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The Role of Futures Prices in Pricing Commodity Exports of Developing Countries

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THE ROLE OF FUTURES PRICES IN PRICING COMMODITY EXPORTS OF
DEVELOPING COUNTRIES

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ABSTRACT

The purpose of this thesis is to study the empirical linkages between the ICE/NYBOT nearby futures prices for coffee and cash prices in selected Latin American countries. This theme was entertained in Fortenbery and Zapata (2004a) and subsequently by Fortenbery and Zapata (2014b) and Li and Fortenbery (2013). This thesis expands the data period from January 1990 to May 2013 and adds new prices, producer and export prices, relative to the first paper. It also adds Brazil and Colombia to the country mix. Cointegration methodology is used to study such price linkages. Implications for speculative activity are derived in light of the last two cited papers above.

Cointegration tests suggest that New York nearby futures prices are strongly linked with export prices in Brazil and Guatemala as well as with producer prices in Brazil and Honduras. Producer and export prices were cointegrated with each other only in Brazil, suggesting that Brazil's local prices for coffee at different market levels are strongly linked and causal in at least one direction. Optimal lag lengths used for cointegration tests imply that information transmission between the cointegrated series is slower than expected when compared to some US commodity markets that can reflect price changes in up to 3 days. Impulse response functions from error correction models and vector autoregressive models confirm the causal nature of the relationship between coffee futures prices and cash prices in the four countries.

When considering the implications of this research, preliminary results from a simple regression analysis suggest that, consistent with Li and Fortenbery (2013), increases in intertemporal spreads by noncommercial speculative activity significantly decreases price volatility. For countries where coffee contributes to significant economic activity, and with a

large number of small producers, studying the dominant-satellite relationships between cash-futures prices for coffee price risk management seems natural. Hedging in futures markets or distributing futures price information to local cash market participants in developing countries could improve pricing performance of local cash markets.

CHAPTER 1: INTRODUCTION

1.1 Developing Countries and Coffee

Agricultural commodities are not only a source of food for families and communities but can also be a strong basis of livelihood. They can be used as raw materials for processors and provide significant export earnings for nations. It is estimated that out of the 2.5 billion people that engaged in agriculture in developing countries, about one billion derive a substantive part of their income from export commodities. For many developing countries, commodities remain the backbone of their economies. Out of the total 141 DCs, 95 depend on commodities for at least 50 percent of their export earnings (Common Fund for Commodities - CFC, 2005). Brazil, Colombia, Guatemala and Honduras have a GNI of US$ 11,905 and less and are defined as developing as specified by the World Bank in 2012 (The International Statistical Institute, 2014).

One of the world's most widely traded commodities is coffee. Coffee beans when roasted produce a flavorful, aromatic and caffeine filled drink that is popular all over the world, with over 600 billion cups sold each year (ICO, 2014). Two botanically different trees can produce coffee. Arabica coffee trees produce coffee beans that are more labor intensive in its cultivation and are grown at higher altitudes. This coffee is milder, more aromatic and more complex than its Robusta counterpart (ICE, 2014). For many countries, over 50% of their total export earnings can be accounted for by coffee exports. In fact, the top 10 Arabica coffee exporting countries in the world are considered developing. The USDA estimates that approximately 77 million 60 Kilogram bags were exported from the top 10 coffee exporting countries in 2011-2012. Figure 1 depicts the list of these countries and the amount of coffee they exported in 2011-2012,with

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Brazil, Vietnam, Colombia, Indonesia, Honduras, and Colombia being the top six exporters of Arabica coffee in that year.

■ Brazil	25,930
■ Vietnam	19,000
■ Colombia	7,500
■ Indonesia	5,750
■ Honduras	3,925
■ Guatemala	3,700
■ Peru	3,700
■ India	2,900
■ Ethipia	2,800
■ Uganda	2,000
■ Other	14,041
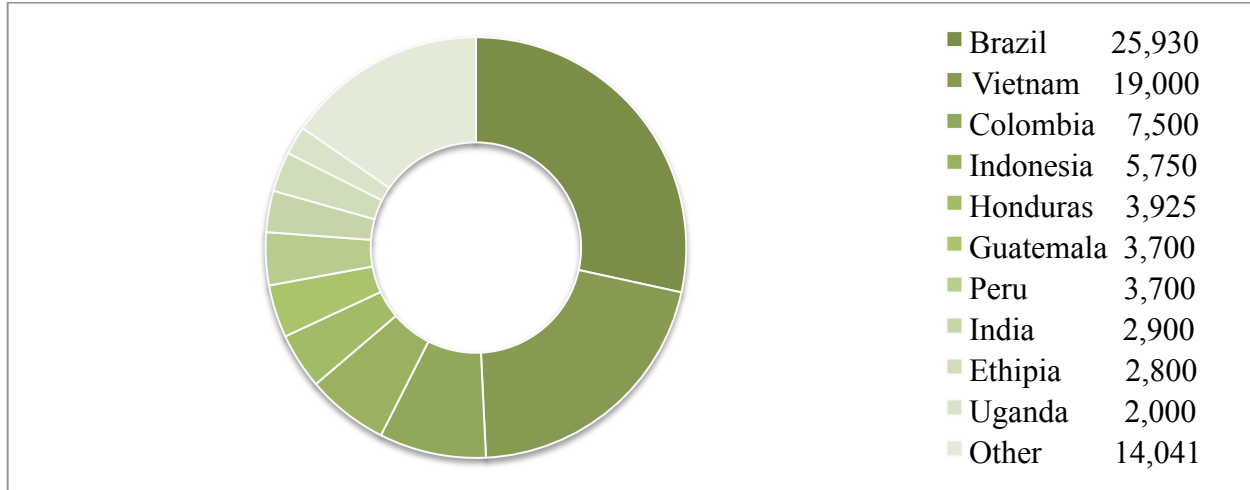
Figure 1. 2011-2012 USDA Arabica Coffee Export Estimates (1,000 60-Kilogram Bags).
Source: U.S. Department of Agriculture 03/27/2014.

The USDA also estimates that approximately 91 million 60-Kilogram bags of Arabica coffee were imported by nations 2011-2012 alone. Figure 2 depicts in detail what countries made the biggest coffee imports.

■ EU-27	43,000
■ U.S.	21,500
■ Japan	5,800
■ Switzerland	2,300
■ Algeria	2,025
■ Canada	2,000
■ Korea	2,000
■ Russia	1,700
■ Australia	1,125
■ Malaysia	1,000
■ Other	8,320
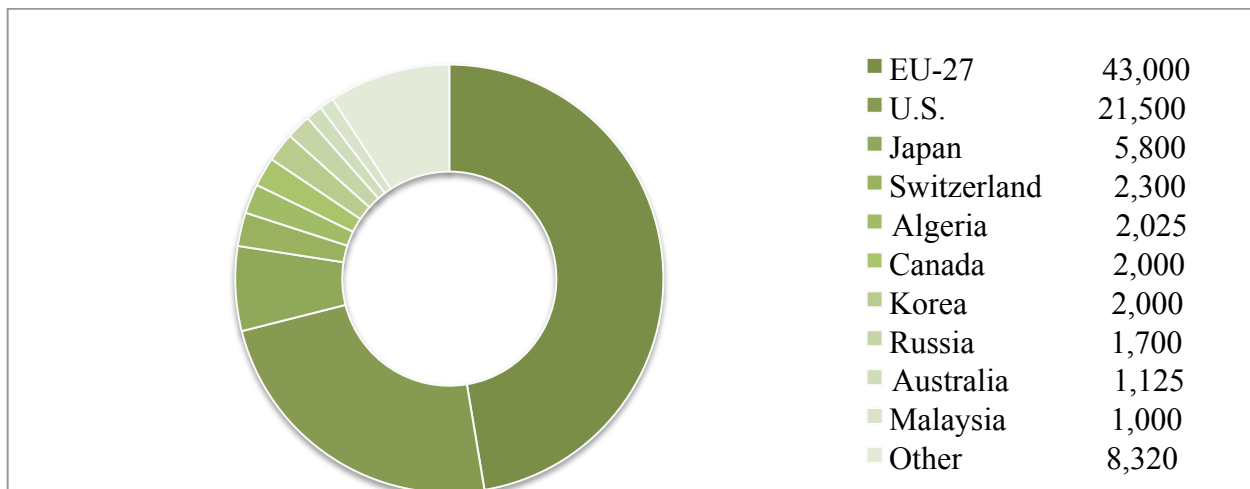
Figure 2. 2011-2012 USDA Arabica Coffee Import Estimates (1,000 60-Kilogram Bags)
Source: U.S. Department of Agriculture 03/27/2014.

These countries that dominate coffee imports produce almost no coffee at all. There are significant income and wealth disparity between the coffee importing and exporting countries. That is why even though coffee prices might not be such a big concern for the importing countries, it is a significant issue for the developing countries who rely on coffee exports for foreign exchange earnings.

1.2 Importance of Coffee in Honduras, Guatemala, Colombia and Brazil

Coffee is one of the most significant exported commodities by Brazil Colombia, Guatemala and Honduras, and as previously noted, these are among the top exporting countries of Arabica coffee. Naturally, coffee plays a significant role in the composition of the Gross Domestic Product and Agricultural Gross Domestic Product of these countries, as can be seen in Table 1. Coffee makes up the highest percentage of both GDP and AGDP for Honduras with 7.37% and 48.17 %, respectively. Honduras is similarly followed by Guatemala with 2.49% and 21.08%; Colombia with 0.86% and 12.53%; and finally Brazil with 0.35% and 6.41%. It is important to emphasize, however, that the dollar value of coffee's contribution to GDP and AGDP is the highest in Brazil, followed by Colombia, Honduras and lastly Guatemala.

Table 1. The Role of Coffee in GDP and AGDP.

Country	GDP	% GDP From Agriculture	Value of Agricultural GDP	% of GDP from Coffee	% of AGDP from Coffee	Value of Coffee in GDP
Brazil	$2,476,652,189,879.72*	5.46%*	$135,132,855,525.84	0.35%**	6.41%	$8,668,282,664.58
Colombia	$336,559,866,920.82*	6.86%*	$23,101,027,719.79	0.86%**	12.53%	$2,894,414,855.52
Guatemala	$47,688,885,121.16*	11.81%*	$5,631,891,883.73	2.49%**	21.08%	$1,187,453,239.52
Honduras	$17,588,097,149.75*	15.30%*	$2,690,837,498.33	7.37%**	48.17%	$1,296,242,759.94

Data: World Bank* and ICO**.

It is commonly known that Brazil is the largest coffee producer in the world. The USDA's Foreign Agricultural Service says coffee production estimates will be about 56.10 million bags. Roughly 80 percent of that though has already been marketed, as growers have

been resistant to sell the crop in expectance of higher prices. The International Coffee Organization ICO estimated that total world consumption of coffee for 2012 will be around 142 million bags. Out of this amount 31 million bags come from Brazil.

As for Colombia, information from the USDA's Foreign Agricultural Service says that the coffee sector has historically played a large role in Colombia's economic success, providing a livelihood for over 500 thousand producers and their families. However, these coffee producers claim that current production costs have created an unprofitable environment for growers. A strong Colombian peso has worsened the fall in price. This led to a subsidy program that will provide growers a direct payment per bag subsidy. It is estimated that in 2013/2013 exports will reach 8.2 million bags, increasing further for 8.9 million bags in 2013/14.

The National Coffee Association in Guatemala (ANACAFE) estimates that about 276,000 hectares of the country are planted with coffee. The 2011-2012 coffee harvests generated an export value of approximately $986 million. However, a coffee eating fungus known as Roya has heavily affected this year's harvest productivity. This decrease in productivity coupled with falling international coffee prices can have a serious effect on the countries revenue in 2014, and it can be even more significant if proper price risk management strategies are not implemented.

According to the latest data from the Central Bank of Honduras, coffee accounts for over 1/3 of the total export revenues from agricultural products. The USDA's Foreign Agricultural Service estimates that the coffee sector employs approximately 30% of the economically active population in Honduras. Naturally, coffee price fluctuations in the world market have a strong economic impact on coffee producing countries. Thus, understanding coffee price dynamics is

essential for coffee producers in those countries, perhaps more so than to consumers in importing countries.

1.3. Cash Markets, Futures Markets and Arbitrage

The important role of world coffee prices to a coffee exporting country brings up the empirical question of how coffee prices are determined (cash Prices) and discovered (futures prices). According to Catlett and Libbin(1999), Cash and futures markets are two separate, yet very related, markets that trade commodities. Whereas the cash market refers to the actual buying and selling of physical commodities in the present, the futures market deals with the buying or selling of future obligations to make or take delivery of the underlying asset. A cash market transaction occurs in the present, but a futures market transaction is an agreement for an exchange of the underlying asset in the future.

Prices in the cash and futures market of a certain commodity differ from each other as a result of the difference in timing of delivery. This difference in prices is called the basis. This is because of the costs of carry (e.g., storage and insurance) that come together withholding a commodity for future delivery. As a contract approaches maturity, the futures price and spot price are expected to converge. This is because at the maturity date, the spot and futures price should be the same. Cost of storage, for example, plays a significant role as a cost of carry. Storage costs are usually expressed as a percentage of the spot price and is added to the cost of carry to physical commodities such as is coffee. Therefore, adding the cost of storage to a sport price and accounting for other carrying costs will yield the expected futures price.

Arbitrage is the practice of capitalizing from the price difference in two or more markets by simultaneously buying and selling an asset. Garner(2010) says that the true definition of

arbitrage is risk free profit. However, the opportunities for arbitrage are extremely uncommon and are normally eliminated in a matter of seconds. Yet, without arbitrage there would be no incentive for future and cash market prices to be correlated.

Arbitrage is what enables efficient market pricing for hedgers and speculators. In other words, if speculators were to notice that the price difference between the cash and futures prices of a commodity exceeds the carrying costs, they will buy the undervalued (cash market commodity) and sell the overvalued (futures contract written on underlying commodity). This causes the spread between the prices in the two markets to decrease until it becomes equal to the cost to carry.

1.4. Coffee C Contract

Coffee futures first started trading in the New York Cocoa Exchange in 1882. They then traded in the Coffee, Cocoa and Sugar Exchange, followed by the New York Board of Trade and are presently traded in the ICE Futures Exchange. The C contract in New York is the benchmark for world coffee prices. In other words it is what Arabica Coffee producers and buyers worldwide utilize as reference when fixating the price for which they will buy or sell their coffee. Its depth, liquidity, volatility and diversifying properties the contract has also made the contract a preferred instrument among hedgers and speculators (ICE Futures U.S., 2014).

The price of the coffee futures contract has been extremely volatile over the years. This can be clearly observed in the contrast between the quoted prices for February 2002 where the contract was at its lowest level since the 1930's against the May 2011 contract price, which was highest level since 1997. Coffee is very sensitive to price shocks, and past examples of this have been freezes in Brazilian highlands disrupting the commodities main supply source or new

exporters like Vietnam buying market share through lower prices (ICE Futures U.S., 2014).

Figure 3 depicts the changes in coffee prices since 1972 in both current and constant dollar

terms.
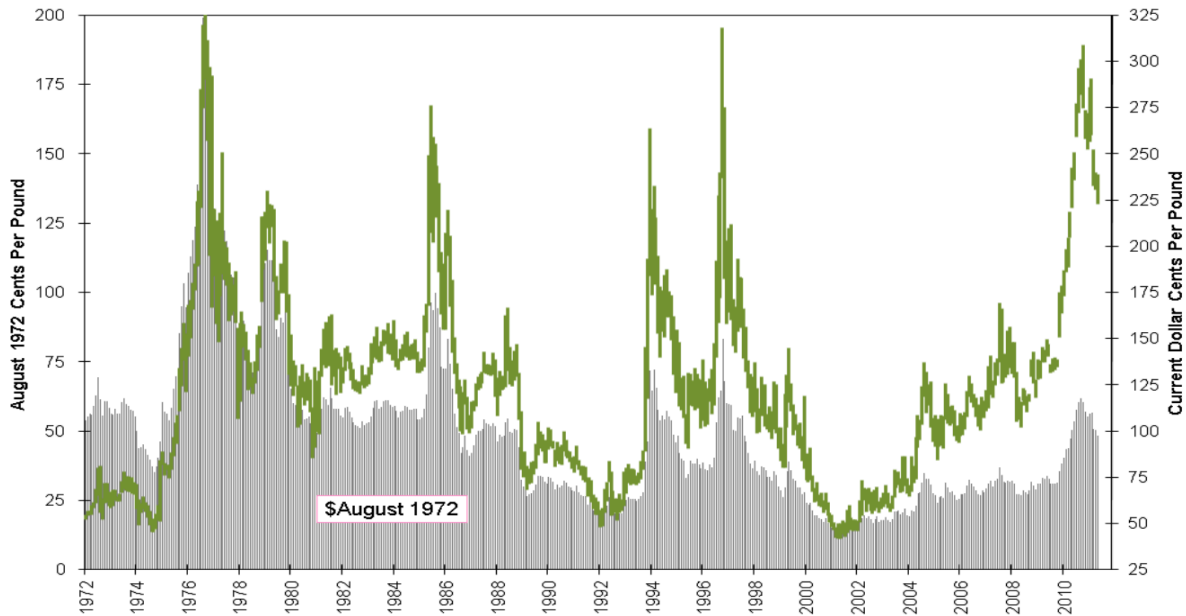
Figure 3. Price of Coffee C.
Source: Intercontinental Exchange.

