcane and wholesale prices

		Probability	t-statistic
α Constant	0.295393	0.0000	24.50701
β Coefficient	0.118351	0.0000	5.070208
R^2	0.780924		
Probability(F-statistic)	0.000000		

The ADF test was done on the residuals and the model for testing was specified as shown in table 4.18.

Table 4.18: Model structure for the ADF test

Variable	Model	Lags	Test Statistics
Resid	None	0	-5.717694

To test the hypothesis the ADF test statistic was compared with the C(p) and the conclusion on cointegration was made based on the decision rule.

Table 4.19: Critical values and ADF test statistics

	C(p):ADF
1%	-3.96273 < -5.717694
5%	-3.3729 < -5.717694
10%	-3.07019< -5.717694

Conclusion: Cointegration between sugarcane and wholesale prices at 1per cent level of statistical significance.

4.10.6 <u>Sugarcane and Retail Prices</u>

The long run relationship between retail and wholesale prices was specified as: $P_{sugarcane} = \alpha + \beta P_{retail}$

Table 4.20: Estimates for the long run relationship between sugarcane and retail prices

		Probability	**t-statistic**
α Constant	0.227899	0.0000	23.46181
β Coefficient	0.094449	0.4170	0.813649
R^2	0.949285		
Probability(F-statistic)	0.000000		

The ADF test was done on the residuals and the model for testing was specified as shown in table 4.20.

Table 4.21: Model structure for the ADF test

Variable	**Model**	**Lags**	**Test Statistics**
Resid	None	0	-5.000055

Table 4.22: Critical values and ADF test statistics

	C(p):ADF
1%	-3.96273 <-5.000055
5%	-3.3729 < -5.000055
10%	-3.07019< -5.000055

Conclusion: Cointegration between sugarcane and wholesale prices at 1 per cent level of statistical significance.

Table 4.22 below summarises the cointegration among the price series.

Table 4.23: Summary of cointegration results among price series

Price Series ΔP_{1t}	Price Series ΔP_{2t}	Cointegration?	Significance Level
Wholesale	World	Yes	5%
Retail	World	No	
World	Sugarcane	No	
Retail	Wholesale	No	
Sugarcane	Wholesale	Yes	1%
Sugarcane	Retail	Yes	1%

4.10.7 <u>Explaining the Cointegration Results for the Zambian Sugar Markets</u>

Based on the cointegration tests, it can be concluded that the world and domestic sugar prices are integrated; sugarcane and wholesale sugar prices are also integrated and sugarcane and retail prices are integrated. There is however, no cointegration between retail and wholesale prices and world and sugarcane prices implying no integration between markets.

Integration between the world and wholesale prices (spatial) integration is possibly because of increased trade (exports) between Zambia and the world. Some of the policies Zambia implemented discussed in Chapter 2 possibly account for the observed cointegration. These include liberalisation, privatisation, investment promotion have increased sugar exports with the world. Vertically in the sugar value chain cointegration is found between the sugarcane and sugar wholesale price. This is possibly because of co-ordination between sugarcane producers and sugar millers in the value chain. The sugarcane price is an agreed price and farmers are organised into out grower schemes, which represents them during price negotiations which take place in April every year. The lack of cointegration between wholesale and retail prices is possibly because high transaction costs particularly in distribution. The varying margins in the fragmented retail market could possibly contribute to the observed lack of cointegration. While cointegration tells us whether markets are linked or not, the story is not complete as there are more aspects of the markets that still need

further investigation. The section that follows goes into more details by building and error correction model for co integrated price series. Cointegration established whether markets are integrated; the ECM tells us how integrated and efficient the markets are.

4.11 ECM FOR PRICE SERIES

An ECM was built for two price series with co integrated long run relationships[2]. Despite cointegration between the retail and sugarcane prices, the ECM was not built as the important relationship is between the processor and producer price. The ECM was specified following equation (5) in Eviews 3.0.

4.11.1 Spatial Price Transmission: ECM for Wholesale and World Prices and Prices

The ECM for wholesale and world prices is as summarised in Table 4.23.

Table 4.24: Error correction model for Zambia's wholesale and world sugar prices

Variable	Coefficient	Probability
θ (Error correction term or speed of adjustment)	-0.092575	0.0170
ε [3] (Long run elasticity of price transmission)	0.90880	0.0000
δ (Short run elasticity of price transmission)	-0.293556	0.1790
R^2	0.043194	
Adjusted R^2	0.025797	
Probability(F-statistic)	0.062718	

[2] Although cane prices and retail sugar prices are cointegrated, the ECM is not estimated because the relationship between the two price series is not theoretically important to the study. The important vertical relationship is that between processors (wholesale price) and cane producers (cane price).

[3] The equation used to calculate the long run elasticity of price transmission is $\ln P_{wholesale} = \alpha + \ln \beta P_{world}$ where β is the long run elasticity of price transmission.

The error correction term θ which shows the speed of adjustment back to equilibrium after a shock should be a negative value; thus the value of θ = -0.093 indicates that any shocks between the Zambian wholesale sugar prices and world sugar prices reverts to equilibrium. However, the ECT value is closer to zero than to negative one which indicates that the speed of adjustment to equilibrium is slow. When there is a shock to the equilibrium between wholesale and world prices the system only corrects about 9.26 per cent of the error in one month, and corrects 9.26 per cent of the remaining error in the following month and again 9.26 per cent of the remaining error in the third month and so forth. Although the Zambian sugar market is integrated with the world sugar market the level of integration is very low.

As earlier referred to, shipment costs for Zambia's sugar to Northern Europe makes up a significant proportion of the export parity for price for Zambia's sugar (World Bank, 2006) and these high transaction costs are a major factor affecting efficiency and integration between the domestic and world sugar market. This low transmission of prices from the world market to domestic Zambian prices has policy implications in that as the new EU sugar trade regime takes effect, the rate and extent to which the changes in the world market are transmitted into the domestic market will consequently be slow as evidenced by the low rate of transmission.

However, the other angle to this, is that high world prices can easily transmit to the local market depending on how asymmetric the price adjustment tends to be (asymmetry in price transmission is tested in the next section). Given the role that trade plays in market integration and efficiency, Zambia's integration with the world market can be enhanced if the nation can leverage on the opportunity in the EU through the expansion programmes, which are already in effect to increase exports to the world. However, distortionary policies such as import restrictions work against efficiency in the market as trade flows are unidirectional which results in low integration.

The long-run elasticity of price transmission ε between Zambia wholesale and world sugar prices is 0.909. A one per cent increase in world sugar prices increases domestic prices by 0.909 per cent implying that the wholesale price is inelastic with respect to world prices in the long run. However, in the short run elasticity of price transmission from world to wholesale prices is -0.29 which implies that a one per cent increase in world sugar prices reduces the wholesale price by 0.29 per cent. The negative short-run response in wholesale prices to changes in world prices can also be observed in figure 4.4 and figure 4.5 where there is an immediate drop in the price, which rapidly

rises above equilibrium then follows a gradual price adjustment. A possible explanation for this is the high levels of distortions in the global sugar market especially by the EU, high volatility in global markets as well as high transaction costs involved in trade between Zambia with regional and global sugar markets.

An evaluation of the ECM for the relationship between wholesale and world sugar prices reveals that the ECM is not robust in that it only explains 4.3 per cent of the model behaviour. This implies that other factors other than prices determine the spatial market outcomes between the Zambian sugar wholesale and world prices. This further testifies that integration between the two markets is very weak. Though some variables in the ECM are not significant, they are jointly significant as indicated by the probability of the F-statistic at 10 per cent significance level.

4.11.1.1 Simulating the Response of Wholesale Price to World Price Shocks

A simulation of a 20 per cent increase in world sugar prices was performed on the estimated Zambian sugar wholesale price. The 20 per cent shock in world prices was applied in May 2001. The time for applying the shock was selected randomly, however, the effect is the same regardless of which time is selected. .

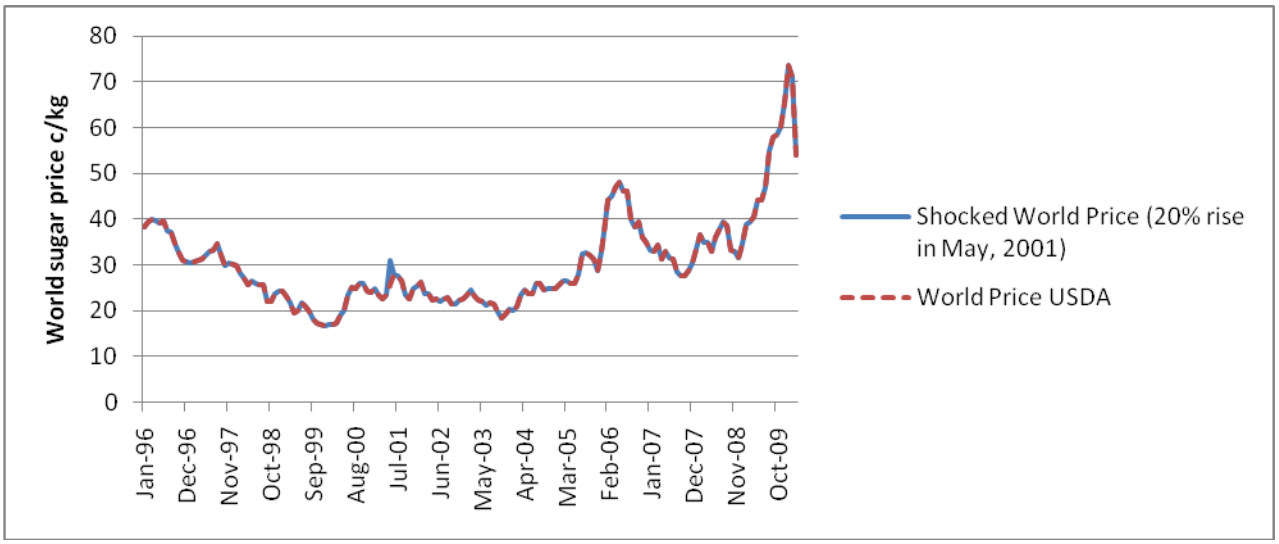

Figure 4.4: 20 per cent upward shock on the world price in May 2001

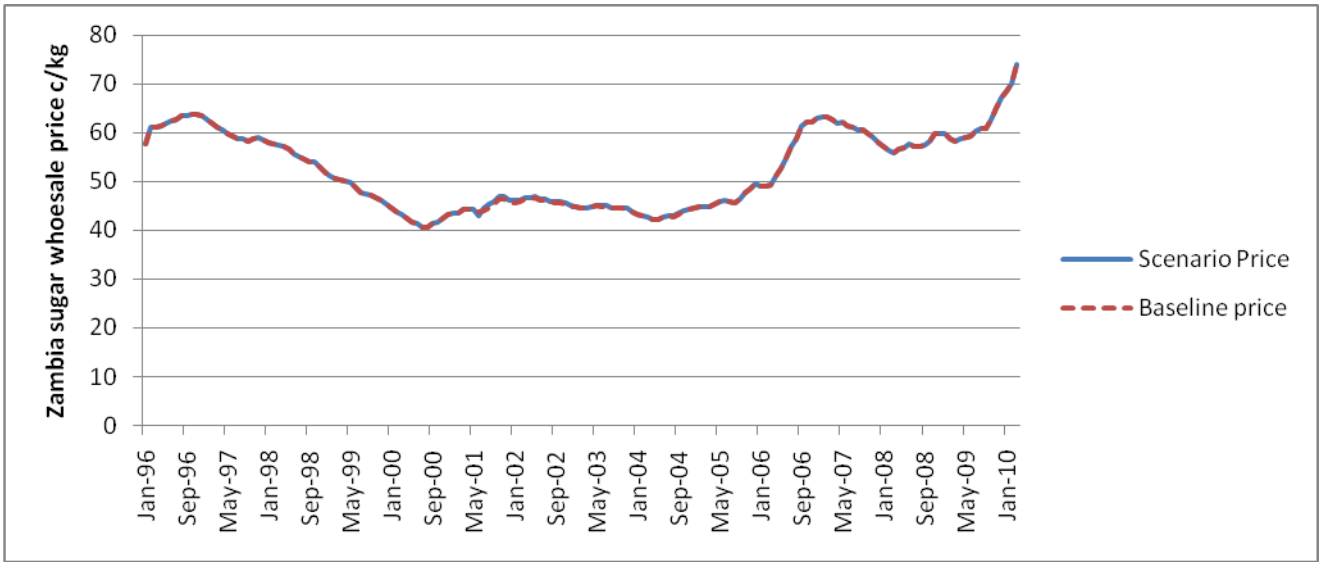

Figure 4.5: Simulating the response of the Zambian wholesale price to a 20 per cent world price upward shock

As observed in the price transmission results the wholesale price falls sharply in response to the rise in world prices then quickly rises and gradually and reverts back to equilibrium. This is also reflected in the negative short run elasticity of price transmission (see table 4.23). Possible reasons for this observation include distortions in the world price and transaction costs in taking the sugar to regional and global markets as already discussed in section 4.81.

