

Price Determination in Coffee Market:

The Impact of Supply and Demand shifts

—
John Ssenkaaba

Master's Thesis in Economics - May 2019



Acknowledgement

Firstly, am grateful to God almighty for the good health and wellbeing that were necessary to completion of this work.

I wish to express my gratitude to my Supervisors, Associate professor Eirik Eriksen Heen and Associate professor Sverre Braathen Thyholdt for sharing their knowledge and guidance with me in the most efficient way to this accomplishment.

With great regards, I would like to express my appreciation to all the staff at the school of business and economics, all courses that were part of my master's program have been great and useful.

To all my classmates, friends and family, thank you very much for your love and support.

Abstract.

Coffee market prices have been unstable over time. Determining the relative impact of supply and demand shift on price is a subject of discussion in this thesis. I use an index approach that was first introduced by Marsh (2003) to estimate the annual shifts in demand and supply for the periods from 2005 to 2017. This approach gives estimates to change in demand and supply of a given commodity which is due to other factors apart from the commodity's own price.

The results show that both demand and supply for coffee beans shifts considerably between periods, with the global average annual supply shift as 0.99% and global average annual demand shift as 3.19%. Much of the shift in supply fluctuate frequently between positive and negative shifts implying an increase and decrease in supply respectively, where as much of the shifts in demand are mainly positive implying demand growth over the same period.

Since both supply and demand are non-constant over time, they do explain the continuous fluctuations in coffee bean prices. However, since shift in supply experience more positive and negative shifts, its determined that price fluctuations in coffee are more influenced by supply shift than demand shift.

Key words: Coffee, demand shift, supply shift, price volatility

Table of Content:

Acknowledgement	1
Abstract	2
List of figures and tables	5
Chapter 1: Introduction	6
1.1 Introduction	6
1.2 Problem Statement	7
1.3 Research questions	8
Chapter 2: Literature Review	10
2.1 Demand and/or Supply	10
2.2 Back ground to the study of demand and supply	11
2.3 World coffee production and market situation	12
2.3.1 World demand	12
2.3.2 World coffee supply and market	14
2.3.3 Arabicas Vs Robustas	16
2.3.4 Current production by region	18
2.4 The International Coffee Agreement (ICA)	19
Chapter 3: Method and Data	22
3.1 Methodology for demand shift	22
3.2 Methodology for supply shift	27
3.3 Methodology for price determination	29
3.4 Data	29
3.4.1 Quantity data	29
3.4.2 Price data	30
3.4.3 Elasticity parameters.....	31
Chapter 4: Results and Discussions.....	33
4.1 Introduction	33
4.2 Results	33
4.3 Discussions	36
4.4 Sensitivity analysis	39
Chapter 5: Summary and Conclusion	41

5.1 Summary	41
5.2 Conclusions	42
References	43
Appendix	46

Figures and Tables.

List of figures

Figure 1: Quarterly world coffee prices	7
Figure 2: Coffee producing countries by type and region	15
Figure 3: Coffee production by region	19
Figure 4: Horizontal shift in demand between two periods	23
Figure 5: Vertical shift in demand	26
Figure 6: Horizontal supply and demand shift, impact on prices	27

List of Tables

Table 1: Summary statistics of price and quantity data	31
Table 2: Elasticity parameters' summary statistics	32
Table 3: Relative changes in quantities and price	34
Table 4: Supply and Demand shifts, 2005-2017	35
Table 5: Supply and Demand growth index, 2005=100	38
Table 6: New annual average supply shifts	39
Table 7: New annual average demand shifts	40

Chapter 1: Introduction

1.1 Introduction.

Coffee is one of the most consumed beverages in the world and is the second largest traded commodity after petroleum (Mussatto, Machado, Martins, Teixeira, & Technology, 2011). It is truly a global commodity and a major foreign exchange earner to several producing countries (Ponte, 2002). Developing countries are the main producers of coffee whereas developed countries provides the biggest market. More than 50 nations, almost all in developing world, produce and export coffee (Lewin, Giovannucci, & Varangis, 2004). Coffee is normally grown on both large and small scale in almost all producing countries. This means that, coffee is a significant source of income to both large farm owners and the individual small family units. Between 17 and 20 million families were directly involved in coffee production according to 2002 studies from World Bank and Oxfam(Lewin et al., 2004).

Over the years, the demand and supply of coffee has always been affected by several factors which have been followed through different studies by several scholars. Price has played a significant role in explaining the behavior of producers and suppliers of coffee. World coffee bean prices have shown large fluctuations during the past years (Bettendorf & Verboven, 2000). Several studies have shown differences in consumer prices and bean prices, for example in the Netherlands, bean prices dropped in 1992 but consumer prices hardly responded (Bettendorf & Verboven, 2000).

It is known that producers from agricultural commodity exporting countries are particularly vulnerable to the fluctuations of world market prices as they are widely exposed to price shocks and have little ability to cope with them (Subervie, 2008). According to Subervie (2008), World commodity price volatility is caused by shocks to both supply and demand, but shocks in supply predominantly affect agricultural commodities. Supply shocks can occur through damage to store grain , strikes, embargoes, shipping disputes, wars frosts or droughts (Subervie, 2008).

Two major types of coffee are produced and traded: arabicas and robustas. Robustas are grown at lower altitudes and taste bitter whereas arabicas are grown on high altitudes and have a milder taste (Goddard & Akiyama, 1989). Robustas are more suitable for making

instant coffee as they produce a higher volume for a unit weight of beans. On average, arabica prices are 10% higher than Robusta prices (Goddard & Akiyama, 1989).

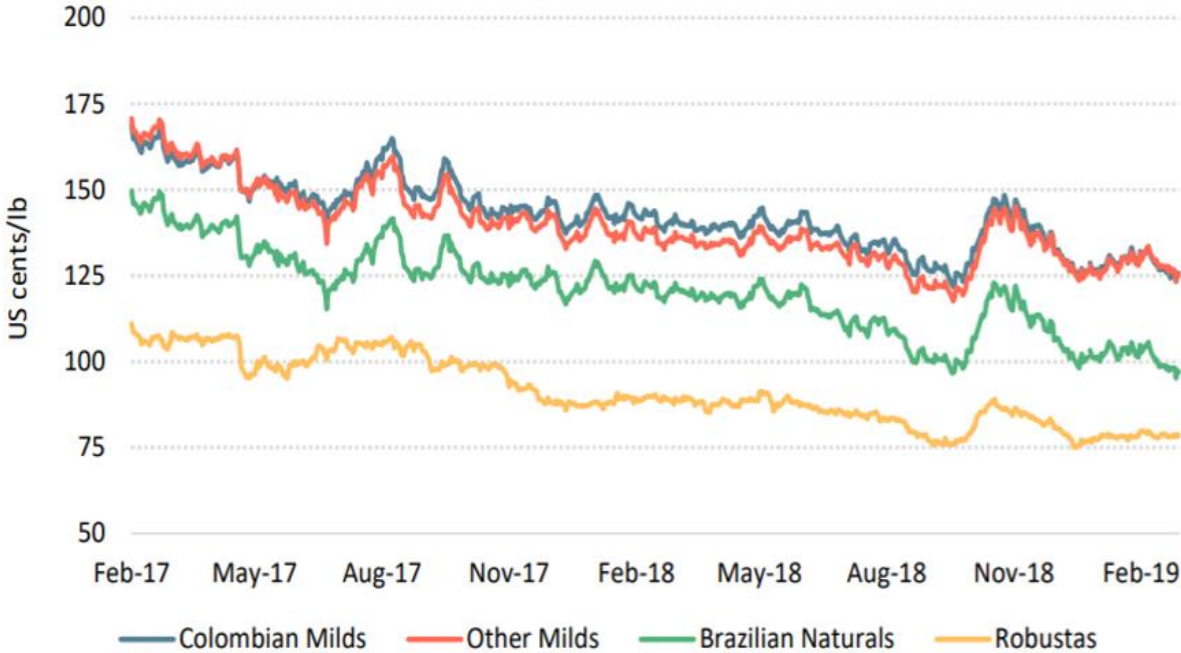
In several coffee producing countries, coffee accounts for at least 20 percent of the total export earnings, where approximately 100 million people are affected directly by the coffee trade (Lewin et al., 2004). Therefore, changes in demand, supply and price of coffee would destabilize the economies of the producing countries and the world market as well.

However, the prices of coffee have been fluctuating over time. These price volatilities have had several consequences in different producing countries. The consequences of the crisis in each country and region have been different according to the industry structure of the country concerned.

1.2 Problem Statement.

Price volatility in coffee has been a common occurrence in the industry for a long time, as it is the case to most markets for agricultural commodities (Tomek & Robinson, 2003). In general, agricultural produce are characterized with a combination of short periods of high and volatile prices and long periods of low prices and low volatility (Deaton & Laroque, 1992). Therefore, price instabilities in agricultural commodities, coffee inclusive are inevitable. Over the period since 1970s, prices have averaged a 3 percent per year price decline for arabica and a 5 percent decline for Robusta (Lewin et al., 2004).

Figure 1: Quarterly world Coffee prices



Source: (International Coffee Organization-ICO,2019)

The falling trend in prices was characterized by among others the combination of increased productivity, rising production as new lower-cost producers enter the market, rising share of export prices, and a sequence of renewable planting and innovation that follows price spikes that occur occasionally, usually following a frost or drought in Brazil (Lewin et al., 2004).

