

Aus dem Institut für Ernährung und Verbrauchslehre der Christian-Albrechts-  
Universität zu Kiel

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**Effects of Policy Reforms on Price Transmission and Price Volatility  
in Coffee Markets: Evidence from Zambia and Tanzania**

Dissertation zur Erlangung des Doktorgrades Agrar-und  
Ernährungswissenschaftliche Fakultät der Christian-Albrechts-Universität zu Kiel

Vorgelegt von  
MSBS. Rhoda Mofya-Mukuka  
Aus Kasama, Zambia

Kiel, May 2011

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Dekan: Prof. Dr. Uwe Latacz-Lohmann

1. Bericht: Prof. Dr. Awudu Abdulai

2. Bericht: Prof. Dr. Dr. Christian Henning

Tag der Mündlichen Prüfung: 14.07.2011

Gedruckt mit Genehmigung der  
Agra-und Ernährungswissenschaftlichen Fakultät der  
Christian-Albrechts-Universität zu Kiel

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*This Thesis is dedicated*

*to God almighty, the one who makes all things possible*

*and*

*to my late parents Mr and Mrs Mofya in their loving memory*

## Acknowledgements

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I owe my deepest gratitude to my Supervisor, Professor Awudu Abdulai, Chair of the Institute of Food Economics and Consumption Studies of the Christian-Albrechts University Kiel, for his guidance and support throughout the program. Although I remain responsible for any shortcoming in this study, this thesis would not have been possible without his valuable ideas and encouragement that made me understand the subject, dig deeper into my research and remained motivated.

The financial support, provided by the *Katholischer Akademischer Ausländer-Dienst* (KAAD) is greatly acknowledged. In particular, I thank Dr Marko Kuhn, head of the African Department at KAAD and Mrs Simone Saure who were always ready to attend to my needs. I also thank Mrs Sabina Kamp, the chaplain for Catholic Students at Kiel University for supporting my application to KAAD.

The support of Dr Kassi, Dr Becerril, Dr Ali and Dr Ogundari, to whom I always ran to for questions, is highly acknowledged. I also thank my colleagues Kai-Brit, Rakhshanda, Rebecca, Christian, Jan, Daniela and Dr Thiele for a beautiful and friendly working environment. Special thanks to Kai-Brit for the German version of the summary of this thesis. I also thank the amicable secretary at the institute, Mrs Nicola Benecke.

The unique mentoring program of the African Women in Agricultural Research and Development (AWARD) made me realize my career goals contributing to the success of this thesis. I am grateful to AWARD for accepting me as their fellow from 2009 to 2011. I especially thank Dr Aslihan Arslan, my AWARD mentor for the monthly meetings and for taking her time to read through this thesis. In Zambia, I acknowledge the staff at Zambia Coffee Growers Association, Zambia Coffee Board and the Ministry of Agriculture for providing me with all the information I needed.

Lastly, I offer my heartwarming acknowledgement, love and blessings to my husband John and my children Chewe, Kasongo and Andela for their love and patience. I also thank my siblings, the Mofyas, for the encouragement, support and prayers. Great appreciation also goes to the Pfeiffer family of Kronshagen for the great hospitality and for their endless prayers. May God continue blessing you.

## Table of Content

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Dedication	ii
Acknowledgement	iii
Table of Content	vi
List of Tables	vii
List of Figures	viii
Summary	ix
Zusammenfassung	xi
List of Acronomy	xiv
<b>Chapter 1: General Introduction.....</b>	<b>1</b>
1.1 Problem Setting and Motivation .....	1
1.2 Objectives of the Study .....	5
1.3 Significance of the Study.....	6
1.4 Hypotheses .....	7
1.5 Data Sources .....	7
1.6 Coffee Production in Tanzania and Zambia- an Overview .....	8
1.7 Organization of the Thesis.....	11
<b>Chapter 2: Policy Reforms and Governance Structures in Coffee Value Chains: A study of Zambia and Tanzania.....</b>	<b>16</b>
Abstract.....	16
2.1 Introduction .....	17
2.2 Background Information on Value Chain Analysis and Governance .....	20
2.2.1 The Value Chain Theory .....	20
2.2.2 Theory of Governance in Value Chains .....	21
2.2.3 Theory of Income Distribution in Value Chain .....	24
2.3 Coffee International Markets .....	25
2.3.1 The International Coffee Value Chain .....	27
2.3.2 Governance in International Coffee Value Chains .....	29
2.4 Tanzania Coffee Value Chains .....	30
2.4.1 On-farm Processing .....	30
2.4.2 Coffee Cooperatives .....	31
2.4.3 Exporting Stage.....	32

2.4.4 Governance Structures and Price Shares .....	33
2.4.5 Tanzania Fair Trade Coffee .....	34
2.5 Zambia Coffee Value Chains .....	35
2.6 Discussion and Conclusion .....	38
2.7 Policy Recommendations.....	40

**Chapter 3: Asymmetric Price Transmission in Coffee Markets: Impacts of Economic Reforms for Zambia and Tanzania .....** **46**

Abstract.....	46
3.1 Introduction .....	47
3.2 Modelling Asymmetric Price Transmission.....	50
3.3 Data Description.....	56
3.4 Results and Discussion.....	58
3.4.1 Unit Root Tests .....	58
3.4.2 Results of the Symmetric Cointegration Model .....	60
3.4.3 Threshold Cointegration Results.....	61
3.4.4 Impulses Response.....	67
3.5 Conclusion .....	71

**Chapter 4: Impact of Economic Reforms on Coffee Price Volatility in Zambia and Tanzania.....** **79**

Abstract.....	79
4.1 Introduction .....	80
4.2 Economic Reforms and Coffee Markets in Tanzania and Zambia .....	84
4.3 Theoretical Framework for Understanding Commodity Price Volatility.....	85
4.4 GARCH Model Estimation Procedure .....	90
4.5 Data Description.....	91
4.6 Results .....	93
4.7 Conclusion .....	100

**Chapter 5: Response of Coffee Supply in Zambia: Implications for Policy ....** **105**

Abstract.....	105
5.1 Introduction .....	106
5.2 Theoretical Framework .....	109

5.3 Model Estimation.....	114
5.4 Data Description.....	117
5.4.1 Rationale for Variable Selection.....	119
5.5 Results.....	121
5.5.1 Symmetric Cointegration and Error Correction Results.....	122
5.5.2 Asymmetric Cointegration and Error Correction Results.....	126
<b>Chapter 6: Conclusion .....</b>	<b>134</b>
6.1 Study Focus .....	134
6.2 Summary of Results.....	135
6.3 Policy Implications.....	137
<b>APPENDICES .....</b>	<b>141</b>
Appendix A: Structural Break Unit Root Test Theory .....	141
Appendix B: Threshold Vector Error Correction Results .....	143
Appendix C: Coffee Processing Stages.....	149
Appendix D: Curriculum Vitae .....	148

## List of Tables

---

Table 3.1: Unit Root Test Results .....	59
Table 3.2: Results of Engle-Granger Cointegration .....	60
Table 3.3 Threshold Autoregression Results.....	62
Figure 3.4 TAR Error Correction Model results .....	63
Table 3.5: Results of ECM for MTAR.....	64
Table 3.6: Results of ECM for MTAR.....	66
Table 4.1: Descriptive statistics for the series.....	93
Table 4.2: Unit Root Tests.....	94
Table 4.3: ARCH test results.....	96
Table 4.4: Volatility Estimates of GARCH and TGARCH Models.....	98
Table 5.1: Unit Root Tests for Supply Response Variables.....	122
Table 5.2: Johansen Cointegration Test.....	124
Table 5.3: Symmetric Error Correction Estimates.....	125
Table 5.4: Error Correction Estimation above the Threshold.....	128
Table 5.5: Error Correction Estimation below the Threshold.....	128
Table B1: Asymmetric Error Correction Estimations for Zambia and World Prices (Full sample).....	143
Table B2: Asymmetric Error Correction Estimations for Tanzania and World Prices (Full sample).....	144
Table B3: Asymmetric Error Correction Estimation for Supply Response below the Threshold.....	145



## List of Figures

---

Figure 1.1: Tanzania Coffee Production Export and Value	3
Figure 1.2: Coffee Production, Exports and Value for Zambia	3
Figure 2.1: Arabica and Robusta Coffee Prices (1980 to 2009)	25
Figure 2.2: Producer and Retail Coffee Prices in US\$ cents per pound	28
Figure 2.3: Coffee Value Chain in Tanzanian and Zambia	36
Figure 3.1 A Threshold of 0.04 Identified from the Minimum RSS	55
Figure 3.2 Zambia and CIP price trends	57
Figure 3.3 Tanzania and CIP price trends	57
Figure 3.4 Response of Positive and Negative Shocks for Zambia- Full Sample	68
Figure 3.5 Response of Positive and Negative Shocks for Zambia Post- Economic Reforms	68
Figure 3.6 Response of Positive and Negative Shocks for Tanzania- Full Sample	69
Figure 3.7 Response of Positive and Negative Shocks for Tanzania before Economic Reforms	70
Figure 4.1: Steps in Modelling Volatility	90
Figure 4.2: Coffee Prices for Zambia and Tanzania in US\$/ per Lb	91
Figure 4.3: Return Price Series for Zambia and Tanzania	92
Figure 4.4: Autocorrelations of Price Returns	95
Figure 4.5: Volatility of Zambia and Tanzania prices Compared to World prices	99
Figure 5.1: Coffee Production in Zambia	107
Figure 5.2: Supply Response variables	118
Figure 5.3 Zambia Annual Inflation Rate (2003-2011)	121
Appendix C: Coffee Processing Stages	150

## Summary

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Price is the most critical factor in determining the way markets function. In a perfect market a price shock is transmitted to other vertically or horizontally connected markets within a given period of time. However, when markets do not function perfectly the speed and the magnitude of price transmission may be hampered. State controlled agricultural commodity markets prevent efficient price transmission, as a result, producer prices cannot not reflect world prices. Many developing countries have implemented measures to improve price transmission through agricultural market liberalisation policies and providing incentives for farmers. However, instead of prices being transmitted symmetrically, monopoly or oligopoly markets, government policies and high transaction costs may lead to asymmetric price transmission. The lead firms in commodity value chains tend to become reluctant to pass on prices that squeeze their margins. As a result, producers may not benefit from consumer price increases and similarly, consumers may not benefit from producer price decreases.

This study takes a look at these issues in the analysis of coffee producer prices for Zambia and Tanzania. Coffee is an important export commodity in both of these countries and contributes significantly to the creation of foreign exchange and employment even if the total production is relatively low. Both countries have liberalised their coffee markets during the economic reforms of the late 1990s to differing extents. The effects of these reforms on coffee price transmission, price volatility and on coffee supply response are examined in this study.

This dissertation consists of four papers that investigate various aspects of coffee markets for Zambia and Tanzania. First, the study investigates coffee value chains in both countries, paying attention to the governance structure and its implications for producer prices. Second, price transmission between coffee world prices and producers' prices in Tanzania and Zambia is examined. The third paper examines price volatility in both countries and assesses the impacts of trade liberalisation policies on price volatility. The fourth paper analyses coffee supply response to coffee prices in Zambia.

Results for Zambia indicate improved price transmission after the implementation of economic reforms. As expected, the transmission is asymmetric where price decreases are passed on quicker than price increases. In the case of Tanzania, results do not show any improvements after the economic reforms. Similar results are obtained from the volatility study where economic reforms led to an increase in coffee price volatility in Zambia, with negative shocks inducing more volatile prices than positive shocks. However, in Tanzania the inconsistent market reforms have had no significant effects on coffee price volatility. The study of coffee supply response for Zambia shows that in the long-run, coffee prices have negative although insignificant impacts on supply. This could be related to the fact that as a perennial crop supply tends to reach the market when prices are on the decline. However, in the short-run, coffee supply response changes are only significant for price decreases, indicating that coffee supply falls faster than it rises with respect to price changes. On the other hand, supply responds negatively to a stronger local currency and to price of maize, the main competing crop. However, the 1990s economic reforms in Zambia have had positive effect on coffee supply.

These findings have important policy implications as they reveal a short and efficient value chain and governance structure that enables the producers to receive larger shares of the final coffee price. In addition, the results discuss favourable policies for improving transmission from world markets to producer prices over the post economic reform period although the transmission remains asymmetric. An efficient price transmission may work to the disadvantage of the growers in the short-run as prices become exposed to volatile world prices, but in the long-run, it may yield the desired outcome. The findings also show the importance of a liberalised currency for increased coffee supply.

## Zusammenfassung

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Der Preis ist der entscheidendste Einflussfaktor, wenn es darum geht zu verstehen, wie Märkte funktionieren. Handelt es sich um eine perfekte Marktsituation, so wird ein Preisschock eines Marktes innerhalb einer gegebenen Zeitspanne auf andere vertikal oder horizontal miteinander verbundene Märkte übertragen. Wenn Märkte jedoch nicht perfekt funktionieren, kann die Geschwindigkeit und das Ausmaß von Preistransmission behindert werden. Agrarmärkte, die staatlich kontrolliert werden, können Preistransmission zum Teil vorbeugen, was dazu führt, dass die Produzentenpreise nicht den Weltpreisen entsprechen. Viele Entwicklungsländer haben darum Maßstäbe eingeführt, um die Preistransmission zu verbessern, indem Agrarmärkte liberalisiert und Anreize für die Landwirte geschaffen werden. Nichtsdestotrotz führen zu einem Monopole und Oligopole in der Wertschöpfungskette, zum anderen hohe Transaktionskosten zu einer asymmetrischen anstatt zu einer symmetrischen Preistransmission. Die führenden Firmen in der Wertschöpfungskette tendieren dazu, nur widerwillig die Preise zu überliefern, die ihre Gewinnspanne in die Enge treiben. Demzufolge können weder die Produzenten von den steigenden Konsumentenpreisen, noch die Konsumenten von den reduzierten Produzentenpreisen profitieren.

Diese Studie behandelt diese Thematik, indem die Produzentenpreise von Kaffee in Sambia und Tansania untersucht werden. Kaffee stellt ein wichtiges Exportprodukt in diesen beiden Ländern dar und trägt signifikant dazu bei, dass es Fremdwährung und Arbeitsplätze gibt, auch wenn die gesamte Kaffeeproduktion in diesen Ländern relativ niedrig ist. In beiden Ländern fand eine unterschiedlich stark ausgeprägte Liberalisierung der Kaffeemärkte im Zuge der ökonomischen Reformen in den späten 90er Jahren statt. In dieser Studie werden die Auswirkungen dieser Reformen auf die Preistransmission bei Kaffee, die Preisvolatilität und die Angebotsentwicklung von Kaffee untersucht.

Diese Doktorarbeit besteht aus vier Teilen, die verschiedene Aspekte der Märkte für Kaffee in Sambia und Tansania behandeln. Zuerst wird die Wertschöpfungskette von Kaffee in den beiden Ländern genauer betrachtet. Dabei wird insbesondere ein Auge

auf die jeweilige Regierungsstruktur geworfen und es werden die daraus resultierenden Auswirkungen hinsichtlich der Produzentenpreise erörtert. Als nächstes wird die Preistransmission von den Weltpreisen zu den Produzentenpreisen für Kaffee in Tansania und Sambia analysiert. Im dritten Teil wird die Preisvolatilität der beiden Länder untersucht und es werden die Auswirkungen der Liberalisierung des Handels auf die Preisvolatilität berechnet. Der vierte Teil ermittelt die Angebotsentwicklung von Kaffee in Sambia.

Die Ergebnisse für Sambia zeigen eine verbesserte Preistransmission nach den ökonomischen Reformen. Wie erwartet ist diese Preistransmission asymmetrisch, wobei Preissenkungen schneller übertragen werden als Preissteigerungen. Im Falle Tansanias lassen die Ergebnisse keinerlei Verbesserungen der Preistransmission nach den ökonomischen Reformen erkennen. Ähnliche Resultate zeigen die Untersuchungen der Preisvolatilität. Die ökonomischen Reformen führten zu einem Anstieg der Preisvolatilität von Kaffee in Sambia, wobei negative Schocks volatilere Preise verursachten als positive Schocks. Im Gegensatz dazu haben die inkonsistenten Marktreformen in Tansania keinerlei signifikante Auswirkungen auf die Preisvolatilität von Kaffee gehabt. Die Studie über die Reaktion des Kaffeeangebotes in Sambia zeigt, dass Kaffeepreise auf lange Sicht einen negativen, wenn auch nicht signifikanten Einfluss auf das Angebot haben. Dies könnte daran liegen, dass Kaffee einen beständigen Ertrag liefert, sodass das Angebot den Markt genau dann erreicht, wenn die Preise fallen. Jedoch ist auf kurze Sicht die Reaktion des Kaffeeangebotes nur bei Preissenkungen signifikant, was darauf hindeutet, dass das Kaffeeangebot bezüglich Preisänderungen schneller fällt als dass es steigt. Auf der anderen Seite reagiert das Angebot negativ auf eine stärkere lokale Währung und auf den Preis von Mais, der als Hauptkonkurrenzprodukt betrachtet werden kann. Jedoch hatten die ökonomischen Reformen der 1990er Jahre in Sambia einen positiven Einfluss auf das Kaffeeangebot.

Aus den Ergebnissen lassen sich insofern wichtige politische Implikationen ableiten, als dass sie eine kurze und effiziente Wertschöpfungskette und eine Regierungsstruktur offenbaren, die es den Produzenten ermöglicht, größere Anteile des endgültigen Kaffeepreises zu erhalten. Des Weiteren werden mit Hilfe der Ergebnisse wünschenswerte politische Maßnahmen diskutiert. Diese beschäftigen

sich mit einer verbesserten Transmission von den Weltpreisen hin zu den Produzentenpreisen im Zuge der Zeitspanne nach den ökonomischen Reformen, obwohl die Preistransmission asymmetrisch bleibt. Auch wenn eine effiziente Preistransmission den Landwirten kurzfristig Nachteile erbringt, da die Produzentenpreise volatilen Weltpreisen ausgesetzt sind, so kann sie langfristig dennoch das erwünschte Ergebnis erzielen. Ferner zeigen die Ergebnisse wie wichtig hohe und stabile Preise und eine stabile Währung hinsichtlich eines gesteigerten Kaffeeangebotes sind.

## List of Acronyms

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AIC	Akaike Information Criteria
APT	Asymmetric Price Transmission
ARCH	Autoregression Conditional Heteroskasticity
ARMA	Autoregression Moving Average
CBZ	Coffee Board of Zambia
CIP	Composite Indicator Price
CV	Coefficient of Variation
ECM	Error Correction
FAO	Food and Agricultural Organisation
FAO	Food and Agricultural Organisation
GARCH	Generalised Autoregression Conditional Heteroskasticity
GDP	Gross Domestic Product
GVC	Global Value Chain
ICA	International Coffee Agreement
ICO	International Coffee Organisation
IMF	International Monetary Fund
KNCU	Kilimanjaro Native Cooperative Union
MTAR	Momentum Threshold Autoregression
SSR	Sum of Squared Residuals
SETAR	Self Exciting Threshold Autoregression
TMB	Tanzania Marketing Board
TAR	Threshold Autoregression
TCB	Tanzania Coffee Board
TCSO	Tanzania Central Statistics Office
TECM	Threshold Error Correction Models
TGARCH	Threshold Autoregression Conditional Heteroskasticity
ZCSO	Zambia Central Statistics Office

# Chapter 1

## General Introduction

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### 1.1 Problem Setting and Motivation

Coffee is a commodity of critical economic importance in many African countries, such that even countries like Zambia and Tanzania that have very small shares of the world market depend highly on it for foreign exchange and rural employment. Coffee remains the most traded commodity by poor countries with a global annual export of 438,000 metric tonnes in 2010 (FAO, 2010). Export values ranged between \$5 billion and \$12 billion between 1997 and 2005 (ICO, 2007). Over 2.25 billion cups of coffee are consumed per day (approximately 800 billion cups per year) by 40 per cent of the world's population mainly in the industrialized countries. It is also estimated that more than 25 million people are directly employed in the coffee sector worldwide (Ponte, 2004). However, despite its economic importance, the performance of the industry in the producing countries and the impact on the incomes and welfare of the producers has been unsatisfactory (Oxfam, 2002a). Past research shows that the more dependent the country is on coffee exports the lower the per capita income (Fitter and Kamplinsky, 2002). Actually, coffee producer prices showed the greatest fall during the last 20 years, as prices of major agricultural commodities fell between 50 and 86 per cent (Slob, 2006).

During the same period, global coffee markets have transformed rapidly. The emergence of new consumption patterns such as 'ethical consumerism' have not only increased demand for specialty and high quality coffee, but also given rise to new governance structures along value chains. Large transnational corporations increasingly coordinate and control production and processing in an effort to satisfy changing consumer preferences. However, firm consolidation at roasting and retailing stages of the coffee value chains has given rise to oligopoly and monopsony powers, with a few firms setting standards and virtually determining producer prices (Ponte, 2002a). Conversely, aggregated producer power which was reflected in coffee marketing boards in most producing countries, has weakened substantially following

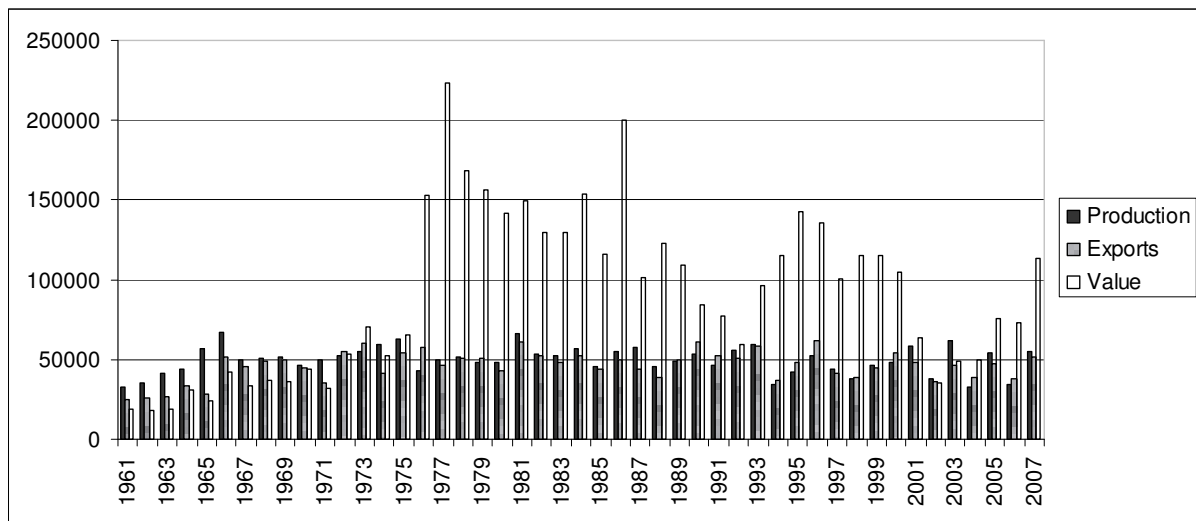


the abolishment of marketing boards as part of market liberalisation policies. Kaplinsky (2004) argues that bargaining power shifted from the poor producers to international traders and roasters.

Market liberalisation has also led to more efficient pass through of prices from world prices to producer prices in almost all coffee producing countries, however, the transmission is mostly asymmetric, such that price decreases are transmitted faster than price increases (Krivonos, 2004). The improvement in price transmission has, nevertheless, exposed producers to the high volatility of world prices. Empirical research by Fortenbery and Zapata (2004) confirms that price risk for coffee is even higher for smaller export countries (like Zambia) than in the overall sector. The authors argue that the choice of an effective price risk management strategy can be challenging for low-volume producing countries because they lack the capacity to influence prices.

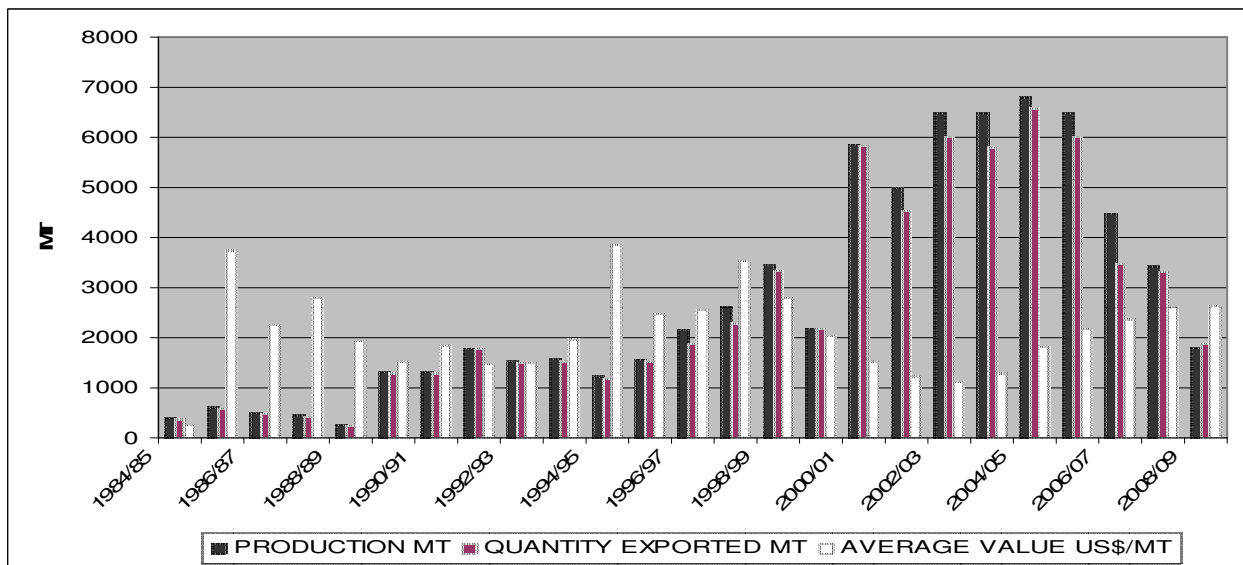
Valid concerns have been raised regarding the changing power structure in the coffee industry including the increasing market power of international traders, the asymmetries in the price transmission, the declining producer prices and the extensive short-term producer price volatility (Kaplinsky; 2004, Oxfam, 2002a; Bacon, 2004; Slob, 2006). Many researchers are concerned about the effects of these factors on the livelihoods of the producers as well as on long-term coffee production. In countries like Zambia and Tanzania, investment in coffee production declined considerably in the last decade, a probable consequence of declining and volatile prices. In some cases farmers have resolved to uprooting coffee trees replacing them with food crops like maize (Baffes, 2005). In Tanzania's case, coffee revenue declined from \$200 million in the late 1980s to less than \$50 million in the 2004 (Pirrotte et. al, 2006). For Zambia, exports declined substantially from 6,700 metric tonnes in 2004 to less than 2,000 metric tonnes by 2009 (see Figure 1.1 and Figure 1.2). Several large coffee estates in Zambia have closed down, leaving a large rural population out of seasonal or permanent employment. At the global level, coffee production has been increasing at declining rates of 0.5 percent between 1998 and 2010 from 1.7 percent rate in the previous decade (FAO, 2010). Roasters and retailers are unable to find enough quantities of some coffee varieties needed for certain coffee blends.

Figure 1.1: Tanzania coffee production export and value



Source: Own Presentation based on Data from FAO and TCB

Figure 1.2: Coffee production, exports and value for Zambia



Source: Own Presentation based on data from Zambia Coffee Growers Association (ZCGA)

Value chain approach has become an increasingly useful approach to gain a comprehensive view of the structure and barriers in commodity markets. As a result, the body of literature on Global Value Chains (GVC) has expanded considerably in the last two decades. Much empirical and conceptual analysis has focused on chain governance and producer upgrading (Gereffi, et. et, 2005; Schmitz, 2004; Ponte 2004; Humphrey and Schmitz, 2005), market power and distribution of gains (Talbot, 1997a; Pelupessy, 2001; Fitter and Kaplinsky, 2001; Kaplinsky and Morris, 2001;

Gilbert, 2006; Swinnen et. al, 2007), standards (Ponte, 2004) and more recently, fair trade (Slob, 2006; Kamplinsky, 2006). This study relates to this body of literature in examining the effects of value chain and governance structures on producer prices. Further, the study examines coffee price transmission, volatility and supply response in order to provide a wider perspective of understanding nature and effects of producer price changes.

While many studies have examined the international coffee market structure including supply and demand elasticity, empirical evidence on asymmetric coffee price transmission and volatility is limited. Krivonos (2004) and Warako (2008) examine asymmetric price transmission in the coffee market using the Houck (1977) model, where dummy variables for price increases and price decreases are introduced. This method can be misleading in cases where agents do not adjust prices immediately but only do so when the price change reaches a certain threshold. In reality, price adjusting costs, such as menu or communication costs, prevent agents from adjusting continuously until the price difference between two markets reach a certain threshold. A similar argument can be applied to supply response analysis, where for example, changes in prices must reach a certain threshold before inducing a change in supply of a commodity. This study applies Threshold Autoregression (TAR) class of models that enable the identification of thresholds in the analysis of asymmetric price transmission. Von Cramon and Meyer (2000) applied TAR models to commodity price transmission, but they used zero as a threshold. TAR model with threshold equal to zero does not display a significant degree of asymmetry, and ignore the possibility that the threshold could be different from zero (Enders, 2004). Enders (2004) also mentions that, a non-zero threshold has more advantages in that it captures strategic behaviours and adjustment costs that are rarely observed with small changes.

Most price transmission studies also overlook the possibility of structural breaks in unit root hypothesis testing. Several researchers including Perron (1989), Zivot and Andrews (1992), Lumsdaine and Papell (1997), Lee and Strazicich's, (2003) and Narayan and Smyth (2005) found evidence of false non-rejection of the null hypothesis in the traditional Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) after applying structural break unit root models to systems which are actually

stationary with structural breaks. Glynn et al. (2007) discussed two advantages of applying structural break unit root testing: First, it prevents test results that are biased towards non-rejection. Second, since the procedures can identify when the possible presence of structural break occurred, it provides valuable information for analysing whether a structural break on a certain variable is associated with a particular government policy, economic crisis, regime shifts or other factors. Besides, structural breaks can lead to the rejection of the null hypothesis of symmetric transmission more often than appropriate (von Cramon-Taubadel and Meyer, 2000). These are some of the critical overlooked aspects in price transmission studies that are addressed in this study. Overall, this study expands the existing literature on agricultural commodity prices by taking into account value chain structures, threshold price movements and endogenous structural breaks in order to contribute to more effective and efficient policy formulation.

## **1.2 Objectives of the Study**

The aim of this study is to examine coffee producer price movements for Zambia and Tanzania, and to establish the effect of those price changes on coffee supply. To this effect, four specific objectives have been identified:

- i. Investigate coffee value chains and governance structures and the implications on producer price changes in the two countries.
- ii. Evaluate the effects of trade policy changes on world-to-producer price transmission, taking into account threshold price movements.
- iii. Measure and explain coffee price volatility with respect to coffee market liberalisation policies.
- iv. Examine supply response of coffee to price movements in Zambia. Compared to Tanzania, Zambia's coffee production declined significantly in the last five years.

The first objective is addressed using a global value chain analysis approach with a focus on governance structures at both the international and the local market levels. The second objective is tackled using threshold cointegration and error correction models. The issue is whether coffee prices from world markets are symmetrically

transmitted to producers, and how the economic reforms have changed the nature of the price transmission. GARCH models are used to address the third objective with due attention to asymmetric volatility using threshold GARCH models. The fourth objective is also dealt with using threshold cointegration and error correction models in order to take into account potentially asymmetric effects of coffee prices on coffee supply.

### **1.3 Significance of the Study**

A key challenge facing most countries in Sub-Saharan Africa is achieving sustainable economic growth sufficient enough to reduce or even eliminate poverty. Given the abundant land and a tropical climate suitable for most agricultural production, sustainable economic growth in Sub-Saharan Africa can be achieved through enhanced agricultural production and exports. Stable prices that enable farmers to efficiently plan production are essential for sustainable success of the agricultural industry. Given that the coffee value chain is buyer-driven, most growers are basically price takers. It is, therefore, important that policy makers and farmers in the producing countries understand how the value chain they feed into operates, how this influences producer prices, how producer prices respond to changes in other markets, and how this affects supply. Understanding these factors become critical for the development of policy interventions – especially those related to price risk management strategies.

This study is novel in several aspects: First, it is the very first study to examine the coffee industry from an economic perspective in Zambia. Coffee has received very little attention from researchers and policy makers despite having potential for improving economic diversification in Zambia's copper dominated economy. Second, this paper extensively employs the analysis of value chains and governance structure, which are critical elements in understanding efficiency and distributional effects. Third, although the literature on asymmetric price transmission has increased in the recent past, this is one of the few studies that apply threshold cointegration models to coffee price transmission. To the best of my knowledge, this is the first study that applies threshold cointegration to a supply response model. Moreover, this

is also the only study that uses structural break unit root tests in the analysis of coffee price transmission.

#### **1.4 Hypotheses**

To achieve the study objectives, various hypotheses concerning coffee price transmission and supply response have been formulated based on previous theoretical and empirical findings in the economic literature. The hypotheses are listed below:

- i. Market liberalisation policies induce closer cointegration relationships between coffee producer prices and world prices, but lead to high price volatility.
- ii. Considering the high concentration of firms in the international coffee markets, coffee price transmission from the world market to producers is asymmetric where agents pass on price decreases faster than price increases, such that negative shocks to coffee prices are more persistent than positive shocks.
- iii. Negative price shocks induce higher price volatility at producer level than at world market.
- iv. An increase in coffee prices lead to an increase in coffee supply, but the response is asymmetric, where supply responds more to negative price shocks than to positive price shocks

#### **1.5 Data Sources**

The main source of data was the International Coffee Organisation (ICO). The ICO was set up in London in 1963 under the auspice of United Nations because of the great economic importance of coffee. As the main inter-governmental organisation for coffee, one of the activities of ICO is providing information on the world coffee sector by means of statistics and market studies (ICO, 2010). The organisation collects average price data from member countries and compiles daily, monthly, quarterly and annually. Additional data was obtained from Food and Agriculture Organisation of the United Nations (FAO), Zambia Central Statistics Office (ZCSO), Tanzania Central

Statistics Office (TCSO) and the Zambia Coffee Growers Association (ZCGA). Comprehensive background information on coffee production in Zambia and in the region was obtained during a research stay at the Coffee Board of Zambia and the ZCGA in September 2009.

## **1.6 Coffee Production in Tanzania and Zambia- an Overview**

Tanzania is located in Eastern Africa bordering Kenya and Uganda in the north, Zambia, Malawi and Mozambique in the South and Congo DR, Rwanda and Burundi in the west. To the east lie the Indian Ocean and the islands of Pemba, Zanzibar and Mafia. Tanzania's population is estimated to be 30 million, 80 per cent of which is engaged in agriculture. Agriculture remains the backbone of Tanzania's economy accounting for 50 percent of GDP and 40 percent of the exports. As the largest sector in the economy, agriculture has a significant effect on national revenues, household incomes and poverty levels. The sector is dominated by small-holder farmers cultivating average farm sizes of 0.9 hectares to 0.3 hectares. Approximately 5.1 million hectares (85 percent of the total arable land) is under food crop production composed of mainly maize, sorghum, wheat, millet, rice, beans, plantain (bananas), potatoes, and cassava. Tanzania also produces a variety of agricultural export crops such as coffee, cotton, cashew nut, tobacco, sisal, tea and some horticultural crops.