The contract for coffee futures offered by the Intercontinental Exchange is delivered

physically. Its key specifications are given in table 2.

Table 2. ICE Futures U.S. Coffee C Futures Specification.

Hours	0330 Eastern Standard Time to 1400 Eastern Standard Time.
Symbol	KC.
Size	37,500 pounds.
Quotation	Cents and hundredths of a cent per pound to two decimal places.
Contract Cycle	Mar - May - Jul - Sep - Dec
Minimum Fluctuation ('tick')	.05 cent; each .05 cent = $18.75 fluctuation.
Settlement	Physical delivery.
Grade	A Notice of Certification is issued based on testing the grade of the beans and by cup testing for flavor. The Exchange uses certain coffees to establish the "basis;" those judged superior and inferior receive a premium and a discount, respectively.

Table 2. Continued.

Deliverable Growths (Differential: Country)	Basis: Mexico, Salvador, Guatemala, Costa Rica, Nicaragua, Kenya, New Guinea, Panama, Tanzania, Uganda, Honduras and Peru Plus 200 points: Columbia. Minus 100 points: Venezuela, Burundi and India. Minus 300 points: Rwanda. Minus 400 points: Dominican Republic and Ecuador. Minus 900 points: Brazil (effective with March 2013 delivery)
Delivery Points	Exchange licensed warehouse in port of New York (at par); ports of New Orleans, Houston, Bremen/Hamburg, Antwerp, Miami and Barcelona at discount of 1.25 cents per pound.
Daily Price Limit	None
First Notice Day	Seven business days prior to the first business day of the month.
Last Trading Day	One business day prior to the last notice day.
Last Notice Day	Seven business days prior to the last business day of the month.

Source: Retrieved from Intercontinental Exchange 03/27/2014 at https://www.theice.com/productguide/ProductSpec.shtml?specId=15.

1.5. Price Discovery in Latin American DCs

Do futures market prices for coffee help discover local market coffee prices? Whether it is for the producers, the exporters or even the government, agricultural commodity futures prices play an important role for the commodity market participants in developing countries that are particularly reliant on commodity exports. If the futures prices, which are a benchmark for export prices, vary significantly or if they cannot be appropriately predicted, the DC's ability to pay foreign debts may be threatened due to increasing foreign exchange revenue risk. For exporters, price volatility influences the variability of cash flows and inventory value. In these DCs the producers of agricultural commodities usually have poor access to effective price risk management instruments and price information mechanisms which may lead them to recur to crop diversification in order to obtain some type of revenue stability. By doing this they receive none of the benefits that can come through specialization and producing just one commodity (Dehn, 2000).

Futures markets give two major contributions to economic activity, risk transfer and price discovery (Garbade & Silber, 1983). Risk transfer refers to the use of futures contracts by

hedgers to shift risk to others. Price discovery on the other hand, refers to the use of futures prices to determine the expectations of future cash prices at a specific delivery period (Schroeder & Goodwin, 1991). The use of futures markets provides the primary benefits of informed production, storage and processing decisions of the underlying commodities (Black, 1976). Therefore, it is crucial for commodity exchanges to effectively serve their price discovery function.

Analyzing the price discovery relationship between futures and cash prices usually focuses on two questions (Garbade & Silber, 1983). The first is the *unbiasedness hypothesis* or if the futures prices are unbiased estimators of future cash prices. This is usually evaluated by looking for the existence of cointegration between cash and futures prices. The second is the *prediction hypothesis* or if the futures prices serve as useful predictors for future cash prices, in other words testing if the futures market leads the cash market in price discovery.

It is clear that the agricultural export market of Honduras, Guatemala, Colombia and Brazil all depend on coffee to an extent that relying on a coffee futures contract that is not effectively serving for price discovery could hinder their economic development while depriving themselves from the potential benefits of establishing a local exchange that does efficiently perform the required functions of a futures market. In other words, if the markets are not linked, would it be beneficial for these countries to establish their own exchange for the purpose of it performing a more efficient price discovery function for the agricultural commodities their economy relies upon?

1.6. Hedging

According to Catlett and Libbin (1999) hedging is simply shifting the risk of price change in the cash market to the futures market. In other words establishing a position in the futures market opposite from the one held in the spot (cash) market. A short hedge exists when a producer or a seller of commodities, trying to reduce price risk during the production or storage of a commodity, sells an equivalent quantity of the commodity in the futures market. At a date closer to the time you price the physical commodity, you would buy back the futures contracts you initially sold.

On the other hand, if you are buyer of commodities and want to hedge your position, you would initially buy futures contracts for protection against rising prices. At a date closer to the time you plan to actually purchase the physical commodity, you would offset your futures position by selling back the futures contracts you initially bought. This type of hedge is referred to as a long hedge.

In a perfect hedge, the loss in the cash market is exactly offset by the gain in the futures market. Hedging is possible because of the relationship that exists between futures prices and cash prices for the commodity traded. The basis, or the difference between the futures and the cash price of the commodity, narrows as the delivery month is approached, and it approaches zero at the delivery point at the maturity of the contract. Long hedgers benefit from a weakening basis while short hedgers benefit from a strengthening basis.

1.7. Problem Statement

It is worth addressing if market instruments, such as futures contracts in established commodity exchanges such as the NY Coffee C, can be effectively used to stabilize agricultural

sector incomes for coffee exporting countries. For this to be the case the futures market in NY must contribute positively to overall price discovery in DCs cash markets. However, the overall role of the Coffee C contracts in discovering cash prices in exporting countries is not well understood. Research suggests that for a hedge to reduce price risk there must be a stable and predictable relationship between the movements of cash and futures prices (Fortenbery Zapata and Armstrong, 2005). While there has been a significant amount of research that evaluates this relationship in futures and cash prices of commodities produced in the United States, work that examines the price relationships between the futures markets in developed countries and cash prices for DCs commodities is less extensive (Fortenbery and Zapata, 2004).

Smaller export countries are subjected to an even higher price risk for commodities than the overall sector (Fortenbery and Zapata, 2004). If the futures/cash price relationship is found to be stable and predictable, then developing countries could effectively use futures positions to minimize the cash price risk of their major exporting commodities.

This research will test the empirical linkage between the nearby futures prices for coffee in New York and exporting and producer prices in Brazil, Colombia, Honduras and Guatemala. This will serve to give an insight on whether the New York futures contract for coffee offers hedging opportunities for selected countries in central and South America. The linkage between export and producers prices will also be evaluated. This research will analyze if there is evidence of excessive speculation in the futures market that may destabilize cash market prices. If excessive speculation exists, it may be an incentive to develop domestic futures markets even when the markets prove to be linked with the NY coffee contract.

1.8. Justification

In February 2002 world coffee prices were at their lowest levels since the 1930s. By comparison in May 2011 coffee prices were at their highest levels since 1997. Substantial price volatility that affects commodities is obviously an issue, one that is intensified in developing countries (DCs) because of the lack of other sources of price formation. Because of volume of trade and other requirements, it is nearly impossible for small producing countries to set up their own exchanges, leaving them dependent on other exchanges for price discovery. The strength of the relationship between cash prices and futures prices for coffee in foreign exchanges can serve to determine whether producers and any commercial trade should rely on futures prices in setting local cash prices. With supply management schemes no longer being acceptable methods for price risk management, only if the already existing futures markets can prove to be the center for price discovery for DCs can they effectively seek market-based solutions like forward contracting and hedging in these futures markets. For countries like Brazil, Colombia, Honduras and Guatemala who are residual suppliers, the price discovery function of such exchanges can also result in more efficient use of resources in production and an effective supply chain.

The main benefactors from this thesis will be producers, consumers, processors and exporters from developing countries that have a stake in the coffee industry and may be potential actors in agricultural commodity exchanges. If the futures market in New York does prove to be the center of price discovery for the cash markets in Brazil, Colombia, Honduras and Guatemala, for consumers, processors and exporters with a stake in these DCs coffee markets, the findings of this study can serve as a basis for recommending market based alternatives for price risk management. This thesis research can serve as a point of further empirical evidence on the usefulness of futures market prices in New York for pricing country specific commodities.

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According to the ICE/NYBOT contract specifications, Brazil, Colombia, Guatemala and Honduras are "deliverable growths," with Brazil at a 900 point discount, Colombia at 200 point premium, and Guatemala and Honduras at par for exchange-grade green beans. Thus, a-priori, there is an expectation that ICE/NYBOT futures market could be serving a dominant price discovery role in setting local (country specific) cash prices.

If the prices in the futures market and the cash markets prove to not be significantly linked or if it appears to be evidence of excessive speculation in the futures market is destabilizing the cash market prices, then it would mean that forward contracting would not serve to stabilize agricultural sector incomes. This thesis would serve to suggest to economic agents in the DC's coffee market along with the government officials and policy makers interested in some sort of price stability to consider futures markets for market pricing and price risk management in the coffee industry.

1.9. Research Objectives

The main objective here is to build on the work of Fortenbery and Zapata (2004) and examine the statistical relationship between the futures contracts for Coffee C and cash prices with the most recent data. This research adds to Fortenbery and Zapata by examining the statistical relationships between the futures contract for coffee, FOB export prices and producer prices for Brazil, Colombia, Honduras and Guatemala. The second objective is to search for evidence that may point to the existence of excessive speculation in the coffee contract traded in New York, which may cause an increase in the volatility of futures prices.

1.10. Specific Objectives

1.10.1 To perform a comparative analysis of the statistical relationship between futures prices, producer and FOB export prices for Brazil, Colombia, Guatemala and Honduras.

1.10.2. To test for evidence that may point to the existence of excessive speculation in the coffee contract traded in New York (ICE/NYBOT, Coffee C Futures).

1.11. Research Questions

The study addresses the following research questions:

1.11.1. Based on cointegration analysis of coffee cash prices and nearby futures prices, is the foreign futures Coffee C contract and the producer prices in the above countries closely linked?

1.11.2. Based on cointegration analysis of coffee cash prices and their corresponding futures contract, is the foreign futures Coffee C contract and the FOB export prices in the DCs closely linked?

1.11.3. Are the producer prices and the FOB export prices in the DCs cointegrated?

1.11.4. Does excessive speculation contribute to overall price volatility?

1.12. Research Hypotheses

Based on the research questions and literature review, the study addresses the following research hypotheses:

1.12.1. The coffee futures market in NYBOT does not significantly play a coffee price discovery function for producer prices in Honduras, Guatemala, Colombia and Brazil for coffee prices.

1.12.2. The coffee futures market in NYBOT does not significantly play a coffee price discovery function for FOB export prices in Honduras, Guatemala, Colombia and Brazil for coffee prices.

1.12.3. The coffee FOB export prices and producer prices in Honduras, Guatemala, Colombia and Brazil are not cointegrated

1.12.4. There is no evidence of excessive speculation in the ICE coffee futures contract.

CHAPTER 2: LITERATURE REVIEW

2.1. History of Price Risk Management Methods and DCs

For decades, economists have debated about what the ideal risk management policy for Developing Countries should be as well as what effect and impact it might have on those who implement it. Massell (1969) examined the welfare effects of price stabilization through the public management of buffer stocks in a model containing both producers and consumers. This was one for the first suggested policies meant to manage commodity price risk. To measure welfare gain, Massell (1969) used the expected value of the change in consumer and producer surplus to suggest that price stabilization would result in a gain to producers and a loss to consumers if you ignore the effects of variance on consumer's and producer's income. However, with an increasing expected value of producer income variance, producers might on balance lose welfare (Massell, 1969).

In 1981 Newberry and Stiglitz published a book titled The Theory of Commodity Price Stabilization that unlike previous strategies looked into the effects of not eliminating but only reducing price volatility. They thought that complete price stabilization was neither feasible nor desirable. They concluded that reducing volatility did not affect consumers but it did decrease producer income as they were left with lower average earnings. Gemill (1985) would later challenge this idea by suggesting an alternative strategy in which individual producers would instead of taking collective action make individual forward contracts. He examined whether or not the cost of obtaining a level insurance on export earnings is less with an international buffer stock than with an individual forward contract when dealing with commodities such as sugar, coffee and cocoa; coffee being of significance for this thesis. Gemill used earlier work from Nguyen (1980) to first theoretically analyze the costs and benefits of partial price stabilizing

buffer stocks. He then made an analysis of costs and benefits of forward trading. Finally, he used theoretical analysis to calculate the costs and benefits for his sample of countries.

Of the three commodities considered by Gemill, for a price stabilization program, sugar showed the largest relative costs and benefits due to its greater level of earning instability. For this reason using forward contracting to obtain export earning insurance was significantly cheaper. Sugar was also the only case where the risk benefits of either instrument seem likely to exceed the cost by a reasonable margin. For coffee in general the expenses to maintain a buffer stock program outweighed the benefits it produced. Forward contracting proved to be a much more cost effective method for the six countries examined by Gemill. However, for three of these six countries, forward trading for coffee could not attain the level of risk benefit that is attainable with a buffer stock program.

Recent policies implemented by DCs focus on liberalizing markets and removing state intervention (Morgan, Rayner, & Vaillant, 1999). These policies leave exporters exposed to a greater price risk. For this reason market based solutions and risk management instruments are replacing supply management schemes. As mentioned earlier, commodities play a significant role in the exports of DCs.

2.2. Existing vs. New Futures Markets

Morgan, Rayner and Vaillant discuss futures markets and their possible use as trading instruments by traders or group of traders in DCs. They also look into whether DCs should establish new exchanges domestically or if the existing ones located in developed countries offer ideal hedging opportunities.

Morgan et al. point out that there is an implied demand for the use of futures markets by DCs, either foreign or domestic, due to their export revenue flows needing protection against price variability. The issue that arises when hedging in a foreign market is that the DCs must attempt to manage not only the price risk but also exchange rate risk between the developed country and itself. Creating a local futures market that trades future contracts priced in local currency is very expensive and requires a well-developed financial sector to support a well-defined legal and regulatory system. The financial sector is needed to bring forth the liquidity that the futures market requires to survive and effectively provide their price insurance and price discovery roles. The decision of which type of futures market to use depends on which is most cost effective.

Fortenbery and Zapata (2004) built up on Morgan et al. and suggest that the decision of which exchange to use depends on the costs of infrastructure development of a local futures market with the cost of exchange rate exposure when hedging in foreign exchanges. Exchange rate risk refers to the risk that there may be an adverse movement in the exchange rate of the denominated currency in relation to the base currency before the date of completion of the underlying transaction. If exchange rate risk cannot be managed using market tools or directly hedged then there should be a favor towards creating a local exchange.

Both Gemill and Morgan et al. assumed that there was efficient price transmission between the developed country's exchange and the DCs cash prices. This meant that the only reason to develop a domestic futures exchange is to eliminate exchange rate risk between futures and cash markets. Bessler and Covey (1991) questioned whether there was efficient price transmission between futures and cash markets of live cattle in the USA. If this is the case in a place where both cash and futures prices are in the same currency, then it is reasonable to assume

that in cash markets in DCs with different currencies might not be effectively linked with a developed countries future market from a market efficiency standpoint. This, however, should not be interpreted as a lack of usefulness of price discovery for local trade in commodities in DCs.

Witherspoon (1993) investigated into the price discovery function of futures markets. He points out that excessive speculative activity in a futures market can have a destabilizing effect on cash markets. If such is the case engaging in hedges in the futures market will only reduce the price risk that results from futures market activities and not the risk that originates from commodity cash market fundamentals.

Fortenbery and Zapata also question if there is a situation where local exchange development should be pursued even if exchange rate risk does not exceed the cost of developing a local exchange. This may be the case when a situation like Witherspoon's excessive speculation arises. If the futures market is not effectively sharing information with the cash market, a basis risk associated with hedging that is unacceptable regardless of exchange rate volatility would be created. The excessive speculation may also increase the future markets price volatility, which would then be passed on to the cash market in the DCs.

Fortenbery and Zapata (2004) specifically examine the relationship between the New York Coffee Futures Market and the cash export prices for Honduras and Guatemala. The paper evaluates DCs futures market development in situations when exchange rate risk is not the factor to consider. They tested New York futures contract for coffee and whether it offered hedging opportunities for Honduras and Guatemala as well as to analyze the relationship between the

trade compositions in NY and the volatility of the coffee prices in the cash markets of these countries. This paper is the basis for this proposed thesis.

Outtara, Schroeder, Sorenson(1990) attempted to determine the optimal hedging level for Ivory Coast, a developing country that is typical of most coffee producing countries as it economically depends very much on coffee exports. This paper is a great example of the results that may be obtained by utilizing futures market for hedging opportunities. Like all other DCs in that have an economic dependency for coffee, price fluctuations in international coffee prices have made the countries development planning process uncertain. They view hedging as a great additional marketing strategy to insure stable revenues from coffee exports. They conclude that through the use of coffee futures market to hedge coffee exports, Ivory Coast could have reduced the standard deviation of revenues by almost 29% and reduced average revenue by about 22% relative to using only the export cash market. This means that the country's export earnings could be stabilized through judicious use of marketing strategies involving coffee futures.