As in the market of other agricultural commodities, long spells of declines in coffee prices are followed with short spells of increase in prices. This could also be attributed to several factors such as farmers' speculations. Once excess supply is in the system and prices have fallen, these stocks act as a restraint on price increases coming from a short-run supply fluctuations because traders will hold stocks for both speculative reasons, expecting to sell them for a profit at a later date if price rise, and for precautionary reasons expecting to meet sales obligations to roasters during shorter periods of coffee unavailability (Lewin et al., 2004)

In figure 1 above, price for all forms of coffee beans are represented and the patterns shows quarterly fluctuations according to ICO (2019) for most recent records. Robusta's prices are relatively lower than all Arabica coffee types, nevertheless none of the coffee types exhibits constant price trends over time.

The exogenous factors that shift demand and supply contributes to unexplained changes in price of agricultural and perishable commodities. Therefore, this thesis studies the way prices fluctuations in the global coffee market has been influenced by un explained changes in demand and/ or supply. Prices can increase due to increased demand or reduced supply. Demand and supply factors can also simultaneously contribute to changes in food prices (Trostle, 2010).

1.3 Research question.

As coffee is one of the most foreign exchange earners for majority of the producing developing countries, it's also a source of consumer satisfaction both to importing and producing countries. Therefore, understating the growth in demand and supply for coffee and their impact on price is a global concern hence a point of concentration in this thesis. In this regard the following questions have been formulated as a basis for this research:

1. What is the level and nature of demand growth for coffee in the world market over a given period?
2. What is the level and nature of supply growth of coffee in the world market over a given period?
3. What is the impact of demand and supply shifts on coffee price volatility in the world market?

The concept of demand shifters and supply shifters is applied to understand the level and the nature of growth in accordance to the given research questions. In this case the nature can be a positive shift, a negative shift or a combination of the two. The Level of growth is a percentage at which a given variable has changed or shifted from one period to another.

When either demand or supply for a given commodity shifts, future prices are affected. This research therefore concludes by determining if really shifts are experienced in the coffee market to know the reason behind substantial unstable coffee prices in the world market.

Chapter 2: Literature Review.

2.1 Demand and/ or Supply Shifters.

A shift in demand is the movement of the demand schedule between two periods. Measuring demand growth has not attracted much attention in the literature as measuring productivity growth due to limited or lack of methodological framework (Brækkan & Thyholdt, 2014). There are several factors both economical and structural that can shift the demand or supply curves for commodity goods. Income of the consumer, price of the substitute and price of complementally commodities are among the common economic factors which can change demand of a given commodity. Other non-economic factors such as climate change, are termed as structural factors (Brækkan, 2014).

In studying the demand growth of Atlantic salmon fish Brækkan and Thyholdt (2014) applied a method developed by Marsh (2003). This allows measuring of total changes in demand caused by factors other than product's own price. In other words, the approach allows demand to vary independently between years and avoid restrictions that require smooth demand growth over time (Brækkan & Thyholdt, 2014). Therefore, the researchers were able to come to conclusions on demand growth for salmon in emerging markets like Brazil, more established markets such the United states and Japan, as well as the estimate of the world growth.

Quantifying factors that shift demand and supply can be challenging because not all factors can easily be assigned numbers. This is especially so when dealing with structural factors other than economics factors of income, price of substitutes and price of complementally goods. Other sources of demand shift such as changes in demographics, changes in socioeconomic factors, the appearance of new information of a product or accumulation of consumption capital, changes in product attributes such as product form and quality among other factors may require a well-developed methodology to be accounted for in the demand or supply analysis of a given product. Such changes are likely to occur interdependently and simultaneously over time, and data availability often prevents most of these factors from being included in econometric demand models (Brækkan, Thyholdt, Asche, & Myrland, 2018). Its further maintained that the research will most likely run into issues of endogeneity and collinearity between variables, and thus might end up omitting some or most variables away (Brækkan et al., 2018).

In a way of accounting for other non-economic factors which shift demand Brækkan et al (2018) formulated a category of unknown factors that affect demand growth of salmon fish. These were divided into known-unknowns and unknown-unknowns. Known unknowns were defined as factors that shift demand but where it is too difficult to quantify their effect even though they are well known to the researcher. Such factors include a proliferation of varieties of value-added product forms or a reduction in consumers' transportation cost. Additionally, variables affecting demand and are unknown to researcher were termed as unknown unknowns (Brækkan et al., 2018). However, these concepts are not given special attention in this paper since it integrates all economical and structural factors that affect demand and supply and later jointly cause price fluctuations in the coffee market. The detailed explanations of the approach of measuring demand and supply shift together with their impact on prices is provided in the methodological part of this thesis.

2.2 Background to the study of demand and supply shift.

Supply and demand are one of the most fundamental concepts of economics and the backbone of a market economy. Demand refers to how much (quantity) of a product or service is desired by buyers. The quantity demanded is the amount of a product people are willing to buy at a certain price; the relationship between price and quantity demanded is known as the demand relationship. Supply represents how much the market can offer. The quantity supplied refers to the amount of a certain good producers are willing to supply when receiving a certain price. The correlation between price and how much of a good or service is supplied to the market is known as the supply relationship. Price, therefore, reflects supply and demand.

The relationship between demand and supply underlie the forces behind the allocation of resources. In market economy theories, demand and supply theory will allocate resources in the most efficient way possible. How? Let us take a closer look at the law of demand and the law of supply.

The law of demand states that, if all other factors remain equal, the higher the price of a good, the less people will demand that good. In other words, the higher the price, the lower the quantity demanded. The amount of a good that buyers purchase at a higher price is less because as the price of a good goes up, so does the opportunity cost of buying that good. As a result, people will naturally avoid buying a product that will force them to forego the

consumption of something else they value more. The general principle of the law of demand was introduced by Marshall in the 1920s (Marshall, 1961). Like the law of demand, the law of supply demonstrates the quantities that will be sold at a certain price (A. Smith, 1863). But unlike the law of demand, the supply relationship shows an upward slope. This means that the higher the price, the higher the quantity supplied. Producers supply more at a higher price because selling a higher quantity at a higher price increases revenue.

Demand shift and supply shift however assumes a constant commodity price. In other words, these variables can increase or decrease in response to other factors other than commodity's own price. In chapter 3, graphical explanations and equations are provided to give a broad picture on the differences between change in quantity demanded or supplied and change in demand or supply (demand shift and supply shift for this case).

In accordance to Brækkan (2014), the true nature of demand and supply curves caused a controversy among economists. In what was termed as the notorious "pitfalls debate" between Frisch (1933) and Leontief (1929), the former violently disagrees when the later derived a procedure for estimating supply and demand curves by using only price and quantity data based on independence of demand and supply principle (Brækkan, 2014). Frisch stated that the nature of the specific data would contradict the underlying assumption of independence between shifts in supply and demand. Brækkan (2014) further notes that the disagreement reflects two fundamental approaches to demand and supply analysis; in one the economic theory of supply and demand comprises the essential foundation for useful data analysis; in the other, the data at hand be taken into consideration in any analytical approach. Therefore, Leontief was considered a strong proponent of the use of quantitative data in estimating demand and supply whereas Frisch is considered the founder of econometrics (Brækkan, 2014).

2.3 World Coffee production and Market Situation

2.3.1 World demand.

World demand for coffee in 2003 was approximately 115 million bags, comprised of about 87 million bags in importing countries and 28 million bags in producing countries (Lewin et al., 2004). Additionally, 65 percent of the world's coffee was consumed by just 17 percent of the world's population before 2004 which indicates opportunities for market growth.

From continental perspective, European countries consumed the highest dollar worth of imported coffee during 2018 with purchases valued at US dollars (USD) 18.2 billion or 58.8% of the global total. In second place were North American importers at 22.6% while 13.6% of coffee imports were delivered to Asia. Africa and Oceania imported nearly the same amount that accounted for 1.8% each. Much of the Oceania's imports is dominated by Australia and New Zealand, and then Latin America imported 1.3% excluding Mexico but including the Caribbean (Daniel, 2019). It is clearly not a surprise that Asia, Africa and South America imports the least amount of coffee since they are the major producing regions. Therefore, although much of their produce is exported, they also reserve a proportion to be consumed in their domestic markets.

The United states is one of the world's largest coffee importers, they import from a variety of different countries, which are aggregated into different groups representing a certain number of broadly defined types of coffee (Goddard & Akiyama, 1989). In the year 1964-1982, the United states of America remained the world's largest importer and it imported between 27 and 45 percent of total worlds imports. According to Akiyama (1969), the United states of America re-exported only a small percentage of its coffee imports of about 7 percent and the rest was observed in domestic consumption. Like in most countries, coffee consumption in the United States of America is affected by the structure of the population. Immediately after the postwar period, the income elasticity of coffee was negative for small children and youth and positive for the elderly (Hughes, 1969). In other words, coffee becomes an inferior good as one gets younger and, in most cases, a normal good for the elderly. Therefore, a change in the population structure can be another factor the results into substantial shift in demand for coffee in a given economy

In Sweden, there is a wide spread belief that consumer coffee prices are high relative to bean prices and that lower consumer prices would lead to substantial increase in bean export from third world countries (Durevall, 2007). A low-price elasticity of demand for coffee in Sweden was established at 0.19 for the period between 1968 and 2002, and it was determined that impact of price decrease would be small because of the long-run coffee demand is dominated by changes in the population structure in combination with different preferences across age group

2.3.2 world coffee supply and market.