Coffee is the main export crop being the country's second largest export after the mining industry. Tanzania is actually the fourth largest producer of coffee in Africa after Ethiopia, Uganda and Ivory Coast. Coffee, which was introduced as an estate crop in the 1920s, is now largely cultivated by Tanzania's small-scale farmers. It is estimated that more than 400,000 small-holder farmers are responsible for growing 94 percent of Tanzania's coffee, and derive most of their livelihoods from coffee. Approximately, 160,000 hectares of land is under coffee cultivation in Tanzania's main coffee growing areas of Kilimanjaro, Arusha, Mbeya, Kigoma and Kagera (Newmann, 2006). Robusta coffee, which makes up approximately 30 percent of Tanzania's coffee production, is mainly grown in Kagera, while the rest of the regions grow Arabica. Up to 75 percent of Tanzania's coffee is exported to Germany, Netherlands and Japan. Despite its connection to niche markets like Japan, Tanzania's coffee has suffered from very low prices compared to other countries in

the region. Tanzania's price trends in the last 20 years have been far below the world prices (see Figure 2.2 of Chapter 2). One of the consequences of low prices has been the abandonment of coffee production in preference to maize. As a result, the country's coffee exports reduced significantly from 36 percent of the total exports in 1985, down to 17 percent in 2004 (Pirrotte et. al., 2006).

Turning to Zambia, the country is located in South-central Africa. Zambia is completely land locked and covers an area of 752,612 square kilometres. It is bordered by Botswana and Zimbabwe to the south, Malawi and Mozambique to the East, Tanzania to the north, Namibia and Angola to the south west and Congo to the North West. Zambia has a population of 12 million (2006 estimates), which is almost three times smaller than Tanzania's population.

Agriculture contributes only 18 per cent to GDP despite employing 60 per cent of the population. The economy of Zambia is heavily dependent on its mining activities (mainly copper), which constitute 78 per cent of all exports. The lack of economic diversity subjects Zambia to economic shocks arising from fluctuating copper prices. Consequently, poverty levels remain high; with 63.8 per cent of the population living below the poverty line (2004 estimation).

Coffee in Zambia is one of the crops that the Government introduced in the late 1970s as a non-traditional export crop in order to implement the export diversification policy that aimed at moving away from complete reliance on copper exports. Specifically, the crop was introduced as an estate crop and is still largely produced by large-scale farmers, who also go into contractual arrangements with small-scale farmers. It is estimated that 99 percent of Zambia's coffee comes from large-scale estates, while the 150 small-scale farmers only contribute 1 percent. Coffee is mainly grown in the Northern Province (close to Tanzania) in the high altitude rural districts of Kasama, Isoka, and Nakonde. Large estates are also found on the copper-belt province and in the southern province areas around Mazabuka District. Currently only 3,100 ha of land is under coffee cultivation in Zambia, which is relatively small compared to other countries in Eastern and Southern Africa.



Although Zambia remains a very small coffee producing country contributing only 0.02 percent to the world market, its coffee industry is probably the second agricultural industry with a large workforce employing between 17,000 and 15,000 seasonal workers in the rural areas (ZCGA, 2007). In 1984, Zambia was allowed to become a member of the ICO on grounds that it would grow and export high quality washed Arabica coffee, which was by then in short supply (ZCGA, 2007). Zambia's coffee production rose from about 1,600 metric tonnes in 1995/96 to almost 7,000 metric tonnes in 2005/06, but then declined significantly to less than 2,000 metric tonnes in 2008/09 (see Figure 2.4 of Chapter 2). Various factors have been associated with the drastic decline in Zambia's coffee supply including depressed world green coffee prices between 2000 and 2005, the lack of long term finance, the appreciation of the Kwacha (Zambian currency) and a drought in 2004. Given that the coffee trees take up to four years before the first harvest, the current low production could largely be a consequence of farmers' low investment in planting and crop management during the price decline and drought periods.

To conclude, the coffee industry in both countries seems to face a number of challenges. First, being a perennial crop, the revenue is not realised immediately compared to alternative cash crops like tobacco, cotton, beans, groundnuts, maize and horticultural production. Even when the plant becomes productive and remains so for fifteen to twenty-five years, farmers are unable to predict future prices. As a consequence, some tend to uproot the coffee plants replacing them with other crops. Second, since coffee is not produced for the local market, farmers rely on various supply chains to access the export markets in the high income countries. The consistence and reliability of these supply chains remains uncertain to the farmers. Further, poor infrastructure in the rural areas, where coffee is mostly produced, leads to high transaction costs making arbitrage difficult as well as hindering the flow of price information. There is also a lack of literature on the economic aspects of the commodity, particularly for Zambia because coffee is a relatively new and a very small sector; therefore, having no basis for policy formulation and farmers' decision making.

## 1.7 Organization of the Thesis

The next chapter describes the influence of value chains and chain governance structures' on producer prices in Tanzania and Zambia. This chapter is generally descriptive relying on past studies as well as information gathered during the author's four-week research stay at the Coffee Board of Zambia and the Zambia Coffee Growers Association. Chapter 3 examines price transmission between coffee producer prices for Tanzania and Zambia and world coffee producer prices over a period of 20 years using monthly price data. Chapter 4 is dedicated to price volatility analysis for the two countries. This chapter focuses on the influence of market policies on price volatility. In order to have a wider view of volatility in other markets, the chapter compares the volatility at the producer level with the volatility at the retail level using coffee retail prices in Germany. Monthly price data is also used for this analysis. Chapter 5 examines coffee supply response to coffee price instability in Zambia. Other variables that play a role in coffee supply such as prices of alternative crops, real exchange rates and economic reforms are also included. The chapter generally focuses on Zambia, which has high price instability and a large price range over the period under consideration. Chapter 6 concludes and makes some recommendations for policy formulation.

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## Chapter 2

### **Policy reforms and Governance Structures in Coffee Value Chains: A study of Zambia and Tanzania**

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#### **Abstract**

Coffee, one of the most governed commodity value chains, demonstrates a high asymmetric power structure which has raised contentious debate with regards to rent distribution, producer prices and consequently producer welfare. This paper, applies the concept of 'Governance in Value Chains' to understand how coffee value chains are coordinated and how this can have a strong bearing on small scale producer prices in Africa. The study notes that coffee producers in Zambia and Tanzania find themselves in captive relations, where lead firms (the roasters) set the rules under which the growers operate. The cost of switching to other buyers is high, and moving vertically up the value chains is hindered by barriers set by the actors at those levels. In theory, high coordination leads to unequal profit distribution along the chain, while a large number of intermediaries in such consumer-driven chains lead to lower producer prices. According to the findings of this study, the highly coordinated and more complex value chain in Tanzania's coffee sector dominated by small-scale farmers, explains Tanzania's low producer prices to a large extent. In contrast, a less complex value chain governance structure in Zambia's case has enabled the farmers to receive high prices. The paper concludes that, the current two-tier private cooperative union structure for small-scale farmers in Tanzania, if well managed, can raise coffee incomes through value adding and a stronger bargaining power. This would result in more balanced power symmetry along the chains.

Key Words: Value Chains, Governance, Coffee Producer Prices, Zambia, Tanzania

## 2.1 Introduction

Coffee is an important foreign exchange earner in most African countries. In Zambia and Tanzania, like in many other producing countries, the coffee sector has undergone significant structural changes following economic liberalization. This has brought about shifts in the control and coordination of the value chains, fundamentally moving away from government controlled chains, through various marketing boards, to private sector driven chains through Transnational Co-operations (TNC). Whilst these changes have led to more efficient markets in the case of Zambia, where 99 percent of the crop is produced by large-scale farmers, there has been disappointing sectoral performance in Tanzania, where 94 percent of the crop comes from small holder farmers (Bargawi,2008).

Market liberalization in Tanzania has induced a private sector influx in the coffee industry giving rise to the number of intermediaries in the value chain, each demanding a share of the export price. In some cases, the removal of marketing services by the cooperatives has left even the smallest farmer to deal with large TNC, and at the same time exposing producer prices to global price volatility (Kaplinsky, 2006). In contrast, while coffee retail prices in the importing countries have been escalating, producer prices have not increased at the same rate, creating a widening gap which has raised wide concerns among researchers (e.g. Ponte, 2004; Kaplinsky, 2004; Slob, 2006). However, the effects of the new global and local value chain governance structures on coffee producer prices remains less investigated. As Schmitz (2001) explains; there is limited knowledge on how trade is organized and how this affects the producers.

The current tendency towards firm concentration in the high income countries, the differentiation of products, the increased number of standards and the new marketing strategies have attracted attention in coffee value chain studies (see e.g. Ponte, 2004; Slob, 2006). These factors have been associated with globalisation, which has seen TNC moving from local to global sourcing. Governance, which describes both power relations in commodity value chains and the institutions which mould and wield this power, has, therefore, become a distinctive feature in value chains (Moris and Kaplinsky, 2004). According to Swinnen et. al. (2007), “the governance of food markets and commodity chains is a crucial element for efficiency and distributional



effects, and that chain governance becomes endogenous in an environment of weak enforcement and imperfect markets.”

The coffee value chain is among the highly governed commodity chains due to a number of factors. First, its market is highly concentrated especially at the trading and roasting stages, creating imperfect markets.<sup>1</sup> Gilbert (2007) observes that, while the coffee value chain is relatively simple, there is considerable concentration at the later stages of the value chain giving rise to potential exercise of monopoly and monopsony powers. Second, as chain governance largely depends on the value in the chain (Swinnen, 2007), it is likely to be high for coffee given its value relative to other agricultural export commodities. Third, coffee has a production-consumption pattern whereby production takes place mainly in developing countries while consumption is mainly in rich countries.<sup>2</sup> This implies that coffee producers depend on established supply networks to access the markets in consuming countries.

Most coffee producers, especially in Africa are predominantly small-scale farmers, cultivating on less than 5 hectares. Farmers are mostly located in isolated remote areas (Ponte, 2002a, 2002b), such that a direct link between producers and consumers in rich countries does not exist. Given their small scale, they are required to sell through a complex of intermediaries that includes local traders, exporters, international traders, roasters and retailers before getting to the consumer. In view of the complexity of the coffee value chain and the increasing fragmentation in the geographies of coffee production, chain governance has strengthened in the last two decades (Bacon, 2004).

The distribution of rents along the chain and subsequent effect on the incomes and welfare of small-scale farmers as well as on the export revenues of the producing

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<sup>1</sup> By 2007, almost 40% of the global trade was being controlled by four companies: Neumann Kaffee Gruppe (A German Group with operations in 17 coffee producing countries); Volcafe Agroindustrial Corp Ltd (A Swiss-Spanish Group with commercial operations in 13 coffee exporting countries); Dreyfus (a Global Conglomerate Group with operations in more than 53 countries and is engaged in processing, trading and merchandising a range of agricultural commodities).

At Roasting stage, 4 roasters control 45% of the global market: Nestle SA (Switzerland), Kraft Foods Inc (USA) Procter & Gamble (USA) and Sara Lee Corporation (USA) which also brands as Douwe Egberts in Europe.

<sup>2</sup> Europe accounts for 40% of the global coffee demand. The US accounts for 24% while Japan just over 10% (Fitter and Kaplinsky, 2001). More than 70% of the world's coffee is produced in Latin America, Asia and Africa (Oxfam, 2001).

countries has raised concerns among researchers in recent years (see e.g. Bargawi 2008; Pelupessy, 2001; Kaplinsky, 2004; Oxfam, 2001; Ponte; 2002a; 2002b; 2004; Slob, 2006). Most studies argue that the largest shares of value chain rents accrue to the chain actors outside the producing countries, mainly to international traders, roasters and manufacturers/retailers (see Oxfam, 2002a, Bacon, 2004). While an average of 20 percent of total income was retained by producers in the 1970s, in 2003/2004 only an average of 13 percent was retained and the remaining 78 percent accumulated in the consuming countries (Ponte, 2004).

Large amount of work has been done on coffee markets, especially on the effects of deteriorating and volatile prices on the welfare of the producers (e.g. Ponte, 2004; Kaplinsky, 2004; Slob, 2006). However, literature focusing on issues of governance in coffee value chains, which may well provide insights into price movements and the distribution of rents along the chain and consequent effects on producer welfare, is limited. The study by Muradian and Pelupessy (2005) attempted to examine governance in coffee value chains focusing on the role of voluntary regulatory systems. The current paper focuses on changes in governance structures in coffee value chains and how this affects rent distribution along the chain, and subsequent effects on small-scale producer prices. The paper applies a global value chain approach because it enables us to decompose the total value chain returns into those arising from, for example, production, marketing, roasting and retailing. Essentially, we are able to explain how the returns accrue to which actors in the chain, and why. We hypothesise that, governance in value chains is a concealed factor, yet it has significant bearing on rent distribution and subsequently on producer prices. Because it is a concealed factor in value chains, we observe that governance has been less investigated especially with regards to the coffee sector. As Newman (2005) explains, the understanding of factors behind changes in distribution of rents along commodity chains is critical to understanding the mechanisms of price determination in commodity markets. Similarly, Fitter and Kamplinsky (2001) argue that, entry into global markets that allows for sustainable income growth requires knowledge of dynamic factors within the whole value chain and not only profit margins.

For this study, we refer to two countries in Eastern and Southern Africa: Tanzania and Zambia. The rationale behind the selection of the two countries is to compare the types of value chains and governance forms between two different scales of coffee production. While Tanzania's coffee is predominantly grown by small-scale farmers, Zambia, a neighbouring country to Tanzania, has 99 percent of the coffee grown on large estates. In fact, Zambia is a unique case in Africa where coffee production has barely been adopted by small-scale farmers. Second, Coffee marketing in Zambia is completely liberalised where producers sell directly to roasters. On the other hand, although Tanzania had liberalised its domestic coffee markets in the mid-1990s, cooperative unions still dominate the industry, with high government regulation through the Tanzania Coffee Board (TCB). The TCB is also mandated to conduct all coffee auctions (see Ponte, 2002; Baffes, 2005). Examining the two countries, with different scales of coffee production and different degrees and trajectories of market liberalisation, ensures a wider viewpoint.

The rest of the paper is organised as follows. Section two draws attention to the theory of value chains and governance in order to provide a background for understanding how coffee value chains operate and how they are governed. A description of international coffee markets and governance in value chains is then given in section three. In section four, we discuss Zambia and Tanzania coffee production and marketing focusing on how they fit into the global coffee value chains and how they are governed. In section five, we discuss and make conclusions on some constraints and opportunities for coffee producers based on how the value chain and governance theory relates to the situation in coffee markets in the two countries. Section six provides some policy recommendations.

## **2.2 Background Information on Value Chain Analysis and Governance**

### **2.2.1 The Value Chain Theory**

The literature on value chains has expanded considerably both empirically and theoretically in last two decades. The theory of value chains can be traced back from Wallerstein's concept of "world systems approach" to economic analysis (Wallerstein 1974). Later, Porter (1985), took an intra-firm approach and introduced a new area of

attention, focusing on interrelations between intra-firm activities and resources that bring a product to its final form. According to Porter's definition, value chains are "systems of interrelated economic activities" within a firm. Based on Porter's theory, economists embraced an inter-firm approach involving an analysis of whole range of activities and actors from production to consumption. A broader approach was necessary as more firms began to specialise in specific production activities linked to activities by other firms. In view of these developments, researchers like Gereffi (1994) suggested a Global Value Chain (GVC) approach, which has formed a foundation for most current value chain analyses. For example, Gilbert (2006) defines a value chain as "consisting of full range of interrelated productive activities performed by firms in different geographical locations to bring out a product or a service from conception to complete production and delivery to the final consumers." A global value chain, therefore, consists of multiple business partners across countries that add on to the value that is ultimately presented to the buying public (Gereffi, 1994).

Value chain analysis considers issues of market power, regulation and supply chain restructuring to study their implications upstream. The difference between a value chain and a supply chain analysis is that the value chain analysis is concerned with the added value at each node of the chain and how the actors interrelate in adding value. Supply chain analysis, on the other hand, is only concerned about how goods move from one actor to another.

Gereffi (1994) and Gereffi et. al. (2005) identify three key dimensions of commodity chains: i) the input-output structure and geographical coverage; ii) the form of governance; and iii) the institutional framework. While the input-output structure and the geographical structure help us understand the processing of the commodity and transaction costs, chain governance explains the level of firm concentration, providing insights into market power.

### **2.2.2 Theory of Governance in Value Chains**

Governance in value chains is best described in terms of control and coordination of activities in the chain. The question of who coordinates and controls the value chain

and how the chains are coordinated and controlled could partly be understood through the two broad categories of value chains: i) 'producer-driven' value chain, in which the key governors are producers (suppliers) embedded in the production chain and commanding core technologies and; ii) the 'buyer-driven' value chain, where the reins of power are held by the key buyers also referred to as lead firms (Gereffi, 1994; 2005). These categories determine the nature of the access of producers to final consumers. While producer-driven chains focus on attaining economies of scale, buyer driven chains are characterised by domination of retail companies and brand-named merchandise. The key buyers or lead firms determine the nature of access of producers to final consumers. Hence they are the 'governors' of the chain. The decisions of lead firms (governors) create winners and losers in an industry. For example, research on the UK-Africa horticulture chain suggests that small growers are marginalised not because of the efficiency advantage of large growers but because of the lead firms' sourcing strategies (Oxfam, 2002b). Traceability is critical for the lead firms if they are to meet health, safety, environmental, and labour standards demanded by consumers, NGOs and government agencies (Dolan and Humphrey, 2000; 2004). Small farmers often cannot get into these export markets because they cannot meet the demand for traceability.

According to Humphrey and Schmitz (2001), the concept of governance is central to the global value chain approach as the term is used to express that some firms in the chain set and/or enforce parameters under which others in the chain operate. These parameters are: 1) what to produce? Referring to product design and specifications; 2) how to produce it? This involves the definition of production process, which can include elements such as the technology to be used, quality systems, labour standards and environmental standards; 3) how much to produce? and; 4) when to produce? This is basically production scheduling and logistics. These parameters help to understand the influences of chain governance on producer activities.

In view of variations of types of value chains and the chain actors, distinguishing between forms of governance (type of relationship) that exists within a particular chain becomes vital in value chain analysis. Gereffi et. al. (2005) and Schmitz (2004) distinguish between four types of chain relationships in global value chains: The first is "arm's length" market relations, where enterprises deal with each other in "arms

length” transactions. Maradian and Pelupessy (2005) posited that this form of governance is no more than market transaction where coordination is low or missing. There is low information exchange mediated only by prices and standard attributes of products. Parties can easily switch to other commercial partners because the cost of switching is very low (Gereffi, 2005). However, high power asymmetry in the case of oligopoly and monopsony is likely to exist in market transactions, even when there is no coordination (Maradian and Pellupessy, 2005). The second category is “balance networks,” where enterprises co-operate and have complementary competences but have no control over each other. According to Maradian and Pelupessy (2005), balance networks are characterised by low monitoring costs for buyers and low costs of switching to other commercial partners (both for buyers and suppliers). The third category is “captive networks” in which lead firms set parameters under which others in the chain operate – this relationship is quasi-hierarchical (Gereffi et al, 2005). According to authors, suppliers in captive networks face significant switching costs and are, therefore, held ‘captive’. These relationships are characterised by a high degree of monitoring. Besides, captive suppliers are confined to a narrow range of tasks and are dependant on the lead firm for complementary activities. In this case mutual dependence is likely. The fourth category of chain relationships is “hierarchy governance,” where the lead firm takes direct ownership of some operations in the chain. The case of intra-firm trade between transactional companies and their subsidiaries falls into this category.

Recently a term referred to as “homologation” has been closely linked to global governance in value chains. The term refers to a system, where uniform global rules are applied to the small-scale producers by the lead firms. These rules include quality measures, specific grades of products and environmental standards. Kamplinsky (2004) argues that these rules govern the integration of small producers into the global value chain.

It is also important to note that, in addition to lead firms’ governance, there are several agents external to the chain that regulate product design and manufacture, not only with a view to consumer safety, but also to create transparent markets (e.g. by defining standard weights and sizes, technical norms). It is argued that, where clearly defined standards and systems are enforced (for example, certification

systems) the need for governance by lead firms is reduced (Swinnen, 2007). Instead of monitoring performance along the chain, buyers can rely upon external monitoring and verification to guarantee product and process standards. In many cases, network actors control opportunism through the effects of repeat transaction and reputation that are embedded in particular geographic location or social groups (Gereffi et. al, 2005).

### **2.2.3 Theory of Income Distribution in Value Chain**

The theory of income distribution along value chains is adequately explained in Schumpeter's theory of entrepreneurship and barriers to entry (Schumpeter, 1961). According to Schumpeter's theory, "the ability to insulate activities can be encapsulated by the concept of rent, which arises from the possession of scarce attributes and involves barriers to entry" and that "scarcity can be constructed through purposive action. In that way, an entrepreneurial surplus can accrue to those who create this scarcity." This implies that, the primary returns to value chain rents accrue to those parties, who are able to protect themselves by creating barriers to entry. Thus, income growth can be sustained through an enduring barrier to entry for some chain activities. This is closely related to roasters and manufacturers in coffee value chains. The changes in governance structure of the chain are a result of struggle for rents as actors attempt to increase the income and profit derived by participation (Muradian and Pelupessy. 2005). Thus the degree of vertical coordination in supply chains influences economic outcomes, in particular efficiency and equity (Swinnen et. al, 2007). Besides, this could also lead to a large value added accumulating in those segments obtaining a lower share of the total retail value through producer upgrading. Rents can be related to product and marketing, technology, financial, resource, infrastructural and policy (Newman 2005).

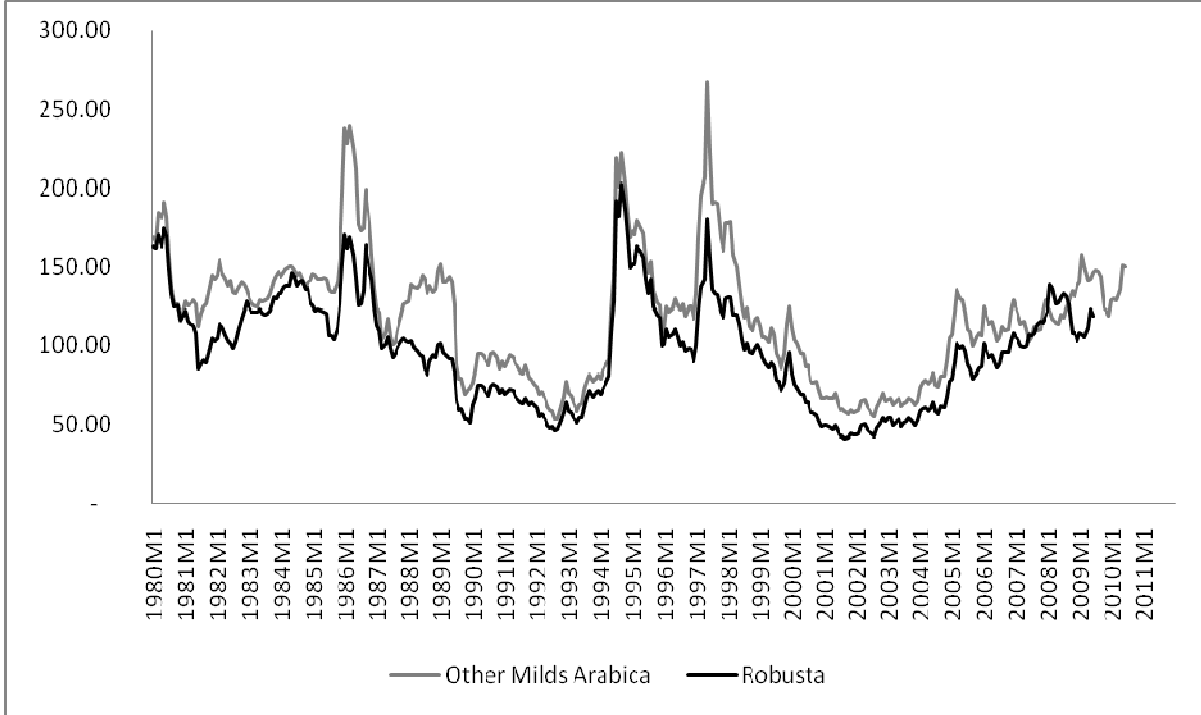
In this study, the focus is on governance in coffee value chains because it determines the extent to which producers can participate in the chain. For example, involvement in roasting adds value to green coffee. Schmitz (2005) explains that working to the specifications of large global buyers often provides a fast track to upgrading processing and products. This subsequently influences the price of a commodity. In addition, the forms of governance in value chains determine the speed and

magnitude of price transmission along the chain. As North (1995) argues, price formation and transmission are not only influenced by supply and demand but also institutional structures. If market institutions allow efficient transmission of price, producers can then take advantage of the opportunities to increase their production. Therefore, the analysis of forms of governance in value chains establishes the industry’s attractiveness and provides insights into how prices will evolve in the future.

**2.3 Coffee International Markets**

Coffee is possibly the most traded perennial crop in the world. The commodity is broadly categorised into two species: Arabica (*Coffea Arabica*) and Robusta (*Coffea Conefora*). The beans of the two varieties differ considerably in taste and flavour. Arabica bean is considered to produce better quality coffee than the Robusta bean, and therefore, fetches a higher price (Figure 2.1).

Figure 2.1: Arabica and Robusta coffee prices (1980 to 2009)



Source: Own Presentation based on Data from ICO(2010).



The two species also vary in their agro-ecological requirements. While Arabica coffee grows better in higher altitudes of semi-tropical climates, Robusta coffee is mainly produced in low laying areas in tropical climates. Arabica is further differentiated into three flavours; Brazilian Arabicas, Columbian Milds, and Other Milds. Each type makes different blends and fetches different prices. For example, Zambia's Other Milds is used as a tastemaker and it is highly priced (Pelupessy, 2001). Certified coffee such as Fair Trade, Organic, Utz Kapeh, Bird Friendly, Rainforest Alliance-certified and many other certifications, have slowly gained market shares in the coffee world market. The success of speciality coffee on the world market is largely associated with new consumption patterns, such as 'ethical' consumerism, that have emerged in the industrialised countries (Ponte, 2004).

Coffee is produced in 85 countries in Africa, Asia, Latin America and Australia. Brazil, which produces Arabica coffee, is the largest coffee producing country in the world accounting for 31.5 percent of the total volumes of coffee produced globally based on 2009 estimations by the International Coffee Organisation (ICO) data<sup>3</sup>. By the year 2000, Vietnam emerged to be the second largest coffee producing country in the world after Brazil, surpassing most Latin American countries such as Costa Rica and Columbia. Currently, Vietnam produces 17.7 percent of the total global production according to ICO production data and it only produces Robusta coffee. Ethiopia, the largest coffee producer in Africa accounts for only 2 percent of the total global production. Tanzania has only 1.2 percent, while Zambia has 0.02 percent share of the total global production.

Coffee consumption is mainly in the industrialised countries. The United States of America (USA) is the largest consumer of coffee accounting for 18 percent of the total global consumption. Brazil, the second largest, consumes 13 percent of the global coffee consumption. Germany is the third largest with 9 percent share of all the coffee consumed worldwide. Although, the demand for coffee has stagnated over the last few years, demand for high quality coffee has increased considerably (Slob, 2006). The later observation is still growing across the sector but it is estimated to be less than 10 percent of the total coffee produced on the world market. Recently, there has been a growing demand for specialty coffee by China as a result of a growing

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<sup>3</sup> [www.ICO.org/m1.htm](http://www.ICO.org/m1.htm) downloaded on 4th February, 2010.

middle class. The Chinese demand was expected to increase the world demand for coffee by 70 percent by 2008 (Slob, 2006).

In the last two decades, coffee exporting countries have faced a crisis as a result of low world producer prices. The world price of green coffee between 1998 and 2002 dropped from US\$1.20/lb to between US\$0.40 and US\$0.75 (Bacon, 2005). In February 2002, the prices reached the lowest levels since 1930s. It is estimated that the price fell by 25 percent between late 1990s and early 2000's (Common Fund for Commodities, 2000). In contrast, retail prices of coffee in high income countries increased over the same period. As the coffee bean price fell by 25 percent, the margins of coffee roasters rose by more than 50 percent (Common Fund for Commodities, 2000). This trend is attributed to increased market power, which originates from firm consolidation at manufacturing and retail stages resulting in oligopoly markets in the coffee industry (see e.g. Fitter and Kamplinsky, 2001; Slob, 2006). It is often argued that, as a result of loss of bargaining power by the farmers following the abolishment of the cooperative boards, incomes which accrued in the producing countries have been transferred to rich countries (Kamplinsky 2006, Ponte, 2004). Similarly, coordination and control of coffee supply shifted from the government-run cooperatives to multinational companies (See Swinnen et. al. 2007).

### **2.3.1 The International Coffee Value Chain**

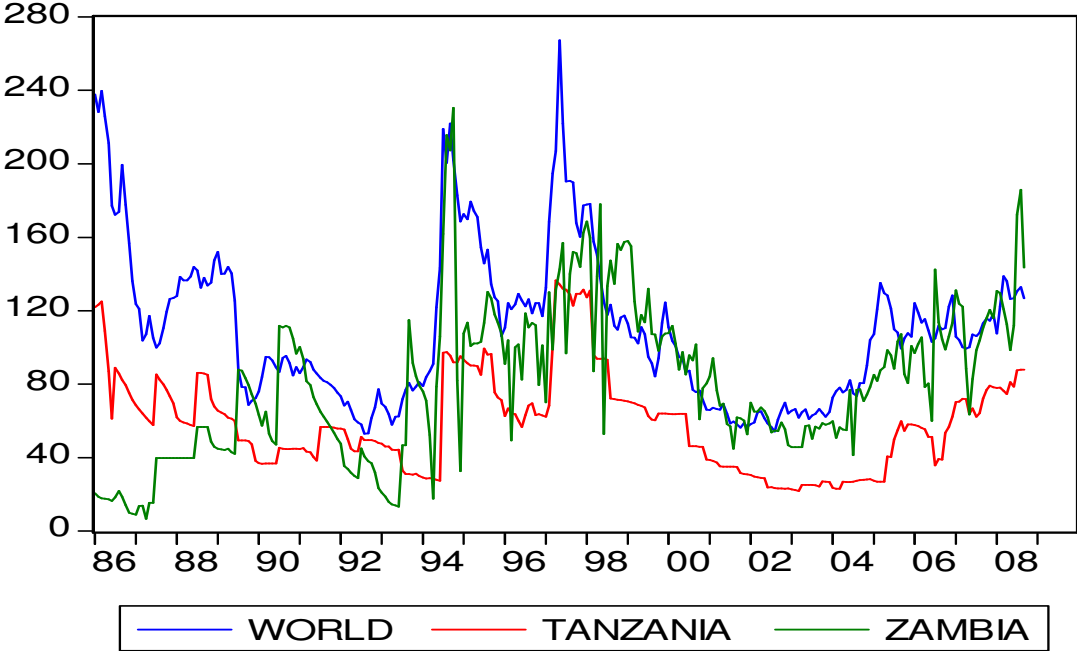
Unlike many other agricultural commodities, most of the post-harvest processing of coffee takes place on the farm. The farmers harvest red (ripe) coffee cherries which are either wet processed or dry processed. Wet processing is typically applied to Arabica coffee. It involves soaking and fermenting the cherries in order to remove the coffee bean. The bean is then dried in the sun to a certain moisture level. Tanzania and Zambia both apply wet processing, which yield a better quality. The coffee bean is then sold as parchment coffee to private buyers, cooperatives (as in the case of Tanzania) or directly to exporters or roasters based in the consuming countries.

The major players in the global coffee value chain are producers, cooperatives or associations, local traders, international traders (exporters), importers/roasters, manufactures/retailers and the consumers. Most of the intermediaries like local

traders, cooperatives or exporters do not add any significant value to the coffee bean other than incurring transportation and other transaction costs. It is not until the bean reaches the roasters that it is roasted and blended with other varieties according to consumer preferences. The roasters then sell the coffee either as roasted beans or as ground coffee to manufacturers/retails or direct to coffee outlets such as supermarkets, restaurants and cafés.

Coffee processing differs from several other commodities like cotton, in that the large part of coffee processing is done by the farmers themselves. However, several studies have shown that despite most of the processing taking place on the farm, the producers receive a very small share of the retail price, such that in some cases it is only 9 percent (e.g. Oxfam, 2002b; Kaplinsky, 2004). The studies show that approximately 30 percent of the value of the retail price goes to the roasters. The local traders and exporters' together get approximately 15 percent share of the retail price while retailers may retain up to 15 percent. Figure 2.2 shows coffee prices at producer level for Zambia and Tanzania in comparison to world producer prices and retail prices taking the Germany retail prices.

Figure 2.2: Producer and retail coffee prices in US\$ cents per pound



Source: Author's Presentation based on Data from ICO

### **2.3.2 Governance in International Coffee Value Chains**

The International Coffee Agreement (ICA), which was basically a set of agreements on production and consumption quotas, governed the global coffee industry for most of the period from 1962 to 1989. The primary objective of the ICA was to raise and stabilise prices in member producing countries that comprised 99 percent of the coffee exporters. The idea was to raise prices in consumer countries which subsequently raised prices in producing countries (Bohman and Jarvis, 1990). When the producer price indicator calculated by the ICO rose over the set price, quotas were relaxed; when it fell below the set price, quotas were tightened. In some cases when prices rose extremely, quotas were abandoned until prices dropped back within a certain band (Ponte, 2001b).

It is often argued that the breakdown of the ICA in 1989, combined with the collapse of government-run cooperatives in most developing countries following liberalisation policies, led to the drastic drop of coffee producer prices in the early 1990s (Bacon, 2004). The prices improved in the period 1994-1998, and then plummeted again in the early 2000s before surging during the second half of the last decade. Brown et.al (2008) argue that although the ICA was relatively successful for two decades with active supply management objectives, it eventually succumbed to common flaws such as insufficient financing and unrealistic price targets in extended periods of low prices and increasing supplies.

During the ICA regime, the global coffee chain was not controlled or 'driven' by any actor (Ponte, 2002b). In principle, neither the producers nor consumers controlled the coffee value chain. However, during the post ICA period, the coffee value chain has mostly exhibited characteristics of a 'buyer-driven' chain. To be more specific, Ponte (2002b) refers to it as a 'roaster-driven' chain. Following trade liberalisation in most coffee producing countries that led to the withdrawal of ministries and government-owned marketing boards from coordinating coffee production, marketing and quality control, governments lost international negotiating power (producer drive). Kamplinsky (2004) argues that the aggregated producer power which had been reflected in these marketing boards has weakened, and small-scale producers, who previously linked to final markets through the various forms of marketing boards, found themselves selling directly into volatile world markets. Large-scale

transnational traders and roasters quickly moved in to fill the gaps left by the governments' marketing board, while gaining negotiating power. Swinnen et. al. (2004) observes that the combination of market liberalisation and increased coffee production coincides with rates of transnational corporation concentration. Notably, most roasters have moved to dealing with only a few traders who abide by their conditions. The adaption of supplier-managed inventory (SMI) has been stiffened by the requirements that traders have to abide by if they have to qualify to supply coffee to the roasters. These requirements have led traders to have more supervision over producers. Furthermore, at the roasting stage, there are various strategic barriers such as setting of minimum quantities needed for a particular type of coffee to be included in a certain blend or patent rights to certain processing technologies that have been created in the last ten years (Ponte, 2002b).

In addition, the ICO, the International Coffee Council and several other regional and national bodies play an important role in setting standards for coffee production and marketing. In some countries, the government has specific standards set with regards to consumer safety (e.g. EurepGAP).