The Ivory Coast markets coffee through a Stabilization Fund which is similar to a marketing board. It, however, does not necessarily take physical possession of the product. It only supervises the marketing operation, guarantees a fixed price to producers each year, and guarantees a CIF (Cost, Insurance, and Freight) price to local licensed exporters.

The Fund has become progressively more involved in the sale of large quantities of coffee to the largest volume buyers. Under these circumstances, the exporter simply serves as an intermediary between the Fund and the buyer. Therefore, the fund is exposed to coffee price fluctuations between the time when it sets purchase prices for producers and the time it sells the

coffee abroad. It is during this period of exposure to price changes that coffee hedging could help the Fund stabilize export revenues.

2.3. Price Discovery and Cointegration

The dynamics of price discovery have received a lot of attention across futures and cash prices of commodities produced in the United States; however, work that examines the same dynamics relationships between the futures markets in developed countries and cash prices for DC's commodities is less extensive (Fortenbery and Zapata, 2004). Garbade and Silber (1983) first examined these characteristics of price movements in cash and futures markets of storable commodities in the United States through a partial equilibrium model. They looked at how efficiently the futures market performed its two basic functions, price discovery and risk transfer. They name the degree of market integration as a function of elasticity of arbitrage. Greater elasticity means more highly correlated price changes, and thereby facilitating the risk transfer function. However, the elasticity of supply of arbitrage services is constrained by storage and transaction costs meaning that futures contracts will generally not perfectly perform their risk transfer function over short time horizons. In the long run, however, the cash and futures prices should be integrated. The price discovery function depends on which market leads the other in reflecting new information on their prices.

Garbade and Silber (1983) found that all markets were integrated over a month or two, considerable slippage between futures and cash markets occurred in the short run, especially for corn wheat and oats. These results are useful for hedgers as there are indications of nontrivial risk exposure over short time intervals in the futures markets for grains and to a lesser extent copper and orange juice. Futures markets were found to generally dominate cash markets. Cash markets in wheat, corn, and orange juice seemed to be largely satellites of their respective futures

markets with about 75% of new information incorporated first in futures prices and then flowing to cash prices. This also seems to be the case with gold whereas silver, oats and copper were more evenly divided between the cash and futures markets.

Koontz, Garcia and Hudson (1990) looked to determine the extent to which the spatial nature of the price discovery process has changed in the U.S. cattle slaughter market. They identified the lead/lag relationships between major cash markets and the live cattle futures market. Markets that were dominant in the price discovery process were revealed using: lead/lag relationships, a strength of causality measure, and tests for symmetry of feedback between markets. The symmetry test that tested the strength of feedback relationships was the most important one because previous research has noted a high degree of market interaction (Koontz, Garcia, & Hudson, 1990). Price discovery and the changing structure of the U.S. cattle industry were examined by analyzing spatial prices over three time periods between 1973-84.

They concluded that price discovery within the U.S. live cattle market appeared to be in the direct cash markets, the Nebraska market being the most important one. They did show, however, that the futures market still plays an important, yet reduced function in price discovery. This is because the Nebraska direct market, which appears to dominate the early week price discovery process, seemed to influence the futures market. However, when analyzing weekly futures average it emphasized that the futures market remained a viable price discovery force as it is relied upon to register information (which emerges late in the week when the cash markets are inactive) that will be reflected in the cash markets the following week.

Gomez and Koerner (2009) examined price transmission asymmetries between international and retail coffee prices in the US, France and Germany. In other words, they

examined how quickly a price change in the international coffee price became observable in the retail prices of their selected countries, serving a similar price discovery function as the one being addressed in this paper.

Although all processors of roasted coffee purchase green coffee at the same price in the international markets, one finds significant differences in retail prices among these countries. The study developed an error correction (EC) representation model to assess price transmission asymmetry of non-stationary models. They suggest that differences in price transmission mechanisms provide evidence for disparities in market structure and market performance across countries. His observations suggested that price adjustments in Germany tended to take place more quickly than in France and the US.

Fortenbery and Zapata's first objective was to evaluate price transmission between the NY futures market and the cash market in Latin America to see if the futures market was serving its price discovery function. Price discovery in futures markets refers to the use of futures prices in determining cash market prices. They used cointegration because it evaluates the performance of two related markets and identifying their relationship in the long run, while allowing for deviations in the short run. Schroeder and Goodwin (1991) looked into the short-term price leadership roles and the long-term efficiency of the cash to futures price relationship for live hogs in the Omaha cash and CME futures markets. Through the use of cointegration they looked at the long-run stability of the live hog futures to cash market price relationship.

Cointegration tests between prices of a futures and a cash market will measure to what extent the basis is stationary. A stationary basis implies that there is a constant mean and variance over time, therefore, if information causes a change of price in the futures market it will

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also cause a change of price in the cointegrated cash market.

Fortenbery and Zapata rejected the hypothesis of no cointegration and implied that the market is serving its price discovery function; therefore, suggesting that the NY contract for coffee would be a vehicle for price risk management.

2.4. Effects of Excessive Speculation

Witherspoon (1993) points out that excessive speculative activity in a futures market can have a destabilizing effect on cash markets. If such is the case engaging in hedges in the futures market will only reduce the price risk that results from futures market activities and not the risk that originates from commodity cash market fundamentals. Following Witherspoon's hypothesis, Fortenbery and Zapata combined a regression model that examined the impact of the futures market composition on the futures price volatility as well as the results of the residual behavior from the cointegration equations. This would share insight on the potential impact of the speculation activities in the market on the futures price volatility and how much the future markets volatility corresponds to the volatility in the cash markets at DCs. The results found that the percent of speculative open interest increases along with price volatility. This suggests that cash market price risk for exporting DCs may increase due to the futures trading activities in developed countries. The paper pointed towards evidence to the existence of excessive speculation in the coffee market but did not conclude its existence.

2.5. Agricultural Commodity Exchanges in LAC

One of the objectives for this research is to recommend if it would be beneficial for the DCs to look into developing their own futures exchange. As mentioned by Morgan et al. (1999) and Fortenbery and Zapata (2004), it is not easy to institute a new domestic exchange and the

potential pitfalls are great. One of the central concerns is the comparison of costs between establishing domestic futures markets and using existing exchanges in developed countries. Still it is important to understand the requirements and conditions necessary for local exchange development in DCs.

In 2011 Arias, Ferreira-Lamas and Kpaka wrote an assessment of the conditions necessary for developing Agricultural Commodity Exchanges in Latin America and the Caribbean (LAC). They note that there are presently many different exchanges that facilitate the trade and development of financial products for the countries in LAC whose economies have a relatively elevated proportion of primary and secondary agricultural activities, agricultural exports or substantial food imports. They explain how the growth of agricultural commodity exchanges in LAC has accelerated in the last decades due to an increase of macro-level factors such as (i) the liberalization of trade and (ii) policies that favor agricultural development.

The liberalization trade along with an increase of international trading has opened new opportunities to agricultural development in LAC. Local bilateral and multilateral agreements between LAC and international agreements with the USA, Canada or the EU require the existence of a safe, organized and cost effective system for the international exchange of agricultural commodities. These agreements also lead to an increase in the supply and demand of agricultural commodities creating a need to develop agricultural exchanges that would provide the legal and regulatory framework to facilitate the purchasing and selling of contracts as well as the availability of agricultural credit or trade financing and a standardized quality control mechanism. In some cases they would also facilitate tax payments and the registration of trade.

The use of non-market oriented policies usually prevents the development of exchanges. In LAC agricultural policies have changed from price support (non-market oriented) to direct support programs (market oriented), reducing the distortion of price formation mechanisms and making price determination more transparent thus serving as an incentive for the development and use of commodity exchanges. However, the degree of support from agricultural policies varies from country to country.

There are important preconditions necessary for the success of agricultural commodity exchanges in LAC. Aside from the trade and farmer support factors the heterogeneity among the exchanges in the area suggests that there are different requirements or conditions that have a direct impact on the level of success of said exchanges. The necessary requirements according to Eura Shin (2006) are: (i) the need for large market size and a high minimum volume of trade necessary for long-term viability; (ii) a large number of traded contracts are required to reduce price volatility and to allow for liquidity; (iii) clear and transparent rules and regulations are essential for those already participating in the market and those who are interesting in beginning to participate; (iv) financial intermediaries (brokers, banks, traders, etc.) are necessary to share credit risk; (v) it is necessary to have committed agribusiness participants (supermarkets, processing plants, exporters, etc.) as they can benefit from them in many different ways (tax exceptions, the benefits of having a publicly known reference price, quality control and standards set by a third party, arbitration mechanisms, etc.); (vi) most commodities traded in exchanges must be able to be able to be identified by agreed on standards and quality grades; (vii) a final and very important requirement for these exchanges is to be able to provide differentiated contracts to avoid competition and allow for a lower basis risk, for example offering unwashed

coffee contracts instead of the washed contracts offered in the NYBOT or offering the same contracts at different times of the year.

In summary, the partial equilibrium model proposed by Garbade and Silber (1983) has been the basis for much of the published works that study the price discovery function of futures markets. Recent applications of this model have used cointegration and error-correction models to empirically analyze dynamics in the price discovery process. The recent application by Fortenbery and Zapata (2004) has highlighted the fact that futures market prices may play a price discovery role for cash prices of the same commodity in developing countries. There is a lack of research on whether the linkage between the New York Coffee C contract nearby futures prices is significant for a larger set of countries and for cash prices at the producer and export levels.

CHAPTER 3: METHODOLOGY

3.1. Cointegration and Error Correction Models

To begin estimating whether futures prices are unbiased predictors of future cash prices (the unbiasdness hypothesis) we must estimate a regression between cash and future prices:

1) $C_t = \alpha + \beta F_t + e_t$

Here, C_t is the cash price in the specific developed country at a specific time t, F_t is the nearby futures price at a specific time t, and e_t is an error term. This regression would imply that new information will affect both market instantaneously (i.e., neither the futures market leads the cash market or vice versa) and in the same way. However, new information can cause distortions in price relationships and market efficiency. This is what has led to the application of cointegration theory on price relationships between futures and cash markets. Garbade and Silber (1983) and contemporaneous applications of their model investigate short run price discovery for storable commodities and non-storable commodities, respectively, as follows:

$$2)\begin{bmatrix} C_t \\ F_t \end{bmatrix} = \begin{bmatrix} \alpha_c \\ \alpha_f \end{bmatrix} + \begin{bmatrix} 1 - \beta_c & \beta_c \\ \beta_f & 1 - \beta_1 \end{bmatrix} \begin{bmatrix} C_{t-1} \\ F_{t-1} \end{bmatrix} + \begin{bmatrix} e_t \\ e_t \end{bmatrix}$$

Here, t refers to the day, and C and F are the logarithms of the cash and futures prices. The coefficients β_c and β_f reflect the impacts of the previous day's price in one market on the other market's price. The constants α_c and α_f reflect any trends in the price series. The ratio $\beta_c/(\beta_c+\beta_f)$ provides an indication of the level of price discovery occurring in each market. If $\beta_c/(\beta_c+\beta_f) = 0$ then the futures market is influenced completely by the cash market. If the ratio $\beta_c/(\beta_c+\beta_f) = 1$ then the cash market is influenced completely by the futures market. Intermediate values indicate mutual adjustments and feedback effects between the two markets.

Equation (2) can also be used to examine the rate of convergence or persistence of the cash-futures price basis from one day to the next.

$$3) \ F_t - C_t = \alpha + \delta(F_{t-1} - C_{t-1}) + e_1$$

Here the $\alpha = \alpha_f - \alpha_c, \delta = 1 - \beta_f - \beta_c, and \ e_t = e_{tc} - e_{tf}$ If δ is near 1, then the basis is fairly stable from day to day and the cash and futures prices do not tend to converge rapidly. If δ is small, relatively little of the previous day's basis is present in the current day's basis. A large value for δ would suggest that relatively large cash to futures price differences can occur before arbitrage is undertaken to bring convergence (Schroeder & Goodwin, 1991).

We introduce the concept of 'cointegration' in simple terms by stating that if there exists a stationary linear combination or equilibrium relationship between two non-stationary time series integrated of order 1 or I(1), the two variables combined are said to be 'cointegrated' (Mohamed I.E., 2009). In other words, two non-stationary series are cointegrated when their first differences are stationary, and both variables move together in the long-run (short lived deviations may be observed). Concluding that Cash markets and futures markets are cointegrated implicates that relevant information is getting priced similarly in both markets, suggesting that futures and cash markets are functioning in a manner that allows the futures market to be used as a risk management vehicle for cash market participants.

A two-step approach is often used to evaluate the cointegrating properties of a concurrent pair of nonstationary economic time series. The first stage involves estimating the cointegrating regression (in our case equation 1) using OLS, which is then used to calculate estimates of the residual errors, $\hat{z}_t$ where

$$4) \ \hat{z}_t = C_t - \hat{\alpha}_1 - \widehat{\beta_1} F_t$$

The Garbade-Silber model assumes that futures and cash prices maintain the structural long-run relationship derived from partial equilibrium theory and that deviations from such equilibrium are quickly corrected; this component in the model is defined an error-correction term for cointegrated series. Short-term price fluctuations are accounted for by adding lagged changes of futures and cash prices as is commonly done in vector autoregressive models with integrated series. This model is commonly known as an error-correction model (ECM) and can be written as:

$$5)\ \begin{bmatrix} \Delta F_t \\ \Delta C_t \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \mu_2 \end{bmatrix} + \begin{bmatrix} \gamma_{11,1} & \gamma_{12,1} \\ \gamma_{21,1} & \gamma_{22,2} \end{bmatrix} \begin{bmatrix} \Delta F_{t-1} \\ \Delta C_{t-1} \end{bmatrix} + \dots + \begin{bmatrix} \gamma_{11,k} & \gamma_{12,k} \\ \gamma_{21,k} & \gamma_{22,k} \end{bmatrix} \begin{bmatrix} \Delta F_{t-k} \\ \Delta C_{t-k} \end{bmatrix} - \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} \begin{bmatrix} C_{t-1} - \hat{\alpha}_1 - \widehat{\beta_1} F_{t-1} \\ C_{t-1} - \hat{\alpha}_1 - \widehat{\beta_1} F_{t-1} \end{bmatrix} + \begin{bmatrix} e_{1,t} \\ e_{2,t} \end{bmatrix} ;$$

An 'error correction model' (ECM) is a dynamic modeling technique that directly estimates the speed at which a dependent variable returns to equilibrium after a change in an independent variable. Popularized by Engle and Granger, the ECM is used to estimate the acceleration speed of the short-run deviation to the long-run equilibrium. An error correction model for nearby futures prices and local cash prices would then serves to estimate how quickly a change in the futures markets is reflected in local cash markets and vice versa. The error correction model becomes a tool that reconciles the short run and long run behavior between futures and cash markets.

Like Fortenbery and Zapata (2004), Cointegration will be tested using Johansen and Juselius's (1990) maximum likelihood approach. The cointegration test based on a fully specified error correction model (ECM) for a series that is integrated of order one just as represented in Equation 5, can also be written as:

$$6)\ \Delta Y_t = \mu + \Gamma_1 \Delta Y_{t-1} + \dots + \Gamma_{k-1} \Delta Y_{t-k+1} + \Pi Y_{t-k}^* + \emptyset D + e_t\ ;$$

where $e_{t=}$ NID (0, Λ), $\Gamma_1, \ldots, \Gamma_{k-1}, \Pi, \emptyset, \Lambda = $ parameters to be estimated, $\Delta = 1 - L$ where L is a lag operator, D= A matrix of dummy variables, and t =1,2,...,T

To test cointegration one must examine the rank of $\prod$. If the rank of $\prod$ is zero, no cointegration exists, and there is no long run equilibrium relationship between the variables considered. If the rank of $\prod$ is between zero and p, p being the number of variables in the system, then cointegration does exist. The number of cointegrating relations is defined by the rank of $\prod$.

The relevant hypothesis when testing for cointegration is

H_0: $\prod$ = αβ′ ; where: α and β = p x r matrices, β = the cointegrating vector, α = the weight vector that measures the speed of adjustment towards equilibrium, r = number of cointegrating relations.

The following likelihood function is maximized:

7) ln L = -(T/2){Σ_I ln(1-λ_I), +ln|S_{00}|}, i=1,2,...,r

A likelihood ratio test or Trace Test for at most r cointegration vectors takes the form:

8) -2 ln Q = -TΣ_I ln(1-λ_I), i=r+1,...,p

Johansen and Juselius recommend the use of a λMAX statistic when testing cointegration. It is the same as the trace test but it evaluates maximum eigen values only. Tabulated critical values for the trace test are present in the appendix of Johansen and Juselius.

Market dynamics shall be examined by estimating the cointegration relationships between the cash markets and their corresponding futures contracts in New York. $\prod Y^*_{t-k}$, which

is the error term in the equation six, includes a constant that will allow the partial equilibrium relationship between futures and cash prices to be properly modeled, and to choose the corresponding critical values of the Trace and λMAX. The lag-length of the error-correction model (ECM) will be chosen by sequentially testing lags in a VAR at the levels representation of the model(up to maximum of 10 lags) and using a modified likelihood ratio test to select the appropriate lag (Fortenbery & Zapata, 2004)The ECM will be estimated at the optimum lag length and the residuals tested for autocorrelation to assure that the model is adequate. Impulse response functions (Fortenbery & Zapata, 2004)will be estimated for the ECM with the cointegration restrictions imposed (Fortenbery & Zapata, 2004).

