MARKET REFORM AND ITS IMPACT ON THE PRICE TRANSMISSION IN THE COFFEE SUPPLY CHAIN: A CASE STUDY OF COLOMBIA, GHANA AND IVORY COAST.

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ABSTRACT

Historically, coffee has been an important cash crop in the developing world and a major source of employment, foreign exchange and revenue. However, coffee producers have not always received a very large share of the export price of green coffee. Reasons that are often mentioned are heavy government intervention and high marketing and processing costs. Prior to reforms, government regulation of the domestic coffee markets in the form of fixed producer prices and the monopoly power of the Marketing Boards in Africa put a substantial wedge between the producer price and the world price of coffee by imposing an implicit tax on producers. From the early 1990s onwards, various Structural Adjustment Programmes were introduced in coffee exporting countries. This had direct consequences for the various forms of marketing boards which were prevalent in the coffee and other commodity sectors. In most cases, they were either dissolved or had their powers curtailed. One of the key objectives driving the reforms was to ensure that the farmer received a higher proportion of crop proceeds. Liberalisation was envisaged to have a positive effect on producer prices and price transmission signals from world markets to producers. This paper, an Error-Correction Model (ECM), analyses the impact of policy reform in Colombia, Ghana and Ivory Coast. A key question is whether producers of coffee beans received a higher share of the international price after reforms, as was the desired policy outcome. As findings indicate, the reforms induced stronger relationships among domestic and international prices in Colombia, but not in Ghana or the Ivory Coast. The institutional arrangements coordinating the domestic coffee system and contract enforcement may help explain the differences and should be explored further.

BIOGRAPHICAL SKETCH

Arnold Xavier graduated from the Institute of Business Administration (Karachi, Pakistan) in May 2006 with a Bachelor of Business Administration. Graduating with majors in Finance, Arnold maintained a position that was within the top 5 in his cohort throughout his undergraduate study.

Upon completion of his undergraduate studies in June 2006s, Arnold joined Citibank as a management trainee and successfully completed the program a year later. Arnold worked at Citibank for 2 years before being offered a position at Barclays Bank Plc., which he took. A year later Arnold successfully secured the prestigious Fulbright Scholarship to study in the United States of America and decided to pursue a graduate education in applied economics at Cornell University.

When Arnold is not working or studying he enjoys playing the drums and listening to music.

To my parents.

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I. Background-The Coffee Market and its importance to the developing economies

Brazil and Colombia have been the top world coffee producers for most of the twentieth century (Karp 1993). This situation has changed recently with the extremely fast growth of coffee production in Vietnam. In 1999/2000, Colombia was replaced by Vietnam as the world's second largest producer. In 2010, Vietnam produced 17.5 million 60 kg bags of coffee (USDA2010a) nearly double that of Colombia at 8.8 million 60 kg bags (USDA 2010b). Yet within Colombia coffee is still an important cash crop. Despite relatively smaller individual contributions, collectively the African continent is an important player. Coffee producers in Africa, for their part, accounted for about 12% of global supply and approximately 11% of global exports of the product for the 2009/10 production season. Africa's exports in recent times have been comparable to those of Indonesia's (Commodity Market Brief 2010), which is the fourth largest world producer of the commodity.

Coffee, both in terms of growing as well as processing, is one of the most important industries in Colombia. As of 2010, coffee accounted for 0.75% of Colombian GDP and 5.22% of Colombian exports (ICO 2010). Today the coffee industry is extremely important to the Colombian economy, providing employment to about 800,000 people, representing nearly a third of total rural employment (Ramirez- 2003). For more than one century coffee generated the majority of the country's foreign income. Today its greatest economic and social importance lies in its capacity to generate employment, redistribute income, and promote regional development, supporting the social stability of the coffee zones.