## **2.4 Tanzania Coffee Value Chains**

### **2.4.1 On-farm Processing**

Coffee in Tanzania is harvested by hand as red ripe cherries grown on small plots of 1 to 5 acres. The bean is removed from the cherries using a hand pulping machine. The two halves of the seed, referred to as the coffee beans are then dried for approximately 11 days before it is sold as parchment coffee to the primary societies. In its green coffee form, the coffee can stay up to 12 months before it can start deteriorating in flavour. Roasting reduces shelf life; a reason for most roasters preferring to carry it out shortly before consumption, preferably in the consuming countries.

## 2.4.2 Coffee Cooperatives

Coffee in Tanzania has a production and marketing system which is historically and closely linked to cooperative movements. Currently, Tanzania's coffee industry is dominated by a two-tier cooperative system, whereby farmers from multiple village level primary societies (groups of 100 to 1,000 persons) form cooperative unions. The unions have the primary responsibility of input supply (as loans), free extension services and purchase of produce. In addition, the unions are responsible for financing, transporting, marketing and supervising the sale of coffee supplied by their primary societies (Parrish et. al., 2005). The cooperatives buy, store and process coffee using their own facilities. Prior to economic reforms (before 1991), all cooperatives were government-owned and all small-scale farmers were obliged to belong to one. Presently, the cooperatives operate as private entities, owned and managed by members, and are supposed to compete with private traders. Membership of the cooperatives is not mandatory anymore, while a lot of services such as input supply and extension services have been withdrawn (Chachage, 2004; Cooksey, 2004 cited in Mhando and Mbeyale, 2010). Presently, most farmers rely on government paid extension agents, which has also drastically reduced from three in 1985 to one per four villages of about 1,200 households in 2007 (Mhando and Mbeyale, 2010).

After the primary societies have purchased a minimum required quantity of parchment coffee, it is sold to the cooperative unions such as the Kilimanjaro Native Cooperative Union (KNCU). After market liberalisation in 1994, private traders were allowed to buy coffee directly from the farmers, thereby competing with existing cooperatives in the purchase of the crop at village level (Bargawi, 2008).<sup>4</sup> The private traders purchase directly from farmers and some of them even process it in their own factories before sending it to the TCB operated auction. However, despite the market liberalisation, only 20 percent of the farmers sell directly to private traders, the remaining 80 percent sell their coffee to cooperative unions or to small private local traders (Newman, 2006, Bargawi, 2008). In some areas like Mshiri in Kilimanjaro

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<sup>4</sup> In the 2001, the Coffee Industry Act, private traders were mandated to choose only one licence; purchasing parchment coffee from the farmers, curing or exporting. However, in reality these traders have designed a mechanism whereby they operate at many stages of the along the through partner companies (Mhando and Mbeyale, 2010).

region, 94.1 percent of the farmers sell to cooperatives and only 5.9 percent sell to private traders (Mhando and Mbeyale).

A major reason for the farmers' preference to sell their coffee to cooperatives is that the cooperatives pay in three instalments (September/October, December/January and February/March). Farmers who go for this choice also avoid storage costs such that awaiting further payment from the cooperatives unions may only be an option for the most affluent coffee producers (Bargawi, 2008). Even when private traders offer a higher price than the initial price offered by the cooperatives, most farmers still prefer the instalment payment system by the cooperatives because prices tend to increase for the second and third payments. The second and third payments also help the farmers meet other cash needs later in the season such as payment of school fees for their children or purchase of inputs for the next season (Bargawi, 2008). In addition, cooperatives also pay a premium on top of the best price offered. Bargawi (2008) noted that the continued functioning of the cooperative unions is seen as medium of stability to the producers with a more stable producer price. However, in some cases, for example, in Kiruweni and Wanri villages in Kilimanjaro region, private traders have resorted to compete with cooperatives on quality rather than price, such that the poor grades that are rejected by the cooperatives is what the private traders buy (Bargawi, 2008). Primarily, the choice to sell to private traders is linked to urgent cash needs as most private traders bought the coffee early in the season, when the prices are still low.

### **2.4.3 Exporting Stage**

At the cooperative union level, the parchment coffee is milled and re-graded before it is taken for curing and re-grading at the curing factories.<sup>5</sup> Recently, vertically integrated exporters working as subsidiaries of multinational companies have emerged in Tanzania and now own all the processing factories in the country (Temu et. al 2001 cited in Maradian and Perupessy, 2001). At these curing factories, the

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<sup>5</sup> The coffee in Tanzania is graded into classes ranging from 1 to 13. The best grade is 1 while 13 is the worst grade (Mhando and Mbeyale, 2010).

coffee is dehulled and re-graded in readiness for the weekly coffee auction. The TCB organises and facilitates the coffee auction and sends graded samples to licensed exporters, before conducting auctions through the Moshi Coffee Auction, a private company owned by the TCB. The auction company buys coffee from cooperatives, private traders or directly from the farmers. The TCB auction is primarily a marketing agent charging 1.6 percent of the auction sale (Baffes, 2005). Figure 2.3 shows the value chain structure in Tanzania.

#### **2.4.4 Governance Structures and Price Shares**

The exporters coordinate and control all the value adding activities along the value chain within the country on behalf of the large multinational roasting companies based in the consuming countries. The exporters decide the quality of coffee to buy and how it should be produced. The exporters are the ones who bid at the auction with capability to influence the prices. Moreover, it is estimated that the largest share of the coffee export price goes to the exporters as they are well informed of the price being offered by the roasters (Mhando and Mbeyale, 2010).<sup>6</sup>

Although the TCB is the main regulatory body of the coffee sector in Tanzania, its monitoring of activities in the sector is not very effective (Mhando and Mbeyani). For example, the private traders are not allowed to buy parchment coffee from the farmers at the farm gate; instead they are supposed to set up purchasing points, where farmers could bring their coffee. However, this is not the case as the traders still buy at the farm gate. In addition, private traders start buying coffee even before the buying season is officially authorized.

In 2003/04, the TCB introduced direct sale of coffee to buyers overseas in order to eliminate intermediaries. However, direct sales seem to apply only to premium coffee or specialty coffee such as fair trade coffee. The rest of the producers largely sell to cooperatives and private traders, who tend to make profits without necessarily adding any value to the commodity. Most farmers cannot sell directly to roasters in developed countries because they are not able to meet the exporting costs involved, i.e. curing, transportation, communication, packaging and export duties. Additionally,

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<sup>6</sup> The exporters sell their coffee to roasters mostly in Germany, Netherlands and Japan. The three countries constitute 75% of Tanzania's exports.



issues of traceability become critical if small-scale farmers have to deal directly with retailers or consumers. Most roasters and manufacturers in the consuming country own property rights for certain processing technologies creating barriers for entry for coffee producers.

As private traders were allowed to purchase directly from farmers at the village level, the cooperatives that provided inputs to the farmers lost the monopsony purchasing power. Farmers obtained subsidised inputs from the cooperatives, but then sold their crop to private buyers offering higher coffee prices. The desertion by the farmers left the cooperatives with large debts, unable to continue with the input provision services (Bargawi, 2008). This coupled with the removal of fertilizer subsidies by government from 70 percent (of the total fertilizer requirement by the farmers) in 1990/91 to zero in 1994/95 drastically reduced fertilizer application and pesticide use. Estimates show that, while 51 households used pesticides, insecticides and herbicides in Kilimanjaro region in 1994/95, the number had reduced to 35 by 2002/2003 (United Republic of Tanzania, 1996; United Republic of Tanzania, 2006 cited in Bargawi, 2008). Consequently, the quality of Tanzanian coffee has significantly reduced following economic reforms (Baffes, 2005). Some researchers relate the declining prices of Tanzania coffee to low quality of coffee produced (e.g Baffes, 2005, Ponte, 2002). Quality is also lost through processing when small-scale producers use dry processing instead of the wet processing which yields better quality.

#### **2.4.5 Tanzania fair trade coffee**

Fair trade is a commercial partnership aimed at creating greater equality in the current liberalised markets through offering a minimum price. A guaranteed minimum price of \$1.26/lb for trade fair coffee was agreed upon between producers and Fair Trade Organisations (FTO) in June 1995. On top of that, a price premium of 5 to 10 percent is paid above the fair trade price. The premium price is meant for community development programs. Despite the fact that it was the first country in sub-Saharan Africa where it was introduced in 1990 However, fair trade coffee represents only a small fraction of the total coffee production in Tanzania (Pirrotte et. al. 2006). The two largest co-operatives which are active in fair trade coffee production are: Kagera Co-operative Union (KCU) and Kilimanjaro Native Co-operative Union (KNCU) account for only 5 percent of the country's coffee exports (Pirrotte et. al, 2006). The amount of

coffee exported to fair trade market significantly dropped in the last few years from 52,380kg in 2006/07 to 32,760kg in 2007/08 (Mhando and Mbeyale (2010). Although all coffee exports in Tanzania have to go through the auction, the TCB recently adjusted some rules to allow fair trade coffee producers to export directly to roasters by passing the auction (Parrish et al, 2005).

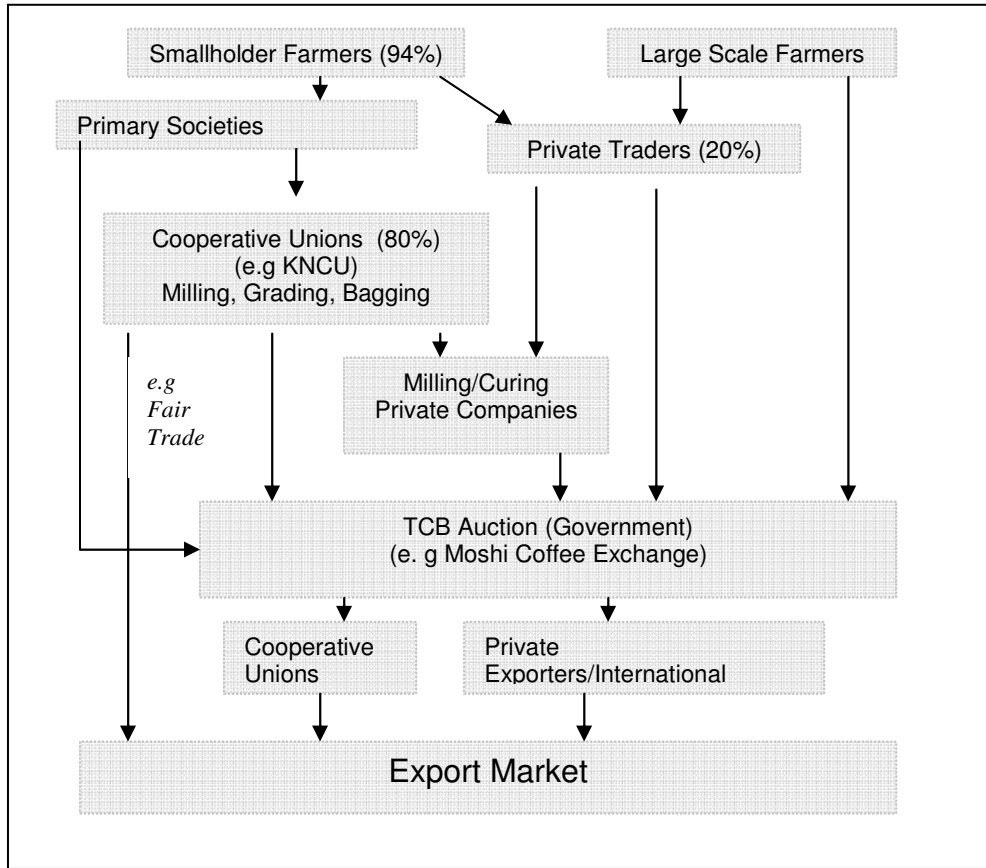
## **2.5 Zambia Coffee Value Chains**

The coffee value chain in the case of Zambia is less complex than the Tanzania value chain (see Figure 2.3). For Zambia, Parchment coffee from the farmers is exported directly to roasters in the consuming countries through the Zambia Coffee Growers Association (ZCGA). Unlike the case of Tanzania, Zambia produces mainly speciality coffee and does not rely on the large TNC's roasters for its markets. The producers have established relations even with some small buyers in the consuming countries. The coffee marketing in Zambia is completely liberalised and government does not interfere in price setting. All coffee producers (large- and small-scale producers) are, by law, members of the ZCGA which provides marketing, quality control, milling, warehousing, shipping, extension and secretarial services to the growers. Although the ZCGA has been delegated marketing functions by the Zambia Coffee Board (ZCB), the former also gives licences to some members that want to market their own products. The association also issues certificates of quality to all export shipments. The ZCGA is an operating wing of, and supervised by the ZCB, whose members represent the government, small-scale farmers, large-scale farmers, and agricultural research and extension services.

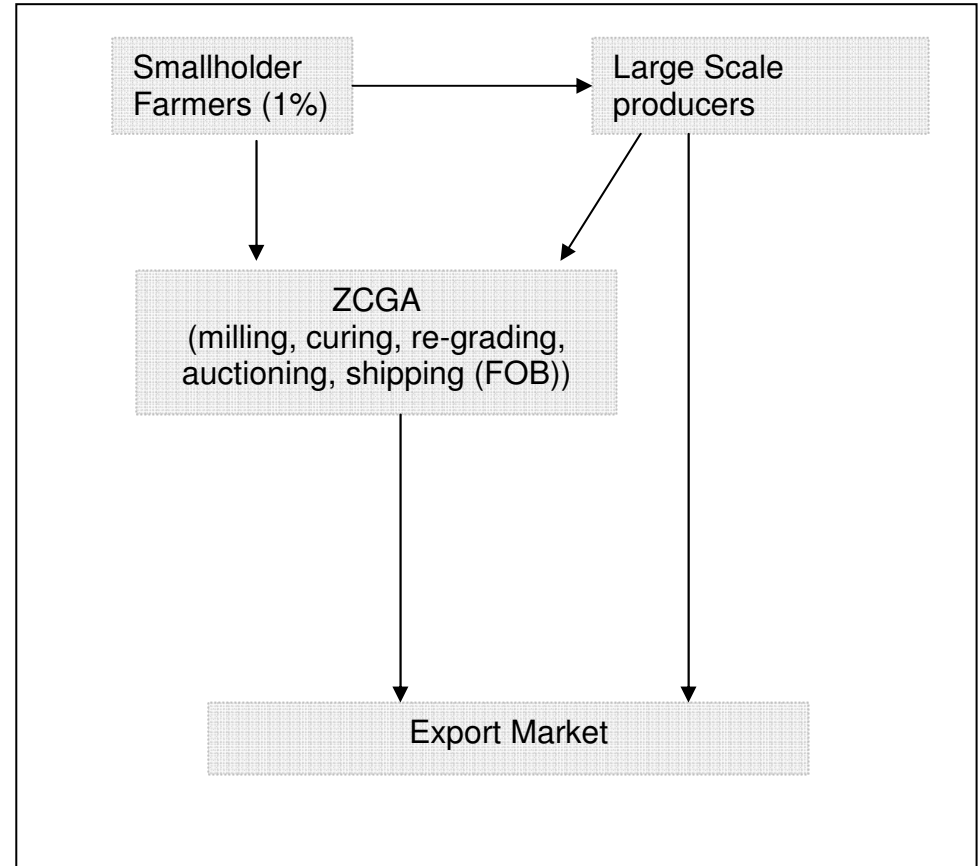
On-farm coffee processing in Zambia is similar to Tanzania's wet processing. However in the case of Zambia, the parchment coffee is washed, sorted, graded and bagged right on the farm, before being taken to the ZCGA for auctioning. At the ZCGA, the coffee undergoes milling and re-grading before the samples are sent to the roasters to prepare for the auction. The grading and export presentation is in grades AAA, AA, AB, AB, PB and many small grades making up to twelve coffee grades. The grades are based on bean size with AAA being the largest size achieved through using proper field management practices.

Figure 2.3: Coffee value chain in Tanzanian and Zambia

a. Zambia Coffee Value Chain



Tanzania Coffee Value Chain



Source: Author's own design based on discussions with the Zambia Coffee Growers Association (ZCGA) and the Zambia Coffee Board (ZCB) as well as various other literature sources.

All physical exports are, however, handled by the ZCGA and are usually routed via Durban in South Africa or Dar es Salaam in Tanzania using road and rail. As a land locked country, Zambia uses the ports of its neighbours for exporting its coffee. Ultimately, a large share of profits is used to pay international transport services and duties. Zambia's coffee exports go to Europe (94%), the United States (1%) and the remaining 5% is exported to South Africa, Australia, and Japan (ZCGA, 2007).

The pricing system at the ZCGA organised auctions are based on the trading price at the New York Board of Trade (BOT)<sup>7</sup>. At present, the association uses a silent telephone auction system. This system, however, is not only expensive, but also limits the number of bidders. Most buyers tend to know each other whereby transparency can be limited. The most important setback of this system is that bidders can collude and avoid high bids.

However, Zambia's coffee is one of the highly priced coffees in Africa and portrays closer movements to the world price as shown in Figure 2.2 above. In 2009, Zambia received the highest producer prices in the whole of Africa (Mafusire et. al., 2010). Traditionally, Zambian coffee farmers grow a variety of Arabica coffee called Bourbon, which, despite being highly susceptible to pests and diseases, produces high quality speciality coffee. Because of Zambia's late start in the coffee industry, the growers immediately adopted some latest technologies for cultivation practices including composite manual from the coffee pulp and pest management through chemical and biological methods. In addition, they use sophisticated methods for irrigation, fertilization, and chemical application. The application of the appropriate technologies and good management practices has enabled the country to produce high quality speciality coffee and to penetrate niche markets in Europe, USA and Japan. In 2007/2008 the ZCGA sold 74 metric tonnes to specialty markets (ZCGA, 2009).

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<sup>7</sup> Renamed Intercontinental Exchange in September 2007.

## 2.6 Discussion and Conclusion

The paper has analysed value chains and governance structures in Zambia and Tanzania and how producers access world coffee markets. Despite the differences (in quality and value chain structure) between the two countries, which are largely due to differences in scales of production and levels of market liberalisation, there is commonness in the two countries in that coffee producers in both countries feed into a concentrated world coffee market. However, the characteristics of governance structures in Tanzania's value chain reflect that of captive relations. In these types of relationships, lead firms set the rules under which others operate and the costs of switching to other buyers is very high. The producers, as seen in the case of Tanzania's small-scale production are confined to narrow tasks, which is basically production of parchment coffee while the curing companies have dominated the industry at processing level. Essentially, there are high barriers for producers to move up the chain. Even if the Tanzania coffee marketing system is supposedly a competitive market, where cooperatives compete with private traders in purchasing coffee at village level, farmers prefer to sell to the cooperatives because the system allows them to access second and final payment, taking advantage of any seasonal increases in coffee prices. The strategy by the cooperatives to pay the farmers in instalments, have earned them comparative advantage over the private buyers. This, in a way, hinders the private traders from purchasing directly from the farmers, on the grounds that they cannot compete with cooperative unions on issues of stabilising seasonal prices. Evidently, between the first and second actors in the value chain, i.e.; the farmers and the cooperatives; the cooperatives are the price setters.

At the second level of the value chain, i.e.; between the cooperatives and the exporters/international traders, the price setters are the exporters/international traders acting on behalf of roasters that are based in the consuming countries. An important observation in Tanzania's value chain is the emerging of vertically integrated curing companies and exporters, working on behalf of multinational companies, who now own all the coffee processing companies in the country. The exporters, through their large investment in processing machinery, benefit from economies of scale, creating barriers for producers to engage into processing. In so doing, they manage to capture the largest share of the retail price in comparison to other actors operating within the country.

Turning to Zambia coffee markets, the interpretation of relations between the farmers and the roasters is close to free market or arm's length. In free markets, standards and price become the medium of communication between the suppliers and the buyers. There is very little supervision from the buyers because the supplier meets the required standards, which determine the price. An essential observation in the Zambia coffee value chain is the small number of actors which has enabled high prices received by the producers in comparison to other countries on the continent. Much of the success of the coffee markets in Zambia is due to a well organised institutional set-up consisting of the ZCGA, which represents the private sector and the ZCB which represents the public sector. Given that the ZCGA provides most services including transportation, the number of actors in the chain is reduced. As the coffee is sold directly to roasters in the consuming countries, the cost of switching to other roasters is low and the farmers can sell to any buyer depending on the price offers. Thus, the farmers are able to sell at prices that reflect world producer prices. A visual inspection of price movements for Zambian coffee over the past twenty years shows that the prices move closely with world producer prices, an indication that the price changes for Zambian reflect changes in world. Since Zambia's coffee is usually of good quality, there is always demand for it, such that bidders are forced to bid higher prices. However, one shortcoming in the Zambia auction system is the auction method. Telephone auctions limit the number of roasters participating, consequently limiting higher bids.

At international level, the market structure for coffee beans is in general oligopolistic in nature, where growers have little power and are therefore unable to capture large parts of the generated surplus. The high level of concentration at the roasting stage gives the roasters a leeway to be slow to pass on price increases to producers. This ultimately explains the ever widening gap between producer prices and retail prices. As observed in the case of transnational buyers, who have increasingly, began to operate in the producing countries, now capture large shares of the value of the commodity slowly gaining monopoly of the industry.

Power asymmetry, which is largely supported by high market concentration at the roasting and manufacturing stages, is evident in coffee markets. This article supports

previous assertions that market power in the coffee industry has resulted in imbalances of rent distribution along value chains (e.g. Kaplinsky, 2004). In consequence, the price for green coffee, rather than being determined by market forces, is largely determined by the roasters in the chain. In the case of Tanzania for example, whether farmers sell to the cooperatives or private traders, the world price is determined by large transnational roasting companies through the national auction market. The cooperatives and private traders offer prices according to how they anticipate offer prices by exporters/international traders at the bi-monthly coffee auctions.

As often argued, private regulatory systems should lead to stronger coordination, since they increase the amount and complexity of non-market information exchange although these result in reduced rents at the lower levels of the chain. In comparison to large-scale producers in Zambia, coordination for small-scale farmers in Tanzania is high, the effect being unequal distribution of rents across the chain. As often argued (e.g. Oxfam, 2002b), the price captured by the farmer largely depends on how much processing is done at a local level, hence the power shifts and production trends have drastically reduced producing country's share of the final retail price. However, going into processing to consumer specifications for small-scale farmers is often faced with several barriers such as lack of capital, equipment and the required skills. Such barriers to entry create imbalances in rent share distribution as explained in the Schumpeter theory.

## **2.7 Policy Recommendations**

As discussed in the theory section above, in order to understand the rent distribution along value chains, it is vital to map out which activities sustain high incomes in the chain. Given the high profitability at the later stages of the value chain (roasting and manufacturing); carrying out these activities by the producers would create value added for the producing countries. This would not only increase economic activities in the producing countries but also raise export revenues. However, the paper has shown that there are high barriers for the producers to go into these activities. The roasters, through their subsidiaries based in the producing countries, have dominated the processing, including tacit knowledge of processing and intellectual property

rights as most of them own patents on processing technologies. Other limitations to producers going into processing include the lack of capacity to source other types of coffees from other parts of the world for blending to consumer specifications. Further, issues of traceability become critical for consumers dealing directly with small-scale farmers. Therefore, government policies on improving coffee incomes through value addition should be directed towards removing such barriers, especially reducing transportation costs by improving infrastructure. In addition, capacity building for producers in terms of building skills and developing technology for various value adding activities should be a priority.

A more equal distribution of profits along value chain can be achieved if cooperatives manage to break these barriers and are able to compete successfully with the local subsidiaries of TNC. Alternatively, primary cooperatives can mobilise themselves to sell directly at the auction like in the case of Mruwia and Materuni primary cooperatives in Kilimajoro. In addition, fair-trade coffee growing should be strengthened among small-scale farmers in Tanzania. The fair-trade markets must be strictly monitored to ensure that agents buy all the fair-trade coffee produced and avoid cases where fair-trade coffee is sold at the lower conventional prices due to lack of demand.

Another strategy would be to strengthen coordination among producers within the countries or across countries with common coffee varieties. For example, strengthening south-south relationships in order to gain bargaining power through agreeing on a minimum price becomes necessary. The already existing coffee producing countries association would be a starting point of discussion



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## Chapter 3:

# Asymmetric Price Transmission in Coffee Markets: Impacts of Economic Reforms for Zambia and Tanzania

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### Abstract

Applying threshold autoregression models, we examine effects of market liberalisation on coffee price transmission from world prices to grower prices in Zambia and Tanzania. Contrary to previous studies, structural breaks due to agricultural policy shifts have been identified endogenously to determine the true effects on the data. Generally, results confirm that price transmission improved in the case of Zambia where coffee marketing is fully liberalised although the transmission is asymmetric. In that case, producer prices are able to adjust to correct price decreases more than price increases over an identified threshold. Results indicate that examining price transmission without taking into account structural breaks inevitably leads to false rejection of the null hypothesis of symmetric transmission.

### Key words

Economic Reforms, Coffee Markets, Asymmetric Price Transmission, Threshold Autoregression, Endogenous Structural Breaks.

### 3.1 Introduction

During the 1980s and 1990s, most countries in sub-Saharan Africa undertook extensive economic reforms to move to a more market-based development strategy (White and Leavy, 2001). Because agriculture plays a significant role in most of the countries, market reforms in the agricultural sector took a key position in the economic reforms (FAO, 2003). The reforms which included removal of price controls, trade liberalisation, and privatisation of government owned agricultural enterprises, were aimed at improving producer prices and enhancing trade efficiency. However, the poor performance of the agricultural sector (stagnant growth, poor and volatile prices, unstable markets) coupled with increasing poverty levels on the continent, has raised questions about the effects of the reforms (see e.g. White and Leavy, 2001; Widner, 1994). While some studies have maintained that trade liberalisation has led to improvements in the agricultural sector, there is growing body of literature stating that the reforms have, inevitably, led to the current hardships in Africa. Others argue that the reforms paid less attention to fundamentals of market functioning, which the poor, often uneducated farmers, could inexorably be exposed to.

In the Coffee industry particularly, most empirical studies have found that although economic reforms have improved price transmission from world prices to producer prices, the transmission has become more asymmetric with price decreases in the world price being transmitted to producer prices faster than price increases (Krivonos, 2004; Warako, 2008, Fafchamps and Hill, 2008). Others have argued that coffee market liberalisation has led to increased producer prices, though the prices have become more volatile (Hill, 2010). On the contrary, other studies have linked market liberalisation and fall of cooperatives to reduced farmers bargaining power, leading to low producer prices which do not reflect changes in world prices (Kaplinsky, 2004; Slob, 2006). In theory, when price adjustments are not efficiently conveyed to producers or consumers, market intermediaries are benefiting from imperfections and are reducing market transparency (Le Goulven, 2001). Particularly the ever widening gap between coffee retail prices in the high income countries and producer prices in the growing countries means that either the producers are not benefiting from price increases or the consumers are not benefiting from price

decreases. The fact that coffee is mainly produced in low income countries while consumption is mostly in the high income countries means a more complex price pass through that involves the north and the south.

Although the number of studies on the impact of economic reforms on producer prices has increased in the recent past, many price transmission articles published over the past two decades have not paid attention to possible anomalies, such as structural breaks and asymmetries (Abdulai 2007). Even though there is high evidence of asymmetric price transmission (APT) in agricultural commodities (Meyer and von Cramon Taubadel, 2004), there has been very little empirical investigation in the coffee industry. The few studies that have attempted to discuss APT in coffee include Krivonos (2004), who investigated impact of economic reforms on price transmission from world to various producing countries. Krivonos found that the speed of adjustment of coffee producer prices improved in sub-Saharan Africa following economic reforms compared to South America though price increases were transmitted slower than price decreases- an indication of APT. Another study by Fafchamps and Hill (2008) on Uganda's Robusta coffee found evidence suggesting that price increases in the international market were transmitted to local traders but not to producers. Warako et. al. (2008) found that the share of producer prices in world price substantially increased for all types of coffee in Ethiopia since the introduction of economic reforms although the transmission was symmetric.

However, the studies motioned above did not take into account the fact that a threshold value may have to be reached before price changes in one market are provoked in another market, considering that transaction costs such as menu costs prevent agents from adjusting prices continuously. Second, the studies paid no attention to possibilities of endogenous structural breaks in the data. This study fills in these gaps by first identifying thresholds in the price movements that can potentially alter the speed and magnitude of the transmission. Thus, the price transmission is examined according to whether the prices are increasing or decreasing. Second, this study identifies the economic reform periods using structural break unit root tests. This is based on the understanding that structural breaks can lead to more rejection of the null hypothesis of symmetric transmission than appropriate (von Cramon-Taubadel and Meyer, 2004).

This study specifically examines the impact of the policy changes on the rate and magnitude of price transmission in a completely liberalised coffee industry country Zambia as well as Tanzania, a country that is still under considerable marketing regulations in the industry (Baffes, 2004). Given that policies were implemented over a period of time, we identify the structural breaks endogenously to ensure the correct effect of policy shifts on the data. As literature would reveal, this is the first study that has employed endogenous structural breaks in asymmetric price transmission analysis.

Different sources of APT have been examined in the literature. Market power that rises from imperfect markets is the most widely cited source of APT. Rationally, under imperfect markets; any price movement that squeezes the margin is transmitted more rapidly than any price movement that enlarges the margin (Meyer and von Cramon-Taubadel, 2004). Depending on the price relationship, two types of APT can be observed. Either market agents transmit price decreases from world prices to producers faster than they transmit price increases or a situation where price increases from the producers are transmitted faster to the consumers than price decreases. In this case of coffee, price decreases from the world market are expected to be transferred faster to the producers than price increases. The high level of market concentration at the roasting and trading stages of coffee pave way for roasters to be slow or less likely to pass on price decreases to consumers or retail price increases to producers. The international coffee market is highly concentrated such that, the top five importers, i.e. Kraft General Foods Jacobs Suchard, Nestle, Douwe Egberts, Tchibo and Eduscho, account for over 40 per cent of total global trade, while the top ten account for more than 60 per cent (Fitter and Kamplinsky 2001; Slob, 2006). Ward (1982) also argues that market power can lead to APT if the oligopolistic traders are reluctant to risk losing market share by increasing outside prices.

Another form of APT arises from high transaction costs, particularly menu costs that prevent economic agents from adjusting prices continuously. Adjustment only takes place after a certain threshold. Threshold price transmission is based on the understanding that prices in one market may not be transferred to another, vertically or horizontally connected market until the price difference reaches a certain threshold



(Enders and Granger, 1998). A related cause of APT is asymmetric movement of information from a central market to peripheral market (Abdulai, 2000). By virtue of being at the centre of the network of information, the central market price may tend to be less responsive to price changes in the peripheral markets.

### **3.2 Modelling Asymmetric Price Transmission**

Various economic models for examining APT have been employed in Literature. The models can broadly be classified into two. The first class of models are those that segment the price variables into positive and negative regimes. Houck (1977) introduced this class of models using a static model. One shortcoming of Houck's procedure is that it implicitly assumed that the properties of the series included linearity and stationarity, in such a way that, where those properties did not apply, the results would carry incorrect implications for inference about market symmetry (Gauthier, 2003). Although Houck's model was later modified by Ward (1982) to include lagged values of the independent variable in order to account for dynamic responses, it still assumed stationarity and linearity in the data. Studies that have applied this class of APT models include von Cramon (1998) and Aguiar and Santana (2002).

The second class of APT models include those that are extensions to the basic cointegration theory and deals with nonlinearities in cointegration relationships. The models take into account time series properties of stationarity. They include threshold autoregression models (TAR) with its extensions; SETAR (self exciting threshold auto regression) which distinguishes regimes in time series dynamics with potentially different parameters (and thus dynamic properties) of each regime; STAR (smooth adjustment autoregression) which allows for smooth transition of adjustments between regimes (Chan and Tong, 1986); and the MTAR (momentum threshold autoregression) which allows the degree of autoregressive decay to depend on the state of the first difference of the variable in a model. While the TAR model can capture asymmetrically 'deep' movements in a series, the MTAR captures the possibilities of asymmetrically sharp or steep movements in a series (Enders and Granger, 1998). In this study, both TAR and MTAR models are employed and compared. Several studies including that of Enders and Siklos (2001) and Abdulai

(2002) found the power of the MTAR test to be many times higher than that of the symmetric Enders-Granger cointegration tests.

Cointegration models are based on the theoretical understanding that explains convergence of residuals of a pair of prices to long run equilibrium (Granger, 1983). The models imply that two or more integrated time series of any order have a linear combination of a lower order of integration. That is, if two or more series, each of which are  $I(1)$  are cointegrated then there exists a stationary representation that is called the error-correction representation (Engle and Granger, 1987). The models suggest that prices move closely in the long run, although in the short run they may drift apart. The Engle and Granger (1987) discuss a symmetric cointegration model that includes an error correction model to examine short run adjustments to the long-run equilibrium.

Taking  $P_{1t}$  as producer price in Zambia or Tanzania at time  $t$  and  $P_{2t}$  as world prices at time  $t$ , the Engle granger two-step symmetric cointegration model is represented as:

$$P_{1t} = \beta_0 + \beta_1 P_{2t} + \mu_t \quad (1)$$

Where  $P_{1t}$  must be non-stationary and integrated of the same order e.g.  $I(1)$ ,  $\beta_i$  are the parameters to be estimated, and  $\mu_i$  is the disturbance term that may be serially correlated.

In the second step, the residual from equation (1) are used to estimate  $\rho$  in the following relationship;

$$\Delta\mu_t = \rho\mu_{t-1} + \sum_{i=1}^k \rho_{t-i} v_t \quad (2)$$

Where,  $v_t$  is a white noise process. It then follows that, if  $\rho = 0$  the null hypothesis of no cointegration is not rejected while if  $-2 < \rho < 0$ , then the residuals in (1) are stationary with mean 0. In this case (1) is an attractor such that its pull is strictly

proportional to the absolute value of  $\mu_t$  (Enders and Siklos, 2001). Testing the null hypothesis of ‘no cointegration’ is similar to testing for unit root. Enders and Siklos, 2001 introduce several statistics to test the residuals of the OLS regression of the levels’ data for unit root.

Error correction model supplements the cointegration model by capturing the effect of adjustment of the dependant variable when it deviates from the long run equilibrium. We present the error correction model in two simultaneous equations taking each of the two prices as a dependant variable. The model is presented as:

$$\left. \begin{array}{l} \Delta P_1 \\ \Delta P_2 \end{array} \right\} = \delta_t (P_{1t} - a_t - P_{2t}) + \sum_{i=1}^k \beta_{1i} \Delta P_{1t-i} + \sum_{i=1}^k \beta_{2i} \Delta P_{2t-i} + v_t \quad (3)$$

where  $v_t$  is a white noise disturbance term,  $k$  is the lag length and the error correction mechanism is given by the term in parenthesis.  $P_{1t}$  and  $P_{2t}$  are coffee producer and world prices respectively. The  $k$  lag is set to correct for serial correlation using a combination of methods such as the Akeike Information Criteria (AIC) and the Bayesian Information Criteria. A model with smaller values of AIC is considered better than one with a larger value. The AIC values from the TAR and MTAR models are therefore examined to establish the best model. The Durbin Watson (DW) value is used to check if there is no serial correlation. Ideally, when there is no serial correlation, the DW value should be around 2. Values greater than 2 indicate negative serial correlation, and those below 2 are an indication of positive serial correlation.

A major limitation to the Granger and the Engle-Granger cointegration models is that they implicitly assume a linear adjustment mechanism which could lead to misleading results in the presence of asymmetric adjustments (Enders and Siklos 2001). The models assume that tendency to move towards long run equilibrium is present every time which may not be the case. According to Enders and Granger (1998) the cointegration tests from Engle-Granger are misspecified if the adjustment to long run equilibrium is asymmetric. Another weakness of the symmetric cointegration model is that a statistically significant coefficient may be due to common trends in the price

pairs from factors such as population growth, inflation or climate patterns rather than price integration (Abdulai, 2007).

