ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

MARKET EFFICIENCY OF THE ETHIOPIA COMMODITY EXCHANGE: The Case of Export Coffee Trading

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The Case of Export Coffee Trading

A Thesis submitted to the School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Master of Science in Economics (Economic Policy Analysis)
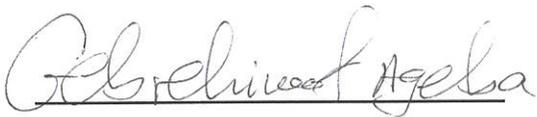
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Acronyms

ADF	Augmented Dickey Fuller
AIC	Akaike's information criterion
AMC	Agricultural Marketing Corporation
ARCH	Autoregressive Conditional Hetroskedasticity
ARCH-M	Autoregressive Conditional Hetroskedasticity in Mean
BDS	Brock-Dechert-Scheinkman test
BIC	Schwarz's Bayesian information criterion
BK	Brenner-Kroner
BLUE	Best Linear Unbiased Estimators
CZCE	China Zhengzhou Commodity Exchange
DCE	Dalian Commodity Exchange
DEFRA	Department of Environment, Food and Rural Affairs
DF	Dickey Fuller
ECEA	Ethiopian Commodity Exchange Authority
ECM	Error Correction Mechanism
ECX	Ethiopia Commodity Exchange
EEA	Ethiopian Economic Association
EGC	Ethiopian Grain Corporation
FDRE	Federal Democratic Republic of Ethiopia
GARCH	General Autoregressive Conditional Hetroskedasticity
GARCH-M	General Autoregressive Conditional Hetroskedasticity in Mean
IM	Intermediary Member
JB	Jarque-Bera
LDC	Least Developed Countries

LIFFE	London International Financial Futures Exchange
LM	Lagrangian Multiplier
MoARD	Ministry of Agriculture and Rural Development
MoFED	Ministry of Finance and Economic Development
MoIPAD	Ministry of Information Press and Audiovisual Department
NEAA	National Exchange Actors Association
OLS	Ordinary Least Square
PASDE	Programs and Targets for a Plan for Accelerated and Sustainable Development to End Poverty
TGWM	Tianjin Grain Wholesale Market
TM	Trading Member
WAP	Weighted Average Price
ZGWM	Zhengzhou Grain Wholesale Market
"3Is"	Initiative, Market Infrastructure and Market Institution

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Abstract

Despite the pivotal role of agriculture in the Ethiopian economy, the sector's development is highly constrained by infrastructural and institutional problems. To tackle part of the institutional problem, spot-trading Ethiopia Commodity Exchange (ECX) was established with a vision to revolutionize the country's agriculture through an efficient, dynamic, forward-looking and orderly marketing system. This thesis is probably the first of its type to study the market efficiency of the ECX in trading its major commodity, namely export coffee.

The Efficient Market Hypothesis (EMH) is widely used in market efficiency studies. This thesis tested the weak form of EMH using the ADF, the Lo-MacKinlay variance ratio and the BDS tests for random walk to study the price formation behavior of washed and unwashed export coffees traded in the exchange for 16 months. The post estimation tests on the ADF regression showed that ADF is inappropriate to use for the purpose for the study. The test for normality of observations also showed that parametric tests for random walk are not appropriate to study most of the prices series. The results from the non-parametric Variance Ratio and BDS tests, however, consistently showed that there are both linear and non-linear dependencies in the price series of both commodities and there is no observable trend towards efficiency. To further strength the results, the Spearman's Rank Correlation coefficient results have supported the presence of a persistent and strong dependencies in the price series. The result thus entails that, within the study period, ECX is weak-form inefficient and there is possibilities of taking trading position that potentially offer traders excess profit using the predictability in the price series.

The result, however, is not surprising given the presence of price band limits, the infancy of the Exchange and most importantly the nature of the trading (spot-based) in ECX. To address the market efficiency problem and other crucial issues, the Exchange has to shift to futures based trading. As such shifts cannot be made overnight, some measures are recommended that can be implemented alongside the institutional development process in order to make the existing system a more efficient one.

CHAPTER ONE

Introduction

1.1. Background of the Study

The history of commodity exchange dates back to the middle ages. The growth and the scale of overseas trade in England had created the incentive to establish the Royal Exchanges in the sixteenth century (Forrestor, 1931). The 1840s Berlin Grain Exchange in Germany (Hirschstein and Scholz, 1931) and Chicago Exchange in the US (Gabre-Madhin and Goggin, 2005) were eye-breakers in their respective country. Around the same year, the Japanese established spot commodity exchange to facilitate the commercial transaction of their exceptionally large market produce-rice (Sano and Lura, 1931). The stories of such market institutions in the developing nations, however, are a little more than a decade old. There are more than 100 of these exchanges across developing countries of which only three are located in Africa (Gabre-Madhin and Goggin, 2005).

With a wealth of experience in the developed nations and with little practical examples in Africa, Ethiopia Commodity Exchange (ECX) was launched in April, 2008 and joined the pioneers in the continent. ECX has begun its operation by only offering spot trading and with a legal mandate to launch futures contract transactions (ECX, 2008). Gabre-Madhin (2008) strongly argued that the benefit from a fair, orderly and efficient marketing system can better be exploited in sport trading than introducing a futures market that may potentially bring risk by excessive speculation given the existing food price crisis and the county's development stage. Gabre-Madhin (2007) however, stressed that an organized marketing institution better serve its users by

addressing the central function of the market- to address market risk- which can be better achieved by futures exchange than spot trading.[1]

The policy makers and academicians push to establish a market institution as substitute to the very poorly organized agricultural commodity markets in the country has marked the beginning of the end with establishing a market institution. ECX has the vision *"to revolutionize Ethiopian agriculture through creating a dynamic, forward-looking, efficient, and orderly marketing system that serves all"*. ECX is currently trading coffee, sesame, maize, wheat and haricot beans. Teff is missing from the list of commodities that the would-be commodity exchange centers were planned to accommodate in the country's agricultural policy document prepared by the Ministry of Agriculture and Rural Development[2].

Though it may be too early to blame the institution and academicians for not making much research in support or scrutiny of the institution, the two years experience the institution went through can potentially be used to make a research based recommendations. Such efforts inevitably add to the successful achievement of the institutions vision; as its vision address the crux of the country's development. This thesis is, therefore, one of such attempts to make a scientific research based study of the institution's market efficiency.

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[1] The concepts of futures and spot markets are discussed in section 3.1.5 of this thesis
[2] The agricultural policy document is issued in 2006 entitled *"Agricultural Polices, Programs and Targets for a Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) 2005/6-2009/10"*.

1.2 Statement of the Problem

Agriculture provides livelihood to nearly 85% of the population in Ethiopia, where majority of the rural and the poor dwell. The sector has been given a primary focus by the pro-poor development strategy of the FDRE government to generate surplus to stimulate growth in other sectors. The development strategy hypothesized the installation of an efficient marketing system to create link between agriculture and industry thereby trickling down the economic growth in the agriculture sector to the urban population (MoFED, 2002).

Being characterized by low productivity, subsistence farming overwhelmingly dominates the country's agriculture. This trend inevitably is inconsistent with the most wanted accelerated and sustainable development. A more intensive farming that can increase the marketable output to own consumption ratio has to replace the existing trend for the sector to serve as an engine for growth (*Ibid*). The development strategy therefore gives a paramount attention to the introduction of market oriented agriculture together with establishing an efficient marketing system (MoARD, 2006).

The 1990s liberalization of the marketing system is one of the significant steps the government has taken to realize the development goals through the creation of an efficient marketing system, though it has failed to achieve its envisaged impact on poverty reduction and the growth in the agricultural sector (Dadi et'al, 1992) and others cited in (Gabre-Madhin & Goggin, 2005). The failure to achieve the envisaged goal is mainly linked to two major constraints to the performance of the market: weak infrastructure and missing institution especially orderly, organized and

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credible market. The presence of these constraints limits the potential of the market to fuel production growth and improve rural living standard (*Ibid*).

The weakness in infrastructural developments affects the market performance through an increase in transportation cost and a rise in physical marketing costs. The marketing cost constitutes 40-60% of the final commodities price of which 70% accrues to the transportation cost. Transactions cost, that mostly emanates from the absence of an efficient market institution, also plays a significant negative role in the working of the existing markets. The failure of the existing marketing system was clearly seen during the 2002-2003 food crises, where a surplus production resulted in a collapse in market prices. The market reform might have cleared the possible policy distortion in the market but the need to act beyond market reform to the development of the market itself should capture the development strategy's primary attention (Gabre-Madhin & Goggin, 2005).

The dire need to establish an efficient market institution in the country seems to capture the policy makers' attention in the turn of the century. MoFED (2002) promised a research based future possibility of establishing an agricultural products exchange market. MoIPAD (2001) stressed the need to establish commodity exchange centers to play an important role in a market system in which comprehensive market information is available for producers and consumers. Gebreab (2002) has also acknowledged the need to promote marketing of grains through the introduction of commodity exchange and ware housing system.

Following MoFED (2006), the over-arching framework for development programming and policies, MoARD (2006) issued the strongest and clearest policy direction regarding market institutions giving due importance to the Ethiopian commodity exchange center, standard contract enforcement, grades and regulations, which can mutually reinforce one another. The policy document has also outlined that 10 commodity exchange centers will be established for six commodities: namely teff, wheat, maize, sesame, Haricot bean and coffee. The policy initiative finally made possible an organized market institution in April 2008- Ethiopian Commodity Exchange.

As the recommendations from studies on Ethiopian agricultural marketing structure and studies on the impact of the market reform stressed, the institutional solution to the problem has to go beyond mere establishment of the institution to its efficient working. The same stress is also given by almost all government development policy documents referred in this thesis. Accordingly, ECX has envisioned to bring efficiency to the market and adopted localized commodity exchange with high profile staffs on board to achieve it. Thus, such empirical study of market efficiency of ECX can supplement the achievement of the development strategy's and the institution's visions.

Among the broad spectrums of efficiency studies, experiences in study of market efficiency show that the concept of "Efficient Market Hypothesis" is widely employed in measuring market efficiency in capital and commodity markets. The practical application of the hypothesis is closely attached with studying the process of price formation than the outcome of the market

(Fama, 1970). The concept of the expected return theories with its special cases of random walk theory and martingale model have been used to strengthen the hypothesis's theoretical background and empirical testability. Following similar works, this study measures the ECX's market efficiency on export coffee trading in light of the efficient market hypothesis.

1.3. Objectives of the Study

The general objective of this thesis is to measure the market efficiency of ECX as a market institution using the weak-form of efficient market hypothesis applying the theory of random walk. To this end, the study has the following specific objectives:

- To test the existence of the random walk process in the prices series of washed and unwashed export coffee types using the Augmented Dickey-Fuller test, the Lo-MacKinlay Variance Ratio test and the Brock-Dechert-Scheinkman (BDS) test;

- To investigate the trends towards market efficiency or inefficiency in washed and unwashed export coffee trading;

- To evaluate the strength and persistence of dependency in the washed and unwashed export coffee prices;

- To explore the differences in market efficiency between washed and unwashed coffee types and among different random walk statistical tests; and

- To indicate future directions towards market efficiency

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1.4. Significance of the Study

Bulks of studies on Ethiopian economy indicate that the lack of market institution is posing a bottle-neck to the fruitfulness of the agricultural and rural-focused pro-poor development strategy the country adopted. The same truth has already won the heart and minds of policy makers and the need for an efficient market institution has gone beyond policy recommendation to practical installation of the market institution itself. The ECX is one of such institutions.

As the policy makers' intention is to create an institution that efficiently performs its duties, this thesis provides inputs to the policy makers in evaluating the institution against the country's need and take corrective action, if any. This study can also be used by the ECX management as an indication of the progress made towards the achievement of the institution's mission. As it is probably the first attempt to study the new institution from its market efficiency perspective; the study can also provoke and motivate further researches. Finally, the result from this thesis is expected to contribute to the diverse conclusions of the EMH across time, across commodities, across statistical methodologies and across countries.

1.5. Scope of the Study

This thesis confines itself to analyzing the market efficiency of ECX in terms of price formation of washed and unwashed export coffee. Organizational or operational efficiency issues which may include employee-employer relationships, ware housing and the like that often pertain with the management aspect of an organization are not the concern of this study. In this study more

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than 300 trading day weighted average of closing price series of washed and unwashed export coffee are taken and both descriptive and inferential statistics are used to analyze the data in the full sample period, in two sub-periods and in four windows for each coffee type. The study is confined to studying only the weak form of market efficiency and uses the test for random walk process in the price series to measure the market efficiency. Study of the spatial efficiency and other forms of EMH are not under the scope of this thesis.

1.6. Limitations of the Study

Most of the limitations the researcher faced are related to the newness and uniqueness of the operation of ECX. First, ECX being an infant institution, academic resources on issues helpful to the body of this thesis are very few and they are from single academician. Secondly, ECX being among the pioneers in Africa and its uniqueness in providing only spot exchange service, this has hindered the research from taking parallel country's examples. Moreover, as most studies in commodity markets frequently used the martingale model, the type of the service the exchange gives (spot exchange) has enforced the use of the random walk model that is often used in capital market studies. Finally, the very short time experience of the institution would affect this thesis from capturing possible development that may rise due to learning by doing trends.

1.7 Organization of the Paper

The thesis is organized as follows: the first chapter is an introductory chapter. Issues related to the Ethiopia Commodity Exchange are presented in the second chapter. The third chapter reviews

theoretical and empirical works in market efficiency literatures. The fourth chapter details the research methodology including the data type and sources used in the thesis. The fifth chapter is devoted to descriptive data analysis together with random walk test results. The final sixth chapter is attributed to conclusion and recommendations of the thesis.

CHAPER TWO

The Dynamics of Agricultural Marketing and Marketing Institutions in Ethiopia

A land mark proclamation was issued by the parliament that paved the way for the establishment of the Ethiopian Commodity Exchange Authority under the supervision of MoARD in Proclamation No.551/2007 (Negarit Gazeta, 2007). Under the custody of the Authority, the Ethiopia Commodity Exchange entered the commodity market in April, 2008. The Exchange has a vision "*to revolutionize Ethiopian agriculture through creating a dynamic, forward-looking, efficient, and orderly marketing system that serves all*" (Gabre-Madhin, 2006a).

ECX is a market place to sell or buy commodities. Its operation, however, is well integrated with and substantially dependent on other institutions and sectors. The Exchange promises to replace the unorganized, unreliable, inefficient commodity market with a market that has better efficiency, order, transparency and integrity (Gabre-Madhin, 2009). Beside the poor infrastructural development in the country, the weakly organized agricultural marketing structure is the source of higher transaction cost and unfair distribution of trade benefits (Gabre-Madhin, 2001).

Studies in African and Ethiopian economies have pointed out, among others, weak infrastructural development and missing institutions as the potential reason behind the failure of the market reform widely launched in the 1980s and 1990s. To tackle part of these problems, ECX follows an integrated approach towards filling the gap created by the "missing institutions". The Exchange unusually offers a spot trading. Studies often recommend futures exchange than spot exchange to tackle the income variability that follows the price volatility created by the market

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reform[3] (Hill & Bender, 1995 and Gemech & Stuthers, 2007). Gabre-Madhin (2007) added that futures exchange better addresses market risks than spot exchange and the presence of functioning alternative spot market further compromises the success of the Exchange. The lesson from well developed futures market, however, shows that it is impractical to apply it in a poorly developed market structure and with inadequate volume of speculators (Hills & Bender, 1995). Thus, cash (spot) exchange has to precede futures exchange (Hills & Bender, 1995; Gabre-Madhin, 2008).

2.1 Market Reforms in Africa

Across the 1980's and early 1990's, market reforms highly dominated the development agenda in Africa. Despite the stagnation in economic growth, the shortage in consumer goods and inflation in the continent, many countries were hesitant to make market reforms until their trade deficits depleted their foreign reserves and put their fate at the mercy of the International Monetary Fund (IMF) and World Bank. The funding from these institutions was attached with policy preconditions that mainly promote market reforms (Kherallah et'al, 2000). Due to the significant role of agriculture in the African economy, the reform is mainly centered upon commodity market and especially the agricultural commodity market. In addition to the political and economic events that triggered the reform in Africa, the increasing recognition of the crucial role of agriculture to economic development and the government's role in development process among development economists' are also reflected in these reform initiatives (Akiyama et'al, 2003).

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[3] Agriculture serves as source of income and livelihood for farmers. The income they get from their productions largely depends on the price they receive in the market; the more volatile is the price the more unstable will be their income. In a futures market, since prices are set ahead and production decision are made accordingly, the prices are more stable than spot prices. This stability in prices induces stability of income for producers.

A market reform can be defined as *"steps taken toward opening domestic and export markets to competition and toward putting in place public and private institutions consistent with and supportive of private markets"* (Akiyama et'al, 2003, p1). The authors also define a reform in a commodity market as *"reducing government involvement in marketing and in production, increasing participation of the private sector in these activities and reducing distortions in commodity prices – especially producer prices."* Measures taken in Africa to accomplish these goals include the privatization or the closure of government marketing agencies and government owned-assets, elimination of controlled prices, the opening of the market to competition and reduction in implicit and explicit taxes (*Ibid*). Important changes in the foreign exchange market were also made to encourage export (Kherallah et'al, 2000).

In the post-reform era, Akiyama et'al (2003) argued, in many African counties the control of agricultural commodities with their supporting institutions is inherited from their colonial past. Their control often exercised through marketing boards. In addition to their past legacy, Kherallah et'al (2000) further underlined that there was also a common view among policy makers that markets are not trust-worthy to successfully coordinate economic activities given the exploitative nature of private traders. Moreover, policy makers in African were having the wrong view that the role of agriculture in the economy is to supply raw materials, labor and food to the industrial sector; and economic development can only come through industrialization.

Kherallah et'al (2000) discussed a long list of the impacts that the reform created in sub-Saharan African countries. They found that, market performance[4] has shown an improvement since the 1980's. An increase in the total factor productivity[5] and production of export crop were also observed in the post reform period. The increase in production of export crop was accompanied by a hike in export crop prices that has generated an attractive benefit to farmers engaged in it. The market reform that includes removal of subsides resulted in an increase in fertilizer prices. In countries where there was state-sponsored credit system, farmers' access to credit for input use has declined. A reduction in consumer price and a mixed effect across countries on producers' price was observed after the reform. Though the agricultural market reform is aimed at both increasing agricultural production and alleviating poverty by creating an incentive mechanism for farmers that include a higher price for their produce and a well-functioning market, empirical facts in Sub-Saharan Africa indicate that the negative average growth of agricultural production per capita that starts in 1970s is not reduced. Thus, the reform is short of reaching its expectation and much effort is still required from all parties involved in the process.

Akiyama et'al (2003) noted that growth and answers to social needs cannot be guaranteed by market reform alone. Market reform need to be taken as a significant first step; and for the reform to be successful there is a need to have strong commitment from the government side, proper institutional structures, participations and coordination among stakeholders and proper sequencing and pace of the reform along with critical monitoring and evaluation of the process.

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[4] They assessed market performance in terms of " the expansion of private trading, reductions in marketing margins (defined as the difference between producer and consumer prices) and increases in market efficiency-measured by the degree of market integration" (Kherallah et'al 2000, p.12). Market integration refers to "the extent to which price changes in one market are associated with price changes in other markets" (Gabre-Madhin, 2001,p 8)

[5] It is "defined as the amount of total output generated by all factors used in production"(Ibid, 2000,p.17)

Kherallah et'al (2000) attributes the lack of the expected success in the reform to structural, institutional, implementation related and exogenous factors. Structural factors include reduction in infrastructural investment, research, communication and marketing information due to budgetary reasons. The institutional factors include the weak government regulation over property right, contract enforcement, quality control and lack of good governance. The partial implementations of the reform, the weakness in the government's commitment and in some instances policy reversal are among the implementation related factors. Exogenous factors like disease, drought, war and others have also played their role in constraining the reform.

2.2 Market Reform in Ethiopia

Unlike most African countries that adopted the reform under international donors and lenders pressure, the market reform in Ethiopia is initiated locally (Negassa & Jayne, 1997). Fisseha (1994, cited in Gabre-Madhin, 2001), is rather of the view that the reform in Ethiopia too is an answer to external pressure. The market reform in Ethiopia begins with an instantaneous declaration of market liberalization made on March 1990 by the then socialist-oriented government (Negassa & Jayne, 1997; Gabre-Madhin & Goggin, 2005).

Negasssa & Jayne (1997) stated that, in the pre-reform period the government, with support from World Bank, established the Agricultural Marketing Corporation (AMC) in 1976 with a mandate of stabilizing basic commodity prices. The history of government intervention in the market dates even back to the monarch regime. The Ethiopian Grain Corporation (EGC) was established in 1960 with primary objective to stabilize prices and engage in export and import of grains. The corporation, however, fails short of achieving its objective and even failed to cover its

administrative cost. In the Dergue regime, the unsuccessful EGC was replaced by AMC (Holmberg, 1977). AMC was selling grains bought from farmers at consistently lower fixed prices than the market price to state organizations and urban consumers. There has also been quota system that forces farmers to sell part of their produce to AMC at a fixed price[6]. A restriction on inter-regional trade was also part of the government's marketing policy (Lirenso, 1993 cited in Gabre-Madhin, 2001). The food rationing shops in urban areas, which were run by AMC, were distorting the grain market than stabilizing it (*Ibid*). In addition to this, the quota system was having three devastating effects to the economy: (1) it depressed rural income (2) it served as a resource transferring tool from poor rural household to urban households through cheap food prices (3) it reduces the production of cereals (Lirenso 1995;Dercon 1994; Franzel et al. 1989 cited in Negassa & Jayne, 1997)

The March 1990 proclamation created a surprise U-turn in the country's economic policy. The scope of the reform can be read from the following quote taken from the proclamation cited in Gabre-Madhin (2001, p6-7): "*In the trade sector of the economy, private entrepreneurs will be able to compete with state-run trade enterprises in agriculture or industrial commodities as well as in import-export trade. In the area of trade in grain products in particular, trade exchange will henceforth be conducted on the basis of free market pricing while the grain control situation and the quota system will cease. The Agricultural Marketing Corporation (AMC) will enter the free market and operate as a state trade organization.*" The new transitional government, that advocates a market economy, came to power in 1991. This government endorsed the reform and further strengthened the reform process.