Almost 90% of the coffee producers are very small farmers, with less than 3 hectares planted to coffee. In 1997, the average amount of land planted to coffee by each of Colombia's 423,368 household coffee farms was 1.5 hectares (FNC, 1997). Currently, around 560,000 families are small and medium farmers who depend directly on coffee production. Most are located in the central region of Colombia. An estimated three million people depend, in one way or another, on the different stages of the coffee industry in this country. Additionally, the country's coffee regions have achieved a faster, more consolidated level of development primarily because of the long tradition of cultivating coffee with a competitive advantage and also by the important role that the institutional arrangement of the coffee growers has played in the past (Ramirez- 2003). Colombian coffee farmers organised themselves into the Colombian Coffee Growers' Federation in 1927 at the Second National Coffee Congress with the objective to protect and defend coffee for the welfare of their country and to promote the economic and social well-being of growers (Junguito and Pizano 1997).This institutional set up for the growers has been key to their success. Establishing the Federation not only kept private exporters from colluding to drive down prices paid to farmers, but over the years, the Federation established a number of subsidiary institutions, including a research institute, a capital fund and a merchant marine fleet (Bentley 2000). The Federation also set up experimental farms and began the publication of a magazine, in which coffee growers could learn about the results of the experiments (FNC 1928). A further reason for success is the Federation's long-standing political independence. The Colombian President no longer has to approve the committee's measures (Junguito and Pizano 1997). The Federation is able to keep most of its earnings and manage its own business and farmers play a key role in setting the research agenda.

Coffee previously was the most important export crop produced in Africa. During 1984–6, it represented a staggering 24 per cent of the total value of African agricultural exports (Raikes 2000). Africa's share of the world coffee market has been slowly, yet continuously shrinking, from 17% in 1995 to 13.6% in 2007, to closer to 11% in 2011. Yet, a number of African countries – even those with a low share of the global export market – still rely on coffee for a high proportion of their export earnings. While Africa's contribution to global coffee production in 2011 was only 11%, coffee is still an important export commodity and source of livelihoods for large proportion of the population in some countries. For example, Ethiopia and Rwanda respectively derived 26% and 22% of their export revenues from coffee in 2009. Furthermore, in Africa, coffee exports during 2010–11 represented more than 5 per cent in nine countries (ICO 2010). In 2010, Ethiopia was one of the world's largest coffee producers, ranking as the 5th largest coffee producer after Brazil, Vietnam, Indonesia and Colombia1 (ICO). In the Ivory Coast, the value of coffee constitutes 0.74 % of GDP and 2.9 % of all commodities exported. In Ghana the value of coffee constitutes 0.01 % of GDP and 0.03 % of all commodities exported. Africa has both large plantations, and small-scale family plots, although the small-scale producers dominate, in West Africa there are many areas where coffee is the single crop of small-scale farmers (Promar Consulting 2011). Thus, though individual contributions are small, the coffee supply chain benefits many more people in producing countries.

II.The rational for studying the Coffee sector

Examination of the coffee-marketing chain is particularly important for several reasons. First, over 90 per cent of global coffee production takes place in tropical and developing nations ,

while consumption takes place mainly in the industrialised world[1]. Second, and importantly, for most of the period after the Second World War, coffee has been the second most valuable traded commodity after oil[2]. Third, coffee was one of the first 'regulated' commodities; with attempts dating back to the beginning of the twentieth century. Fourth, for a number of African countries, even those with a low share of the global export market, coffee constitutes a high proportion of their export earnings. Fifth, coffee has been treated as a 'strategic' commodity by governments of coffee producing countries; case in point the Ivory Coast's current political stalemate. The winner of the November 2010 presidential election in the Ivory Coast, Alassane Ouattara, attempted to get Gbagbo (ex-president) to cede power and this led to civil war and a humanitarian crisis (CNN2011). The Ivory Coast derives a significant amount of foreign exchange from export of coffee and cocoa and the industry is a crucial revenue source for the military and civil service. Ouattara called for a ban on coffee and cocoa exports in January of 2011 in an effort to reduce the funding going to Gbagbo and pressure him to give up power (Espresso and Coffee Guide 2011).

Clearly, coffee is an important cash crop in the developing world and a major source of employment and revenue. The debate over the policies that surround its production, trade and finance are not only important, but in personal view, also necessary to the establishment and nurturing of a system that treats all market participants fairly, and none at the expense of others. The analysis of the coffee-marketing chain provides key insights for understanding the impacts

[1] The major exception is Brazil, which is the top producer and also one of the main consuming countries in the world. In Africa, the only country with substantial coffee consumption is Ethiopia.
[2] This has changed recently. In 1996/7, coffee ranked only fifth among internationally traded commodities after oil, aluminum, wheat and coal.

of the liberalization of domestic commodity markets in developing economies in relation to a changing global environment.