To exploit the possibility of asymmetries in price cointegration, we employ a threshold cointegration model that recognises the fact that a shock may have to reach a significant level before a response is provoked. A threshold regime switching model known as the threshold autoregression was first proposed by Tong (1978) and later discussed in detail by Tong and Lim (1980), Tong (1983), Balke and Fomby (1997), Enders and Granger (1998) and Enders and Siklos (2001). Later important application of the model in the form of auto regression to account for potential nonlinearities and asymmetries in the adjustment of individual prices and providing more information regarding the dynamics of the data include Abdulai (2000,2002;2007), Strikholm and Teräsvirta (2005), Hansen and Seo (2002) and Gonzales et. al. (2003). A detailed explanation of the model is found in Enders (2004) and Zapata and Gauthier (2003).

TAR is a nonlinear regime switching model that allows the researcher to differentiate between two periods when the spread is away from the long run equilibrium, that is, when the system diverts to levels above or below the equilibrium, which is essentially, the estimated threshold value (Enders, 2004). Threshold models assume that tendency to move to long-run equilibrium is not always present due to the presence of transaction costs that may prevent economic agents from adjusting continuously (Abdulai, 2002). The model suggests that adjustment towards equilibrium takes place only if the equilibrium error gets larger than a certain threshold value. In other words, as long as the deviations from equilibrium are small, the variables evolve independently and become cointegrated once the disequilibrium is substantial.

Balke and Fomby (1997), Enders and Granger (1998) Enders and Siklos (2001) introduce a two-step approach to examine threshold cointegration; residuals are obtained from a linear cointegration analysis in the first step and in the second step, threshold auto-regression is employed to take into account asymmetric movements of the residuals. To account for short term dynamics, a test for cointegration with asymmetric error correction model (ECM) can be employed. Granger and Lee first

introduced asymmetric error correction specification where they segment positive and negative components of the first differences. Later extensions of the ECM to threshold adjustments have been discussed by Enders and Granger (1998) and Enders and Siklos (2001), and more recently Wolfram (2005).

Again using the residuals from equation (1), a 2-regime TAR model can be presented as;

$$\Delta\mu_t = I_t\rho_1(\mu_{t-1}) + (1-I_t)\rho_2(\mu_{t-1}) + \sum\beta_i\Delta\mu_{t-1} + \mu_t \quad (4)$$

$$I = \begin{cases} 1 & \text{if } \mu_{t-1} \geq \tau \\ 0 & \text{if } \mu_{t-1} < \tau \end{cases} \quad (5)$$

In this regard, the first lag of the residuals is taken as the threshold variable, where the system will be 1 when the deviations from long-run equilibrium is above the threshold or equal to the threshold and 0 when the deviation is below the threshold. There are several techniques developed to estimate a consistent threshold (e.g Tsay, 1998; Chan, 1993; 2004)

Modifying equation (4) to fit in the first difference of the lagged variable, the MTAR model is given by:

$$I = \begin{cases} 1 & \text{if } \Delta\mu_{t-1} \geq \tau \\ 0 & \text{if } \Delta\mu_{t-1} < \tau \end{cases} \quad (6)$$

Similar to the Engle-Granger cointegration model, an error correction model can be estimated once threshold cointegration is confirmed. We present the threshold ECM as follows:

$$\left. \begin{matrix} \Delta P_1 \\ \Delta P_2 \end{matrix} \right\} = \sum_{i=1}^k \alpha_i \Delta P_{1t-i} + \sum_{i=1}^k \beta_i \Delta P_{2t-i} + \gamma_1 Z_{-plus_{t-1}} + \gamma_2 Z_{-minus_{t-1}} \quad (7)$$

Where  $Z_{-plus}$  and  $Z_{-minus}$  are dummy variables representing the state when price differences are above and below the threshold respectively.  $\alpha_i, \beta_i, \gamma_1$

and  $\gamma_2$  are parameters to be estimated.  $\gamma_1$  and  $\gamma_2$  represent the speed of adjustment of the dependant variable in each state.  $v_t$  is a white noise disturbance term,  $k$  is the lag length.  $P_{1t}$  and  $P_{2t}$  are producer and world prices respectively.

Many researchers set Zero as a threshold coinciding with long run equilibrium, but Enders (2004) points out that a non-Zero threshold has an advantage in that it captures strategic behaviours and adjustment costs that are rarely observed with small changes. He argues that a TAR model with threshold equal to Zero does not display significant degree of asymmetry, possibility that the threshold could not be Zero. Chan(1993) introduces a method of estimating a consistent threshold through grind search over all possible values. Enders (2004: pp 413) explains the application of the Chan procedure TAR models. First, the threshold variable is sorted in ascending order. Ideally, the first and last 15 percent values of the threshold variable are excluded such that the search is limited to the middle 70 percent. Then a search is done over the potential threshold in order to minimise the Sum of Squared Residuals (SSR). The estimated threshold that minimises the SSR is the optimal threshold as illustrated in Figure 3.1.

Figure 3.1 A threshold of 0.04 identified from the minimum RSS



Source: Own computation based on MTAR estimation for Tanzania and World Prices

If there are more than one threshold (more than two regimes) then there will be several minima of the SSR (Strikholm and Teräsvirta, 2004).

### 3.3 Data Description

Monthly coffee prices are employed to examine price transmission. The series' include monthly observations of Arabica coffee producer prices for Tanzania and Zambia, measured in US cents per pound (lb)<sup>8</sup>. The producer price is the actual price received by the farmers which have been obtained from the international Coffee Organisation (ICO). The response of producer prices is examined in relation to the world prices taking the producer composite indicator prices (CIP)<sup>9</sup>. The CIP is calculated by ICO based on market share of exports of each group of coffee weighted. All the price series have 273 monthly observations covering the period January 1986 to September 2008. During this period, world prices had an average of \$1.10 per pound, which was much higher than the two producer prices. Zambian prices had an average of \$0.80 per pound while Tanzanian prices have been the lowest with an average of \$0.58 (see Figure 3.1 and 3.2).

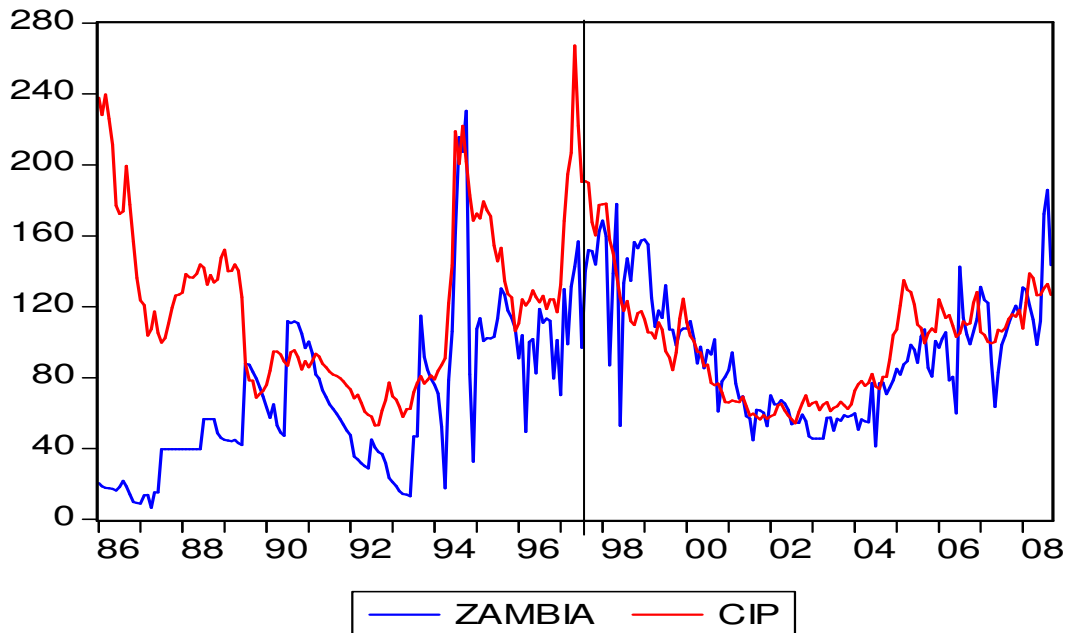
For Zambia, coffee marketing has been fully liberalised where producers sell directly to traders. Even before the economic reforms, Government intervention in the coffee industry was very limited. Nevertheless, reforms in other sectors of the economy could have some direct impact on the coffee industry, such as currency liberalisation and the restructuring of Government institutions. Therefore, changes in price transmission from world prices are expected over the observed period. The pre-economic reforms in Zambia have had negative implications on agriculture during 1980s due to several exogenous and domestic policy components that had a strong anti-trade bias and an estimation of the real exchange-rate distortion (IFPRI, 1993).

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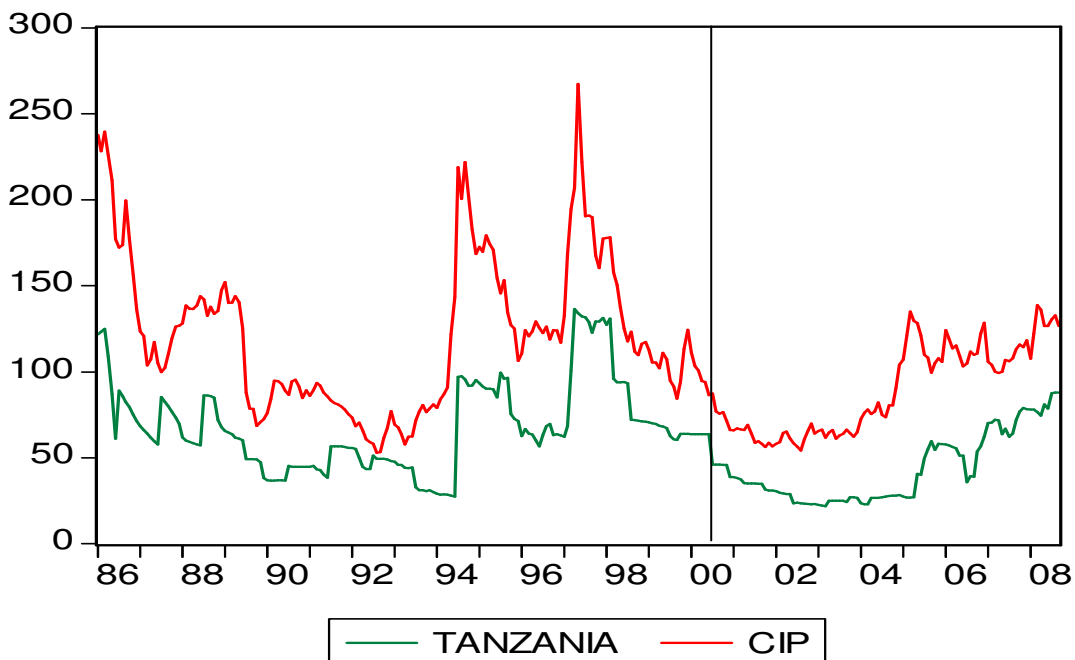
<sup>8</sup> Lb is the abbreviation for Libra which is the roman word for pound. One pound is 0.453 592 37 kilo grams (kgs).

<sup>9</sup> CIP is the price calculated based on market share of exports of each group of coffee weighted in accordance with Annex 1 of EB-3776/01 rev. 1 of the International Coffee Organisation (ICO).

**Figure 3.2 Zambia and CIP price trends showing the structural break in 1998:05**



**Figure 3.3 Tanzania and CIP price showing the structural breaks in 2000:06**



For Tanzania, although the reforms led to improvement of private sector participation, the functioning of input markets deteriorated as provision of credit declined. This, coupled with the decline in quality and quantity of services such as research and extension, resulted in drastic decline of overall quality of coffee. As a result Tanzanian coffee prices continue to trail far below world prices and remain the lowest



in sub-Saharan Africa. Krivonos (2004) notes that Tanzania is the only country where the target share of producer prices in the world market price did not increase after market liberalisation.

Prior to the economic reforms, farmers had been required to sell their export coffee through the Government-run Moshi Coffee Auction. USAID (2006) described the Moshi Coffee Auction as impractical because of its 22,000 pounds export minimum which effectively barred small farmers from participating as individuals<sup>10</sup>. In 1994 cooperatives lost their monopoly after the Government passed a legislative to allow multinational and domestic buyers from Individual farmers. However in 1999/2000, the Government reversed the liberalised trade policies as it was felt that the policies did not benefit the small scale farmers (Baffes, 2004). Currently, all the coffee produced in Tanzania is traded through the Government-run auctions. The issuing of trading license also remains restrictive (Krivonos, 2004).

### **3.4 Results and Discussion**

The sequence of reporting the results are as follows: In the first part the results of unit root tests are discussed. Next, the results from the Engle and Granger cointegration and ECM are discussed before turning to the results of the TAR and MTAR models and the threshold ECM. The last part examines impulse response of the producer prices to a shock provoked by changes in the world prices.

#### **3.4.1 Unit root tests**

The hypothesis that the price series are nonstationary is tested using both the Augmented Dickey-Füller (ADF) and Lee and Stracizichi Lagrange Multiplier (LSLM) structural break unit root tests suggested by Lee and Stracizichi (2004). The Akaike information criterion was employed to determine the appropriate lag length which varied across the series. The DW values also confirmed absence of autocorrelation.

All the series were non-stationary at level but stationary at first difference from both the ADF and the LSLM tests. The identified structural break for Zambia is May 1998 which coincides with the completion of economic reforms in the agricultural sector. For Tanzania a structural break is affected in the data in June 2000, a period when the coffee market liberalization policy was reversed giving back to the cooperatives the monopoly of purchasing coffee from the farmers. This implies that, the actual liberalisation policies that took place in Tanzania in the late 1980s and early 1990s did not have significant effect on the coffee price movements. Therefore, the identified structural break in the case of Tanzania is actually the reverse of liberalisation policies. For World prices, a structural break occurred in June 1989 coinciding with the liberalisation of the international coffee market following the collapse of the international coffee agreement in 1989 which had regulated international coffee supply and price. The results of the unit root tests with structural breaks are presented in Table 3.1 together with the results of normal ADF tests.

Table 3.1: Unit root test results

	ADF(Intercept, no trend)		LSLM (Intercept no trend) Structural Break	LSLM (Intercept no trend)	
	Level	1st difference		Level	1st Differences
Log Zambia 9 lags	-2.470	-7.656***	1998:05	-2.586	-7.308***
Log Tanzania 13 lags	- 2.162	- 4.627***	2000:06	-2.511	-4.681***
Log World Price (CIP) 10 lags	-2.287	-4.723***	1989:06	-2.2415	-4.974***

\*\*\*, \*\*, \* denotes rejection of the null hypothesis of stationarity at 1%, 5% and 10% significance levels respectively.

Critical values for ADF tests are from MacKinnon (1996).

Critical Values for LSLM Unit Root Test (Crash model) are from Schmidt and Phillips (1992)

### 3.4.2 Results of the symmetric cointegration model

Table 3.2 reports results of the Engle-Granger symmetric cointegration model estimation (equation 1). For Zambia, the null hypothesis of no cointegration between the Zambian price and the world price is overwhelmingly rejected in the full sample. The t-statistic value of -3.595 is much higher than the 1% critical value of -3.44 indicating rejection of the null hypothesis. However, examining the relationship while taking into account the economic reforms, the results show that in the first sub-sample, the two price series did not co-move. The t-statistic value of -2.029 is lower than the 10% critical value of -2.57; hence the no-cointegration null hypothesis cannot be rejected. A long-run relationship is however observed after economic reforms. The null hypothesis of no cointegration is highly rejected at 1% given a t-statistics value of -3.845. The results indicate that economic liberalisation, which included trade and currency liberalisation, among other reforms, has led to improvements in price transmission. These findings support most findings from other coffee producing countries showing improvement in price transmission after economic reforms (see Krivonos, 2004). The Estimated  $\beta_1$  coefficients shows that in long-run a one unit change in the world prices leads to a 0.998 increase in the Zambian coffee prices after the economic reforms. However, in the pre-reform period, the change only led to a 0.428 increase.

Table 3.2: Results of the Engle and Granger cointegration

Zambia-World Prices					
Sample	$\beta_0^a$	$\beta_1$	$R^2$	$\rho_1^b$	DW
1986:01-2008:09	2.690 (5.433)***	0.330 (3.096)**	0.978	-0.124*** (-3.595)	2.006
1986:01-1998:05	2.000 (2.616)*	0.428 (2.667)*	0.967	-0.091 (-2.024)	2.022
1998:05-2008:09	-0.042 (-0.127)	0.998 (13.705)***	0.998	-0.332*** (-3.845)	2.006
Tanzania-World Prices					
Sample	$\beta_0$	$\beta_1$		$\rho_1^b$	
1986:01-2008:09	-0.661 (3.039)	1.001 (21.389)***	0.995	-0.117*** (-4.093)	1.985
1986:01-2000:06	0.285 (1.193)	0.816 (16.210)***	0.997	-0.150*** (-3.301)	1.974
2000:06-2008:09	-1.088 (-2.320)	1.068 (10.145)***	0.994	-0.111 (-2.422)	2.051

\*\*\*, \*\*, \* denotes rejection of the hypothesis at the 1%, 5% and 10% significance levels respectively.

CIP is Composite Indicator Price calculated by ICO representing world producer prices

Z represents the Tanzanian coffee price and Z represents the Zambian coffee price

Turning to Tanzania, there is a long-run relationship with world prices in the entire sample. When this relationship is examined in two sub-periods, the estimations show that the two prices are cointegrated only in the first sub-sample and not the second sub-sample. According to the Tanzanian coffee trade policies, the first sub-sample is the period the government allowed the private traders to buy directly from the farmers, reducing the monopoly of cooperatives. The coffee market became liberalised during this period. However, for the period between 2000:06 and 2008:09, there was no long-run relationship between the two price series. This could be due to the fact that, in the year 2000 the government reversed the liberalisation policy, giving back the monopoly of buying coffee to the cooperatives. As discussed earlier, high government intervention in commodity markets prevents price transmission.

The high r-squared values indicate that the models have a good fit, while the Durbin Watson (DW) values, which are close to 2, are an indication that there is no autocorrelation in the residuals.

### **3.4.3 Threshold Cointegration Results**

This section presents cointegration and error correction results for both the TAR and MTAR model. However examining the AIC and BIC values for both models shows that the MTAR model provides a better fit than the TAR model. Therefore, conclusions of this study are drawn only from the results of the MTAR cointegration and ECM. Supply response functions are also examined based of the rate of adjustment from the TAR model.

#### **TAR Model Results**

Results for TAR which are presented in Table 3.3 indicate that Zambian Coffee producer prices and world prices are not cointegrated over the entire sample. However, the null hypothesis of no-cointegration is strongly rejected in the post-reform period, but could not in the pre-reform period. This means that after the reforms the prices changes in world prices are transmitted to the producers while prior to the reforms this transmission was not significant. The coefficients on both negative and positive shocks show that adjustment improved after the reforms. For

example, while the Zambian coffee prices adjusted by 0.15% to correct a deviation from long-run equilibrium due to a decrease in the world prices prior to the reforms, this adjustment increased to increase to 2.45% after the economic reforms. This implies that economic reforms improved price transmission. Test for symmetry in the adjustment was done only for the post economic period in which the cointegration test is significant. According to the F-statistic value of 22.817, which is way above the 1% critical value of 8.35, the null hypothesis for  $\rho_1 = \rho_2$  could not be rejected. In that case price transmission is asymmetric (indicating presence of a threshold). These results confirm the importance of taking into account structural breaks in the data. Making conclusions based only on results from the entire sample which show no price transmission, would be misleading as the transmission is, in actual fact, established in the post economic reform period.

Table 3.3 Threshold Autoregression Results

Zambia-World Prices						
Sample	$\tau$	$\rho_1^a$	$\rho_2$	$\phi^b$	$\rho_1 = \rho_2^c$	DW
1986:01-2008:09	-0.567	-0.124 (-2.348)	-0.219 (-2.000)	4.502	---	2.020
1986:01-1998:05	-1.006	-0.074 (-1.128)	-0.160 (-0.518)	0.780	---	2.007
1998:05-2008:09	-0.235	-0.217 (1.990)	-2.541 (-5.220)	14.605***	22.817***	1.944
Tanzania-World Prices						
Sample	$\tau$	$\rho_1^a$	$\rho_2$	$\phi^b$	$\rho_1 = \rho_2^c$	
1986:01-2008:09	0.030	-0.258 (-3.265)	-0.204 (-2.921)	8.604***	0.299	1.977
1986:01-2000:06	-0.030	-0.157 (-2.452)	-0.678 (-4.157)	11.451***	8.976***	1.985
2000:06-2008:09	-0.268	0.024 (0.218)	-0.034 (-0.205)	0.051	---	2.054

- $\rho_1$  and  $\rho_2$  are the estimated coefficients from the threshold cointegration regression. The numbers in parentheses are  $t$ -statistics.
  - $\phi$  are F-statistics testing the null hypothesis of no-cointegration (i.e.  $\rho_1 = \rho_2 = 0$ )
  - Are F-statistics testing the null hypothesis of symmetric cointegration (i.e.  $\rho_1 = \rho_2$ )
- \*, \*\*, \*\*\* denotes rejection of the null hypothesis at the 10%, 5% and 1% level respectively. Critical values at the 1%, 5% and 10% level of significance are 8.35, 6.29 and 5.39 respectively for a model with consistent threshold (Enders, 2004)
- indicates that no tests was carried out because there is no cointegration between the price pairs.

For Tanzania, results show evidence of a long-run but symmetric relationship with world prices in the full sample. The F-statistics value of 8.604 indicates rejection of the null hypothesis of no-cointegration at 1% significance level. On the other hand, the null hypothesis of symmetric adjustment could not be rejected at conventional levels over the entire period. However, the tests from the first sub-sample, during the time that the coffee trade was liberalised, show a long-run and asymmetric relationship between Tanzania and world prices. On the contrary, the results from the second sub-sample, the period when the liberalisation trade policy was reversed, shows no-cointegration between the two price series. Again these results indicate that economic reforms that support trade liberalisation lead to improvement in price transmission from world prices.

#### TAR ECM results

Table 3.4 shows the results of the short-run adjustment to the long-run equilibrium. Since the error correction estimations examine rate of adjustments were price pairs are cointegrated, only the full sample for Zambia, the full sample for Tanzania and the first sub-sample for Tanzania are examined as reported in Figure 3.4.

Figure 3.4 TAR Error Correction Model results

Zambia-World Prices				
	Zambia		World Prices	
Sample	<i>Z – Plus</i>	<i>Z–minus</i>	<i>Z – Plus</i>	<i>Z–minus</i>
1998:05-2008:09	-0.393(-2.608)	-0.551(-3.266)**	-0.061(-0.807)	-0.001(-0.019)
Tanzania-World Prices				
	Tanzania		World Prices	
Sample	<i>Z – Plus</i>	<i>Z–minus</i>	<i>Z – Plus</i>	<i>Z–minus</i>
1986:01-2008:09	0.016(0.519)	-0.075(-2.203)	-0.866(-1.877)	-0.149(-2.915)**
1986:01-2000:06	-0.121(-1.900)	-0.236(-3.422)**	0.081(1.963)	-0.141(-3.148)**

The results indicate quicker adjustment for negative deviations from long-run equilibrium in all the three cases. It is also quiet evident that the Zambian prices do

not influence world prices but the other way round given the insignificant results from the model when the world price is the independent variable. Without even carrying out causality tests, it can be concluded that causality is in one direction with Zambian prices being caused by world prices. This is as expected because Zambia, being a very small exporter of coffee, is not likely to have significant influence on the world price. For Tanzania, there is causality in both directions given the significant coefficients from the model when the world price is the independent variable. However, as mentioned earlier, this study also examines the MTAR where the overall conclusions are drawn from.

### MTAR Results

From the MTAR model, unlike in the TAR model, the null hypothesis of  $\rho_1 = \rho_2 = 0$  (no cointegration) is rejected in every case. Similarly, the null hypothesis of  $\rho_1 = \rho_2$  (symmetric adjustment) is rejected, apart from the pre-reform period for Zambia.

Table 3.5: MTAR model estimation results

Zambia-World Prices						
Sample	$\tau$	$\rho_1^a$	$\rho_2$	$\phi^b$	$\phi^c$	DW
1986:01-2008:09	-0.149	-0.094** (-2.702)	-0.327*** (-3.869)	10.535***	6.760**	2.039
1986:01-1998:05	-0.159	-0.1003* (-1.988)	-0.348** (-2.897)	5.787*	3.806	2.019
1998:05-2008:09	-0.167	-0.127 (-1.235)	-0.753*** (-4.315)	9.399***	11.467***	2.049
Tanzania-World Prices						
Sample	$\tau$	$\rho_1^a$	$\rho_2$	$\phi^b$	$\rho_1 = \rho_2^c$	
1986:01-2008:09	-0.040	-0.207** (-3.546)	-0.055 (-1.249)	6.532*	5.048*	1.990
1986:01-2000:06	-0.098	-0.089 (-1.639)	-0.393*** (-4.331)	9.982***	9.191***	2.032
2000:06-2008:09	0.042	-0.280** (-3.692)	-0.018 (-0.337)	7.353**	6.043*	1.995

\*\*\*, \*\* and \* represents significance at 1%, 5% and 10% respectively

z-plus are F-statistics value testing the hypothesis that all lagged price increases above the threshold are jointly equal to 0

z-minus are F-statistics value testing the hypothesis that all lagged price decreases below the threshold are jointly equal to 0

The same results are observed in the first sub-sample for Tanzania. However, different results are observed for Tanzania in the full sample and the second sub-sample where  $\rho_1$  is larger than  $\rho_2$ . These results mean that negative shocks are not passed on to the producers due to price stabilisation policies. In that way the shocks are absorbed by Government which may not be sustainable in the long-run.

The estimates for Zambia in the full sample and the second sub-sample show that  $\rho_2$  is more persistent than  $\rho_1$ , an indication that negative shocks are more persistent than positive shocks.

### *MTAR ECM*

Having established the long-run relationship as well as the symmetry of adjustment, the rate of adjustment is examined using the ECM. The results, which are presented in Table 3.5 indicate that adjustment towards the long-run equilibrium is quicker when the price spread deviates below the equilibrium for Zambia in the entire sample and the second sub-sample. For Zambia, the pre-economic reform period, threshold ECM was not estimated because there was no evidence of asymmetric adjustment. As expected, the rate of adjustment to negative world price shocks is quicker than to the positive shocks in entire sample and the post-economic reform period. While negative shocks in the world price are transmitted at a rate of 30% to producers, positive shocks are transmitted much slower at a rate of 10%. Similarly for the post-economic reform period, negative shocks are transmitted at a rate of 75 percent, while price increases are transmitted at 31% percent speed in every period. These finding suggest that due to market power and high transaction costs, agents are more likely to pass on negative price changes while reluctant to pass on price increases to the producers.

On the other hand, the results for Tanzania-World markets are quite different with the exception of the second sub-sample, the liberalized period. Whereas 21 percent of a positive deviation is eliminated within a month, the corresponding figure for negative deviations is just about 5 percent, suggesting that positive deviations are eliminated faster than negative deviations. However, when the policy reforms are considered,



the results appear to differ for the different policy regimes. Specifically, the estimated parameters for the pre-reform period indicate that only 8 percent of positive deviations are eliminated within a month, while 39 percent of negative deviations are eliminated. After the reforms, as much as 28 percent of positive deviations appear to be eliminated within month, while just about 2 percent of negative deviations are eliminated.

Table 3.6: Results of ECM for MTAR

Zambia-World Prices				
	Producer price		World Prices	
Sample	<i>Z - Plus</i>	<i>Z-minus</i>	<i>Z - Plus</i>	<i>Z-minus</i>
1986:01-2008:09	-0.106 (-2.918)**	-0.302 (-3.416)**	0.002(0.245)	-0.048(-1.827)*
1986:01-1998:05	-0.135(-2.477)**	-0.072(-0.727)	0.013(0.869)	0.023(0.879)
1998:05-2008:09	-0.319(-2.233)**	-0.747(-4.146)***	-0.033(-0.518)	0.001(0.014)
Tanzania-World Prices				
	Producer price		World Price	
Sample	<i>Z - Plus</i>	<i>Z-minus</i>	<i>Z - Plus</i>	<i>Z-minus</i>
1986:01-2008:09	-0.163(-3.298)**	-0.112 (-3.235)**	0.0137(0.439)	-0.142(-1.552)
1986:01-2000:06	-0.087(-1.811)*	-0.523(-6.033)***	0.024(0.672)	-0.161(-2.450)**
2000:06-2008:09	-0.427(-3.046)***	-0.191(-1.202)	-0.161(-1.703)	-0.197(0.052)

\*\*\*, \*\*, \* denotes rejection of the hypothesis at the 1%, 5% and 10% significance levels respectively.

$\tau$  is the threshold value determined along with the values  $\rho_1$  and  $\rho_2$

$\phi$  are F-statistics values for TAR and MTAR with unknown threshold testing the null hypothesis

$\rho_1 = \rho_2 = 0$

$\rho_1 = \rho_2$  are F-statistics values testing the null hypothesis of symmetric adjustments i.e.  $\rho_1 = \rho_2$

CIP is Composite Indicator Price calculated by ICO representing world producer prices

Z represents the Tanzanian coffee price and Z represents the Zambian coffee price

The results are in line with the policy reforms in the two countries. In Zambia, reforms were implemented to ensure privatization of the coffee sector and to allow private firms to purchase coffee from producers and sell on the world markets. In Tanzania,

reforms that took place in 2000 rather reversed the previous privatization policy, and rather introduced policies to ensure stable prices for farmers. This involved ensuring that farmers benefitted from higher world market prices, while price declines on the world market were absorbed by the government through stable prices.

Like the error correction estimations from the TAR models, MTAR error correction coefficients presented in Table 3.5, show faster adjustments at a rate of 33.3 percent for price negative shocks than positive shocks where adjustment is only by 10.7 percent in the entire sample.

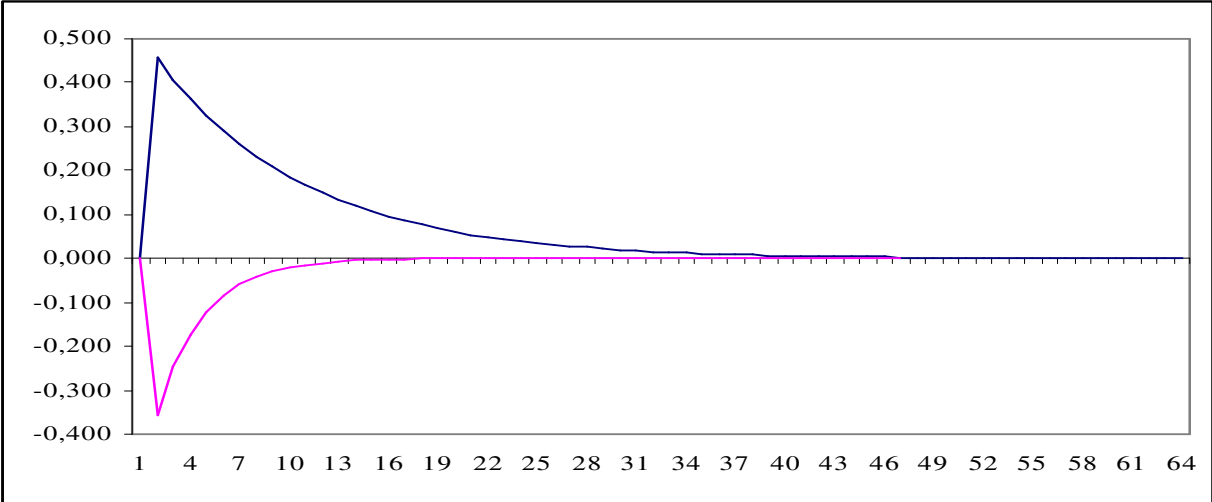
#### **3.4.4 Impulses response**

Impulse response measures the time profile of the effect of a shock on the behaviours of a series (Koop et. al, 1996). Therefore, the interpretation of dynamic interrelations among prices in different markets can be best analysed through impulse response functions (Porter, 1995). Impulse response is examined if price relations are found to be cointegrated in order to examine how producer prices respond to negative and positive deviations from the long-run equilibrium. In this subsection, the impulse response is examined only for the price relations that are cointegrated in the MTAR model and exhibit asymmetric price transmission. These include the Zambia- world price cointegration in full sample and in the second sub-sample (after economic reforms) and the Tanzania-world price in the full sample and both sub-samples.

Figure 3.4 shows the response of Zambian coffee prices to negative and positive shocks as a result of changes in coffee world prices. Although the impulse is observed over 100 months, the prices revert back to the normal trend within the first 50 months (5 years). Response is however asymmetric in that, a negative shock in the world prices is fully transmitted to the producers within 16 months while it takes 4 years (48 months) for the producers to fully adjust to a positive shock in world markets. The magnitude of the positive shocks is, however, larger than the magnitude of the negative shocks. This is an indication that the Zambian prices are likely to rise by a larger value when they are hit by a positive shock but decline by a smaller value if hit by a negative shock of the same magnitude. As discussed earlier,

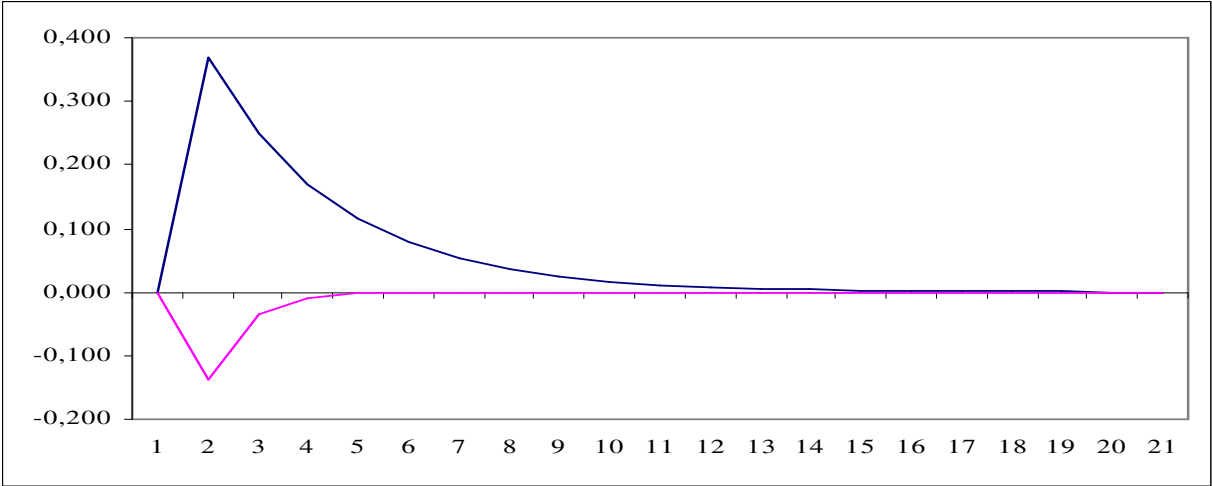
it is important to note here that, asymmetry exists in the form of speed and magnitude and also varies whether the shock is positive or negative.

Figure 3.4 Response of positive and negative shocks for Zambia- full sample



The impulse response of the Zambian prices after the economic reforms has a similar picture. As shown in Figure 3.5 the negative shocks are larger in magnitude and are more persistent than the positive shocks.