3.2. Testing for Evidence of Excessive Speculation

Whiterspoon's hypothesis implies that excessive speculation in the futures market would result in an increase of cash price volatility even in cointegrated markets. If such hypothesis is true, then developing countries must worry about trade activity in the developed futures market impacting cash price risk and having adverse effects on market participants such as exporters and producers.

Fortenbery and Zapata (2004) revealed that the percent of speculative activity in the New York coffee contract has been increasing. The also observed that as both volume and the percentage of open interest accounted for by speculators have increased prices have fallen. It is possible that this represents only skilled and informed speculation with commercial trade activity decreasing as commercial buyers are not aggressively hedging due to their expectation of lower prices. When speculators are lead to believe that prices will continue to fall after observing that prices have already been falling for a number of days, they may become aggressive sellers. These type of technical traders may simply be noise traders. This pushes the market to even

lower levels when in fact market fundamentals would suggest that prices should not go lower. When the market fundamentals finally impact price levels, prices rebound and the resulting trading range is greater than what they would have been if no noise trading had occurred.

The relationship between speculative activity and volatility in commodity markets will be tested using monthly data to estimate the following model:

$$9)\ FUTVOL_t = \alpha + \beta_1 * \text{NCOIL}_{t-1} + \beta_2 \text{NCOIS}_{t-1} + \beta_3 * \text{NCOISP}_{t-1} + \beta_4 * 4trdrl_{t-1} +$$

$$\beta 5 * 4trdrs_{t-1} + \beta_6 * Price$$

FUTVOL$_t$ is the futures volatility, defined as the standard deviation of the percent change in daily prices for a given month, NCOIL$_{t-1}$ is the percent of open interest accounted for by long non-commercial traders as of Friday the previous month, NCOIS$_{t-1}$ is the percent of open interest accounted for by short non-commercial traders the previous month, NCOISP$_{t-1}$ is the percent of open interest accounted for by non-commercial spread traders the previous month, 4trdrl$_{t-1}$ is the percent of total long open interest accounted for by the four largest traders the previous month, 4trdrs$_{t-1}$ is the percent of total short open interest accounted for by the four largest short traders the previous month, and price is the nearby monthly average New York futures price.

3.3. Data

For the first objective, the data series utilized spans from January 1990 to May 2013, for a total of 281 observations per series. The prices used are the average monthly New York coffee nearby futures prices and monthly producer prices for Honduras, Guatemala, Colombia and Brazil. FOB prices for Brazil, Colombia and Guatemala will also be composed of 281 observations. Fob prices for Honduras, due to it becoming collected quotation when it became

part of the indicator price system in March 2011, will span from March 2011 to May 2013 for a total of 27 observations. Futures prices were collected from the Intercontinental Exchange product data; producer prices (who had only monthly data available) and FOB prices were collected from the International Coffee Organization[1] database. All prices were collected in US cents per lb.

The data used to address impact of market composition on price volatility in objective 2 spans from January 1993 through June 2013. Price volatility measures will be calculated as the standard deviation of period-to-period percentage price changes from the monthly nearby futures prices. Data used to represent market composition comes from the Commitment of Futures Traders reports released by the Commodity Futures Trading Commission each week. The reports place traders in several categories; these are non-commercial and commercial, long and short, percent of open interest by each trader type, and percent of open interest accounted of the four largest traders who are long and the four largest traders who are short in the market.

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[1] We Thank the International Coffee Organization and their Research Assistant Darcio De Camillis for providing this data.
[2] The cointegration relationship between futures, export prices, producer prices and interest rates were examined and

CHAPTER 4: EMPIRICAL RESULTS

This chapter reports research results obtained by this research on price linkages between New York nearby futures prices and local cash prices for four coffee exporting countries. It also sheds empirical light on the effect of speculation on price volatility in the NYBOT nearby coffee futures prices. The first section provides Augmented Dickey Fuller (ADF) test results for log values of nearby futures prices as well as log values for FOB and producer prices of Brazil, Colombia, Honduras and Guatemala in order to determine whether the series are nonstationary. The second section provides ADF test results for the first difference of all the time series in order to determine if the series are integrated of order 2 or I(2), thus being eligible for cointegration testing. The third section presents the results and impulse response functions for the test of cointegration between futures prices and FOB export prices. Section 4 presents results similar to those in section 3 but using producer prices instead of export prices. Section 5 presents the results for the cointegration analysis and impulse response function between producer prices and export prices. Finally, the sixth section presents the results of the trader composition tests.

4.1. Test for Stationarity in Level Representation

The first step in determining the series integration order is to test if the series is stationary. The most popular test for determining whether a series is stationary or nonstationary is the Dickey-Fuller test. This test determines whether a unit root is present in an autoregressive model. The Augmented Dickey Fuller test is an augmented version of the Dickey Fuller test for larger and more complicated sets of times series models (Carter Hill, Griffiths, & Lim, 2011). There are three variations of this test. These variations were designed to take into account the role of the constant term and the trend in stochastic processes (Carter Hill, Griffiths, & Lim, 2011). The first test is designed to take account of the roles of having neither a constant term nor

a trend; the second test a constant term but no trend, and the third test with both a constant and a trend. To correctly test for stationarity, you must use the Dickey Fuller test that is appropriate for the series being tested

For our analysis we will test the stationarity in the natural log of our series through the Augmented Dickey Fuller (ADF) Test 2(only a constant) and Test 3(constant and a trend). An ADF test statistic called the τ (tau) statistic is generated, and it must be compared to a specifically generated critical value(τ_c). These critical values are different for all three Dickey Fuller tests because the addition of a constant term and the time-trend changes the behavior of the time series. Having $\tau < \tau_c$ suggests that the series is stationary while $\tau > \tau_c$ suggests nonstationarity. The 5 percent critical values for test 2 and 3 are -2.86 and -3.41 respectively (Carter Hill, Griffiths, & Lim, 2011). Table 3 and Table 4 show the results obtained for these ADF tests compared against their critical values.

Table 3. Test for Unit Roots - ADF Test with a Constant of All Series (Jan 1990 to May 2013).

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
Brazil Log FOB Price	-1.86	>	-2.86	Nonstationary therefore, has a unit root	2.05
Colombia Log FOB Price	-1.69	>	-2.86	Nonstationary therefore, has a unit root	1.83
Guatemala Log FOB Price	-1.84	>	-2.86	Nonstationary therefore, has a unit root	2.04
Honduras Log FOB Price	-1.07	>	-2.86	Nonstationary therefore, has a unit root	2.08
Brazil Log of Producer Price	-1.86	>	-2.86	Nonstationary therefore, has a unit	1.99

Table 3. Continued.

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
				root	
Colombia Log of Producer Price	-1.34	>	-2.86	Nonstationary therefore, has a unit root	1.77
Guatemala Log of Producer Price	-1.56	>	-2.86	Nonstationary therefore, has a unit root	2.02
Honduras Log of Producer Price	-2.14	>	-2.86	Nonstationary therefore, has a unit root	1.98
Log Nearby Futures	-1.90	>	-2.86	Nonstationary therefore, has a unit root	2.05

Under the Dickey-Fuller test showed in table 3, the nearby futures prices and all the export prices had generated Tau statistics that were all greater than the 5% critical value of -2.86 (Carter Hill, Griffiths, & Lim, 2011). This means that through the ADF Test all the series are nonstationary. With the Durbin Watson being very close to 2 for all series, we can conclude that there is no indication of autocorrelation. With this we can proceed and test if their first differences are stationary and therefore, I(1) through an Augmented Dickey Fuller test of the first difference of each of the series .

Table 4. Test for Unit Roots - ADF Test with a Constant and Trend of All Series (Jan 1990 to May 2013).

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
Brazil Log FOB Price	-2.02	>	-3.41	Nonstationary therefore, has a unit root	2.05
Colombia Log FOB Price	-1.85	>	-3.41	Nonstationary therefore, has a unit	1.83

Table 4. Continued.

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
				root	
Guatemala Log FOB Price	-2.07	>	-3.41	Nonstationary therefore, has a unit root	2.05
Honduras Log FOB Price	-2.29	>	-3.41	Nonstationary therefore, has a unit root	1.96
Brazil Log of Producer Price	-2.19	>	-3.41	Nonstationary therefore, has a unit root	1.99
Colombia Log of Producer Price	-1.75	>	-3.41	Nonstationary therefore, has a unit root	1.76
Guatemala Log of Producer Price	-2.23	>	-3.41	Nonstationary therefore, has a unit root	2.01
Honduras Log of Producer Price	-2.74	>	-3.41	Nonstationary therefore, has a unit root	1.96
Log Nearby Futures	-2.07	>	-3.41	Nonstationary therefore, has a unit root	2.05

The nearby futures prices and all the spot prices had generated Tau statistics that were all greater than the 5% critical value of -3.41. This means that through the ADF Test 2 the futures price, all FOB prices and producer prices are said to be nonstationary. With this we can proceed and test if their first differences are stationary and therefore, I(1) through an Augmented Dickey Fuller test of the first difference of each of the series.

4.2. Test for Stationarity in First Differences

The second step before proceeding towards a cointegration analysis is to determine if the series are integrated of order 2 or I(2). Cointegration occurs if there is a stationary linear combination or equilibrium relationship between two non-stationary time series integrated of order one or in other words that their first differences are stationary(Granger, 1983). It has already been determined that all the series are stationary. Tables 5 and 6 present the results for the ADF test 2 and 3 on the first differences of all the series.

Table 5. Test for Unit Roots – ADF Test with a Constant for First Differences of All Series (Jan 1990 to May 2013).

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
Brazil Log FOB Price	-13.78	<	-2.86	Stationary therefore, no unit root	2.04
Colombia Log FOB Price	-17.78	<	-2.86	Stationary therefore, no unit root	1.99
Guatemala Log FOB Price	-14.05	<	-2.86	Stationary therefore, no unit root	2.04
Honduras* Log FOB Price	-6.54	<	-2.86	Stationary therefore, no unit root	2.02
Brazil Log of Producer Price	-13.86	<	-2.86	Stationary therefore, no unit root	1.99
Colombia Log of Producer Price	14.94	<	-2.86	Stationary therefore, no unit root	1.99
Guatemala Log of Producer Price	21.21	<	-2.86	Stationary therefore, no unit root	2.02
Honduras Log of Producer Price	16.80	<	-2.86	Stationary therefore, no unit root	2.00
Log Nearby Futures	-14.26	<	-2.86	Stationary therefore, no unit root	2.03

*Honduras FOB Price spans from March 2011 to May 2013 (26 Observations vs. 281 for other Countries).

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Because the first difference of the nearby futures prices and all the spot prices had generated Tau statistics that were all less than the 5% critical value of -2.86 they are concluded to be stationary. With this we can conclude that the first differences of the nearby futures, export prices and producer prices for Brazil, Colombia, Honduras and Guatemala are all stationary and therefore, I(1). With the Durbin Watson being very close to 2 for all the series we can conclude that there is no indication of autocorrelation.

Table 6. Test for Unit Roots -ADF Test 3 with a Constant and a Trend for First Differences of All Series (Jan 1990 to May 2013).

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
Brazil Log FOB Price	-13.75	<	-3.41	Stationary therefore, no unit root	2.05
Colombia Log FOB Price	-15.48	<	-3.41	Stationary therefore, no unit root	2.02
Guatemala Log FOB Price	-14.02	<	-3.41	Stationary therefore, no unit root	2.04
Honduras Log FOB Price	-6.05	<	-3.41	Stationary therefore, no unit root	2.08
Brazil Log of Producer Price	-13.84	<	-3.41	Stationary therefore, no unit root	1.99
Colombia Log of Producer Price	14.92	<	-3.41	Stationary therefore, no unit root	1.99
Guatemala Log of Producer Price	21.18	<	-3.41	Stationary therefore, no unit root	2.02
Honduras Log of Producer Price	16.77	<	-3.41	Stationary therefore, no unit root	2.00
Log Nearby Futures	-14.26	<	-3.41	Stationary therefore, no unit root	2.04

* Honduras FOB spans from March 2011 to May 2013 (26 Observations vs. 281 for other Countries).

Because the first difference of the nearby futures prices, export and producer prices had generated Tau statistics that were all less than the 5% critical value of -3.41 they are concluded to be stationary. With this we can conclude that the first differences of the Nearby Futures and Export Prices for Brazil, Colombia, Honduras and Guatemala are all stationary and therefore, I(1). With the Durbin Watson being very close to 2 for all the series we can conclude that there is no indication of autocorrelation.

4.3. Test of Cointegration between Futures and Export Prices

Having concluded that the series are all integrated of orders one, the cointegration relations between all the series are tested utilizing the Johansen approach. The optimal lag length of the error correction model (ECM) is chosen by sequentially testing lags in a VAR of the level representation of the series, up to a maximum of 10 lags, and the appropriate lag order is selected according to the modified likelihood ratio test or LR test statistic criterion. Table 7 presents the first results for the Johansen cointegration test between the Log of Futures and the Log of FOB prices.

Table 7. Cointegration Results for the LOG of Futures and LOG of Export Prices (Jan 1990 to May 2013).

Country	LAG	Hypothesized # of CE(H$_o$)	Trace		Critical Value 10%	LMax		Critical Value 10%	No. of Cointegration Equations
Brazil	4	None	24.94	>	17.98	21.12	>	13.91	T=1
		At Most 1	3.81	<	7.56	3.81	<	7.56	ME=1
Colombia	3	None	16.50	<	17.98	12.21	<	13.91	T=0
		At Most 1	4.29	<	7.56	4.29	<	7.56	ME=0
Guatemala	4	None	21.93	>	17.98	18.34	>	13.91	T=1
		At Most 1	3.59	<	7.56	3.59	<	7.56	ME=1
Honduras*	1	None	13.76	<	17.98	11.01	<	13.91	T=0

Table 7. Continued.

	At Most 1	2.75	<	7.56	2.75	<	7.56	ME=0

Note: T= No. of cointegration relations from Trace Test.
ME= No. of cointegration relations from Max Eigenvalue Test.
* Honduras spans from March 2011 to May 2013 (26 Observations vs. 281 for other Countries).

Results in table 7 are based on the error correction model specification that was outlined in equation 6 where we test two variables, coffee futures prices and export cash prices in place of Y. For Brazil and Guatemala, there is a finding of cointegration between the futures contract and their FOB prices. This suggests that futures and their FOB prices do respond to the same information sets and that they possess a stationary basis. The lag length of 4 indicates a 4 month delay between price changes in the New York futures market and the associated changes in the cash market. It is important to note that this is a relatively long lag length and demonstrates very slow information transmission between futures and cash markets, as Fortenbery and Zapata (2004) pointed out, the US soybean and corn markets price changes were completely reflected between cash and futures markets between 1 to 3 days. Both FOB prices seem to completely respond after 4 months to the changes in the futures market. This is not the case, however, between the futures contract against Colombia and Honduras. At their optimal lag lengths of 3 and 1, respectively, at a 10% level of significance the Johansen cointegration test fails to reject the null of no cointegration implying a lack of information transmission between their futures and export prices.

An impulse response is a one-time shock to one of the innovations on current and future values of the endogenous variables, in this section (i.e. futures and FOB prices). Cholesky decomposition is used for transforming the impulse. Figure 4 illustrates the impulse response functions for the cointegrated model of futures and Brazil export prices. The panels on the left side of figure 4 show the response of the New York futures prices and Brazil export prices to a

one time shock in futures prices. Both series reveal an immediate positive impact that rises in the first 4 months and then settle at a new equilibrium 7-8 months later. Both responses seem to be very similar with the response of export prices seeming to settle at a slightly higher equilibrium. The panels on the right side of figure 4 represent the response of futures and export prices when a shock occurs on Brazilian export prices. Both responses are very close to zero and seem to settle at a very similar equilibrium. It appears that New York Future prices have a strong effect on Brazilian export prices as these settle on a new equilibrium following a change in futures prices. However, futures prices show only a minimal reaction to changes in Brazilian export prices.
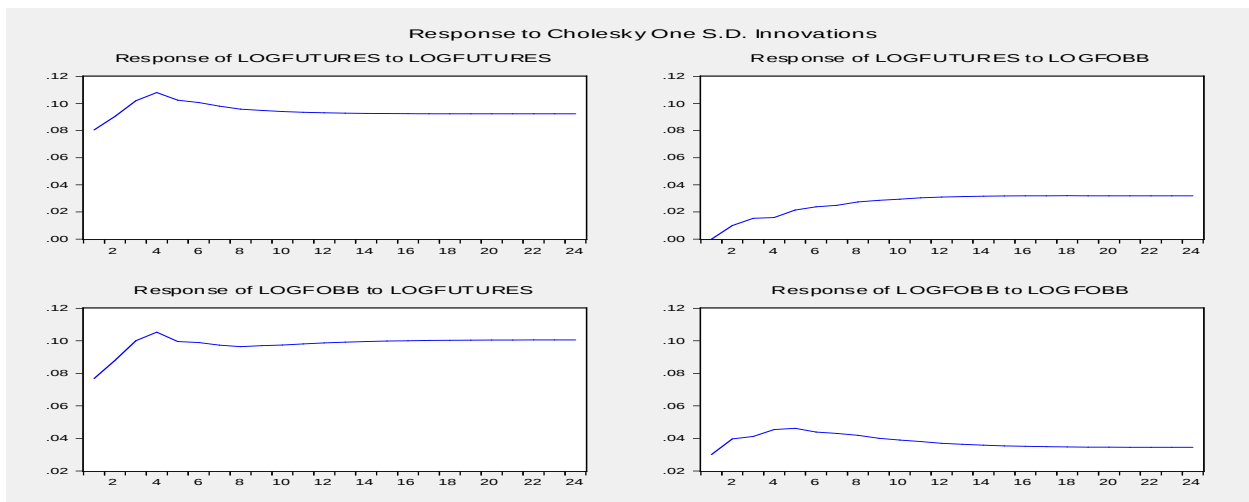
Figure 4. Impulse response Functions of Futures and FOB Prices Brazil.