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[6] "*Farmers also had to deliver between 10 to 50 percent of their grain harvest as a quota to the AMC*" (Lirenso, 1995 cited in Negassa & Jayne, 1997 p.2).

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2.2.1 The Impacts of the Reform

Negassa & Jayne (1997) measured the impacts of the reform on maize, white teff and white wheat. They used a time series data that covers the period from January 1986 to July 1996 to compute descriptive statistical results. Due to data unavailability for some markets, they covered the period from January 1986 to December 1993 to make econometric analysis for eight markets across the country. They found that, the market liberalization has decreased the price spread[7] (both among major regional markets and surplus and deficit regions). They also got a consistent result holding exogenous factors like seasonality, rainfall and other variables constant. Their study has also established that the wholesale cereal prices have generally become less volatile after the reform. Withstanding its limitation, the result from correlation coefficient analysis have shown that wholesale price changes are quickly transmitted among markets after the reform, this imply that the markets are better integrated than they were before. Addis Ababa and some major markets in the country were also found to be better integrated in the post-reform era (Amha, 1999 cited in Omamo, 2005). Gabre-Madhin & Goggin (2005) cited a range of studies made before and after (Negassa & Jayne, 1997) and concluded that, the market reform has made grain prices more volatile than they were before. Using monthly coffee producers' prices in a sample period of January 1982 to December 2001, Gemech & Struthers (2007), also found the same increase in volatility of real coffee prices in the post reform period. Gabre-Madhin & Goggin (2005), however, substantiated findings of Negassa & Jayne that the market reform has enhanced market integration than before. They further added that private sector participation in grain trade has significantly increased and marketing margins have also been reduced in the post-reform period.

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[7] Depending on the context of analysis Negassa & Jayne, (1997) price spread in this study has been used to represent "the difference between wholesale prices in major regional markets" (Exclusive summary) and as "the difference between wholesale prices in surplus and deficit regions " (p.10).

Consistent with what is found in the African case, the reform in Ethiopia too has promising results; yet it is still short of achieving its envisaged goals- growth in agriculture and poverty reduction. Studies on the impact of the reform on Africa and Ethiopia give similar explanation and policy recommendation to the setbacks the reform faced. Negassa & Jayne (1997, p18) recognized that the reform has enhanced allocative efficiency and decreased marketing cost[8] that were attributed to policy restriction, but there are still *"substantial scope to improve technical efficiency of marketing activities through strengthening of market institution"*. To this end, they recommended the government to play a major role in (1) Improving infrastructure (2) Tax removal on regional checkpoints (3) Improving public market information system (4) Fostering the legal and political foundations of marketing system. They argued that if marketing activities are made in a well-functioning political and legal framework, the transaction cost[9] and the risks private traders face will decline. Gabre-Madhin & Goggin (2005) summarized the explanation given by numerous studies to the inability of the reform to produce the envisaged impact to the existence of considerable constraints to the performance of the market. Among others, the two major constraints are: missing institutions and weak infrastructure. Quite similarly, the weakness of marketing institutions and the poorly developed physical infrastructures explains the poor supply response to commodity prices in Africa (Krueger, Schiff and Valdes, 1992; Poulton et'al, 1999 cited in Akiyama et'al, 2003). It is for this reason that most studies (both in context of Africa and Ethiopia) include in their recommendation the development of market infrastructures and marketing institutions in order to reap the full benefit of the reform (Negassa & Jayne, 1997;

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[8] As used by Gabre-Madhin (2001, p.32) marketing costs (what she calls it "physical marketing costs") include handling costs, sacking costs, transport costs, storage costs, road stop (*kella*) costs, broker costs, travel costs, tips and others.

[9] Gabre-Madhin (2001. p3) distinguished between transactions costs and physical marketing costs and defined transaction cost as costs that *"arise from the coordination of exchange among market actors"*. These costs include obtaining and processing market information, negotiating contracts, monitoring agents and enforcing contracts. The author in her study included the market search cost which *"includes both the search for market information and search for a trading partner"* (p.51) as transaction costs.

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Kherallah et'al, 2000; Akiyama et'al, 2003; Chowdhury et'al, 2005; Gabre-Madhin & Goggin, 2005; Gabre-Madhin, 2006)

In addition to studies on the impact of market reform, research discourses on Ethiopian agricultural marketing system also attributes, among others, the underdevelopment in the infrastructure and institutions to the poor performance of the agricultural sector. Almost all of these studies explicitly recommended strong government intervention in these areas.

2.2.2 Market Infrastructure and Market Institution

Both market infrastructure and market institution constitute what is known as the "3 I's of market development": Incentives, Infrastructure, and Institutions. Gabre-Madhin (2006, p5) gave a list of components under each item: Incentive comprises *"the overall policy environment and the stability therein, the general investment climate, the macro-economic framework, as well as tax and trade policies"*. Infrastructure for development of markets involves *"telecommunications, transport, storage, and logistics in terms of physical capacity as well as research, skills, and extension, in terms of technical capacity"*. Market institutions on the other hand includes *"market information, grades and standards, contract enforcement, the coordination of market actors, trade and producer associations, market regulation, industry wide forums for dialogue, and trade finance"*. All the three are considerably inter-related and significantly affect market outcomes.

The weakness in infrastructural development inevitably contributes much to the physical marketing costs. In Ethiopia, marketing cost alone constitutes 40 to 60 percent of the price

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consumers pay for cereal commodities (Gabre-Madhin & Goggin, 2005; Negassa & Jayne, 1997), of which 70 percent is attributed to transportation cost (Gabre-Madhin & Goggin, 2005). Owing to the poor infrastructural development Ethiopia has, production coordination failure between surplus and deficit areas continue to affect Ethiopians in both areas. While producers in surplus areas are getting unattractive prices people in the deficit areas continue to suffer from food insecurity and famine (Amha and Gabre-Madhin, 2004). Having one of the lowest road densities in the world (EEA, 2005; Von Braun & Olofinbiyi, 2007), transportation infrastructure in the country is mainly limited to road transport. Moreover, the radial configuration of the road network around the capital city, made inter-regional trade to make a physical pass through Addis Ababa (Gabre-Madhin, 2001). It thus makes transportation cost higher that in turn impedes regional markets integration. The higher transportation cost also had a role in the food prices instability the country faced (Negassa & Jayne, 1997).

Though there have been improvements in the storage facilities in Ethiopia after the reform, like the road infrastructure the country's storage infrastructure is also poorly developed.[10] Given the consistent demand for agricultural produces and the inherent seasonality in production, storage facilities play the role of smoothening supply of agricultural outputs (Amha and Gabre-Madhin, 2005). The inadequate storage infrastructure partly explains the low price farmers get (Von Braun & Olofinbiyi, 2007) and the food insecurity the country faces (Amha and Gabre-Madhin, 2005).

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[10] *"The storage capacity of traders, millers and state farms at national level is estimated at 2 million MT and the existing storage capacity is mostly owned by state enterprises (Resal-Ethiopia 1999). About 32.4 percent of the storage capacity in Ethiopia is the property of the Ethiopian Trading Grain Enterprise (EGTE)."* (Amha and Gabre-Madhin, 2005,p.60-61)

Despite their pivotal role, the post-reform era and even most studies in Ethiopian agricultural marketing system have noticeably neglected and least understood market institutions. There have been clear differences among institutional economists in defining institutions. Some consider institutions to be *"players of the game"* and others *"rules of the game* (exogenously driven)". There are also other who consider institutions to be *"equilibrium strategies of player* (endogenously determined rules)". The fourth view considers institutions to be *"self-sustaining system of shared beliefs"*.[11] Gabre-Madhin (2006, p10) coiled a broader definition of market institutions as: *"a set of constraints -formal or informal, exogenously or endogenously determined- that govern the relations between individuals or groups in the exchange process"*.

Much of the reform agenda gave an over-emphasis to elimination of policy distortions and policy incentives. This approach has been blind-folded to addressing institutional and infrastructural issues (Kherallah et'al, 2002 cited in Gabre-Madhin, 2006). For the market reform to make its envisaged impact, Gabre-Madhin (2006) forcefully argued that the policy thinking need to shift from *"getting prices right"* perspective to *"getting the market right"* perspective.[12] In "getting the market right" market institutions play a crucial role and it is the way to economic prosperity. North (1989 cited in Gabre-Madhin,2001, p82) emphasized the role of institutions in economic growth as *"Economic growth is dependent on stable political and economic institutions that provide low costs of transacting in impersonal political and economic markets"*[1]

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[11] See Gabre-Madhin (2006) for a brief and interesting discussion of the four definitions of institution.

[12] *"Getting prices right implied that market order will emerge spontaneously or endogenously and that markets will take care of themselves once incentives are aligned. Getting markets right implies that market order depends on an underlying set of institutions and supporting infrastructure, requiring guidance from a "visible hand"."* (Gabre-Madhin, 2006, p3)

Gabre-Madhin (2006, p8) deducted three "roles of institutions for market exchange" from the different stands of thought that prevailed in New Institutional Economics literatures as:

- to minimize transaction costs,
- to redress missing market, and
- to create or formalize social capital.

Transaction costs play a key role in the performance of an economy (North, 1989 cited in *Ibid*). In Ethiopia, there is evidently higher transaction cost in commodity market transactions that seriously hampered market performance. These costs are seen in Ethiopian context in terms of *"the lack of sufficient market coordination between buyers and sellers, the lack of market information, the lack of trust among market actors, the lack of contract enforcement, and the lack of grades and standards"*(*Ibid*, p3).[13] In the grain market, lack of grading and standards (Demeke, 1999) and restricted access to market information (von Braun & Olofinbiyi, 2007) were observed. There are also grain markets where both problems are prevalent (SID-consult, 2008). The lack of contract enforcement has been revealed in vegetables market (Haji, 2008). These situations resulted in thin markets, less arbitrage (both across time and across space) making the market less responsive to changes in demand and supply (Gabre-Madhin, 2005). This sore truth is taxing the country's growth and continues to gloom the growth in the agricultural sector; as the Nobel-laureate Douglass North stated *"The inability of societies to develop effective, low-cost enforcement of contracts is the most important source of both historical stagnation and contemporary underdevelopment in the third world"* (North, 1990 cited in Gabre-Madhin & Goggin, 2005; Gabre-Madhin, 2006). After studying the vegetable market, (Haji, 2008) has stressed the need to go beyond provision of new technologies to farmers to the

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[13] In defining components of a transaction cost, transportation costs and other costs that Gabre-Madhin, 2001 call them physical marketing costs were used in some papers like in (Von Braun & Olofinbiyi, 2007). In this thesis, we adopte that of (Gabre-Madhin, 2001)'s distinctions between the two in order to have a clearer discussion.

providing institutional support in Ethiopia. The need to rescue the country's growth through a proper institutional arrangement must then top the development agenda.

An institutional arrangement that has been historically proved to be a promising avenue to transform markets and to significantly reduce transaction cost is a commodity exchange. Commodity exchanges can also play a prominent role in creating the link with the global agro-food system (von Braun, 2007). (Omano et'al, 2005) has recommended the establishment of an organized futures contract commodity market for grain in Ethiopia in order to avoid the higher transaction cost and uncertainty prevalent in the existing spot market. They also alleged that such a market would induce efficiency and transform the marketing system. Further strong justification for the establishment of an organized commodity exchange in Ethiopia has been made by Gabre-Madhin & Goggin (2005). They thoroughly discussed eight "push" and six "pull" factors for the establishment of a commodity exchange in Ethiopia.[14]

2.3 The Orderly Market

The underdeveloped marketing system the country has partly takes the blame for the poor performance of the country's Economy (EEA, 2005). Within this marketing system, there is higher transaction costs (Gabre-Madhin, 2001), output price fluctuation (von Braun & Olofinbiyi, 2007) and farmers have weak price bargaining power (Demeke, 1999; Amha & Gabre-Madhin, 2004; SID-consult, 2008; and Mulat, 2000 cited in Haji, 2008). The marketing system can also potentially constrain farmers' incentive to increase production and hinder linkages between agricultural and non-agricultural sectors (EEA, 2005) and rural-urban linkages (Von Braun,

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[14] "Push" factors refer to *"internal circumstances that motivate the development of an exchange"* and "Pull" factors refers to *"circumstances or factors outside of the market itself which justify the development of a commodity exchange in Ethiopia"* (Gabre-Madhin & Goggin, 2005, p. 14).

2007). The negative effect such a system has in the productivity and production of the sector shades its dim light on the country's food security effort (Amha and Gabre-Madhin, 2004; Adenew, 2005). Unless resolved, the inefficient marketing system inevitably compromises the growth in the sector and the economy in general (Amha and Gabre-Madhin, 2004).

The policy level initiatives and these existing visible gaps led to the creation of commodity exchange in Ethiopia that pledges a dynamic, orderly, progressive and efficient marketing system. The following discussion shows the structural difference that exists between an agricultural market with commodity exchange and an unorganized marketing framework.

2.3.1 Agricultural Market Structure in Ethiopia

Commodity exchanges introduce order to trading system. The agricultural commodity marketing structure that exists in the country shows a clear disorder and complexity. The following figure shows the market structure of the disorderly and complex agricultural market in Ethiopia:

Figure 2.1 *Agriculture Market Structure in Ethiopia*

Source: (Gabre-Madhin, 2009)

23
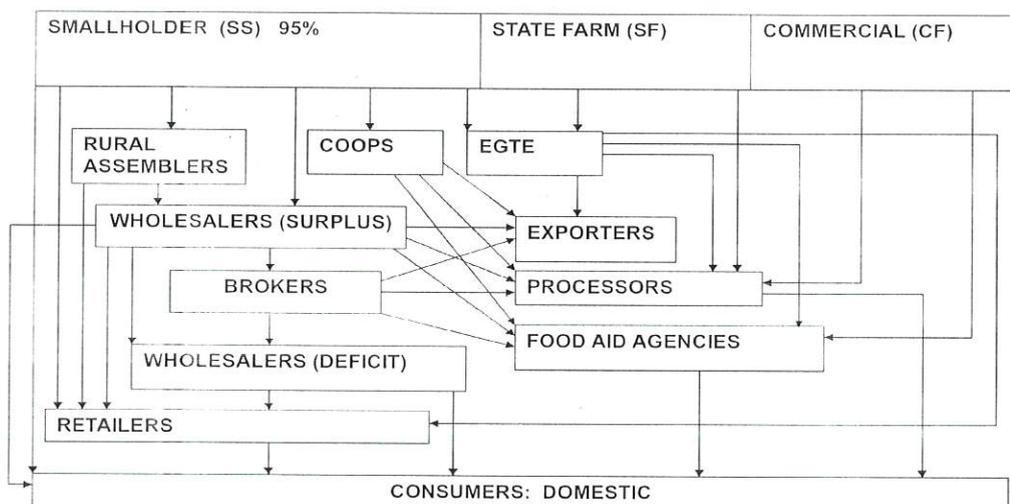
An actor in this market structure is expected to interact with many other actors in order to sell what he/she produces or buy what he/she wants. The small holders, who accounts for 95% of the agricultural production and characterized by low living standard, sell their produce to six actors in the market. In order to make these interactions, they face a higher transaction cost that attributes to search cost, contract enforcement cost etc. The shortage of finance, poor infrastructural development and storage capacity, that are prevalent among small holders, even make their problem more acute. These problems together hinder smallholders from making arbitrage across time and space and force them to be price takers.

The final demanders of the raw agricultural produce do also face an immense problem. Processers are also expected to manage their interaction with at least six market actors. These complex interactions are prone to create supply instability (both quality and quantity) that attributes to marketing and transaction costs. This has a wider negative impact on the supply of final goods, industry capacity utilization and employment (Gabre-Madhin & Goggin, 2005). Unless resolved, this structural problem may even go further to paralyze the development of agro-processing industries in the country. The supply instability also extends to exporters. Given the importance of foreign exchange the country needs for its development, this structural problem potentially creates a visible danger.

The structure-related problem that also includes absence of a regulatory body to administer interactions in the market is a series problem to the development of agriculture and the country at large. It, in addition to infrastructural problem, effectively denies smallholders price bargaining power and the processors and exporters unfavorable investment environment. Such structure

compromises the creation of price incentive that the market reform premises to boost agricultural production and alleviate poverty (Gabre-Madhin & Goggin, 2005). Policy makers' intervention in creating an alternative structure that establish order to the market and distribute a fair share to each actor is, therefore, a constructive first step to facilitate economic growth.

A commodity exchange together with its linked institution provides a dependable alternative that can potentially clear the back-draws of the existing market structure and fill the gaps that were wide-open in unorganized market. Transaction costs are considerably reduced in commodity exchanges by "*facilitating contact between buyers and sellers; enabling centralized grading of products; ensuring that contracts are enforceable; providing a mechanism for price discovery; simplifying transactions with standard contracts; and, transmitting information about prices and volumes. Further an Exchange increases market liquidity, enables the transfer of price risk, and enhance trust, order, and integrity in the market*"(Gabre-Madhin, 2006 p. 33). The following figure shows the change in market structure that a commodity exchange can bring to the market:

Figure 2.2: *Agricultural Market Structure with a Commodity Exchange*

Source: (Gabre-Madhin, 2009)

25
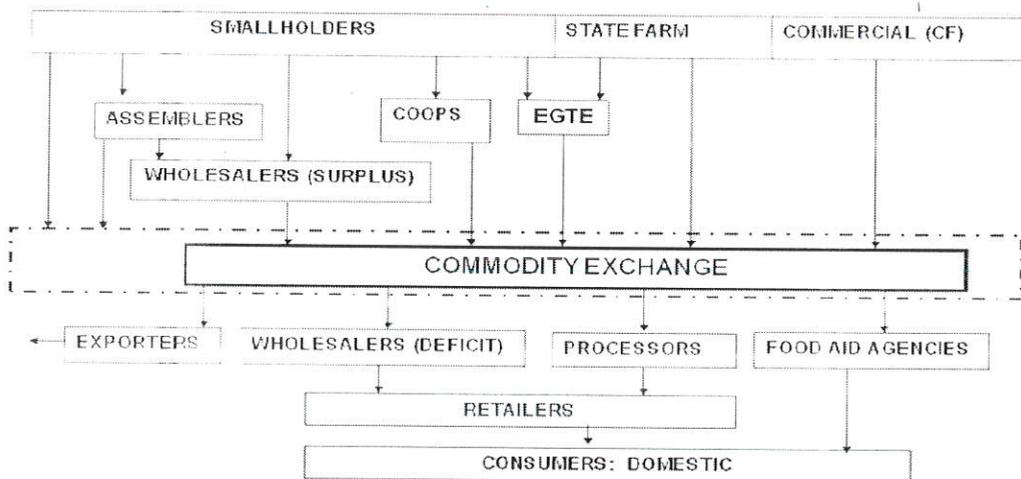
The structure neatly shows the formation of a smooth and orderly market, on which a commodity exchange serves as a "middle men". Smallholders can now better access the market either directly or through their cooperatives. The market information and the well regulated trading mechanism give the smallholders a strong price bargaining power (Gabre-Madhin, 2009). Exporters and processors are also expected to benefit from the possible uninterrupted quality and quantity supply that creates a comfortable working environment. The benefit from a commodity exchange also likely to extends to the government revenue authority. The proposed transparency that the exchange creates may help in the reduction of tax non-compliance that widely exists in unorganized market.

2.3.2 How ECX Works?

ECX follows an integrated approach that critically depend on other core institutions like the trading system, market information system, warehouse receipt system, arbitration tribunal, actors association and regulation framework. Its success also heavily relies on other sectors like banking, insurance, transport, IT sector etc.

2.3.2.1 Management of the Exchange

The Ethiopian Commodity Exchange Authority (ECEA) is established with proclamation No. 551/2007. The authority has the responsibility of ensuring the development of an efficient trading system and to regulate the secure, transparent and stable functioning of the exchange. The authority is lead by Board of Directors. Article 3 of the "Rules of Ethiopia Commodity Exchange" details the management of the exchange. The board, that oversees the activities of the exchange management, has eleven members composed of six appointees (including the

chairman) by the MoARD and the rest five elected by the exchange members. [15] The management of the exchange is planned to have a professional and autonomous management with an independent salary structure. It has a CEO and six chief officers to look after business operations, strategy and business development, compliance, risk management, finance and administrations, and information and technology divisions. These divisions have under them their own distinct units. The structure is amendable by the exchange management after the approval of the board. The exchange also has six support offices that directly report to the CEO. The structure of the support offices too is amendable.

2.3.2.2 Membership of the Exchange[16]

ECX is a membership based exchange. Any individual, private company, public enterprise, or cooperative that meets the membership requirement can be a member of the exchange. The membership requirement is detailed in article 4.6 of the Rules of the Ethiopian Commodity Exchange. The fees and the deposit requirements does not persuade, at least myself, that the market it for everyone; it rather looks a market for high class traders. As to the composition of members, 99% is from private sector and 12% of the membership is owned by cooperatives representing more than 250,000 farmers (Gabre-Madhin, 2009). ECX provides two types of membership- Full and Limited membership.[17] Full members own a permanent and transferable seat in the exchange. They can also trade in any commodity. A limited member, on the other hand, has a membership

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[15] The Board of Directors is composed of : State Ministers of Ministry of Finance and Economic Development (Chairperson) and Ministry of Trade and Finance, Director Generals of Privatization and Public Enterprise Supervisory Agency and Ethiopia Information and Communication Development Agency, President of Commercial Bank of Ethiopia, Head of Legal Affairs Bureau Prime Minster Office, and General Managers of S.A. Bagresh PLC, Ethiopia Grain Enterprise, Challenge Coffee Traders PLC, Kality Food Share CO., Southern Region Farmers Cooperative Federation

[16] Unless indicated, the discussion in sections 3.3.2.2 and 3.3.2.3 are paraphrased from ECX's official website www.ecx.com.et

[17] Currently Full Memberships are closed and Limited membership seats are available.

seat that lasts a year, trades only one commodity and has one position (either sell or buy). A limited type of membership is created to accommodate smaller actors. All members who own a seat in the exchange are liable to their transaction and are required to follow the Rules of the Exchange. Within each type of membership there are two classes of membership- Trading Member (TM) and Intermediary Member (IM). TM trades only from his or her own account, whereas IM trades either from his or her account or on behalf of clients. Clients only work through intermediary members. Though the relationship between a member and a client is private, the exchange closely watches and regulates their interactions to safeguard the smooth functioning of the system. When a client decides to trade through a Member, the members submits a Member-Client Agreement (MCA) form to the Exchange. The Exchange sets a fee payment by a client to the member not to exceed 2% of the total value of the trade.[18] In case of controversies, clients can bring their case to Exchange Arbitration Tribunal. Members of the exchange can also appoint an Authorized Representative (an individual employed as an agent or staff of a member) to trade on their behalf.