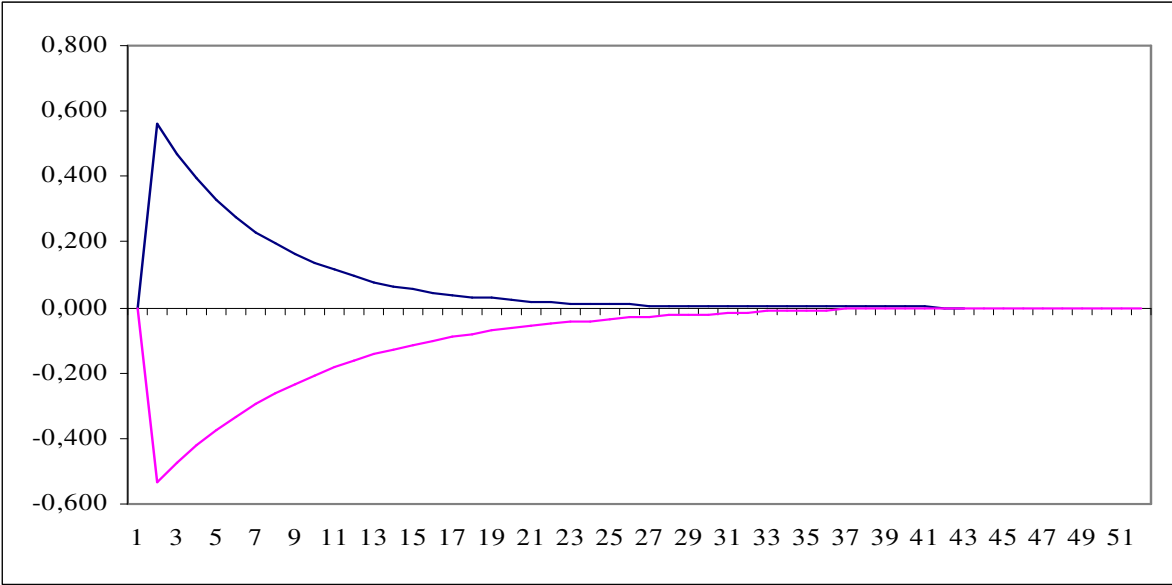
Figure 3.5 Response of positive and negative shocks for Zambia after economic reforms



While it takes approximately 5 months for price decreases in world prices to be transmitted to the coffee producers in Zambia, the price increases take up to 15 months before they are transmitted. This affirms assertions that prices tend to be stickier downwards than upwards in liberalised markets. As discussed earlier, following international coffee market liberalisation after the collapse of the ICA, the markets have become oligopolistic whereby a few firms dominate the industry.

Turning to Tanzania, the impulse response of the coffee prices to deviations from long-run equilibrium differs from the response in the case of Zambia in the full sample as illustrated in Figure 3.6. While negative shocks are more persistent than positive shocks in the Zambian case, positive shocks tend to persist more than the negative shocks in the case of Tanzania. This implies that, for Tanzania, positive deviations from the long-run equilibrium are corrected faster than the negative deviations. It takes 27 months for producer prices to react to price world price increases and up to 37 months for price world price decreases to be transmitted. In such cases, the price decrease from world prices tend to be absorbed by Government in order to achieve price stability policies.

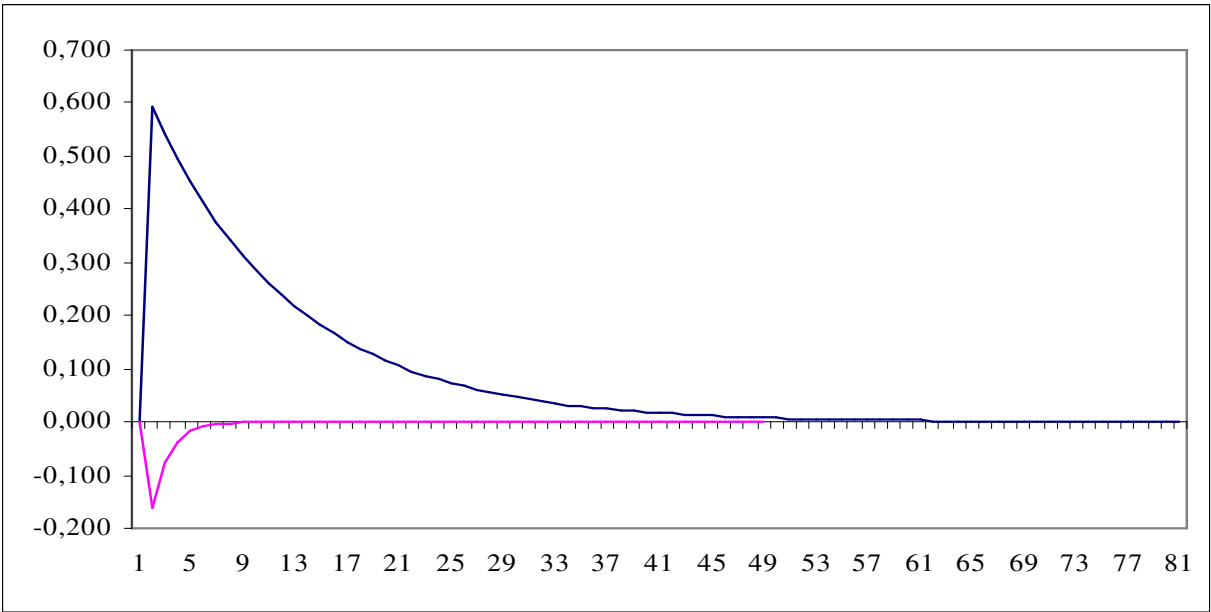
Figure 3.6 Response of positive and negative shocks for Tanzania- full sample



The pattern of the price impulse response to deviations from long-run equilibrium for Tanzania before economic reforms is different from the pattern in the full sample

(Figure 3.7). While in the full sample positive shocks tend to persist over a longer period, in the pre-economic reform period, negative deviations from long-run equilibrium persist longer. Whereas positive shocks only take about 9 months to return to equilibrium, positive shocks take up to 50 months (more than 2 years) before the prices get back to the normal trend. It should be noted that, for Tanzania, this is the period when the coffee trade was liberalised and the cooperatives lost the monopoly of purchasing coffee.

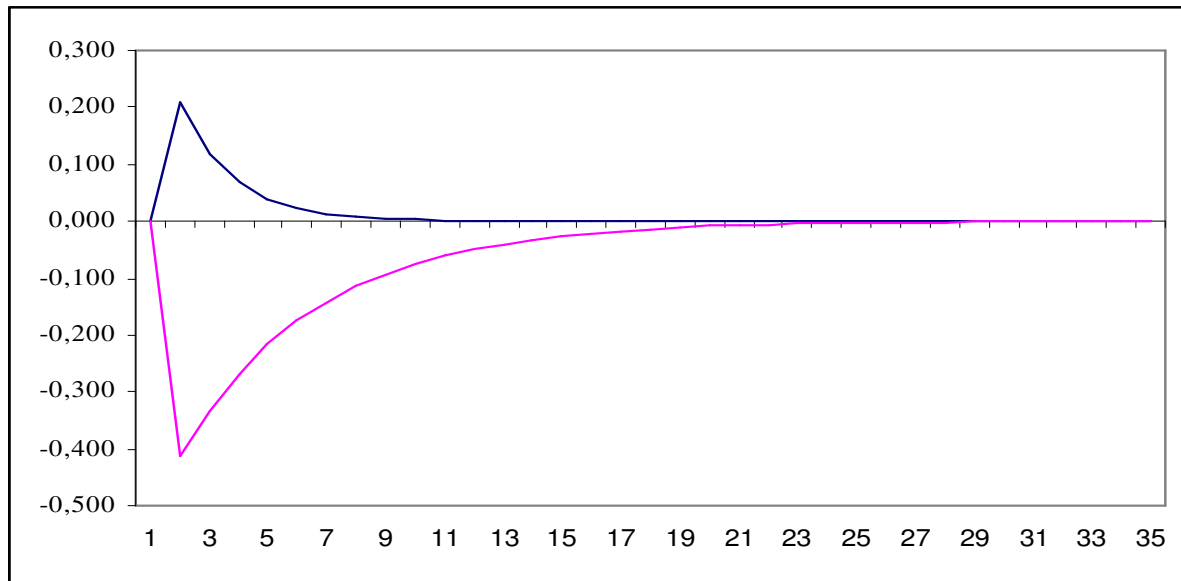
Figure 3.7 Response of positive and negative shocks for Tanzania before economic reforms



Like in the case of Zambia, the results strongly demonstrate asymmetries in the transmission of world price to producer price, a reflection of imperfect markets among other factors.

In the post-economic reform period, when the liberalisation policy was reversed, the Tanzanian prices react slowly to world price decreases but swiftly to world price increases. As illustrated in Figure 3.8, price increases are fully transmitted to the producers within 9 months while price decreases take up to 22 months before they are transmitted.

Figure 3.8 Response of Positive and Negative Shocks for Tanzania Post Economic Reforms



### 3.5 Conclusion

Several conclusions can be drawn from the results of the study. First, it has come out clearly that when data is examined without paying attention to structural breaks, coffee producer prices in Tanzania and Zambia are found to move together with world prices. However, when the sample is divided according to the pre and post-economic reforms period, estimations from the TAR model show that signals from world prices were not being transmitted to Zambia prices in the pre-reform period. As price transmission was only established after economic reforms, it clearly shows that trade liberalisation does connect producer prices. As demand for coffee is likely to increase, following China's economic boom, the producers are in this regard likely to benefit from increased prices in the long-term. If Governments want to aim at improving prices, especially in the case of Tanzania, less control of the marketing system should be considered. However, policies should take into account the fact that improved transmission also means exposing the prices to the volatility of the world price. Therefore, measures should be put in place to ensure that farmers take advantage of market-based risk minimising strategies for coffee prices.

Overall, the study has found that asymmetric price adjustments evident in coffee markets. In Zambia's case, the study has shown that although market liberalisation policies improve price transmission from world prices, price decreases are transmitted faster than price increases. High transaction costs and lack of market information are some of the factors that lead to asymmetric price transmission. As an intervention to ensure efficient price transmission, farmers need to be informed on time, the world market changes. This can only be possible if infrastructure is developed especially in the rural areas where the coffee is grown. Infrastructural development also reduces the transaction costs, another important factor contributing to asymmetric price transmission. In the case of Tanzania, the study has shown that, controlled market policies, although could lead to stable prices, do not help producers benefit from price increases because price transmission is either slow or non-existent. Trade policies that encourage greater integration with world prices can be beneficial to the producers in the long-run, although short-run price volatility can discourage the producers.

Second, our study found MTAR with more power to reject the hypothesis as compared to TAR and the Engle-Granger symmetric cointegration tests. The AIC and SBC values also confirm that the MTAR is a better model. However, both threshold models provide better explanation of short run adjustments and asymmetries compared to the symmetric Engle-Granger cointegration model. In any case, researchers should apply both models because while the TAR model can capture asymmetrically 'deep' movements in the series, the MTAR captures the possibility of asymmetrically sharp or steep movements in a series. A combined application of the two models has been missing in most articles of asymmetric price transmission that have been published in the recent empirical literature.

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## Chapter 4:

### Impact of Economic Reforms on Coffee Price Volatility in Zambia and Tanzania

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#### Abstract

During the 1990s, Zambia and Tanzania both implemented economic reforms that included agricultural market liberalisation with differing levels of depth and impact on coffee markets. This paper investigates the effects of these economic reforms on coffee producer price volatility in the two countries. Unlike most previous work which employ only symmetric GARCH models, this paper employs Threshold GARCH (TGARCH) models to examine asymmetric effects of shocks on volatility, taking into account the fact that positive and negative shocks may not have the same effect on volatility. This is essential for price interventions policy. The results show that market liberalisation led to an increase in coffee price volatility in Zambia. The volatility is asymmetric such that negative shocks lead to more volatile prices than positive shocks of the same magnitude. On the contrary, in Tanzania where coffee market liberalisation has been inconsistent, the reforms have had no significant effects on coffee price volatility.

Key Words: Volatility, Coffee Markets, GARCH, TGARCH, Economic Reforms

## 4.1 Introduction

Designing economic policies to achieve price stabilisation has long been a challenge for most countries in Africa. Agricultural commodity prices have continuously remained unstable, leading to devastating effects on food security and the general welfare of the producers, who are mostly small-scale poor farmers (World Bank, 2009). Low-income countries tend to be vulnerable to price volatility in their export commodities as they have limited ways to protect themselves from global price volatility (Akiyama et. al, 2003). High price volatility makes it difficult for producers to plan production since they do not know in advance how international prices will be. Consequently, governments cannot predict export revenues, and hence, cannot engage in stable socio-economic policies.

Economic reforms in Africa significantly changed the way primary agricultural commodities were marketed (Akiyama et. al, 2003). While price stabilisation was the policy objective prior to the reforms, the main objective after the reforms was to enhance private sector participation in order to enable farmers receive a larger share of the export price. The agricultural reforms introduced by world bank and IMF aimed at reducing state control of agricultural markets thereby opening up to the private sector, thus fostering competitive markets which would lead to increased agricultural production. In general, the reforms included 1) liberalisation of input and output prices by eliminating subsidies on agricultural inputs such as fertilizer and credit, by bringing domestic crop prices in line with world prices, and by ending the practice of imposing a single price for all regions and seasons; 2) reducing overvalued exchange rates by partially liberalising the market for foreign exchange; 3) encouraging private-sector activity through removal of regulatory controls in input and output markets; 4) restructuring and/or privatising public enterprises and restricting marketing boards' activities such as providing market information and maintaining security stocks (Kherallah, 2000, pp9).

Whether producer prices essentially improved in magnitude and stability in the post reform era is a question that most economists have attempted to address in recent studies. Although in-depth empirical studies on coffee price volatility are few, the evidence available shows that price volatility significantly increased after economic

reforms despite the fact that farmers' shares of the retail prices considerably increased (e.g. Karanja et al., 2003; Krivonos, 2004; Newman, 2006; Gemech and Struthers, 2007; Hill, 2010). In other countries such as Uganda, studies show that coffee prices became very vulnerable to internal price fluctuations (Fafchamps and Hill, 2008). In general, the economic reforms in Sub-Saharan Africa in the 1990s were less restrictive than elsewhere, resulting in sudden dissolution of producer cooperatives and consequent reduction in the producer's bargaining power, such that farmers were now exposed to price risks that were previously absorbed by the government (Krivonos, 2004). However, for commodities that were taxed prior to reforms, the welfare consequences of reform may be offsetting, that is, the reforms that boost producers share of export prices may well compensate for increased price volatility (Akiyama et al. 2003).

Crop commodities in particular, are highly susceptible to price volatility because of the nature of the production and marketing cycle.<sup>11</sup> When prices increase, farmers are motivated to increase production, such that excess production may lead to price decline. When prices decline, farmers get discouraged from investing in production, leading to low yields and less supply. In the end, prices rise again due to low supply. In the case of Coffee, volatility is exacerbated by the fact that coffee is a perennial crop with lags between plantation and harvesting varying between 18 to 24 months. Peak yields are only experienced after 5 to 7 years. This implies that, while input investments respond quickly to price changes, supply response in coffee markets is very slow. Consequently, additional supply tends to reach the market when prices are on the decline, leaving the farmers with no choice but to sell at any price. Moreover, following the fall of the International Coffee Agreement (ICA)<sup>12</sup> in 1989, which had put in place a pricing mechanism to stabilise prices, coffee producer prices at international level became very volatile (ICO data). Some researchers have also linked the deregulation of the international coffee market to increased coffee supply

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<sup>11</sup> There are various other factors associated with coffee price volatility. Three factors have come out strongly in literature; 1) Market deregulations- at domestic and international levels, 2) failure of international cooperation to stabilise prices 3) the development of commodity exchange markets- with future deals making up to 80% of coffee trade. It is argued that price volatility encourages futures trading, which in turn magnifies volatility (Gilbert and Brunetti, 1996).



on the market, especially after the emergence of Vietnam as second largest producer after Brazil. Consequently, international coffee prices fell drastically in the last two decades hitting lowest prices in 1992, a situation which severely affected many producing countries. In Tanzania, many producers were forced to diversify their income-generating activities from coffee in order to reduce price risks (Pirrotte et al., 2006; Newman, 2006). In some cases, coffee trees were being uprooted and the fields replaced with other crops such as maize. Similarly for Zambia, a number of large estates closed down, leaving tens of thousands of the rural population out of employment. Zambia's coffee production also drastically declined from approximately 7000mt to less than 2000mt in the last four years.<sup>13</sup>

While the body of literature on commodity price volatility has increased in the last two decades, specific literature on coffee price volatility is rather scanty. Currently there are only two studies that have empirically examined coffee price instability and the causes; Newman (2006) studied the extent to which changing market structures have caused rise in coffee price volatility while Krivonos (2004) investigated the impact of trade reforms on coffee price movements. Krivonos concluded that, the improvement in coffee price transmission from world markets has exposed producer prices to the risk that was previously absorbed by the government. The Newman (2006) study even included a volatility analysis in the case of Tanzania but did not provide statistical evidence of increased price volatility in the post economic reforms as compared to the pre-economic reform period. While the Krivonos (2004) study only carried out price transmission analysis but did not examine the volatility. Further, none of these studies considered threshold or asymmetry effects of volatility.

Ever since Glosten et. al. (1993) introduced asymmetry volatility models, most of its application has been confined to financial data save for a few studies that have extended the model to commodity markets. One example is the study by Guilda and Mtringe (2004) that applied symmetric and asymmetric volatility models in financial and commodity price series. They found that asymmetric models led to better forecasts than the symmetric one. Another interesting study was by Shively (2001) who examined threshold volatility in spatial maize markets in Ghana. He found that grain prices in Ghana followed a threshold process characterized by low variance

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<sup>13</sup> [www.zcga.co.zm](http://www.zcga.co.zm)

and high variance regimes. In this study, auto-regression conditional heteroskedasticity (ARCH)-type models are employed, particularly the Threshold Generalized ARCH (TGARCH) in order to examine asymmetric effects of shocks on volatility. There has been very little application of asymmetric models in volatility analysis in most economic literature, despite evidence of asymmetric price transmission in agricultural commodity markets (See e.g Krivonos, 2004). More over, the TGARCH model enables the assessment of asymmetric effects of the shocks on price volatility, an aspect that most studies have overlooked.

Volatility of coffee prices for Zambia and Tanzania is examined paying attention to asymmetric behaviour and the impact of coffee market liberalisation. In both countries, significant market reforms occurred especially in agricultural commodities. However, the liberalization process, particularly in the coffee industry, varied between the two countries, both in the scope of the reforms and their consequences (Akiyama et. al. 2003). While Zambia's coffee market is fully liberalized where producers sell directly to traders, Tanzania's coffee market still has some government intervention such as mandatory coffee auctioning (Jeffes, 2004; Akiyama et al. 2003; Newman, 2006). The diversity between the two countries provides a better understanding of impacts of economic reforms under different market structures. Coffee is Tanzania's largest agricultural export commodity with half a million small scale farmers directly earns their living from the commodity. For Zambia, coffee has a very small share of agricultural exports, although it counts as one of the top ten non-traditional exports. Zambian coffee (a mild Arabica variety) fetches very high but unstable prices compared to coffee from most African countries. On the other hand, Tanzanian coffee prices (both for Arabica and Robusta varieties) are among the lowest on the continent but very stable (See Figure 4.2 in section 4.5). Moreover Tanzania is the only country in Africa where the target share of producer prices of the world market price did not increase following liberalization (Krivonos, 2004).

This study investigates price volatility in coffee markets for Zambia and Tanzania. The analysis includes an examination of the effects of economic reforms on coffee price volatility in the two countries. More important, the study examines the impact of negative and positive shocks to the prices on price volatility.

The rest of the paper is organised as follows: In the next section, an overview of economic reforms in Zambia and Tanzania is given, particularly those that directly or indirectly relate to the agricultural sector and the coffee industry in particular. Section three discusses the conceptual framework including a discussion of the models used and the methodology of this study. Section four describes the data and the results are discussed in section five. The last section gives a conclusion.

## **4.2 Economic Reforms and Coffee Markets in Tanzania and Zambia**

Prior to the 1990s economic reforms in Tanzania, all coffee marketing was handled by the Tanzania Marketing Board (TMB) and the cooperative unions, who also provided inputs, transportation and processing services. In 1990, Tanzanian government took the first steps in restructuring the coffee industry. A notable improvement of the reforms was the prompt payment (within three weeks) to the unions by the Coffee Board (Baffes, 2005:25). By 1992 the cooperatives were allowed to decide prices paid to growers. In 1993 legislation allowing private sector participation in marketing and processing coffee was passed, which also further reduced government's control of pricing. In 1994 cooperatives lost their monopoly after the Government passed a legislation to allow multinational and domestic buyers to buy directly from individual farmers.

Although this move led to improvements in private sector participation, the functioning of input markets deteriorated as the provision of credit declined. This, coupled with the decline in the quality and the quantity of services such as research and extension, resulted in a drastic decline in the overall quality of coffee. Subsequently, in 1999/2000, the Coffee Board adjusted the policies in order to help the small-scale farmers, who, it seemed, had not benefited from trade liberalization. Currently only about 20% of the coffee is sold directly to international traders (mainly by large estates), while 80% has to go through the government run auctions (Newman, 2006).

For Zambia, prior to economic reforms, the Zambian economy was characterized by strong state intervention in agricultural markets, which involved the fixing of producer prices, the provision of transportation, storage and inputs, and subsidizing of credit

for agricultural commodities (Wichern and Hausner, 1999). The exchange rate was also constantly overvalued, which had an indirect impact on the producers of tradable commodities. Private traders of all agricultural commodities were not allowed and even discouraged by the fixed market margins by the Government. After 1990, government implemented a series of liberalization policies that aimed at decontrolling prices, privatization of state-owned enterprises, reducing inflation and introducing market-based exchange and interest rates. The privatization included large scale coffee estates, which under government management had become insolvent as mentioned above. Although the liberalization policies were constantly reversed for some crops (especially for maize after some shocks such as droughts), the coffee industry in Zambia remained fully liberalized where producers sell directly to traders.

It is quiet evident that coffee price volatility in the two countries is influenced by the trade policies. Since the policies determine how price shocks in world markets are transmitted to producer prices, the level and persistence of the volatility will largely depend on the market policies. In order to understand how the level and persistence of volatility is measured, the next section gives a theoretical background for understanding volatility in commodity markets.

### **4.3 Theoretical Framework for understanding commodity price volatility**

Most commodity price data tend to exhibit volatility persistence, leverage effects<sup>14</sup> and the tendency of large residuals to cluster together in such a way that large changes follow large changes and small changes follow small changes- a fashion known as volatility clustering. The changes are largely unpredicted both in the magnitude and the sign. Large disturbances become part of the information set used to construct the variance forecast of the next period's disturbances. As a result, large shocks either negative or positive can persist, influencing future prices for several periods. Therefore, volatility shows the variance/standard deviation of the error term and what makes them large.

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<sup>14</sup> Leverage effects are a kind of asymmetric effects of the previous periods' variance on volatility. It is a situation where negative return sequences are associated with increases in the volatility of the prices.

Commodity price volatility is modelled using Autoregressive Conditional Heteroskedasticity (ARCH)-type models such as the Generalised Autoregressive Conditional Heteroskedasticity (GARCH) (Bollersler, 1986). Ideally, the goal of the ARCH/GARCH model is to provide a volatility measure, such as the standard deviation, that can be used for making decisions concerning risk and derivative pricing (Engle, 2001). ARCH/GARCH models consider the variance of the current errors to be a function of the actual size of the previous errors. Enders (2004) explains that since the conditional heteroskedasticity of  $\{\varepsilon_t\}$  in equation (1) will result in heteroskedasticity in  $\{y_t\}$ , ARCH-type models are able to explain periods of volatility and tranquillity. Because of the presence of heterosdasticity in the error term, ARCH-type models have an advantage over other volatility measuring mechanisms such as the coefficient of Variation (CV).<sup>15</sup> ARCH-type models have widely been used in different studies (e.g. Boleslaw, 1990; Shivery, 2001; Brooks, 2002 and Linton, 2008).

Contrary to the homoskedasticity assumption,<sup>16</sup> ARCH/GARCH models are based on the expectation that not all data have all error term values that are the same at any given time. Especially for agricultural commodities and in particular producer prices that rely on external markets, the variance of the error term is not likely to be constant over time. In this case a problem would arise as heteroskedasticity or data in which the variances of the error term are not equal, resulting in errors and confidence intervals estimated by least squares being narrow, giving false sense of precision (Engle, 2001). To avoid this problem, ARCH models treat heteroskedasticity as a variance to be modelled. In this way, the deficiencies of least squares are corrected and a prediction is computed for variance of each error.

The basic ARCH-type model is the ARCH model itself and is composed of two equations, which are estimated simultaneously. The first equation is the conditional mean equation which describes the expected value of the stochastic process  $y_t$ . It is

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<sup>15</sup> The CV is the absolute value of ratio of the standard deviation to the mean.

<sup>16</sup> For a homoskedasticity innovation, the error term, with mean zero is assumed to have a constant

variance over a period of time, presented as:  $\varepsilon_t^2 = a_0 + \sum_{j=1}^q a_j \varepsilon_{t-j}^2 + u_t$  where  $u_t | \psi_{t-1} \sim N(0, \sigma_t^2)$ .

assumed that the time series  $y_t$  is stationary with constant variance. The second equation is the conditional variance equation and the variance is assumed to be heteroskedastic. Since volatility is unobservable characteristic of a series, a proxy is chosen for it which is the variance  $\sigma_t$ .

$$y_t = X_t' \theta + \varepsilon_t \quad \text{where } \varepsilon_t | \psi_{t-1} \sim N(0, \sigma_t^2) \quad (1)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 \quad (2)$$

While in the ARCH model, the conditional variance depends on the squared residuals of the last period, in the GARCH model the conditional variance term will depend upon the lagged variances as well as the lagged (squared) residuals. This allows for persistence in volatility with a relatively small number of parameters. Presence of ARCH effects does not imply absence of GARCH effects. ARCH effects indicate presence of autocorrelation, such that, high order models are required. To circumvent such misspecification, volatility is better modelled using GARCH models, which combines the ARCH (q) and variance (p) equation into a non-linear ARMA (p,q) process presented as:

$$\sigma_t^2 = \omega + \sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \beta_i \sigma_{t-i}^2 \quad (3)$$

It follows that, if there are no GARCH effects the sum of the coefficients should be equal to zero, i.e.

$$\sum_{i=1}^q \alpha_i + \sum_{i=1}^p \beta_i = 0 \quad (4)$$

In that case, the long run variance  $\omega = \sigma_t^2$ .

Since variance is strictly positive, sufficient conditions to ensure non-negativity are;

$$\begin{aligned}
\omega &> 0 \\
\alpha_i &\geq 0 \\
\beta_i &\geq 0
\end{aligned}
\tag{5}$$

where  $i=1, 2, \dots, p$  If  $\sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \beta_i \sigma_{t-i}^2 < 1$  in equation (4), then volatility is stationary, that is any shocks to the system will dissipate or vanish over time. But if  $\sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \beta_i \sigma_{t-i}^2 \geq 1$  then the shocks will accumulate or persist over time. In a special case when  $\sum_{i=1}^q \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \beta_i \sigma_{t-i}^2 = 1$ , shocks will persist indefinitely such that arbitrage will not be able to adjust the level of volatility to a long run equilibrium. Engle and Bollerslev (1986) refer this to Integrated GARCH (IGARCH). Due to non-linearity of most time series data, ARCH/GARCH models are estimated using the maximum likelihood.<sup>17</sup>

A challenge facing the ARCH/GARCH model is the implication that positive and negative residuals have a symmetric impact on the conditional variance. GARCH models assume that good and bad news have the same effect on volatility, an assumption which is often violated (Black, 1976). Glosten et al. (1993) and Rabemananjara and Zakoian (1993) discuss threshold models that allow for negative residuals to affect the conditional variance differently from the positive residuals. Noticably, ever since Glosten et al. (1993) introduced asymmetry volatility models, most of its application has been to financial data analysis, except for a few studies that extended the model to commodity markets. One example is the study by Guilda and Matringe (2004) that applied symmetric and asymmetric volatility models to financial and commodity price data. They found that asymmetric models led to better forecasts than the symmetric one, based on values of various model fit statistics. Another study examined threshold volatility in spatial maize markets in Ghana (Shively, 2001). The study found that grain prices in Ghana followed a threshold

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<sup>17</sup> The maximum likelihood is given by:

$$L_n = -\frac{1}{2} \sum_{t=s+1}^n \left[ \ln \left( h_t + \frac{\varepsilon_t^2}{h_t} \right) \right]
\tag{6}$$

where  $s = \max\{p, q\}$

process characterized by low variance and high variance regimes. The Threshold GARCH model is specified as:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \lambda_i \varepsilon_{t-i}^2 d_{t-i} + \sum_{i=1}^q \beta_i \sigma_{t-i}^2 \quad (7)$$

where  $\lambda_i$  is the parameter capturing asymmetric effects in the model such that tests for asymmetry include a test of all  $\lambda_i$ . If the  $\lambda_i$  is statistically different from Zero, the data contain a threshold effect. The threshold in this case is  $\varepsilon_{t-1} = 0$  such that the effects of the shocks greater than the threshold will be different from those below the threshold.  $d_{t-1}$  is an indicator function for  $\varepsilon_{t-1}$  such that  $d_{t-1} = 1$  when  $\varepsilon_{t-1}$  is negative and  $d_{t-1} = 0$  when  $\varepsilon_{t-1}$  is positive. That means that negative values of  $\varepsilon_{t-1}$  tend to increase the variance more than positive values. This is because the effect of the shock on the variance when  $\varepsilon_{t-1}$  is negative and  $d_{t-1} = 1$  will be  $\alpha_i + \lambda_i$  but when  $\varepsilon_{t-1}$  is positive and  $d_{t-1} = 0$ , the effect will be only the  $\alpha_i$ . Therefore a positive value of  $\lambda_i$  means that a past negative return has a larger impact on conditional volatility than a past positive return of the same amplitude- a situation commonly referred to as leverage effect (Enders, 2004: pp. 141). This implies that the bad news has more effect on the variance than the good news.

To examine the effect of economic reforms on volatility while at the same time, taking into account possibility of asymmetric movements, I modify the TGARCH model to include a dummy variable for the period of the economic reforms as identified endogenously using Lagrange multiplier unit root tests. Because the reforms were implemented over a period of time, the structural break is identified endogenously to ensure the true effect of the reforms on the data generating process. Equation (4) is therefore modified as;

$$\sigma^2 = \omega + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^p \lambda_i \varepsilon_{t-i}^2 d_{t-i} + \sum_{i=1}^q \beta_i \sigma_{t-i}^2 + \delta RF \quad (8)$$

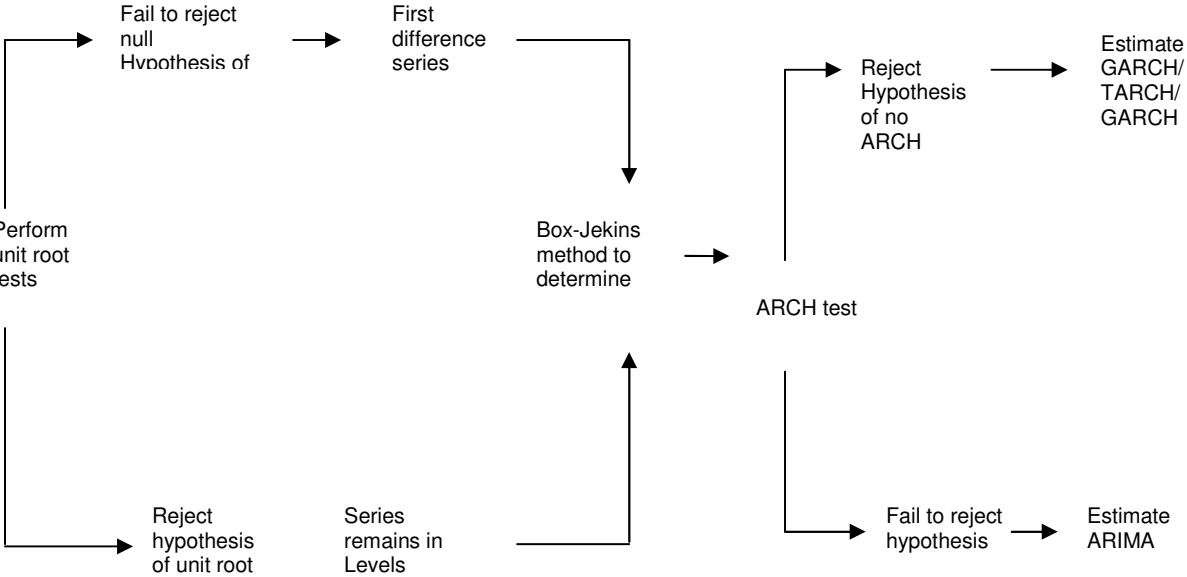
where  $RF$  is a dummy variable for Economic reforms such that  $\delta = 1$  for the period before the reforms and  $\delta = 0$  for period after the reforms.



### 4.4 GARCH Model Estimation Procedure

Figure 4.1 illustrates the methodology for estimating GARCH models as suggested by Moledine et al. (2007). The first step is unit root testing. Ideally, stationary series should be used in modelling volatility in order to meet the time series modelling assumption of zero mean. If the series is non-stationary, then it should be differenced to attain stationarity.

Figure 4.1: Steps in Modelling Volatility



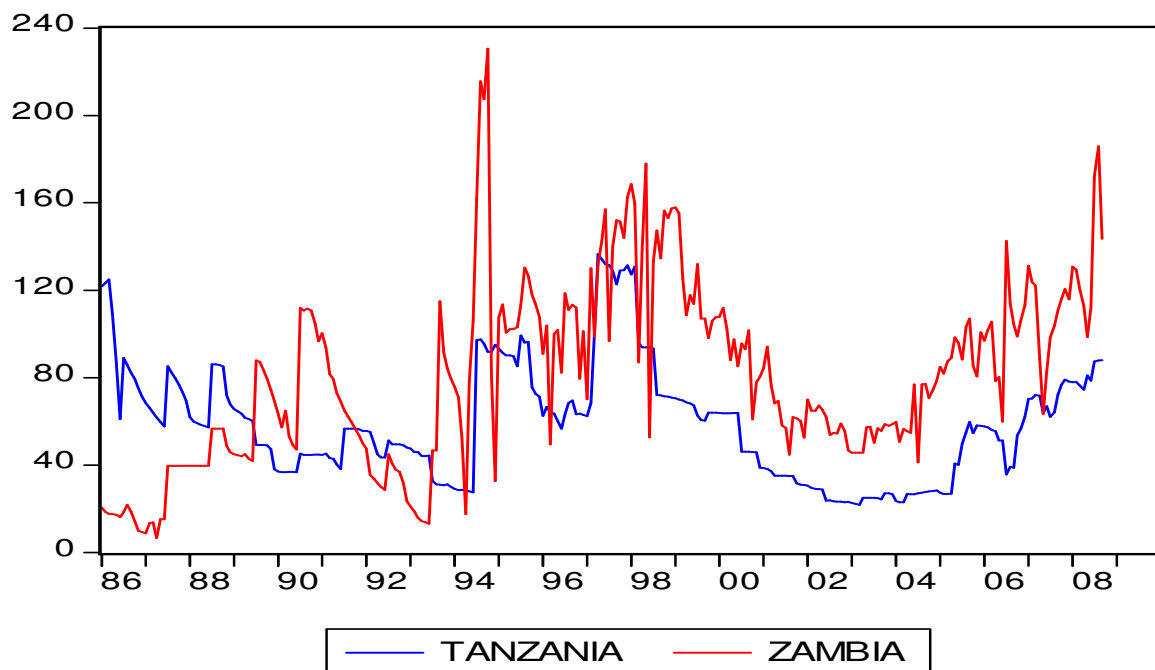
Source: Moledine et. al. 2007

The second step is the identification of the model (number of lags) using Box-Jekins approach along with information criteria such as the Akaike Information Criteria (AIC). After identifying the number of lags, the model is tested for ARCH effects. If the hypothesis of ‘no ARCH’ effects is rejected, then there is heteroskedasticity in the error term. It is then clear that the model should not be estimated with ordinary ARMA models, rather, with GARCH models which do not assume homoskedasticity (Engle, 2001).