III. The Organization of the Global Coffee Industry

The global coffee trade offers a basis for a diverse array of research questions. For example ,the industry can be broken down by varieties which are eventually processed differently and cater to different markets. It can also be considered in terms of trade, either before or after processing or in terms of how the International Coffee Organization (ICO) categorizes coffee types. Another interesting research question. The one addressed here, is to determine the characteristics of the industry pre and post-structural adjustments.

The industry is organized around two primary coffee varieties (*Coffea Arabica and Coffea canephora* – also known as '*Arabica*' and '*Robusta*', respectively) and two primary processing methods ('*wet*' and '*dry*'). With the 'wet' method, the end result is 'Mild' (or washed) coffee, normally of the Arabica type. With the 'dry' method, the end result is 'Hard' coffee, either Hard Arabica or Robusta. The distinction is important as Mild Arabica, Hard Arabica and Robusta coffees are differentiated products that are priced differently, and are therefore traded separately. In all three cases, the product ready for export is called 'green' coffee which is packed in 60 kg bags (Brown 1991). Some Robusta coffee is also processed with the wet method, but its volume in international trade is insignificant.

The ICO[3] categorizes exports by type of coffee. Mild Arabica coffees are divided into '*Colombian Milds*' and '*Other Milds*'. Colombian Milds comprise coffees produced in Colombia, Kenya and Tanzania. The main players in the Other Milds category are Guatemala, Mexico and India. 'Brazilian Naturals' basically consist of Hard Arabicas from Brazil and Ethiopia. Another ICO category comprises Robusta coffees from all origins. Here, Vietnam is by far the main producer, but Côte d'Ivoire, Indonesia and Uganda are also major players (ICO 2011, Ponte 2001). The bulk of coffee produced in Ghana is Robusta because low elevation and high temperatures do not allow extensive agriculture of Arabica coffee (Kwapong 1997).

The other two forms of coffee trade are instant and roasted coffee. Trade between producing and consuming countries consists mostly of green coffee and bulk instant coffee. Bulk instant coffee imported from producing countries is usually blended and re-packaged in consuming countries. The roasted coffee trade takes place almost exclusively between consuming countries. This pattern of trade comes from the fact that green and instant coffees can be stored for longer periods of time, while roasted coffee loses its freshness much more quickly (Talbot 1997).

An important question that one may research is the change in price transmission that may have occurred after the implementation of reforms. Thus the international coffee industry may be studied by breaking it up into the 'pre structural adjustment' and 'post structural adjustment' periods. Structural Adjustment Facilities (SAF) began its operations in 1986. As a condition of

[3] The ICO Is the International Coffee Organization (ICO) is the main intergovernmental organization for coffee, bringing together exporting and importing Governments to tackle the challenges facing the world coffee sector through international cooperation. Its Member Governments represent 97% of world coffee production and over 80% of world consumption. The ICO was set up in London in 1963 under the auspices of the United Nations because of the great economic importance of coffee. It administers the International Coffee Agreement (ICA), an important instrument for development cooperation. The latest Agreement, the ICA 2007, entered into force on 2 February 2011.

receiving these loans, countries had to agree to adopt IMF structural adjustment programs. Structural adjustment programs (SAPs) generally required countries to adopt policies such as a reduction in government spending, monetary tightening (high interest rates and/or reduced access to credit), elimination of government subsidies for food and other items of popular consumption, privatization of enterprises previously owned or operated by the government, and reductions in barriers to trade, as well as to foreign investment and ownership (Naiman 1999). The dates for implementation of SAPs were different for different countries and thus the period before SAPs (pre structural adjustments) and after SAPs (after structural adjustments) differ accordingly.

IV. Pre-Structural Adjustment

The pre structural adjustment period, as mentioned above is that which existed before the implementation of SAPs in the various countries. Categorized by heavy government intervention in agricultural and financial markets, pre structural adjustments led to heavy spending on and protection of the agricultural sectors.