As earlier mentioned, coffee is mainly produced by world's developing countries especially in South America, Asia and Africa. Brazil, Colombia and Vietnam are the major producers. In accordance to United States Department of Agriculture (USDA), it was estimated that world production has been rising by an average of 1.8 percent per year since 1965, which was a consistent increase despite the decrease in real prices (Lewin et al., 2004). The growth rate drops to 1.4 percent when these three producing countries are removed from the picture implying that the most recent growth of the world supply came from the first two of these origins.

In the periods between the year 1960 and 2003, production from Latin America was the highest followed by Africa. However, Asia experienced an increasing trend and Africa exhibited a relatively constant and later a decreasing trend in gross production. Therefore, towards the late 1990s, total production from Asia surpassed total production in Africa.

Brazil and other countries in the Central South America are the major producers of Arabica coffee while majority of African and Asian countries are the major producers of Robusta. The International Coffee Agreement (ICA) divides coffee output into four major groups. These include two groups for washed arabicas, and one group each for natural arabicas and robustas. Additionally, the washed arabica group is divided in two as Colombian Milds and Other Milds. The following table shows Fifty-five producing countries by principal type and region.

Figure 2: Coffee Producing Countries by Type and Region

<i>Milds</i>	<i>Natural Arabicas</i>	<i>Robustas</i>
<p>Colombia Milds</p> <ul style="list-style-type: none"> ▪ *Colombia ▪ Kenya ▪ Tanzania 	<p>All Natural Arabicas</p> <ul style="list-style-type: none"> ▪ *Brazil ▪ Ecuador ▪ Paraguay ▪ Yemen 	<p>American Robustas</p> <ul style="list-style-type: none"> ▪ *Brazil ▪ Ecuador ▪ Trinidad and Tobago
<p>American Milds</p> <ul style="list-style-type: none"> ▪ Bolivia ▪ Costa Rica ▪ Cuba ▪ Dominican Republic ▪ Ecuador ▪ El Salvador ▪ Guatemala ▪ Haiti ▪ Honduras ▪ Jamaica ▪ *Mexico ▪ Nicaragua ▪ Panama ▪ Peru ▪ Venezuela ▪ United States (PR and HI) 		<p>Asian Robustas</p> <ul style="list-style-type: none"> ▪ India ▪ Indonesia ▪ Lao PDR ▪ Malaysia ▪ Philippines ▪ Sri Lanka ▪ Thailand ▪ *Vietnam
<p>African Milds</p> <ul style="list-style-type: none"> ▪ *Burundi ▪ Cameroon ▪ DR Congo ▪ Madagascar ▪ Malawi ▪ Nigeria ▪ Zambia ▪ Zimbabwe 		<p>African Robustas</p> <ul style="list-style-type: none"> ▪ Angola ▪ Benin ▪ Cameroon ▪ Central African Republic ▪ DR Congo ▪ Equatorial Guinea ▪ Gabon ▪ Ghana ▪ Guinea ▪ Liberia ▪ Madagascar ▪ Nigeria ▪ Togo ▪ Sierra Leone ▪ Tanzania ▪ *Uganda
<p>Asian Milds</p> <ul style="list-style-type: none"> ▪ *India ▪ Indonesia <p>Papua New Guinea</p>		

*Asterisk indicates leading-producing country by type and region in 03/06 crop year, according to USDA

Source. World Bank (Lewin et al., 2004)

In figure (2) above we see that Countries in South America have the biggest percentage of Arabica supply. However, Colombia Milds are also found in some African and Asian countries. Brazil the world’s biggest supplier produces both Arabica and robusta. In Africa,

Uganda is a major supplier of Robusta despite the changing quantity levels. Below is a detailed explanation of the major coffee types, their sub categories and their place of production.

2.3.3 Arabicas vs Robatas.

Arabicas

Arabica contributes about 70 percent of total production in the world (Bunn, Läderach, Rivera, & Kirschke, 2015). It is a type of coffee made from the beans of the coffee arabica plant. Arabica coffee is said to have originated in southwestern highlands of Ethiopia where it was eaten as stimulant by the Oromo tribe. Furthermore, It went to Arabia in the 7th century where it was said to have been born, hence the name “Arabica coffee” (Dena, 2018).

In accordance to figure (2), Arabica is categorized into natural and Colombian Milds. Natural Arabica is unwashed arabica, where the production process does not involve water. The cherries are dried in the sun or in mechanical dryers and then milled to produce green beans. The two biggest producers of Natural Arabica are Brazil and Ethiopia (Lewin et al., 2004). The quality of natural arabica is substantially high due absence of water contacts which would affect the produce during fermentation of water and the cherry. Lewin et al (2014) notes that both Brazil and Ethiopia produce some washed and (in Brazil) semi-washed coffee. Therefore, Brazilian arabica have a major impact on the world’s coffee market given both the country’s total volume and the willingness of the industry to use them to replace other arabicas in their blends according to price.

Washed Arabicas is another category of arabica as shown in figure (2), which is also separated into Colombian Milds (mostly for Colombia) and other Milds (mostly for American, African and Asian). Colombia and Kenya are among the major producers of Colombian Milds. In the two countries, the cost of production is quite high due to the efforts made to maintain the quality of the output. Colombia alone is the world’s largest producer of washed arabica and the world’s second largest producer of coffee in general (Lewin et al., 2004). A series of Unique circumstances including fertilizers subsidies in the early 1990s briefly pushed production to reach a record high of 18 million bags in early 2000s (Lewin et al., 2004). Despite the shirking production area, Colombia’s increased productivity per

hectare is an important factor in its ability to control quality and costs, still according to Lewin (2004).

The two East African Countries of Kenya and the United Republic of Tanzania both produce some of the world's finest washed arabicas, although the United Republic of Tanzania produces both arabica and Robusta (Lewin et al., 2004).

“Other Milds category” involves all washed arabicas from other producing countries other than Colombia. These include American Milds, Asian Milds and African Milds. In Latin America, Central American production peaked at 21.3 million bags in 1990-2000, which later experienced some shifts with countries such as El Salvador and Panama, unable to sustain their periodic advances, making production to fall for three consecutive years because of low prices between 2000 and 2003 (Lewin et al., 2004). In 1993 Peru became a significant washed arabica producer whose production rose to nearly 3 million bags during the same crop year. According to Lewin (2004), the production growth came because of two sets of influences: First, higher coffee prices following the Brazil frost led economic incentives to shift illicit crops, and this was aided at the same time by a steep drop in the price of some illicit drug crops following successful action by the Colombian government that broke the supply chain for these products. The second set of influence was a combination of internal political and economic liberalization, as well as a partial settlement of the security situation that allowed farmers access to land that gave them confidence in expanding production. Venezuela, Ecuador and Bolivia also produce washed arabica with Ecuador producing both washed and unwashed Arabica. The quantities from these countries are relatively lower due to political instabilities, poor infrastructure and other structural factors according to Lewin (2004).

Robustas.

Robusta accounts to almost 30 percent of the total world coffee production, with Vietnam and Brazil as the biggest producers (Lewin et al., 2004). Robusta is noted for its resistance to diseases hence suitable for growth in tropical environments of Africa which are most vulnerable to pests and diseases (Van der Vossen, 2009). Although Robusta coffee has a flavor that is inferior to that of arabica coffee, with a caffeine content more than double, it has in proportion a greater stimulating action, and also offered advantages to the manufacturers of instant coffee extracts, and also has a higher content soluble extractives which makes it more economical in the manufacturers of instant coffee (R. F. Smith, 1985).

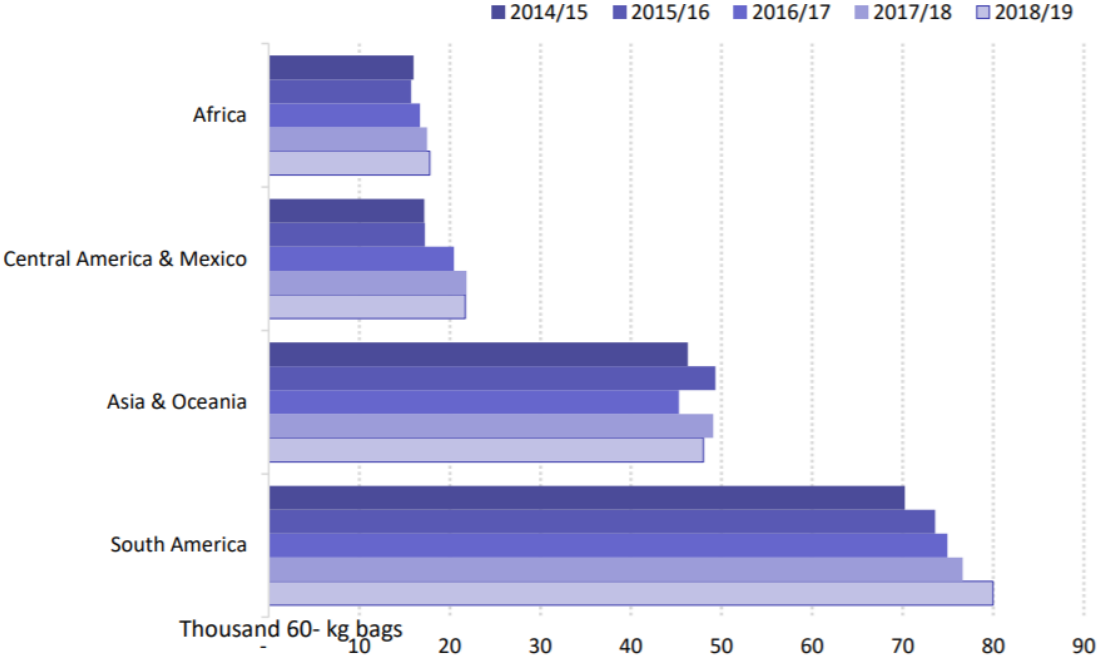
Vietnam is by far the main producer after Brazil but Ivory Coast, Indonesia and Uganda are also major players (Ponte, 2002). In accordance to figure (2) Robustas is categorized according to the place of origin, which clearly shows that there are more Asian and African producing countries than Latin America robustas producers.