Members and their Authorized Representatives are obliged to participate in the National Exchange Actors Association (NEAA). The Association has the responsibility ranging from building member capacity through training to public education and advocacy of the Exchange on behalf of the Actors.

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[18] As the driving objective of the Exchange is to improve farmers' life, there has to be a regulation to guarantee that much of the benefit from the trade goes to producers. In addition to other costs that the actors pay for the ECX services, unrestricted brokerage fees may compromise the fundamental rationale of the establishment of the Exchanges.

2.3.2.3 Operation of the Exchange

ECX offers an end-to-end operation that includes warehousing, trading, clearing and settlement of payment, and delivery of commodity.

Warehouses and Central Depository

ECX claims that its warehouse use state-of-the art grading and weighing equipment to sample, grade and weight commodities that it receives. The warehouse then issues an Electronic Good Received Note. These notes become negotiable, transferable or represent legal entitlement of the deposited commodity only when the Central Depository issues the bearer an Electronic Warehouse Receipt.

ECX operates eight (three of them in Addis Ababa) large warehouses that are situated in major surplus regions of the country[19]. These warehouses are presumed to have the maximum reasonable insurance coverage and use an inventory management system that meets global standards. Its inventory management system is believed to secure the quantity and quality of the commodities throughout the storage period.

Trading at ECX

ECX offers a spot exchange on its octagonal trading floor.[20] The exchange is now trading five commodities on regular business hours holding various sessions for transacting different commodity contracts. The Exchange uses an open-outcry system to ensure competitive method of price discovery. The following figure demonstrates the trading process in the Exchange:

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[19] As per the information obtained from the official website of the Exchange on December 07, 2009
[20] The trading floor is named octagonal after its octagonal shape.

Figure 2.3 Trading Process at ECX
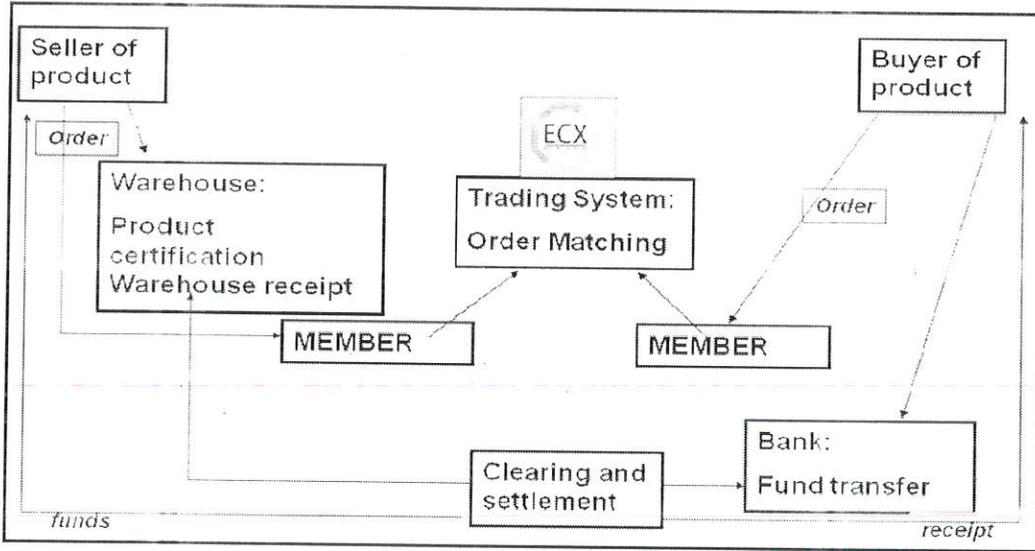
Source: (Gabre-Madhin, 2009)

The seller of a commodity uses the Electronic Warehouse Receipt issued by the Central Depository, which clearly describes the amount and the quality of the deposited commodity, to trade at the Exchange. The seller instructs his/her broker to post offer in the trading floor. On the other side, the buyer deposits fund into settlement accounts in the Exchange partner banks[21] and instructs his/her broker to bid price. The two Electronic Tickers in the trading floor displays price information (previous trading closing price, the price band limit and New York coffee price, if any) and prices of currently transacted coffees with price deference with previous closing price in brackets. While local coffees are traded in the morning session, export coffees are traded in the afternoon session. The beginning of trading in the morning and afternoon session is declared with

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[21] ECX is electronically connected and working with seven settlement banks namely: Commercial Bank of Ethiopia (CBE), Dashen Bank S.C, Awash International Bank S.C, United Bank S.C, NIB International Bank S.C., Wegagen Bank S.C. and Bank of Abyssinia S.C.

a ringing of a hanged bell and other trading within these sessions are separated with a ringing of a desk-bell. In the trading floor, the trading process takes the following steps:

- Exchange staffs make announcement to brokers of the two sides with a specific coffee category in same warehouse to enter the octagonal trading floor (surveillance persons also enter trading floor and there is also a surveillance camera to record the trading).

- Following the ringing of the bell, buyers shout out the coffee grade, the price and the quantity it wants (e.g to buy 5 lots of grade 1 of Harar A coffee at a price of 700, the buyer shouts out "Harar A1 at seven hundered 5 lots") making his palm inward toward his face

- If a seller agreed with the bid, he/she shouts out the same quote showing one hand with the palm facing outward and if he/she does not get what it wants the seller shouts out its own different offer (whenever offers/bids are made it has to be pronounced loudly)

- When offers and bids are meet, the two traders shake hands and they record their contract on Order Tickets

- The exchange staff make a voice announcement to traders when one minute is left to end the trading and ring the desk-bell when the time is up

Taking minutes, the exchange back office validates and reconciles their contract after checking the existence and validity of the Warehouse Receipt and the availability of the fund in the buyers account. The clearing and settlement department make a cash transfer and commodity ownership transfer among members.

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Though the prices on the trading floor are discovered using an open-outcry, they are regulated to fluctuate within certain price limits.[22] The exchange, unless in exceptional circumstances, make a certain percentage price fluctuation limit that relay on previous day closing prices for each contract. The average of all prices traded during the closing period (the one minute period prior to the closing of the trading session) is the closing price of the day. The exchange has also put a Daily Position Limit- a limit on the maximum amount of contracts a member can buy or sell during a trading session.[23]

The Exchange is currently trading five commodities: Coffee, Sesame, Haricot Beans, Maize and Wheat. Though it lately joined the Exchange, the strategic importance of coffee to the economy is evidently reflected in the Exchange's trading sessions and the volume of the transaction. Coffee highly dominates the transaction in the exchange that it is traded on daily basis. Broadly speaking, the Exchange offers six types of coffee contracts, two types of haricot beans contracts and one type of contract of each of the remaining commodities. The over-whelming dominance of coffee justifies the selection of this thesis to study its trading efficiency to represent ECX's market efficiency.

Market Data

ECX uses the might of modern information and communication technologies to create access to market information to all its actors including the general public. The Exchange uses rural based Market Information Tickers, mobile phone Short Messaging Service (SMS), Interactive Voice

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[22] These limits can help traders to know how the market is doing and it may also protect uninformed traders from exploitation. It is, however important to note that these limits can be relaxed in exceptional cases.
[23] Such restriction can protect the market from a monopoly threat and creates the chance for members to participate in the trade.

Response (IVR) service, Mass media (TV, Radio, Newspaper) and Website to disseminate market information. Market information on commodity prices in different markets and commodity offer to sell and bids to buy, and others are collected, processed, updated and disseminated to market actors. Price information on Electronic Tickers is updated in less than 4 seconds and market information through mass media is disseminated on daily basis.

Risk Management

Despite the reduction in risk involved in its operation due to the use of spot exchange than a futures exchange, ECX goes beyond risk avoidance to identifying and managing an acceptable level of risk. The exchange, within its domain, manages different types of risks like: operational risk, credit risks, liquidity risks, and reputation and image risks. In order to maintain integrity of the price discovery process and to safeguard the quality of the market, the exchange has a market surveillance team that detects and prevents market manipulation practices, insider trading and misstatements (false information to mislead the public).

Compliance

The formulation and enforcement of the Rules of the Exchange and other laws that affect the Exchange's operation are mandated to the Compliance Division. To this end, the division has four units with specific responsibilities: the Rules and Regulations Unit, the Compliance Monitoring and Investigation Unit, Discipline and Enforcement Unit and the Arbitration Tribunal.

2.3.2.4 Coffee Trading at ECX[24]

ECX offers more than 250 coffee contracts in the broadly defined washed and unwashed coffee category. The basic distinction between the two categories arises in their preparation. If coffee is prepared using wet processing it becomes a washed coffee and when it is prepared using dry processing it is labeled in the Exchange as unwashed coffee. Under each category three types of coffee are traded: specialty, export (commercial) and local (domestic) coffee. Specialty coffee refers to the high quality coffee traded in the Exchange. Specialty coffee is introduced to the Exchange in December 2009. Coffee types that get grade 1 to grade 3 in the preliminary assessment are selected to undergo specialty assessment. In practical terms, unwashed and washed coffee types that get grade 1 and 2 are effectively included in the new arrangement as specialty coffee. On the other hand, unwashed and washed coffee types that have very inferior quality are traded under the local (domestic) coffee type. The exchange makes a daily trading of the specialty and commercial coffee (Monday-Friday except public holidays); and local coffee is traded three days per week.

The Exchange kept limits on important parts of the trading system in order to safeguard the smooth functioning of the system. There are limits on the price fluctuation and on the maximum amount of a member can transact. Expiration dates are also in place on the warehouse receipt and on the delivery period. Based on the previous trading session closing prices, coffee prices are allowed to fluctuate a 5% range unless the Exchange sets a new range.[25] The maximum amount of a member transact (what is called in the Exchange as Daily Position Limit) is set in terms of

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[24] The discussion under this section is taken from ECX Coffee Contracts available at :
https://www.ecx.com.et/downloads/Contracts/Coffee/CoffeeContracts.pdf
[25] A limit on the warehouse service encourages more trading on the exchange and discourages hoarding. Moreover, due to limitations in the storage infrastructure the country has, such a limit may embolden an effective use of this scared resource.

lot size.[26] In a single day, a member can transact 200 lots for himself or for a single client; or 1000 lots collectively for himself and his clients. In the Exchange, the ware house receipt issued to customer to trade in the Exchange floor has an expiration date. Beyond the 30 days limit that the warehouse store the good at a price 0.16 birr per bag per day, the exchange penalize the customer 3.5% of the current value of the stored good per day. If a buyer fails to collect the commodity within the 10 days delivery period, the buyer is penalized to pay 1% of the transaction value on daily bases.

Apart from the membership registration fee, other service fees and penalty charges serve as a source of revenue for the exchange. Members in the exchange are expected to pay 0.2% of the transaction value as an exchange transaction fee. As a handling and product certification fee, sellers in a coffee trading pay 2.70 birr per bag and 2.10 per bag is paid by the buyer. Handling fees are paid for services like sampling, grading, weighting, loading and unloading given by the Exchange.

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[26] A standard lot size in the exchange refers to 30bags (net weight of 60 kg) for washed coffee or 30bags (net weight of 85 kg) for unwashed coffee.

CHAPTER THREE

Review of the Literature

In a broader sense, attainment of efficiency and equity are the main objectives of microeconomic policy (Maddala & Miller, 1989). Among the many possible goals of a policy, these two objectives have almost entirely captured the attention of economic theorists (Hirshleifer, 1980). Thus, the continuing debate in measuring the efficiency of a policy and the ongoing developments in the theory of efficiency came as no surprise. Based on existing theories, there are voluminous empirical investigations made across the different perspectives of efficiency.

3.1 Theoretical Literature

3.1.1 The Concept of Efficiency

Forwarding a single definition of efficiency is not a simple task. The concept of efficiency has been used in different perspectives. It has been used from consumers' perspective, producers' perspective, market perspective and economic perspective. (Mas-Colell et'al, 1990) stated that the issue of efficiency captured a great deal of the focus of welfare economics. This can generally indicate what is meant by efficiency when it is used in either of the perspectives. It can also be deducted that efficiency has something to do with welfare enhancement.

The use of efficiency in consumers' and producers' perspective refers to maximization of consumer and producer surpluses as a measure of welfare gain by the two economic agents

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respectively. Unregulated competitive markets, except in the presence of externalities and market failure, always end up with such welfare enhancing efficient outcomes. When consumers' and producers' welfare are aggregated, it gives us economic efficiency (Pindyck & Rubinfeld, 1995). In terms of allocation of resources, an efficient outcome implies Pareto efficiency. The discussions in most microeconomics theory books tend to measure efficiency in terms of the outcome than on the process. This attributes seem to deliver a misleading conception of market efficiency in economic literatures like by (Preston & Collins, 1966)[27]. As the focus of this paper is market efficiency we will be engaged more on it than the other perspectives of efficiency.

3.1.2 Defining Market Efficiency

It is difficult to get a single definition of market efficiency that may hold for all markets. Even within the same market, different authors use different definitions. Ratchford et'al (1996, p. 168) forwarded a concise definition of market efficiency that they have deducted from the studies they reviewed. They defined it in terms of the "*actual or potential losses to individual consumers, which results from imperfect information about alternatives: An inefficient market is one in which such losses are or can be large.*" This definition seems to focus on the end results than the process in the market. Preston & Collins (1966, p. 155) on the other hand forwarded a definition that emphasizes the process in the market than the end results as "*the facility and effectiveness with which the potential exchanges are accomplished*". As the authors themselves admit, their definition is divorced from the specific characteristics of the quality and volume of goods and services being traded and the trading prices used in the exchange process. Though the discussion

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[27] Preston & Collins (1966, p.155) has equated efficiency of a market in economic literature with the "*market outcomes generated by perfect competition*". This comparison, however, neglect the vast literatures on market efficiency that focuse on the process like price formation than the outcomes.

in this old work was interesting and informative, they seem to overlook the price formation process that most studies in commodity and financial markets extensively apply in their study of market efficiency.

The most widely used definition of an efficient market was given by Fama (1970, p.383) in which he stated that "*A market in which prices always "fully reflect" available information is called "efficient"*". Some authors, among others, like Kaminsky & Kumar (1996) and Washburn & Binkley (1990) prefer to call such efficiency as "*informational efficiency*". The use of efficiency in this sense is quite different from its use in the notion of Pareto efficiency (Ross, 1987, cited in Kaminsky & Kumar, 1996) and efficiency of a market in the informational sense does not guarantee Pareto efficient allocation of resources (Lundholm, 1991).

Besides informational efficiency, Blake (1990, p243) introduced operational efficiency and allocative efficiency to characterize a perfectly efficient market. In a competitive economy markets are said to be allocatively efficient if they "*allocate scarce resources between competing ends in a way that leads to the scarce resources being used most productively*" and operational efficiency is said to exist "*when the transaction costs of operating in the market (namely, the market-maker's spread and the broker's commission) are determined competitively*". For Blake, it is when these three types of efficiency are fulfilled we say that the market is perfectly efficient market. The author attributes the Fama's definition of an efficient market to represent what is known in literatures as the "Efficient Market Hypothesis".

Eugene Fama himself admitted that his definitional statement needs to specify in more detail the process of price formation in order to make the too general definitional statements a testable model. Beaver (1981, p23) belittled the difficulty to make the definitional statement a testable model as "*a pervasive phenomenon not unique to the efficient market literature*". Beaver argued that the fact that empirical investigations preceded the development of theories of market efficiency "*make the widely cited definitions of market efficiency conceptually incomplete and deficient in a fundamental sense*" (p23). The efficient market framework is also criticized for inconsistency with some forecasting techniques usually used in economics and the validity of the hypothesis, thus, can only stand on the cost of the effectiveness of these techniques (Laffer & Ranson, 1978). In addition to this, after recognizing Fama's work to be influential Malkiel (2003) documented a challenge to the hypothesis from economist who stress behavioral and psychological elements especially in the capital market. Answering all these critics induces the need to discuss the concept of market efficiency from its grass root[28].

3.1.3 Development in Market Efficiency Theories

In the areas of market efficiency, empirical works had preceded the development in the theory side (Fama, 1970). The foundation of market efficiency concept is attributed to Bachelier (1900) who had first recognized the informational efficiency of a market in his statement after a close observation of commodity prices series saying "*past, present and even discounted future events are reflected in market price, but often show no apparent relation to price changes*" (cited in Dimson & Mussavian, 1998, p91-92). The same randomness in prices was also observed on US

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[28] The explanation regarding empirical setbacks in market efficiency hypothesis are discussed in empirical review of this paper.

stock prices and other economic time series by Working (1934) and Cowles & Jones (1937) both cited in *Ibid*).

Economists being faced with accumulated strong empirical evidence, felt compelled to give some rationalization. Their attempt resulted in the theory of efficient markets explained in terms of random walks[29] (Fama, 1970). Malkiel (2003) nicely forwarded the rationale behind the link between the efficiency of a market and the randomness of prices. Malkiel argued that in a situation where a market fully and immediately reflects existing information, the prices will become unpredictable and random since news (information) by definition is unpredictable. Tomorrow's price thus only reflects tomorrow's news and forecasting based on past information becomes a futile task. After a review of large sum of existing works in market efficiency, Fama (1970) defines an efficient market to be a market that fully reflects available information.

Eugene Fama has distinguished between three versions of efficient market hypothesis (EMH): the weak, semi-strong and strong efficient market hypothesis, with their distinction based on their definition of the information set.

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[29] The concept of "random walk" is thoroughly discussed in the next sections.

3.1.3.1 The Three Forms of Efficient Market Hypothesis

The Weak Form of EMH

The weak form of EMH defines its information set to be its own historical prices (returns)[30]. In a market where past price information is perfectly and fully reflected on today's price, this hypothesis rules out the possibility of earning a consistent excesses return using this historical data to predict future behavior of the security (commodity) price (Pilbeam, 2005). It effectively devalues the effort of chartists and technical analysts by producing an average zero profit from their forecasts[31]. In testing for the existence of the weak form of EMH, the filter-rule test and other statistical tests that range from the simple runs test to complex statistical tests are widely used. Though most studies found strong evidence for the existence of weak- form of EMH, there have also been few predictable patterns observed in some data sets; what they are often called anomalies related to the day-of-the week effect, the January effect and the winner-loser problem (*Ibid*).[32]

The Semi-strong Form of EMH

The semi-strong form expands the information set with the inclusion of other publicly available market information. The semi-strong form of EMH hypothesizes that in an efficient market not only past price history are reflected but also all publicly available information are impounded in the current price. In a security market context, Fama (1970) includes announcements of annual

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[30] The relationship between prices and returns is discussed in the next section

[31] Both make their living by making profitable forecasts of future behavior of security prices. While chartists use "recent charts of the security's prices" the technical analysts use "statistical approach to analyzing the data-set" (Pilbeam, 2005, p252)

[32] The definition and the use of the filter-rule and other statistical tests are discussed in the empirical review of this thesis.

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earnings, stock splits, etc as publicly available market information. Pilbeam (2005) further added news of takeover, changes in dividend policy and newspaper columns as publicly available information. Generally, information that is made available to the public that may include economic forecasts, industry report and company announcement or report are included in defining the information set impounded in the semi-strong form of EMH (*Ibid*). Pilbeam stated that investment analysts use different types of methods that ranges from simple models to complex econometric models to detect undervalued securities and make benefit of them. Like the weak form of EMH, the semi-strong form nevertheless witnessed anomalies that are often mentioned in literatures as: the size effect, the price earning effect, the earnings announcement effect, etc (*Ibid*).

The Strong Form of EMH

The strong form of EMH stipulates that market prices not only quickly incorporate their price history and other publicly available information but they also swiftly adjust to private (insider) information[33]. This form of EMH has a strong implication that even those with a privileged private information, like directors, cannot make a consistent excess profit by using the inside information to make future trading (Pilbeam, 2005). Despite the use of indirect approaches to test the existence of the strong-form of EMH, Pilbeam attributes the difficulty in testing this form of EMH to the lack of appropriate proxy for insider information. As we will be discussing in the empirical literature, there is nearly no strong established evidence for the existence of the strong form of EMH.

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[33] Insider information is piece of information that the trader in the exchange has a monopoly on it and the information is only known to him.

The EMH in short implies that no market actor can outsmart the market and collect an abnormal profit by possession of information; since the market has already adjusted to the new information before the actor exploits it.

In an attempt to give the EMH a theoretical base, Fama (1970) has built on existing works on Expected return or "fair game" models. The author's discussion is presented below:

3.1.3.2 The Expected Return or "Fair Game" Models[34]

As discussed earlier, the definitional statement lacks empirical testability due to the too general wordings used to portray an efficient market. In an attempt to make a testable model and explain what is meant to "fully reflect" available information on market prices, there is a need to specify the price formation process. The first attempt to use the expected return or "Fair Game" models in market efficiency theory was rigorously studied by Mandelbrot (1966) and Samuelson (1965) both cited in Fama, 1970). Such theories would posit that conditional on some relevant information set, the equilibrium expected return is a function of its "risk". And different theories would then differ primarily on how "risk" is defined.