Historically, four major parties have played critical roles in the coffee production chain; the farmers, global traders, roasters and the bodies that tied them together were the marketing boards. The global traders, sourced coffee from a variety of origins, and sold them on to the fourth major party in the chain. The roasters, who branded and sold the coffee on to retailers. While Farmers, traders and roasters remained after structural adjustments, the farmers and marketing boards were a key focus in the SAPs.

The farmers have been central to the marketing chain, and until recent years when Brazilian farmers have gone in for large-scale irrigated farming (Mathey et. al- 2004), most of these

growers have been operating on a small or medium-scale. The vast majority of coffee farms in Brazil are less than ten hectares in size. According to the Diagnosis of the Coffee Production in Minas Gerais, 71% of farms are less than 10 hectares, 25% of farms had less than 50 hectares, and only 4% of farms were larger than 50 hectares (Coffeeresearch 2011). The majority of coffee farmers in Africa are small holders with farm sizes hardly exceeding 2 hactres (Kucel). Small-sized farmers produce 76% of coffee in Colombia, because small farm size provides heterogeneity of the landscape (Miura 2011).

In most producing countries, the second party of significance has been the marketing boards (particularly African countries) and producer associations (especially in South America) who have been responsible for various non-farm activities in the producing countries – milling, buying, quality checking, marketing and exporting. They could take any of the following three forms:

• Marketing Boards: Located in many ex-British economies. More often they worked closely with producer cooperatives. The cooperatives were responsible for buying and milling coffee, and the marketing boards set the prices, licensed producers, were responsible for quality control and upgrading, and exported the product. The marketing boards also coordinated the production systems, and were the intermediaries between producers and global traders. Marketing boards also often held or coordinated coffee auctions.

• Instituto: Some Latin American countries used a diluted form of Marketing Boards. Though they had many of the regulatory functions of marketing boards, including price formation and quality assurance, they played a less active role in buying.

• Caisse de Stabilisation. This was a francophone equivalent to the Marketing Boards operating in many ex-British colonies. It replicated many of the functions of the Boards, but unlike the Boards, it seldom physically handled the coffee. In other words, it assumed the role of governance without becoming involved in direct production processes.

V. Reason for Establishment of Marketing Boards

During most of the 20th century, governments not only intervened in primary commodity markets, but in fact accepted such interventions as part of the development policy framework (Akiyama 2001). While the instruments of intervention varied across countries and commodities, a dominant architecture based on the marketing board (Deaton 1999; Kaplinsky 2004) emerged. Designed to stabilize producer incomes, they often served as a monopoly distribution network (Kreuger 1990), and administered domestic prices that were normally pan-seasonal, pan-territorial, and detached from international prices (Gilbert 1999a / Gilbert 1999b).

The dominant feature of almost all primary commodity markets during the 1980s was a fall in both real and nominal prices which was secular in nature (Tollens 1999). Experiences with famine and food shortages convinced many governments in Asia and in newly independent Sub-Saharan Africa that control of the food crop sector was paramount to maintaining food security.

Controls were frequently extended to cash crops, which had a strategic value as a source of foreign currency and tax revenues (Akiyama 2003)

Development theory and political considerations also encouraged continued intervention. Many developing countries in Africa, Asia, Latin America, and the Middle East, influenced by the example and aid of the Soviet Union, believed strongly in state-dominated economic development which was further promoted by the prevalent structure of commodity exchange between the developing world and the Soviet Union (Fienberg and Avakov 1991). Moreover governments frequently pursued policies that taxed agriculture in order to promote industrial development (Timmer 2009), and establishing a marketing board was a common way to achieve that

Practical and economic considerations often provided a further rationale for intervention in commodity markets. Commodities were often useful revenue sources, and some policymakers saw taxing commodity exports as the most convenient and practical way to finance state activities (Bates 1981). Government-controlled systems also provided a source of political patronage— for example; politicians could reward supporters with trading licenses or high-level appointments to marketing boards. Further, state management often provided politicians and government officials with funding for discretionary expenditures. Government control of key commodity markets created opportunities for corruption. Indirect taxes on export commodities provided financial benefits to the urban elite (Bates 1981) who were important political allies. To make planting decisions easier, prices were frequently fixed for the crop year. To smooth annual price fluctuations, domestic prices were uncoupled from international prices. And to resolve

regional disparities, fixed prices were pan-territorial so that all producers received the same purchase price. However, as time passed, economic conditions changed and hence a change of perspective was ushered in. After decades of preserving and promoting institutional control over the coffee markets, governments began designing policies to reform the marketing boards and to let market forces drive coffee export supply chains.