In Asia Vietnam's Robusta production grew at an average rate of about 27 percent per year in early 2000s making it the second largest producer of Robusta after Brazil and the world's third largest producer of coffee in general after Brazil and Colombia. According to Lewin (2004) Brazil and Vietnam together added 20 million bags to the world supply since 1991. In Africa, Robusta production is dominated by two main producers Ivory Coast which produces only Robusta and Uganda of which 90 percent is Robusta (Lewin et al., 2004).

2.3.4 Current World production by Region

Currently, South America is by far the largest producer due to the presence of Brazil and Colombia which are world giants in production of both arabica and robusta coffee. According to International Coffee Organization (ICO), Brazil's production in coffee year 2018/19, amounted to a record 60.1million bags, which has contributed to oversupply of coffee in this crop year, and Colombia is estimated to have harvested 14.2 million bags, an increase of 2.7% compared to the previous year 2017/18 (ICO, 2019). Asia and Oceania take the second step, Central America and Mexico in the third place and Africa the least place, as shown by figure (3) below:

Figure (3) Coffee Production by Region



Source (ICO, 2019)

From figure (3) was obtained from the Coffee Market Report for February 2019 published by International Coffee Organization (ICO). Supply for coffee is normally inelastic in the short run due to long periods of plant growth. In south America, over 70 units of thousand 60 kg bags were produced each year in most recent periods with 80 units of thousand 60kg bags in the crop year 2018/2019. This show a slight increase in supply in the short run. Between approximately 45, and 50 units of thousand 60kg bags were produced in Asia and Oceania each year in the same period, 15- 22 units of thousand 60 kg bags in Central America and Mexica and approximately the average of 18 units of thousand 60 kg bags were produced each year in the period between 20014 to 2019.

2.4 The International Coffee Agreement (ICA).

The evolution of fluctuating coffee prices is not complete if we don't mention the role of the International Coffee Agreement (ICA). This is an international commodity agreement between coffee producing countries and consuming countries, whose primary goal was to ensure raising and stable coffee prices through maintained quotas on exporting countries. The

agreement was signed in 1962 (Mehta & Chavas, 2008) for the first time, and later it temporarily collapsed in 1989 (Charveriat, Practice: Agriculture, & Land, 2001). The ICA evolved from the Inter-American Coffee Agreement (IACA) signed in 1940 between the United States and fourteen Latin-American coffee producing countries, which was aimed to lessen the burden imposed by the loss of European market to Latin American producers (Pichop & Kemegue, 2005). Following the signing of IACA, the United States restricted its importing quotas to a certain amount and the Latin American countries restricted their production, which doubled the prices by the end of 1940. Prices increased continuously until the attainment of degree of equilibrium in 1957.

An attempt to maintain the price, gave way to the signing of the first ICA, where a target price was set, and export quotas were allocated to each producing country. The requirements of the agreement were supervised by the International Coffee Organization (ICO). According to Pichop and Kemegue (2005), members mutually agreed to stabilize prices by increasing consumption, achieve a long-term equilibrium between production and consumption and assure adequate supply to consumers and markets to producers at equitable prices. In stabilizing market prices, ICO increased quotas when price rose above the set price, and the quotas were decreased whenever prices fell below the set price (Daviron & Ponte, 2005).

During the operation of the ICA, two coffee markets co-existed with one involving consumers from member countries and the other involving consumers in non-member countries. Therefore, the imposition of the world quota caused prices in member market to rise above the free trade price, and prices in the nonmember market to fall below the level, according to Pichop and Kemegue (2005). So Coffee exporters thus faced two distinct markets: one with high prices constrained by quotas and the other unconstrained with low prices, a situation which was earlier predicted (Mikesell, 1963).

In 1983, new quotas were instituted on each producer, which brought about some disagreements among the member states. The changing consumer tastes in favor of milder and high-quality coffee (Daviron & Ponte, 2005), led to major producers especially Brazil not to comply to new quotas set. Brazil for example failed to reduce its quotas despite its falling market share. This, together with the dissatisfaction among importing member countries stemmed from the lower prices paid by nonmember countries led to failure of the ICA in 1989. Free markets were therefore established and the agreement became a mere statement of good intentions from member states (Pichop & Kemegue, 2005).

The most recent agreement is the International Coffee Agreement 2007, the seventh since 1962. This is agreed by exporting and importing countries, where the European Union (EU) is taken as one importing country to represent 28 individual countries.

Unlike the previous agreements, “ the 2007 agreement will strengthen the ICO’s role as the forum for intergovernmental consultations, facilitate international trade through increased transparency and access to relevant information, promote a sustainable coffee economy for the benefit of all stakeholders and particularly of small-scale farmers in coffee producing countries”, (ICO, 2007)

Chapter 3 Method and Data

3.1 Methodology for demand shift

The approach used to measure shifts in demand and supply is based on works of Marsh (2003), where it was first introduced and later used by different researchers in agricultural and food commodity economics. In the study about demand for beef in the United States, Marsh defined shifts in the retail demand for beef as a percentage change difference between observed retail beef prices and estimated retail prices holding demand constant (Marsh, 2003).

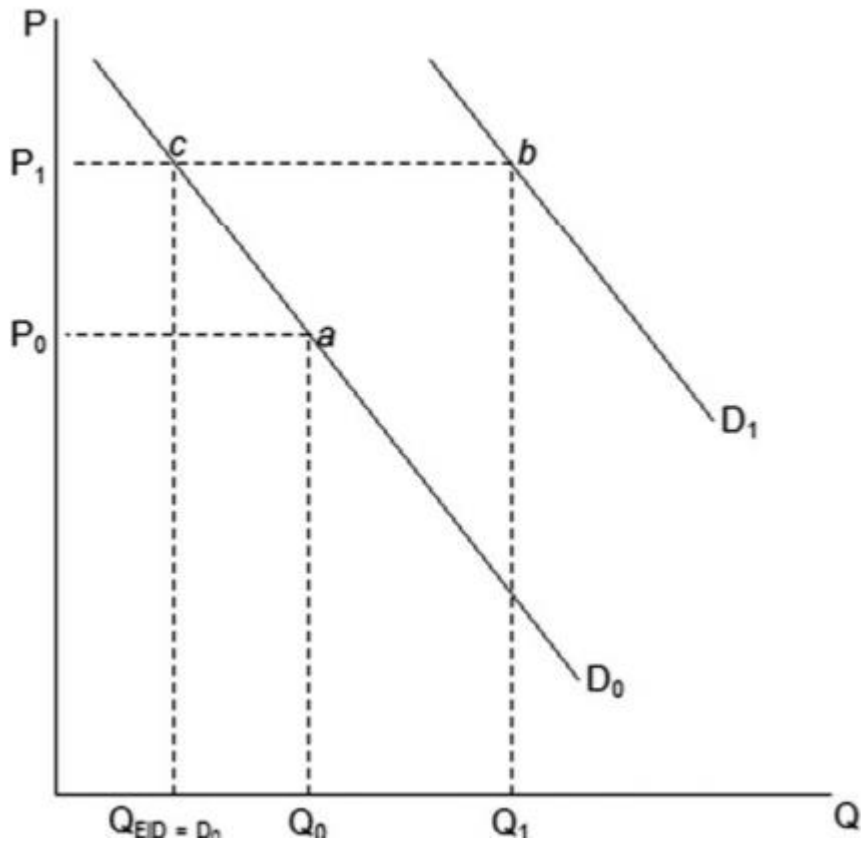
Demand shift as explained in Chapter 2 entails a movement of the demand schedule, the inward and outward movement of the demand curve represents decrease and increase in demand respectively. However, the movement can be either horizontally or vertically (Wohlgenant & policy, 2011).

A horizontal shift can be interpreted as a change in quantity demanded at a given price while a vertical shift can be interpreted as the change in consumers' willingness to pay for a given quantity (Brækkan et al., 2018). In this study for coffee, the demand shift in quantity direction (horizontal) is chosen. It's also noted that when given Horizontal shift, the corresponding vertical shift can simply be obtained (Sun & Kinnucan, 2001).

In figure (4) below, a shift in quantity direction is illustrated when demand is studied for two periods 0 and 1. Each period is represented by its own demand schedule.

D_0 is the demand schedule for period 0 and D_1 is the demand schedule for period 1. P_0 and Q_0 are equilibrium price and the quantity for periods 0, respectively. P_1 and Q_1 are equilibrium price and quantity in period 1, respectively.

Figure (4): Horizontal Shift in Demand between Two Periods.



If the demand did not shift from period 0 to 1, an increase in price from P_0 to P_1 would lower the quantity demanded from Q_0 to $Q_{EID=D_0}$. This implies that quantity obtained in the event of no demand change is the expected quantity. Therefore, the absolute horizontal shift is given by the difference between the expected quantity $Q_{EID=D_0}$ (In the situation where demand never shifted) and the observed quantity Q_1 (new quantity after the shift in demand). This is measured by the horizontal distance between c and b from figure (4).