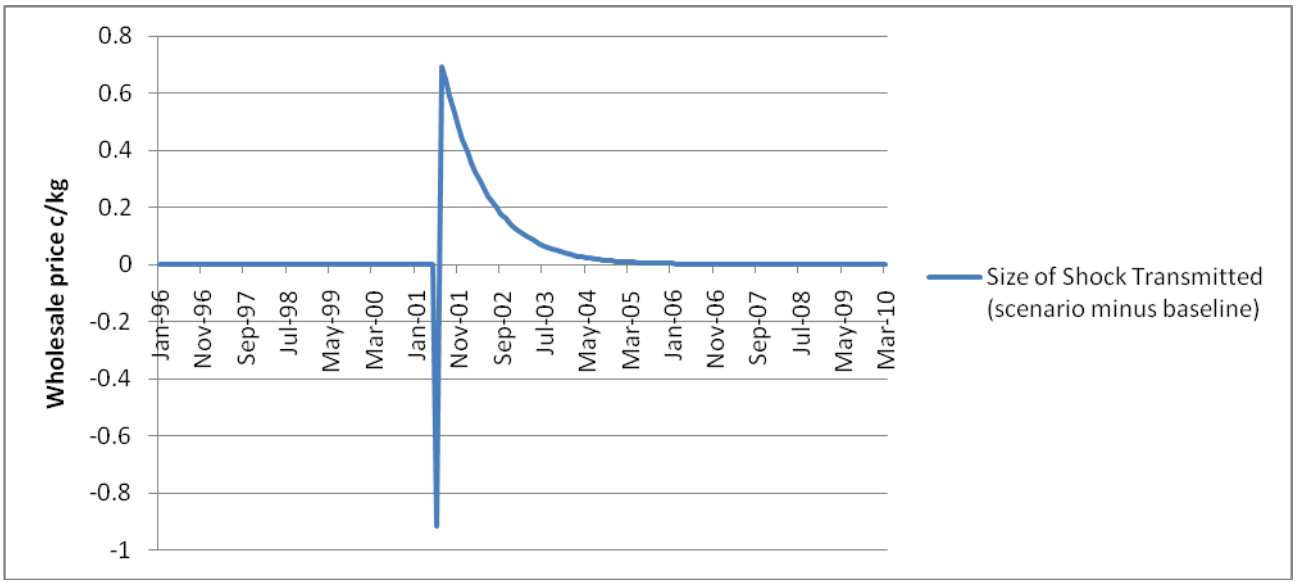

Figure 4.6: Size of the effect of the world price shock on Zambia's wholesale sugar price

From figure 4.6, it can be seen that the 20 per cent shock on world prices, which occured in May 2001 is corrected by 2004. Thus, it takes 3 years or 36 months for the domestic market to return to equilibrium after a shock in the world price.

4.11.1.2 Test for Asymmetry in Price Transmission between Wholesale and World Sugar Prices

The results of the test for asymmetry are summarised in table 4.24.

Table 4.25: Test for asymmetry between wholesale and world prices

Variable	Coefficient	Probability
ϕ^+	-0.159998	0.0136
ϕ^-	0.023817	0.75340
δ^+	0.293175	0.0688
δ^-	0.320104	0.34200
R^2	0.074205	
Adjusted R^2	0.074205	
Probability(F-statistic)	0.012722	

Source: Own compilation

To test for symmetry in price transmission the following hypothesis is tested:

H_0: $\delta^+ = \delta^-$

H_1: $\delta^+ \neq \delta^-$

The above hypothesis is tested using the t-test with the test statistics shown below[4]:

|t|=23.39618

From statistical tables: $t_{(n-k)} = t_{(160)} = 1.645$ at 5per cent significance level

Thus, |t|>: $t_{(n-k)}$

The null hypothesis of equality between the two parameters δ^+ and δ^- is rejected at 5per cent significance level which implies that there is asymmetric price transmission between world and Zambian domestic wholesale prices. The domestic market response to world prices varies

[4] The t-statistic is calculated using the formula (Gujarati,2003:265): $|t| = \frac{(\hat{\beta}_i - \hat{\beta}_j) - (\beta_i - \beta_j)}{\hat{\sigma}_{(\hat{\beta}_i - \hat{\beta}_j)}} \approx t_{n-k}$

depending on whether the shock is an increase or a decrease. Thus the price adjustment differs for upward and downward shocks.

4.11.2 Error Correction Model for Sugarcane and Wholesale Sugar Prices

Table 4.25 shows the price transmission results for Zambia's sugarcane and wholesale prices. The error correction term θ of -0.199 indicates that shocks in wholesale prices are corrected more rapidly than shocks between world and wholesale prices.

Table 4.26: Price transmission results for sugarcane and wholesale sugar prices

Variable	Coefficient	Probability
θ (Error correction term or speed of adjustment)	-0.199130	0.0000
ε [5] (Long run elasticity of price transmission)	0.944755	0.0000
δ (Short run elasticity of price transmission)	0.008547	0.3221
R^2	0.154467	
Adjusted R^2	0.139094	
Probability(F-statistic)	0.000004	

About 20 per cent of the errors are corrected within the same month and 20 per cent of the remaining errors in the following month and so forth. The long run elasticity of 0.945 indicates that a 1 per cent increase in wholesale sugar prices increases sugarcane prices by 0.945 per cent. However, in the short run, a 1 per cent increase in wholesale sugar prices increases sugarcane prices by only 0.009.

Both the long run and the short run elasticity of price transmission indicate that the wholesale to sugarcane price transmission is inelastic. The short run prices barely change in response to a 1 per cent change in wholesale prices while in the long run the change is 0.828 per cent. The inelastic

[5] The equation used for long run elasticity of price transmission is $\ln P_{sugarcane} = \alpha + \ln \beta Pwholesale$ where β is the long run elasticity of price transmission.

market is possibly because the administered prices between sugarcane producers and wholesalers does not change monthly but is only allowed to change annually.

An evaluation of the ECM indicates that the R^2 value of 15.4 indicates that there are other factors that explain the behaviour of the market other than prices. These may include policies, market structure and the level of concentration.

The price transmission results indicate that the sugar value chain from producer (farmers) to processors is relatively more integrated than between the wholesale and world prices. However, the level of integration between the sugarcane and wholesale prices is still low and this may be attributed to a number of factors. Firstly, the pricing in the value chain does not allow the sugarcane prices to vary within the year. According to the agreement between cane producers and processors, at least 92 per cent of the sugarcane price is fixed for the year in the Zambian sugar value chain while only 8 per cent of the price is allowed to vary. This has an impact on the speed of adjustment because while wholesale prices vary so often, the cane prices remain constant.

4.11.2.1 Simulating the Response of Sugarcane Prices to Wholesale Price Shocks

The price transmission model was used to simulate the response of sugarcane prices to shocks in the wholesale prices. Figure 4.6 shows the 20 per cent upward shock in the wholesale sugar prices in January 2000. Figure 4.7 shows the response of the sugarcane prices to a 20 per cent rise in the sugar wholesale price in January 2000.

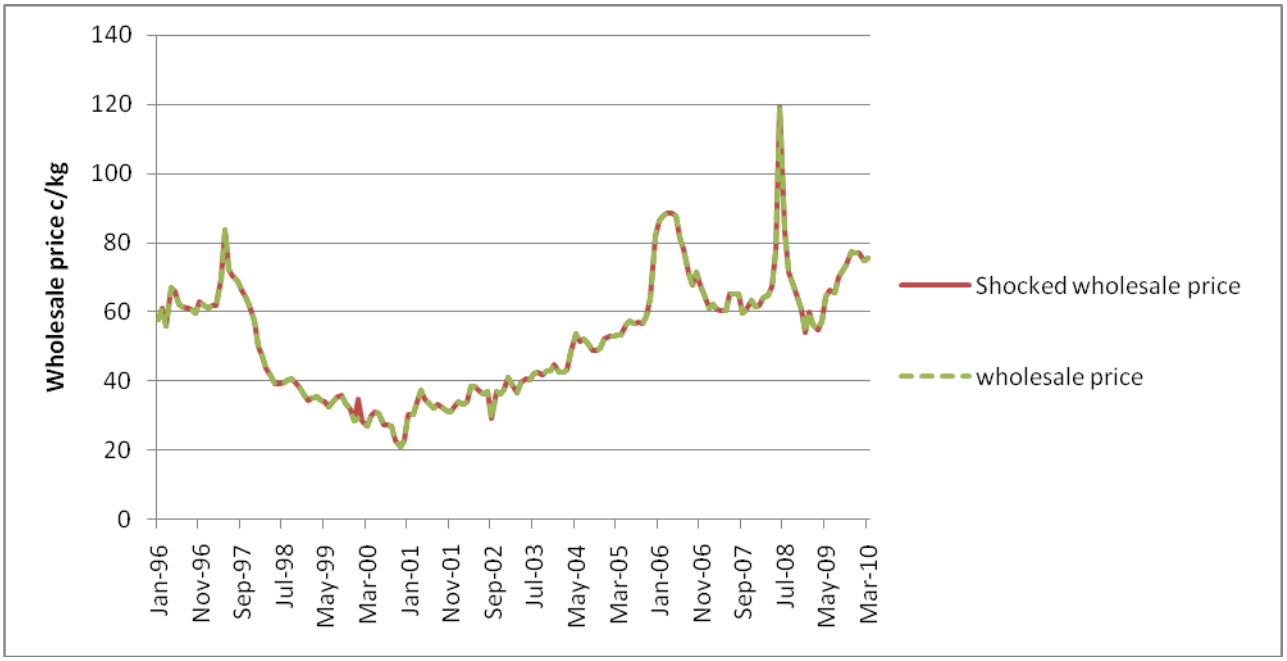

Figure 4.7: A 20 per cent rise in sugar wholesale prices in January 2000

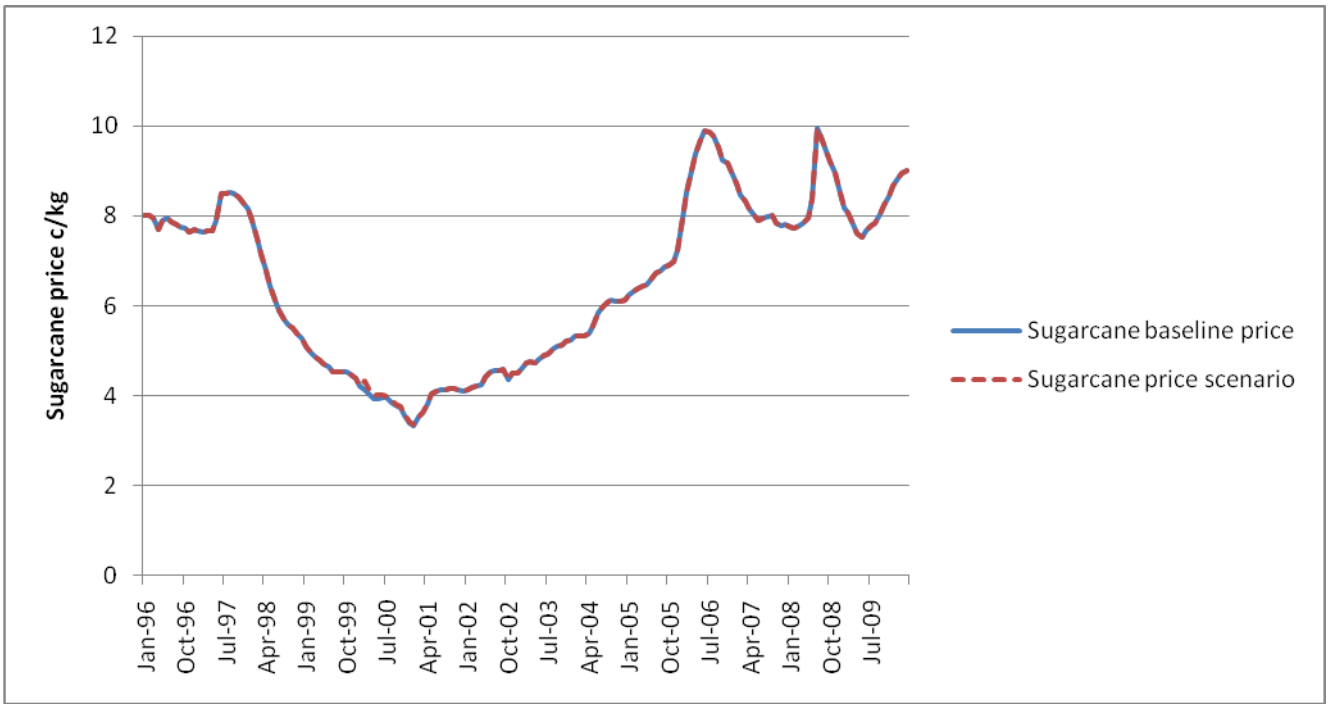

Figure 4.8: Simulating the response of sugarcane prices to a 20 per cent increase in wholesale prices

Corresponding with the price transmission results, the effect is minimal and the speed of adjustment indicates that the market reverts to equilibrium quicker than what was observed with the world to wholesale price transmission.