VI. Post Structural Adjustment

Economist at one time embraced a policy encouraging interventions by marketing boards. However, changes in the international dynamics of the coffee market soon generated a set of new problems. Governments' fiscal problems and parastatals' financial difficulties combined to prompt market reforms in many coffee- and cocoa producing countries(Akiyama 2001).

The single most important factor behind the liberalization of the coffee subsector may have been the collapse of the ICO's export quota system in July of 1989 which was exacerbated by Brazil's lack of interest in preserving the export quota system and the United States' withdrawal from the International Coffee Agreement. The first International Coffee Agreement (ICA) was signed 1962 and included most producing and consuming countries as signatories. Under the ICA regime, a target price (or a price band) for coffee was set, and export quotas were allocated to each producer country. When the indicator price calculated by the International Coffee Organization (ICO) rose over the set price, quotas were relaxed; when it fell below the set price, quotas were tightened. If an extremely large rise in coffee prices took place (as in 1975-77), quotas were abandoned until prices fell back within the band. Although there were problems

with this system, most analysts agree that it was successful in raising and stabilizing coffee prices (Akiyama and Varangis 1990; Bates 1997; Daviron 1996; Gilbert 1996; Palm and Vogelvang 1991). The inherent stabilizing force of the ICA, coupled with regulated markets in producing countries, created a relatively stable institutional environment where rules were relatively clear, change politically negotiated, and proportions of generated value added fairly distributed between consuming and producing countries. The relatively homogeneous form of trade limited the possibilities of product upgrading, but producing countries ensured product valorization through higher prices generated by the ICA (Ponte 2001b). However, the ICA system was eventually undermined by free-riding and squabbling over quotas. Other problems were the increasing volume of coffee traded with (or through) non-member importing countries at lower prices, the growing fragmentation of the market, and the increasing heterogeneity of development models (as Brazil and Indonesia moved towards a more export-oriented industrial strategy) (Daviron 1993, Daviron 1996). The collapse of the International Coffee Agreement (ICA) significantly impacted the marketing and pricing systems coffee-producing countries and eliminated the need for government marketing agencies. The collapse of the marketing boards in most producing countries increased exports as it was believed that high sales levels would ensure higher quotas on the re-establishment of the ICA. This led to a decline in international prices while the need for additional funds to maintain prices paid to domestic producers at pre-reform levels grew. At the same time coffee-generated tax revenues to governments fell, making the situation non-sustainable. This led to shortfalls at the marketing boards which were finding it difficult to carry out their core function of maintaining fixed producer prices. The allocation of export quotas had became a source of rents for rentiers within the system and was used to sustain marketing agency activities within the government (Bohman et. al.1996). The political economy

of domestic interventions also changed in lieu of the collapse of the international agreements which made resistance to liberalization more difficult.

Other reasons that thrust economies towards market reforms were changes in the views of development economists, and push for market reforms from agencies such as the World Bank and the International Monetary Fund (IMF). As development economists' preference for market-based policy instruments grew, a number of political and economic events reinforced the notion that market interventions stifled growth and economic opportunity and created an opportunity for reform. These include the successful adoption of more market-oriented domestic agricultural policies in China, the failure of several commodity agreements, and the collapse of the Soviet Union. Additional factors also encouraged change, including accumulated debt burdens in Latin America and Africa and increased activism by the international financial institutions to bring about policy changes (Akiyama 2003). These ideological and political changes were a factor in the emergence a market based approach in economies around the world, especially those that were looking towards such agencies for financial assistance. From the early 1990s onwards, various Structural Adjustment Programmes were introduced in coffee producing countries, sometimes under the insistence of multilateral and bilateral aid agencies, and in other cases with the active participation of governments. This had direct consequences for the various forms of marketing boards which were prevalent in the coffee and other commodity sectors. In most cases, they were either dissolved or had their powers curtailed. One of the key objectives driving the reforms was to ensure that the farmer received a higher proportion of crop proceeds. The Common Fund for Commodities Report which involved a cooperation between the World Bank and the International Coffee Organisation concluded that “the key benefits of liberalisation is

that increased competition throughout the marketing chain leads to a reduction in marketing costs and growers receiving a higher proportion of the export unit value" (CFC 2000).