So, the relative horizontal shift in demand d^h can be illustrated as follows:

$$d^h = (Q_1 - Q_{EID=D_0})/Q_0 \quad (1)$$

We can further modify equation (1) by doing some mathematical manipulations as follows:

By adding and subtracting Q_0 to and from the numerator, respectively we obtain equation (2) below.

$$d^h = \frac{(Q_1 - Q_0) - (Q_{EID=D_0} - Q_0)}{Q_0} \quad (2)$$

Equation (2) shows the difference between the actual and the expected relative change in quantity where, $(Q_1 - Q_0)/Q_0 = Q^*$ is the observed relative change in quantity,

and $\frac{(Q_{E|D=D_0} - Q_0)}{Q_0} = Q_E^*$ is the relative difference between expected quantity in period 1 and observed quantity in period zero.

Now we must determine the value of Q_E^* by using the common definition of the price elasticity of demand (η)

$$\eta = \frac{\text{percentage change in quantity}}{\text{percentage change in price}}$$

$$\eta = \frac{\frac{Q_1 - Q_0}{Q_0}}{\frac{P_1 - P_0}{P_0}} \quad (3)$$

In this case, we must use the expected quantity $Q_{E|D=D_0}$ in case of no demand shift instead of Q_1 , which gives the following expression:

$$\eta = \frac{\frac{Q_{E|D=D_0} - Q_0}{Q_0}}{\frac{P_1 - P_0}{P_0}} \quad (4)$$

Simplifying of the equation (4) by doing cross multiplication we obtain the following expression:

$$\frac{(Q_{E|D=D_0} - Q_0)}{Q_0} = \frac{\eta(P_1 - P_0)}{P_0} \quad (5)$$

From equation (5) the expression of the Left-Hand Side (LHS) is equal to the expected relative change in quantity Q_E^* . In accordance with the demand schedule, D_0 , the price change corresponding to Q_E^* is the relative price change, $\frac{P_1 - P_0}{P_0} = P^*$, on the Right-Hand Side (RHS) of the equation (5).

This follows that if given the change in price, P^* and the predetermined elasticity of demand η , we can solve equation (5) for the relative change in quantity Q_E^* . Therefore, equating the LHS to the RHS of equation (5) we obtain the following expression:

$$Q_E^* = \eta P^* \quad (6)$$

By substituting for Q_E^* from equation (6) into equation (2), the relative shift in demand can be obtained as follows.

$$d^h = Q^* - \eta P^* \quad (7)$$

Alternatively, we define the expected relative change in quantity as follows

$$Q^* = d^h + \eta P^* \quad (8)$$

The asterisks (*) denotes relative change throughout this study. In other words, relative changes for the commodity in question “coffee” with regards to price and expected quantity will be obtained in the subsequent chapter.

In addition, the elasticities from the previous research will be used to cater for the values of η as shown in chapter 4 of the analysis section.

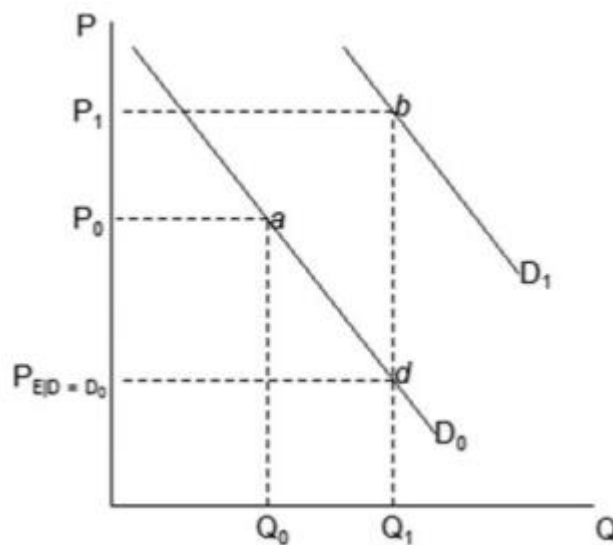
Figure (4), Illustrates horizontal shifts in demand d^h which is mathematically obtained in equation (7). When given the horizontal shift in demand, the corresponding vertical shift can be obtained dividing by the negative elasticity of demand (Sun & Kinnucan, 2001). Hence the expression for demand shift from the price side is obtained in equation (9) below:

$$d^v = \frac{d^h}{-\eta} \quad (9)$$

The argument for vertical shift in demand is not different from that of the horizontal shift in demand. The only unique aspect is that the during vertical shift in demand, the expected price level $P_{E|D=D_0}$ is determined at a point in case demand is assumed not to have shifted as illustrated by figure (5) below.

Like figure (4), figure (5) also shows two demand schedules of periods 0 and 1, with their respective equilibrium points for price and quantity. Given the observed quantity Q_1 and if demand remains constant at D_0 , the expected price level in period 1 is given by $P_{EID=D_0}$. This is shown by point d on the demand curve from period 0. This leads to definition of absolute demand by Mash (2003) as the difference between the expected price $P_{EID=D_0}$ and the observed price P_1 . It is also defined as the relative increase in price at any quantity on the new demand schedule (Muth, 1964).

Figure (5) Vertical Shift in demand (d^v)



The gap between points b and d of figure (6) indicates a vertical shift in demand. Substituting equation (9) in equation (7), gives the following expressions

$$\frac{d^h}{-\eta} = -\frac{Q^*}{\eta} + P^* \quad (10)$$

Alternatively,

$$P^* = \frac{Q^*}{\eta} - \frac{d^h}{\eta} \quad (11)$$

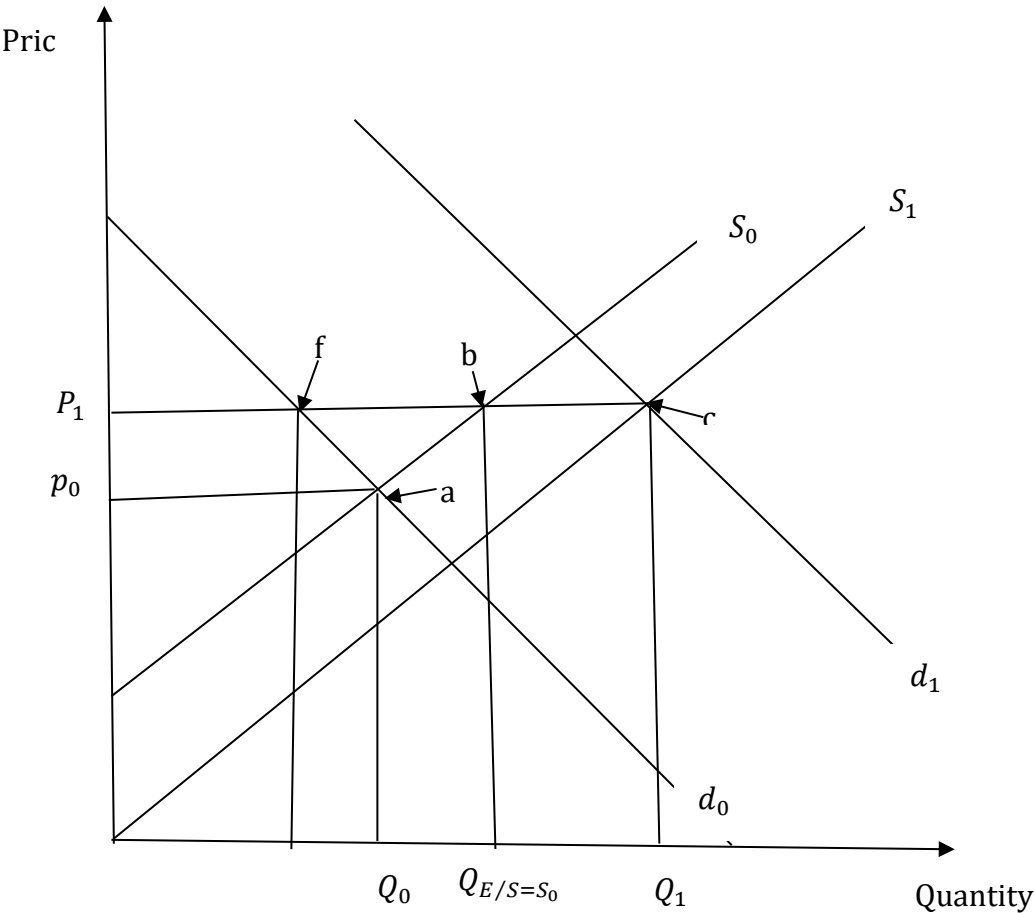
Where equation (10) is the expression for absolute relative vertical demand shift and equation (11) is the simplified expression for the expected relative price level. At the look of equations

(10), the vertical demand shift is identical to horizontal demand shift if the elasticity of demand is -1.

3.2 Methodology for supply shift

The procedure of estimation of change/ shift in supply is very similar to the procedure of estimation of a change or a shift in demand. In figure 6, both horizontal demand shift and supply shift are represented. Since I have already discussed the procedure for horizontal demand shift, here I put focus on the horizontal supply shift under this section. The original equilibrium point is a where equilibrium quantity and price are Q_0 and P_0 respectively. This implies that quantity Q_0 is supplied along the supply curve S_0 of period 0.