## 4.5 Data Description

The study uses monthly observations of coffee prices measured in US\$ per pound (lb) for Tanzania and Zambia. Both series have 273 monthly observations covering the period January 1986 to September. The price series' are presented shown in Figure 4.2.

Figure 4.2: Coffee Producer Prices for Zambia and Tanzania in UD\$/ per Lb



Source: Author's Presentation based on Data from ICO

In order to compute the data in a continuous way as well as ensure stationarity, prices are in natural logarithms of returns. The price return is calculated as logarithm price at a given time less the logarithm price at the previous time presented in

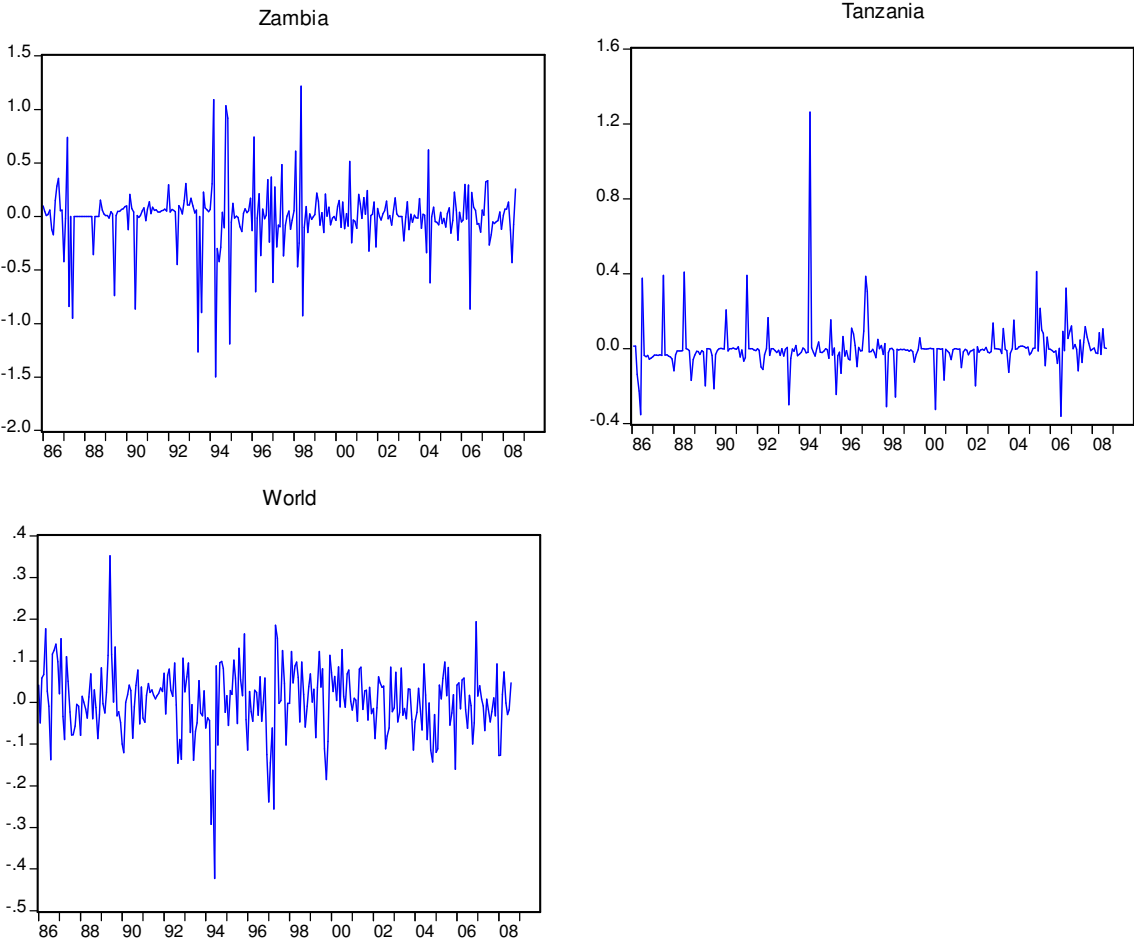
$$R_t = \ln P_t - \ln P_{t-1} \quad (9)$$

Where  $R_t$  is the price return,  $P_t$  is price at time t and  $P_{t-1}$  is price at the previous period. In this way the variance of the price return is taken as the risk level of the returns (Engle, 2001). Presence of heteroskedasticity therefore implies that some

time periods are riskier than others, where the magnitude of the variance is higher in some periods and lower in other periods.

A visual inspection of price return series (Figure 4.3) shows some evidence of heteroskedasticity given that the variance is not the same over time. The amplitude of the variance is higher in some periods while very low in other periods. For example, the both producer prices experienced very high volatility around 1994, a time when major economic reforms were taking place.

Figure 4.3 Price returns for Zambia and Tanzania



Statistical properties of the series are reported in Table 4.1. If the standard deviation is taken as a measure of volatility, Zambia prices are the most unstable with a standard deviation of 0.297. Tanzania series is less volatile than Zambia prices but its standard deviation is 0.03 higher than world price. Additionally, all the three producer price series show evidence of fat tails since they are all above the normal

distribution value of 3. Retail prices on the other hand show evidence of normal distribution with kurtosis less than 3. Since volatility clustering, which is a type of heteroskedasticity, is responsible for excess kurtosis (fat tails), high volatility for the three producer prices compared to the retail price is expected but not for retail prices.

Table 4.1: Descriptive statistics for the series

	Zambia	Tanzania	World
Mean	0.007	-0.001	-0.002
Std Dev.	0.297	0.112	0.082
Skewness	0.833	2.0533	0.563
Kurtosis (excess)	7.169	13.010	3.669

Skewness is positive and significantly different from zero for Zambia and world prices, an indication that there are more values above the zero mean than below. It is somehow abnormally high in the Tanzania series, probably due to non free trade policies in that country during most of the time period under review. It is also positive but relatively smaller for retail prices compared to producer prices, an indication of normality.

**4.6 Results**

Volatility analysis requires that the variables are stationary in order to obtain meaningful results. Unit root tests to examine stationarity were performed using Augmented Dickey Fuller (ADF) test and Lagrange multiplier structural break tests. It was necessary to apply structural break unit root tests because the observed period experienced policy changes at domestic and international level, which could result in structural breaks in the data. Lee and Strazichich (2004) structural break unit root test, which simultaneously indentifies a structural break and tests for unit root, was applied to all the four series. Results show that all series are non-stationary at level while stationary at first difference (Table 4.2).

Table 4.2: Unit root tests

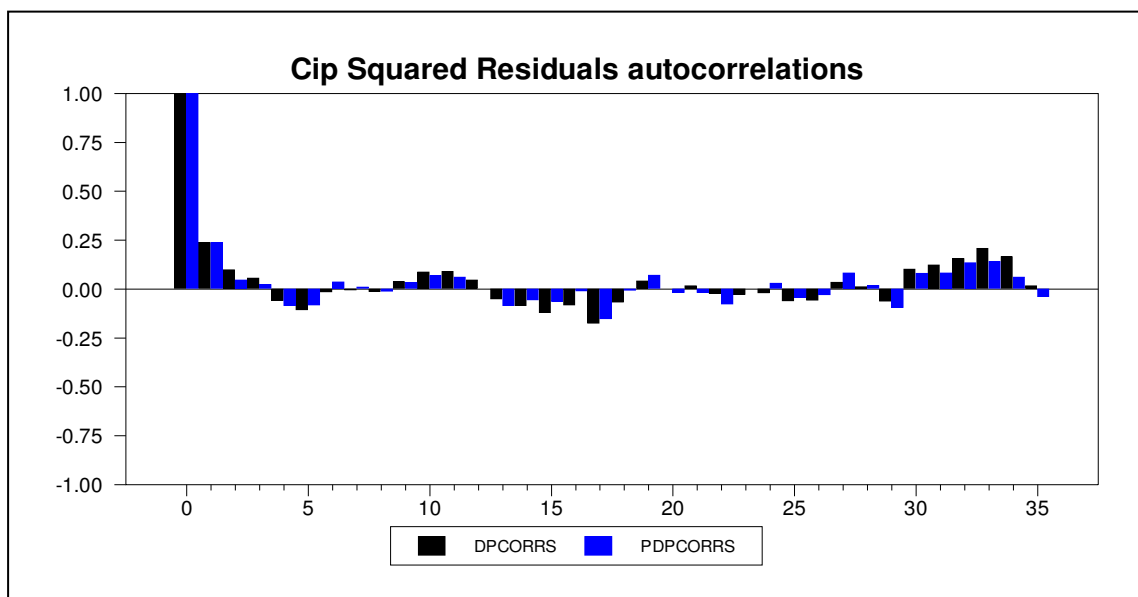
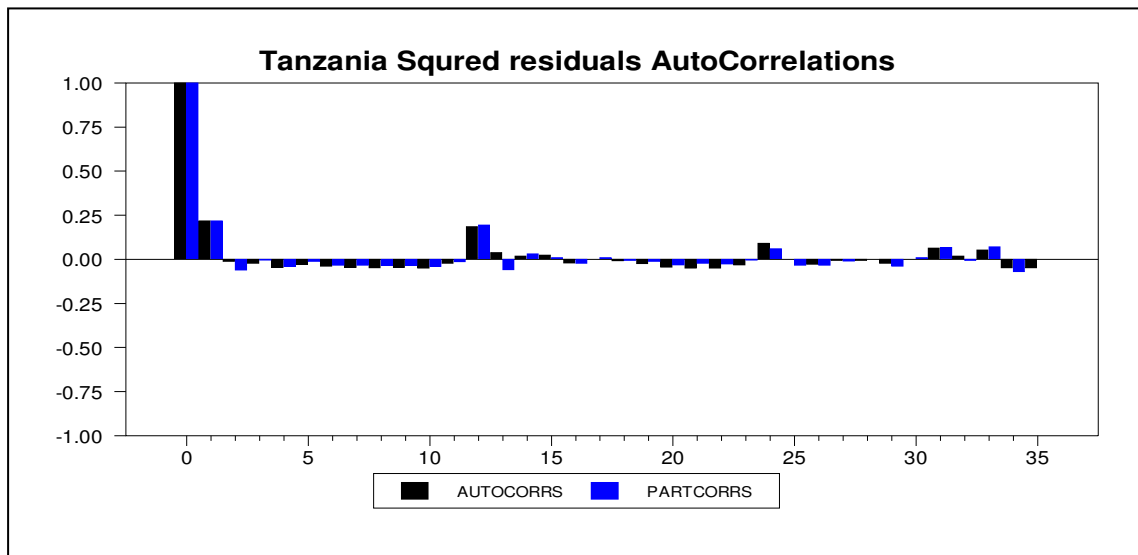
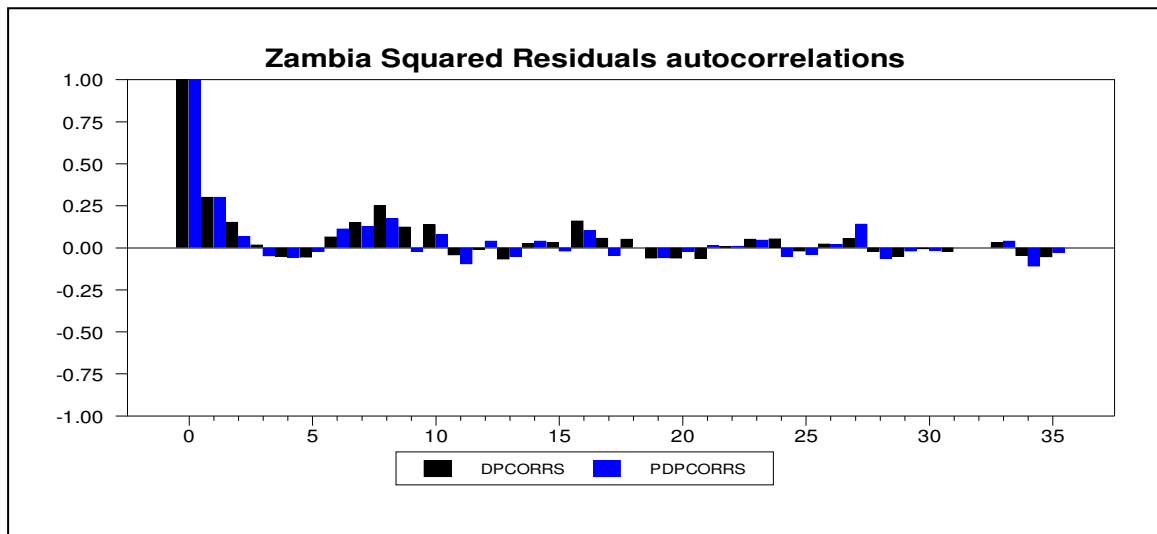
Coffee Prices 1986:1 to 2008:9	ADF		LSLM (Intercept no trend)		
	Level	1st difference	Structural Break	Level	1st Differences
Log Zambia 9 lags	-2.470	-7.656**	1998:05	-2.586	-7.308**
Log Tanzania 13 lags	- 2.162	- 4.627**	2000:06	-2.511	-4.681**
Log World Price (CIP) 10 lags	-2.28700	-4.7236**	1989:06	-2.2415	-4.9736**

According to Lee and Strachizic structural break unit root tests, Zambia coffee prices experienced a structural break in May, 1998. Given the occurrence of agricultural market policy changes, 1998 coincides with completion of agricultural liberalisation initiated around 1991 (Rainer Wichern, 1999). In Tanzania's case, a structural break occurred in June 2000. From the occurrence of coffee trade policy changes, Tanzania adopted liberalised trade system in 1991. However, in 2000/2001 the coffee Board revoked the buying licenses of private traders, effectively handing the monopsony power back to the unions (Krivonos, 2004).

To establish the number of lags to include in the model, we examine the autocorrelation using Box-Jenkins model. As presented in Figure 4.4, the series have the p-values which are almost zero, apart from the first lag which is almost one. In this case, the models should include one lag to account for the autocorrelation. The models are then GARCH (1, 1) and TGARCH (1, 1).



Figure 4.4: Autocorrelations of price returns



Statistical analyses of ARCH effects confirm heteroskedasticity for both Zambia and Tanzania at 1% significance level. The ARCH results are presented in Table 4.3.

Table 4.3: ARCH test results

	F-statistic	Significance
Zambia	7.233	0.000***
Tanzania	3.689	0.006***
CIP	4.997	0.001***

The F-statistics show that Zambia experienced the most volatile coffee producer prices over the observed period, which is even more than world prices. However, Tanzania prices are less volatile than world prices. The volatility is significant in all series, an implying presence of heteroskedasticity. GARCH models can then be applied to examine volatility. For this study, GARCH (1, 1) and TGARCH(1,1) models are estimated for Zambia, Tanzania and world prices, to establish impact, persistence and symmetric effects of price shocks on volatility. The value of  $\alpha$  parameter (the ARCH component of the model) in equation (8), which is the sum of squared residuals, measures the impact of price shocks on volatility. The variance parameter  $\beta$  (the GARCH component of the model) and the threshold parameter  $\lambda$  show persistence and symmetry of the price shocks respectively.

The results of the estimation and the statistical verification of the two models (GARCH and TGARCH) are summarized in Table 4.4. The estimated coefficients for GARCH(1,1) have the correct sign for Zambia and are all statistically significant. Ward tests for the restriction  $\alpha + \beta = 1$  which tests the null hypothesis of 'no GARCH' effect is rejected at 1 percent for all the three producer prices. The estimated coefficients affirm preliminary results discussed earlier, which show evidence of high volatility for Zambia compared to the other price series. Any shock to the system triggers 58 percent volatility in the case of Zambia. The shocks hardly have any effects on Tanzania prices, where a shock to the prices, leads to only 0.08 percent volatility. However, even if Zambia experiences the largest impact, persistence of the volatility is relatively low. The price volatility due to a shock persists for only 15



months before disappearing. Volatility persistence is however very high in the case of Tanzania lasting up to 51 months. The coefficient for the domestic economic reforms is not significant in both countries in the GARCH (1, 1) model.

The results from the TGARCH present a different picture. For Zambia, almost all the coefficients are positive and statistically significant. Unlike in the GARCH estimation, the impact of the shocks on volatility is very low for Zambia in the TGARCH (1, 1) estimation. The shocks trigger only 0.04 percent volatility which is not statistically significant. The volatility is however more persistent such that the prices remain volatile due to a shock in one period for the next 59 months (almost 5 years). In that case, persistence of even small impacts is very high. Similar to GARCH results, the impact of shocks on volatility of prices in Tanzania is very low in TGARCH compared to Zambia. In Tanzania's case any shock triggers only 0.8 percent, although that persists up to 38 months. Again, a plausible explanation for the differences could be the extent of liberalisation (although that could not be the only factor). The sign for the dummy variable representing economic reforms is positive and statistically significant for Zambia in the TGARCH model but not in the GARCH model. The results indicate that price volatility increased after the economic reforms. However, for Tanzania, the impact of the economic reforms is not significant probably due to the fact that the reforms have been constantly reversed as discussed earlier.

The  $\lambda$  parameter in the TGARCH models is significantly different from zero for Zambia confirming existence of asymmetric effects. Since the coefficient is positive, a conclusion can be made that bad news (negative shocks) has more effect on volatility than good news. However, the hypothesis of 'no asymmetric effect' is not rejected for Tanzania, an indication that positive and negative shocks had the same effect on volatility. Again this could be explained by high government intervention in setting prices, which does not reflect the actual movements of world producer prices.

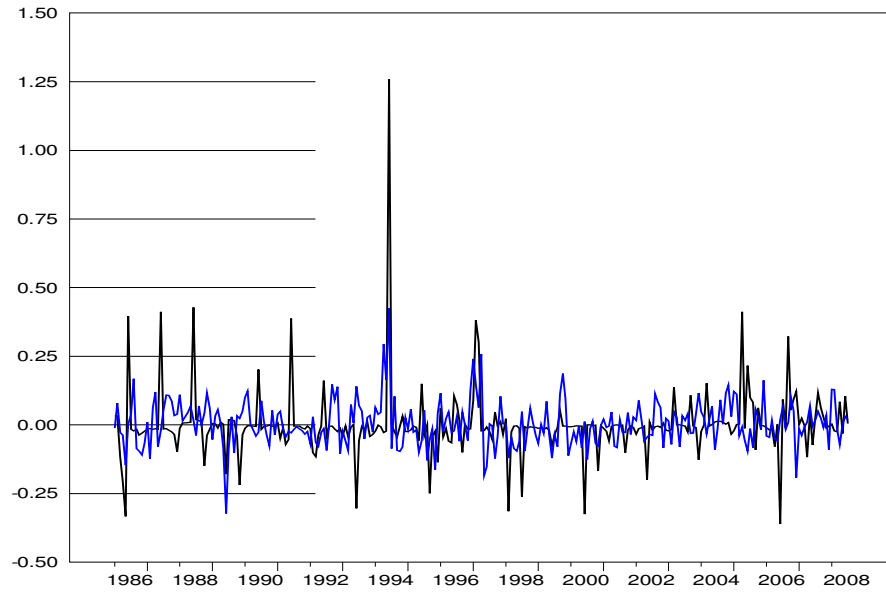
To verify previous empirical findings that Asymmetric TGARCH models are better than symmetric GARCH model (Guida and Matringe, 2004) different statistics that explain the best fit for the model are examined.

Table 4.4: Volatility estimates of GARCH and TGARCH models

Coefficient	Zambia GARCH	Zambia TGARCH	Tanzania GARCH	Tanzania TGARCH	World GARCH	World TGARCH
Mean	-0.004(-0.234)	-0.038(-2.369)	0.008(0.849)	0.008(0.718)	-0.005(-1.142)	-0.005(-0.965)
$C$	0.036(7.421)***	0.010(3.177)**	0.018(4.206)***	0.017(2.616)*	-0.014(-1.23)	0.003(2.955)
$\alpha$	0.581(3.510)***	0.037(1.217)	0.077(1.231)	0.377(3.293)**	0.309(3.178)	0.387(2.767)
$\beta$	0.148(2.099)*	0.594(10.012)***	-0.506(-1.820)	-0.593 (-0.918)	0.378(3.112)	0.324(2.242)
$\lambda$	---	0.830(3.311)**	---	0.020(0.336)	---	---
Reform	-0.015(-0.571)	0.074(2.970)**	-0.014(-1.227)	-0.013(-1.047)	---	---
F-stats( $\alpha+\beta+\lambda=0$ )	30.43(0.000)***	64.66(0.000)***	55.54(0.000)***	5.470(0.004)**	18.165(0.000)	12.835(0.000)
LL	-18.55	-9.800	217.453	218.096	309.89	310.87
AIC	0.173	0.116	-1.562	-1.560	-2.2492	-2.2490
SBC	0.239	0.196	-1.495	-1.480	-2.196	-2.183

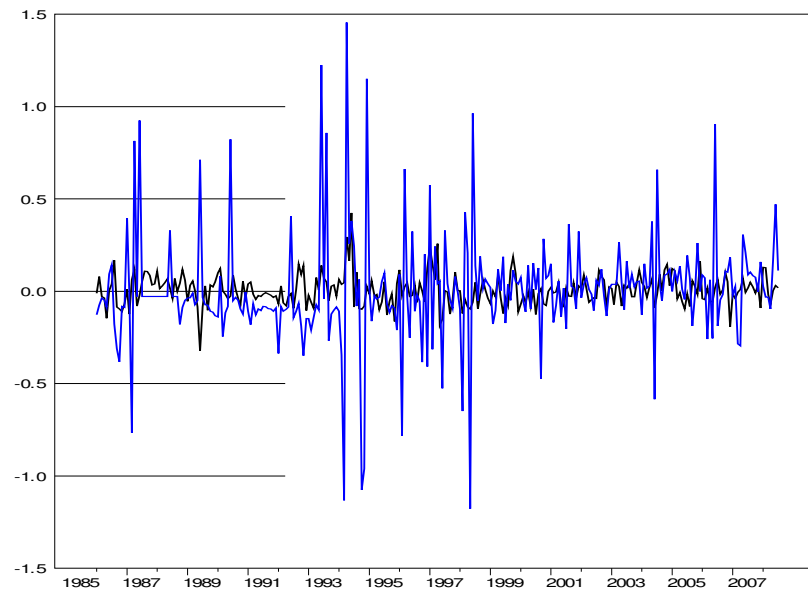
The t-statistics are given in parentheses while f-statistics are given in brackets. \*\*\*, \*\*, \* denote significance at 1%, 5% and 10% respectively.

Figure 4.5: Volatility of Zambia and Tanzania prices compared to the world price



a. Volatility of Zambian and World Prices

— World Prices — Zambia



b. Volatility of Tanzanian and World Prices

— Tanzania — World Prices

The three include the Log Likelihood (LL), Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). In this case, a lower statistic in absolute values is an indication of a better model fit. Results (presented in the last 3 rows of Table 4.4) show that in each of the three price series, TGARCH has lower values compared to GARCH models. Thus the best results are achieved by TGARCH, which also takes asymmetric effects of shocks into account.

Overall, the study has confirmed that coffee producer prices at producer level and world market level are more volatile than retail prices. Visual inspection of price volatility in Figure 4.5 above, shows that whereas the volatility of the Tanzanian prices are relatively on a rather constant low level, the volatility of the Zambian prices shows huge up-and down turns. On the hand the volatility for world prices is more constant compared to Zambia, but less so compared to Tanzania.

#### **4.7 Conclusions**

This paper has investigated the impact and persistence of shocks on coffee price volatility in different markets. Special attention was given to the impact of economic reforms that included coffee market liberalization in Zambia and Tanzania. Structural breaks around the times of economic reforms were identified using endogenous Lagrange multiplier unit root tests. Although the paper applied two ARCH-type models (GARCH and TGARCH), the conclusion is mainly drawn on the results of the TGARCH model, which was found to provide a better fit of the model, based on absolute values of the log likelihood, the AIC and BIC.

TGARCH results show discernible effect of economic reforms on price volatility in completely liberalised markets. It is evident that producer prices in Zambia, which has a completely liberalized coffee market, showed lower impact but longer persistence of shocks on volatility compared to producer prices in Tanzania. The persistence of shocks on volatility in the Zambian case was even longer than for world prices. However, world prices had a higher impact of the shocks on volatility than Zambia and Tanzania. Although certainly not the only factor, economic reforms have inescapably exposed coffee producer prices to world prices, as concluded by several earlier studies. Other factors could be that, small producers like Zambia, are

inevitably price takers with neither capacity nor government interests in controlling price movements.

On the other hand, the Government in Tanzania pays much attention to ensuring price stability, even after the implementation of economic reforms, given the significant role coffee plays on the economy (as the second export commodity). Although price stability could be to the advantage of the producers for stable incomes in short-run, the price intervention policies have negatively affected Tanzanian coffee prices in the long-run. As the study has shown, Tanzanian prices have in the long-run lagged far below world producer prices, and are even much lower than Zambian prices (again there could be other factors such as quality of coffee produced that could contribute to price levels and volatility). Moreover, this study found that the effect of economic reforms was not significant for Tanzania, indicating that continued government intervention in price stabilisation prevented the intended economic reforms to have any impact on price volatility.

What governments should focus on is a holistic approach to ensuring price stability – especially market based price stabilisation policies. The direct Government intervention in price stabilisation may not be sustainable in the long-run. In addition, infrastructure developments in order to improve communication and information dissemination become important in minimising price volatility. Current price interventions in coffee markets such as Fair trade initiatives are another option that can enable farmers obtain a fair share of the retail prices.

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## Chapter 5:

### Response of Coffee Supply in Zambia: Implications for Policy

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#### Abstract

This article examines coffee supply response to variance incentives in Zambia. Results show that in the long run coffee supply does not respond to coffee prices, but that it responds negatively to local currency (Kwacha) appreciation. At the same time, economic reforms which were implemented in 1998 have had a positive effect on coffee supply. Vitaly, results show that in the long-run, real exchange rate has had the highest impact on coffee supply. This implies that currency liberalisation has positive effect on coffee production in Zambia. To examine asymmetric short-run supply adjustments, unlike previous research, this study employs a dynamic threshold error correction model based on threshold auto regression estimation. Results confirm asymmetric short-run adjustment to long-run equilibrium. Particularly supply response is significant for positive shocks while insignificant to negative shocks. These results show that coffee supply does not adjust immediately, until the shocks reach a certain threshold. This study fills in a gap in the supply response literature, which has virtually failed to analyse asymmetric supply response so far.

## 5.1 Introduction

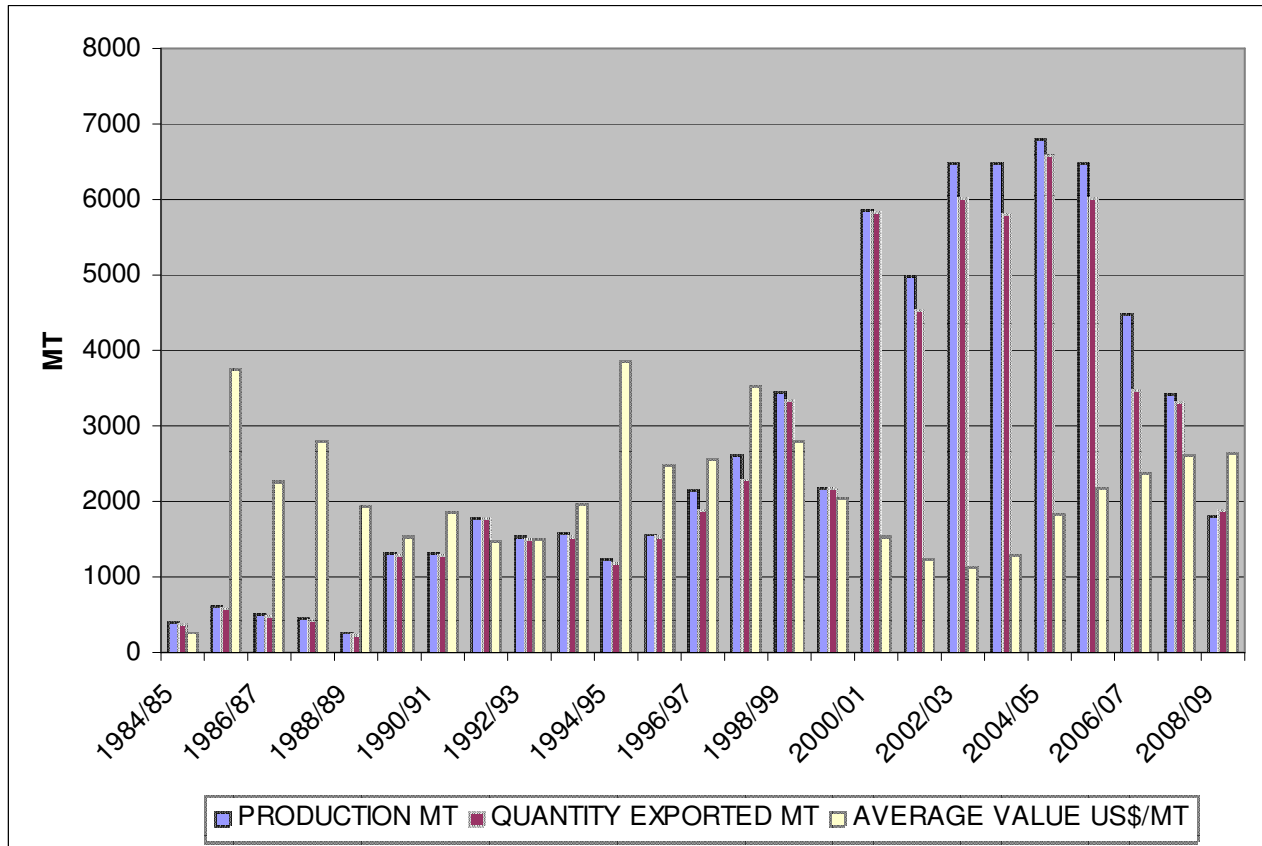
High and sustainable agricultural growth, mainly driven by agricultural productivity is needed for African countries to reduce poverty and foster economic development. Agricultural growth in Africa remains a key factor in economic development as it accounts for large shares of national income, employment and foreign trade (Forum for Agricultural Research in Africa, 2006, pp.7). The growth in agricultural productivity is likely to depend on, among other things, adequate access to productive resources, well functioning markets, infrastructure, and a conducive policy environment (e.g. stable macro economic policies). In the last two decades, many countries in Africa implemented structural adjustment programs, which included agricultural policy changes, in the effort to provide conducive environment for increasing output. Despite these economic reforms, most countries in sub-Saharan Africa, including Zambia, continue to face the challenges of declining agricultural productivity compared to other continents, raising concerns on supply responsiveness.

Coffee, an essential export commodity in most eastern African countries, has suffered declining levels of production amidst declining and unstable prices.<sup>18</sup> Zambia, in particular, experienced drastic decline in coffee production from about 6800 metric tonnes (mt) in 2005 to less than 2000 metric tonne in 2009 (Figure 5.1). The causes of the decline in coffee production in the country have never been investigated. A plausible explanation could be the decline in coffee producer prices or the strengthening of the Zambian currency (Kwacha) in the last decade. Despite the fact that, economic policies in Zambia have, for a long time, emphasised export diversification from the traditional export commodity, copper, to non-traditional exports like coffee, there has not been any study that has looked into the economic aspects of coffee. To the best of my knowledge, this is the first study to examine supply response of an agricultural export commodity in Zambia. Despite an increasing body of literature on supply response in sub-Saharan Africa in the recent past, very little similar work has been done for Zambia. The few supply response studies in Zambia focused on Maize, obviously because it is the largest produced crop as well as the staple food (see e.g. Wold, 1997, Xu et. al. 2006; Nyairo, 2009).

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<sup>18</sup> International Coffee Organization (ICO) price data. [www.ico.org](http://www.ico.org)

Figure 5.1: Coffee Production in Zambia



An understanding of agricultural commodity supply responsiveness becomes a useful guide in economic policy formulation, particularly those relating to incentives for production. It is important for policy makers to know precisely the supply responses of commodities if effective policies are to be implemented. Supply response studies become relevant in providing empirical evidence for policy makers to identify key variables that are important in determining agricultural commodity supply. Basically, agricultural supply response explains the elasticity of output adjustment to various policy and other production incentives. As Rao (1989) explains, the extent to which farm production decisions respond to information on various incentives should be central in policy planning. The rational expectations of supply utilises all information to generate predictions of production incentives. For example, high prices should provide incentives for more production such that quantity supplied should move linearly and in the same direction as price.

However, with recent revelation of asymmetric behaviour of most economic and financial time series, the theoretical assumptions of linear adjustment of supply to price or other incentives become inappropriate and may lead to misleading conclusions. The implication of a linear adjustment is that a shock to the price is assumed to lead to the same response in the output, regardless of whether the shock reflected a price increase or a price decrease. Yet in most cases, the reaction of commodity supply to increases in incentives is different from its reaction to decreases in the incentives. It is in this regard that this study focuses on asymmetries in supply response, a missing subject matter in most supply response literature.

A large body of literature exist on symmetric supply responsiveness for different agricultural commodities across Africa. Presumed factors affecting supply response vary widely across commodities as well as across countries. Abdulai and Rieder (1995) concluded that cocoa supply in Ghana is significantly influenced by real producer prices of cocoa, real maize prices (as a substitute crop), real exchange rate and supply of manufactured goods. Muchapondwa (2009) found that price incentives did not affect aggregate agricultural supply in Zimbabwe between 1970 and 1999. In his/her study, Molua (2010) found that irrigation, export promotion and access to affordable finance significantly affect productivity and supply of rice. Rahji and Adewumi (2007) attribute the increase in local rice supply in Nigeria to a ban on rice importation coupled with provision of production incentives especially of certified seeds, fertilizers and agro-chemicals. In Uganda coffee farmers were responsive to producer prices, such that when prices increased, they responded by raising production (Otim and Ngategize, 1993). Kidane (1999) argued that coffee supply in Ethiopian was actually responsive to the real exchange rate, despite arguments by some economists that small scale farmers in developing countries do not respond to price incentives in a rational and predictable manner. In view of the outcome of theses studies, it is quiet evident that factors that influence supply vary widely depending on the commodity as well as the country.

The methodologies applied in these studies also vary widely. While most studies employ the Nerlove (1958) model, more recent studies (e.g. Abdulai and Rieder, 1995; Alemu et. al. 2003) have adopted a modelling technique that recognises the use of cointegration and error correction to overcome the problem of spurious results

arising from the use of integrated series in the Nerlove model. As noted earlier, these studies employed linear cointegration and error correction estimation to arrive at conclusions of supply elasticity. Linear estimates cannot differentiate the effects of positive and negative price shocks on supply. As literature would reveal, very little attention has been paid to asymmetric supply response. Shirvin and Wilbratte (1999) examined asymmetric response of domestic prices to import prices in different developed countries using asymmetric error correction models. Their study however, differs from this study in the segmentation of the error correction term. In this study, a threshold is identified in a threshold variable, which is the error term, using Threshold Autoregression (TAR) models to examine threshold cointegration. Short-term asymmetric supply adjustments are then analysed using threshold error correction models.