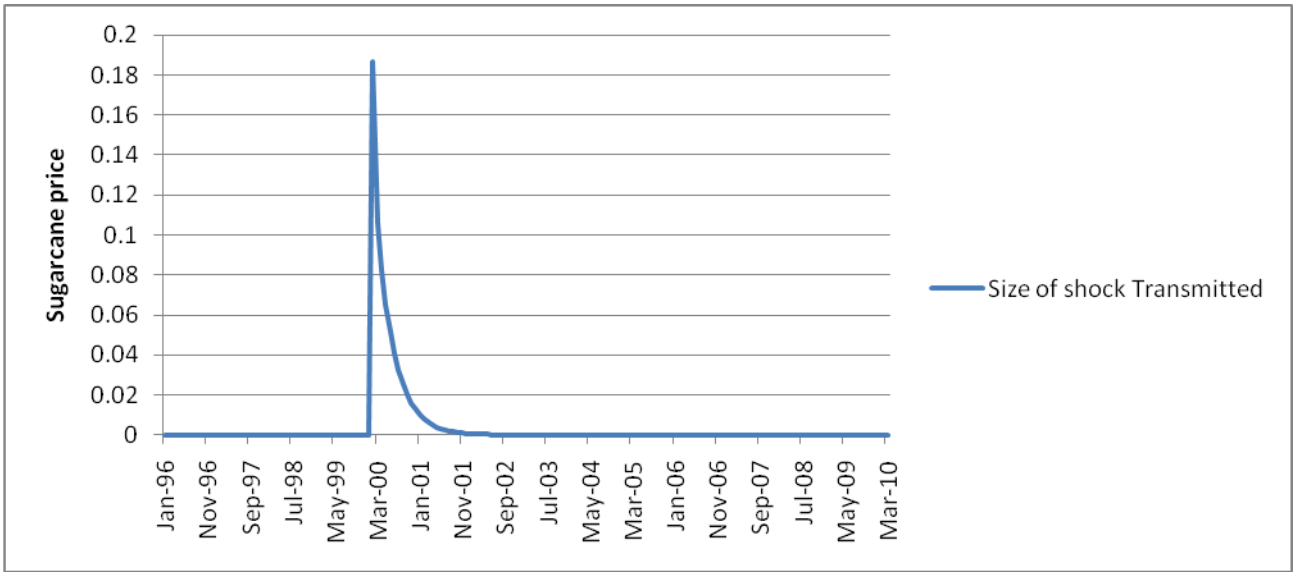

Figure 4.9: Size of the effect of the wholesale price shocks on Zambia's sugarcane prices

4.11.2.2 Test for Asymmetry in Price Transmission between Sugarcane and Wholesale Prices

Table 4.26 shows the results of the test for asymmetric price transmission between sugarcane and wholesale sugar prices.

Table 4.27: Results for test for asymmetry in price transmission

	Coefficient	Probability
ϕ^+	-0.197286	0.0054
ϕ^-	-0.249371	0.0003
δ^+	0.014799	0.1022
δ^-	0.030595	0.1086
R^2	0.173426	
Adjusted R^2	0.153265	
Probability(F-statistic)	0.000003	

To test for symmetry in price transmission the following hypothesis is tested:

H_0: $\delta^+ = \delta^-$

H_1: $\delta^+ \neq \delta^-$

This was tested using the t-test with the test statistics as shown below:

|t|=0.980

$t_{(n-k)} = t_{(160)} = 1.645$ at 5per cent significance level

The null hypothesis of equality between the two parameters δ^{+} and δ^{-} is not rejected at 5per cent significance level which implies that there is symmetric price transmission between Zambian domestic wholesale and sugarcane prices.

The price relationship between producer and processor levels indicates that some integration exists between sugarcane and wholesale prices. There is symmetry observed in the price adjustment, which is possibly because of a vertically co-ordinated market where price adjustment is administered. Thus, prices transmit symmetrically in the long run implying arbitrage in the value chain (market).

4.12 SUMMARY

Spatial price transmission results show that world prices transmit into domestic wholesale prices. However, the speed of adjustment is low suggesting the two markets are only loosely integrated. A negative short run elasticity of price transmission indicates that Zambian domestic prices moves opposite to world prices in the short run although they move in tandem in the long run. It takes 36 months for a shock in the world price to be corrected in the domestic market indicating the markets are loosely integrated. Price transmission is also asymmetric. The study finds integration in the vertical price relations (between the wholesale and sugarcane price). The sugarcane and wholesale markets are relatively more integrated with adjustment from shocks taking about a 1 year 6 months in the simulation. This can be explained by the fact that sugarcane producers and processors adjust prices annually although the simulation has estimated it to be 1 year and 6 months (about twice the speed of the vertical price transmission). Vertical price relations are also found to be symmetric which implies that price adjustment does not vary whether the price increases or falls. A possible explanation for the observed is that the sugarcane price determinations involve agreement between farmers and processors which results in symmetric price adjustment.

Despite the observed integration in the cointegration and price transmission analysis, both the world to wholesale and wholesale to sugarcane markets are not efficient. Although there is co-movement in the price series and errors in the equilibrium are adjusted in the long run, both ECMs do not sufficiently explain the process of price adjustment suggesting that transaction costs, structure, policies and other market distortions significantly affect the market outcome other than prices. It is necessary to remove distortions in the market in order for it to be more efficient and integrated.

Removal of the fortification requirement would result in lower prices and a more integrated market in that it would result in free trade flows (both imports and exports). It would also promote growth of emerging sugar mills since the investment costs will be lowered. International distortions such as the previous actions of the European Union, which resulted in low world prices, also contributed to inefficiency. However, with the new EU regime more efficiency and integration in the market is expected.

An interesting observation on the simulated price response for the spatial price transmission model is that the price fall below equilibrium before quickly returning to equilibrium in response to an upward price shock, which is supported by the negative short run in the estimated results. This response is also observed in the partial equilibrium model simulation in Chapter 6

CHAPTER 5

A PARTIAL EQUILIBRIUM FRAMEWORK FOR ZAMBIA'S SUGAR PRICE FORMATION: METHODOLOGICAL APPROACH, RESULTS AND DISCUSSION

5.1 INTRODUCTION

The purpose of this chapter is to build a partial equilibrium framework for the Zambian sugar market. The essence of building the partial equilibrium framework is to answer the question: "where do sugar prices come from?" Due to the complex nature of the market, a number of behavioural equations are used to build the model, which simulates the sugar market in its entirety, reflecting all the realities in the Zambian sugar market. Being a net exporter of sugar, the model is closed on trade and price is modelled reflecting the reality that prices are exogenously determined in Zambia. In other words this suggests that prices are determined outside the model and factors such as policy, world prices (export parity) and local demand and supply are essential in determining prices. The robust model thus constructed is able to generate an outlook for the sugar market, which projects all variables and is able to simulate the behaviour of the market based on any given assumptions. The Zambian sugar market baseline is present and a number of scenario analyses are presented. A baseline is a simulation of the sector model under agreed policy and certain assumptions with respect to macroeconomics, the weather and technological change. The baseline does not constitute a forecast but rather a benchmark of what could happen under a particular set of assumptions (Meyer, 2006).

5.2 MODELLING THE SUGAR MARKET

Benirschka**,** Koo and Lou (1996), formulated the world sugar model including 18 countries and regions. The behavioural equations estimated in the model were specified as follows:

5.3.1 Area Harvested

Benirschka *et al*., (1996) specified area harvested as:

$$ah_t^s = f(ah_{t-1}^s, p_{t-1}^s, p_{t-1}^c, g_t, t) \quad (7)$$

Where:

ah_t^s is the sugarcane or sugar beet acreage harvested, p^s is either the world market price of sugar, the domestic sugarcane price, or the domestic sugar beet price, p^c is the price of is the price of alternative crops, g_t is a policy parameter and t is a time trend

5.3.2 Yield

Sugar beet and sugarcane yields depend on lagged yields and a time trend, thus Benirschka *et al*.,(1996) specified yield as:

$$y_t^s = f(y_{t-1}^s, t) \quad (8)$$

Where y^s the sugarcane or sugar beet is yield, and t is a time trend

5.3.3 Production

Total sugar production is the sum of cane sugar production and beet sugar production, thus Benirschka *et al*., (1996) specified production as:

$$qp_t^s = ah_t^{sc} * y_t^{sc} * er_t^{sc} + ah_t^{sb} * y_t^{sb} * er_t^{sb} \quad (9)$$

Where qp^s the quantity of sugar produced is, er^{sc} is the cane sugar extraction rate, er^{sb} is the sugar beet extraction rate. The sugar extraction rates are exogenous variables.

In some countries, sugarcane acreage and sugar production are not closely related because a significant proportion of the sugarcane harvested is used for purposes other than centrifugal sugar production. For these countries, sugar production is a function of lagged sugar production qp_{t-1}^s, lagged sugar price p_{t-1}^s , and a time trend t :

$$qp_t^s = f(qp_{t-1}^s, p_{t-1}^s, t) \quad .(10)$$

5.3.4 Sugar Demand

Sugar demand comprises demand for domestic consumption, carryout stocks, and net exports. The model specifies behavioural equations for domestic consumption and for carryout stocks, while net exports are the difference between domestic sugar supply and demand (Benirschka *et al*., 1996).

5.3.5 Domestic Consumption

Per capita sugar demand is a function of the sugar price, income, and a time trend. Thus (Benirschka,*et al*.,(1996) specified domestic consumption as:

$$cqd_t^s = f(p_t^s, cy_t, t) \quad (11)$$

Where cqd_t^s the domestic per capita consumption of sugar is, p_t^s is the price of sugar, cy_t is per capita income, and t is a time trend.

Total domestic sugar demand is the product of per capita consumption and population

$$qd_t^s = cqd_t^s * pop_t \quad (12)$$

Where qd_t^s the total is domestic sugar consumption, and pop_t is the population count

5.3.6 Carry-out Stocks

Carryout stocks are a precaution against unexpected supply shortfalls. Thus, these stocks are likely to be related to the level of domestic sugar consumption. However, since the Opportunity cost of holding sugar stocks depends on the sugar price, stocks should respond to price changes. In the model, carryout stocks are a function of carry-in stocks, domestic consumption, and sugar price.

$$qd_t^s = f(qs_{t-1}^s, qd_t^s, p_t^s) \quad (13)$$

Where qd_t^s denotes sugar carry-out stocks, and p_t^s is the sugar price (Benirschka,*et al*.,1996).

5.3.7. Net Exports

Net exports are the difference between domestic sugar supply and demand

$$qx_t^s = qs_{t-1}^s + qp_t^s - qd_t^s - qs_t^s \quad (14)$$

Where qx_t^s denotes the net exports of sugar. If net exports are negative, the country is a net importer (Benirschka *et al*., 1996).

5.3.8 <u>The Price Linkage</u>

World market prices are converted into domestic prices using the official exchange rate.

$$pm_t^{s,i} = pm_t^{s,us} * er_t^i \quad (15)$$

Where $pm_t^{s,i}$ is the domestic price of sugar in country i, and is the exchange rate of country I (domestic currency units per U.S. dollar). To simulate changes in trade policies, specific and ad valorem tariffs (and subsidies) can be added to the linkage equation for the world price:

$$pm_t^{s,i} = pm_t^{s,us} * er_t^i * (1 + r^{s,i}) + t^{s,i} + t^{s,us} \quad (16)$$

Where $r^{s,i}$ is an ad valorem tariff rate, $t^{s,i}$ is a specific tariff quoted in national currency, and $t^{s,i}$ is a specific tariff quoted in U.S. dollars (Benirschka,*et al*.,1996).

5.3.9. <u>Market Equilibrium</u>

Equilibrium implies that total supply equals total demand, i.e., the sum of net exports of all countries and regions equals zero.

$$\sum_{i=1}^{n} qx_t^{s,i} = 0 \quad (17)$$

Where $qx_t^{s,i}$ the net sugar is exports of country i. The model is solved by finding an equilibrium price such that total demand equals total supply (Benirschka,*et al*.,1996).

5.3.10. <u>The Accounting Identity for Market Equilibrium</u>

To equate total supply to total demand throughout the model is to essentially restrict the model to the following identity (Meyer, 2010):

Production +Beginning stocks + Imports=Domestic Consumption +Ending Stocks + Exports+ Wastes + Statistical Identity (18)

5.3.11. Model Closure

Model closure is the manner in which the model ensures that the above accounting identity holds. There are various ways to close a model; the right way depends on the nature of the country's policies that in the end determines the equilibrium pricing conditions (Meyer, 2010). Model closure differs depending on whether the commodity is at autarky, export parity, or import parity. If the price is exogenous or it is dependent on factors such as world price and government, then the price equation will be modelled and the model will close on trade *Option 2*. If the price is endogenous or depends on domestic supply and demand, then there is no price equation, the trade equation will be modelled, and the model will close on price *Option 1*.

A number of behavioural equations are determined including production, consumption, domestic use, trade (Import and export), and the model is closed on either price or trade. Future projections (outlook) can then be generated for all the variables. The information generated will complement the price transmission analysis.

5.4 THE ZAMBIAN SUGAR MODEL: THE PARTIAL EQUILIBRIUM FRAMEWORK

In this study, the Zambian sugar model is formulated in a similar manner as the model built by Benirschka**,** Koo and Lou (1996) but with various adaptations. The behavioural equations are modified to the realities of the Zambian sugar market. The sugar model is built from a number of endogenous and exogenous variables relevant to the sugar industry. Exogenous variables are external factors, which cannot be controlled in the model such as inflation, exchange rate, rainfall, temperature, domestic and international policies and so forth. Endogenous variables are factors that can be controlled including area planted, yield, production, consumption, imports, exports and so forth.

The data used to build the partial equilibrium for Zambian sugar was secondary data obtained from various sources; most of them publicly available. The data was complemented with field visits to the sugarcane producers, sugar millers and marketers.
The data obtained was time series for the period 1990 to 2010.

5.4.1 Building the Partial Equilibrium Model and Outlook for Zambia's sugar Model

The starting point for building the partial equilibrium framework for the Zambian sugar market was to restrict the sugar market to the accounting identity already referred to which equalises supply and demand. This was modified because beginning, ending stock was not available, and data on waste was not available.

Thus, the identity used was as follows:
Production+ Imports=Domestic Consumption+ Exports+ Change in Stock (19)
Behavioural equations were then estimated for all the endogenous variables. The variables affect either supply or demand for sugar.