Figure 6: Horizontal supply and Demand shift, impact on prices



An increase in supply from period 0 to 1 can change the equilibrium to point c if the outward shift of the supply curve from S_0 to S_1 is accompanied by the demand shift as shown by curve d_0 to d_1 . This will lead to equilibrium quantity Q_1 . However, if only demand changed in period 1 and supply curve never shifted, $Q_{E|S=S_0}$ would have been the new quantity supplied at a higher new price p_1 .

In this case the observed quantity for period 1 is Q_1 and the expected quantity (in case of no supply shift) is $Q_{E|S=S_0}$. The absolute shift in supply is defined as the horizontal difference between the supply schedules in periods 0 and 1, which is equal to the horizontal distance between points c and b in figure 6.

Following the same procedure as shift in demand from equation (1) to equation (7), we obtain the following expression for horizontal shift in supply.

$$S^h = Q_s^* - \varepsilon P^* \quad (12)$$

Where: S^h is the horizontal shift in supply of coffee.

ε is the price elasticity of supply.

P^* is the relative change in price.

The vertical supply shift can be computed simply by dividing equation (12) by negative elasticity of supply, hence expression below:

$$\frac{S^h}{-\varepsilon} = -\frac{Q_s^*}{\varepsilon} + P^* \quad (13)$$

3.3 Methodology for price Determination

Under the Equilibrium Displacement Model (EDM), the forces of demand and supply determines the equilibrium price. When demand curve shifts outwards to represent a growth in demand without a substantial growth in supply in the same period, consumers would compete for the scarce commodity hence forcing producers to supply at higher prices. In the same way a fall in demand will force suppliers to lower the prices to attract and encourage buyers.

When supply increase (positive shift in supply), it may create excess supply in case demand remained constant, hence forcing producers to sell at lower prices to encourage buyers to take up their excess surplus in the market. A decrease in supply will create scarcity of a product, hence selling the competitive scarce commodity at higher prices.

Therefore, whenever demand or supply shift, prices are directly affected and determined within the EDM. If the outcome of the study represents continuous shifts in supply and demand, it will automatically tell something about the continuous price fluctuation in the coffee market.

3.4 Data

The international Coffee Organization (ICO) avails free data to download from 1990 to present. The ICO is an intergovernmental organization established by the United Nations in 1962, including both coffees' producing and consuming member countries (Osorio, 2002). It specifically addresses world coffee problems and issues in view of coffee's exceptional economic importance and development implications.

In relation to the period 2005-2017, I was able to download the required quantities and prices. All quantities are given in thousands of 60kg bags and prices are in US cents per pound.

3.4.1 Quantity Data

Quantity data gives the amount of coffee beans that are demanded and supplied. On supply side, I consider data about total production by all exporting countries. According to ICO, all exporting countries are categorized into five production seasons depending on when each

country harvests coffee beans. These periods include April, July and October. Additionally, quantities for both Arabica and Robusta were given for each country that produce both. However, this research is based on aggregation of all forms of coffee and all seasons of harvest are treated as a one-year production period. Therefore, the final data set that represented the supply for each year is a summation of all production in all countries. In this regard, annual production totals in thousands of 60kg bags were obtained to represent quantity supplied.

Import data is used to represent demand. Even though most producing countries have domestic demand, more of their production totals is exported to the international market (Balassa, 1990). Therefore, demand for coffee from most developing producing countries is almost equivalent to the amount that is exported. ICO provides quantities imported by the European Union, Japan, Russian Federation, Tunisia, USA and Switzerland. Tunisia is the only African importing country represented and none from Asia. However much some African and Asian countries import a given amount to supplement their domestic production, their share on total imports is very small (Slob, Osterhaus, & Challenges of Fair Trade, 2006) and it cannot influence the results of this study. Total quantity imported in thousands of 60kg bags were for each year were obtained.

3.4.2 Price Data

ICO provides a variety of prices which includes price given to growers, retail prices and ICO Composite indicator prices. I chose to use ICO composite price indicator for simplicity. This is the annual average ICO obtained from group indicator prices. According to ICO (2019) group indicator prices are prices to all forms of coffee which include Colombian milds, Other milds, Brazilian naturals and Robusta. In the same coffee market, prices of all forms of coffee are cointegrated, hence forming the ICO composite indicator price that is a representative of all forms of coffee prices

The nature of ICO composite price indicator is also supported by other studies that tested co-integration among various types of coffee. Ghoshray (2010) found overwhelming support for co-integration when non-linear Exponential Smooth Transition Autoregressive (ESTAR) adjustment approach was used to test the prices of different coffee types (Ghoshray, 2010).

This therefore implies a single market and the average of all prices give reliable results (R.Carter, William E, & Guay 2018), since a price change in a particular type of coffee would lead to a similar change in the price of other quality of coffee in the market.

It should be noted that prices were given in US cents per pound, however I converted all prices to US cents per kilogram to be consistent with the units for both the production and import quantities.

Table 1: summary statistics of price and quantity data

	minimum	Mean	Maximum
Production	11803	137874	159047
Import	96376	112205	127178
Price	197.0	288.3	463.8

Production is quantity supplied in thousands of 60kg bags, Import is quantity demanded in thousands of 60kg bags and Price is the ICO composite price in US cents per kg.

3.4.3 Elasticity Parameters.

The choice of elasticity parameters is based on the research by Akayima and Varangis (1990) where they examined the effect of the International Coffee Agreement’s export quota system on world coffee prices (Akiyama & Varangis, 1990). In their approach, Akiyama and Varangis applied a model that required the use of both demand and supply elasticities and thereby computing different elasticities that applied to different producing countries and importing countries. Since in this research applied the means of the elasticities that were published, it may be important to assess the reliability of the results, through a sensitivity analysis that I discuss in chapter 4. Mean elasticity parameters used for my research are 0.35 and -0.23 for supply and demand respectively

Table 2. Elasticity Parameter’s summary Statistics

	Suppl Elasticity	Demand Elasticity
Minimum	0.13	-0.54
Mean	0.35	-0.23
Maximum	0.95	-0.13

From table 2, the global average supply elasticity of price for coffee is 0.35 which is somehow elastic but numerically inelastic. The minimum supply elasticity is inelastic at 0.13. This was experienced in Mexico which also offers less at the world market. Brazil, the highest supplier had its elasticity recorded at 0.36 which is slightly above the average (Akiyama & Varangis, 1990). The Maximum value for the elasticity parameter is 0.95 which shows very elastic supply and was recorded in Burundi.

Akiyama and Varangis (1990) also estimated price elasticities of demand from different importing countries with the average being -0.23. This implied that the global import of coffee reduces by approximately 0.23% during a 1% increase in average world coffee prices. However, demand elasticities vary substantially between different importing countries with highest being -0.54 and the lowest being -0.13 which indicates both elastic and inelastic demand respectively.

Chapter 4: Results and Discussions.

4.1 Introduction:

This section includes presentation of the results obtained after the analysis of the data using the index approach as discussed in the methodology section in chapter 3. It also gives a simple overview regarding the estimation procedure. All the analysis is done using Microsoft Excel and R-studio. A shift in demand and supply are all given as percentages which represents a percentage change in quantity demanded or supplied when price is held constant. The results of demand and supply shifts exhibits both positive and negative values that represent growth and reduction respectively. The positive shift indicates that a consumer is willing to buy a higher quantity of coffee beans than in the previous period when price is unchanged. For example, a 5% shift in demand implies that importing countries will bring in 5% more coffee than in the previous period even when price remain unchanged. Also, a 5% positive shift in supply implies that exporters can produce 5% more coffee than in the previous period at a constant price.

In addition to price and quantities, the choice of elasticity parameters used is the mean of all obtained predetermined elasticities of demand and supply for demand and supply shift respectively. This is a good representative of all countries where elasticity values were obtained. Therefore, 0.35 and -0,23 are the respective elasticities of demand and supply used. Both elasticity values are almost inelastic. A sensitivity analysis is performed later in this section by using different values of the elasticity parameters to establish the consistency and reliability of the results.

4.2 Results

Relative changes in quantity supplied and demanded together with relative changes in price where estimated first in accordance the procedure of the index approach before application of the elasticity parameters. These relative changes are represented in the table3 below:

Table 3: Relatives Changes in quantities and price

year	Relative change in quantity supplied (%)	Relative change in quantity demanded (%)	Relative change in price (%)
2005	0.00	0.00	0.00
2006	-3.80	5.39	7.15
2007	16.15	3.04	12.46
2008	-6.11	2.05	15.39
2009	10.01	-2.14	-6.91
2010	-4.56	4.43	27.29
2011	8.97	2.44	42.89
2012	3.56	1.22	-25.69
2013	4.71	2.44	-23.56
2014	1.86	3.53	29.91
2015	-3.57	1.13	-19.70
2016	3.37	4,77	2.12
2017	3.57	-0.84	-0.49
Average	2.63	2.11	4.68

The relative changes in table 3 above together with given elasticity parameters will give the shifts in demand and supply. From chapter three we see that the shift in demand is obtained by finding the difference between the relative change in quantity demanded and the product of price and the elasticity of demand, as given by equation (7). The same way, the shift in supply is calculated as the difference between the relative change in quantity supplied and the product of the relative change in price and the elasticity of supply, as shown by equation (12) in chapter three. It should be noted that horizontal demand and supply shifts are the ones computed in this research other than verticals. The results of the outcome are presented in table 4 below:

Table 4: Supply and Demand Shifts, 2005-2017

year	Supply shift (%)	Demand Shift (%)
2005	0.00	0.00
2006	-6.31	7.03
2007	11.79	5.91
2008	-11.50	5.59
2009	12.42	-3.73
2010	-14.11	10.71
2011	-6.04	12.31
2012	12.55	-4.69
2013	12.96	-2.98
2014	-8.61	10.41
2016	3.32	-3.40
2015	2.63	5.26
2017	3,74	-0.95
Average	0.99	3.19

4.3 Discussions

From table 4, the reported results indicate the average annual supply shift as 0.99%, which implies that global coffee suppliers will produce almost 1% more coffee in one period than in the previous period when price is unchanged. However, supply shift varies between years with some years exhibiting growth (positive supply shift) and some exhibiting decline in supply (negative supply shift). The biggest amount of supply growth was recorded in 2013, 2009, and 2007 with 12.96%, 12.42 % and 11.79% global annual supply growth respectively. This implies that suppliers increased their output by at least 11% than in the previous period at a constant price.