Figure 5 illustrates the impulse response functions for the cointegrated model of futures and Guatemala export prices. The panels on the left side of figure 4 show the response of the New York futures prices and Guatemala export prices to a one time shock in futures prices. Both series reveal an immediate positive impact that rises in the first 4 months and then settle at a new equilibrium 7-8 months later. Both responses seem to be very similar with their responses seeming to rise for up to 4 periods and then decrease thereon after. The panels on the right side

of figure 4 represent the response of futures and export prices when a shock occurs on Guatemalan export prices. Both responses seem to have almost no effect on the first 4 months but then increase until they reach the same equilibrium. It appears that New York Future prices have a strong effect on Guatemalan export prices as these settle on a new equilibrium following a change in futures prices. However, futures prices show only a minimal reaction to changes in Brazilian export prices at first, yet they seem to have a significant effect in the long run.
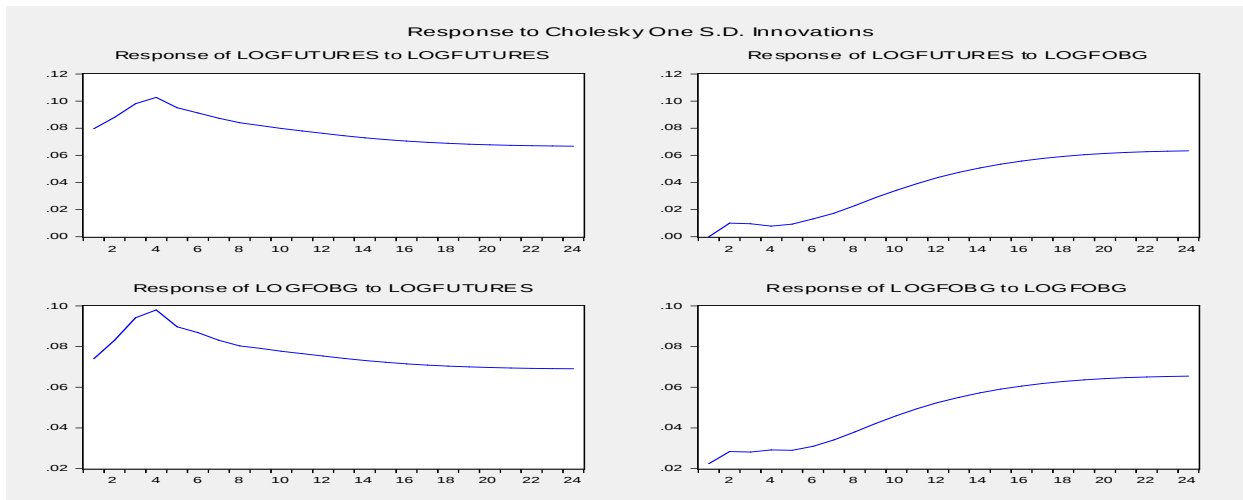
Figure 5. Impulse response Functions of Futures and FOB Prices Guatemala.

Figure 6 shows the impulse response functions from a VAR model for the first set of series that were not cointegrated, futures and export prices of Colombia. A shock to futures prices produces an almost identical response for both futures and Colombian export prices. The series rise for the first four months but then declines continually thereafter. A shock in the export price of Colombia first causes a negative reaction in the futures price followed by an increase that settles in the same equilibrium as the export prices.
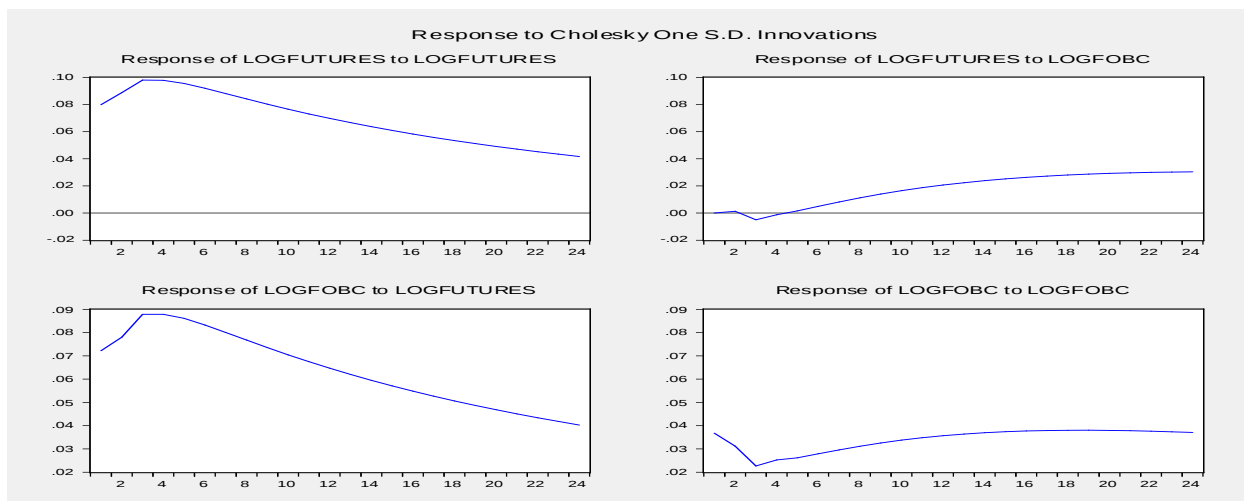
Figure 6. Impulse response Functions of Futures and FOB Prices Colombia.

Impulse response functions in figure 7 show that a shock to futures prices produces an almost identical response for futures and export prices. The shock on futures causes Honduran export prices and futures to decrease monotonically towards zero throughout the entire time period. When the shock is applied to export prices both futures and the export prices also seem to react almost identically. The shock in export prices is very close to zero and they increase at first for a period of about six months and gradually decrease thereafter. It appears from the impulse response functions that none of these shocks causes any of the series to settle at a new equilibrium level.
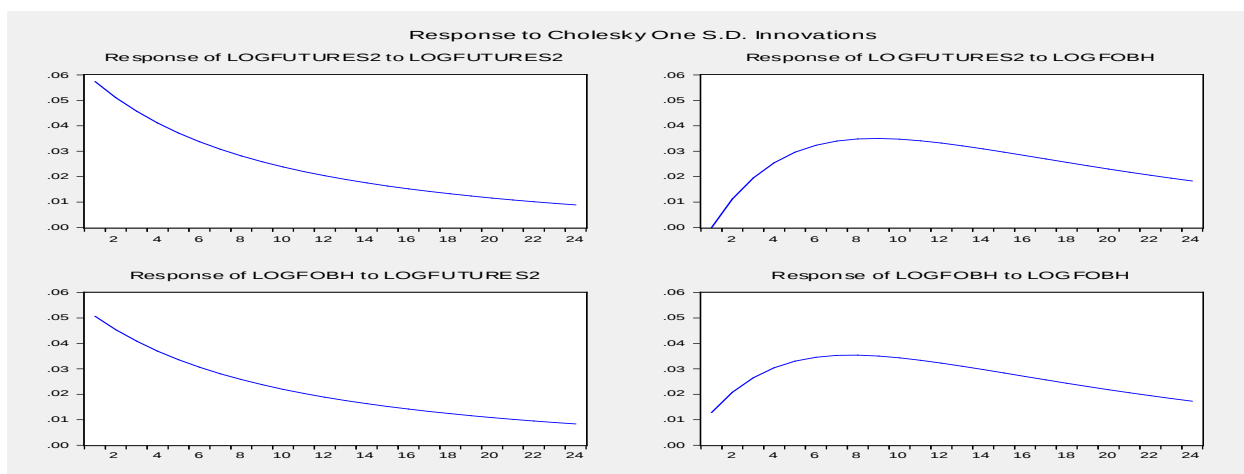
Figure 7. Impulse response Functions of Futures and FOB Prices Honduras.

4.4. Test of Cointegration Futures and Producer Prices

Table 8 presents the results for the Johansen cointegration test between the Log of Futures and the Log of producer prices for Brazil, Colombia, Guatemala and Honduras. These results are also based on the error correction model specification that was outlined in equation 6 where we have two variables, coffee futures prices and producer prices, taking the place of Y.

Table 8. Cointegration Results for the LOG of Futures and LOG of Producer Prices (Jan 1990 to May 2013).

Country	LAG	Hypothesized # of CE(H_o)	Trace		Critical Value 10%	LMax		Critical Value 10%	No. of Cointegration Equations
Brazil	8	None	19.85	>	17.98	15.84	>	13.91	T=1
		At Most 1	4.00	<	7.56	4.00	<	7.56	ME=1
Colombia	5	None	11.00	<	17.98	8.95	<	13.91	T=0
		At Most 1	2.05	<	7.56	2.05	<	7.56	ME=0
Guatemala	6	None	11.16	<	17.98	8.43	<	13.91	T=0
		At Most 1	2.73	<	7.56	2.73	<	7.56	ME=0
Honduras	4	None	30.22	>	17.98	26.57	>	13.91	T=1
		At Most 1	3.65	<	7.56	3.65	<	7.56	ME=1

Note: T= No. of cointegration relations from Trace Test.
ME= No. of cointegration relations from Max Eigenvalue Test.

For Brazil and Honduras, there is a finding of cointegration between the futures contract and their producer prices. This suggests that futures and their producer prices do respond to the same information sets and that they possess a stationary basis. The lag length of eight for Brazil and four for Honduras indicates an eight month and a four month delay between price changes in the New York futures market and the associated changes in the cash market for Brazil, respectively. There is a significant difference in response times across both markets. As mentioned earlier, even though Honduras responds twice as fast as Brazil, its response time is

still significantly slow compared to the American corn and soybean futures and cash markets (Fortenbery & Zapata, 2004). This is not the case, however, between the futures contract against the producer prices of Colombia and Guatemala. In this case, at their optimal lag lengths of 5 and 6 respectively at the 10% level the Johansen cointegration test fails to reject the null of no cointegration.

In this section impulse response functions are the result from an impulse or a one-time shock to an innovation on current and future values of futures and producer prices. Cholesky decomposition is used for transforming the impulse. Figure 8 illustrates the impulse response functions for the first cointegrated model in this section, that of futures and Brazil producer prices. The panels on the left side of figure 4 show the response of the New York futures prices and Brazil producer prices to a one time shock in futures prices. Both series reveal an immediate positive impact that rises in the first 4 months and then begins to decrease. The responses of both series show a small amount of oscillation after 4 months up to 16 months where they finally begin to settle at approximately the same equilibrium. The panels on the right side of figure 8 represent the response of futures and export prices when a shock occurs on Brazilian producer prices. Futures prices show no response on the first month and followed by a very weak response that remains very close to zero up until 8 months where it begins to increase until it reaches a new equilibrium about 16 months later. Producer price has higher response and it settles into a higher equilibrium. It appears that all the series have a strong effect on each other as they all settle on a new equilibrium following a shock in futures as well as a shock in producer prices.
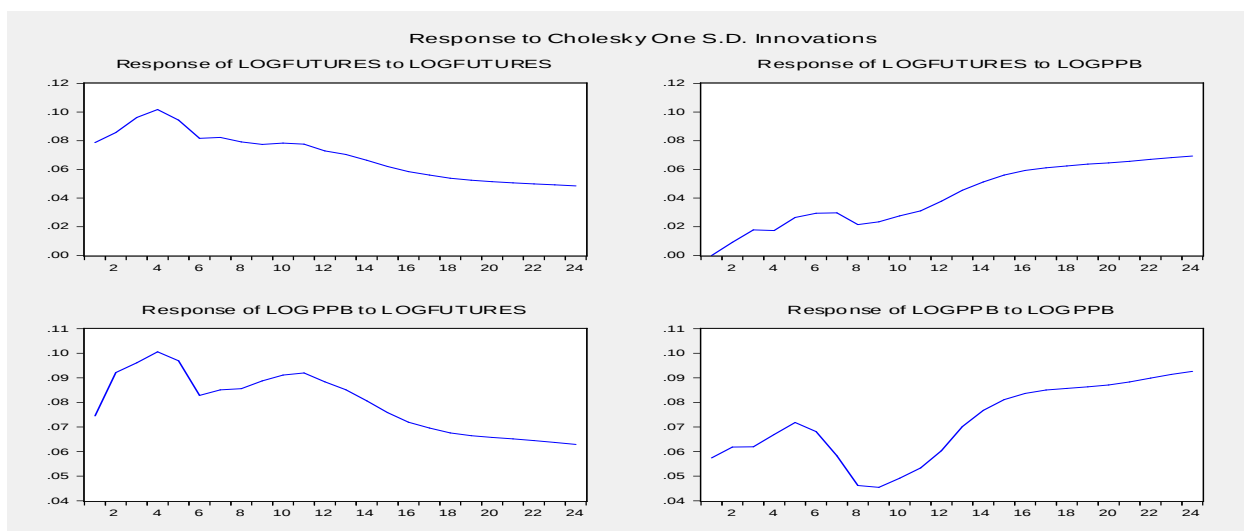
Figure 8. Impulse response Functions of Futures and Producer Prices Brazil.

The impulse response function of the second set of cointegrated series is presented in figure 9. These were obtained from the cointegration equation between futures and producer prices of Honduras. The panels on the left side of figure 4 show the response of the New York futures prices and Honduras producer prices to a one time shock in futures prices. They rise in the first 4 months and then settle in an equilibrium about 8 month later. The responses of both series show a small amount of oscillation after 4 months up to 16 months where they finally begin to settle at approximately the same equilibrium. The response for Honduras producer prices is initially steeper than that for futures prices. The panels on the right side of figure 9 represent the response of futures and producer prices when a shock occurs on Honduran producer prices. Honduran producer price initially respond positively to the shock in its own price and quickly decline to an equilibrium level that coincides with the equilibrium level of New York futures prices. Futures prices have almost no response to a shock in Honduras producer prices as expected.
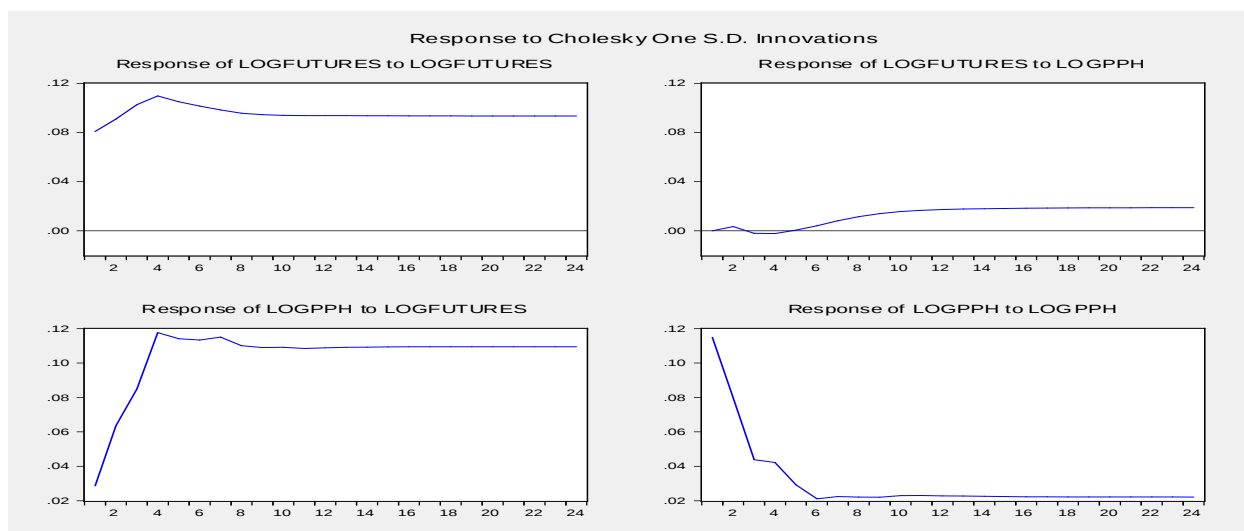
Figure 9. Impulse response Functions of Futures and Producer Prices Honduras.