5.4.1.1. Sugar Supply equations

- Sugarcane Area Planted
- Sugarcane yield
- Sugarcane production
- Sugar imports

5.4.1.2 Sugar Demand Equations

The following are the demand side variables for the Zambian sugar model:

- Sugar domestic use
- Sugar exports
- Sugar per capita consumption
-

5.4.2 Sugar Supply Equation

The following are the supply side variables for the Zambian sugar model:

5.4.2.1 Sugarcane Area Planted

The regression results for sugarcane area planted are summarised in table 5.1 below.

Table 5.1: Sugar area planted equation

Variable	Coefficient	t-statistic	Probability	Elasticity
Intercept	16.842	4.372	0.000	0.019
Lagged Domestic sugar price	0.046	1.766	0.099	0.136
Fertiliser	-0.002	-1.635	0.124	-0.115
Interest rate	-0.050	-1.856	0.085	
Privatisation Dummy	1.235	0.813	0.429	
Expansion Shift	3.689	2.760	0.015	
R^2	0.884			
Probability (F-statistic)	0.000			

The sugarcane area planted depends on the lagged domestic price by one year; It also depends on the fertilizer price and the level of interest rates. Two dummy variable liberalisation and expansion also affect the area planted. Area planted is inelastic to price changes as shown by the elasticity of 0.14, which indicates that, a 1 per cent increase in the lagged domestic price increases area planted by 0.14 per cent. Area planted reduces with increases in fertilizer price and interest rates and it is inelastic with respect to fertilizer price with an elasticity of 0.12. Liberalisation policies, which began in 1993, have resulted in increased area planted up to 1200 hectares while the recent expansions have increased the area by about 3700 hectares according to the regression estimates.

5.4.2.2. Sugarcane Yield

Sugar yields in Zambia depend on rainfall, temperature, and technology. Table 5.2 shows that it is inversely related to rainfall because above average rainfall reduces yields while it is positively related with temperature and technology trends. The low R^2 of 20per cent indicates that there are other factors affecting yield than the ones included. The sugar market is inelastic to changes in temperature and rainfall but responds more to rainfall than temperature. Data limitations did not allow inclusion of all possible factors.

Table 5.2: Sugarcane yield equation

Variable	**Coefficient**	**t-statistic**	**Probability**
Intercept	133.809	5.305	0
Rainfall	-0.049	-1.42	0.176
Temperature	0.085	0.288	0.778
Technology Trend	2.802	1.854	0.083
R^2	0.202		
Probability(F-statistic)	0.321		

5.4.2.3 Sugarcane Production

Sugarcane production is derived from multiplying area planted and yield. Thus it is not estimated from regression:

Sugarcane production=Area planted *Yield (20)

5.4.2.4 Sugar Production

Similarly, sugar production is derived from sugarcane production.

Sugar production=sugarcane production*extraction percentage (21)

5.4.3 Sugar Demand Equation

5.4.3.1 Sugar Per Capita Consumption

Sugar per capita consumption is the average amount of sugar consumed by each person in Zambia. It is an indicator of domestic sugar demand and it depends on the real domestic sugar price and real per capita GDP and changing trends in consumption

.

Table 5.3: Sugar per capita consumption equation

Variable	Coefficient	t-statistic	Probability	Elasticity
Intercept	14.473	10.866	0	
Real Domestic Sugar Prices Zambia	-0.001	-0.94	0.362	-0.01
Real Per capita GDP	0.002	1.615	0.127	0.095
Consumption Trend	-0.949	-1.78	0.095	
R^2	0.323			
Probability(F-statistic)	0.101			

Table 5.3 shows regression output for Zambia's sugar per capita consumption. In line the expectations from theory, per capita consumption in Zambia is inversely related to the real domestic sugar price and positively related to real per capita GDP. Both the regression coefficients and the elasticity of sugar consumption show that sugar consumption is not responsive to either real per capita GDP or real price Consumption however, is more responsive to per capita GDP than the domestic price implying a stronger income effect than the price effect on consumption. Thus, sugar

consumption remains relatively constant despite changes in the price and GDP per capita. The consumption trend was included in the regression and the purpose was to account for changing trends in sugar consumption over time. Per capita sugar consumption is negatively related to the trend, which suggests that consumer tastes and preferences have shifted towards consuming less sugar; possibly due to health reasons.

5.4.3.2 Domestic Use

Domestic use is derived from per capita sugar consumption. Domestic use =Per capita sugar consumption * total consumption (22).

5.4.3.3 Sugar Imports

Zambia's sugar imports depend on domestic factors, which incorporate demand and supply, the domestic price relative to the import parity price and the policy requiring all sugar in the country to be fortified with vitamin A, which restricts imports. Table 5.4 shows the import equation for Zambian sugar market. As sugar domestic use increases relative to production sugar imports in Zambia increase. Sugar imports also depend on the relative price, which is the domestic price, divided by the export parity price; as the relative price increases, sugar imports increase. The major factor explaining sugar imports in Zambia is the policy on Vitamin A fortification. All sugar in Zambia whether domestically produced or imported is required to be fortified with Vitamin A. This legislation is not present in many countries, which can be potential sources of sugar imports into Zambia, thus any potential imports end up being denied entry, as they do not meet the standard. Thus, the policy acts as a non-tariff barrier restricting sugar imports. Due to the policy on fortification sugar imports have reduced by about 25,700 tons per year.

Table 5.4: Sugar import equation

Variable	Coefficient	t-statistic	Probability
Intercept	23.009	2.928	0.019
Sugar domestic use divided sugar production	3.429	0.202	0.845
Sugar domestic price divided by the import parity price	2.207	0.998	0.348
DUM 2000 Policy on Vitamin A fortification	-25.715	-6.574	0.000
R^2	0.8701		
Probability(F-statistic)	0.000		

5.4.3.4 Export Parity Price

The export parity price for Zambia's sugar is calculated by subtracting containerised freight from Lusaka to Durban, shipment by sea from Durban to Northern Europe and insurance from the world market sugar price.

5.4.4 Zambia Sugar Market Model Closure

Sugar domestic price is exogenously determined in the model as it depends on policy, world price and domestic demand. As such, the sugar domestic price was estimated as shown in table 5.5.

Table 5.5: Sugar price equation

Variable	Coefficient	t-statistic	Probability	Elasticity
Intercept	33.023	0.901		
Real Export Parity Price	2.828	74.316	0.000	1.091
Domestic use/Production	20.521	0.434	0.669	1.398
Liberalization Dummy	-44.681	-3.29	0.005	
DUM 2000 Policy on Vitamin A fortification	1.171	0.109	0.915	
R^2	0.993			
Probability(F-statistic)	0.000			

The sugar domestic price in Zambia depends on the real export parity price[6], sugar domestic use relative to production and policies (liberalisation and vitamin A fortification). The regression coefficient for the export parity price indicates that the sugar price is related to the world price. A 1 US Cents rise in the real export parity price increases the price of domestic sugar price by 2.8 US Cents. The price of sugar also depends significantly on local demand and supply factors as measured by the factor domestic use/production. Policy also plays a major role in price formation in Zambia. Liberalisation of the sugar market in 1991 has reduced the price of sugar by about 45 US Cents. The policy on fortification of sugar with vitamin A which restricts imports has increased the price of sugar by 1 US Cent according to the model.

[6] While the price transmission results in Chapter 5 indicate integration between domestic and world sugar prices the Zambian sugar baseline indicates that the domestic price is more linked to the import parity price (see figure 5.1.).

The Zambian sugar model was closed on exports. The closing identity for Zambia's sugar model calculated as follows:

Exports= sugar production+ Imports- consumption+ change in stock (23)

This ensured that actual and estimated exports were equal

5.4.5 The Baseline for Zambia's Sugar Market

The baseline for Zambia's sugar is based on the macroeconomic assumptions that have been summarised in table 5.6. These projections are exogenously determined therefore they were sourced from a number of institutions. They form the basis for the projection for the endogenous variables, thus any changes in these variables impacts on the endogenous baseline projections.

Table 5.6: Assumptions for the Zambian sugar baseline

Variable	Units	2010	2011	2012	2013	2014	2015
GDP per Capita	USD	1,123.0	1,280.0	1,452.0	1,661.0	1,888.0	2,090.0
Consumer Price Index	Index	2,013.9	2,207.2	2,439.0	2,658.5	2,857.9	3,052.2
Inflation rate	per cent	9	9.6	9.2	9	7.5	6.8
Interest Rate	per cent	17.0	16.0	15.0	13.0	12.0	11.0
Nominal Zambia Exchange Rates	ZMK/USD	4,800.0	4,700.0	4,625.0	4,500.0	4,375.0	4,300.0
Total population of Zambia	Millions	13.3	13.6	13.9	14.3	14.6	15.0
World Sugar Prices	Cents/Kg	61.2	71.1	66.0	68.7	69.4	70.2
Input Prices		623.0	638.3	620.0	610.0	600.0	590.0
Rainfall	Mm	800.0	771.0	773.0	815.4	794.6	890.0
Temperature	^{0}C	28.9	29.5	27.5	30.9	30.4	28.5

Source: Economic Web Institute, 2010; Trading Economies,2011; USDA,2011; World Bank, 2010; Zambia Meteorological Services; Central Statistical Office Zambia

Zambia's economic growth is projected to continue in all its sectors thus GDP per capita is expected to grow steadily from USD 1,280 in 2011 to USD 2,090 in 2015. Zambia's population is also expected to grow steadily at pace with GDP per capita. The inflation rate falls between 2011 and 2015 and is sustained below 10 per cent as the general price levels fall in response to continued growth in the economy. Due to a fall in inflation rate, interest rates are expected to drop from 17 per cent in 2011 to 11 per cent in 2015. The fall in interest rates reduces the cost of borrowing thus increasing production and trade in all sectors of the economy. This results in the appreciation of the

local currency, the Kwacha from ZMK 4,800/USD to ZMK 4,300/USD. World sugar prices rise between 2010 and 2011 due to the liberalisation in the EU quota regime, which has resulted in a higher, liberalised world market price. However, the world price falls in 2012 due to surplus production because of major plant expansions taking place globally in response to the higher world price. The world sugar price then rises gradually from 2013 through to 2015.

The Zambian sugar baseline is presented in table 5.7. The assumptions already referred to allow the formulation of a number of behavioural equations already referred to for the sugar model. This then makes it possible for the model to make projection about the endogenous variables from 2011 up to 2015.

Table 5.7: Sugar Baseline for Zambia

		2010	2011	2012	2013	2014	2015
Sugar production	1,000 tons	374	415.0	424.3	464.4	469.7	470.8
Sugar imports	1,000 tons	0	0.9	0.8	0.6	0.8	1.0
Sugar Domestic Use	1,000 tons	167	193.6	202.9	218.0	226.5	237.5
Sugar Exports	1,000 tons	176	222.3	222.2	247.0	244.0	234.4
Sugar domestic price	US Cents/Kg	96.2	109.9	103.9	102.7	109.8	124.1

Sugar production increases throughout the baseline period increasing to 415,000 tons in 2011, 424,000 tons in 2012 and continues to rise steadily reaching 470,000 tons in 2015. This is in line with major production and capacity expansion in all the sugar producing companies and cane growers in Zambia. The model projects that imports flow into Zambia albeit small in quantity. The barrier set by the government prevents even these projected imports from entering the country. On the other hand, these imports may represent unrecorded informal cross border sugar trade. In line with projected population growth, Zambia's domestic use increases due to strong domestic demand. Exports are on a steady rise as Zambia responds to regional and international demand with the expanded duty free access in the EU market playing a major role. The sugar domestic price increases in 2011 then falls in 2012 and 2013 before rising between 2014 and 2015 to reach US Cents 124/kg.

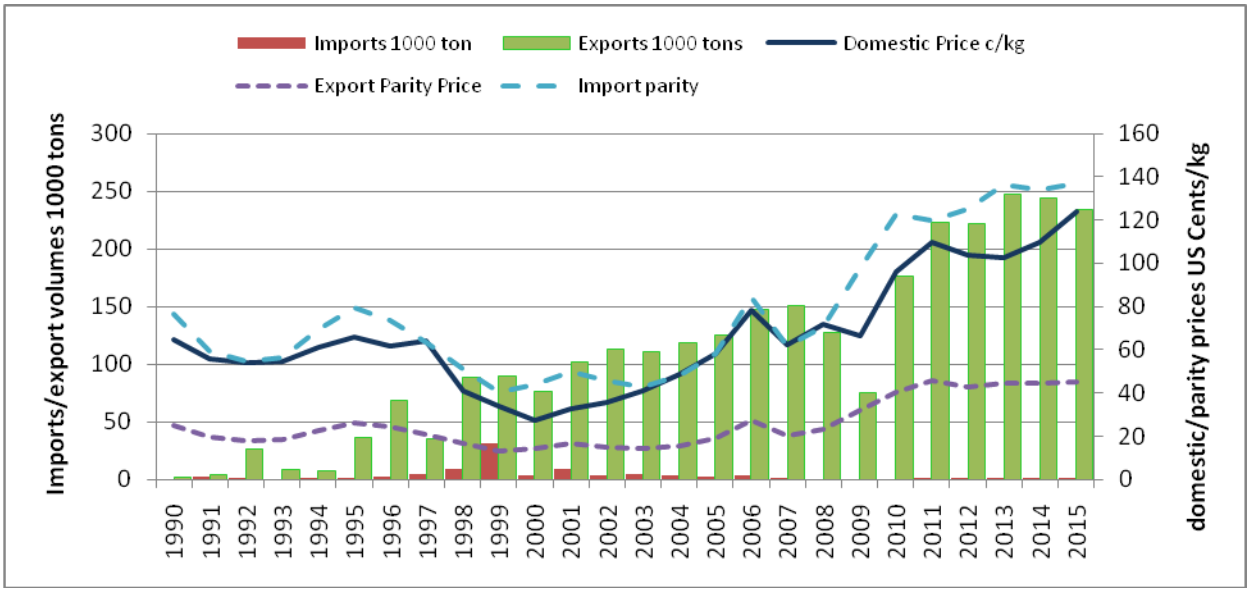

Figure 5.1: Price space for Zambia's sugar market

Figure 5.1 shows the price space for Zambia's domestic price which shows domestic price movements within the upper (import parity price) and lower (export parity price) bands from 1990 to 2015. The figure also shows import and export levels for the period 1990 to 2015. The import and export parity are the Import and export parities are important as they indicate the price formation mechanism followed in the market. It can be observed from the figure that sugar prices in Zambia are closer to import parity price rather that export parity although co-movements in the domestic and export parity prices can be observed. This is contrary to expectations because as a net exporter, Zambia's prices should be determined by export parity prices. This is partly due to high transaction costs in the domestic market. It can also be observed that since 2009, the domestic price is trending closer to the export parity price because the import parity price has risen very fast in the same period. This observation in the price formation process as well as the results of the price transmission process in Chapter 4 implies that the Zambian and the international sugar markets are highly distorted. The world sugar prices have been kept low for a long time by actions of major players in the sugar industry causing inefficiency. The observed trend whereby domestic prices are at import parity is not unique to Zambia as this has also been observed in net exporters such as Brazil and South Africa.