All expected return theories can symbolically be expressed as:

$$E(\tilde{p}_{j,t+1}) = [1 + E(\tilde{r}_{j,t+1}|\Phi_t)]p_{jt} \qquad (3.1)$$

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[34] All the equations and their descriptions discussed in this section are almost directly taken from (Fama, 1970, pp384-387)

E is the expected value operator; p_{jt} is the price of j commodity or stock at time t; $p_{j,t+1}$ is its price at t+1; $r_{j,t+1}$ is the one-period percentage of return $(p_{j,t+1} - p_{jt})/p_{jt}$; Φ_t is a general symbol for whatever set of information is assumed to be "fully reflected" in the price at t; and the tildes indicate that $p_{j,t+1}$ and $r_{j,t+1}$ are random variables. The model summarized by (3.1) as the "fair game" model, are implications of the assumptions that:

i.   The conditions of market equilibrium can be stated in terms of expected returns, and

ii.   The information Φ_t is fully utilized by the market in forming equilibrium expected returns and thus current prices

These two assumptions have a major empirical implication i.e. they rule out the possibility of trading system that have expected returns in excess of equilibrium expected returns. To put it notationally:

$$\text{Let } x_{j,t+1} = p_{j,t+1} - E(p_{j,t+1}|\Phi_t) \tag{3.2}$$

$$\text{then, } E(\tilde{x}_{j,t+1}|\Phi_t) = 0 \tag{3.3}$$

The equations imply that the sequence of $\{x_{jt}\}$ is a "fair game" with respect to the information sequence $\{\Phi_t\}$. Equivalently putting it in terms of the return:

$$\text{Let: } z_{j,t+1} = r_{j,t+1} - E(\tilde{r}_{j,t+1}|\Phi_t) \tag{3.4}$$

$$\text{Then, } E(\tilde{z}_{j,t+1}) = 0 \tag{3.5}$$

The sequence $\{zjt\}$ is also a "fair game" with respect to the information sequence $\{\Phi_t\}$.

$x_{j,t+1}$ is excess market value of a security (commodity) j at time t+1: it is the difference between the observed price and the expected value of the price that was projected at t on the basis of the

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information Φ_t. Similarly, $z_{j,t+1}$ is the return at t+1 in excess of the equilibrium return projected at t.

There are two special cases of the "fair game model" namely the submartingale and the random walk models.

The Submartingale Model

Suppose we assume in equation (3.1) that for all t and Φt

$$E(\tilde{p}_{j,t+1}) \geq p_{jt}, \text{ where } E(\tilde{r}_{j,t+1}|\Phi_t) \geq 0 \qquad (3.6)$$

This is a statement that the price sequence $\{p_{jt}\}$ for security (commodity) j follows a submartingale with respect to the information sequence $\{\Phi_t\}$. But on the other hand as Blake (1990) noted if the expected future price level is less than its current price we will have a supermartingale process[35]. If equation (3.6) holds as equality, then the price sequence follows a martingale shown below:

$$E(\tilde{p}_{j,t+1}|\Phi_t) = p_{jt} \qquad (3.6')$$

Samuelson (1965) cited in Xin & Chen (2006) proposes the use of a martingale process in explaining an efficient futures market. In such an efficient market, Samuelson, argued that the futures price determined today is the unbiased estimator of the expected future spot price.

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[35] A model is said to follow a submartingale process if the future expected price of a security (commodity), given the information set, is greater than its current (t) price; and the exact reverse of a submartingale process is a supermartingale process. Both models (processes) show an incorrect prediction (by the market) of the price that a specific (commodity) will have in the future and they indicate inefficiency in the market.

The Random Walk Model

In an efficient market model the statement that current price "fully reflects" available information is assumed to imply that successive price changes (successive one-period returns) are independent and are identically distributed. These two premises together constitute the random walk model. Formally, the model says:

$$f(r_{j,t+1}|\Phi_t) = f(r_{j,t+1}),$$ (3.7)

Equation (3.7) states that the conditional and marginal probability distributions of an independent random variable are identical. Moreover, the density function f must be the same for all t. This expression says much more than the general expected return model summarized by equation (3.1). If for example we restrict equation (3.1) by assuming that the expected return on security (commodity) j is constant over time, then as Fama (1970) put it we have

$$E(\tilde{r}_{j,t+1}|\Phi t) = E(\tilde{r}_{j,t+1})$$ (3.8)

It implies in equation (3.1) that, the mean of the distribution of $r_{j,t+1}$ is independent of the information available at t, Φ_t, whereas in the random walk model of (3.7) it also implies that the entire distribution is independent of Φ_t. Another distinction between the "fair game" model and the random walk model is that the "fair game" model only says that the conditions of market equilibrium can be stated in terms of expected returns with little details of the stochastic process generating returns compared to the random walk model.[36]

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[36] The random walk is special case of a martingale process (Wilson & Marashdeh, . 2007; Lo & MacKinlay, 1988).

Finally, Fama described the sufficient conditions that facilitate the perfect adjustment of the prices to changes in information i.e. an efficient market prevails in a market where:

i. There are no transaction costs in trading securities

ii. All available information is costlessly available to all market participants, and

iii. All participants agree on the implications of current information for the current price and distribution of future prices of each security

3.1.4 The Random Walk Model and Market Efficiency

The EMH is closely associated with random walk model (Malkiel, 2003). Accumulated evidence on security and commodity prices entail their characterization by a random walk model. Economists then strive to offer rationalization for the empirical evidences which then resulted in the efficient market hypothesis described in terms of random walks (Fama, 1970).

After examining 22 UK commodity and stock price series, Kendall (1953 cited in Dimson & Mussavian, 1998) concluded that "*in series of prices which are observed at fairly close intervals the random changes from one term to the next are so large as to swamp any systematic effect which may be present. The data behave almost like wandering series.*" Though inconsistent with economists view, Kendall also found out that the price changes have near-zero serial correlation. The empirical results then came to be labeled as the "random walk model" or the "random walk theory". In a random walk process prices have no memory of their past behavior and "*the way they behaved in the past is not useful in divining how it will behave in the future*" (Malkiel, 2003, p.6).

Samuelson (1965 cited in Dimson & Mussavian, 1998, p93) forwarded an equivocal statement creating the link between price formation in competitive markets, which are assumed to be efficient by economists, and the market efficiency in commodity and security markets through the random walk theory. Samuelson stated that "*in competitive markets there is a buyer for every seller. If one could be sure that a price would rise, it would have already risen...arguments like this are used to deduce that competitive prices must display price changes... that perform a random walk with no predictable bias.*"

3.1.5 Futures vis-à-vis Spot Markets

Futures contract is one of the key products in the market for derivative products. They are called derivates because they are derived from other products (Valdez, 2007). Futures contract in a financial market refers to "*an agreement between two counterparties to exchange a specified amount of a financial security (bond, bill, currency or stock) at a fixed future date at a predetermined price*" (Pilbeam, 2005, p.334). Futures contract in a commodity market can be defined as "*a commitment to buy or sell a given quantity of an underlying product by a given date in the future at a price agreed now*" (Valdez, 2007). Pilbeam (2005) noted that futures contracts have proved to be popular in both financial and commodity markets.

In making futures contracts, the contract specifically details the type, the amount and the delivery date of the good. In an exchange based futures contract, when two counterparties agreed to make a futures contract after their wants are mate in an open-outcry system or using computer screen technology, the central clearing house of the exchange takes the responsibility to guarantee the

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contract. During the contract period, if either of the counterparties fail to full fill their obligations under the contract and make default; credit risk arises. As the exchange has the responsibility to guarantee the contract, it solely assumes the credit risk. In order to decrease its exposure to credit risk, the clearing house obliges the two parties to make an initial deposit known as "initial margin". If the movement in market prices are to create loser and gainers in the contract, the clearing house then require the losing party to make further deposit, known as "variation margin", to compensate for the loses associated with the contract. If the losing trader fails to make a settlement of the margin, the exchange will make an offsetting contract in order to minimize its risk exposure (*Ibid*). [37]

A seemingly similar but a fundamentally different concept related to futures contract is forward contract. Among others, the basic difference between the two contracts is that forward contracts are made by traders who want the physical delivery of the commodity. Futures contract on the other hand are often completed by an opposite contract and the settlement is made on cash than physical receipt of the commodity. Speculators and hedgers widely use futures contracts (Valdez, 2007)[38].

Speculators, hedgers and arbitrageurs are the three types of professional users of derivative products. Speculators are less interested in current level of prices and always try to make profit by predicting where the market prices are to move next (Blake, 1990). The hedgers on the other

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[37] When either party that made contract on a transaction in the exchange defaults, the exchange sells the contract to another volunteer trader. Such contract is known as an offsetting contract.
[38] See Pilbeam (2005) for a detail distinction between the two contracts.

hand use the market to offset risk. Hedgers lock-on the contract they made with one party with another contract with the third party in order to avoid risks they currently face or expected to face in the future. Speculators are thus risk loving while hedgers are often risk averse individuals. Users who exploit price anomalies in different markets for the same commodity and make a profitable trade are called arbitrageurs (*Ibid*). Arbitrage can be of two types: arbitrage across time and arbitrage across space. The earning of a benefit by transporting a commodity to other market to which the prices are higher is arbitrage across space and the collection of the benefit by storing the commodity until the prices get right is an arbitrage across time Gabre-madhin & Goggin (2005). Literatures on derivative market often explain arbitrage in terms of the former definition. In spot (cash) market, however, both types of arbitrage can be reasonably used to make profit. A spot market offers a spot contract. ECX (2008) defines spot contract in its context as an *"exchange traded contract for payment on the same day and physical delivery within a maximum of 10 working days from the date of transaction"*. Exchange based spot markets also use an open-outcry system or a computer screen to match trader's wants. The price of a commodity that prevails in spot market that serves as the price of the commodity today is a spot price. Thought the price discovery system may take a similar approach, the futures price is the price that traders agree on today to make a transaction sometime in the future i.e. on the contract maturity day.

3.2   Empirical Review

Empirical investigation of the EMH continues to give uneven results. The lack of conclusive evidence attributed to, among other, the non uniform samples used, the difference in time periods of the study and the difference in the econometric techniques applied (Kaminsky & Kumar,

1990). In their review of theoretical and empirical works, Fama (1970) and Dimson & Mussavian (1998), contend that the weak and the semi-strong versions of the EMH are in fairly strong conformity with empirical results and there are no influential evidences against these hypothesizes; the strong form of the hypothesis however confronted empirical setbacks. The strong form of the EMH rather serves as a bench marking in differentiating the level of information than its empirical testability (Fama, 1991). Despite anomalies demonstrated by some study results against market efficiency, Jensen's belief is shared by many economists. Jensen (1978 cited in Lo & MacKinlay, 1988) forcefully stressed that "*there is no other proposition in economics which has more solid empirical evidence supporting it than the Efficient Markets Hypothesis*". Thus, financial economists often try to explain the anomalies than to accept them as evidence against the hypothesis.

3.2.1 Market Efficiency Tests

Johnson et'al (1990, p65) summarized the concerns of the type of tests used in futures market into three main areas:

a) Testing random walk on futures prices

b) Testing the efficiency of forecasting the spot price from its futures price, and

c) Testing the possibility of generating profit using trading rules

The test for random walk hypothesis using different statistical tools is widely used in the capital market than the commodity market. Solnik (1973) used the standard serial correlation test to study the behavior of daily closing prices of common stocks taken from 8 of the major European stock markets. Marashdeh and Shrestha (2008) studied the market efficiency of Emirates stock

market using unit root test of Augmented Dickey Fuller (ADF) and Philip-Perron (PP). The PP and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) tests for unit root were also employed by Mishra et'al (2009) to examine the weak form of market efficiency in the Indian stock market.

Unit root test are mostly parametric and they are thus valid only when the assumption of normality of the data distribution is guaranteed; most financial time series, however, violet the assumption of normality (Xin & Chen, 2006). A plausible alternative and widely used non-parametric test for random walk is the Lo-MacKinlay variance ratio test introduced by Lo and MacKinlay (1988). They first introduced the test in their study of random walk in market efficiency of the New York Stock Exchange. The same test was used by many studies including Tabak (2002) on the Brazilian and Lock (2007) on the Taiwan stock markets. A variant of the Lo-MacKinlay variance ratio test is the multiple variance ratio test; Smith et'al (2002) and Smith and Smith & Ryoo (2003) used it to test the weak form of market efficiency in 8 African stock market and 5 emerging European stock markets respectively.

The problem with most of the tests for random walk (discussed above) is their inability in detecting non-linear dependencies in the time series. Using these non-linear dependencies traders in an exchange can devise profitable trading rules to earn excess return. [39] This had been seen in

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[39] Filter rule (Mechanical trading rule) is a *"system that concentrate on individual securities and that define the condition under which the investor would hold a given security, sell it short, or simply hold cash at any time t."* (Fama, 1970, p386). Fama gave an example of a y% filter rule as *"if the price of a security moves up at least y%, buy and hold the security until its price moves down at least y% from a subsequent high, at which time simultaneously sell and go short. The short position is maintained until the price rises at least y% above a subsequent low, at which time one covers the short position and buys. Moves less than y% in either direction are ignored."*(Ibid, 1970, p.394-395). Van Horne & Parker (1967) used filter rule to test random walk in 30 industrial stocks traded in the New York Stock Exchange (NYSE).

the work of Leuthold (1972). Leuthold found a profitable trading rule after the market was declared to be weak form efficient using the spectacular analysis. Most financial return series appear often to look completely random to spectral and standard linear tests; and that using other powerful techniques may unveil more complex dependencies in the series which will ultimately lead to the refutation of the existence of a random walk process (Brooks, 1996 cited in Lim et'al, 2004). Fama (1970, p.394) has also noted that "*Moreover, zero covariances are consistent with a fair game model, but as noted earlier, there are other types of nonlinear dependence that imply the existence of profitable trading systems, and yet do not imply nonzero serial covariances*". One of statistically powerful test to study such complex dependencies is Brock-Dechert-Scheinkman (BDS) test for random walk. Lim et'al (2004) used the BDS test to study market efficiency in eight major Asian stock markets. Another alternative way to test random walk in financial time series is the detection of predictability patterns in trading days. Along this line, Jarrett (2008) investigated market efficiency of the third largest exchange in Asia Pacific- the Hong Kong Exchanges. Jarrett tested the predictability in returns making daily returns as a dependent variable and using five dummy variables to represent the five trading days- Monday to Friday- as independent variables.

The test for weak form of market efficiency in commodity market is rarely done using the random walk theory. Much of the studies in commodity markets concentrate on testing the efficiency of forecasting the spot price from its futures price (applying the martingale model). In testing for random walk in commodity markets, among others, serial correlation test, runs test, unit root tests, variance ratio, spectral analysis, mechanical trading rules (filter techniques) were used. Still others used the combination of test on the same data set like Stevenson & Bear (1970)

in soybeans and corn prices and Leuthold (1972) in live cattle future market. In commodity futures market the concept of cointegration was widely applied to test the relationship between futures prices and spot prices. The cointegation concept is expanded to apply what is known in literature as the "unbiasedness hypothesis" and "the BK hypothesis" in studying commodity futures market efficiency. The ARCH-M and GARCH-M models were also used in commodity futures markets to explain market efficiency. Unfortunately, the results in both capital and commodity market are as diverse as the methodology applied. The following sections make a full review of representative empirical works that employ the different methodological tools in studying market efficiency in commodity markets.

3.2.1.1 Market Efficiency in Commodity Markets

Almost all organized commodity markets make futures trading and they are often termed as commodity futures market. Though the concept of market efficiency is often attached to asset market it has same applicability in commodity futures market (Kaminsky & Kumar, 1990). In studying the futures market efficiency, a random walk theory was tested on closing prices (Stevenson & Bear, 1970 and Leuthold, 1972) and on futures prices (Phukubje & Moholwa, 2006). Moreover, the expected return or the "fair game" hypothesis was used to study commodity futures market efficiency by Kaminsky & Kumar (1990) and cointegration analysis and its extended versions were used by Li et'al (2004) and others.

The Test for Random Walk Hypothesis in Commodity Markets

Hoping to formulate a more meaningful statement about random walks in commodity futures market, Stevenson & Bear (1970) applied the serial correlation test, runs test and filter techniques covering the July contracts in the period 1957-1968 to check the randomness of 240 daily closing price differences in commodity futures markets. They took two of the largest traded commodities (in terms of volume and total open interest) on the Chicago Board of Trade namely Soybeans and Corn. The researchers used one day, two-days and five-days lag separately and found different results. In the one-day and two-day lag a negative correlation coefficient, that was more prevalent in soybeans than in corn, was observed. The rule that daily trading prices are based on previous day closing prices partly explain the phenomenon especially in soybean. The five-day lag on the other hand witnessed a greater positive bias in general and more prevalent in corn prices. The results from the runs test were also found to be consistent with the correlation coefficient results and the filter (mechanical trading rule) test. They concluded that prices in the commodity futures market follow a systematic pattern (trend) than random walk. As to the implication of the study, the authors preferred to be cautious about the applicability of the efficient market hypothesis in commodity futures markets than to question the validity of the hypothesis itself.

Stevenson & Bears' conclusion is a setback to the application of the random walk hypothesis to test EMH in commodity futures market. Despite the use of different statistical tools the results seem to be the same. As noted in EMH literatures, the runs test and the serial correlation coefficient test are too unsophisticated to trace complex dependencies; yet the result of Stevenson

& Bear goes against the null hypothesis that there is random walk. Leuthold (1972) tested random walk with a relatively complex statistical tool (discussed below); yet again the random walk theory fails to explain the price change consistently across the study period.

Leuthold (1972) identified the failure to use different tests on an identical data as a possible explanation for the lack of consensus on any single result. The author acknowledges Stevenson & Bear's (1970) attempt to address the issue but he is critical of their use of unsophisticated statistical tools. Taking these shortcomings seriously, the study used a relatively sophisticated technique- namely spectral analysis- together with mechanical filters technique to verify the random walk hypothesis (and by implication the EMH) in live cattle markets. Leuthold studied the daily closing prices of 30 live beef cattle futures contracts in the period April 1965 to February 1997. The study has included 6914 observation and approximately 230 observations per contract. The spectral analysis result showed that the price changes are in conformity with the random walk theory for only some part of the study period. The filter technique however uncovered that even in periods that the spectral analysis accepted randomness; there are possibilities of arranging profit generating trading rules. As the employed statistical test looks for linear dependency, the trading rules might have exploited the existence of non-linear dependencies to create such profitable trading arrangements. Leuthold called for more investigations and noted the need to formulate statistical techniques that can capture the type of price movements witnessed in the filter techniques.

Both works discussed make us to be cautious about the use of random walk theory to explain market efficiency in commodity futures market. Similar to the stock market, efficiency studies in commodity markets also showed mixed results (Leuthold, 1972; Kaminsky & Kumar, 1990; He & Holt, 2004). The random walk hypothesis that was unable to hold in Leuthold (1972) & Stevenson & Bear (1970) papers was found to hold in Kendall (1953cited in Fama, 1970), Larson (1960) and Cargill & Rausser (1969) both cited in Leuthod (1972) and many others.

Another new approach of studying market efficiency comes from Phukubje & Moholwal (2006). They investigated the South African futures market for wheat and sunflower seeds for the weak-form of market efficiency. This work is a significant contribution to the very few existing similar studies that have tested the market's efficiency in white maize and yellow maize. The researchers departed from what they call the traditionally used spot and futures prices cointegration test to regressing current futures prices on past futures prices due to the lack of data on spot prices. They argued that "*if the futures market is efficient, then past futures price changes should have no significant information for predicting current futures price changes*" p.201. The study used daily settlement prices[40] of the two commodities for the five contract termination months within the year 2000 to 2003.

Ljung-Box Q-statistic is used to determine the optimal lag length that can keep the autocorrelation in the error term close to zero. To reduce computational errors, they scaled the log price differences by 100. The F-test is used to test the joint null hypothesis of no

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[40] Settlement price refers to "*the last price for a futures contract on any trading day*" (Phukubje & Moholwa1 2006, p203)

predictability for the two crops. The results showed that the daily futures prices are partially predictable from past futures prices and implied the rejection of the weak form of the EMH. Using trading rules that accounts for the time value of money and brokerage costs, the paper has shown that the model cannot be exploited to make a profitable trade that implies that the weak-form inefficiency has no strong support. The paper finally tested the stability of the results using the likelihood ratio test to check whether a trend exist towards efficiency. The result from the stability test revealed that the parameters are stable and there is no trend towards efficiency.

Beyond their contribution to the limited studies available in the area, their methodological approach shows how to escape the lack of spot price data to study market efficiency. Their study has only tested the weak form of the EMH. The following study demonstrates the test for both the weak and semi-strong forms of the EMH in commodity futures market.

Kaminsky & Kumar (1990) employed simple averages and econometric regressions to test market efficiency in fairly large and diversified commodities. They centered their study on the implied premises of the "fair game" hypothesis that excess rate of return to speculation in commodity futures market should be zero. They disaggregated the possible excess return into risk premium and forecasting error components. A data of eight commodities in the time period 1976 to 1980 from different sources in the US economy were taken and different econometric tests were used to measure the efficiency of the markets in four forecast horizons (one, three, six and nine months). Unlike the detailed sub-periods analysis results which have depicted a complex picture, unconditional excess return was found to be close to zero for the full study period.

The study has also tested the weak and semi-strong forms of the EMH in the data set; and failed to be conclusive as to the weak and semi-strong efficiency of the markets. The researchers used OLS regression the predictability of returns from the dependent variables to test the existence of predictable patterns; thus, the random walk hypothesis. The weak form of market efficiency (here measured as an OLS regression between the return and its lagged values) has been shown to prevail for some of the commodities. The study incorporated the US consumption, terms of trade, interest rate, industrial production, money supply and consumer price index as components of publicly available information to test the semi-strong form of market efficiency. The paper once again used an OLS regression of the return on its lag value and the macro- variables. The regression result shows that, the test fail to reject the null hypothesis of semi-strong market efficient for one and three months forecast horizon while it soundly rejected the null for a longer time horizon. The lists of the macro-variables listed in the publicly available information set gives a good insight to the defining the information set in a commodity market context. Their methodological approach has also showed an alternative approaches to test the EMH. The results they got still add to the differences in results in EMH studies in terms of differences in methodology and time horizons.

The Test for Cointegration in Commodity Markets

Fama's definition of an efficient market and its subsequent discussion on "fair game" and martingale model has an additional empirically applicable implication in the commodity futures market. The definition also entails that an efficient futures commodity that "fully reflects" all the known available information presented in the martingale model implies that futures prices must

provide full information to predict their future spot prices on maturity. In technical terms, there must be a cointergation relationship between the futures prices and its corresponding spot prices.