The overriding objective of this study is to estimate an asymmetric coffee supply response to price incentives. However, it would be difficult to obtain robust results if other important incentives to supply are not controlled for. Therefore, the study includes prices of competitive crops (specifically maize) and real exchange rate (given that coffee is grown specifically for export) in an asymmetric autoregression model. Motivated by the work of Deaton and Laroque (2003), this study not only takes into account asymmetries, but also the nature of the coffee crop as a perennial crop. Thus, I include lags in the supply response analysis considering the fact that coffee takes up to four years before the first harvest as well as the fact that maintaining current trees may have implications on supply. Supply response is therefore, likely to go over one period. At the same time, it is important to note that, while economics and econometrics assume a stable policy structure, which clearly is not the case in Africa, where potential structural breaks in fundamental economic behaviour make modelling problematic. Unlike previous studies, this study pays attention to endogenous identification of structural breaks, particularly those relating to economic reform periods. The study is designed to provide necessary information for policy planning on the response of coffee supply to various incentives following policy regime changes in the agricultural sector. The aim is to inform policy makers about the effects of an increase or a decrease in the price of coffee and other incentives will have on coffee supply.

The rest of the paper is organised as follows: The next section discusses the economic theory in which supply response is embedded. Section three describes the methodology used in modelling supply response, and is followed by a description of data in section four. The results of the analysis are presented and discussed in section five which is followed by a conclusion in section six.

## 5.2 Theoretical Framework

Modelling supply response has its roots in the partial adjustment, adaptive adjustment and rational expectation theories embedded in the theory of a firm<sup>19</sup>. The partial adjustment and adaptive adjustment model developed by Nerlove (1958) captures the dynamics of agricultural supply with regards to price and other expectation. Specifically, the model assesses the farmers' optimisation behaviour and how they react to changing targets with respect to changes in other incentives.

The partial adjustment model shows a dynamic partial adjustment where an observable output variable  $y_t$  is adjusted, through time, to an expected or desired but unobservable output variable  $y_t^*$  in the equation below:

$$y_t - y_{t-1} = \beta(y_t^* - y_{t-1}), 0 < \beta < 1 \quad (1)$$

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<sup>19</sup> A profit maximising firm is observed how it adjusts its supply in response to price expectations. Given that supply response is only focused on the output supply function, and not necessarily on the demand function, the model only considers the firm decisions on output supply. Since any profit maximising firm assumes that output optimisation has already been achieved in the input space, it will produce output up to the point where it equates marginal revenue to its marginal cost. The cost minimising behaviour equates marginal costs to price, which the firm cannot influence in a competitive market, as the case is with farmers. Being a price taker, the firm sees the market price for its product, assumes it will remain the same regardless of how much or how little it sells and makes its plans accordingly. Since the main objective is to maximise profits, the firm chooses the level of output and the combination of factors that solve the equation  $\text{Max } Pf(y) - \sum_{i=1}^n w_i x_i$  subject to  $x_i \geq 0$ . The solution to the equation explains how much output the firm will sell and how much of which inputs it will buy.

Equation (1), postulates that change in output between the current and previous is a fraction of the difference between the output optimum level and the previous year's output. In other words, at any particular time (period t), only a fixed fraction ( $\beta$ ) of the desired adjustment is accomplished. Equation (1) shows that the adjustment of the output between period t and t-1 is equal to  $\beta(y_t^* - y_{t-1})$  where the coefficient  $\beta$  measures the speed of adjustment assuming the values between 0 and 1. The larger the value of  $\beta$ , the faster the adjustment such that when  $\beta=1$  adjustment is instantaneous and the smaller the value the longer it takes for output to adjust to the desired level, implying a higher adjustment lag.

However, the targeted or desired output  $y_t^*$  is not observed, but is influenced by various other observed factors  $x_t$  such that:

$$y_t^* = x_t \quad (2)$$

where  $x_t$  are current or lagged variables of other economically important variables.

Substituting 2 into 1 gives

$$y_t - y_{t-1} = \beta(x_t - y_{t-1}) \quad (3)$$

where  $x_t$  is a vector of variables influencing the firms' decision to invest in attaining the optimal or desired output. These variables could be lagged prices, lagged output, and lagged prices of substitute crops.

A major limitation to the Nerlovean approach is the possibility of spurious regression arising from not taking into account stationarity properties of time series. Furthermore, the long run price elasticity cannot be estimated using the Nerlove model, unless assumptions of whether it is a partial adjustment or price expectation model are made. This implies no forward looking behaviour by the farmers.

Nerlovean model has been extensively applied in modelling supply response in a wide range of agricultural empirical research.<sup>20</sup>

Nevertheless, the Nerlovean model is used in connection with the adaptive expectation. In adaptive expectations, the farmer makes his/her expectations based on what happened in the past. In the equation below, if  $y_t^*$  is the expected value of some variable which is unobserved. In the adaptive expectation model, the adjustment of expectations from time  $t$  to  $t-1$  is presented as:

$$y_t^* = \alpha x_t + (1 - \delta)y_{t-1}^* \text{ where } 0 < \delta < 1 \quad (4)$$

Where  $x_t$  is the observed value of  $x$  in period  $t$ ,  $y_{t-1}^*$  is the target level of a particular ratio or the value of  $x$  expected to prevail in the period  $t-1$ ,  $y_t^*$  is the value of the ratio for  $t$  or the value of  $x$  expected to prevail in period  $t$ .  $\delta$  is the coefficient of expectations, the proportion of the current change in the industry mean/median taken to be permanent rather than transition.

Unlike the adaptive expectations, in rational expectations theory, the farmer takes into account all information available to make his expectations. It is often argued that rational expectations are model consistent in that it assumes that market outcomes that are forecasted do not deviate widely from the equilibrium, but that the deviation becomes consistent with assumption of random standard error in modelling expectations (See Muth, 1961; Seay et. al, 2004).

This study examines supply response in the framework of rational expectations theory. Supply response basically examines speed and magnitude of changes in planned output in response to anticipated output prices. However, neither planned output nor anticipated price is observable, because first, weather and other environmental factors can make observed output deviate from planned output and second, because the farmer only knows past and current prices (Rao, 1989). Proxies

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<sup>20</sup> See Askari and Cummings (1977) for a survey of the supply response approaches in agricultural commodities.



for these variables, therefore, need to be employed, although having in mind that the choice of the proxy has significant bearing on the results. For example, several economists suggest the use of acreage as proxy for output because it is thought to be more subjective to farmers' control (Askari and Cummins, 1977; Rao, 1989). However, if yield improves given unchanged acreage, this proxy can be misleading.

So far, empirical work of supply response to price of agricultural commodities is found to be consistent with rational expectation theory (Rao, 1989). In theory, a rise in market price of a commodity encourages producers to produce more, such that, an increase in price means a rise in supply. Most time series studies find positive supply response for specific crops with respect to relative price changes (Rao, 1989). In general, short-term supply elasticity of total agricultural output to changes in prices ranges from 0.1 to 0.3 (Meerman, 1997). In the long-run, because of the mobility of factors of production such land, labour and Capital, the production response to improved prices for the entire agricultural sector is much higher- 0.3 to 1.2 (Rao, 1989). Such that, when prices are not attractive in the long-run, not only are the resources reallocated to other competing crops, but also to other uses. Abdulai and Rieder (1995) argued that if farmers receive high prices for their commodities relative to other goods, they would be encouraged to increase output within their limits.

With regards to economic reforms, most empirical findings are consistent with theory depicting that agricultural production and exports increases in response to structural adjustment programs (Meerman, 1997). However, one constraint to faster production response is the inconsistency of the reforms. Meerman (1997) argues that, the private sector become reluctant to invest if Government "ownership" and the persistence of the reforms are in doubt, such as in situations where reforms have often times been reversed or halted and fall short of full liberalisation. Closely linked to economic reforms and commodity trade liberalisation is currency liberalisation. The theory of "getting the price right" through exchange rate devaluation implies an increase in prices and profitability of export crops relative to locally consumed commodities, hence an important incentives for increasing output supply (Meerman, 1997). In a study of cocoa in Ghana, Abdulai and Rieder (1995) found that overvaluation of domestic currency serves as a disincentive to production of tradable, particularly export commodities. They argue that, to provide incentives to producers

of export crops, the general macro-economic environment that determines real exchange rate needs to be put on a sound base.

### 5.3 Model Estimation

In order to address the Nerlove model limitations and to give consistent estimation of short and long-run supply elasticity, this study applies cointegration and error correction models. Two models are estimated and results compared. The first model employed in the analysis i.e. the traditional cointegration and error correction model (ECM) models assumes linear or symmetric adjustment to long-run equilibrium, while the second model considers asymmetric adjustment. In the second phase, threshold cointegration and error correction models is employed to assess asymmetric adjustments of supply to various incentives. In general, error correction specifications examine short-run adjustments to a long-run equilibrium. Several researchers including Abdulai and Rieder (1995), Mc Kay (1999) and Thiele (2003), have applied cointegration and ECM in supply response analysis in different commodities. Unlike the Nerlovean model, cointegration models demand that the variables in question must be integrated of the same order in order for the long-term relationship to be established without giving spurious results. According to Engle and Granger (1987), two or more non-stationary variables may wonder apart in the short-run, but in the long-run there exists a relationship which itself is stationary. The long-run relationship between coffee supply and coffee price, maize prices, real exchange rates and policy changes is given by:

$$Q_t = \beta_0 + \beta_1 P_t^c + \beta_2 P_t^m + \beta_3 RER_t + \beta_4 RF + \varepsilon_t \quad (4)$$

where:  $Q_t$  Logarithm of coffee production at time t

$P_t^c$  = Logarithm of coffee prices at time t

$P_t^m$  = Logarithm of maize prices at time t

$RER_t$  = Logarithm of real exchange rate for the kwacha dollar

$RF$  = Dummy variable for economic reforms

and  $\beta_i$  are the parameters to be estimated. All the variables in equation (4) must be non-stationary and integrated of the same order e.g.  $I(1)$ .  $\varepsilon_t$  is a disturbance term that may be serially correlated. If a long-run relationship exists, then the error term  $\varepsilon_t$  is stationary even when the individual variables are non-stationary. The well known augmented Dickey-Fuller (ADF) statistic is used to ascertain whether the residuals  $\varepsilon_t$  are stationary in the following equation:

$$\Delta \hat{\varepsilon}_t = \rho \hat{\varepsilon}_{t-1} + \sum_{i=1}^p \gamma_i \hat{\varepsilon}_{t-i} + v_t \quad (5)$$

where  $v_t$  is a white-noise disturbance. The null hypothesis of unit root is not rejected if  $\rho = 0$  against an alternative hypothesis of  $-2 < \rho < 0$ . In the case of equation (4), the series are said to be cointegrated if the null hypothesis of unit roots in  $\varepsilon_t$  is rejected. That means presence of a unique long-run equilibrium between coffee supply on the one side and coffee producer prices, real exchange rates and maize prices on the other side.

The ECM is presented as;

$$\Delta Q_t = \delta_i (ECM_i)_{t-j} + \sum_{j=1}^k \beta_{1i} \Delta Q_{t-j} + \sum_{j=1}^k \beta_{2i} \Delta P_{t-j}^c + \sum_{j=1}^k \beta_{3i} \Delta P_{t-j}^m + \sum_{j=1}^k \beta_{4i} \Delta RER_{t-j} + \sum_{j=1}^k \beta_{5i} RF + v_t \quad (6)$$

The term  $(ECM_i)_{t-j}$  represents the error correction term  $v_t$  which is derived as the residuals from the cointegration estimation from equation (4).

A major limitation of the linear cointegration models is that they implicitly assume a linear adjustment mechanism contrary to the characteristics of most time series data (Enders and Siklos 2001). According to Enders and Granger (1998) the symmetric or linear cointegration tests are misspecified if the adjustment to long run equilibrium is asymmetric<sup>21</sup>.

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<sup>21</sup> A detailed discussion of symmetric and asymmetric cointegration methodologies is given in Chapter 2.

To account for asymmetric supply response, threshold error correction models (TECM) is applied within the framework of threshold autoregression (TAR). Building on the works of Enders and Granger (1998), Granger and Lee (1998), Enders and Siklos (2001) and Enders (2004), a multivariate threshold error correction specification is developed in this study to assess possible asymmetries of short-run supply adjustments to its long-run equilibrium based on changes in coffee prices, maize prices, real exchange rates and economic reforms.

To examine threshold cointegration and error correction adjustments, the residuals ( $\varepsilon_t$ ) obtained from the long-run relationship (equation (4)) are used in the estimation of the TAR (equation (7)). To establish a threshold, this study follows the procedure by Chan (1990, 1993) and Enders (2004) where the threshold is selected from all possible values of a threshold variable by a grid search. The selection of the threshold is done alongside estimation of  $\beta_t$  where all Sums of Squared Residuals (SSR) from the TAR models are recorded. The TAR model with a threshold that minimises SSR is selected.

A TAR model is presented as follows:

$$\Delta Z_t = I \left[ \alpha + \sum_{i=1}^k \alpha_{1i} Z_{t-i} \right] + (1-I) \left[ \alpha_{2o} + \sum_{i=1}^k \alpha_{2i} Z_{t-i} \right] + \mu_t \quad (7)$$

where  $I_t$  is the Heaviside indicator function such that:

$$I_t = \begin{cases} 1 & \text{if } Z_{t-1} \geq \tau \\ 0 & \text{if } Z_{t-1} < \tau \end{cases}$$

$\Delta Z_t$  is the first difference of the residuals derived from the long-run cointegration estimation in equation (4);  $I_t = 1$  if  $Z_{t-1} \geq \tau$ ;  $I_t = 0$  if  $Z_{t-1} < \tau$ . This implies that when  $Z_{t-1} \leq 0$ ,  $I_t = 0$  and  $(1-I_t)=1$ .

Examining threshold cointegration is equivalent to testing the null hypothesis of no cointegration by testing the joint restriction that  $\alpha_{1i} = \alpha_{2i} = 0$  in equation (7), based

on F-statistics and its significance level. The F-statistics values are tabulated in Enders and Enders (1998). If the null hypothesis of no-cointegration is rejected, then asymmetric adjustments can be tested. Examining asymmetric supply adjustments is equivalent to examining the presence of a threshold which is done by testing whether  $\alpha_{1i} = \alpha_{2i}$  in equation (7). If the hypothesis is rejected, then the system has asymmetric adjustment effects. In that case, asymmetric short-run adjustments to the long-run adjustment are estimated using a Threshold Error Correction Model (TECM). As suggested by the rationale expectation theory, asymmetric adjustment in supply response is treated as a short-run phenomenon. Therefore, the conclusions are mainly drawn on the short-run estimations.

In order to render the results robust with respect to the asymmetric effect of the dependent variables on supply, this study develops a TECM for each regime, i.e. for the adjustments above the threshold and those below the threshold. Each model is then estimated as a normal symmetric ECM given in equation (6). The two models are represented as:

$$\Delta Q_t = \lambda^+ Z_{t-1}^- + \sum_{j=1}^k \alpha_k \Delta Q_{t-k} + \sum_{j=1}^k \beta_k \Delta P_{t-k}^c + \sum_{j=1}^k \delta_k \Delta P_{t-k}^m + \sum_{j=1}^k \lambda_k + RF + v_t \quad (8)$$

$$\Delta Q_t = \lambda^- Z_{t-1}^+ + \sum_{j=1}^k \alpha_k \Delta Q_{t-k} + \sum_{j=1}^k \beta_k \Delta P_{t-k}^c + \sum_{j=1}^k \delta_k \Delta P_{t-k}^m + \sum_{j=1}^k \lambda_k + RF + v_t \quad (9)$$

Where  $Z_{t-1}^+$  and  $Z_{t-1}^-$  are derived from (7) depending on whether the system is above or below an estimated threshold.  $Z_{t-1}^+$  are positive shocks above a threshold and  $Z_{t-1}^-$  are the negative shocks below a threshold. Similarly  $\lambda^+$  and  $\lambda^-$  represent the adjustment coefficients when the system is above and below the threshold respectively.

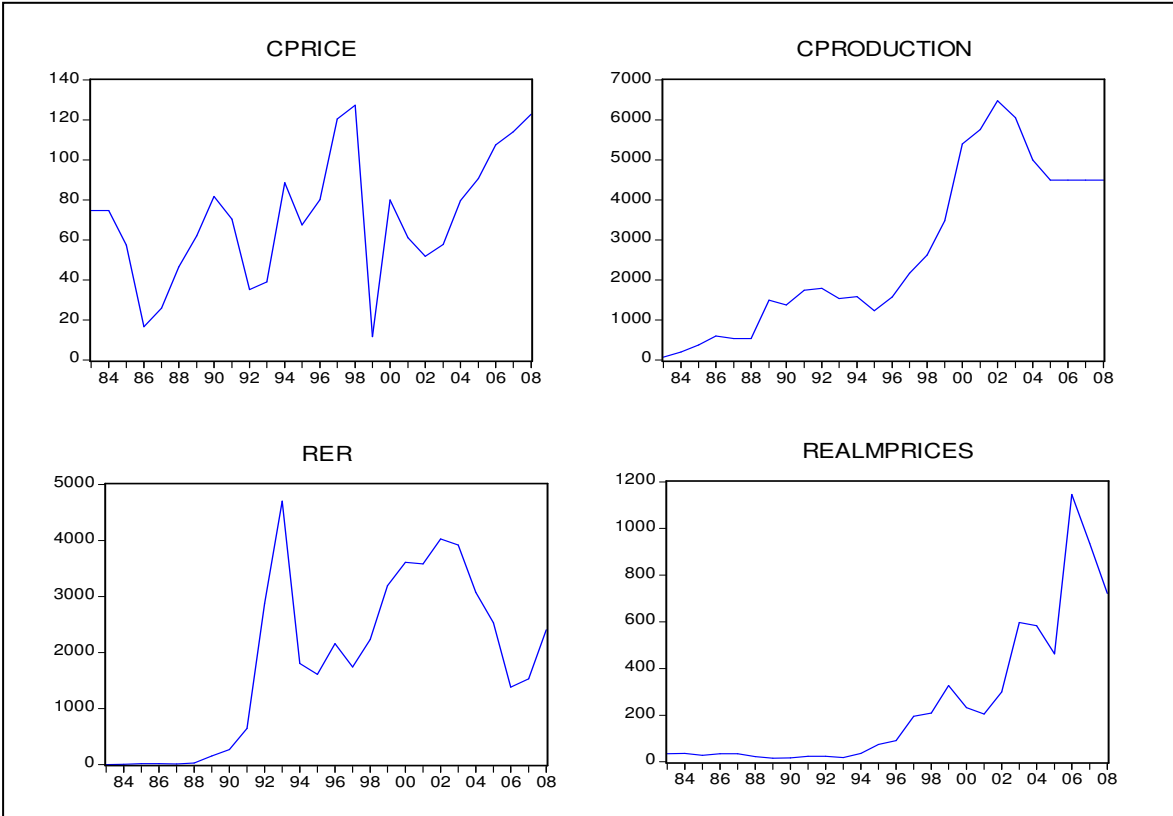
#### 5.4 Data Description

Annual series data covering the period 1983 to 2008 is used for the empirical analysis. The variables include annual coffee production in metric tonnes, coffee

producer prices in US cents per pound (lb),<sup>22</sup> real maize prices ZMK per kg and real exchange rate for the Kwacha currency. Coffee production and price data were obtained from the International coffee organisation (ICO), data on real exchange rates and maize prices (1994-2008) were obtained from Bank of the Zambia (BOZ), while the other part of the maize prices (1983 to 1994) were obtained from a study conducted by Wold (1997). A dummy variable identifying the economic reform is included to control for a potential structural break. This structural break was determined endogenously using the Lee and Strazichici (2003) structural break unit root tests in the real exchange rates variable. I choose to use the exchange rate variable to determine economic reform because currency liberalization took a central stage during the economic reforms.

The original data on exchange rate and for maize prices were in the local currency needed to be deflated with a price index. Consumer price index (CPI) with the year 2000 as the base was used to deflate exchange rates for the entire period and maize prices for the period 1994 to 2008. Maize prices which were obtained from the study by Wold (1997) covering the period 1984 to 1994 were already in real terms, deflated using low income CPI. Figure 5.2 plots these variables.

Figure 5.2: Supply Response Variables



Cprice are Zambian coffee prices in US cents/lb; Cproduction is coffee production for Zambia in metric tonnes; RER is the Real exchange rate expressed as Zambian Kwacha (ZMK) per USD.

#### **5.4.1 Rationale for Variable Selection**

The selection of the variables was based on theoretical understanding of supply response discussed in section 5.3. In the first place, farmers make their production decisions based on past price information. As noted by Askari and Cummings (1997), crop specific price risk increases supply responsiveness particularly of peasants whose livelihood may be threatened by down-side risks. This is especially so with export crops like coffee which demonstrate acute period to period volatility. In theory, high prices are supposed to motivate farmers to produce more. Thereby, prices having a positive effect on production of a particular commodity. However, in perennial crops, where supply tends to reach the market when prices are on the decline, the price coefficient may not be positive. For coffee in particular, when prices increase, farmers are motivated to increase production, such that excess production may lead to price decline. When prices decline, farmers get discouraged from making investments in new trees or maintaining the old ones, resulting in low yields and less supply. In the end, prices rise again due to low supply. This is exacerbated by the fact that coffee is a perennial crop with lags between plantation and harvesting varying between 18 to 24 months. Peak yields are only experienced after 5 to 7 years. This implies that, while input investments respond quickly to price changes, supply response is very slow. Consequently, additional supply tends to reach the market when prices are on the decline.

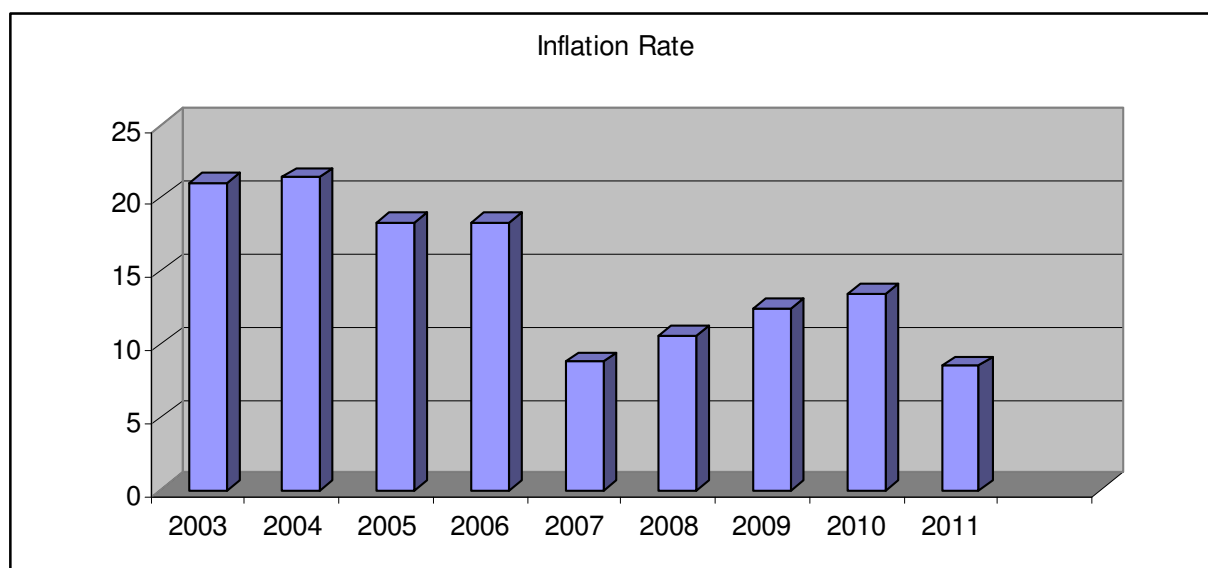
Second, alternative crops prices may influence coffee production. As maize is Zambia's main stable crop, its successes and failures in terms of yield and price may have a bearing on the farmers' decisions to grow an alternative cash crop such as coffee. Askari and Cummings, 1997 explain that where multiple cropping is possible and rigid patterns of land use are not dictated by substitute requirements, farmers set of choices is wider. Hence, responsiveness is likely to be greater. In this case, coffee supply response to maize prices is expected to be significant but negative.

Third, Zambia embarked on economic reforms in the 1990s when agricultural trade was liberalised. The change from a controlled system that included price fixing could have significant effect on the coffee supply. As explained by Rao (1989), the analysis of long-run response must distinguish changes in supply conditions that are brought about by the decentralised private actions from changes that result from centralised public actions. Given that trade liberalisation encourages private traders which could lead to increased and more efficient markets, the coefficient of the dummy variable for economic reforms is expected to be positive. Whether the coefficient would be significant is subject to investigation because trade liberalisation did not directly affect the coffee industry. Even before the reforms the government did not have much control of the industry as it was relatively small and insignificant. However, the reforms in other sectors of the economy such as exchange rates, privatisation of state owned enterprises and decentralisation of the agricultural institutions could have an impact on the coffee industry.

Fourth, exchange rates influence farmers' decision to increase supply. A stronger currency makes exports more expensive than a relatively weaker currency relative to prices of locally consumed commodities. The trend in most cases is that a stronger currency results in a decline in exports. Abdulai and Rieder (1995) argue that overvaluation of the domestic currency serves as disincentive to production of tradable, particularly of export commodities. In the last decade Zambian Kwacha steadily gained strength against the US Dollar. Hypothetically, a strong currency reduces profitability of exports crops. As such a positive coefficient for real exchange rate is expected in both the long and short-run model estimation. Figure 5.4 shows Zambia's annual inflation rate in the last eight years.



Figure 5.3 Zambia Annual Inflation Rate (2003-2011)



Source: Bank of Zambia (BOZ) data at [www.boz.zm](http://www.boz.zm)

## 5.5 Results

The use of cointegration demands that the variables be non-stationary and integrated of the same order. To assess stationarity of each variable, the ADF tests (equation 5) unit root tests are employed. The number of lags to include in the ADF model is selected using the Akaike Information Criteria (AIC).<sup>23</sup> A general-to-specific approach is also employed to verify the AIC selection.<sup>24</sup> The results presented in Table 5.1 show that all variables are non-stationary in levels while their first differences are stationary.

<sup>23</sup> Akaike's (1987) Information Criteria (AIC) and Schwarz's (1983) Bayesian Criteria (SBC) are commonly used to determine the number of parameters to include in a model. The model giving the smallest value of AIC and SBC is considered best and most likely gives the best goodness of fit. Based on theoretical explanations and various simulation studies, SBC is preferred for large samples because the AIC tends to select models with too many parameters when the sample size is large. However, the number of observations in this study is 26 for all the variables justifying the use of AIC.

<sup>24</sup> In a general-to-specific approach, different lags are included in the unit root test until the appropriate lag is reached. The procedure involves starting with many lags and reducing until the appropriate number of lags is reached, based on the results of the unit root test as well other indicative values for autocorrelation such as the Durbin Watson (DW) value.

Table 5.1: Unit Root Tests for Supply Response Variables

	With Constant		With Constant and Drift	
	Level	First difference	Level	First difference
Coffee Production (2)	-1.863	-5.008***	-3.438*	3.555***
Coffee Price(2)	-2.217	-5.176***	-2.739	-5.035***
Maize Prices(5)	-0.276	-3.752***	1.130	-4.490***
Real Exchange rates(1)	-2.398	-3.729**	2.612	-4.462***

\*,\*\* and \*\*\* denote significance at 10%, 5% and 1% respectively. The number of lags for each variable are indicated in parentheses.

According to the t-statistics, the null hypothesis of unit roots cannot be rejected at the 1 percent level for all variables in levels. However, the null hypothesis of unit roots is highly rejected when applied to first differences of the variables. That means that all the variables are integrated of order one or are  $I(1)$ .

Cointegration analysis has been carried out using both the Engle and Granger (1987) and Johansen (1988) tests, which presumes a linear cointegration, and the TAR model which takes into account possibilities of asymmetric cointegration. Further, both symmetric and asymmetric error correction models are estimated to examine the short run adjustments to long run equilibrium.

### 5.5.1 Symmetric Cointegration and Error Correction Results

The Engle-granger cointegration procedure involves two steps. In the first step long-run relationships are established between coffee supply at time  $t$  and the explanatory variables (coffee producer prices, maize prices, the real exchange rate and economic reforms) as specified in equation (4). The results are presented in equation (10) where t-statistics obtained from ADF distribution are given in parentheses.

$$Q_t = 5.154 - 0.0421P_{t-1}^c + 0.010P_{t-1}^m + 0.331RER_t + 0.795RF \quad (10)$$

(8.910) (-0.317) (0.086) (9.031) (2.373)

$$R^2 = 0.9155 \quad AIC = 1.0556$$

The most significant variable in determining supply response is the exchange rate in real terms. A positive coefficient of the exchange rate means that when the Zambian Kwacha weakens against the dollar (an increase in the exchange rate) coffee supply increases. Given that coffee is grown solely for export, a strong currency makes the commodity less competitive, hence unattractive for farmers to plant more or invest more in the already growing trees. As equation (10) shows, one unit appreciation of the Zambia Kwacha leads to 0.33 percent increase in coffee supply in the long-run. Thus, the 2004 peak coffee production that Zambia experienced can be associated with the 21.4 percent annual inflation rate in the same year (Figure 5.4 above).

In addition, the results show that economic reforms, which occurred in 1998 (according to a structural break in the real exchange rate), have had a positive impact on coffee production. Since the t-statistic value of 2.373 on the economic reform coefficient is higher than the 5 percent critical value of 1.708, the impact is significant. The coefficient is positive, an indication that coffee production increased.

On the contrary, the effect of coffee prices on coffee production in Zambia in the long-run is not significant. A plausible explanation for the insignificant coffee prices is that the prices are in dollars and that is what the farmers receive. Therefore, the incomes for the farmers, in the local currently, greatly depend on the exchange rate. As long as the local currency continues to weaken, coffee farmers will always find it attractive to produce more, even if price remains the same. Similarly, price for maize, the competing crop with coffee, has no significant impact on supply. An explanation for this outcome is that land may not be a factor for the large scale farmers, such that maize is not grown as an alternative crop, but as complementary to maize.

Nevertheless, the second step of the Engle Granger cointegration approach, is to test stationarity of the residuals  $\varepsilon_t$ . As mentioned earlier, ADF tests are employed for this

test (equation (5)). The null hypothesis of non-stationary presented by  $\rho = 0$  was rejected at 0.01 given a t-statistic of -3.759. This value is greater than the 1 percent critical value of -3.707 which justifies the rejection of the null hypothesis.<sup>25</sup>

Given the possibility that there may be more than one cointegration vector, the multivariate cointegration approach proposed by Johansen and Julius (1990) was also applied to examine the number of cointegration vectors. Unlike the Engle and Granger cointegration test, the Johansen test does not assume a single cointegration relationship. It therefore becomes necessary to apply the Johansen test as well to establish the number of cointegration relationship. The results are presented in Table 5.2. The procedure involved testing for the number of cointegration vectors between coffee supply on one side and coffee prices, real maize prices, real exchange rate and a dummy of economic reforms on the other. Results indicate two cointegration equations significant at 5 percent level. The Johansen results provide further evidence supporting the results of the Engle-Granger tests which shows evidence of cointegration between the variables as shown in equations (10). As in the Engle granger cointegration test, the Johansen test shows that at most two variables have a significant effect on coffee supply.

Table 5.2: Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.875244	101.5900	69.81889	0.0000
At most 1 *	0.696712	51.63643	47.85613	0.0212
At most 2	0.434481	23.00272	29.79707	0.2459
At most 3	0.218464	9.322430	15.49471	0.3364
At most 4	0.132327	3.406570	3.841466	0.0649

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

<sup>25</sup> The critical values are for cointegration relationships for four variables with a constant in the cointegration vector. The values are tabulated in Enders, 2004 pp. 441

Having established the existence of a long run relationship, a symmetric ECM, is employed to capture short-run supply adjustments to the long-run equilibrium estimated using equation (4). The ECM presented in equation (6) estimates the short-run adjustments of supply toward the long-run equilibrium. The maximum order for the ECM, given the number of observations for this study, is two. The DW value confirms the absence of autocorrelation when one lag is included for each variable. As Deaton and Laroque (2003) have shown, coffee supply response to increasing coffee prices can occur within two years; hence a model with two lags is sufficient to capture coffee supply elasticity.

Table 5.3 shows the short-run adjustments. The error correction term (ECT) is negative as expected from ECM and significant at the 15% level. This means that when all incentives increase, supply does not increase proportionally; instead it lags behind creating a negative disequilibrium which gets corrected over time. The deviations from the long-run equilibrium are short lived, such that 0.41% of the previous year's disequilibrium from the long-run relationship is corrected in the current year.

Table 5.3: Symmetric Error Correction Estimates

	$\beta_i$	t-statistics	Standard Error
$\Delta\Phi_{t-1}$	-0.181*	-1.315*	0.313
$\Delta\Phi_{t-2}$	-0.173	0.718	0.305
$\Delta p_{t-1}^c$	0.190	0.890	0.241
$\Delta p_{t-2}^c$	0.089	0.620	0.213
$\Delta p_{t-1}^m$	-0.128	0.567	0.143
$\Delta p_{t-2}^m$	0.326	-0.142	0.226
$\Delta RER_{t-1}$	0.326*	1.575	0.285
$\Delta RER_{t-2}$	-0.126	-0.653	0.206
$\Delta RF_{t-1}$	0.237	0.652	0.194
$\Delta RF_{t-1}$	0.256	0.694	0.385
ECT	-0.412*	-1.315	0.369
C	0.097	0.773	0.126

\*\*\* Significance at 15%

The changes in the RER seem to have a larger impact on changes in supply, given a 15% significant coefficient. The coefficient on the RER is also positive supporting the argument that a depreciation of the currency (as the exchange rate value increases) attracts investment in agricultural exports. The coefficient on price is positive although the short term adjustments for two lags are not significant. Similarly the short run adjustment for maize prices is not significant for the first lag although it has the expected negative sign. The previous period's production has relative effect on current period's production given the significant coefficient at 15% level.

Detailed vector error correction estimation is presented in Table 5.4. The t-statistics on the estimated coefficients give an indication that coffee prices, exchanges rates and maize prices do not influence each other in the short-run.

### 5.5.2 Asymmetric Cointegration and Error Correction Results

The results discussed above do not differentiate between effects of positive and negative shocks on supply response. Due to a possibility of asymmetric supply movement, threshold cointegration was examined using the TAR model (equation 7).<sup>26</sup> The results indicate the existence of a threshold of 0.23367. The selection of this threshold was based on grid search for the smallest SSR computed from TAR estimations using all possible threshold values.

The null hypothesis of no threshold cointegration, which is equivalent to a test that  $\alpha_{1i} = \alpha_{2i} = 0$  in equation (7) was strongly rejected at 5%. The test gives a P-value of 5.204 with 0.016 level significance. This value is greater than the 5% critical value of 3.55 with 2,18 degrees of freedom. A test of asymmetric supply response to the long-run equilibrium involves a Wald test of the null hypothesis that  $\alpha_{1i} = \alpha_{2i}$  in equation (7). If supply response to all the variables is asymmetric, then it is expected that  $\alpha_{1i}$  differs significantly from  $\alpha_{2i}$ . The hypothesis is rejected at 5% giving a P-value of 5.260 which is greater than 3.55. The results mean that coffee supply adjusts according to whether a deviation from the long-run equilibrium is above a threshold of 0.233 or below the threshold.