Factors such as high transaction and transformation costs such as energy costs, concentration (market power) and policy could be contributing to the inefficiency observed. The world market distortions caused by actions of regional blocks such as the European Union have led to low world sugar prices. The regime is set to change and this is expected to result in increased efficiency in the

global sugar market. High cost producers will no longer compete while efficient producers such as Zambia will be more competitive. Trade is the major channel through which markets become integrated. As exports increase, the Zambian sugar market is expected to be more integrated with the world sugar market. The level of integration could be higher if there were no restrictions in imports.

5.4.6 Scenario Analysis for the Zambian Sugar Market

Scenario analysis is the analysis of what happens to the endogenous variables if there is a change in any of the baseline assumptions. Scenario of the world sugar price and policy are set and the effect on endogenous variables are observed.

5.4.6.1 *Scenario 1: The world sugar price increases by 10 per cent in 2012*

Table 5.8: Effects of a 10 per cent increase in world price in absolute amounts

		2010	2011	2012	2013	2014	2015
Sugar production	1,000 tons	0.0	0.0	0.0	7.6	-2.5	0.9
Sugar imports	1,000 tons	0.0	0.0	0.2	-0.1	0.0	0.0
Sugar Domestic Use	1,000 tons	0.0	0.0	0.0	0.0	0.0	0.0
Sugar Exports	1,000 tons	0.0	0.0	0.2	7.5	-2.5	0.9
Sugar producer price	US Cents/Kg	0.0	0.0	12.9	-4.1	1.5	-0.6

Table 5.9: Effects of a 10 per cent increase in world price in per centages

		2010	2011	2012	2013	2014	2015
Sugar production	%	0.0	0.0	0.0	1.6	-0.5	0.2
Sugar imports	%	0.0	0.0	29.5	-16.5	4.5	-1.3
Sugar Domestic Use	%	0.0	0.0	0.0	0.0	0.0	0.0
Sugar Exports	%	0.0	0.0	0.1	3.1	-1.0	0.4
Sugar producer price	%	0.0	0.0	12.4	-4.0	1.4	-0.5

The effects of a 10 per cent increase in world prices in 2012 on the Zambian sugar market are summarised in table 5.8 and 5.9. Sugar production rises by 7600 tons (1.6 %) in 2013 then reduces by 2.5 tons (0.5 %) in 2014 before by to 0.9 tons(0.2 %) in 2015). The sugar domestic price rises

by 12.9 US Cents/kg (12.4 %) in 2012 but falls in 2013 by 4.1 US Cents/kg (4 %). The price then rises in 2014 by 1.5 Cents/kg (1.4 %) then reducing by 0.6 Cents/kg (0.5 %). Interactions between supply and price are clearly exemplified in this scenario analysis. The rise in the sugar domestic price in 2012 prompts sugarr suppliers to produce more sugar in the following year(2013), since supply response is lagged by one year. As more sugar is supplied in the domestic market, the price falls in 2013 prompting suppliers to supply less in 2014. This then leads to a slight rise in the sugar price in 2014 and the cycle is repeated in 2015 when producer supply slightly more sugar and the price falls slightly. This observation explains the response to a shock in world prices observed in the price transmission analysis in Chapter 4 section 4.8.1.1. Imports initially increase by 200 tons (29.5p%) in 2012 then drop by 100tons(16.5 %) in 2013 remaining unchanged until 2015.There is no change in the domestic use (demand) due to its inelastic nature. In response to the rise in the world price, exports increase by 200 tons (0.1 %) in 2012, rises again by 750 tons in 2013 (3.1 %) before falling in 2014 then rising in slightly 2015.

5.4.6.2 *Scenario 2: Barriers to sugar importation (Vitamin A fortification requirement) lifted and/or modified in 2012*

Table 5.10 Effects of lifting the barrier on sugar imports in absolute amounts

		2010	2011	2012	2013	2014	2015
Sugar production	1,000 tons	0.0	0.0	0.0	-16.8	-12.9	-15.2
Sugar imports	1,000 tons	0.0	0.0	25.2	25.4	25.3	25.4
Sugar Domestic Use	1,000 tons	0.0	0.0	0.0	0.0	0.0	0.0
Sugar Exports	1,000 tons	0.0	0.0	25.2	8.6	12.4	10.2
Sugar producer price	US Cents/Kg	0.0	0.0	-28.2	-21.5	-25.4	-25.2

Table 5.11: Effects of lifting the barrier on sugar imports in percentages

		2010	2011	2012	2013	2014	2015
Sugar production	%	0.0	0.0	0.0	-3.6	-2.8	-3.2
Sugar imports	%	0.0	0.0	3,273.2	4,505.8	3,351.9	2,481.1
Sugar Domestic Use	%	0.0	0.0	0.0	0.0	0.0	0.0
Sugar Exports	%	0.0	0.0	11.3	3.5	5.1	4.3
Sugar producer price	%	0.0	0.0	-27.2	-21.0	-23.2	-20.3

The second scenario analysed is the removal and/or modification to the fortification requirement that acts as a barrier to sugar imports in Zambia. The results of the policy change are summarised in Table 5.10 below. As the restriction imposed on imports through the requirement for all sugar in Zambia to be fortified with Vitamin A is lifted, imports surge by an average of 25,300 tons (3,403 %) in response to a more open trade regime. As a resulting of increased imports, production falls in 2013 by 16,800 tons (3.6 %) and by 12,900 tons (2.8 %) in 2014 and in 2015 by 15,200(3.2 %) (an average of 15,000 tons (3.2 %). Domestic use is not affected by the policy change due to the fact that sugar consumption is highly inelastic. In response to the policy change, exports rise by an average of 14100 tons (6.1 %). This is because as imports flow into the country, domestic demand is not only met by production but also by imports hence increase in sugar surplus. As a result of increased supply due to increased imports, the domestic sugar price falls by an average of US Cents 25.1(22.9 %). Despite the loss in production of 3.2 per cent, Zambia gains from an increase in exports of 6.2 per cent (roughly twice the percentage loss in production). Thus Zambia gains in export revenue from the policy change since the world price is projected to increase and also gains from increased consumer welfare as the domestic price reduces.

5.5 SUMMARY

Despite the many domestic and international market distortions in the Zambian sugar market, the sugar partial equibrium model is successfully built from a number of behavioural equations. The model is closed on trade and prices are modelled since prices are exogenously determined. This section has shown that sugar price formation depends on the export parity with an elasticity of 1.09.

The elasticty between the domestic and world price of 1.09 is similar to the one found in the price transmission (0.91) which suggest unitary elasticity between world and domestic prices. The price equation confirms the theory that price formation is determined by the world price (through the export parity price), domestic demand and supply conditions and policy.

Although correlation between the sugar domestic and export parity price is established in the price equation the price space analysis indicates that the domstic price is trading closer to the import parity price than the export parity price indicating that there are high transaction costs and distortions in the domestic market causing the domestic price to be high. This similar to the case of

other sugar netexporting countries such as South Africa as found in a study by NAMC (2003). This is indicative of distortions in the sugar market.

Scenario analysis of sugar production shows that the sugar price increase in response to a 10 per cent rise in world price the price but falls later due to a fall in domestic price. Sugar imports rise and fall remaining constant up to 2015, while domestic demand is unchanged throughout the period. The domestic sugar price rises and falls adjusting to equilibrium around 2015 while exports rise and then fall.

A scenario analysis of lifting of the barrier to sugar imports reduces sugar production in 2014 and 2015 by 3.2 per cent. Imports rise up by about 25,300 tons (3,403 per cent) due to lifting the barrier, domestic use is unchanged, exports rise by about by an average of 14,100 tons (6.1 per cent).. Domestic sugar price falls by US Cents 25.1(22.9 %) as more sugar supplies enter the domestic market through imports. The loss in production 3.2 per cent is offset by the gain in exports of 6.1 per cent which is about twice the perntage loss in production. This will benefit the sugar industry as there is a guaranteed market in the EU and as the world price is on the rise. Consumers gain welfare due to the drop in the price while the whole industry structure becomes more competitive.

CHAPTER 6

SUMMARY AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter presents a summary of the study, draws some conclusions and makes recommendations. A brief summary of the study is outlined, thereafter conclusions are drawn and recommendations are made for policy makers and industry players in the Zambian sugar market.

6.2 SUMMARY OF THE STUDY

The study analysed price transmission and formation in the Zambia sugar value chain.
The study began with a review of the Zambian sugar value chain and domestic and international policies affecting the value chain. The study found that the sugar market in Zambia is highly concentrated with only three millers; one holding about 90 per cent of the market share. The sugarcane price is a negotiated price between sugarcane suppliers and millers , the wholesale and retail prices are determined by mark-up pricing by sugar producing companies and their wholesalers, retailers and agents... The domestic sugar price was found to be high despite the low costs of sugar production and it has been argued that the high price is a reflection of the high cost of doing business in Zambia (tax, energy, distribution, cane payments, wages among other cost). Sugar supply has been on the increase since the 1990s and this is primarily because of increased domestic production. The growing export sector is a major driver of increased sugar production and this is due in part to increased regional demand as well as opportunities in the EU trade regime where the quota for LDCs has been increased to 250000 tons .

Policies affecting the sugar market in Zambia include liberalisation policies pursued by Zambia in the 1990s. These include lowering of tariffs on most lines, reduction or abolishment of export fees and attracting FDI. Apolicy requiring all sugar in Zambia to be fortified with Vitamin A has been deemed a barrier to trade and investment. The sugar domestic price was found to be above the parity price and this remains the case even at varying FOB prices.

The study also conducted a review of price transmission, price spreads and price formation concepts. While there are many studies analysing all concepts, they have done so in isolation without establishing the link among the concepts. Supply and demand conditions in one market affects trade and therefore prices in other markets as equilibrium is restored through spatial arbitrage. Recent studies are increasingly focusing on equilibrium and integration, transaction and switiching regime price transmission combining price, trade and transaction costs.

The study conducted a spatial and verical price transmission analysis of the Zambian sugar market. The study found cointegration between world and domestic wholesale sugar prices, between wholesale and sugarcane prices and between retail and sugarcane prices. ECMs were build for the cointegrating relationships between wholesale and world prices and between wholesale and sugarcane prices. The price transmission results show that it takes a long time for a price shock in the world market to be transmitted to the domestic market due to the low speed of adjustment of -0.09. The short run elasticity of price transmission is -0.29 while the longrun elasticity is 0.91 implying a negative short-run response while in the long run there is a positive response though the adjustment is inelastic but closer to unitary elasticity. The simulation of price response shows that it takes about 36 months for prices to adjust to equilibrium. This is indicative of low integration between the two markets. The wholesale and sugarcane prices are more integrated as the the speed of adjustment is about 0.199and the simulation indicates that adjustment takes place within one and half year which is faster than the world to wholesale price transmission. The elasticity of price transmission is 0.009 which is inelastic while the long run elasticity is 0.944 which is inelastic but close to unitary elasticity. The low level of price transmission from the world to domestic is indicative of domestic and international distortions in the markets caused by policies, structure, transaction costs and actions of international players such as the EU. The vertical integration between sugarcane and wholesale prices is possibly a result of vertical co-ordination between sugarcane producers and millers. Despite the fixed sugarcane price, the wholesale and cane prices are fairly well integrated. Price spreads in Zambia have been rising and have been volatile and this has been driven by the market structure, policy, exchange rates and fuel prices.

The study finally built a partial equilibrium framework for the Zambian sugar market based on a number of behavioural equations and macroeconomic and climatic assumptions. A price model was estimated and the model was closed on trade as Zambia is a net exporter of sugar. The price

equation for the Zambian sugar market shows that the Zambia sugar domestic price depends on the real export parity price, sugar domestic use relative to production and policies (liberalisation and vitamin A fortification). Thus, Zambia's sugar price agrees with theory; it depends on the international price, domestic demand, supply and policy. The price model also estimates an elasticity of price transmission of 1.09 which is comparable to that found in the price transmission model (0.91).