The biggest decline in growth was recorded in 2010 and 2008 with -14.31% and -11.50% respectively, thereby implying that producers reduced their supply by at least 11% from the previous period even when prices never changed. This can imply inefficiency in production and low productivity. Given that most of the coffee producing countries are in the developing world, the effect of low levels of technology (Rice, 1999), climate change (Gay, Estrada, Conde, Eakin, & Villers, 2006) and other factors could have been in play.

With technology, it should be noted that most of the coffee producer in the developing world use labor intensive technology in most of their production stages. In Kenya for example, 50% of the technology employed from planting to harvesting is labor intensive (Gathura & Sciences, 2013), which is not sustainable enough to increase supply in periods of high demand.

On the side of climate change, it is known that coffee growth is most suitable in warm environments. In Veracruz, Mexico for example. It was estimated that the average temperatures that maximizes coffee production in summer and winter are 24.79 degrees and 20.03 degrees respectively (Gay et al., 2006). This implies that any temperatures below and above these averages will lower production. Therefore, supply will always shift negatively whenever temperatures diverge from the average which is necessary to maximiser the output.

In 2010 the relative increase in price is very high at 27.29% as shown in table 3. This could have caused some producers to expect further price increase, as it is the case in most agricultural commodity markets (Ezekiel, 1938), hence withholding production and plan to

supply more at a later date during further price increase, hence a fall in supply in 2011 by -6.04%.

The small average annual supply shift (0.99%) for period of 2005-2017 implies that the difference in positive growths and negative growths is very minimal. In the Equilibrium Displacement Model, increase in supply and a decrease in supply have different impacts on future prices. Therefore, frequent shifts in opposite directions (growth and negative growth) explains the unexplained price frequent fluctuations in coffee market. A growth in supply leads to excess supply that is sold at lower prices while a decline in supply create scarcity, which eventually pushes prices even higher.

Demand shift from period 2005 to 2017 also vary substantially. A series of growth and decline is also observed, and the average annual shift is 3.19%. This implies that on average importers are willing to take 3.19% more coffee in a given period than the previous period even when prices are held constant. 10.71% is the maximum annual growth which is the one that corresponds to 2010 and -4.69% of 2012 is the highest decline in global demand for coffee. On average the global demand for coffee is increasing each year. A bigger positive average annual growth implies that demand growth is relatively higher than a decline in demand. This can be explained by the level of necessity of coffee to world consumers (Chiciudean, Funar, & Chiciudean, 2013), the world population structure (Gutierrez, Villacorta, Cure, & Ellis, 1998), introduction of new market (Kim & Mauborgne, 1999) and other factors that affect demand for coffee other than product own price. Most of these factors were discussed in detail in chapter two.

However, since none of the periods exhibit zero shift, prices are also directly affected by the continuous shifts in demand through the Equilibrium displacement model. At a constant price and a given elasticity of demand, a positive shift in demand will result into competition on a given product, pushing prices higher and a fall in demand will force suppliers to sell at a lower price, hence lowering the price. Continuous shifts will push prices up and down thereby creating price instabilities in the coffee market. The results of table 3 indicates that supply of coffee shifts more than demand. Therefore, fluctuations in prices are influenced more from the supply side rather than demand side.

To be more precise, table 5 gives a real picture of the shifts if we consider 2005 as the base year and set it at 100 initial level of output. There after we accumulate the proceeding new

quantity levels by adding the percentage annual shifts in demand and supply in a given year to the previous level of output.

Table 5. Supply and Demand Growth Index, 2005=100

Year	Supply Growth	Demand Growth
2005	100.0	100.00
2006	93.69	107.03
2007	105.48	112.94
2008	93.98	118.53
2009	106.4	114.8
2010	92.29	125.51
2011	86.29	137.85
2012	98.84	133.13
2013	111.8	130.15
2014	103.19	140.56
2016	106.51	137.16
2015	109.14	142.42
2017	112.88	141.47
Average	0.99%	3.19%

The in table 5 above clarifies the results of table 4. In comparison with the base year 2005, supply growth varied above and below 100. This indicate substantial variations in supply over the years. Hence implying continuous increase and decrease in supply of coffee, thereby affecting coffee prices. On the demand side the index shows growth over 100 from 2005 to

2017. However, some declines in annual average growth were experienced in some years although their effects are not big enough to reduce the index below 100. This shows that demand is steadily increasing with only a few years of small decline.

4.4 Sensitivity Analysis:

Since the choice of elasticity parameters is based on the research by Akayima and Varangis (1990) where they examined the effect of the International Coffee Agreement’s export quota system on world coffee prices (Akiyama & Varangis, 1990). As it has been noted before that the price elasticity parameters of 0.35 and -0.23 for supply and demand respectively were the means of several elasticities. Therefore, it is a big concern to find out what happens to global average shifts at different values of elasticity parameters.

In verification procedure, I simply re-calculate the shifts by using different price elasticity parameters. The new elasticity parameters are same as those presented in table 2 of chapter 3 which represents the maximum and minimum elasticity values for both demand and supply. The results of the global average shifts are presented in table 6 and 7 below

Table 6: New Annual average supply Shifts.

Elasticity	Min=0.13	Mean=0.35	Max=0.95
Average annual supply Shift (%)	2.02	0.99	-1.82

Table 7: New Annual average demand Shifts

Elasticity	Min= -0.54	Mean=-0.23	Max=-0.08
Average annual Demand shift (%)	4.64	3.19	2.48

From table 5, the price elasticity of supply determined at the mean and at minimum are inelastic and they both give growth in supply of 2.02% and 0.99% respectively. This implies the results of the study can remain unchanged if the elasticity of supply remains inelastic, since both elasticity values give positive annual average shifts in supply.

On the other hand, the elastic supply of 0.95 determined at the maximum result into a negative annual average shift in supply which is different from the results obtained in the study that depended on the mean value. However, it remains a question of doubt for the elasticity value to be as elastic as 0.95 since it was recorded in the study of Akayima and Varangis 1990 as the price elasticity of supply for Burundi, a country with lower technology of production as compared to the main producer Brazil whose elasticity of supply was estimated as 0.36 in the same study.

From table 6 all estimates for annual average shift in demand are positive indicating an average growth in demand. All price elasticities of demand are inelastic with the most elastic one being -0.56. Since the nature of growth is the same for all possibilities, the results of our study on demand shift are reliable.

In the nutshell, both the results of the shift in demand and supply for coffee are reliable based on the comparisons from the results of the sensitivity analysis.

Chapter 5: Summary and Conclusion

5.1 Summary

This thesis consists of five chapters. Chapter one introduces the concept of coffee, its importance and the benefits the world's population derives from the commodity. It also introduces the problem statement where the concept of price fluctuation in coffee market is explained and how it has been experienced in different forms of coffee. Chapter one ends with the research questions which acts as the basis for this thesis.

Chapter two gives the literature review of the thesis. It starts by introducing the concept of demand and supply shift, the previous research that is based on the same concept as the one used in this thesis. It further gives the difference between demand/supply shift and change in quantity demanded/supplied. It still gives literature on the foundations of the studies concerning measurement of supply and demand. Chapter two is extended to give an over view of the world supply and demand in connection to coffee. Here, importers and exporters are mainly discussed to represent demand and supply respectively. More discussion on countries which export various forms of coffee is given, and finally the role of the ICA to impact coffee demand, supply and price has been discussed at the end of this chapter.

Chapter three is the methodology section of this thesis. It starts by introducing the concepts of demand shift and how it is estimated by an index approach that was first introduced by Marsh (2003). It later gives a mathematical derivation of the expression that measures demand shift. Furthermore, the concept of supply shift is also introduced in this section and later its expression derived. Lastly, chapter three gives an overview of the data used which includes both price, quantities and the elasticity parameters.

Chapter four shows the analysis, presentation of the results, discussion of the results and verification of the reliability of the results.

Finally, chapter five contain the summary of the thesis and the conclusion, that represent the general understanding of the outcome and some possible recommendation for further research that can stem from this thesis.

5.2 Conclusion.

Understanding the reason behind price volatility of agricultural commodities is a topic of debate among researchers and agricultural economists. In coffee market, prices are not stable. This thesis helps to explain the price uncertainties in the coffee market by looking at the shifts in demand and supply of coffee beans. This is achieved by answering the research questions such as: (1) what is the level and nature of demand and supply growth/ shift of coffee? and (2) what is the impact of supply and demand shift on coffee price fluctuations in the market?