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<sup>26</sup> The TAR model was estimated using Regression Analysis for Time Series (RATS) program.

The results from the TAR model imply that positive shocks (represented as  $Z_{t-1}^-$  in the ECM) and negative shocks ( $Z_{t-1}^+$ ), have different impacts on the adjustment of coffee supply in the long-run. Therefore, short run adjustments to the long-run equilibrium can be determined based on estimations of the two ECMs presented in equation (8) and (9).<sup>27</sup> Results, which are presented in Table 5.4 and 5.5 shows that, for all the variables apart from coffee prices, short-run adjustments of coffee supply to its long-run equilibrium tends to occur only when the shocks are above the threshold and not when the shocks are below the threshold. Regarding the changes in coffee prices, results show that about 0.26% of the deviations from long-run equilibrium are corrected back whenever the price changes move above the threshold. Below the threshold, maize prices do not have any significant effect on supply. What this means is that coffee price increases only lead to increases in coffee supply in the short run if the deviation from long-run equilibrium gets above the threshold. However as explained earlier, given the nature of the coffee tree as a perennial crop, is best examined in a long-term. Changes in maize prices do not seem to have any significant effect on coffee supply in the short run, whether the system is above or below the threshold. For real exchange rate, threshold short run adjustment results show that whenever the Zambian Kwacha depreciates by one unit above the threshold, coffee supply increases by 0.19%.

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<sup>27</sup> One lag each variable is included in the models. The model for positive shocks gives an AIC value of 0.449, SBC of 0.793 and a DW value of 2.24 while the AIC value for the negative shock model is 0.516, the SBC is 0.859 and the DW is 2.23. Given that Coffee is a perennial crop which can take up to 4 years before the first harvest and that the trees can last up to 50 years, more lags would be needed to explain the adjustments to shocks that occurred several years back. However, the best model was selected for one lag. This could be partly because of the small number of observation in the sample.

Table 5.4: Error Correction Estimation above the Threshold

Variable	Coefficient	t-statistics	Standard Error
$\Delta\Phi_{t-1}$	-0.527*	-1.638	0.120
$\Delta p_{t-1}^{c+}$	0.260*	2.578	0.020
$\Delta p_{t-1}^m$	0.006	0.037	0.971
$\Delta RER_{t-1}$	0.191*	1.348	0.195
$\Delta RF_{t-1}$	0.330*	1.659	0.115
$Z_{t-1}^+$	0.216*	1.323	0.203
C	0.790**	2.889	0.010
Obs	24		
$\bar{R}^2$	1.229		
DW	2.23		

Table 5.5: Error Correction Estimation below the Threshold

Variable	Coefficient	t-statistics	Standard Error
$\Delta\Phi_{t-1}$	-0.240	-0.879	0.391
$\Delta p_{t-1}^{c+}$	0.131	1.290	0.214
$\Delta p_{t-1}^m$	-0.081	-0.462	0.650
$\Delta RER_{t-1}$	0.134	0.952	0.355
$\Delta RF_{t-1}$	0.107	0.569	0.577
$Z_{t-1}^+$	-0.144	-0.744	0.467
C	0.501*	1.557	0.138
Obs	25		
$\bar{R}^2$	0.18		
DW	2.50		

\*, \*\*, \*\*\* represents significance at 10%, 5% and 1% respectively

This demonstrates that farmers find exporting profitable when the Zambian Kwacha depreciates against the US Dollar.



## 5.7 Conclusions

The study investigated coffee supply response in Zambia using threshold error correction model. The main objective was to address the question of whether changes in coffee supply do respond asymmetrically to various incentives, thus departing from earlier studies on this topic that paid no attention to asymmetric adjustments. In this study asymmetric adjustments are examined both in the long-run and the short-run, such that the error term is split into two series; when the deviation from equilibrium is above the threshold and when it is below the threshold. Several conclusions are drawn from the results.

First, there is robust evidence that a strong currency does not favour coffee production and export in both the long-run and the short-run. The results have shown that when the Zambian currency (the Kwacha) appreciates, coffee growers receive less Kwacha for the same quantity of exports, although the value in US Dollars remains the same. This in return discourages the growers as most production expenses such as labour and other inputs are paid for in the local currency. The results are consistent with theory of “getting the price right” through currency devaluation, which leads to profitability of export crops relative to locally consumed commodities. As such, policies should focus on putting in place a general macro-economic environment that determines exchange rate needs. Over valuation of the exchange rate discourage the production of export commodities.

Coffee prices which are hypothetically the main factor influencing production have been found to have no significant effect in the case of Zambia. A conclusion can be made here that in perennial crops like coffee, prices become endogenous to supply. The supply response to prices tends to be slow in that it reaches the market when prices are on the decline. Furthermore, the farmers are more concerned about the exchange rate in their production decisions and not on the prices per se. This is because they receive coffee revenues in US dollars while their expenses are in the Zambian Kwacha. In addition the coefficient for economic reforms, which is highly significant, demonstrates that a liberalised economy favours the production of coffee in the short run.

Regarding asymmetric supply response, the study found that positive shocks to the variables such as increase in coffee prices have more impact on coffee production than the negative shocks. Such asymmetric response cannot be captured in the linear cointegration models. The application of threshold cointegration models which has provided evidence that there is no reason for presumption that cointegration is linear. As observed in the study, supply may not continuously adjust to its long-run equilibrium until the changes in the influencing variables reach a certain threshold. Analysing supply response without taking into account asymmetric effects, can lead to misleading result. Therefore, in comparison to the symmetric cointegration models, a conclusion can be made that the TAR mechanism provides a straightforward and a more meaningful explanation of time-series data adjustments to shocks due to changes in the exogenous variables.

Estimates of a dynamic threshold error correction model with two lags have clearly shown that coffee supply adjusts to shocks in coffee prices above the threshold but not to shocks below the threshold. Since the model is only lagged for one year, this result means that when coffee prices increase in year  $t-1$ , farmers increase their investment in maintaining the coffee trees to be harvested and exported in year  $t$ . Furthermore, coffee trees may be subjected to several shocks such as weather or pests over time, such that a longer lag operator can give misleading results, if such variables are not properly controlled for. Substantively, future research should consider a possibility of more than one threshold in the error correction term such that multiple regime analysis which be considered.

Overall, the theory that supply adjusts to price incentives may not apply to export commodities where the farmers receive their incomes in a foreign currency. In that case the motivation to produce more highly depends on the exchange rate in relation to locally consumed goods and wages. In that case policies should focus on increasing non-price incentives and creating an environment for determines real exchange rates.

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## **Chapter 6:**

### **Conclusion**

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This study examined coffee value chains, price transmission, price volatility and supply response in the presence of structural breaks arising from economic reforms. The main economic challenges facing coffee markets are asymmetric power structures arising from high firm concentration at the trading and roasting stages of the coffee value chain which prevent efficient price transmission from world prices thereby preventing the producers from benefiting from increases in world producer prices. While on the other hand, price decreases in world prices are quickly passed on to the producers. Consequently, coffee producers in the Zambia and Tanzania, like in many other producing countries, have experienced declining producer prices and extensive short-term producer price volatility in the last decade. These challenges affect production, incomes and consequently the welfare of the producers who are mostly poor small scale farmers fragmented across developing countries. The coffee value chain, like many other agricultural commodities, is buyer driven. This implies that producer prices are determined by forces at higher stages of the chain. This Chapter first gives an overview of the study by summarising the major findings. The conclusions are drawn based on the findings and the hypotheses of the study. The question of what the results mean for policies relating to the coffee sectors and the welfare of the growers is then addressed.

#### **6.1 Study Focus**

The analysis of the results reported in this section aimed at investigating the impacts of trade policy reforms on coffee price movements i.e. the stability and asymmetry of price transmission from international producer prices to grower's prices in the producing country. The main motivation for studying coffee price movements is that while coffee remains the most important export crop in Eastern Africa, its prices declined the most in comparison to other export commodities in the last decade. Further, coffee producer prices have remained the most volatile compare other agricultural commodities. Undoubtedly, understanding the explanations behind the

price trends, other than basic market forces of supply and demand, which could have an effect on supply, becomes vital in price policy formulation. In order to achieve the objectives of the study, four specific studies have been done: i) value chain and governance structures and implications on producer prices, ii) asymmetries in Price transmission and the effects of economic reforms iii) price volatility analysis and iv) supply response to price movements.

## **6.2 Summary of Results**

A review of the international coffee value chains and governance structures in coffee markets gives an indication that the coffee value chain is composed of complex interrelations among the actors. Despite Zambia and Tanzania having different degrees and trajectories of coffee market liberalisation, there is something in commonness in that both countries feed into a complex value chain that is governed by multinational corporations. In the case of Tanzania, where coffee is the main export crop is mainly produced by small scale farmers, the chain is even more complex as coffee has to pass through several of intermediaries that include cooperatives and traders. Despite the liberalisation of coffee marketing, by law, all coffee exports in Tanzania go through the government owned coffee auction. Due to high government intervention in marketing, large number of intermediaries as well as quality issues, Tanzania's grower prices are far below the world producer indicator prices. In contrast, Zambia's coffee from the farmers only go through the private Zambia coffee growers association before it is exported. As a result Zambia producer prices much higher than most countries in Africa albeit being very volatile. This however is a real reflection of world prices.

To substantiate the findings of the qualitative analysis of coffee markets, an analysis of coffee price transmission from international markets to producers has been carried out. The study uses 273 monthly observations of coffee producer prices for Zambia, Tanzania and the world producer indicator price. The analysis has been done for the entire sample as well as for the two subsamples using threshold auto regression and the momentum threshold auto regression models. For each of the two producer prices, cointegrated with world prices is examined specifically, whether the transmission is symmetric or asymmetric. If the test for long-run relation (implication

of cointegration) is significant, asymmetry is tested to establish the nature of the transmission.

The results from the threshold autoregression model indicate that price transmission for Zambia improved after economic liberalisation while in the case of Tanzania, the transmission has not improved. The TAR model specifically examines 'deepness' of price adjustments to long-run equilibrium, while the MTAR examines steepness of the adjustment. Comparing TAR and MTAR models, the results show evidence of high rejection power of the null hypothesis of symmetry for the MTAR model. In the second stage of the analysis, short run adjustments to long-run equilibrium are examined using threshold error correction models. Results show that, after the economic reforms in Zambia, price decreases have a larger impact on producer prices than the price increases. For example, a negative shock on Zambian prices led to the prices adjusting by 58.3 percent while a positive shock only led to 43 percent adjustment in the Zambian prices. In most cases the adjustment for CIP in response for shocks initiated by changes in producer prices was not significant. For Tanzania, negative shocks lead to 30 percent price adjustment towards the long-run equilibrium while positive shocks only initiate 9 percent adjustment.

Price volatility has been analysed to examine coffee price variations in Zambia, Tanzania, the international market price and retail prices in Germany. The aim is to assess the effect of the fall of the ICA in 1989 and market liberalisation policies in the two producing countries. Retail prices demonstrated homoskedasticity such that GARCH models could not be estimated. It should be noted that the idea of GARCH models is to establish impact and persistence of shocks in variables with heteroskedasticity. According to threshold GARCH results, the impact of shocks was highest in world prices where a shock to the prices increased volatility by 35.2 percent. On the other hand, a shock to the prices increased volatility by 3.5 percent in Zambia while it actually reduced volatility by 0.8 percent in Tanzania's case. However shocks were most persistent in the case of Zambia such that it took up 59.3 months before dying away while it only took 32.7 months before it is eliminated in the world prices and Tanzania prices respectively. Results also show that volatility was asymmetric for Zambia and World prices while symmetric in Tanzania's case. This means that in Tanzania's case positive and negative shocks had similar effects



on volatility. Further, between TGARCH and GARCH models, the analysis finds TGARCH models to provide better fit for the results.

The last part of the study examined supply response of coffee in Zambia. The motivation for this study is that coffee, despite its potential for increasing Zambia's export diversification, is still a very small sector compared to other countries in eastern and southern Africa. Understanding the factors that influences coffee supply would render policy makers develop some pathways for increasing supply. Applying cointegration and threshold error correction methods, results show that all the independent variables i.e. coffee prices, maize prices, exchange rates and dummy variables apart from economic reforms have significant impact on coffee supply. As expected the price of maize the main competing crop and real exchange rates have negative effects on supply. This means that when maize prices increase farmers resent coffee and opt for maize. Coffee exported also become discouraged when the local currency gains against the dollar as exporting becomes more expensive.

### **6.3 Policy Implications**

The results of the study have significant policy implications. First, the effect of value chain governance structures on producer prices is evident although it has been less investigated in economic literature. Producer price share of the final price is much of a consequence of value chain governance structures that producers find themselves in. Clearly, the rules for participation in the chain, which are set by the governors of the chain and the barriers to entry, determine the extent to which producers can participate, subsequently, the price that they receive. In addition, comparing the two value chain structures, i.e. the Zambian and the Tanzanian value chains, the study shows that the more the intermediaries in a given chain, the less price growers are likely to obtain. It is therefore important that government policies be directed towards having fewer but effective players at intra-country level. The cooperative unions arrangement in the case of Tanzania, if well organised like in Zambia's case can help Tanzania's coffee growers receive higher prices than what they are currently receiving. The cooperatives should however operate as private entities free from state interventions like in Zambia's case.

Second, this study has confirmed assertions that commodity price movements are fundamentally asymmetric whereby positive and negative shocks to prices have different impacts on long-run adjustment to equilibrium as well as on volatility. As price decreases tend to have large impacts and persists longer in producer prices, any trade intervention policy should be directed towards working on modalities that help eliminate negative shocks quicker. Market-based price risk interventions like futures become ideal for preventing negative price shocks without distorting market functioning. Fair trade initiatives may also provide solutions to negative price shocks although empirical evidence of fair trade impact and extent is largely missing.

Further, it has been established from the TAR model that, price transmission in the case of Zambia improved after economic reforms while it was not the case for Tanzania. These results confirm earlier findings that Tanzania was the only coffee producing country where price transmission did not improve after economic liberations. From the results, it can be concluded that economic liberalisation lead to improved price transmission. There is also strong evidence of negative shocks increasing the persistence of volatility more than positive shocks. Zambia which is more exposed to world markets experiences higher volatility than Tanzania and even more than the world prices. As negative shocks lead to more volatile prices than positive shocks, policies should be directed towards minimising the negative shocks if stable prices are to be achieved. Again, market-based initiatives are recommended.

Investigating supply responsiveness of coffee becomes critical for Zambia where production significantly declined in the last 5 years. An important finding from this study is that, contrary to theoretical assertions that commodity production responds positively to prices, it is not the case with coffee in Zambia. Since coffee is mainly produced for export and the farmers receive their revenues in US Dollars, the exchange rate tends to play a key role in the farmers decisions to produce more coffee. Therefore, the study has shown that farmers have not taken advantage of price increases to increase production. For policy decisions, it is important to understand that non-price incentives play a key role in improving production.

## APPENDICES

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### Appendix A: Structural Break Unit Root Test Theory

In Chapter 3, 4 and 5, structural break unit root tests have been employed to determine the structural break due to economic reforms in the data. This section discusses an endogenous unit root tests.

Lee and Strazicich's (2004) developed a Langrage Multiplier (LM) testing strategy (LSLM) that allowed for two structural breaks to be determined endogenously under both the null and the alternative hypothesis. The LSLM is based on Perron (1989)'s structural break unit root tests that follows three models: Model A allows for a break in the intercept, model B in the trend and model C in both the trend and intercept. The LSLM model is basically an extension of the Perron (1989) model, which also allows for a structural break under both the null and the alternative hypothesis. Considering data-generating process, the model is presented as;

$$y_t = \delta' Z_t + e \quad e_t = \beta e_{t-1} + \varepsilon_t$$

Where  $Z_t$  is a vector of exogenous variables and  $\varepsilon_t$  is an iid  $N(0, \sigma^2)$ . The two structural breaks under Model C28 are described by,  $Z_t = [1, t, D_{jt}, DT_{jt}]$  for  $t \geq T_B + 1$  and zero otherwise, for  $DT_{jt} = t - T_B$   $j=1, 2$  and zero otherwise.  $D_{jt}$  is the indicator dummy variables for a mean shift occurring at times  $TB_{jt}$ .  $TD_{jt}$  are the corresponding trend shift variables. The DGP includes breaks under the null ( $\beta = 1$ ). According to the LM (score) principle, unit root test statistics are obtained from

$$\Delta y_t = \delta' \Delta Z_t + \phi \tilde{S}_{t-1} + u_t \tag{10}$$

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<sup>28</sup> Lee and Strazicich's (2003) model, like in the Perron C<sup>28</sup> model, allow for changes in the level and trend.

where  $\tilde{S} = y_t - \tilde{\psi} - Z_t \tilde{\delta}$   $t = 2, \dots, T$ ,  $\tilde{\delta}$  are coefficients in the regression of  $\Delta y_t$  on  $\Delta Z_t$ ;  $\psi_x$  is given by  $y_1 - Z_1 \tilde{\delta}$ ; The Unit root null hypothesis is described by  $\phi = 0$ . Note that the testing regression (9) involves  $\Delta Z_t$  instead of  $Z_t$ . To correct for serial correlation errors, the augmented terms  $\Delta \tilde{S}_{t-j}$ ,  $j = 1 \dots k$  are included to the equation using the general specific lag selection method suggested by Perron (1998). The method involves selecting a number of lags  $P$  from a more general structure length such that the coefficient of the last lag is significant, and that the coefficient in an auto-regression of order more than  $P$  is insignificant up to an optimal number of lag lengths- where the error term is stationary. Selection of lag length is critical as too few lags lead to auto correlation and too many lags will lead to inefficiency. The LM test statistic is given by:  $\Delta \tilde{S}_{t-j}$ , t-statistic for testing the unit root null hypothesis that  $\phi = 0$ . The location of the structural break ( $T_B$ ) is determined by selecting all possible break points for the minimum t-statistic as follows:

$$\text{Inf} \tilde{\tau}(\tilde{\lambda}_t) = \text{Inf} \tilde{\tau}(\lambda), \text{ where } \lambda = T_B / T$$

Lee and Strazicich (2004) argue that the LM unit root tests statistics which is estimated by the regression according to the LM principle will not spuriously reject the null hypothesis of unit root. That it is also invariant to nuisance parameter, as such it does not require the assumption of no break under the null. The advantage of the model is that the parameters do not change regardless of whether the series is stationary.

## Appendix B: Threshold Vector Error Correction Results

In Chapter 3, an analysis of short-run adjustments to long-run equilibrium has been carried out. The results presented in Table 3.4 and 3.5, are a summary of vector error correction estimation. Figure B1 and B2 presents the vector error correction estimations explaining how the Zambian coffee prices and Tanzanian coffee prices adjust to world prices and vice versa. The error term has been estimated from TAR and MTAR models presented in Table 3.3.

The Table B1 shows the results for the Zambia-world price error correction estimation. Up to 12 lags for both variables have been included in the model. A general- to-specific lag selection procedure was used to select the 12 lags. The Durbin Watson (DW) value of 2.009 confirms absence of autocorrelation in the error term for the 12 lags. The results of the error correction estimation from the TAR model indicate that world coffee prices (denoted as  $\Delta P_{cip}$ ) are not influenced by the Zambian coffee prices  $\Delta P_{zt}$  given the insignificant t-statistics for most of the lags in column 2 of Table B1. On the other hand, the Zambian prices are influenced by world prices for most of the lags. The Zambian prices also seem to be influenced by the prices in the previous periods. Similar results are observed from the MTAR model such that when the t-statistics for the coefficients in the last two columns of Table 3.5 are compared, the coefficients for Zambia are more significant for almost all the lags. Asymmetric short-run adjustments have been observed where the Zambian prices adjust by 12.4 percent whenever the deviation is above the equilibrium while adjusting by 14.8 percent the deviation from long-run equilibrium gets below the threshold. This means that the negative shocks have more effect on the Zambian prices in the short run.

For Tanzania, the coffee producer prices do not seem to be significantly influenced by the world prices in the short-run. This is confirmed the insignificant coefficients on the lags of world prices when regressed on Tanzania in the TAR model (Column 3 of Table B2). However the estimations from MTAR model show significant influence of world prices on Tanzania. The adjustments are also asymmetric where 22.7 percent of the deviation from long-run equilibrium is corrected back in the short run.

**Table B1: Asymmetric ECM Results for Zambia and World Prices (Full Sample)**

	TAR		MTAR	
	$\Delta P_{cip,t}$	$\Delta P_{z,t}$	$\Delta P_{cip,t}$	$\Delta P_{z,t}$
Constant	-0.000(0.151)	0.029(1.396)	-0.003(0.655)	0.0244(1.400)
$\Delta P_{Zt-1}$	0.010(0.521)	-0.272(4.06)	0.0216(1.085)	-0.226(3.33)
$\Delta P_{Zt-2}$	0.007(0.338)	-0.108(1.566)	0.0156(0.764)	-0.075(1.074)
$\Delta P_{Zt-3}$	0.007(0.332)	-0.079(1.134)	0.005(0.251)	-0.084(1.231)
$\Delta P_{Zt-4}$	0.019(0.950)	-0.136(1.99)	0.020(1.007)	-0.130(1.949)
$\Delta P_{Zt-5}$	0.012(0.611)	-0.095(1.388)	0.012(0.593)	-0.096(1.419)
$\Delta P_{Zt-6}$	0.024(1.203)	-0.1322(1.960)	0.026(1.322)	-0.125(1.866)
$\Delta P_{Zt-7}$	0.034(1.741)	-0.155(2.309)	0.037(1.878)	-0.145(2.194)
$\Delta P_{Zt-8}$	0.041(2.078)	-0.022(0.331)	0.041(2.100)	-0.021(0.321)
$\Delta P_{Zt-9}$	0.031(1.600)	-0.196(2.936)	0.034(1.731)	-0.187(2.827)
$\Delta P_{Zt+0}$	0.044(2.203)	-0.075(1.100)	0.042(2.158)	-0.079(1.169)
$\Delta P_{Zt+1}$	-0.014(-0.694)	0.000(0.014)	-0.011(0.55)	0.013(0.191)
$\Delta P_{Zt+2}$	0.044(2.338)	0.179(2.777)	0.046(2.457)	0.186(2.918)
$\Delta P_{cip,t+1}$	0.212(3.207)	0.411(1.816)	0.200(3.055)	0.360(1.609)
$\Delta P_{cip,t+2}$	0.007(0.107)	-0.079(0.343)	0.001(0.019)	-0.101(0.451)
$\Delta P_{cip,t+3}$	0.078(1.194)	0.347(1.546)	0.070(1.081)	0.311(1.404)
$\Delta P_{cip,t+4}$	-0.095(1.452)	0.081(0.361)	-0.094(1.442)	0.085(0.382)
$\Delta P_{cip,t+5}$	-0.099(1.519)	-0.367(1.653)	-0.089(1.388)	-0.331(1.504)
$\Delta P_{cip,t+6}$	0.005(0.082)	0.079(0.353)	0.007(0.115)	0.090(0.407)
$\Delta P_{cip,t+7}$	0.009(0.135)	-0.155(2.309)	0.014(0.220)	0.024(0.108)
$\Delta P_{cip,t+8}$	-0.067(1.024)	-0.022(0.331)	-0.089(1.365)	0.274(1.230)
$\Delta P_{cip,t+9}$	0.0138(0.209)	-0.196(2.936)	0.009(0.139)	0.226(1.013)
$\Delta P_{cip,t+10}$	0.0178(0.269)	-0.0749(1.100)	0.004(0.059)	0.038(0.170)
$\Delta P_{cip,t+11}$	0.080(1.218)	0.000(0.0147)	0.099(1.514)	0.289(1.295)
$\Delta P_{cip,t+12}$	-0.017(0.263)	0.1788(2.777)	-0.028(0.441)	-0.112(0.512)
z-plus	-0.011(0.684)	-0.124(2.290)	-0.001(0.171)	-0.0107(0.918)
z-minus	-0.009(0.649)	-0.148(3.027)	-0.062(2.410)	-0.333(0.775)
Q(26)	1.693(0.0226)	3.518(0.000)	1.913(0.006)	3.823(0.000)
DW	2.009	2.016	1.967	2.024

**Table B2: Asymmetric ECM Results for Tanzanian and World Prices (Full Sample)**

	TAR		MTAR	
	$\Delta P_{cip_t}$	$\Delta P_{tzt}$	$\Delta P_{cip_t}$	$\Delta P_{tzt}$
Constant	-0.0157(-2.156)	-0.007(-0.011)	-0.005(-0.941)	0.000(0.050)
$\Delta P_{Tzt-1}$	-0.027(-0.435)	-0.081(0.843)	-0.027(-0.577)	0.021(0.299)
$\Delta P_{Tzt-2}$	0.168(2.703)	-0.019(0.197)	0.113(2.222)	0.047(0.670)
$\Delta P_{Tzt-3}$	-0.025(-0.405)	0.0328(0.338)	-0.049(-1.045)	-0.056(-0.782)
$\Delta P_{Tzt-4}$	0.018(0.290)	-0.014(-0.141)	-0.0247(-0.525)	-0.0300(-0.422)
$\Delta P_{Tzt-5}$	0.019(0.325)	0.073(0.790)	0.012(0.260)	0.0140(0.201)
$\Delta P_{Tzt-6}$	0.123(2.151)	0.010(0.117)	0.095(2.169)	-0.0196(-0.297)
$\Delta P_{Tzt-7}$	-0.025(-0.440)	0.049(0.561)	-0.033(-0.763)	-0.018(-0.230)
$\Delta P_{Tzt-8}$	-0.076(-0.56)	0.047(0.541)	0.0399(0.903)	0.002(0.034)
$\Delta P_{Tzt-9}$	-0.006(-0.121)	0.072(0.880)	-0.019(-0.450)	0.017(0.259)
$\Delta P_{Tzt-10}$	0.035(0.669)	-0.018(-0.225)	-0.023(-0.539)	-0.067(-0.018)
$\Delta P_{cip_t-1}$	0.233(2.513)	0.0090(0.063)	0.229(3.124)	0.078(0.707)
$\Delta P_{cip_t-2}$	-0.051(-0.545)	0.226(1.556)	-0.000(-1.759)	0.185(1.652)
$\Delta P_{cip_t-3}$	0.027(0.287)	-0.192(-1.347)	0.068(0.921)	-0.097(-0.875)
$\Delta P_{cip_t-4}$	-0.197(-2.104)	-0.082(-0.566)	-0.158(-2.143)	-0.084(-0.753)
$\Delta P_{cip_t-5}$	-0.0586(-0.635)	0.184(1.291)	-0.081(-1.095)	0.219(1.953)
$\Delta P_{cip_t-6}$	-0.063(-0.681)	0.022(0.155)	-0.023(-0.319)	0.067(0.609)
$\Delta P_{cip_t-7}$	-0.026(-0.283)	-0.097(-0.687)	-0.002(-0.378)	-0.059(-0.538)
$\Delta P_{cip_t-8}$	-0.122(-1.335)	-0.076(-0.542)	-0.0539(-0.750)	-0.044(-0.401)
$\Delta P_{cip_t-9}$	0.113(1.288)	-0.151(-1.118)	0.028(0.394)	-0.085(-0.807)
$\Delta P_{cip_t-10}$	0.065(-0.739)	0.167(1.230)	0.030(0.425)	0.183(1.732)
z-plus	-0.020(-0.382)	-0.140(-1.770)	0.033(0.880)	-0.147(-2.592)
z-minus	-0.227(-4.105)	-0.293(-3.436)	-0.075(-2.568)	-0.114(-2.577)
Q(22,222)	2.533(0.001)	1.979(0.009)	2.410(0.001)	2.248
DW	1.935	2.003	2.035	2.021

In parentheses are t-statistics values.

$\Delta P_{cip_t}$  and  $\Delta P_{tzt}$  denotes World market and Tanzanian coffee prices in their first differences.

$\Delta P_{cip_t-i}$  and  $\Delta P_{tzt-i}$  denotes first differences of lagged values of the prices.

$\Delta P_{cip_t-i}$  and prices at time t and world prices (the composite indicator price) at time t respectively.

**Table B3: Symmetric Vector Error Correction for Supply Response below the Threshold**

Error Correction:	D(LOGCPRO)	D(LOGCPRI)	D(LOGRER)	D(LOGMPRICE)	D(RF)
CointEq1	-0.412407 (0.31359) [-1.31510]	-0.049755 (0.50945) [-0.09767]	1.184124 (0.59268) [ 1.99793]	0.005432 (0.50575) [ 0.01074]	-0.076617 (0.25640) [-0.29882]
D(LOGCPRO(-1))	-0.181671 (0.30498) [-0.59568]	-0.430571 (0.49545) [-0.86905]	-0.531722 (0.57640) [-0.92249]	0.071455 (0.49186) [ 0.14527]	0.267224 (0.24935) [ 1.07166]
D(LOGCPRO(-2))	0.172989 (0.24088) [ 0.71816]	-0.683077 (0.39132) [-1.74559]	0.368447 (0.45525) [ 0.80933]	-0.332715 (0.38848) [-0.85645]	-0.173264 (0.19694) [-0.87976]
D(LOGCPRI(-1))	0.189898 (0.21259) [ 0.89325]	-0.631559 (0.34536) [-1.82868]	-0.505632 (0.40179) [-1.25845]	0.114555 (0.34286) [ 0.33412]	0.069163 (0.17382) [ 0.39791]
D(LOGCPRI(-2))	0.088893 (0.14334) [ 0.62015]	-0.368863 (0.23287) [-1.58402]	-0.297847 (0.27091) [-1.09943]	0.176536 (0.23118) [ 0.76364]	0.074882 (0.11720) [ 0.63894]
D(LOGRER(-1))	0.325969 (0.20693) [ 1.57528]	-0.146920 (0.33616) [-0.43705]	0.279469 (0.39108) [ 0.71460]	-0.210400 (0.33372) [-0.63046]	-0.025761 (0.16919) [-0.15226]
D(LOGRER(-2))	-0.126425 (0.19372) [-0.65262]	-0.105801 (0.31470) [-0.33619]	-0.813748 (0.36612) [-2.22263]	0.301328 (0.31242) [ 0.96449]	0.135837 (0.15839) [ 0.85763]
D(LOGMPRICE(-1))	-0.128435 (0.22649) [-0.56706]	-0.492271 (0.36795) [-1.33788]	0.171170 (0.42806) [ 0.39987]	-0.043650 (0.36528) [-0.11950]	0.069299 (0.18518) [ 0.37421]
D(LOGMPRICE(-2))	-0.325109 (0.28479) [-1.14157]	-0.407358 (0.46266) [-0.88047]	-0.154505 (0.53824) [-0.28705]	-0.021002 (0.45930) [-0.04573]	0.305409 (0.23285) [ 1.31162]
D(RF)	0.236686 (0.38492) [ 0.61490]	0.640844 (0.62532) [ 1.02483]	0.568730 (0.72748) [ 0.78178]	-0.193735 (0.62078) [-0.31208]	-0.218893 (0.31471) [-0.69553]
C	0.097026 (0.12553) [ 0.77294]	0.490946 (0.20393) [ 2.40748]	0.374581 (0.23724) [ 1.57890]	0.149067 (0.20245) [ 0.73633]	-0.035890 (0.10263) [-0.34969]
R-squared	0.384587	0.793157	0.519701	0.272212	0.271069

Standard errors in () and t-statistics in []



### Appendix C: Coffee Processing Stages



Source: Authors own presentation. The green coffee price of \$0.70/lb is Zambia’s average grower price from January 1986 to September 2008. The price for New York Zambia Ground Coffee was obtained from <http://www.coffeeforless.com/product.asp?id=3925&CatID=523> (downloaded 07.10.2010). A 5lb packet is selling at \$53.73.

## **Appendix D: Curriculum Vitae**

### **Personal Information**

Name: Rhoda Mofya-Mukuka  
Date of Birth: 10/12/72  
Place of Birth: Kasama, Zambia  
Sex: Female  
Nationality: Zambian  
Marital Status: Married

### **Areas of Interest**

Rural development, International Commodity Trade, Commodity Value Chains, Commodity Price Transmission and Volatility and Food Security

### **Academic Qualifications**

**June 2007- date:** **PhD** student at the Department of Food Economics and Consumption Studies at the Christian-Albrecht University- Kiel, Germany.

**Oct. 2002- Aug. 2004:** **Master of Small Business Studies** – Field: Small Enterprise Promotion and Training, University of Leipzig, Germany

**June 1998 - August 1999:** **BSc. Tropical Agriculture**- Field: Rural Extension and Teaching. Larenstein International University, Deventer, Netherlands (a continuation from diploma).

**Oct. 1991 – Aug. 1994:** **Diploma in Agriculture** – Field: Agricultural Business Management (ABM). Natural Resources Development College (NRDC), Lusaka, Zambia

### **Other Trainings**

**Women Leadership and Management Course.** Organized by the African Women in Research and Development (AWARD), Entebbe Uganda.  
September, 2010:

**Proposal writing in Agricultural Research and Development.** Course  
Organized by the African Women in Research and Development (AWARD),  
Entebbe Uganda. March, 2010:

### **Work Experience**

**Period: January 2006- April 2007:**

Projects Support officer for Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH Zambia Office.

**August 2005 – December 2005:**

Agro-economist (Consultant) - Promoting Horticultural production, processing and marketing for International Development Enterprises (IDE) Zambia.

**August 2003 to September 2003:**

Student Intern (Business Start-up Advisor) for Sparkasse Bank's Unternehmensgründer Büro, Leipzig, Germany.

**December 2000- April 2002:**

Farm Economist/Extension specialist for Africare Zambia under the Small Agricultural Mechanisation Promotions Project (SAmEP).

## **February 1995 to November 2000**

Farm Management/Extension Officer for Palabana Farm Power and Mechanisation Centre, Ministry of Agriculture Food and Fisheries, Lusaka, Zambia.

### **Papers Presented and Studies Carried Out**

- **Rhoda Mofya-Mukuka.** “Incorporating Business Development Services (BDS) in Food Processing Entrepreneurship in Zambia: An Empirical Study of Food Processing SMSs in Zambia.” Thesis submitted to the University of Leipzig in partial fulfilment of the Masters Program in Small Business Studies. July 2004.
- **Rhoda Mofya and Henry Sichemebe.** “Contribution of Farm Power to Smallholder Livelihoods in Zambia- Southern Province.” Study carried out as Consultants for FAO. September 2001
- **Rhoda Mofya and Nelson Chisenga.** “Gender and Animal Draft Power.” Paper presented at the 3<sup>rd</sup> ATNESA International Workshop, Mpumalanga, South Africa. September 1999.
- **Rhoda Mofya.** “Approaches to Active Learning in Agricultural Extension.” Thesis submitted to the University of Larenstein in partial fulfilments of the BSc Program in Tropical Agriculture. Deventer, Netherlands. June 1999
- **The Food and Agricultural Organisation.** “Potential for Improving Production Tools used by Women Farmers in Chibombo district in Zambia.” As Research Team Member consulted by FAO and IFAD. July 1997
- **Rhoda Mofya.** “Socio-economic Consequences of Donkey Traction in Areas of Introduction in Zambia.” Paper presentation at the Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop, Debra-Zeit, Ethiopia, May 1997.
- **Rhoda Mofya.** “Cotton Production and Marketing in Zambia's Liberalised Economy.” Student project research paper submitted to the Natural Resources Development College in partial fulfilment of the Diploma in Agriculture. Lusaka, Zambia. July, 1994.