Figure 10 is the first impulse response function for the first set of series in this section that were not cointegrated, futures and producer prices of Colombia. These were obtained from a VAR model of both series. A shock to futures prices produces very similar responses for both futures and Colombian export prices. The initial response for Colombia producer price is initially steeper than the response for futures prices. The impulse response shows that prices rise for the first four months but then the effect begins to decline continually thereafter. A shock in the producer price of Colombia first causes almost no response by the futures price for the first 3 months. At 4 months there is a very small positive reaction which leads to the futures price settling at a new equilibrium about 8 months later. Producer prices react to the impulse positively at first but steeply decline over the next six months, and then rise again until it reaches a very similar equilibrium to that of futures prices.
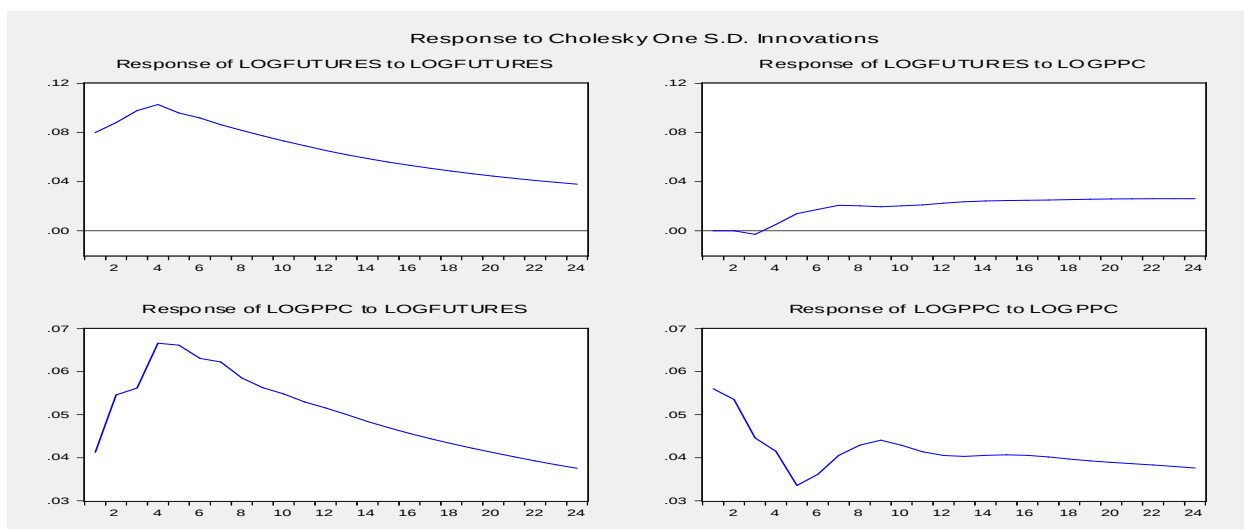
Figure 10. Impulse response Functions of Futures and Producer Prices Colombia.

Figure 11 is the impulse response functions from a VAR model of futures and producer prices of Guatemala, the last set of series in this section that are not cointegrated. A shock to futures prices produces positive responses by both series, yet the initial response by futures is significantly stronger than that of producer prices. The impulse causes both sets of prices to increase at first with futures prices beginning to decline after 4 months and producer prices after 6 months, both responses appearing to reach the same small rate of decline at this point. On the other hand, a shock in the producer price of Guatemala first causes almost no reaction by the futures price but eventually reaches a positive yet very weak response equilibrium. Producer prices react to the impulse positively at first but steeply declining over the next 12 months, until finally reaching an equilibrium that declines at a very small rate slightly above the futures equilibrium.
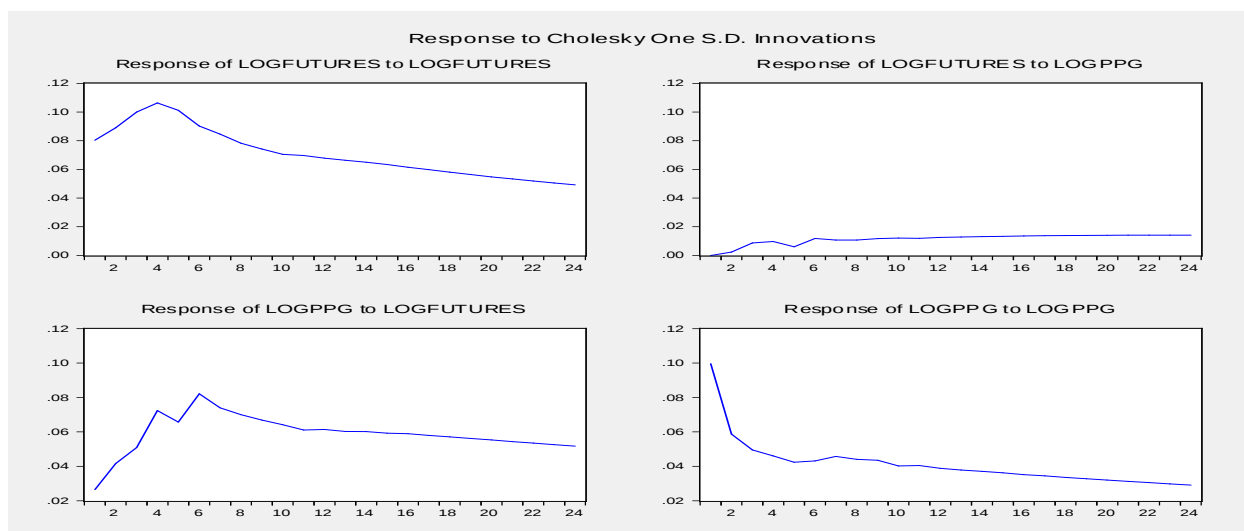
Figure 11. Impulse response Functions of Futures and Producer Prices Guatemala.

4.5. Test of Cointegration Between Producer Prices and Export Prices

Testing for cointegration between producer prices and export prices may yield some insight on the relationship between both markets. Since these markets can be assumed to be a function of each other, finding that they are cointegrated implies that both are equally influence by the same information and that they may be pricing it similarly. Cointegration might suggest that no other forces are acting to spread these prices apart, yet lack of cointegration might imply that these prices may be driven by changes in market factors that impact short term price changes.

Table 9 presents the results for the cointegration relation between producer prices and export prices in Brazil, Colombia Guatemala and Honduras.

Table 9. Cointegration Results for the LOG of Producer Prices and the Log of Export Prices (Jan 1990 to May 2013).

Country	LAG	Hypothesized # of CE(s)	Trace		Critical Value 10%	LMax		Critical Value 10%	No. of Cointegration Equations
Brazil	8	None	19.89	>	17.98	15.17	>	13.91	T=1
		At Most 1	4.71	<	7.56	4.72	<	7.56	ME=1
Colombia	6	None	15.47	<	17.98	12.33	<	13.91	T=0
		At Most 1	3.14	<	7.56	3.14	<	7.56	ME=0
Guatemala	6	None	11.67	<	17.98	8.89	<	13.91	T=0
		At Most 1	2.79	<	7.56	2.79	<	7.56	ME=0
Honduras*	1	None	16.28	<	17.98	9.78	<	13.91	T=0
		At Most 1	6.50	<	7.56	6.50	<	7.56	ME=0

Note: T= No. of cointegration relations from Trace Test.
ME= No. of cointegration relations from Max Eigenvalue Test.
* Honduras spans from March 2011 to May 2013 (26 Observations vs. 281 for other Countries).

These results were also based on the specifications that were outlined in equation 6 with producer prices replacing futures being tested for cointegration against FOB prices. On this situation findings of cointegration were only present in Brazil. This may suggest that its export and producer prices do respond to the same information set. The lag length of eight for Brazil is curious as it indicates an eight month delay between changes in the producer prices being reflected in the commodities export price. For the rest of the countries at their optimal lag lengths of 6,6 and 1 respectively the Johansen cointegration test fails to reject the null of no cointegration at the 10% level. This means that there is no price transmission between producer prices and export prices, implying that the prices received by producers and the prices charged by exporters have no relationship to each other.

In this section the impulse response functions are those that result from an impulse or a one-time shock to one of the innovations on current and future values of producer and FOB prices. Cholesky decomposition is used for transforming the impulse. The final set of impulse response function representations for the last model that proved to be cointegrated is that between Brazilian producer prices and Brazilian export prices (figure 12). The panels on the left side of figure 12 show the response of the Brazilian producer and export prices to a one time shock in export prices. Both series are very similar, revealing an immediate positive impact that rises in the first 4 months and then begins to decrease. The responses of both series settle at approximately the same equilibrium at after about 8 months. The panels on the right side of figure 12 represent the response of producer and export prices when a shock occurs on Brazilian producer prices. The response of export prices has no effect in the first month but begin to increase thereafter. Producer price has higher response and settle at a higher equilibrium.
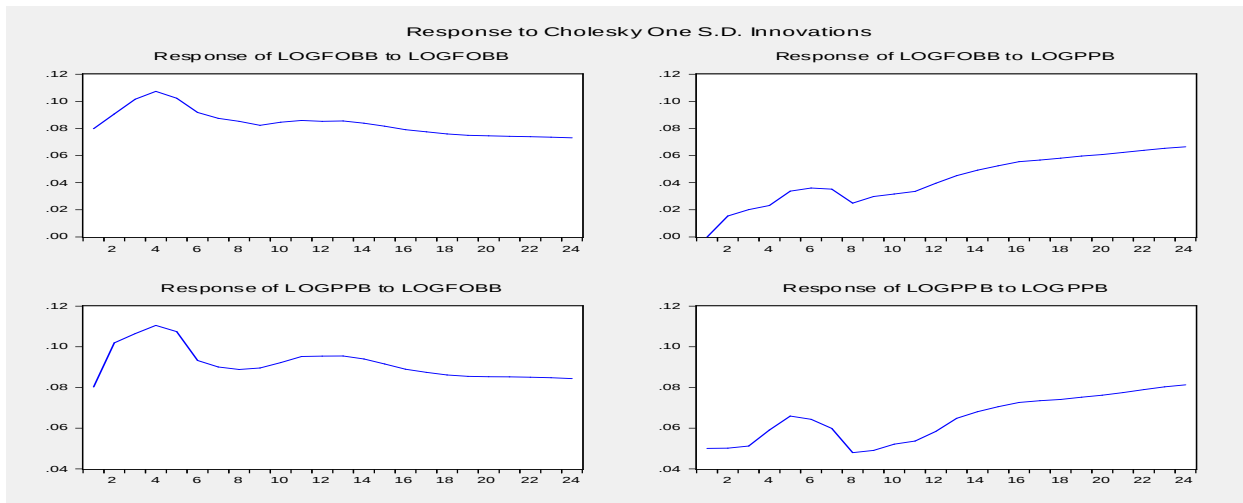
Figure 12. Impulse response Functions of FOB and Producer Prices Brazil.

Figure 13 is the first impulse response function in this section derived from a VAR model for the first set of series that were not determined to not be cointegrated, export and producer prices of Colombia. A shock to export prices produces positive responses by both series, yet the

initial response by export prices is significantly stronger than that of producer prices. Both sets of prices increase at first with both prices beginning to decline after 4 months, with both responses appearing to reach the same equilibrium at about 8 months. On the other hand, a shock in the producer price of Colombia causes almost no reaction by the export prices for the first two months, and then prices begin to increase until they reach their maximum after four months. They then decrease and settle into equilibrium very close to zero after about ten months. Producer prices react to the impulse positively at first but decline afterwards, until finally reaching an equilibrium similar to the one in export prices also very close to zero.
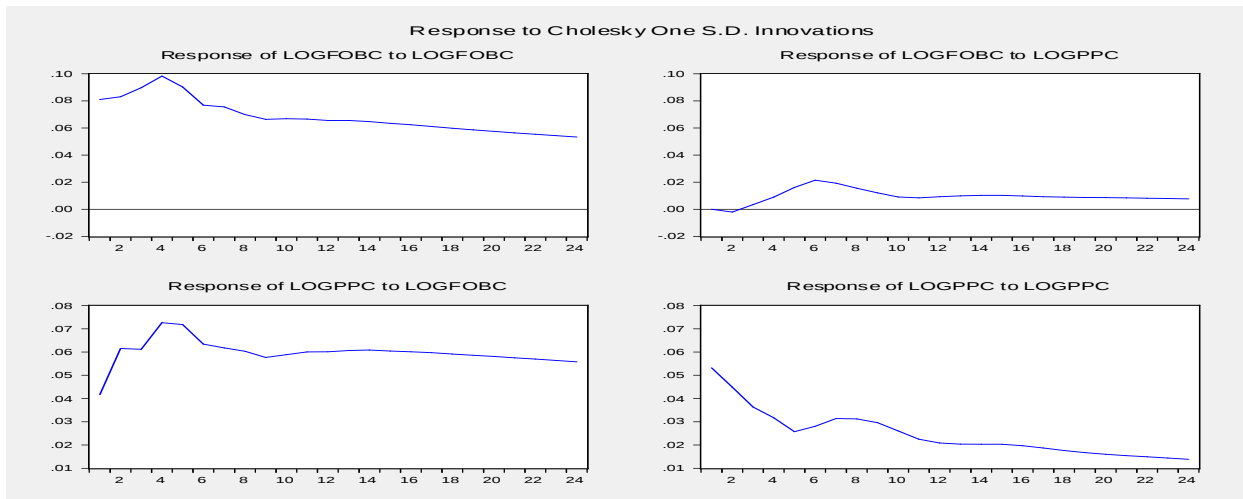
Figure 13. Impulse response Functions of FOB and Producer Prices Colombia.

Figure 14 is the impulse response function derived from a VAR model for export and producer prices of Guatemala, a of series that were also determined not to be cointegrated. A shock to export prices produces positive responses by both series, yet the initial response by export prices is significantly stronger than that of producer prices. The impulse causes both sets of prices to increase at first with export prices beginning to decline after 4 months and producer prices declining after 6 months, both responses appearing to reach the same equilibrium at about 8 months. On the other hand, a shock in the producer price of Guatemala causes a very small

positive reaction by the export prices for the first two months, then decrease and settle into equilibrium very close to zero after about 8 months. Producer prices react to the impulse positively at first but decline steeply thereon after.
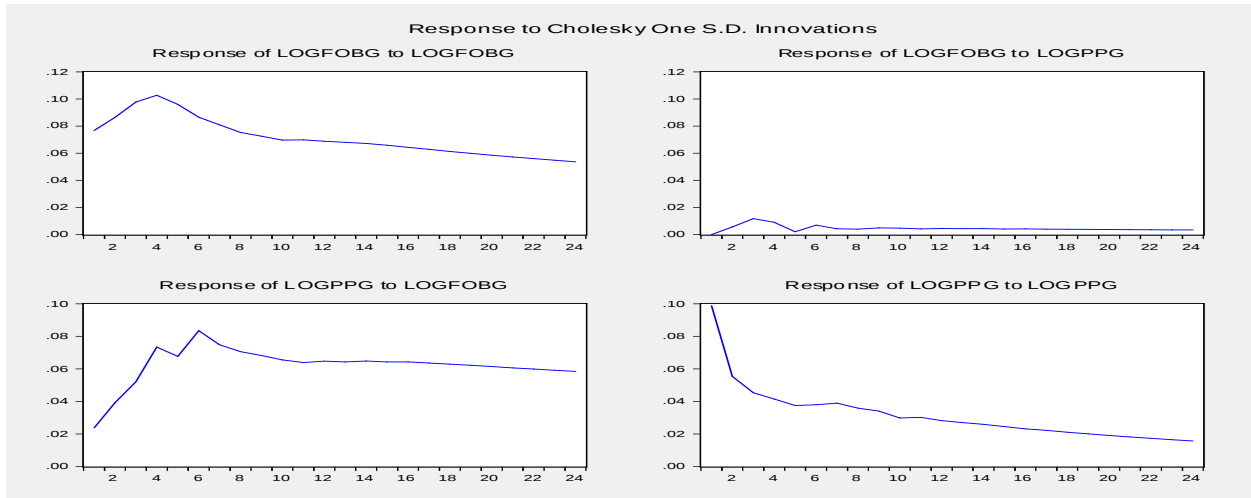
Figure 14. Impulse response Functions of FOB and Producer Prices Guatemala.