The Zambian sugar market baseline up to 2015 was made which projects rising sugar production, increased domestic use, rising exports and domestic prices which rise in 2011, falling between 2013 and 2014 then rising in 2014 to 2015.

Further the analysis of the price space in the Zambian sugar market indicates that the sugar domestic price is trading closer to the import rather than the export parity price. This is a possible explaination for the low price transmission. Although the prices transmit from the world market to the domestic market with a unitary elasticity (Magnitude), the rate of transmission(speed) is low because the domestic price is much higher than the export parity price due in part to distortions in the market, high transaction costs structure and policy.

The market simulations for the Zambian sugar partial equilibrium model agrees with the price transmission simulations. Shocks in the world market take approximately 3 years to revert to equilibrium. In both simulations, there is a temporal fall in the price in response to an upward shock which may be a reflection of some distortions in the market.This is explained by interactions between price and lagged supply response dynamics. This is also observed in the price transmission equation between world and domestic prices where the short run elasticity is negative while the long run elasticity is positive.The simulation of lifting and /or modifying the barrier on imports increases the levels of imports previously at or close to zero. Imports rise by an average of 25,300 tons (3,403 %) due to lifting the barrier,production falls by domestic use is unchanged, exports rise by about 14,100 tons (6.1 %). Domestic sugar price falls by US Cents 25.1(22.9 %).The loss in production 3.2 per cent is offset by the gain in exports of 6.1 per cent.

The partial equilibrium analysis also shows that liberalisation of the sugar market and privatisation resulted in increased production and a lowered the sugar domestic price from The policy on Vitamin A which restricts imports has had a negative impact on liberalisation of the market as this has resulted in prices rising sharply in the domestic market following the legislation.

The study concludes that there is low integration in the sugar market both vertically and spatially resulting in an inefficient market. Vertically the market is more integrated and efficient than spatially possibly because of the nature of the market which is highly co-ordinated from cane production to processing and sale of prossessed sugar. High transaction costs, policy and a highly concentrated structure in the domestic market reduce both efficiency and integration spatially. Price formation in the Zambian market conforms to the theory that it should be determined by export parity price, demand and supply as well as policy. However, the domestic price far exceeds the export parity which signifies that there is a weak link between domestic price and world (prices) which translates in slow price adjustment found in the price transmission analysis.The major policies affecting the sugar market are at a macro level including high tax regime and high interest rates and import restrictions through the vitamin A fortification requirement presenting high investment cost which translate into a highly concentrated market structure. Liberalisation and privatisation resulted in lower sugar prices but this was reversed by the policy on sugar fortification.

6.3 RECOMMENDATIONS

The study make a number of key policy recommendations for policy makers and industry players in the sugar market in Zambia.

- The study has shown that there is low integration in the sugar market and that transmission and price formation are affected by high transaction costs. In this regard, transaction costs which include transportation costs, energy, taxation which are pushing the domestic price upwards need to be lowered. This will lower domestic sugar price as a resultant effect of a more efficient market where prices transmit both spatially and vertically.
- The study points to the market structure in the domestic sugar market as significant factor affecting efficiency and integration. High investment costs renders the market to be highly concentrated. There is need to promote investments in the sugar industry especially for smaller emerging sugar mills by lowering interest rates and taxes. This will result in a more competitive market structure for the Zambian sugar domestic market resulting in more efficiency and integration..Lower lending rates will allow smaller players in the industry to overcome investment barriers such as the cost of Vitamin A fortification.
- The sugar market structure results in an uncompetitive pricing mechanism resulting in an inefficient price formation process. There is need to strengthen competition governing the

industry which will protect consumers,would-be- investors and cane producers from uncompetitive pricing. As more players enter the sugar market, the oligopolistic structure will shift towards competition and price formation and transmission will become more efficient.

- The policy on Vitamin A should be lifted as it is stifling growth in the market and is a barrier to free sugar trade. The lifting of the barrier will result in lower domestic prices while domestic production will only fall slightly. As shown by the simulation model, Zambia will still benefit if the barrier is lifted because the loss in production of 3.2 per cent is lower than the gain in exports of 6.1 per cent. The world sugar price is projected to rise while the EU is offering a huge export quota for Zambia hence Zambia will gain more through exports such that even the fall in domestic price will be offset by the gains in exports.
- In order to achieve the same nutritional benefits of fortification, sugar imports can be allowed in raw form and the Vitamin A fortification can be done in Zambia.
- The study finds that liberalisation of the sugar market in the 1990s resulted in lower prices and increased out put. Increased openess increased both imports and exports. Currently the market is not so open. Apart from the policy on Vitamin A fortification, administrative barriers to trade are still high. in this regard administrative barriers in trade should be removed as this will result in free movement of sugar (both imports and export) and increase supplies to export markets regionally and internationally. As the market becomes more open it will become more intergrated and efficient.

6.3.1 Suggestions For Future Research

Further research is required to include more rigorous methods such as switching regime and switching error correction models.This will give more information regarding how price transmission and formation varies in various trade and policy regimes. This was beyond the scope of this study. There is also need to determine the welfare impact of price transmission and formation on consumers. There is need to determine how the changes in the international sugar trade regimes (liberalisation) affects or are likely to affect the sugar market in Zambiaand/or on the SADC region.

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APPENDIX 1: QUESTIONNAIRES

Appendix 1.1: Sugar Processing Company Questionnaire

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Natural and Agricultural Sciences

Department of Agricultural Economics and Rural Development

DISSERTATION: AGRICULTURAL ECONOMICS

SURVEY QUESTIONNAIRE
SUGAR PROCESSING COMPANY(SPC)

THE ZAMBIAN SUGAR VALUE CHAIN: A PRICE TRANSMISSION AND PRICE FORMATION ANALYSIS

Questionnaire no……..

Instructions:
Please tick (√) the most appropriate response or write the response in the spaces provided.

1 Name of Sugar Processing Company

1.1 How long has the company been in existence

Market Structure

2

Q2.1 **Please provide the following information on sugar production for the 2009/2010 season**

	Area Planted(Ha)	% of total	Cane harvested(tons)	% of total
Independent commercial farmers				
Independent small scale farmers				
Out grower/Contract commercial farmers				
Out grower/Contract small scale farmers				
TOTAL				

Q2.2 **Please provide the following information on the number of cane suppliers for the company in the 2009/2010 season**

	Number of cane suppliers	% of total suppliers
Independent commercial farmers		
Independent small scale farmers		
Out grower/Contract commercial farmers		
Out grower/Contract small scale farmers		
TOTAL		

Q2.3 **How much sugarcane was supplied to the company in the 2009/2010 season**

	Amount of cane supplied	% of total supplied
Own cane production		
Independent commercial farmers		
Independent small scale farmers		
Out grower/Contract commercial farmers		
Out grower/Contract small scale farmers		
TOTAL		

Q2.4 **Please provide the following information on the sugar processing company**

Annual turnover of the sugar company	
Market share of the sugar company	

Q2.5 **Please provide the following information on the sugar agents/wholesalers and retailers**

Number of agents/wholesalers for the company	
Average volumes of sugar traded by each	
Average wholesale price	
Number of main retailers	
Average volumes of sugar traded by each	
Average sugar retail price	

3 Costs of Production per ton of sugar(2009/2010)

3.1 Please provide the following information on the main inputs/costs in sugar processing

Inputs	Source: 1. own 2.Hired/outsourced 3.Imported 4.other specify	Quantities used/ton	Cost/ton
Cane			
Transport			
Machinery(depreciation)			
Fuel			
Electricity			
Seasonal labour			
Permanent Labour			
Other inputs			

3.2 Other costs

Taxes	
Insurance	

3.3 Please provide information on the sugar processing activities

Activities	Percentage(%) of total cost of production
Inbound & outbound transport logistics	
Cane crushing	
sugar Refining	
Vitamin A fortification	
Packaging	
Other activities	

4 Price Formation & Discovery

Sugarcane price

4.1 How is the price of sugarcane determined(provide formula if possible)
4.2 How is the division of proceeds determined?
4.3 How many farmers supplied sugarcane under a contract in the 2009/2010 season?
4.4 What is the length of the contract?
4.5 Is it legally binding?
4.6 What was the required sucrose percentage?
4.7 What was the average sucrose percentage achieved by most farmers?
4.8 What is the price paid to farmers with low sucrose percentage?
4.9 What was the sugarcane requirement(quota) allocated to each farmer?
4.1 What was the total sugarcane requirement by the company?
4.8 How much was supplied by the company's own cane production
4.9 How much was supplied by contracted farmers?
4.10. Is there a different price above the allocated quota(specify)?
4.11. Has the company been experiencing the problem of cross selling by contracted farmers?

Refined Sugar (Wholesale)

4.11 How is the price of sugar (sold to wholesalers)determined(provide formula if possible)?
4.12 Is there a legally binding contract between wholesalers and the company?
4.13 What is the lenth of the contract?
4.14 What is the commission/margin allowed on the wholesalers' price?
4.15 Does the company deliver the sugar to the wholesalers/agents? 1.Yes 2.No
4.16 What was the total sugar sold to wholesalers?
4.15 If yes to the above question, what is the average delivery cost per wholesaler
4.16 Are wholesalers/agents allowed to export sugar 1.Yes 2.No
4.17 If yes to the above question, what is the approximate sugar exported by wholesalers/agents?

Refined sugar(Retail)

4.18 Does the company sell sugar directly through retail outlets? 1.Yes 2.No
4.19 If yes to the above question, how many retail outlets does the company sells with directly?
4.2 Average sugar delivered per month/annually
4.21 Average floor space paid to retailers/month/annual
4.22 How is the sugar retail price determined?
4.23 What is the margin allowed for retailers
4.24 Are there retailers who buy sugar directly from the company
4.25 If yes to the above question, what is the approximate number of retailers buying directly?

Industrial

4.26 How much sugar was sold to industrial customers e.g. confectionery, beverage manufacturers ,etc?
4.27 What was the average price for the above mentioned sugar?

Export Markets

4.28 Please provide information on the total amount of sugar exported in for the past 20 years

	Total amount exported	SADC(Zimbabwe)	Congo DR	Great Lakes	EU(Northern Europe)
Refined sugar					
Raw sugar					
Centrifugal					

Export Markets

4.29 Please provide information on the total amount of sugar exported in for the past 20 years

	Total amount exported	SADC(Zimbabwe)	Congo DR	Great Lakes	EU(Northern Europe)
Refined sugar					
Raw sugar					
Centrifugal					

4.3 Please provide information on the EU quota allocated to Zambia for the past 20 years

4.31 Export Parity

Please provide information on the export parity 1996-2010

SADC (Zimbabwe)	
Road freight (Lusaka to Zimbabwe) border) Excise duty Export charges Road freight(Border to Harare) Insurance Loading and off-loading other charges Harare sugar price	
Congo DR	
Road freight (Lusaka to Congo border) Excise duty Export charges Road freight(Border to Lubumbashi) Insurance Loading and off-loading other charges Lubumbashi sugar price	
Great Lakes(Rwanda)	
Road freight (Lusaka to Rwanda) Excise duty Export charges Road freight(Border to Kigali) Insurance Loading and off-loading other charges Lubumbashi sugar price	
Northern Europe	
Road freight (Lusaka to RSA border) Export charges Road freight(Border to Durban) Sea freight to London Duty and taxes Insurance Loading and off-loading	
London sugar price	

Policies affecting sugar market and price

4.32 State domestic policies and how they are affecting the sugar market and price

4.33 What are the domestic taxes on sugar and how are they applied?

4.34 What are the effects of these taxes on the price of sugar?

4.35 State International policies and how they are affecting the sugar market and price

4.36 How does the law on fortification of sugar in Zambia affect the price

4.37 How does the law on fortification of sugar in Zambia affect the price

4.38 How does the change in the EU policy on sugar likely to affect the Zambian sugar market and price?

Appendix1.2: Sugarcane Producer/Farmers Questionnaire

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Natural and Agricultural Sciences

Department of Agricultural Economics and Rural Development

DISSERTATION: AGRICULTURAL ECONOMICS

SURVEY QUESTIONNAIRE

THE ZAMBIAN SUGAR VALUE CHAIN: A PRICE TRANSMISSION AND PRICE FORMATION ANALYSIS
SUGARCANE PRODUCER/FARMER

Questionnaire no……..

Instructions:
Please tick (√) the most appropriate response or write the response in the spaces provided

1 Background Information

Q1.1 Age.....

Q1.2 Level of education

1 Primary

2 Secondary

3 Tertiary

4 None

Q1.3 How long have you been producing sugarcane?.....

Q1.5 What category of farmers do you fall into

1 Independent commercial farmers

2 Independent medium scale farmer

3 Independent small scale farmer

4 Out grower/contract farmer(Commercial)

5 Out grower/contract farmer (medium)

Out grower/contract farmer(small scale)

6

2.0 Please provide the following estimates for production of cane and two other important crops 2008/09 and 2009/10 seons.