By using an index approach developed by Marsh (2003), I examined the global supply and demand growth for coffee beans. The results indicate that Supply of coffee shifts substantially over time. This give an average annual shift in supply of 0.99%, thereby implying that producing countries on average increase their production by almost 1% in one period than in the previous period at a constant price. Demand shift also vary considerably over time with an average annual shift of 3.19%. Therefore, importers take 3% more coffee in one period than the previous when price is unchanged.

Since neither supply nor demand for coffee is constant over the period, prices are directly affected. Therefore, continuous coffee price fluctuations are partly explained by continuous shifts in demand and supply.

However, the shifts in supply for coffee varies more than the shift in demand. This is represented by a smaller average annual shift in supply relative to demand shift. Continuous patterns of growth and declines are more experienced from the supply side than the demand side over the period from 2005 to 2017. This implies that the changes in prices are essentially more influenced by shifts in supply than shifts in demand.

This research can be extended by disentangling the effects on either supply or demand which are responsible for respective shifts. Factors such as substitution effect, income effect and others can be studied independently using a similar approach to verify how much they influence demand shifts. Also, different exogenous factors can be studied independently with the same approach to see how much each influence supply shift of coffee given data availability. This thesis integrates the effect of all factors without establishing the effect of each individual economic or structural factors.

Refrencess

- Akiyama, T., & Varangis, P. N. J. T. W. B. E. R. (1990). The impact of the International Coffee Agreement on producing countries. *4*(2), 157-173.
- Balassa, B. J. W. d. (1990). Incentive policies and export performance in Sub-Saharan Africa. *18*(3), 383-391.
- Bettendorf, L., & Verboven, F. J. E. R. o. A. E. (2000). Incomplete transmission of coffee bean prices: evidence from the Netherlands. *27*(1), 1-16.
- Brækkan, E. H. (2014). Why do Prices Change? An Analysis of Supply and Demand Shifts and Price Impacts in the Farmed Salmon Market.
- Brækkan, E. H., Thyholdt, S. B., Asche, F., & Myrland, Ø. J. E. R. o. A. E. (2018). The demands' they are a-changin'.
- Brækkan, E. H., & Thyholdt, S. B. J. M. R. E. (2014). The bumpy road of demand growth— an application to Atlantic salmon. *29*(4), 339-350.
- Bunn, C., Läderach, P., Rivera, O. O., & Kirschke, D. J. C. C. (2015). A bitter cup: climate change profile of global production of Arabica and Robusta coffee. *129*(1-2), 89-101.
- Charveriat, C. J. O. P., Practice: Agriculture, F., & Land. (2001). Bitter coffee: How the poor are paying for the slump in coffee prices. *1*(1), 31-44.
- Chiciudean, D., Funar, S., & Chiciudean, G. J. B. U. H. (2013). Study Regarding the Influence of Country of Origin (COO) over the Consumer Decision-Making Process in Buying Food. *70*(2), 407-408.
- Daniel, W. (2019). Coffee Imports by Country. Retrieved from <http://www.worldstopexports.com/coffee-imports-by-country/>
- Daviron, B., & Ponte, S. (2005). *The coffee paradox: Global markets, commodity trade and the elusive promise of development*: Zed books.
- Deaton, A., & Laroque, G. J. T. R. o. E. S. (1992). On the behaviour of commodity prices. *59*(1), 1-23.
- Dena, H. (2018). What is Arabica Coffee? Arabica vs. Robusta: 11 Tasty Differences. Retrieved from <https://enjoyjava.com/arabica-coffee/>
- Durevall, D. J. F. P. (2007). Demand for coffee in Sweden: The role of prices, preferences and market power. *32*(5-6), 566-584.
- Ezekiel, M. J. T. Q. J. o. E. (1938). The cobweb theorem. *52*(2), 255-280.
- Gathura, M. N. J. I. J. o. A. R. i. B., & Sciences, S. (2013). Factors affecting small-scale coffee production in Githunguri District, Kenya. *3*(9), 132.

- Gay, C., Estrada, F., Conde, C., Eakin, H., & Villers, L. J. C. C. (2006). Potential impacts of climate change on agriculture: a case of study of coffee production in Veracruz, Mexico. *79*(3-4), 259-288.
- Ghoshray, A. J. B. o. E. R. (2010). The extent of the world coffee market. *62*(1), 97-107.
- Goddard, E., & Akiyama, T. J. A. E. (1989). United States demand for coffee imports. *3*(2), 147-159.
- Gutierrez, A. P., Villacorta, A., Cure, J. R., & Ellis, C. K. J. A. d. S. E. d. B. (1998). Tritrophic analysis of the coffee (*Coffea arabica*)-coffee berry borer [*Hypothenemus hampei* (Ferrari)]-parasitoid system. *27*(3), 357-385.
- Hughes, J. J. J. A. J. o. A. E. (1969). Note on the US Demand for Coffee. *51*(4), 912-914.
- ICO. (2007). International Coffee Agreement 2007. Retrieved from <http://www.ico.org/ica2007.asp>
- ICO. (2019). Coffee Market Report: Coffee prices diverge in February 2019. Retrieved from <http://www.ico.org/documents/cy2018-19/cmr-0219-e.pdf>
- Kim, W. C., & Mauborgne, R. J. H. b. r. (1999). Creating new market space. *77*(1), 83-93.
- Lewin, B., Giovannucci, D., & Varangis, P. (2004). Coffee markets: new paradigms in global supply and demand.
- Marsh, J. M. J. A. J. o. A. E. (2003). Impacts of declining US retail beef demand on farm-level beef prices and production. *85*(4), 902-913.
- Marshall, A. (1961). *Principles of economics: An introductory volume*: Macmillan London.
- Mehta, A., & Chavas, J.-P. J. J. o. D. E. (2008). Responding to the coffee crisis: What can we learn from price dynamics? , *85*(1-2), 282-311.
- Mikesell, R. F. J. T. A. E. R. (1963). International commodity stabilization schemes and the export problems of developing countries. 75-92.
- Mussatto, S. I., Machado, E. M., Martins, S., Teixeira, J. A. J. F., & Technology, B. (2011). Production, composition, and application of coffee and its industrial residues. *4*(5), 661.
- Muth, R. F. J. O. E. P. (1964). The derived demand curve for a productive factor and the industry supply curve. *16*(2), 221-234.
- Osorio, N. J. I. C. O., London. Available online: [http://www. ico.org/documents/globalcrisis.pdf](http://www.ico.org/documents/globalcrisis.pdf). (2002). The global coffee crisis: a threat to sustainable development.
- Pichop, G. N., & Kemegue, F. M. J. S. W. b. j. (2005). International coffee agreement: Incomplete membership and instability of the cooperative game. *2006*.

- Ponte, S. J. W. d. (2002). The latte revolution? Regulation, markets and consumption in the global coffee chain. *30*(7), 1099-1122.
- R. Carter, H., William E, G., & Guay, C. L. (2018). *Principles of Econometrics*. (5th ed.).
- Rice, R. A. J. G. R. (1999). A place unbecoming: the coffee farm of northern Latin America. *89*(4), 554-579.
- Slob, B., Osterhaus, A. J. B. U. S., & Challenges of Fair Trade, B. F. T. A. O. (2006). A fair share for coffee producers.
- Smith, A. (1863). *An Inquiry into the nature and causes of the Wealth of Nations: With a life of the author, an introductory discourse, notes, and supplemental dissertations By JR M'Culloch*: Ad. and Ch. Black.
- Smith, R. F. (1985). A history of coffee. In *Coffee* (pp. 1-12): Springer.
- Subervie, J. J. J. o. A. E. (2008). The variable response of agricultural supply to world price instability in developing countries. *59*(1), 72-92.
- Sun, C., & Kinnucan, H. W. J. S. J. o. A. F. (2001). Economic impact of environmental regulations on southern softwood stumpage markets: a reappraisal. *25*(3), 108-115.
- Tomek, W., & Robinson, K. (2003). *Agricultural Product Prices*. NY. In: Cornell University Press.
- Trostle, R. (2010). *Global agricultural supply and demand: factors contributing to the recent increase in food commodity prices (rev: DIANE Publishing)*.
- Van der Vossen, H. J. E. A. (2009). The cup quality of disease-resistant cultivars of Arabica coffee (*Coffea arabica*). *45*(3), 323-332.
- Wohlgenant, M. K. J. T. o. h. o. t. e. o. f. c., & policy. (2011). Consumer demand and welfare in equilibrium displacement models. 0-44.

Appendix

Data definition

Supply = Total production of all coffee producing countries for all forms of coffee in a thousand 60kg bags.

Demand = Total imports in a thousand 60kg bags of all for all forms of coffee by all consuming countries.

Price = ICO composite indicator price which is the average price of all forms of coffee, in US cents per pound (later converted to US cents per kg)

Table for Production(supply), Imports (demand) and Price (ICO composite Indicator price)

Year	Supply (thousands 60kg bags)	Demand (in thousand 60kg bags)	Price (in US cents per pound)
2005	116,225	96,376	89.36
2006	111,803	101,567	95.75
2007	129,858	104,655	107.68
2008	121,920	106,758	124.25
2009	134,120	104,513	115.67
2010	128,006	109,145	147.24
2011	139,486	111,812	210.39
2012	144,448	113,171	156.34
2013	151,258	115,931	119.51
2014	154,066	120,028	155.26
2015	148,559	121,384	124.67
2016	153,561	127,178	127.31
2017	159,047	126,110	126.69