Figure 15 is the impulse response function derived from a VAR model for export and producer prices of Honduras, the final series determined not to be cointegrated. A shock to export prices produces positive responses by only export prices, producer prices showing a negative response that increases and reaches equilibrium at about 4 months. Export prices decline and reach a similar equilibrium as producer prices at about 4 months. On the other hand, a shock in the producer price of Honduras causes a very small positive reaction by the export prices that reach a very close to zero equilibrium in about 4 months as well. The initial response by producer prices is significantly stronger than that of export prices. It then declines steeply until they reach equilibrium in about four months very similar to the equilibrium of export price responses as both are very close to zero.
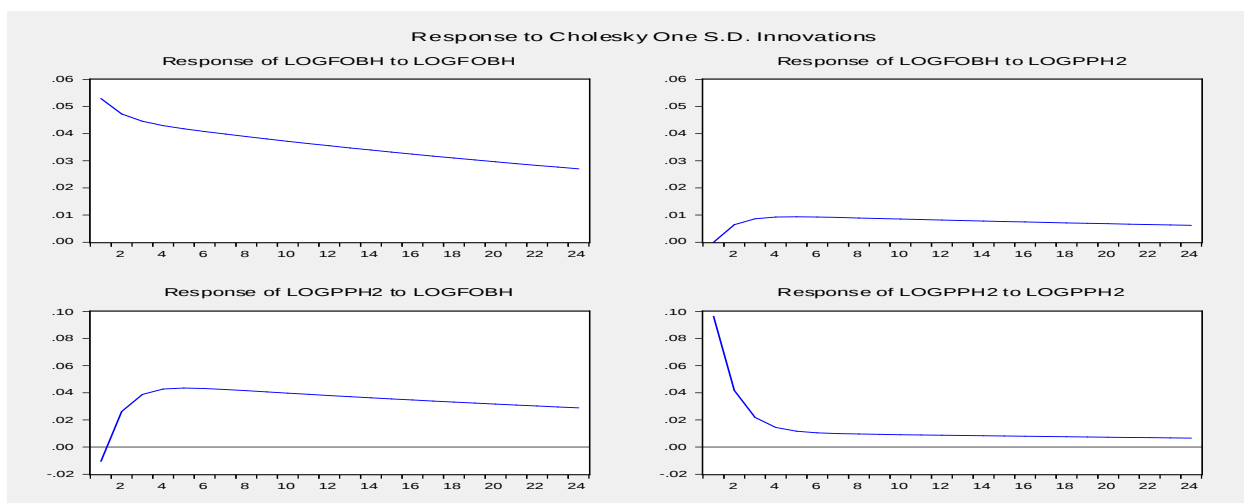
Figure 15. Impulse response Functions of FOB and Producer Prices Honduras.

Although, having non cointegration does not imply a lack of causation between cash and futures prices, it is not clear what contributes to the inconsistency of results. One suggestion by Fortenbery and Zapata (1995) was to test whether the observed nonstationarity in the cash and futures relationship could be explained by the omission of a common stochastic element in the empirical model specifications. The costs of carry that links cash prices and futures prices represent potential compensation for the participant who does not make a cash market transaction at the current cash price in favor of making the same transaction at a later date. These carrying costs can be observed as interest rates which represent opportunity costs that arise from holding inventory between a current period and the period of maturity of a futures contract. If interest rates are nonstationary, then it can be assumed that carrying costs are nonstationary and therefore, that they are significant when analyzing the dynamic relationship between futures and cash markets.[2]

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[2] The cointegration relationship between futures, export prices, producer prices and interest rates were examined and determined to not be significant. These results can be found in Appendix 1.

4.6. Trader Composition Tests

As noted earlier, monthly data was utilized to estimate model 9 and test the relationship between speculative activity and volatility in coffee markets. It must be noted that this model clearly understates speculative activity as it does not account for speculative positions that are held by non-reporting traders or speculative activities by noncommercial traders. It measures the lower limit of speculative impacts on volatility. Table 10 presents the results of the equation.

Table 10. Effects of Trader Composition on Futures Price Volatility (Jan 1993-May 2014).

Variable	Coefficient	T-Statistic
Constant**	2.2693	2.4358
New York Futures Price*	0.0040	1.9468
Noncommercial Long Open Interest(%)	-0.0085	-0.7297
Noncommercial Short Open Interest(%)	0.0123	1.0745
Noncommercial Spread Open Interest(%)**	-0.0557	-2.202467
Largest Four Long Trader Open Interest*	-0.0370	-1.6664
Largest Four Short Trader Open Interest	0.0280	1.2795
AR(1)**	0.3830	5.9514

Note: Initial OLS estimation revealed autocorrelation. The data was transformed by adding an AR(1) term to the OLS equation and the model re-estimated. R^2=0.264 and DW=2.12.
** Statistically Significant at the 5 percent Level.
* Statistically Significant at the 10 percent Level.

Note that the impact of the intercept, future price, noncommercial spreading open interest and the concentration of the 4 largest long traders are significant. It does appear that changes in the market composition causes changes in price volatility. However, only increasing noncommercial open interest accounted for by short traders results in an increase of price volatility. Increasing long open interest and spread trader open interest results in a decrease of

price volatility. With futures price being significant, these results suggest that price risk increases as prices increase. Market share for largest traders is significant for long traders only. They also seem to have a negative effect on futures volatility as they increase.

These results provide evidence that the level of futures market speculation may impact cash price volatility but not in a way that would support Witherspoon's hypothesis. What can be observed from the results is that as more speculators would enter and dominate the trade activity in New York's coffee futures market, futures volatility will decrease. These results fail to point towards evidence that the increase in speculative activities in the futures market is increasing volatility on a monthly basis. As volatility is not increasing in the local exchanges, no increase in price risk is being passed onto DCs. This is mostly significant for small producers and merchandisers (those who would be unable to access a futures exchange for hedging purposes) as these speculative activities in commodity exchanges are most likely not having an adverse effect on the amount of price risk to which they are exposed.

CHAPTER 5: SUMMARY, CONCLUSIONS AND IMPLICATIONS FOR FURTHER RESEARCH

5.1. Summary

The main objective of this thesis was to test leadership in price discovery and the extent to which nearby futures serves to set export and producer prices in developing countries (DCs). Additionally, the linkage between export and producers prices was evaluated as well as the effect of futures market speculation on DCs cash price volatility. A brief description of the background of DCs and their coffee industry, a description of cash, futures markets and the New York coffee contract as well as incentives for local exchange creation by DCs were provided in chapter 1. This chapter also provided the problem definition, the study's significance and objectives of the research. The second chapter presented a review of literature on price risk management practices for developing countries, the challenges and benefits of creating a new commodity exchange in a developed country and an overview of already existing exchanges, cointegration and excessive speculation. Chapter 3 presented the methodology needed to conduct the study. Chapter 4 included the results obtained from the analysis which are important to answer questions raised in the problem statement. Finally, this chapter provides a brief summary, implications, discussion and suggestions for further research.

Cointegration testing was done between the average monthly New York Coffee nearby futures prices and monthly producer prices as well as export prices for Honduras, Guatemala, Colombia and Brazil, all priced in US Cents/lb. All the data series utilized spanned from January 1990 to May 2013, except for Honduras export prices which were only available starting in March 2011. Futures prices were collected from the Intercontinental Exchange product data; producer prices and FOB prices were collected from the International Coffee Organization(ICO)

database[3]. The data used to address impact of market composition on price volatility spans from January 1993 through June 2013. Price volatility measures were calculated as the standard deviation of period-to-period percentage price changes from the monthly nearby futures prices. Market composition data comes from the Commitment of Futures Traders reports released by the Commodity Futures Trading Commission. For this analysis we used non-commercial and commercial, long and short, percent of open interest by each trader type, and percent of open interest accounted of the four largest traders who are long and the four largest traders who are short in the market.

Like Fortenbery and Zapata (2004), Cointegration was tested using Johansen and Juselius's (1990) maximum likelihood approach. First testing was necessary to determine that all series are integrated of order one. Second, the optimal lag length of the error correction model (ECM) is chosen by sequentially tests lags in a VAR of the level representation of the series, up to a maximum of 10 lags, and selecting the appropriate lag order according to the modified likelihood ratio test or LR test statistic. Finally, cointegration tests based on a fully specified error correction model (ECM) for a series integrated of order one were conducted. Impulse response functions were obtained for the ECMs and for VAR models for the series that were not cointegrated.

The relationship between speculative activity and volatility in coffee markets was estimated through an ordinary least squares regression. When this initial estimation revealed autocorrelation the model was transformed by adding an AR(1) term to the OLS equation and the model re-estimated.

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[3] The ICO, through Mr. Darcio De Camillis, generously provided producer prices and FOB prices for Brazil, Colombia, Guatemala and Honduras.

Cointegration results were presented in three sections. Section one presented results for the cointegration tests between of the log of futures and the log of export prices, section two of log of futures and log of producer prices and finally section three of export and producer prices. In section 1, only Brazilian and Guatemalan export prices showed to be cointegrated with nearby futures prices. In Section 2, only Brazilian and Honduran producer prices showed to be cointegrated with nearby futures prices. When testing the relationship of export to producer prices, only Brazilian producer prices showed to be cointegrated with its export prices. This suggests that Brazil is the only country where coffee cash price relationships are causal in at least one direction. The lag length used for the cointegration equations and impulse responses showed that there is very slow information transmission between futures and cash markets compared to the transmission that is observed in local US soybean and corn markets where price changes have been reported in previous literature to be completely reflected between cash and futures markets in 1 to 3 days.

Finally tests of the effect of trader composition towards price volatility revealed that the intercept, future price, noncommercial spreading open interest and the concentration of the 4 largest long traders were all significant. However, it is observed from the results that increased speculative activity reduces futures price volatility in the coffee market. Thus, increased speculative activity in the coffee market may not increase volatility in coffee cash prices when nearby futures and cash prices are strongly linked.

5.2. Conclusions, Limitations and Implications for Further Research

Empirical evidence suggest that the New York coffee futures market is currently serving to discover Brazilian and Guatemalan export prices as well as Brazilian and Honduran Producer prices. Concluding that these series are cointegrated suggest that the futures contract in New

York may offer hedging opportunities for these countries and for these specific markets. The long adjustment period between futures and cash price changes does suggest that hedging may be successful for managing price risk over a relatively long planning horizon. Rejecting cointegration between futures and Colombian and Honduran export prices as well as Colombian and Guatemalan producer prices suggests that for these cash markets, the New York coffee futures market is less useful in explaining long-term relationships between coffee futures prices in NY and these cash markets.

Only Brazil showed that their producer and export prices were cointegrated, meaning that coffee price interrelationships in Brazil may be driven by similar market information, and given the linkage to futures found in this study, NY futures are helping the price discovery process. It is important to point out that there was a liberalization of the coffee sector in Brazil in 1990 (Krivonos, 2008). The sector was almost entirely liberalized as minimum price settings were abolished and marketing was placed in the hands of private traders. Perhaps this may be an explanation as to why the futures market in New York, Brazilian producer prices and Brazilian Export prices are all cointegrated and effectively transfer prices between each other.

It is interesting to observe that for Guatemala, export prices were cointegrated with futures prices while producer prices were not. No cointegration was found between Guatemala FOB prices and producer prices either. This suggests that different factors that impact price transmission between both markets (export and producer) may be at play in these markets. The degree of product handling, storage and processing may have an impact on price differences. If most costs are incurred by coffee buyers and there is no government intervention that regulates prices paid to producers, a likely scenario is that producers lack bargaining power and are forced to be price takers in a market where buyers may have market power. It may be the case that

producers attempt to stabilize their income through practices such as drying their own coffee, and incurring the cost of storing it themselves in an attempt to wait for buyers to offer a higher price. This, of course, may reduce the quality of coffee and in turn decrease their revenue. The opposite might be the case if government intervention leads to buyers paying a minimum price to producers than they usually would under the liberalization of the local coffee market. This study presents the opportunity for future research into this relationship and try to decipher the specific reasons of why the futures market is effectively serving its price discovery for exporters but not for producers, and why there seems to be a lack of price transmission between producer and export prices.

The opposite situation occurs with Honduras as producer prices were proven to be cointegrated while export prices were not. However, this finding may be the result of using a small sample of 27 observations for export prices. No more export price data were available as Honduran export prices started to be collected by the ICO in March 2011 when they became part of their indicator prices. This may have been a limitation to this study. Perhaps having a higher number of observations would have yielded a different result.

Colombia was the only country that showed no cointegration with either set of prices. This suggests that price discovery in NY futures market and Colombian cash prices is suspect. Colombia, however, is an example of a coffee sector ran by a producer association. The Federación Nacional de Cafeteros de Colombia (FNC) exerts major influence on the coffee industry by implementing coffee policy (Krivonos, 2008). Between 1989 and 1994 the FNC gave producers artificially high prices, causing losses to the FNC. This unsustainable system was abolished in 1995 bringing internal prices closer to the world market prices. However, the FNC still continues to be the most powerful player on the market, controlling both domestic marketing

and exporting and fixing grower prices and marketing margins. This may perhaps be affecting cash prices in Colombia or contributing to the lack of linkages between the markets. Colombian coffee is of high quality and commands a premium in the world market. How such premium is determined also influences the linkage to nearby futures prices in New York. The end result may be a weaker link as found in this study.

Results here provide additional evidence that the level of futures market speculation is in fact decreasing the price risk faced by cash market participants. What can be observed from the results is that with more speculative activity in New York's coffee futures market, futures volatility will decrease. Therefore, this study does not find support on the existence of excessive speculation and its volatility spillover effects for developing country cash prices. As volatility is not increasing in the local exchanges, no increase in price risk is being passed onto DCs. This is mostly significant for small producers and merchandisers (those who would be unable to access a futures exchange for hedging purposes) as these speculative activities in commodity exchanges are most likely not having an adverse effect on the amount of price risk to which they are exposed. Finally, this means that coffee trading on a foreign exchange has the potential to provide the environment necessary to stabilize local incomes through market based contracting and to serve as a point of price discovery.

Li and Fortenbery (2013) examined whether speculators' activities in crude oil, wheat and coffee futures markets make the cash prices of these commodities more volatile found the following. First, the futures and cash prices of each of the three commodities were cointegrated. Second, there exists bi-directional volatility spillover between the futures and cash prices for all the three commodities but, like in this thesis, no evidence was found to support the hypothesis that increases in speculative positions increases futures price volatility. Thus speculation activity

does not impact cash price volatility. Here we find that there is strong evidence suggesting that increases in intertemporal spreads by noncommercial speculative activity significantly decreases price volatility. The results of Li and Fortenbery (2013), a sequel to Fortenbery and Zapata (2004), as well as the results from this thesis add evidence that efforts to limit the size of speculative positions may not strongly contribute to commodity price stability. This research, complements that of Li and Fortenbery (2013) in that it adds more countries rather than commodities to the study of price discovery in the coffee futures market.

Previous research reviewed in this thesis suggested that hedging may provide an alternative to supply management strategies in managing price risk for export commodities in DCs, and can stabilize exporter and producer incomes for coffee producing developing countries. For this to be the case the futures market had to contribute positively to overall price discovery in the cash markets. This thesis provides empirical evidence that for Brazil (producer and export prices), Guatemala (export prices) and Honduras (producer prices) there is a stable and predictable relationship between the movements of futures prices and their cash prices, therefore, for these countries and these specific markets, hedging in an existing exchange is a strategy that is worth considering.

The choice between hedging a developing country export commodity on an established exchange in a developed country and developing a local futures contract priced in the domestic currency would partially hinge on a comparison of the relative costs of either managing exchange rate risk through a direct hedge, or incurring exchange rate risk when local currencies are not represented by traded futures. The relatively high costs of developing the infrastructure and regulatory environment necessary to develop a successful local futures market is another determining factor.

Like in Outtara, Schroeder & Sorenson(1990), Brazil, Honduras and Guatemala (given that at least one of their cash markets is cointegrated with the futures market) may attempt to determine their optimal hedging level in order to stabilize export earnings.   Ivory Coast could have reduced the standard deviation of revenues by almost 29% and reduced average revenue by about 22% through futures market hedging relative to using only the export cash market.

The results of Outtara, Schroeder, & Sorenson along with the results of this thesis may be considered for the analysis of policies that could be implemented by Brazil, Honduras and Guatemala. They could establish a domestic fund, for example, with similar policies as the Ivorian Stabilization Fund that through the judicious use of marketing strategies involving coffee futures may stabilize export earnings. It might be worthwhile to study the applicability of an international hedge that takes into consideration exchange rate risk, as suggested by Morgan et Al. (1999) as well as Fortenbery and Zapata (2004), for a cross-section of Latin American countries such as Brazil, Colombia, Honduras and Guatemala as done in this study. This might be an effective way to manage commodity price risk and serve to reduce the uncertainty in developmental planning that arises due the violent fluctuations in international coffee prices and the ensuing revenue stabilization.

Understanding the source local price discovery and efficient hedging strategies can benefit producers, exporters, and governments. Effective price discovery, either from a developed countries exchange or a domestic futures market, leads to more stable or more predictable prices and ultimately to higher incomes. Exporters would be able to reduce variability of cash flows and inventory value. Price stabilization would lead to a more efficient budgetary planning for governments. This in turn would lead to DCs that rely heavily on coffee export earnings for development to improve their ability to pay foreign debts and reduce

uncertainty in their developmental planning. Stabilization of foreign exchange earnings through better use of market based instruments may be a feasible market strategy for countries that rely on coffee exports, such as the four countries studies here, namely, Brazil, Colombia, Guatemala and Honduras.

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APPENDIX: INTEREST RATE COINTEGRATION RESULTS

Not accounting for interest rates when testing for cointegration between futures and cash prices may bias cointegration results if they do in fact affect the cointegration relation between cash and futures when they are included in the cointegration test. Cointegration tests between futures, FOB prices and US interest rates; futures, producer prices and US Interest rates; FOB prices, producer prices and US interests were conducted. The tests were also conducted with significant interest rates for the countries being observed replacing US interest rates. Section 1 presents results when testing against US 3 month treasury bills for the data period spans from January 1990 to May 2013. Section 2 presents results where we test against local interest rates. For Brazil we utilized two different rates, a Basic financial rate obtained from the Central Bank of Brazil and spans from Jan 1992 to May 2013 as well as an Interest Rates, Government Securities, Treasury Bills rate obtained from the International Monetary fund that spans from Jan 1995 to May2013. For Colombia the monthly interest rate for a 90 day certificate of deposit was used obtained from the Central Bank of Colombia spanning from Jan 1990 to May 2013. For Guatemala the monthly passive interest rate in local currency was obtained from the Bank of Guatemala that spans from Jan 1996 to May 2013. Finally for Honduras the monthly interest rate on a checking account was obtained from the Central Bank of Honduras spanning from Jan 1992 to May 2013.