Sugarcane						
	Code	2008/2009	2009/2010			
Total Area Planted in Ha	*Q2.1.*					
Total sugarcane yield in ton	*Q2.2.*					
Total cane sold in ton	*Q2.3.*					
Price obtained per ton ZMK	*Q2.4.*					
Total Income ZMK	*Q2.4.*					
		Crop 1			**Crop2**	
	Code	2008/2009	2008/2009	***Code***	2008/2009	2009/2010
Total Area Planted in Ha	*Q2.10*			*Q2.15*		
Total sugarcane yield in ton	*Q2.11*			*Q2.16*		
Total crops sold in ton	*Q2.12*			*Q2.17*		
Price obtained per ton ZMK	*Q2.13*			*Q2.18*		
Total Income ZMK	*Q2.14*			*Q2.19*		

3.0 What other enterprises are you involved in apart from crop production

	Code	
Formal employment	*Q3.1*	
Livestock keeping	*Q3.3*	
Selling farm labour	*Q3.4*	
Business	*Q3.5*	
Bee keeping	*Q3.6*	
Charcoal burning	*Q3.7*	
other specify	*Q3.8*	

4.0 Please provide the following information on the main inputs used in sugar production

	Code	Source of Inputs	**Code**	Cost of Inputs ZMK
Cane cuttings	*Q4.1*		*Q4.11*	
Chemicals	*Q4.2*		*Q4.12*	
Protective clothing	*Q4.3*		*Q4.13*	
Spaying equipment	*Q4.4*		*Q4.14*	
Fertilizer	*Q4.5*		*Q4.15*	
Irrigation equipment	*Q4.6*		*Q4.16*	
Labour	*Q4.7*		*Q4.17*	
Land	*Q4.8*		*Q4.18*	
Transport	*Q4.9*		*Q4.19*	
other inputs	*Q4.10*		*Q4.20*	

Response codes for source of inputs:

1. Private input supplier
2. Sugar processing company
3. Government
4. Co-operative
5. Farmer organisation
6. Micro financing institution
7. Gift from relatives/friends
8. Other specify

5.0 Did you obtain any of the above mentioned inputs through a loan or contract?
1. Yes 2.No

6.0 If response is yes to previous question, please provide the following information concerning the loan or contract:

	Code	Source of loan/contract	**Code**	Loan amount obtained in ZMK	Code	Interest rate
Cane cuttings	Q6.1		Q6.11		Q6.21	
Chemicals	Q6.2		Q6.12		Q6.22	
Protective clothing	Q6.3		Q6.13		Q6.23	
Spaying equipment	Q6.4		Q6.14		Q6.24	
Fertilizer	Q6.5		Q6.15		Q6.25	
Irrigation equipment	Q6.6		Q6.16		Q6.26	
Labour	Q6.7		Q6.17		Q6.27	
Land	Q6.8		Q6.18		Q6.28	
Transport	Q6.9		Q6.19		Q6.29	
other inputs	Q6.10		Q6.20		Q6.30	

Response codes for source of loan/contract agreement:

1. Sugar processing company
2. Government
3. Micro financing institution
4. Commercial bank
5. Farmer organisation
6. other specify

7.0 If you obtained any loan or had a contract, what were the terms of repayment of the loan?

1 Deducted from the payment for the cane by the sugar company
2 Paid in cash
3 Paid through produce
4 Paid through labour
5 Other

8.0 Please provide the following information on labour requirements in sugar production in 2009/10

	Code	No. Of Man days	**Code**	Cost per man day
Land preparation	Q8.1		Q8.10	
Planting	Q8.2		Q8.11	
Chemical application	Q8.3		Q8.12	
Fertilizer application	Q8.4		Q8.13	
Irrigation	Q8.5		Q8.14	
Fertilizer	Q8.6		Q8.15	
Harvesting	Q8.7		Q8.16	
Loading and offloading	Q8.8		Q8.17	
Other	Q8.9		Q5.18	

9.0 How do you transport the cane from your farm to the processor gate?
1. Hired transport
2. Own transport
3. Through Sugar processing company
4. Through Co-operative
5. Producer organisation
4. Through Association
5. Through Friend/Relative
6. Other
9.0 What was the cost of transporting the cane from your farm to the processors' Gate?
12. Do you have a contract with the sugar processing company?
1.Yes
2.No
13.Please provide the following information regarding the contract:
Q13.1 Length of the contract
Q13.2 Is it legally binding? 1.Yes 2.No
Q13.3 What was the quota allocated to each farmer to supply in 2009/10?
Q13.4 Did you meet the quota in the 2009/10 season
1.Yes 2.No
Q13.5 If no to qn 12.4 what was the reason for the deficit?
Q13.6 Did you produce cane above the quota?1.Yes 2.No
Q13.7 What did you do with the cane above the quota?

Q13.8 What was the required sucrose percentage?
Q13.9 What was your average sucrose percentage?
14 Price Discovery
Q14.1 How long does it take you to discover when there is a price change
Q14.2 Are you always aware of the sugar processor gate price?
Q14.3 Are you always aware of the sugar wholesale price?
Q14.4 Are you always aware of the sugar retail price?
Q14.5 Are you always aware of the sugar retail price?

Appendix 1.3: Sugar Retailers/Wholesalers Questionnaire

UNIVERSITEIT VAN PRETORIA
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Faculty of Natural and Agricultural Sciences

Department of Agricultural Economics and Rural Development

DISSERTATION: AGRICULTURAL ECONOMICS

SURVEY QUESTIONNAIRE
SUGAR RETAILERS/WHOLESALERS

THE ZAMBIAN SUGAR VALUE CHAIN: A PRICE TRANSMISSION AND PRICE FORMATION ANALYSIS

Questionnaire no……..

Instructions:
Please tick (√) the most appropriate response or write the response in the spaces provided.

1.1 Describe your role in the sugar market?

1 Retailer

2 Wholesaler
Both retailer and wholesaler

3

1.2 Please provide information on the costs/prices associated with wholesaling/retailing

Purchase price of sugar ZMK/Kg	
Transport costs per tons	
Loading and offloading	
Selling costs	
Taxes	
other costs	
Margins	
Retail/Wholesale price ZMK/Kg	

1.3 How do you determine your retail/wholesale price of sugar?

1.4 Do you have a contract with the sugar processing company? 1.Yes 2.No

1.5 If yes to the above question, please supply us with the following information?

1.5.1 Length of the contract

1.5.2 Is it legally binding? 1.Yes 2.No

1.5.3 What is the commission/margin given by SPC?

1.5.4 Did you sell all the sugar supplied by the company this year 1.Yes 2.No

1.5.5 If no to the above question, what was amount of the remaining stock?

APPENDIX 2: DOMESTIC AND EXPORT MARKET VALUE CHAIN COMPONENTS

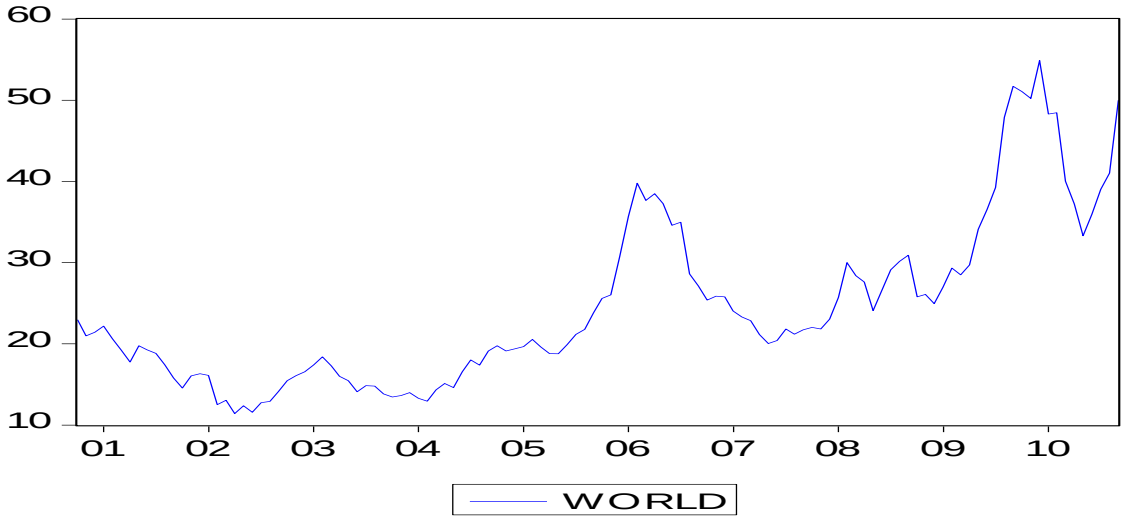
DOMESTIC VALUE CHAIN COMPONENTS

Item	Year					
	2005	2006	2007	2008	2009	2010
	US Cents/Kg					
Farm value	30.2	49.7	34.8	37.4	31	42.5
Processing & refining Spread	28.2	28.6	27.3	34.1	36.1	33.4
Transport, handling, wholesale & retail spread	16.4	19.4	21.1	28.5	15.3	20.4
Retail Value	74.9	97.8	83.2	100	82.4	96.3

EXPORT MARKET VALUE CHAIN COMPONENTS

Item	Year					
	2005	2006	2007	2008	2009	2010
	US Cents/Kg					
Domestic wholesale price	58.4	78.4	62.2	71.5	66.3	96.2
World Sugar Price	29.1	41.9	30.9	35.2	48.8	61.2
Freight Rate (Lusaka-Durban)	5.9	8.5	6.2	7.1	9.9	12.4
Freight Rate (Durban-Northern Europe))	3.2	4.6	3.4	3.8	5.3	6.7
Insurance 0.3%	0.9	1.3	0.9	1.1	1.5	1.8
Export Parity Price	19.2	27.6	20.3	23.2	32.2	40.4

APPENDIX 3: GRAPHS AND CORRELOGRAMS FOR PRICE SERIES

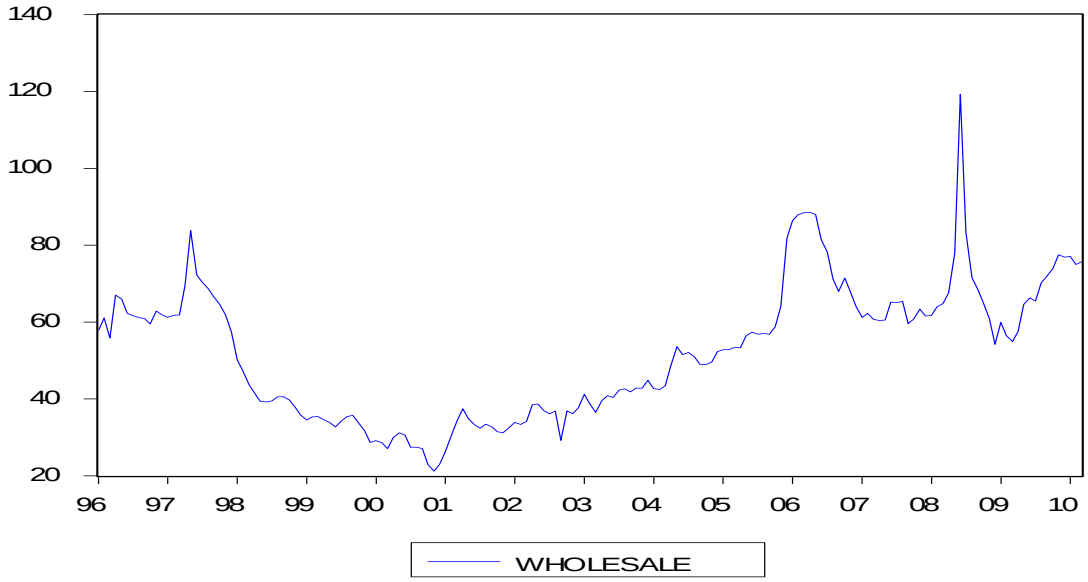


Date: 10/19/10 Time: 02:02
Sample: 2000:10 2010:09
Included observations: 120

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*******|	.|*******|	1	0.946	0.946	110.02	0.000
.|*******|	.|. |	2	0.897	0.022	209.74	0.000
.|****** |	*|. |	3	0.836	-0.131	297.20	0.000
.|****** |	.|. |	4	0.781	0.005	374.11	0.000
.|****** |	.|. |	5	0.730	0.031	441.97	0.000
.|***** |	*|. |	6	0.676	-0.069	500.62	0.000
.|***** |	.|. |	7	0.624	-0.026	551.00	0.000
.|**** |	*|. |	8	0.558	-0.144	591.75	0.000
.|**** |	.|* |	9	0.511	0.123	626.21	0.000
.|**** |	.|. |	10	0.459	-0.048	654.25	0.000
.|*** |	.|* |	11	0.422	0.074	678.20	0.000
.|*** |	.|. |	12	0.385	-0.019	698.31	0.000
.|*** |	*|. |	13	0.343	-0.084	714.38	0.000
.|** |	.|. |	14	0.302	-0.020	727.00	0.000
.|** |	.|* |	15	0.278	0.177	737.82	0.000
.|** |	.|. |	16	0.257	-0.040	747.13	0.000
.|** |	.|. |	17	0.240	0.013	755.34	0.000
.|** |	.|. |	18	0.227	-0.012	762.70	0.000

Based on the graph and correlogram which exhibits an ACF which converges rather slowly towards zero, it appears that world prices are non-stationary. The ADF tests further confirm that world prices are non-stationary until they are differenced once that is, I (1).