Lai and Lai (1991 cited in Li et'al, 2004) premise that in an efficient futures market the cointegration of the futures and the spot prices is a necessary condition as the starting point of their study. It is argued that the futures prices serve as an effective and "unbiased" predictor of future spot prices and also reflect supply and demand equilibrium in an efficient market. Such situation voids the existence of profitable opportunities by exploiting the publicly available information on prices. Given the expected existence of unit root in economic series the futures prices and the spot price series are expected to be cointegrated of order (1,-1) for a market to be efficient.

The researchers tested the "unbiasedness hypothesis"[41] and the "Brenner-Kroner (BK) hypothesis"[42] in a data set collected from the UK Department of Environment, Food and Rural Affairs (DEFRA) on the weekly wheat spot price in the futures contract termination week and the futures prices from wheat futures contracts traded in London International Financial Futures

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[41] (Li et'al, 2004, p 5) cited (Beck, 1994) that from a theoretical view the "unbiasedness hypothesis" is a joint assumption of both risk neutrality and market efficiency. For a market to be efficient the risk premium should have a zero mean and the spot and the lagged futures prices should be integrated in the order (1,-1).

[42] The BK hypothesis is named after (Brenner and Kroner, 1995) cited in (Li et'al, 2004, pp 6-7). They argue that profit maximizing investors include in their decision to trade in futures market its opportunity cost i.e. alternative transaction in the bond market. They extended the "unbiasedness hypothesis" with the inclusion of interest rate in the decision making. Expecting the spot prices, the lagged futures prices and the interest rates to be I(1), they propose that an efficient futures market should create this tri-variate cointegration with a cointegrative vector of (1,-1,1).

Exchange (LIFFE). The interest rate is the Bank of England repo base rate[43]. The study covered the period from November 1985 to January 2004 and collected 110 observations. In addition to the test for the "unbiasedness hypothesis" and the "BK hypothesis" they further intended to examine the "cointegration paradox"[44] uncovered by Kellard (2002).

The Augmented Dickey-Fuller test reveals that the spot prices, lagged futures prices and the interest rate series are all I(1). The estimation of the "unbiasedness hypothesis" and "BK hypothesis" using Johansen's cointegration tests discussed in (Johansen 1988, 1991; Johansen and Juselius, 1990) showed that the "cointegration paradox" doesn't hold in the data set. The analysis results demonstrated that the spot price and the lagged futures price are cointegrated of order (1, -1) while spot price, lagged futures price and the interest rate failed to be cointegrated in the order (1, -1, 1). In the BK model the coefficients of the interest rate were found to be statistically insignificant. The paper thus concludes that the UK wheat futures market satisfies the necessary condition for market efficiency and implies that the spot prices are predictable from their futures prices.

Given the accumulated long year experience in such markets, the result from the study might not come as a surprise. Such developed markets have well informed and sensitive speculators that

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[43] The British Bankers' Association cited in (Li et'al, 2004, p.7-8) defines REPO rates as, "*Repurchase agreements (repos) are collateralised lending transactions. One party agrees to sell securities (e.g. gilts) to the other against a transfer of funds. At the same time the parties agree to repurchase the same or equivalent securities at a specific price in the future*".

[44] Kellard (2002 cited in *Ibid*) called the simultaneous existence of a cointegration between three variables while two of them are also cointegrated with each other as theoretically impossible and labeled the puzzle as "cointegration paradox". By implication it is theoretically impossible for the acceptance of the hypothesis that both the "unbiasdness" and "BK hypothesis" simultaneously hold.

exploit arbitrage opportunities arising from disequilibrum and they bring the market to equilibrium (Mananyi & Struthers, 1997). This study has shown that the UK futures market futures prices and spot prices have a long run relation; this nonetheless does not guaranty short run equilibrium. Capitalizing on these gaps the following papers used existing statistical techniques to study long-run and short-run equilibrium relationship between the two prices.

Wang & Ke (2005) tested the cointegration between the two wholesale cash markets and futures exchanges for wheat and soybean to determine the efficiency of agricultural commodity futures market in China. The researchers used weekly cash market price data from Tianjin Grain Wholesale Market (TGWM) and Zhengzhou Grain Wholesale Market (ZGWM); and futures market prices for the commodities from China Zhengzhou Commodity Exchange (CZCE) and the Dalian Commodity Exchange (DCE). The national average cash price is also included in the study. The study covered the period January 1998- March 2002 and used six forecasting horizons (1 week, 2 weeks, 1 month, 2 months, 3 months and 4 months). In the cointegration analysis, the researchers included two seasonal dummy variables (for growing-season and harvest season) to examine the seasonality effect. Besides the cointegration analysis, a weak exogeneity test is used to check whether transitory shocks can affect the established long-run equilibrium relationship, if any.

The Johansen's cointegration, which uses the maximum likelihood-ratio to test cointegation, result shows that the futures soybean prices are well integrated with all the three cash prices used in the study. The weak exogenity test, however, indicated that the DCE futures price is short-run inefficient with ZGWM cash price. On the other hand, the wheat futures prices fail to cointegrate

with any of the cash price series. Government intervention and over speculation are deemed to explain the inefficiency in the wheat market. Nonetheless, the seasonality effect is not found in both commodity markets.

The study underlined the effect of an interventionist government approach on market efficiency and further concretizes the arguments of the proponents of free market. It has also shown the negative impact of speculation in market efficient. Looking these two issues on the other side, they are policy recommendations to fashion and maintain efficiency of a market. The study used the weak exogenity test to comment on short run relationship between futures and spot prices, an error correction mechanism (ECM) was also used in other studies to test short-run relationships between these prices.

Santos (2009), citing earlier works, distinguished between market efficiency and unbiasedness in a futures market. The risk neutral cointegration between the futures price and the spot price represents the unbiasedness hypothesis whereas an efficient but a biased market exists when the disequilibrum relationship between the two prices is explained by the risk premium. Another extension to market efficiency study employed in this paper is the time dimension; where short-run and the long-run market efficiency are examined. Santos studied futures prices of corn, wheat and oats contracts in the Chicago Board of Trade from the period 1997 to 2007 and from 1880 to 1890. The closing futures prices at the contract maturity date are taken as the corresponding spot prices. The study limits its forecasting horizon to only four and eight weeks due to the dearth of the 19th century data.

Both the Engle-Granger and the Johansen cointegration results fail to accept the null hypothesis that there is no cointegration and proved the efficiency of the contemporary and the 19th century market for all commodities. The unbiasedness hypothesis, however, holds only for four-week-wheat series and eight-week-oat series of the contemporary market and eight-week-oats series of the 19th century futures market. The short run disequilibrium dynamics (studied using an error correction mechanism (ECM) reveal the short-run efficiency of the all wheat series; but the results of oat and corn are mixed. The researcher used a relative measure of efficiency to compare the two periods' short-run market efficiency. [45] Generally, the relative measure shows that the 19th century futures market performed as efficient as the contemporary market. The researcher concluded that the level of efficiency seen in the 19th century market justifies the argument by the grain trade historians on the development of futures exchange that its development is mainly shaped by individuals who wants to reduce price risk.

The development of commodity futures market in developing nations, especially in Africa, has a very short history. The fact that such markets in the US were present in the 19th century and that they were performing as efficient as the contemporary markets is quite an interesting finding. Santos indicates the efficiency but not the unbiasedness of most of the contracts. This study did not empirically show the existence of the time varying risk premium in explaining the difference between the two. A study by Manayi & Struthers (1997) neatly explains such differences using the ARCH and GARCH model.

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[45] Following Kellard et al. (1999) Santos calculated the relative short-rum market efficiency measure as $\varphi = \frac{1-R^2_{UR}}{1-\tilde{R}^2_R}$, where R^2_{UR} is the unrestricted R^2 and $\tilde{R}^2_R$ is the restricted one. The value of φ ranges between 0 and 1; $\varphi = 0$ implies complete inefficiency and $\varphi = 1$ implies complete in efficiency.

Mananyi & Struthers (1997) tested the validity of the EMH for cocoa trading in the London Futures and Options Exchange. A monthly spot and futures prices within the period January 1985 to December 1991 and a cointegration analysis is used in the study. The researchers, among others, argued that the rejection of the EMH implies either the market inefficiency or the existence of a time varying risk premium. Modeling of this time varying risk premium necessitates the use of an auto-regressive conditional heteroscedasticity (ARCH) model and its more general version: the generalized ARCH (GARCH) model[46]. The GARCH- in mean (GARCH-M) model is estimated in the study.

Using the prices in their logarithmic form, the Engle- Granger cointegration method reveals the absence of a cointegrating vector. The researchers then employ the ARCH and GARCH model to verify whether the result implies inefficiency or the existence of a time varying risk premium. In modeling the time varying risk premium, the ARCH (1) model was found to be more appropriate than the GARCH (1, 1) model. The Ljung Box statistics, however, shows the strong persistence of an autocorrelation. The researchers attribute the autocorrelation to the movements in either to

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[46] Financial data sets often exhibit volatility clustering: *"periods in which they exhibit wide swings for an extended time period followed by a period of comparative tranquility"* (Gujarati, 2005, p488). This phenomenon results in a time varying variance in the model i.e. heteroscedasticity. By making the error variance to depend on its past history (implying an autoregressive structure), the autoregressive conditional heteroscedasticity (ARCH) and its general form GARCH can better model the patterns in the data. $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2$ and $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \theta_1 \sigma_{t-1}^2$ represent a typical example of an ARCH and GARCH process, respectively; where: σ_t^2 and u_{t-1}^2 are the variance of the error term and one-period lagged square of the error term of the main regression, respectively. The summation of the α_1 and θ_1 in GARCH model measures the persistence of the time varying volatility (shock). These models in short show the autocorrelation between variances of the error terms (*Ibid*, 2005).

Variance and standard deviations serves as a good proxy to measure risk. In a commodity futures market, there are short hedgers who uses speculators to transfer futures price risk by offering lower price for their contracts than the future spot price and create the disequilibrium relationship between the futures and spot prices. In his intertemporal hedging theory, Keynes (1934 cited in Santos, 2009), called this condition "normal backwardation". The difference between the two, therefore, represents the risk premium that risk averse individuals pay to risk loving speculators. The error tem in the cointegration regression captures this price differences i.e. the risk premium. The variance of the regression is, then, used to model the risk premium using the ARCH and GARCH model.

presence of risk premium or to the inefficiency the market. The sum of the parameters in the GARCH (1, 1) model has indicated presence of shock (volatility) that intern implies market inefficiency. The study labeled its finding to be surprising given the existence of alerted arbitrage forces that exploit such disequilibrium in a market. The authors attribute such surprising finding to the existence of possible supply shocks in the study period and the failure of the study to neglect cross commodity trade effect and complex institutional factors. Despite their hesitation to accept results, they forwarded strong policy implication to LDC's. They recommended that a futures market dependent export stabilization policy is a riskier choice due to the prevalent shocks that exists in primary commodity in such countries and stressed the need to look for other alternative like buffer stock arrangement is a good alternative to the futures market.

The study extended the unbiasedness hypothesis discussed earlier. The conclusions of the study noted the prominent role of arbitrage forces in maintaining market efficiency. Their policy recommendation, however, is difficult to swallow given the relatively short period and the type of commodity studied in the paper.

Studies in commodity market efficiencies have also witnessed the use of both the random walk and cointegration approach to study market efficiency, like in Xin & Chen (2006). Xin & Chen studied the efficiency of copper and aluminum futures trading in China's Shanghai Futures Exchange. In 2004, copper and aluminum futures respectively accounts for 39% and 8% of the total futures trading in the exchange. The random walk hypothesis and the unbiasedness hypothesis were tested using a daily closing price data from the Shenzhen GTA CSMAR futures database covering the period from the 4th of January 1999 to the 31st of December 2004. The spot

prices used in the study are approximated by the delivery date futures closing prices of a contract. The researchers argued that, due to the possible rejection of the assumption of normality of distribution in many financial time series, a better test for the random walk hypothesis is the variance ratio test than the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests.

The variance ratio test for lags 2, 4 and 8 days on log prices fail to reject the null hypothesis for random walk. The results are also consistent with what is found using the ADF and KPSS test. The test for the unbiasedness hypothesis employing the Johansen cointegration has also shown the failure to reject the hypothesis. The independence of the daily price changes, confirmed by the failure to reject the random walk hypothesis, and the cointegration of the futures and spot prices, shown by the failure to reject the unbiasedness hypothesis, implies the efficiency of the exchange for the two commodities in the study period. The study attributes these results, which support the price discovery process, to the increase in the skill and awareness of the exchange participants and the regulatory changes that were made in 1999 to improve the effectiveness and efficiency of the markets in China.

As noted in earlier studies discussed in this thesis, Xin and Chen shows the impact of improvement in skills of market actors in creating an efficient commodity exchange. The need to create a comfortable regulatory environment to guaranty efficiency and integrity of the system in these exchanges sends a noticeable message to emerging exchanges in developing nations like Ethiopia.

3.2.2 Explaining Anomalies in Efficient Market Hypothesis

Mixed results in the test for market efficiency are prevalent in both capital markets and commodity futures market. Li et'al (2004, p3) summarized the possible explanations for these diverse results by earlier works on commodity futures market. The list include "*difference in time periods analyzed and in the methodology used (Jumah et al. 1999), the presence of a risk premium (Krehbiel and Adkins, 1993), the inability of the futures price to reflect all publicly available information (Beck, 1994), the inefficiency of agents as information processors (Kaminsky and Kumar, 1990), and the neglect of interest rates (the non-stationary part of storage cost) which play an important role as they enter arbitrage relationships between spot and futures prices (Brenner and Kroner, 1995)*" There are also mixed result in capital market efficiency studies that implies the predictability of prices (returns) from their past history.

Economist argues that the absence of a non-zero correlation coefficient does not necessarily rule-out market efficiency in a specific market. What matters rather is whether the predictability in the results which is demonstrated by the non-zero correlation coefficient result can be exploited to make an abnormal profit above costs involved in using the information (Malkiel, 2004). Dimson & Mussavian (1998) further noted that the possibility of little abnormal returns before expenses and fees are not ruled out in an EMH. The need to distinguish between statistical significance and economic significance is rigorously noted by (Malkiel, 2004) and (Fama, 1970) in explaining the anomalies prevailed in some studies. They argued that a small level of statistically significant often do not guarantee an economic significance that can be exploited to realize abnormal returns.

Most predictability reported in literatures seems to disappear after a short time or when exposed to other methodological treatments (Malkiel, 2004). The short run predictability of returns, according to experts in behavioral finance, is in conformity with psychological feedback mechanisms. When the price of a certain stock increases more individuals will tend to demand it and result in a continuous increase in its price in the short run. Another possible explanation to the short-run momentum from behavioralists is that investors may under react to new information and results in a positive serial correlation as was found by some empirical works. Such short-run momentum can also be found if investors over react to new information (*Ibid*).

What is important to note is the consistency and strength of such predicable patterns. They often prevail in the short-run and they tend to disappear right after their occurrence. The "January effect" and the "day-of-the-week effect" can be a good example in this respect. Malkiel documented some level of predictable patterns in January (Haugen and Lokonishok, 1988), around the turn of the month (Lakonishok and Smith, 1988), around holidays (Ariel, 1990), and higher Monday returns (Frenchm, 1980). It is for this reason that rejection of random walk does not necessary implies presence of a persistent profitable opportunity (in other words inefficiency) in the market while the failure to reject random walk strictly implies efficiency of the market (Fama, 1970; Lo & MacKinlay, 1988, Malkiel, 2004; Lim et'al, 2004). Though linear and non-linear dependencies in price (returns) shows a potential for their predictability, it has to be demonstrated that these dependencies are strong and persistent enough to create an exploitable profitable trading opportunity in the market; otherwise, as Lim et'al (2004, 131) put it: "*it will be a strong statement to conclude that the market is inefficient*" if we reject the random walk hypothesis. Along this line, the windowed testing procedure with its correlation and bicorrelation

test statistics is used in literatures to identify the persistence and strength of the linear and non-linear dependencies, respectively. The strength of the dependence is, however, can better be demonstrated by a correlation coefficient.

The windowed testing procedure divides the full period data into different sub-periods (windows) and separately test for the presence of dependencies in the time series in each windows using the correlation statistics (for linear dependency) and the bicorrelation test statistics (for non-linear dependency). The approach is based on the rationale that inefficiency in the full study period may be driven by some pocket inefficient sub-periods and the inefficiencies are, thus, episodic and short-lived that cannot be exploited by traders (Ammermann & Pattrson, 2003; Lim & Hinch, 2005; Lim et'al, 2007; Todea et'al, 2009). The correlation statistics is a variant of the Ljung-Box test[47] and the bicorrelation statistics is introduced by Hinich & Patterson (1996) (Ammermann & Pattrson, 2003). Both statistics tests the null hypothesis of an independent and identically distributed observation against non-random walk alternative hypothesis (*Ibid*). These tests only tests provide *p-values* to indicate the statistical significance/insignificance of the persistence of the inefficiency. Though these *p-values* can be used to indirectly tell the strength of the dependence, a correlation coefficient is better in clearly quantifying extent of linear dependencies.

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[47] The portmanteau correlation statistics was also used as alternative to test linear dependencies in (Lim et'al, 2007).

CHAPTER FOUR

Research Methodology

4.1 Source and Type of Data

To materialize the study, a minimum of one year data is collected from ECX on the daily weighted average closing prices of unwashed and washed coffee. Coffee traded in the exchange is generally divided as washed, unwashed and semi-washed. The sem-washed coffee is traded in the exchange only for very few days. Within the washed and unwashed category there are four types of coffees: export, local, prepared and specialties. There is a shortage of data in the prepared and specialties coffees types for analysis purpose. Specialties coffee is introduced to the exchange on December, 2009 while prepared coffee has been traded in the exchange for very few days. The local coffee on the other hand has significant and irregular jumps in its price series that may compromise the data analysis. The consistently daily traded (except on Saturdays, Sundays and public holidays) since its introduction to the exchange is the export coffee. The exchange data archive has reasonably large observations in export coffee prices that will make it an ideal type to use it in this study. The export coffee type also has the largest market share (85.1%) in the Exchange

The prices that are used in this thesis are daily weighted average prices of export coffee for both washed and unwashed coffee types.[48] The weighted average washed and unwashed coffee prices

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[48] The varieties of contract offered in each category of the commodity justify the use of weighted average prices to represent the market price. The international market also uses weighted average prices in reporting coffee market prices.

are calculated using the daily closing prices and volumes of these contracts traded. The Exchange's price-limit range for each day trading depends on its previous session. As the information set we are considering in the weak-form of EMH is past price series, there is no need to insert values in the no-trade days for the reason that each day price resumes from its previous day trading.

4.2. Data Analysis

In this thesis three tests for the random walk hypothesis on the daily weighted average prices of washed and unwashed coffees traded in ECX will be conducted for each commodity separately: the Augmented Dickey-Fuller (ADF) test, the variance ratio test and the Brock-Dechert-Scheinkman (BDS) test. In order to capture the possible trends towards efficiency or inefficiency, the data set for both types of the commodity will be divided into two sub-periods and the same tests will be done separately.

4.2.1. Modeling a Random Walk Process

The starting point for modeling random walk is its relationship with an EMH. Fama (1970) noted that in an efficient market successive price changes (successive one-peirod returns) are independent and are identically distributed. This can be symbolically represented as:

$$f(r_{j,t+1}|\Phi_t) = f(r_{j,t+1}) \tag{4.1}$$

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where $r_{j,t+1}$ is the one-period percentage of return $(p_{j,t+1} - p_{jt})/p_{jt}$; Φ_t is a general symbol for the set of information is assumed to be "fully reflected" in the price at t. Equation (4.1) states that both the marginal and conditional probability distributions of an independent random variable are identical.

Assuming the weak form of EMH and using the alternative usage of equation (4.1) in terms of prices than returns, we get

$$f(p_{j,t+1}|p_t, p_{t-1}, p_{t-2}, p_{t-3}.....) = f(p_{j,t+1}) \qquad (4.2)$$

p_j are lists of price for commodity j

The random walk process can then be symbolically represented as:

$$p_{jt} = p_{j,t-1} + \varepsilon_t \qquad (4.3)$$

ε_t is a white noice error which is IIDN $(0, \delta^2)$. The prices in the equation are all in their logarithmic forms. It can be noted from equation (4.3) that random walk series is a special case of an autoregressive of order one process. A random walk processes can be of two types: random walk without drift and a random walk with drift. Equation (4.3) is a random walk without drift and the random walk with drift is given by:

$$p_{jt} = \alpha + p_{j,t-1} + \varepsilon_t \qquad \text{where } \alpha \text{ is the drift parameter} \qquad (4.4)$$

The sign of drift parameter determines the whether the graph for p_{jt} drifts upward or downwards (if positive it drifts upward and if negative it drifts downward).

In the presence of a time trend in the data set, a random walk process can be written as;

$$p_{jt} = \alpha + \theta t + p_{j,t-1} + \varepsilon_t \quad \text{, where } t \text{ is the deterministic trend term} \tag{4.5}$$

A trend in a time series is said to be deterministic if it is "*completely predictable and not variable*" (Gujarati, 2004, p.802). If the time series p_{jt} is time dependent θ becomes statistically significant.

4.2.2. Tests for Random Walk Process

Empirical works in EMH used different parametric and non-parametric statistical test to trace random walk process in their data set. In this paper the popular unit root test for random walk i.e. Augmented Dickey-Fuller test be used from the parametric types of tests. Parametric tests assume that the observations are drawn from a normally distributed population while in non-parametric tests noting is assumed about the probability distribution of the population (*Ibid*). In market efficiency studies, there have been repeated evidences showing that financial time series have a non-normal distribution. To fill this gap and to make the empirical findings of the thesis stronger, two non-parametric tests are used. These tests are: the Lo-MacKinlay variance ratio test and the Brock-Dechert-Scheinkman (BDS) test will be employed. Brock-Dechert-Scheinkman (BDS) is included in line with the different empirical works call for a more sophisticated statistical tool and especially a statistical tool that can trace the possible non-linear relationships in the analysis.