A.1. Cointegration Results with US Interest Rates

This first section begins with table 11 which includes the Dickey Fuller tests for US interest rates. With this we conclude that these interest rates are indeed integrated of order 1 meeting that requirement for Johansen cointegration testing. Tables 12 to 14 present the results of the cointegration test. All results show no cointegration except for the test between futures

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prices, Honduran producer prices and US interest rates that show 1 cointegration relation. When

testing futures, export prices and US interest rates for Brazil and Guatemala the trace test shows

no cointegration but the max eigenvalue test shows 1 cointegration relation.

Table 11. Test for Unit Roots of US Interest Rates and First Differences (Jan1990 to May 2013).

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
DF Test 2 log Interest Rates	-0.32	>	-2.86	Nonstationary therefore, has a unit root	1.92
DF Test 3 log Interest Rates	-1.58	>	-3.41	Nonstationary therefore, has a unit root	1.92
DF Test 2 of log Interest Rates 1st Differences	-13.54	<	-2.86	Stationary therefore, no unit root	1.93
DF Test 3 of log Interest Rates 1st Differences	-13.57	<	-3.41	Stationary therefore, no unit root	1.93

Table 12. Cointegration Results for LOG of Futures, LOG of Export Prices and Log US Interest Rates (Jan1990 to May 2013).

Country	LAG	Hypothesized # of CE(H_o)	Trace		Critical Value 10%	LMax		Critical Value 10%	No. of Cointegration Equations
Brazil	4	None	30.20	<	32.27	22.77	>	20.05	T=0
		At most 1	7.43	<	17.98	5.64	<	13.91	ME=1
		At most 2	1.79	<	7.55	1.79	<	7.56	
Colombia	8	None	23.25	<	32.27	17.34	<	20.05	T=0
		At most 1	5.91	<	17.98	4.28	<	13.91	ME=0
		At most 2	1.63	<	7.55	1.62	<	7.56	
Guatemala	4	None	31.36	<	32.27	23.58	>	20.05	T=0
		At most 1	7.78	<	17.98	5.89	<	13.91	ME=1
		At most 2	1.88	<	7.55	1.88	<	7.56	

Table 12. Continued.

Country	LAG	Hypothesized # of CE(H_o)	Trace		Critical Value 10%	LMax		Critical Value 10%	No. of Cointegration Equations
Honduras*	1	None	27.30	<	32.27	16.08	<	20.05	T=0
		At most 1	11.23	<	17.98	8.43	<	13.91	ME=0
		At most 2	2.80	<	7.55	2.80	<	7.56	

Note: T= No. of cointegration relations from Trace Test.
ME= No. of cointegration relations from Max Eigenvalue Test.
* Honduras Only 26 Observations. Testing Honduras over 5 lags gives a near singular matrix.

Table 13. Cointegration Results for LOG of Futures, LOG Producer Prices and LOG US Interest Rates (Jan1990 to May 2013).

Country	LAG	Hypothesized # of CE(H_o)	Trace		Critical Value 10%	LMax		Critical Value 10%	No. of Cointegration Equations
Brazil	3	None	26.74	<	32.27	18.91	<	20.05	T=0
		At most 1	7.82	<	17.98	6.12	<	13.91	ME=0
		At most 2	1.69	<	7.55	1.69	<	7.56	
Colombia	5	None	20.51	<	32.27	13.46	<	20.05	T=0
		At most 1	7.05	<	17.98	5.28	<	13.91	ME=0
		At most 2	1.76	<	7.55	1.76	<	7.56	
Guatemala	4	None	25.71	<	32.27	17.99	<	20.05	T=0
		At most 1	7.72	<	17.98	5.43	<	13.91	ME=0
		At most 2	2.28	<	7.55	2.28	<	7.56	
Honduras	4	None	43.11	>	32.27	35.26	>	20.05	T=1
		At most 1	7.86	<	17.98	5.86	<	13.91	ME=1
		At most 2	1.99	<	7.55	1.99	<	7.56	

Note: T= No. of cointegration relations from Trace Test.
ME= No. of cointegration relations from Max Eigenvalue Test.

Table 14. Cointegration Results for the LOG of Producer Prices, Log of Export Prices and LOG US Interest Rates (Jan1990 to May 2013).

Country	LAG	Hypothesized # of CE(H$_o$)	Trace		Critical Value 10%	LMax		Critical Value 10%	No. of Cointegration Equations
Brazil	3	None	20.47	<	32.27	12.58	<	20.05	T=0
		At most 1	7.89	<	17.98	6.14	<	13.91	ME=0
		At most 2	1.75	<	7.55	1.75	<	7.56	
Colombia	6	None	26.15	<	32.27	16.43	<	20.05	T=0
		At most 1	9.72	<	17.98	7.79	<	13.91	ME=0
		At most 2	1.94	<	7.55	1.93	<	7.56	
Guatemala	3	None	29.33	<	32.27	19.92	<	20.05	T=0
		At most 1	9.40	<	17.98	7.36	<	13.91	ME=0
		At most 2	2.04	<	7.55	2.04	<	7.56	
Honduras*	1	None	27.85	<	32.27	14.30	<	20.05	T=0
		At most 1	13.55	<	17.98	8.52	<	13.91	ME=0
		At most 2	0.18	<	7.55	5.03	<	7.56	

Note: T= No. of cointegration relations from Trace Test.
ME= No. of cointegration relations from Max Eigenvalue Test.
* Honduras Only 26 Observations vs. 281 of all other Countries.

A.2. Cointegration Results with Country Specific Interest Rates

This second section begins with table 15-19 which includes the Augmented Dickey Fuller tests for each individual country interest rates. Both tests(ADF test 2 and 3) show that Colombian and Honduran Interest rates are I(1). ADF test 2 for Guatemala showed that the series is I(1) but test 3 revealed that the series might have more than 1 unit root. However, for both Brazilian interest rates ADF test 2 showed that the series were I(1) while test 3 shows that the series were I(0). When further examining the series by plotting them in a graph, it seemed that the most appropriate test would be test 3 as the series seems to have both a trend and an intercept.

Table 15. Test for Unit Roots of Brazil Interest Rates -Treasuries and Securities and Its first Difference (Jan 1992 to May 2013).

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
DF Test 2 log Interest Rates	-1.54	>	-2.86	Nonstationary therefore, has a unit root	1.99
DF Test 3 log Interest Rates	-3.62	>	-3.41	Stationary therefore, no unit root	2.01
DF Test 2 of log Interest Rates 1st Differences	-20.49	<	-2.86	Stationary therefore, no unit root	1.99

Table 16. Test for Unit Roots of Brazil Interest Rates- Brazil-IR, GS, TB and Its First Difference (Jan 1995 to May 2013).

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
DF Test 2 log Interest Rates	-2.13	>	-2.86	Nonstationary therefore, has a unit root	1.99
DF Test 3 log Interest Rates	-3.70	>	-3.41	Stationary therefore, no unit root	2.01
DF Test 2 of log Interest Rates 1st Differences	-17.07	<	-2.86	Stationary therefore, no unit root	1.99

Table 17. Test for Unit Roots of Colombia Interest and its First Difference (Jan 1990 to May 2013).

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
DF Test 2 log Interest Rates	-0.69	>	-2.86	Nonstationary therefore, has a unit root	1.99
DF Test 3 log Interest Rates	-2.70	>	-3.41	Nonstationary therefore, has a unit root	2.01
DF Test 2 of log	-10.36	<	-2.86	Stationary therefore, no	1.99

Table 17. Continued.

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
Interest Rates 1st Differences				unit root	
DF Test 3 of log Interest Rates 1st Differences	-10.35	<	-3.41	Stationary therefore, no unit root	1.99

Table 18. Test for Unit Roots of Guatemala Interest Rates and Its First Difference (Jan 1996 to May 2013).

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
DF Test 2 log Interest Rates	-2.51	>	-2.86	Nonstationary therefore, has a unit root	2.10
DF Test 3 log Interest Rates	-3.06	>	-3.41	Nonstationary therefore, has a unit root	1.94
DF Test 2 of log Interest Rates 1st Differences	-3.16	<	-2.86	Stationary therefore, no unit root	1.93
DF Test 3 of log Interest Rates 1st Differences	-3.24	>	-3.41	Nonstationary therefore, has a unit root	1.93

Table 19. Test for Unit Roots of Honduras Interest Rates and Its First Difference (Jan 1992 to May 2013).

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
DF Test 2 log Interest Rates	-0.016	>	-2.86	Nonstationary therefore, has a unit root	1.97
DF Test 3 log Interest Rates	-1.50	>	-3.41	Nonstationary therefore, has a unit root	1.97

Table 19. Continued.

Country	Tau	> or <	Critical Value Tau 5%	Unit root?/ Stationarity?	DW
DF Test 2 of log Interest Rates 1st Differences	-15.69	<	-2.86	Stationary therefore, no unit root	2.00
DF Test 3 of log Interest Rates 1st Differences	-15.69	<	-3.41	Stationary therefore, no unit root	2.00

Table 20 presents the results of the cointegration test between futures export prices and local interest rates. All results show no cointegration except Honduras that shows 3 cointegration relations under the trace test but no cointegration relations in the max eigenvalue test.

Table 20. Cointegration Results for the LOG of Futures, LOG of Export Prices and Log Interest Rates.

Country	LAG	Hypothesized # of CE(H$_o$)	Trace		Critical Value 10%	LMax		Critical Value 10%	No. of Cointegration Equations
Brazil-TBF[10]	9	None	27.78	<	32.27	18.78	<	20.05	T=0
		At most 1	9.65	<	17.98	7.76	<	13.91	ME=0
		At most 2	1.89	<	7.55	1.89	<	7.56	
Brazil-IR, GS, TB[11]	10	None	23.92	<	32.27	12.61	<	20.05	T=0
		At most 1	11.30	<	17.98	10.09	<	13.91	ME=0
		At most 2	1.21	<	7.55	1.21	<	7.56	
Colombia[1]	6	None	23.19	<	32.27	17.19	<	20.05	T=0
		At most 1	5.99	<	17.98	3.08	<	13.91	ME=0
		At most 2	2.92	<	7.55	2.92	<	7.56	
Guatemala[2]	4	None	28.69	<	32.27	14.85	<	20.05	T=0
		At most 1	13.83	<	17.98	11.24	<	13.91	ME=0
		At most 2	0.01	<	7.55	2.60	<	7.56	
Honduras*[3]	3	None	41.79	>	32.27	15.96	<	20.05	T=3

Table 20. Continued.

Country	LAG	Hypothesized # of CE(H$_o$)	Trace		Critical Value 10%	LMax		Critical Value 10%	No. of Cointegration Equations
		At most 1	25.82	>	17.98	13.72	<	13.91	ME=0
		At most 2	12.10	>	7.55	12.10	>	7.56	

Note: T= No. of cointegration relations from Trace Test.
ME= No. of cointegration relations from Max Eigenvalue Test.
Brazil- TBF spans from Jan 1992 to May 2013.
Brazil- IR, GS TB spans from Jan 1995-May2013.
Colombia spans from Jan 1990-May 2013.
Guatemala spans from Jan 1996-May 2013.
Honduras spans from March 2011 to May 2013.

Table 21 presents the results of the cointegration test between futures, producer prices

and local interest rates. All results show no cointegration except Honduras that shows 1

cointegration relations under the trace test but 2 cointegration relations in the max eigenvalue

test.

Table 21. Cointegration Results for the LOG of Futures, LOG of Producer Prices and Log of Interest Rates.

Country	LAG	Hypothesized # of CE(H$_o$)	Trace		Critical Value 10%	LMax		Critical Value 10%	No. of Cointegration Equations
Brazil-TBF[12]	9	None	24.59	<	32.27	16.45	<	20.05	T=0
		At most 1	8.14	<	17.98	6.60	<	13.91	ME=0
		At most 2	1.53	<	7.55	1.53	<	7.56	
Brazil- IR, GS, TB[13]	7	None	28.99	<	32.27	17.12	<	20.05	T=0
		At most 1	11.86	<	17.98	10.26	<	13.91	ME=0
		At most 2	1.60	<	7.55	1.59	<	7.56	
Colombia[4]	5	None	24.44	<	32.27	17.65	<	20.05	T=0
		At most 1	6.79	<	17.98	4.01	<	13.91	ME=0
		At most 2	2.77	<	7.55	2.77	<	7.56	
Guatemala[5]	6	None	21.39	<	32.27	14.10	<	20.05	T=0

Table 21. Continued.

Country	LAG	Hypothesized # of CE(H₀)	Trace		Critical Value 10%	LMax		Critical Value 10%	No. of Cointegration Equations
		At most 1	7.28	<	17.98	4.23	<	13.91	ME=0
		At most 2	3.05	<	7.55	3.05	<	7.56	
Honduras[6]	5	None	58.35	>	32.27	42.53	>	20.05	T=1
		At most 1	15.82	<	17.98	14.82	>	13.91	ME=2
		At most 2	1.001	<	7.55	1.01	<	7.56	

Note: T= No. of cointegration relations from Trace Test.
ME= No. of cointegration relations from Max Eigenvalue Test.
Brazil- TBF spans from Jan 1992 to May 2013.
Brazil- IR, GS TB spans from Jan 1995-May2013.
Colombia spans from Jan 1990-May 2013.
Guatemala spans from Jan 1996-May 2013.
Honduras spans from Jan 1992 to May 2013.

Finally table 22 presents the results of the cointegration test between export prices,

producer prices and local interest rates. For Brazilian Basic Financial interest rate and

Guatemalan interest rate, no cointegration relations were found. For the Interest Rates,

Government Securities, Treasury Bills rate from Brazil and the Colombian rate, one

cointegration relation was found. Finally Honduras revealed two cointegration relations.

Table 22. Cointegration Results for LOG of Producer Prices, Log of Export Prices and Log of Interest rates.

Country	LAG	Hypothesized # of CE(H₀)	Trace		Critical Value 10%	LMax		Critical Value 10%	No. of Cointegration Equations
Brazil-TBF[14]	9	None	25.14	<	32.27	17.80	<	20.05	T=0
		At most 1	7.34	<	17.98	5.58	<	13.91	ME=0
		At most 2	1.76	<	7.55	1.76	<	7.56	
Brazil- IR, GS, TB[15]	4	None	41.48	>	32.27	25.53	>	20.05	T=1
		At most 1	15.94	<	17.98	13.62	<	13.91	ME=1
		At most 2	2.33	<	7.55	2.33	<	7.56	

Table 22. Continued.

Country	LAG	Hypothesized # of CE(H_0)	Trace		Critical Value 10%	LMax		Critical Value 10%	No. of Cointegration Equations
Colombia[7]	3	None	41.84	>	32.27	35.02	<	20.05	T=1
		At most 1	6.81	<	17.98	4.24	<	13.91	ME=1
		At most 2	2.57	<	7.55	2.58	<	7.56	
Guatemala[8]	10	None	27.15	<	32.27	17.68	<	20.05	T=0
		At most 1	9.50	<	17.98	6.10	<	13.91	ME=0
		At most 2	3.40	<	7.55	3.39	<	7.56	
Honduras*[9]	4	None	57.64	>	32.27	30.79	>	20.05	T=2
		At most 1	28.84	>	17.98	22.38	>	13.91	ME=2
		At most 2	4.45	<	7.55	4.46	<	7.56	

Note: T= No. of cointegration relations from Trace Test.
ME= No. of cointegration relations from Max Eigenvalue Test.
Brazil- TBF spans from Jan 1992 to May 2013.
Brazil- IR, GS TB spans from Jan 1995-May2013.
Colombia pans from Jan 1990-May 2013.
Guatemala spans from Jan 1996-May 2013.
Honduras spans from March 2011 to May 2013.

Overall the tests for cointegration between cash, futures and local interest rates suggest that interest rates are not significant when evaluating price linkages for Brazil, Colombia and Guatemala. Honduras is the only country that presented cointegration relations when evaluating local interest rates. More cointegration relations were found when evaluating producer prices, export prices and interest rates where Brazil, Colombia and Honduras, all showed at least one cointegration relation. This implies that local interest rates might have a significant role in the price linkage of producer and export prices that may bias our results against cointegration between producer and export prices in these countries when local interest rates are not taken into consideration in the cointegration test.

VITA

Jorge Jose Handal Reyes was born in San Pedro Sula, Honduras on January 1990. After receiving his high school diploma from the Escuela Internacional Sampedrana in San Pedro Sula, Honduras, he entered Texas A&M University in College Station, Texas. There he received a Bachelor of Science in Agribusiness and Economics in May 2012. On August, 2012, he entered graduate school in the department of Agricultural Economics and Agribusiness at Louisiana State University Agricultural and Mechanical College encouraged by the opportunity to grow intellectually and personally in an environment that nurtured and challenged his research and analytical skills. He plans to receive his Master of Science in Agricultural Economics under the agribusiness management concentration on August 2014, thereafter pursuing a career in agribusiness.