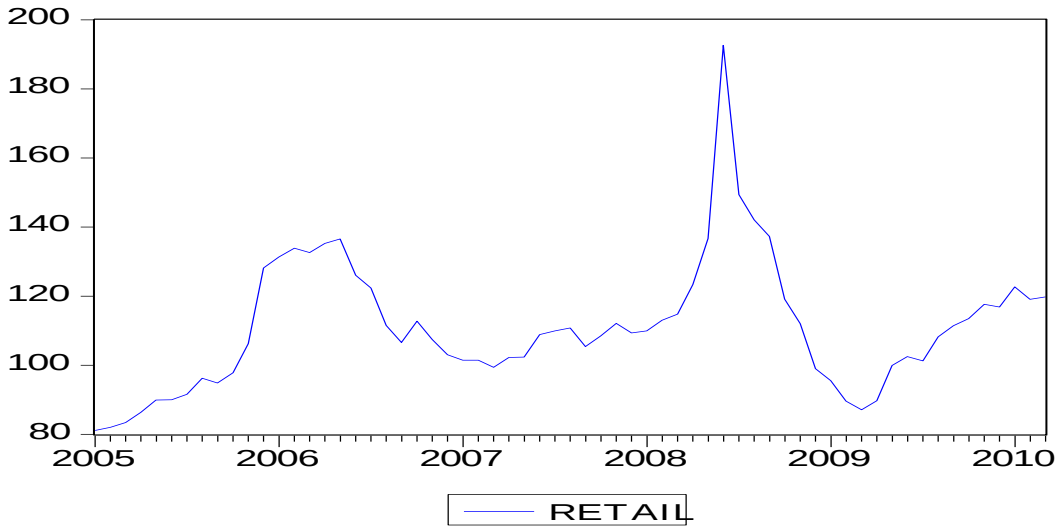
Wholesale Price series



Date: 05/08/11 Time: 20:28
Sample: 1996:01 2010:03
Included observations: 171

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*******|	.|*******|	1	0.943	0.943	154.90	0.000
.|*******|	.|. |	2	0.892	0.020	294.27	0.000
.|*******|	.|. |	3	0.850	0.052	421.37	0.000
.|****** |	.|. |	4	0.805	-0.037	536.06	0.000
.|****** |	.|. |	5	0.758	-0.039	638.35	0.000
.|****** |	.|. |	6	0.717	0.023	730.41	0.000
.|***** |	.|* |	7	0.689	0.102	816.01	0.000
.|***** |	*|. |	8	0.654	-0.063	893.69	0.000
.|***** |	.|* |	9	0.630	0.089	966.24	0.000
.|***** |	.|* |	10	0.619	0.098	1036.7	0.000
.|***** |	.|. |	11	0.609	0.027	1105.2	0.000
.|***** |	.|. |	12	0.598	0.017	1171.8	0.000
.|**** |	*|. |	13	0.580	-0.071	1234.8	0.000
.|**** |	.|. |	14	0.567	0.026	1295.3	0.000
.|**** |	.|. |	15	0.555	0.038	1353.7	0.000
.|**** |	.|. |	16	0.545	0.034	1410.4	0.000
.|**** |	.|. |	17	0.531	-0.032	1464.5	0.000
.|**** |	.|. |	18	0.516	0.007	1516.0	0.000

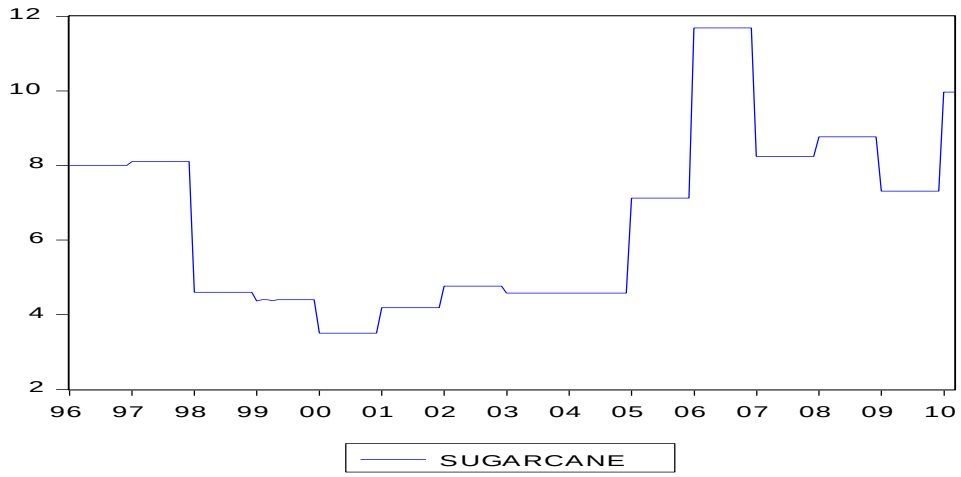
Retail Price Series



Date: 02/22/11 Time: 23:21
Sample: 2005:01 2010:03
Included observations: 63

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |****** |	. |****** |	1	0.813	0.813	43.687	0.000
. |***** |	. | . |	2	0.646	-0.046	71.682	0.000
. |*** |	.*| . |	3	0.457	-0.162	85.938	0.000
. |** |	**| . |	4	0.248	-0.198	90.191	0.000
. | . |	.*| . |	5	0.060	-0.106	90.441	0.000
.*| . |	.*| . |	6	-0.122	-0.144	91.502	0.000
**| . |	. | . |	7	-0.245	-0.015	95.875	0.000
***| . |	.*| . |	8	-0.349	-0.105	104.92	0.000
***| . |	.*| . |	9	-0.413	-0.068	117.88	0.000
***| . |	. | . |	10	-0.422	-0.004	131.67	0.000
***| . |	. | . |	11	-0.404	-0.031	144.49	0.000
***| . |	. | . |	12	-0.358	-0.041	154.77	0.000
***| . |	.*| . |	13	-0.321	-0.121	163.21	0.000
**| . |	. | . |	14	-0.248	0.012	168.34	0.000
.*| . |	.*| . |	15	-0.188	-0.079	171.37	0.000
.*| . |	. | . |	16	-0.114	0.015	172.51	0.000

Sugarcane Price



Date: 05/08/11 Time: 20:42
Sample: 1996:01 2010:03
Included observations: 171

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*******|	.|*******|	1	0.958	0.958	159.77	0.000
.|*******|	.|. |	2	0.916	-0.021	306.76	0.000
.|*******|	.|. |	3	0.875	-0.022	441.45	0.000
.|****** |	.|* |	4	0.843	0.100	567.27	0.000
.|****** |	.|. |	5	0.811	-0.018	684.49	0.000
.|****** |	.|. |	6	0.779	-0.018	793.36	0.000
.|****** |	.|. |	7	0.747	-0.004	894.15	0.000
.|****** |	.|. |	8	0.716	-0.018	987.12	0.000
.|***** |	.|. |	9	0.684	-0.018	1072.5	0.000
.|***** |	.|. |	10	0.652	-0.017	1150.7	0.000
.|***** |	.|. |	11	0.620	-0.019	1221.9	0.000
.|**** |	.|. |	12	0.589	-0.019	1286.4	0.000
.|**** |	.|* |	13	0.568	0.115	1346.7	0.000
.|**** |	.|. |	14	0.547	-0.014	1403.1	0.000
.|**** |	.|. |	15	0.526	-0.016	1455.6	0.000
.|**** |	.|. |	16	0.500	-0.053	1503.4	0.000
.|**** |	.|. |	17	0.474	-0.016	1546.5	0.000
.|*** |	.|. |	18	0.447	-0.018	1585.2	0.000

APPENDIX 4: LONG RUN /COINTEGRATING RELATIONSHIPS, ECMS AND TEST FOR ASYMMETRY

Long run relationship between world and domestic wholesale prices

Dependent Variable: WHOLESALE
Method: Least Squares
Date: 05/15/11 Time: 00:21
Sample: 1996:01 2010:03
Included observations: 171

Variable	Coefficient	Std. Error	t-Statistic	Prob.
WORLD	1.284611	0.087032	14.76021	0.0000
C	13.33006	2.778573	4.797449	0.0000

R-squared	0.563154	Mean dependent var	52.21854
Adjusted R-squared	0.560569	S.D. dependent var	17.40988
S.E. of regression	11.54094	Akaike info criterion	7.741306
Sum squared resid	22509.68	Schwarz criterion	7.778050
Log likelihood	-659.8817	F-statistic	217.8637
Durbin-Watson stat	0.265572	Prob(F-statistic)	0.000000

Long run relationship between retail and world prices

Dependent Variable: RETAIL
Method: Least Squares
Date: 05/15/11 Time: 01:05
Sample: 1996:01 2010:03
Included observations: 171

Variable	Coefficient	Std. Error	t-Statistic	Prob.
WORLD	1.560391	0.110306	14.14605	0.0000
C	18.93827	3.521606	5.377736	0.0000

R-squared	0.542143	Mean dependent var	66.17531
Adjusted R-squared	0.539434	S.D. dependent var	21.55332
S.E. of regression	14.62717	Akaike info criterion	8.215266
Sum squared resid	36158.24	Schwarz criterion	8.252010
Log likelihood	-700.4052	F-statistic	200.1108
Durbin-Watson stat	0.199412	Prob(F-statistic)	0.000000

Long run relationship between sugarcane and wholesale prices

Dependent Variable: SUGARCANE
Method: Least Squares
Date: 05/15/11 Time: 02:02
Sample: 1996:01 2010:03
Included observations: 171

Variable	Coefficient	Std. Error	t-Statistic	Prob.
WORLD	0.163423	0.012321	13.26336	0.0000
C	1.530884	0.393370	3.891713	0.0001

R-squared	0.510027	Mean dependent var	6.478112
Adjusted R-squared	0.507127	S.D. dependent var	2.327308
S.E. of regression	1.633884	Akaike info criterion	3.831424
Sum squared resid	451.1583	Schwarz criterion	3.868168
Log likelihood	-325.5867	F-statistic	175.9167

Durbin-Watson stat	0.162189	Prob(F-statistic)	0.000000

World and Wholesale ECM

Dependent Variable: D(WHOLESALE)
Method: Least Squares
Date: 05/15/11 Time: 18:43
Sample(adjusted): 1996:03 2010:03
Included observations: 169 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECT	-0.092575	0.038379	-2.412134	0.0170
D(WHOLESALE(-1))	0.016607	0.080638	0.205946	0.8371
D(WORLD(-1))	-0.293556	0.217529	-1.349505	0.1790
C	1.382845	0.669735	2.064766	0.0405

R-squared	0.043194	Mean dependent var	0.086903
Adjusted R-squared	0.025797	S.D. dependent var	5.580364
S.E. of regression	5.507915	Akaike info criterion	6.273633
Sum squared resid	5005.625	Schwarz criterion	6.347714
Log likelihood	-526.1220	F-statistic	2.482909
Durbin-Watson stat	1.976168	Prob(F-statistic)	0.062718

Wholesale and Sugarcane ECM

Dependent Variable: D(SUGARCANE)
Method: Least Squares
Date: 05/16/11 Time: 15:40
Sample(adjusted): 1996:03 2010:03
Included observations: 169 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID_CA_WH(-1)	-0.198271	0.044173	-4.488525	0.0000
D(SUGARCANE(-1))	0.035275	0.072961	0.483475	0.6294
D(WHOLESALE(-1))	0.008759	0.008620	1.016072	0.3111
C	0.008474	0.043560	0.194541	0.8460

R-squared	0.154168	Mean dependent var	0.011626
Adjusted R-squared	0.138789	S.D. dependent var	0.610003
S.E. of regression	0.566092	Akaike info criterion	1.723262
Sum squared resid	52.87585	Schwarz criterion	1.797343
Log likelihood	-141.6157	F-statistic	10.02473
Durbin-Watson stat	2.007448	Prob(F-statistic)	0.000004

Test for symmetry in price transmission between wholesale and world prices

Dependent Variable: D(WHOLESALE)
Method: Least Squares
Date: 11/05/11 Time: 06:01
Sample: 1996:03 2010:03
Included observations: 169

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DWORLD*DPLUS	-0.537060	0.293175	-1.831876	0.0688
DWORLD*DMINUS	0.305026	0.320104	0.952895	0.3420
ECT(-1)*ECTPLUS	-0.159998	0.064115	-2.495472	0.0136
ECT(-1)*ECTMINUS	0.023817	0.075684	0.314691	0.7534
C	1.119447	0.651023	1.719521	0.0874

R-squared	0.074205	Mean dependent var	0.086923

Adjusted R-squared	0.051624	S.D. dependent var	5.595144
S.E. of regression	5.448808	Akaike info criterion	6.257810
Sum squared resid	4869.079	Schwarz criterion	6.350411
Log likelihood	-523.7850	F-statistic	3.286244
Durbin-Watson stat	2.144923	Prob(F-statistic)	0.012722

Test for symmetry in price transmission between sugarcane and wholesale prices

Dependent Variable: D(SUGARCANE)
Method: Least Squares
Date: 05/18/11 Time: 23:24
Sample(adjusted): 1996:03 2010:03
Included observations: 169 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(WHOLESALE(-1))*DPLUSWH	0.002578	0.014753	0.174751	0.8615
D(WHOLESALE(-1))*DMINUSWH	0.017159	0.013753	1.247629	0.2139
ECT_CA_WH*ECTDCA_WHPLUS	-0.202211	0.071901	-2.812377	0.0055
ECT_CA_WH*ECTDCA_WHOMINUS	-0.207269	0.085675	-2.419255	0.0166
C	0.027620	0.060107	0.459510	0.6465

R-squared	0.156034	Mean dependent var	0.011626
Adjusted R-squared	0.135449	S.D. dependent var	0.610003
S.E. of regression	0.567188	Akaike info criterion	1.732888
Sum squared resid	52.75919	Schwarz criterion	1.825489
Log likelihood	-141.4290	F-statistic	7.580156
Durbin-Watson stat	1.946231	Prob(F-statistic)	0.000013