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4.2.2.1.   The Augmented Dickey-Fuller Test

A general form of an autoregressive of order one process can be written as:

$$p_{jt} = \alpha + \theta p_{j,t-1} + \varepsilon_t \qquad\qquad (4.6)$$

If in equation (4.5) $\alpha = 0$ and $\theta = 1$, which is a unit root test, the equation will be similar to the random walk process without drift presented in equation (4.3) and the process becomes a non-stationary process: *"thus the terms nonstationarity, random walk, and unit root can be treated as synonymous"*(Gujarati, 2004, p.802)[49]. The test for unit root can be a joint test of $\alpha = 0$ and $\theta = 1$, but the easy and common way is to test for $\theta = 1$; as the null hypothesis of unit root also implies $\alpha = 0$ (Verbeek, 2004). The Dickey-Fuller test for unit root tests the null hypothesis Ho: $\theta = 1$ against the alternative hypothesis of a stationary process i.e. H1: $\theta < 1$. Dickey and Fuller (1979 cited in Gujarati 2004) however noted that under the null hypothesis of unit root, the critical values of the standard t distribution cannot be used and the distribution in such situation rather follows a τ(tau) statistic and they provided unique critical values of such test.

The DF test detects unit root only in first order autoregressive data generating process. The test cannot be used in a higher order autoregressive data generating process. An alternative test that accounts for higher order autoregressive processes is the Augmented Dickey Fuller (ADF) test. By introducing first differences of the dependent variable to the DF test, the ADF test better takes care of the possible autocorrelations in the error term (*Ibid*). Marashdeh & Shrestha (2008) stated that ADF test can take the following three model settings:

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[49] A unit root process is *"a highly persistent time series process where the current value equals last period's value, plus a weakly dependent disturbance"* (Wooldridge, 2000,p.804)

i.   ADF model with constant (drift) and a time trend terms :

$$\Delta p_{j,t} = \alpha + \theta_1 t + \delta p_{j,t-1} + \sum_{i=1}^{m} \gamma_i \Delta p_{j,t-i} + \varepsilon_t \qquad (4.7)$$

ii.   ADF model without time trend term:

$$\Delta p_{j,t} = \alpha + \delta p_{j,t-1} + \sum_{i=1}^{m} \gamma_i \Delta p_{j,t-i} + \varepsilon_t \qquad (4.7a)$$

iii.   ADF model without constant (drift) term:

$$\Delta p_{j,t} = \delta p_{j,t-1} + \sum_{i=1}^{m} \gamma_i \Delta p_{j,t-i} + \varepsilon_t \qquad (4.7b)$$

Where p_j is the price for commodity j, Δ is the first difference operator and m is the lag length in the model. The test examines the unit root null hypotheis $\delta = 0$ aginst its alternative $\delta < 0$.

The test for random walk using the ADF test, thus, involves two decisions

1. Determining the optimal lag length

2. Selecting the fitting ADF model among the three model settings

In this paper, following Gujarati (2004) and Verbeek (2004), we determine the optimal lag length in the ADF test using Akaike's information criterion (AIC) and Schwarz's Bayesian information criterion (BIC). Using the optimal lag length selected by these information criterion, we then make a choice among the three ADF model types using the same model selection procedure.

The procedure selects the one with the lowest AIC and BIC values. When the two criteria select different model settings, Verbeek (2004) proposes the use of BIC because in large sample this criterion selects the more accurate model specification. Moreover, AIC tends to select an

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overparametrized model whereas BIC selects a more parsimonious model. Thus, when the two selection criterions select different model settings the selection by the BIC is used in this paper.

4.2.2.2.   The Lo-MacKinlay Variance Ratio Test

The DF test for unit root and other unit root tests like KPSS depend on the assumption of normal distribution of the observations. This assumption is however often violated in financial time series (Xin & Chen, 2006). Random walk hypothesis implies uncorrelated error terms and a unit root. Smith et'al (2002), citing Shiller & Perron (1985) and others, argued that the unit root test has a very low power and cannot capture departures from random walk. Both papers recommend the use of the variance ratio test that focuses rather on uncorrelated residuals than unit root.

The variance ratio test is widely applied in testing for random walk hypothesis especially when the observations violate the assumption of normal distribution. The test has a good power and size properties and it performs superior to other tests (Campbell et'al, 1997 cited in Smith & Ryoo, 2003). The variance ratio is contributed to the random walk literature by Lo & MacKinlay (1988). Lo & MacKinlay exploited the important property of a random walk that construct the essence of the test that "…*the variance of its increments is linear in the observation interval. That is, the variance of $X_t - X_{t-2}$ (in our model $p_{jt} - p_{j,t-2}$) is twice the variance of $X_t - X_{t-1}$ (in our model $p_{jt} - p_{j,t-1}$). Therefore, the plausibility of the random walk model may be checked by comparing the variance estimate of $X_t - X_{t-1}$ (in our model $p_{jt} - p_{j,t-1}$) to, say, one-half the variance estimate of $X_t - X_{t-2}$ (in our model $p_{jt} - p_{j,t-2}$)*" (p 44).

In building the test, they used the log prices and a random walk hypothesis with a drift as a starting point (presented in equation 4.4). The test is presented below:

Given a random walk model with a drift

$$p_{jt} = \alpha + p_{j,t-1} + \varepsilon_t$$

For the sake of simplicity let us write random walk model as:

$$p_t = \alpha + p_{t-1} + \varepsilon_t \tag{4.8}$$

Suppose we have nq+1 observation $p_0, p_1, p_2, \ldots, p_{nq}$, where q is any positive integer greater than 1. Lo and MacKinlay (1988, p 46) defines the mean ($\hat{\mu}$) and unbiased estimators of the variances as:

$$\hat{\mu} \equiv \frac{1}{nq} \sum_{k=1}^{nq} (p_k - p_{k-1}) = \frac{1}{nq} (p_{nq} - p_0) \tag{4.9}$$

$$\hat{\sigma}_a^2 \equiv \frac{1}{nq} \sum_{k=1}^{nq} (p_k - p_{k-1} - \hat{\mu})^2 \tag{4.10}$$

$$\hat{\sigma}_b^2(q) \equiv \frac{1}{nq} \sum_{k=1}^{n} (p_{qk} - p_{qk-q} - q\hat{\mu})^2) \tag{4.11}$$

Where $\hat{\sigma}_a^2$ and $\hat{\sigma}_b^2(q)$ are the unbiased estimators of the variances of $(p_t - p_{t-1})$ and $(p_t - p_{t-q})$ respectively. The variance ratio at q difference then equals:

$$VR(q) \equiv \frac{\hat{\sigma}_b^2(q)}{\hat{\sigma}_a^2} \tag{4.12}$$

The variance ratio for data characterized by random walk is statistically indistinguishable from one. Lo and MacKinlay have also forwarded the two test statistics of the ratio that asymptotically

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follows standard normal distribution. The first test is derived assuming homoscedasticity of the error term in equation 4.8. Smith et'al (2002, 483-484) summarized the test statistics as follows:

Let $\widehat{M}_r(q) \equiv VR(q) - 1$

The test statistic Z(q), is given by

$$Z(q) = \frac{\sqrt{nq}\,\widehat{M}_r(q)}{\widehat{\sigma}_0(q)} \tag{4.13}$$

Where, $\widehat{\sigma}_0(q) = \left(\frac{2(2q-1)(q-1)}{(3q)}\right)^{1/2} \tag{4.13a}$

The second variance ratio test statistics that assumes heteroscedasticity in the residuals is:

$$Z^*(q) = \frac{\sqrt{nq}\,\widehat{M}_r(q)}{\widehat{\sigma}_e(q)} \tag{4.14}$$

Where, $\widehat{\sigma}_e(q) = \left(4 \sum_{k=1}^{q-1}\left(1 - \frac{k}{q}\right)^2 \widehat{\sigma}_k\right)^{1/2} \tag{4.14a}$

and $\widehat{\sigma}_k = \dfrac{nq \sum_{j=k+1}^{nq}\left(p_j - p_{j-1} - \widehat{\mu}\right)^2 \left(p_{j-k} - p_{j-k-1} - \widehat{\mu}\right)^2}{\left[\sum_{j=1}^{nq}\left(p_j - p_{j-1} - \widehat{\mu}\right)^2\right]^2} \tag{4.14b}$

The variance ratio tests the first order autocorrelation when the value of q=2 (Lo and MacKinlay, 1988 cited in Lock, 2007). The second type of the test statistics can give robust results even with the existence of non-normality and heteroscedasticity in the series (Smith & Ryoo, 2003).

Irrespective of the results found in the ADF unit root test, this study uses the variance ratio test in order to refute or to strengthen the findings in the unit root test. One short coming of this test,

alike the unit root test, is that it only detects linear patterns in the data. As literature in market efficiency shows, there are possibilities of non-linear dependences in the data. After finding a profitable trading rule, Leuthold (1972) recommended the invention of statistical techniques that detect the non-linear patterns used to make profit in the futures market.

4.2.2.3. Brock-Dechert-Scheinkman (BDS) test[50]

The inherent nature that both the unit root and the variance ratio tests only detect linear relationship is very restrictive to make a satisfactory conclusion as there are possibilities of a non-linear dependency in the data that can be exploited to make excess returns in the market. The existence of dependency in the data in either of the types (linear or non-linear) is against the efficient market hypothesis. In an attempt to trace non-linear dependences, Brock et'al (1987 cited in Lim et'al, 2004) forwarded the Brock-Dechert-Scheinkman (BDS) test.

The BDS test is a non-parametric test that uses the correlation integral to provide a test for the null hypothesis of a random walk which is independent and identically distributed. Despite the non-parametric nature of the test, its test statistic is asymptotically normally distributed with mean zero and unit variance and hence, the standard normal tables can be used to test the significance of the test statistic. The test static is given by:

$$W_{m,n}(\varepsilon) = \sqrt{n} \; \frac{T_{m,n}(\varepsilon)}{V_{m,n}(\varepsilon)} \qquad\qquad (4.15)$$

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[50] The discussion of the test with its detailed procedure are almost directly taken from (Lim et'al, 2004)

$W_{m,n}(\varepsilon)$ is the BDS test statistic. n is the sample size, m is the embedding dimension (lag length), and ε is the metric bound that measures the maximum difference between pairs of observations (in our case the difference between pairs of consecutive prices) in computing the correlation integral. $T_{m,n}(\varepsilon)$ measures the difference between the dispersion that an i.i.d. process would generate in these same spaces, that is: $C_{m,n}(\varepsilon) - C_{1,n}(\varepsilon)^m$. $T_{m,n}(\varepsilon)$ has an asymptotic normal distribution with zero mean and variance $V_m^2(\varepsilon)$.

The correlation integral $C_{m,n}(\varepsilon)$ is an estimate of the probability that the distance between any two m-histories, $x_t^m = (x_t, x_{t+1}, \ldots, x_{t+m-1})$ and $x_s^m = (x_s, x_{s+1}, \ldots, x_{s+m-1})$ of the series $\{x_t\}$ is less than ε, that is, $C_{m,n}(\varepsilon) \to prob\ \{|x_{t+i} - x_{s+i}| < \varepsilon, for\ all\ i = 0,1, \ldots m - 1\}, as\ n \to \infty.$ If the series $\{x_t\}$ are independent, then, for $|t - s| > m, C_{m,n}(\varepsilon) \to \Pi_{i=0}^{m-1} proba\{|x_{t+i} - x_{s+i}| < \varepsilon, as\ n \to \infty$. If the series are identically distribute, then $C_{m,n}(\varepsilon) \to C_1(\varepsilon)^m, as\ n \to \infty$. The BDS statistic therefore measures the null hypothesis that $C_{m,n}(\varepsilon) = C_{1,n}(\varepsilon)^m$ (the computed correlation integral at the given lag length and metric bond is equal to the correlation integral of an i.i.d observation), which is the null hypothesis of i.i.d.

The need to choose the plausible right value of ε and m needs justification; as there are already different approaches used in existing literature. For a given m, ε cannot be too small because $C_{m,n}(\varepsilon)$ will capture too few points. On the other hand, ε cannot be too large because $C_{m,n}(\varepsilon)$ will capture too many points. For this reason, it is advisable to set ε as a proportion of the standard deviation of the data, δ. A Monte Carlo simulation tests by Hsieh & LeBaron (1988a,b

cited in Lim et'al, 2004) showed that the value between 0.50 and 1.50 times the δ is the 'best' choice of ε. In determining embedding dimension Monte Carlo simulation demonstrated by Brock et'al (1991 cited in Lim et'al, 2004) that a dimension beyond 5 degrade the small samples properties of the test.

This thesis subsequently follows the foot steps of Lim et'al (2004) and tests the random walk in the price serieses using ε at 0.50, 0.75,0.1,1.25 and 1.5 proportions times the standard devaition. To represent one week of trading, this study used embeding dimension (lag lengths) from 2 to 6.

4.2.3. Trends Towards Efficiency or Inefficiency

The motive behind this trend analysis is to evaluate ECX's move (or lack of it) towards market efficiency. Studies in market efficiency often use significant events that affect the market as the breaking point to study the pre and post event market efficiency. Lim et'al used the 1997 Asian financial crises as a breaking point in the data to study the pre and post market efficiency in the major Asian stock market. Tabak (2002) used the increase in participation on the Brazilian American Deposit Receipt (ADR) program in 1994 to study market efficiency in two sub-periods in the Brazilian Stock Exchange. Solnik (1973), on the other hand, divided the full sample data into equal sub-groups and compared market efficiency in 8 major European stock markets. In their study of market efficiency of agricultural commodities in the South African Futures Market, Phukubje & Moholwa1 (2006) investigated the trends in market efficiency by dividing their three year data into three non-overlapping years. As the interest of this paper is to study the trends in the market and not to figure out the effect of any intervention or event, the data for both washed

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and unwashed export coffee types are divided into two equivalent sub-periods and all the three tests are done once again. The results can then be easily compared. The sub-period that has a close proximity to the random walk property than the other sub-period implies a higher efficiency and vise-versa.

4.2.4. The Persistence and Strength of Dependency

Rejection of random walk does not street-forward imply weak form inefficiency while failure to reject directly implies efficiency. In fact, non-randomness in price (return) series indicates the potential for return predictability and possibility of exploiting it by traders to generate abnormal profit. What matters most is not the rejection of random walk but the strength and the persistence of the dependency in prices that can allow traders in the exchange exploit it to generate excess returns.

To test for the persistence and the strength of the dependences in the export coffee prices, the full period data are divided into to four windows (each containing a four month price series). Since the two full period coffee prices do not have a similar distribution (washed has a normal and the unwashed a non-normal distribution), it would be inappropriate to use a parametric tests of dependence for both. To this end, the non-parametric Spearman's correlation coefficient is used to study the strength and the persistence of the dependence in each window. If higher correlation coefficients are observed in each window, it implies that the inefficiency is strong enough to make a profitable price forecasts. A higher correlation coefficient also implies persistence of the inefficiency all across the study period.

CHAPTER FIVE

Results and Empirical Analysis

5.1 Descriptive Statistics

In the study period that covers coffee trading sessions from the 2nd of November 2008 to the 31st of March 2010, washed and unwashed export coffee types are traded for 309 and 330 days respectively. As can be seen in Table 5.1, both in terms of total amount and value traded in the Exchange, the unwashed export coffee has a clear dominance in the trading. The 34 percentage point advantage the washed export coffee has against the unwashed export coffee in the volume of trade is reduced by 6% in the value of trade due to the relatively higher prices the market offers to washed export coffee type. The table also shows that there is a significant price difference (on average around 140 birr per feresulla[51]) between the two coffee categories. The semi-washed export coffee has been traded for a very few days and has a negligible (0.1%) share in ECX export coffee trading. Within the study period, the Exchange has traded around 15 million feresula of export coffee worth nearly 7 billion birr.

Table 5.1 *Coffee market shares in ECX (washed-unwashed- semi-washed)*

	Total amount traded (in Feresulla)	Total Value (in Birr)	WAP[52]
Washed	4,834,866.00 (32.6%)	2,674,722,042.00 (39.3%)	553.2153
Unwashed	9,993,996.00 (67.3%)	4,133,737,227.00 (60.7%)	413.6221
Semi-washed	10,520.00 (0.1%)	5,684,990.00 (0.1%)	540.3983
Total	14,839,382.00	6,814,144,259.00	459.1933

Source: own computation from the raw data

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[51] One feresulla is equivalent to 17 kilograms
[52] Weighted Average Price.

In terms of coffee types traded in the Exchange, Table 5.2 shows that export coffee type overwhelmingly dominates both in terms of total amount traded (83.5%) and total transaction value (85.1%). Though the local coffee has the second largest share in the total amount traded in the exchange, the lower price the market offers for the commodity lowers its share in the total transaction value. The table also shows that despite its late introduction to the market, specialty coffee is performing well. The higher price the market commands for this high quality coffee increases its market share in terms of total transaction value to 4.5%. The price difference among the coffee types testifies that the market rewards higher price for a higher quality coffee type.

Table 5.2: *Coffee Market Shares in ECX (Export-Local-Prepared-Specialty)*

	Total amount Traded (in Feresulla)	Total Value (in Birr)	WAP
Export	12,394,716.00 (83.5%)	5,798,232,998.00 (85.1%)	467.7988
Local	1,703,712.00 (11.5%)	558,972,737.00 (8.2%)	328.0911
Prepared	211,841.00 (1.4%)	125,192,871.00 (1.8%)	590.9756
Specialty	529,113.00 (3.6%)	331,745,653.00 (4.9%)	626.9845
Total	14,839,382.00	6,814,144,259.00	459.1933

Source: own computation from the raw data

The relationship between the median and the mean values in the summary statistics for the WAP and the amount traded in the Exchange in Table A1 & A2 (in the appendix) shows an important supply price relationship. The mean supply for all coffee types is greater than their median value and the reverse holds in their weighted average prices. These values show that the volume of quantity traded has increased in the second half of each coffee type trading and the average price offered for the increased supply is less than its first half operation. For all coffee types there exists large difference between maximum and minimum values and the spread of the values

around their mean (standard deviation) is also high. This high volume variability can be partly explained by the seasonality of coffee production in the country. Figure 5.1 shows the presence of such seasonality in the supply of washed and unwashed export coffee in the Exchange:

Figure 5.1 *Trends in the Washed and Unwashed Export Coffee Traded (in Feresula)*
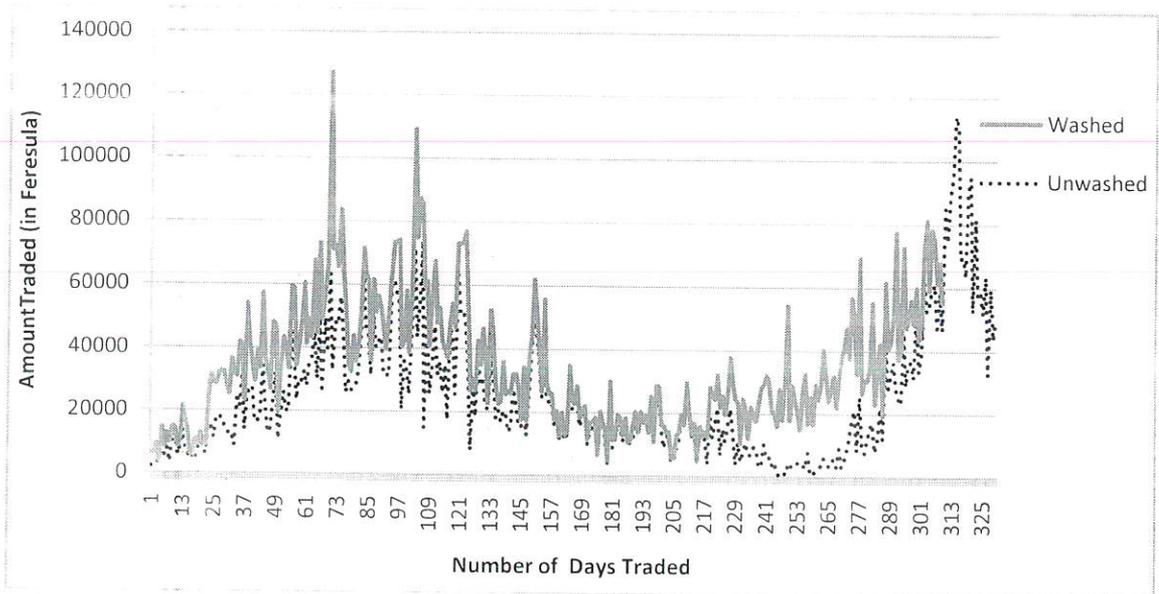
On the price side, roughly speaking, the price series of the two coffee types follow a similar uncommon stationary trend than we observe in most financial time series as can be seen in Figure 5.2. [53]

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[53] During model selection, the deterministic trend term in almost all ADF regressions was found to be statistically insignificant; this shows that the prices series have insignificant relationship with time.

Figure 5.2: *Trends in the WAP of Washed and Unwashed Export Coffee Traded in ECX (in Birr)*
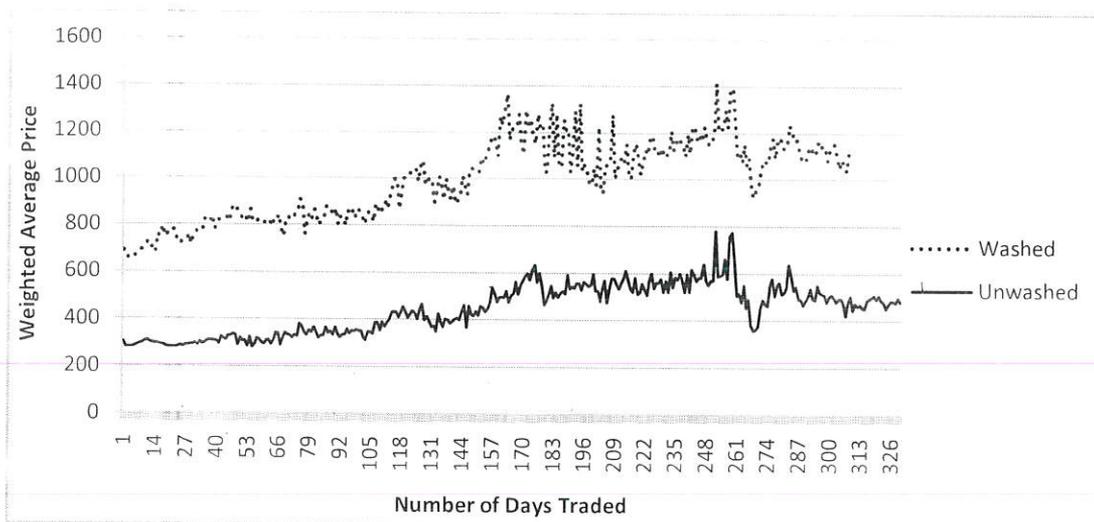
The two coffee price series also shows a relatively similar trend. In addition to the difference in their price level, another slight difference we observe between the two is the presence of a possible drift from initial value in washed coffee than in unwashed coffee; this potentially creates a difference in the form of ADF regression we use in the testing unit root in next section. An interesting thing to note, in the two pictures is the relationship between supply and the average prices. When supply of coffee is relatively lower in August 2009- Novemebr/December 2010, the corresponding average prices are relatively higher than other periods.

5.2 Market Efficiency of Export Coffee Trading in ECX

5.2.1 Test for Random walk using Augmented Dickey-Fuller Test

Depending on the nature of the data a random walk process can take any of the forms given by equation 4.3, 4.4 or 4.5. The specific form to use thus depends on the type of the test and the

model selection criterion. The ADF test involves the estimation of any of the three models presented in 4.7, 4.7a and 4.7b to make the choice on the form of the random walk. Before making the choice among these models our task has to begin with determining the optimal lag length to include in the test followed by the model selection. We now start with washed export coffee and followed by the unwashed export coffee and their sub-periods.

Table 5.3 *Lag Length Selection for Washed and Unwashed Export Coffee*[54]

Washed Export Coffee			Unwashed Export Coffee	
Lag	AIC	BIC	AIC	BIC
0	-295.22	-291.4866	20.95803	24.75712
1	-569.2628	-561.8026	-765.2429	-757.6508
2	-607.4799	-596.2993	-800.0942	-788.7152
3	-624.4909	-609.5965	-806.8693	-791.7094*
4	-625.8636	-607.262	-808.9176 *	-789.9831
5	-647.421	-625.1188*	-803.5408	-780.8378
6	-646.3278	-620.3317	-798.0483	-771.5831
7	-651.8367*	-622.1533	--	--
8	-646.8954	-613.5314	--	--

*shows the selected lag length by each information criterion

As stated by Verbeek, AIC (in both coffee types) has selected a relatively higher lag length than BIC. One of the justification to use ADF than DF is when autocorrelation is present in error terms and the information criteria select the lag length that keeps the autocorrelation at an acceptable level (Gujarati, 2004). Using the BIC, the ADF model includes the first five and three lags for washed and unwashed coffees respectively. As the lag length in the criterions tells the number of lag that is required to reduce the autocorrelation to an acceptable level, the higher number of lags selected in the case of washed coffee imply a relatively higher persistence of autocorrelation in its error terms than the unwashed coffee type. The result, thus, entails that the

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[54] N.B. the natural logarithm of the prices are used in the full study

plausible alternative to test unit root in both coffee price series is ADF than DF test because the former accounts for such autocorrelation.

Using the lag length selected above, we then choose among the three ADF models to test for random walk. The results are displayed in table 5.4

Table 5.4: *ADF Model Selection for Washed and Unwashed Export Coffees*

ADF Models	Washed Export Coffee				Unwashed Export Coffee			
	ADF statistics	ADF 5% critical Value	AIC	BIC	ADF statistics	ADF 5% critical Value	AIC	BIC
With trend and drift	-2.980	-3.428	-646.18	-616.47	-2.221	-3.427	-808.99*	-786.27
Without trend	-2.866	-2.878	-646.33*	-620.33*	-1.871	-2.877	-808.92	-789.98
Without drift	0.945	-1.950	-639.92	-617.64	0.718	-1.950	-807.27	-792.12*

*shows the selected lag length by each information criterion

For washed export coffee, both AIC and BIC selected a smaller value for ADF without trend model: (-646.33) and (-620.33) respectively. On the other hand, the smallest values of the two criteria for unwashed export coffee price selected a different model forms (AIC with trend and drift model and BIC without trend model). Based on the outlined selection procedure, we selected the model identified by the BIC i.e. ADF without drift. Our test then becomes a test for random walk with drift for washed export coffee and a test for random walk without drift for unwashed export coffee. The test for unit root including the first five lags for washed export coffee gave ADF test statistics of -2.866. The value of the test statistics is almost equal to the 5% critical value (-2.878). The result shows the rejection of random walk in the washed export coffee

price series at 10% significance level (-2.570). The test for random walk in the unwashed export coffee is conducted using the ADF without drift and shows the failure to reject the null of random walk at any significance level. The results seem to imply the absence of the weak-form of market efficiency in washed export coffee trading and its presence in the unwashed export coffee trading. However, due to the shortcomings of the test, such conclusion has to wait for the post estimation specification tests.

Another dimension of market efficiency investigated in this thesis is to examine the trend of the market towards efficiency or inefficiency. To this end, the data for both washed and unwashed export coffee types are divided into two equivalent sub-periods as follows:

Table 5.5: *Sub-periods in Washed and Unwashed Export Coffee Trading*

Category	Sub-period	Time Span	Number of Days Traded
Washed Export Coffee	Washed Sub-period 1	December 2, 2008- July 17, 2009	155
	Washed Sub-period 2	July 20,2009 to March 31,2010	154
Unwashed Export Coffee	Unwashed Sub-period 1	December 2, 2008 to July 31, 2009	164
	Unwashed Sub-period 2	August 3, 2009 to March 31, 2010	166

The test for market efficiency in each sub-period follows the same procedure used in the case of the full study period done earlier.

Table 5.6: *Lag Length Selection for Washed and Unwashed Export Coffee Sub-periods*

| | Washed Export Coffee | | | | Unwashed Export Coffee | | | |
| | Sub-period 1 | | Sub-period 2 | | Sub-period 1 | | Sub-period 2 | |
Lag	AIC	BIC	AIC	BIC	AIC	BIC	AIC	BIC
0	-213.6377	-210.5943	-201.0697	-198.0327	-126.0961	-122.9962	-248.6912	-245.5792
1	-426.8738	-420.7999	-233.7258	-227.6649	-447.1394	-440.9519	-355.0755	-348.8636*
2	-442.1509	-433.0596*	-237.801	-228.7293*	-466.4258	-457.163	-357.4362*	-348.1366
3	-442.1976 *	-430.1021	-240.0032 *	-227.9341	-480.0235*	-467.6979*	-353.9348	-341.5598
4	-438.1591	-423.0727	-237.1381	-222.0849	-478.3142	-462.9383		

*shows the selected lag length by each information criterion

Once again, the lag length selection results indicated the need to include more lag terms than we normally use in DF test. The result, thus, implies the appropriate test to use is the ADF than the DF test for unit roots. As usual, in making the ADF test we need to chose for the compatible form of the test specification for our purpose from its three types of model settings.

Table 5.7: *ADF Model Selection for Sub-periods of Washed Export Coffees*

| ADF Models | Washed Sub-period 1 | | | | Washed Sub-period 2 | | | |
	ADF statistics	ADF 5% critical Value	AIC	BIC	ADF statistics	ADF 5% critical Value	AIC	BIC
With trend and drift	-3.067	-3.443	-445.98*	-430.86	-3.784	-3.443	-238.01	-222.92
Without trend	-1.897	-2.887	-442.20	-430.10	-3.807	-2.887	-240.00*	-227.93*
Without drift	1.342	-1.950	-440.45	-431.38*	-0.167	-1.950	-227.82	-218.77

The information criteria selected the ADF without drift and without trend for sub-period 1 and sub-period 2 respectively. The ADF test statistic for sub-period 1 is found to be 1.342 and -3.807 for sub-period 2. Using the conventional 5% significance level critical values (-1.950 for sub-period 1 and -2.887 for sub-period 2), the test fail to reject the random walk hypothesis for sub-

period 1 but rejected it for sub-period 2. The ADF test also gave similar results in the two sub-periods of the unwashed export coffee. The implication of the result on market efficiency, however, has to wait post estimation tests on these regressions.

Table 5.8: *ADF Model Selection for Sub-periods of Unwashed Export Coffees*

ADF Models	Unwashed Sub-period 1				Unwashed Sub-period 2			
	ADF statistics	ADF 5% critical Value	AIC	BIC	ADF statistics	ADF 5% critical Value	AIC	BIC
With trend and drift	-2.615	-3.442	-483.77*	-465.32	-4.487	-3.441	-359.87*	-347.47
Without trend	-0.224	-2.886	-478.31	-462.94	-3.937	-2.886	-357.44	-348.14*
Without drift	1.758	-1.950	-480.24	-467.94*	-0.123	-1.950	-344.37	-338.17

The result from the selection criteria make ADF test to test for random walk without drift for sub-period 1 and random walk with drift for sub-period 2. We get the ADF test statistic of (1.758) for sub-period 1 and a test statistic of (-3.937) for sub-period 2. At 5% significance level, we fail to reject random walk for sub-period 1 but we reject it for sub-period 2. Before interpreting the results as a market efficiency measures we need to make a post estimation specification test in the regression used by each ADF tests.

The finding on market efficiency using the ADF test has to be taken cautiously. Gujarati (2004) argued that the test has lower power and consequently fails to reject unit root when it actually does not exist in the series. Another point we should note on the ADF test is that it is constructed as an Ordinary Least Square (OLS) regression of the first difference of the commodity price on the first lag and lag differences. The validity of the standard errors in the test, therefore, depends on the validity of the assumptions underlining the OLS method. Furthermore, literatures in

market efficiency, like Leuthold (1972), advocate the use of different statistical techniques on the same data to produce a more meaningful result. Summing up all these, to make the random walk test using other statistical techniques that fill the gaps in the ADF test can better concretize our findings.

5.2.1.1 Post Estimation Specification Tests

The validity of an OLS regression, that the ADF test uses, is founded on the fundamental Gauss-Markov assumptions on the error term. The assumption states that *"error terms are uncorrelated drawings from a distribution with expectation zero and constant variance σ^2"* (Verbeek, 2004). When error terms fail to be uncorrelated the problem of autocorrelation among the error terms happens and when the residual term fails to have a constant variance the problem of heteroskedasticity prevails in the data. Both problems result in inappropriate standard errors that directly make the estimation results misleading. To detect these problems there are a number of alternative tests[55]. The popular Durbin-Watson test for autocorrelation and the Breusch-Pagan-Godfrey for heteroskedasticity are used in this thesis.

The model selection criteria used in this paper selects a lag length that keeps the autocorrelation at its lowest level. Thus, it is less likely that we find autocorrelation in the ADF regression. But, still we do the test for autocorrelation using Durbin Watson test. The values of the Durbin-Watson test static (shown in the Appendix Table A.3) are approximately equal to 2. Using the Durbin-Watson upper and lower bound values at 5% significance level, the test completely ruled out the presence of autocorrelation in the error terms for all regressions used by the ADF test.

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[55] Test for equality of two unknown variances, test for multiplicative hetroskedasticity, the Breush-Pagan-Godfrey test, the white test and the Szroeter's rank test are post estimation tests for hetroskedasticity. The Breusch-Godfrey test, the Durbin-Watson test and asymptotic tests are used to make a post estimation test for autocorrelation.

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The Breusch-Pagan-Godfrey test for heteroskedasticity is a Lagrange Multiplier (LM) test and therefore does not require an alternative hypothesis. The test statistic can easily be computed as the product of the number of observation and R^2 from an auxiliary regression of the square of the residual on the independent variables of the main regression (in our case the ADF regression) and a constant (Gujarati, 2004). The test follows a chi-square distribution. In this study, although the prices are used in their natural logarithm form which potentially reduces the occurrence of heteroskedasticity, the test failed to reject the null hypothesis of homoskedasticity for all the sub-periods but soundly rejected it for the full study period for both washed and unwashed export coffee types (shown in Appendix Table A.3). This mixed result casts serious doubt on the validity of the ADF test results obtained for the two coffee categories studied in the full study period.

Another dimension of the diagnostic check on the ADF test we should look into is the distribution of its error term. Gujarati (2004) argued that the normality assumption is critical if we are testing hypothesis than making only point estimation. With absence of normality of the error terms, the parameters of a regression still continue to be best linear unbiased estimators (BLUE) but if one looks for testing their significance the assumption of normality has to be guaranteed. Since our task goes beyond estimation to hypothesis testing and making inference, the normality of the error terms ought to be tested. To this end, Jarque-Bera (JB) test for normality of residuals is made on error terms of all the six ADF regression residuals (the results are shown in Appendix Table A.3).

The Jarque-Bera test is also LM test with the null hypothesis of normality and follows a chi-square distribution with two degrees of freedom. A JB test static close to zero implies normality of the residual. The test uses the skewness and kurtosis coefficients and when they have a value of zero and three respectively, the JB statistic becomes zero. For all ADF regressions estimated in this study, the test entirely rejected the normality of the residuals. The use of other tests for random walk hypothesis thus becomes necessary to depict the correct nature of the prices in the market.

In using parametric tests, like ADF, the assumption of normality of the data distribution plays a central role. The summary statistics of the prices used in this study shows mixed results (see Table A.4). The Jarque-Bera test for normality, fail to reject the null of normality of residuals for washed full study period and its first sub-period. For the rest of the full and sub-periods, the test strongly rejected normality and casts doubt on the use of parametric tests for all the periods to test market efficiency. It is at this point that non-parametric tests like the variance ratio test and the BDS test become handy. The variance ratio test is widely used in Capital markets and has produced mixed results.

5.2.2 Test for Random Walk using the Lo-MacKinlay Variance Ratio Test

Non-normality and heteroskedasity are common phenomena in financial time series (Lo & MacKinlay, 1988). To tackle misleading test results attributed to these problems, Lo and MacKinaly proposed a non-parametric test for random walk hypothesis that has two test statics: one that assumes homoskedasticity ($Z (q)$) and the other that is robust to heteroskedasticity ($Z^*(q)$). The null hypothesis for the test is a random walk process and when it holds the variance

ratio (VR (q)) becomes statistically equal to 1. The test statistics asymptotically has a standard normal distribution.

The results from the test at 2,3,4,5 and 6 lags shows the rejection of random walk for both the full study period and sub-periods for both export coffee types. The p-values (shown in Table 5.9 and Table A.5 (appendix)) clearly show that the price series are nowhere close to the random walk. The finding is strictly against the weak-form of market efficiency. The result show that the prices of washed and unwashed coffee (both for the full study period and the sub-periods) fail to follow random walk processes and implies that the price series follow a predictable pattern. Such predictability in prices can potentially be exploited by exchange members to generate profit by carefully depicting the movement of the prices. Technically putting, sellers sell their produce when prices are expected to be higher and buyers can make their purchase when prices are expected to be low in order to get a higher profit. Using the variance ratio test, Xin & Chen (2006) found a support for random walk hypothesis in the China's Shanghai Futures Exchange. In the capital market, using the variance ratio test Lo and MacKinlay (1988) showed absence of random walk in New York Stock market, which is similar to what is found in this study. Tabak (2002) found mixed results in the full study period and in the sub-period study of the Brazilian stock market. In the Taiwan stock market, Lock (2007) showed compliance of the composite stock index to the random walk theory. Using a variant of the Lo-MacKinlay variance ratio test, Smith et'al (2002) and Smith & Ryoo (2003) found random walk in developed markets and non-random walk process in less developed African and emerging European stock markets, respectively.

Table5.9: *Test for Random Walk using Lo-MacKinlay Variance Ratio Test (Washed and Unwashed Export Coffee)*[56]

Variable**	Values	q=2	q=3	q=4	q=5	q=6
Washed	VR(q)	0.572	0.390	0.323	0.220	0.202
	Z(q)	-7.4380 (0.0000)	-7.1205 (0.0000)	-6.2676 (0.0000)	-6.1656 (0.0000)	-5.5911 (0.0000)
	Z*(q)	-3.4407 (0.0006)	-3.3980 (0.0007)	-3.1101 (0.0019)	-3.1572 (0.0016)	-2.9417 (0.0033)
Unwashed	VR(q)	0.655 (0.0000)	0.506 (0.0000)	0.411 (0.0000)	0.392 (0.0000)	0.364 (0.0000)
	Z(q)	-6.2172 (0.0000)	-5.9687 (0.0000)	-5.6667 (0.0000)	-4.9675 (0.0000)	-4.6326 (0.0000)
	Z*(q)	-4.2688 (0.0000)	-4.2861 (0.0000)	-4.2153 (0.0000)	-3.8059 (0.0001)	-3.5792 (0.0003)

** The results for the sub-periods is available in Appendix Table A.5

Both ADF and the variance ratio tests test linear dependencies (relationship) in the price series. As discussed in the literature review, researchers have been able to construct mechanical trading rules (filter techniques) that can potentially be used to generate positive returns in a market once labeled efficient by some statistical techniques. In the early 1970's Leuthold (1972) emphasized the need for formulating a statistical technique to detect such complex relationship a filter technique exploits after the author found a profitable trading rule on what was once established efficient by the spectacular analysis. This calls for more complex techniques to trace non-linear dependences like the BDS test.

5.2.3 Test for Random Walk using the Brock-Dechert-Scheinkman (BDS) Test[57]

The BDS test is a non-parametric test that has "*good power to detect at least four types of non-i.i.d (independently and identically distributed) behaviour: non-stationarity, linear dependencies, non-linear stochastic process and non-linear deterministic process*" (Lim et'al, 2004, p.134).

The null hypothesis for the test is an independently and identically distributed prices series (i.e. random walk) against unknown alternative hypothesis. As can be seen in Table A.6 in the appendix, the test rejected the randomness in all embedding dimensions (m) (lag length) and metric bonds (ε) for all the prices series. The metric bonds in the test are used as a multiple of their standard deviation of the series. The result is consistent with what is found in the Lo-MacKinlay variance ratio test. The result implies that there is a linear and also non-linear dependency among the price series in both export coffee categories studied here. Like the variance ratio test, the results from the BDS test (in the sub-periods) have also shown the absence of any observable trend towards efficiency. Practically speaking, the rejection of random walk in export coffee prices implies that a member of the Exchange who participates in the trading of export coffee can predict the movement of the prices using its past history and can earn an excess profit without assuming excess risk.

The operation of the ECX creates a favorable environment for both sellers and buyers to exploit the non-compliance of the export coffee prices with the weak-form of efficient market hypothesis found by the variance ratio and BDS test. The warehouse of the exchange allows the storage of members' commodities for 30 days at a moderate cost and this is equivalent to more than 20 trading days. This allows a seller to buy time to make more profitable trading positions using past price information. The operation of the exchange also allows a buyer to take a profitable position. The fact that there is no rule to limit the number of days a buyer in the exchange should stay without making a transaction can potentially create the ground to make a profitable transaction using the predictability of the price levels.

5.3. How Strong and Persistent is the Inefficiency?

One of the concerns in market efficiency literature in using random walk hypothesis is the precaution needed when making conclusion about inefficiency of a market. It is argued that non-random walk in price (return) series can potentially indicate the predictability of the price (returns) but it would be a strong statement to label the market inefficient before addressing two main issues: the persistence and strength of the inefficiency. A market may be inefficient for some period and this inefficient period may dictate the conclusion for the full study period. A market may also be inefficient in statistical terms but the dependencies in the price (return) series may not be strong enough to make any profitable predictions. This second issue is what Fama (1970) described as the differences between statistical significance and economical significance.

Though the sub-period studies can be used to reflect on the persistence and the strength of the dependency in prices, the full study period is divided into four four-month long windows to have a better look at the development in the price series. The first window runs from December 2008 – March 2009, the second from April 2009- July 2009, the third from August- November 2009 and the fourth from December 2009- March 2010. Since our full period prices series for the two coffee types follow different probability distribution (as shown earlier by the JB test) a non-parametric Spearman's Rank Correlation test for dependence is used for both coffee types and the results are presented in Table 5.10 below.

Table: 5.10. *Spearman's Rank Correlation Coefficients of the Windows*

Coffee type	Windows	Spearman's Rank Correlation* With				
		1st lag	2nd lag	3rd lag	4th lag	5th lag
Washed	1	0.7351	0.6737	0.6694	0.5517	0.6018
	2	0.8221	0.7912	0.7569	0.7524	0.6818
	3	0.3266 (0.0140)	0.2332 (0.0837)	0.2460 (0.0677)	0.2747 (0.0404)	0.0007 (0.4384)
	4	0.6300	0.4200 (0.0001)	0.2821 (0.0123)	0.2423 (0.0326)	0.3376 (0.0025)
Unwashed	1	0.6722	0.6217	0.6257	0.6631	0.4792
	2	0.8296	0.8172	0.8367	0.7819	0.7605
	3	0.2758 (0.0145)	0.2769 (0.0141)	0.1799 (0.1150)	0.2159 (0.0576)	0.0702 (0.5413)
	4	0.6955	0.6326	0.5444	0.4877	0.3344 (0.0028)

*the values in the parentheses are p-values. The p-values for all the spearman's rank correlation, except what is indicated in the table, are 0.0000.

The correlation coefficients generally show strong and persistent dependencies in the prices of the two coffee types across all four windows. In the washed coffee type, the correlation is as high as 82.21% and most (except the third window) have a correlation coefficient greater than 60%. The same holds true for the unwashed coffee type. The correlation is as high as 82.96% in the second window and most correlations have more than 60% correlation (except window 3). The high correlation in the market prices can be related to the risk averse nature of the traders in the exchange and the restrictive price band limits. Traders in the exchange seem less interested to analyzing other market information and they just take the prices of previous trading days and do not exploit the farthest values of the price limits. But when the supplies are lower and the prices are higher, like in the third window, the incentive to be a risk averse trader becomes costly. For both coffee types, the third window (August 2009- November 2009) is characterized by lows supply, higher prices and relatively less trading days (especially September). The higher competition for the limited supply that are available in a relatively few trading days necessary

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resulted in higher prices and more informed decisions. This can potentially make the previous day's price less informative and resulted in lower correlation coefficients. This low correlation period is however a very brief time and cannot be taken as a representative to the market. In nutshell, the results from the Spearman's rank correlation coefficient shows a strong and persistent dependency in the prices of both washed and unwashed export coffee and the inefficiency found by the random walk tests are not episodic and weak that do not allow to make profitable price predictions and ECX is weak-form inefficient. These results are setbacks to the exchange and shows that in the study period the Exchange fail to comply with its mission to guarantee an efficient marketing system.

5.4. Explaining the Inefficiency in ECX

The rejection of the weak-form of market efficiency in the export coffee trading cannot be taken as unexpected given the following reasons.

Early Stage of Development

In their early stage of development new agricultural commodity exchanges may become weak-form inefficient (Phukubje & Moholwa, 2006). Research findings also point out that the South African Futures Market, which launched agricultural futures trading in 1995, was found to be inefficient in 1997 and shows efficiency in 1998 (Wiseman et al, 1999 cited in *Ibid*). Developments that cannot be present right away with an exchange establishment like institutional maturity and improvement in skills of participants in the market is deemed to explain the efficiency seen in the Shanghi Futures Market (Xin & Chen, 2006). The lack of skills of participants, that is inevitable in early stage, is also indicated to explain the inefficiencies seen in

two selected commodity exchanges in China (Wang & Ke, 2005). Repeated studies in the capital market have also shown the trend towards efficiency like in the Brazilian Stock Exchange (Tabak, 2002) and the difference between market efficiencies between the well developed and developing capital markets (Solnik, 1973), Smith et'al (2002) and Smith & Ryoo (2003). These and other experiences show that efficiency is a process not something that we create overnight. It is a process through which both market and its participants learn from their past.

Daily Price Limits in the Exchange

The EMH is based on the assumption that in an efficient market, where information is fully reflected, prices series that depend on information are random because information by definition is itself random (unpredictable) (Malkiel, 2003). Fama (1970) argued that price limits retard adjustment of price labels to their equilibrium level and induce dependencies in prices. The 5% daily price fluctuation limit set by the Exchange on coffee trading can partly explain the movement of the price series that follow a predictable path than a random walk. The statistically strong rejection of the random walk hypothesis seen in the variance ratio and the BDS tests is because of the persistence and strength of the dependencies in the daily prices. The same rejection of random walk is observed in the developed Chicago commodity futures market for Soybean due to a similar trading rule practiced in the exchange (Stevenson & Bear, 1970). In the capital market, price limits have believed to explain to dependencies in stock prices in Taiwan stock market (Ammermann and Patterson, 2003) and in Korean stock market (Ryoo and Smith, 2002)

The Nature of the Exchange

The fundamental reason, that may even continue to make the prices nonrandom after solving the above two issues, is related to the nature of the Exchange. ECX is offering a spot exchange similar to what any local market is offering. Though it requires an empirical verification, the structure and the rules of the Exchange put ECX in a better position to create order, integrity and transparency to the market and to potentially reduce transaction costs. The problem with an exchange that only offers spot exchange is its inability to create arbitrage opportunities that prevails in futures exchanges. Arbitrage forces correct temporary disequilibrium or market imbalances induce efficiency in the market (Manani & Struthers, 1997). A futures exchange has the mechanism to create classes of participants who make their living by analyzing information in the market to find exploitable trading opportunity, like speculators, to create competitive and efficient market. Moreover, as Gabre-Madhin (2007) predicted, the presence of functioning alternative spot market in the economy make the Exchange less attractive to participants to join the Exchange on voluntary basis. The effect of this extends from reducing competition in the market, thus compromising efficiency, to questioning the success of the market itself. The negligible volume of non-coffee commodities traded in the Exchange is a clear testimony to this. Not for the legal obligations, coffee trading would also have suffered the same problem.

CHAPTER SIX

Conclusion and Recommendation

6.1 Conclusion

In the last days of the Dergue regime, a socialist junta, markets were overnight declared liberalized in March 1990. The succeeding FDRE government, with a market led economic policy orientation, endorsed the reform and entered the implementation stage. The market reform premised the creation of a price incentive to farmers to boost agricultural production with active private sector participation on board. Like what happened in most African countries, the reform has created an improvement in the rural livelihood but failed critically short of its envisaged objective. Generally, the reason for the disappointment can be attributed to the lack of two of the "3Is" of market development: Market Infrastructures and Market Institutions. The need to shift from "getting price right" to "getting the market right" was therefore a crucial step (Gabre-Madhin, 2006).

Institutions play an important role in market exchange by governing interactions in the exchange process. In the absence of market institutions high transaction costs arise that seriously hamper growth. Douglas North emphasized the absence of just one of the market institutions as: *"The inability of societies to develop effective, low-cost enforcement of contracts is the most important source of both historical stagnation and contemporary underdevelopment in the third world"* (North, 1990 cited in Gabre-Madhin & Goggin, 2005, p.5; Gabre-Madhin, 2006, p.21). In solving the institutional gap in agricultural commodity markets, a commodity exchange that brings order and integrity to the poorly organized market has been historically proved to be the right way (Gabre-Madhin, 2006).

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Cognizant of the dire need, the country's development strategy aggressively pursued the establishment of a commodity exchange in the country. The land mark proclamation that established the Ethiopia Commodity Exchange Authority was followed by an unusual spot (cash) trading commodity exchange – Ethiopia Commodity Exchange (ECX). As repeatedly stressed in the development strategy such market institution has to efficiently perform its task. In the absence of efficiency, neither the Exchange fulfills the promise in its mission statement nor does it attain its vision of revolutionizing the country's agriculture. In such an efficient market "*prices always 'fully' reflect available information*" (Fama, 1970, p.383). The test for market efficiency in this sense takes three forms: a test for random walk, efficiency of forecasting the spot prices from futures prices and testing the presence of trading rules using filter techniques (Johnson et'al, 1990). In this thesis, the test for random walk on washed and unwashed export coffee prices was undertaken.

Despite the invitation from ECX to make trading on five commodities, the Exchange is almost trading a single but economically crucial agricultural commodity (coffee). The Exchange is the only legal entity in the country to make coffee trading. The daily traded export coffee has a significant market share both in terms of volume (83.4 %) and value (85.1%). This coffee type comes from mainly washed (32.6%) and unwashed (67.3%) coffee categories. A cyclical pattern has been observed in the supply of export coffee in the Exchange while the weighted average prices series look roughly stationary in levels. The mean and median values of the commodity show an increase in the supply in the second half and a decrease in the average prices in the same period.

The ADF, the Lo-MacKinlay variance ratio test and the BDS test were employed on the natural logarithm of both washed and unwashed export coffee prices separately. To check the presence of trend towards efficiency or inefficiency, the full study period under each category was divided into two equal sub-periods and all the three tests were performed on all four sub-periods. To strengthen the finding of the study Spearsman's Rank correlation coefficient was calculated for four windows that has a length of four months each for both coffee types. Before making the ADF test, selection of the optimal lag length have been done using AIC and BIC. The choice among the three forms of ADF test was also made using the same information criterions. The result from the ADF test seem to give mixed result but the validity of the analysis using ADF test, however, strictly depends on its underlining assumptions.

The ADF test uses an OLS regression to make the test. To maintain the validity of our analysis, a post estimation test for autocorrelation, heteroskedasticity and normality on the ADF regression error term has followed. The Durbin-Watson test completely rules out autocorrelation for all six estimations. The Breusch-Pagan-Godfrey test for heteroskedasticity, on the other hand, rejected the null of constant variance for the two full study period estimations of the washed and unwashed export coffee categories. The Jarque-Bera test for normality of residuals, however, significantly rejected the normality of the residual of all six estimations. Moreover, the normality test on most of full study period and sub-period prices show the rejection of normality for most prices series. These results together calls for tests, especially non-parametric, that control such problems in the data.

The result from the variance ratio test, a non-parametric test that detects linear dependencies in both homoskedastic and hetroskedastic environment, demonstrates the rejection of presence of random walk process for all study periods (two full study period for washed and unwashed coffee and two sub-period in each of these coffee categories). The result is consistent with a more complex non-parametric random walk test- BDS that test both linear and non-linear dependencies in the data. The test for the efficiency of export coffee trading in ECX shows the presence of both linear and non-linear predictable price movements that can be used for making a profitable trading in the market at least in the study period; which in fact is against the EMH. The Spearman's rank correlation result has also shown that the dependencies in the price are strong and persistent.

It is not uncommon to find such results in emerging exchanges. Literature shows the inefficiency of exchanges in their early years and the differences in efficiency among developed and developing exchange markets. Efficiency gain is a process that comes with the maturity of the institution and its participants. Even with future institutional maturity, compliance with EMH may happen to be difficult due to the price limits practiced in the Exchange and most importantly nature of the trading (spot trading) the Exchange is offering. The result from this thesis is only on the market efficiency of the exchange and does not necessarily entail an overall inefficiency in the Exchange as there are other aspects of efficiency like operational efficiency, spatial efficiency etc.

6.2 Recommendations

The market structure created by ECX can potentially perform well in creating order, integrity and transparency to the agricultural market. The system may also help to expand scarce social capital and give more bargaining power to producers (farmers), who were once unfair price takers of their produces. Though most of what is said needs empirical verification, this thesis found that (within the study period) the Exchange is weak-form inefficient. An important step to reduce the inefficiency is the introduction of futures exchange.

In the process of building futures market institution, efforts have to go beyond awareness creation to providing a market that does not have close substitute. As there are always resistance to changes and fear of transparency in trading, some market actors (buyers and sellers) may prefer the unregulated spot markets. Futures exchanges are best alternative along this line. In futures exchange, market actors create an information sensitive market. A futures market allows more liquidity thus more economic activity. It also encourages production planning and often creates stability to prices, which is the prior concern of farmers in Ethiopia (Amha & Gabre-Madhin, 2004). As coffee traders are interacting with international futures market, such platform can also smoothen traders trading activity. Such a market is a new alternative with a new opportunity to the exiting one and often performs efficiently. As it is part of building an institution, it however depends on other factors like human resource and infrastructural developments that take time. Meanwhile, alongside building this institution, effort has to continue to create efficiency in the existing spot exchange.

Though it looks difficult to create the ideal efficient market discussed in EMH literature with the existing frame work, in an attempt to improve the efficiency of the existing system the first point to begin is to relax the price band limit that potentially creates dependencies in coffee prices. This in fact has to go along with improving the skills of market actors in analyzing market information and relaxing entry requirements to allow brokerage institution to flourish with market professionals. Another important new step can be to share the experience of India briefly discussed in Gabre-Madhin (2007) without compromising economies of scale of each exchange. The Indian government gave license to new joint public and private owned for-profit national exchanges to commence competition among exchanges. In the presence of competing exchanges information will prevail to be an important tool as it creates an across space arbitrage opportunities and drive the market to efficiency. In order to encourage competition within the existing trading system, it would be better to introduce measures that increase the number of buyers in the exchange. Among others, these measures may include registering new members and setting maximum limits on the number of days buyers do not make transactions (similar to limits on warehouse receipts on sellers) so as to restrict exploitation of the price predictability found in the market. In terms of expanding the social capital and encouraging more informed decision, an electronic trading system better serves the purpose than the physical trading system as it (electronic trading) allows easy observation of a range of offer and bids and the possibility of trading with many.

The task of creating an efficient market, therefore, requires a multi-party participation in the process. The government has to actively lead the initiative and infrastructural developments. The responsibility of human resource development has to extend from academic institutions to the

Exchange Authority and mainly the members' associations. The flow of researches on alternative approaches and on performance of each new step has to also take a central stage in the institution development process.

This thesis has only shown predictability of the prices in ECX. The practical use of this predictability to make a profitable trading in the market can better be demonstrated by devising trading rules and by using alternative approaches that specifically depict the price trends like studying the presence of day-of-the-week effect. Another interesting way to characterize the behavior of the market is studying the market's sensitivity to other publicly available information like domestic economic news, introduction of new commodities and the international coffee prices; this can be part of studying the semi-strong market efficiency of the exchange. These points are beyond the scope of this thesis and they are interesting areas for further research on the commodity exchange.

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APPENDIX

Table A.1 *Summary Statistics of Weighted Average Prices in Birr for all Coffee Types Traded in ECX*

WAP	Obs*	Mean	Std. Dev.	Min	Max	Range	Median
Washed	309	554.5767	82.71391	372.75	840	467.25	557.55
Unwashed	330	444.8396	107.6356	281.68	781.13	499.45	461.955
Semi-washed	11	547.97	67.18393	430	610	180	580
Specialty	93	621.6739	44.18847	480	685	205	632.6
Prepared	43	640.8491	158.9715	400	1016.17	616.17	607
Local	332	334.2473	70.79883	178.93	569.09	390.16	324.65
Export	650	498.7522	110.4182	281.68	840	558.32	507.93

*Number of days traded

Table A.2 *Summary Statistics of Amount Traded in Feresula for all Coffee Types Traded in ECX*

Feresula	Obs	Mean	Std. Dev.	Min	Max	Range	Median
Washed	309	12836.72	10457.06	106	63831	63725	10904
Unwashed	330	25508.03	20394.11	300	114483	114183	19650
Semi-Washed	11	956.3636	497.0149	300	1841	1541	900
Export	650	19068.79	17546.45	106	114483	114377	14929.5
Local	332	5131.663	3977.922	150	20161	20011	4254.5
Prepared	43	4926.535	7721.132	52	38733	38681	2012
Specialty	93	5689.387	5065.291	197	20552	20355	4447

Table A. 3. *Post Estimation Specification Tests Results*

Variables	Durbin Watson Test for Autocorrelation	Breusch-Pagan-Godfrey Test for Heteroskedasticity	Jarque-Bera Test for Normality of Residuals
Washed	(7, 303) = 1.957743	13.70084 (0.0332)	126.5221 (0.000)
Unwashed	(5, 326) = 2.001862*	16.68504 (0.0022)	87.34973 (0.000000)
Washed Sub-period 1	(4, 152) = 2.030993*	1.220965 (0.7480)	66.44167 (0.000000)
Washed Sub-period 2	(4, 151) = 2.042287	1.755596 (0.6246)	16.90451 (0.000213)
Unwashed Sub-period 1	(5, 160) = 2.015413*	5.350339 (0.1479)	24.86719 (0.000004)
Unwashed Sub-period 2	(3, 164) = 2.015477	0.032840 (0.9837)	31.27377 (0.000000)

*Since the Durbin Watson test is works with a constant term, the second best model chosen by the information criteria are used to in this three cases.

Table A.4 *Summary Statistics of Prices*

	LNWWAP	LNUWAP	LNU1WAP	LNU2WAP	LNW1WAP	LNW2WAP
Mean	6.307096	6.067408	5.860775	6.271551	6.222141	6.392602
Median	6.323552	6.135468	5.827892	6.271254	6.224360	6.396880
Maximum	6.733402	6.660742	6.288732	6.660742	6.524091	6.733402
Minimum	5.920908	5.640772	5.640772	5.886104	5.920908	6.008494
Std. Dev.	0.149830	0.249400	0.164242	0.114062	0.121080	0.125557
Skewness	-0.147119	-0.205248	0.572644	-0.051522	-0.354579	-0.331621
Kurtosis	3.123215	1.830314	2.319727	5.395218	3.340407	4.100119
Jarque-Bera	1.310133	21.12924	12.12546	39.75485	3.996303	10.58847
Probability	0.519407	0.000026	0.002328	0.000000	0.135586	0.005020
No of Days Traded	309	330	164	166	155	154

*LNWWAP: natural logarithm of washed weighted average prices (full study period)

*LNUWAP: natural logarithm of unwashed weighted average prices (full study period)

*LNU1WAP: natural logarithm of unwashed weighted average prices for sub-period 1

*LNU2WAP: natural logarithm of unwashed weighted average prices for sub-period 2

*LNW1WAP: natural logarithm of washed weighted average prices for sub-period 1

*LNW2WAP: natural logarithm of washed weighted average prices for sub-period 2

Table A.5: *Test for Random Walk using Lo-MacKinlay Variance Ratio Test for Sub-periods (Washed and Unwashed Export Coffee)*

Variable	Values	q=2	q=3	q=4	q=5	q=6
Washed Sub1	VR(q)	0.616	0.472	0.396	0.366	0.334
	Z(q)	-4.6678 (0.0000)	-4.2971 (0.0000)	-3.9302 (0.0001)	-3.4852 (0.0005)	-3.2314 (0.0012)
	Z*(q)	-3.5485 (0.0004)	-3.4818 (0.0005)	-3.3410 (0.0008)	-3.1008 (0.0019)	-2.9552 (0.0031)
Washed sub2	VR(q)	0.564	0.380	0.312	0.198	0.184
	Z(q)	-5.2986 (0.0000)	-5.0415 (0.0000)	-4.4728 (0.0004)	-4.4103 (0.0000)	-3.9598 (0.0001)
	Z*(q)	-2.8344 (0.0046)	-2.7962 (0.0052)	-2.5576 (0.0105)	-2.6296 (0.0085)	-2.4354 (0.0149)
Unwashed sub1	VR(q)	0.613	0.398	0.332	0.301	0.295
	Z(q)	-4.8629 (0.0000)	-5.0446 (0.0000)	-4.4606 (0.0000)	-3.9700 (0.0001)	-3.5633 (0.0004)
	Z*(q)	-3.2755 (0.0011)	-3.5846 (0.0003)	-3.3197 (0.0009)	-3.0868 (0.0020)	-2.8565 (0.0043)
Unwashed sub2	VR(q)	0.682	0.574	0.463	0.442	0.424
	Z(q)	-4.0267 (0.0001)	-3.6063 (0.0003)	-3.6283 (0.0003)	-3.2237 (0.0013)	-2.9086 (0.0036)
	Z*(q)	-2.9769 (0.0029)	-2.7952 (0.0052)	-2.8955 (0.0038)	-2.6221 (0.0087)	-2.4199 (0.0155)

Table A.6: *Test for Random Walk using the Brock-Dechert-Scheinkman (BDS) test*

ε	m	Washed	Unwashed	Washed Sub1	Washed sub2	Unwashed sub1	Unwashed sub2
0.5	2	0.092217 (0.0000)	0.127005 (0.0000)	0.086671 (0.0000)	0.095037 (0.0000)	0.109299 (0.0000)	0.031722 (0.0000)
	3	0.105153 (0.0000)	0.139429 (0.0000)	0.088870 (0.0000)	0.132722 (0.0000)	0.116375 (0.0000)	0.025908 (0.0000)
	4	0.093050 (0.0000)	0.124313 (0.0000)	0.069590 (0.0000)	0.129639 (0.0000)	0.102192 (0.0000)	0.017240 (0.0000)
	5	0.078871 (0.0000)	0.106061 (0.0000)	0.051105 (0.0000)	0.117705 (0.0000)	0.086727 (0.0000)	0.010179 (0.0000)
	6	0.065138 (0.0000)	0.090488 (0.0000)	0.036509 (0.0000)	0.102829 (0.0000)	0.073184 (0.0000)	0.005317 (0.0000)
0.75	2	0.115459 (0.0000)	0.174453 (0.0000)	0.121292 (0.0000)	0.101402 (0.0000)	0.147523 (0.0000)	0.053688 (0.0000)
	3	0.150599 (0.0000)	0.232103 (0.0000)	0.156474 (0.0000)	0.162730 (0.0000)	0.190555 (0.0000)	0.063114 (0.0000)
	4	0.152508 (0.0000)	0.240600 (0.0000)	0.154675 (0.0000)	0.187394 (0.0000)	0.194132 (0.0000)	0.056348 (0.0000)
	5	0.145058 (0.0000)	0.231537 (0.0000)	0.140994 (0.0000)	0.195442 (0.0000)	0.184876 (0.0000)	0.045148 (0.0000)
	6	0.132989 (0.0000)	0.217654 (0.0000)	0.121620 (0.0000)	0.191338 (0.0000)	0.171588 (0.0000)	0.034122 (0.0000)
1	2	0.124159 (0.0000)	0.193098 (0.0000)	0.137120 (0.0000)	0.093000 (0.0000)	0.162346 (0.0000)	0.066579 (0.0000)
	3	0.178246 (0.0000)	0.282594 (0.0000)	0.200992 (0.0000)	0.159041 (0.0000)	0.238482 (0.0000)	0.095737 (0.0000)
	4	0.197524 (0.0000)	0.318204 (0.0000)	0.220233 (0.0000)	0.200772 (0.0000)	0.267848 (0.0000)	0.102152 (0.0000)
	5	0.199388 (0.0000)	0.327262 (0.0000)	0.220369 (0.0000)	0.227260 (0.0000)	0.275157 (0.0000)	0.097612 (0.0000)
	6	0.193089 (0.0000)	0.324136 (0.0000)	0.208534 (0.0000)	0.241225 (0.0000)	0.272606 (0.0000)	0.089642 (0.0000)
1.25	2	0.113805 (0.0000)	0.191545 (0.0000)	0.136681 (0.0000)	0.080534 (0.0000)	0.159599 (0.0000)	0.067724 (0.0000)
	3	0.183036 (0.0000)	0.300856 (0.0000)	0.219161 (0.0000)	0.142519 (0.0000)	0.258360 (0.0000)	0.111426 (0.0000)
	4	0.222385 (0.0000)	0.358709 (0.0000)	0.261059 (0.0000)	0.188267 (0.0000)	0.314206 (0.0000)	0.131731 (0.0000)
	5	0.241299 (0.0000)	0.385654 (0.0000)	0.277611 (0.0000)	0.221188 (0.0000)	0.342710 (0.0000)	0.140554 (0.0000)
	6	0.248394 (0.0000)	0.395966 (0.0000)	0.279073 (0.0000)	0.247345 (0.0000)	0.356662 (0.0000)	0.140899 (0.0000)
1.5	2	0.095335 (0.0000)	0.176786 (0.0000)	0.122569 (0.0000)	0.067068 (0.0000)	0.144939 (0.0000)	0.059119 (0.0000)
	3	0.167096 (0.0000)	0.294822 (0.0000)	0.210049 (0.0000)	0.127932 (0.0000)	0.246541 (0.0000)	0.108652 (0.0000)
	4	0.219608 (0.0000)	0.369056 (0.0000)	0.269101 (0.0000)	0.174319 (0.0000)	0.315461 (0.0000)	0.137409 (0.0000)
	5	0.254470 (0.0000)	0.413023 (0.0000)	0.302536 (0.0000)	0.209753 (0.0000)	0.361311 (0.0000)	0.157938 (0.0000)
	6	0.277130 (0.0000)	0.437838 (0.0000)	0.323216 (0.0000)	0.244957 (0.0000)	0.391363 (0.0000)	0.170061 (0.0000)

Declaration

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university, and that all sources of materials used for the thesis have been duly acknowledged.

The examiners' comments have been dully incorporated.

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