VII.Reforms in Colombia, Ghana and the Ivory Coast

Following the collapse of the economic clauses of the International Coffee Agreement most African countries moved to eliminate government export monopolies in coffee – examples include Cameroon and Côte d'Ivoire, Madagascar, and Uganda. In other countries, for example Ethiopia, it was the change in political regime that prompted the reforms in the coffee subsector (Akiyama, 2001). In most of the coffee cases, domestic and export markets were fully liberalized and structural adjustment lending played a role in several of the countries (Akiyama, 2003). We briefly discuss the reforms in Colombia, Ghana and the Ivory Coast which is intended to serve as context to the reforms in the countries.

Colombia

Colombia is an outstanding example of a coffee sector run entirely by an association of producers. The powerful Federación Nacional de Cafeteros de Colombia (FNC) exerts major influence on how the sector functions in this category. The FNC is contracted by the government to implement coffee policy and its involvement in coffee marketing is substantial. The FNC sets minimum producer prices, controls purchasing, processing and exporting of coffee and provides extension services, support to research and funding of infrastructure projects. FNC's agents handle approximately half of all coffee exports (40% in 1989), with the remaining crop being sold to private traders. In addition, the FNC serves as a stabilization fund, buying surplus coffee

from producers at a guaranteed price, which may exceed the world price net of marketing costs. In particular, between 1989 and 1994 producers received artificially high administered prices, causing losses to the FNC. Unsustainable in the long run, the system was abolished in 1995. Although no radical structural changes were made that year, 1995 is taken as the year of the reforms for this paper, because the artificially high producer prices were suspended, which should have brought the internal prices closer to the world market prices. While the Colombian coffee sector is marked by high degree of semi-governmental intervention (Kronivos 2004), the system seems to benefit the growers. Acting unified, Colombian growers have historically managed to get a substantial price premium on the world market and can influence the domestic policy to their benefit. Unlike in many other coffee producing countries, the system serves the interests of producers, not government bureaucrats or influential exporters in the private sector (Bentley 2000, Kronivos 2004) .

Ghana

As a typical pre-reform state marketing board, the Ghana Cocoa Board (COCOBOD) was a fully controlling the internal marketing, exporting, grower prices and marketing margins. The Produce Buying Company (PBC), a subsidiary of the COCOBOD, bought coffee from producers and stored it in its warehouses after processing, inspection and grading. A different division of the COCOBOD, the Cocoa Marketing Company (CMC), handled external marketing. However, unsustainable levels of government expenditure, an increasingly overvalued exchange rate, import licensing, inflation , price controls and heavy state involvement in the running of the economy (Tsikata 1999, Leith and Söderling 2000) led to a collapse. For example, in 1984 about 2.5 percent of the population was employed in the Civil Service, one of the highest ratios in

Africa at the time. Preliminary audits conducted in 1986 indicated that there were tens of thousands of ‘ghost workers’ on the public sector payroll (Brooks 1997).

In 1984 COCOBOD underwent institutional reform aimed at subjecting the cocoa sector to market forces. COCOBOD's role was reduced, and 40 percent of its staff, or at least 35,000 employees, were dismissed. Furthermore, the government shifted responsibility for crop transport to the private sector. Subsidies for production inputs (fertilizers, insecticides, fungicides, and equipment) were removed, and there was a measure of privatization of the processing sector through at least one joint venture (Alderman, Canagarajah and Younger 1993). Following the structural adjustment programs in 1992, the government liberalized all internal and external marketing of coffee. Private traders were allowed to enter the market, and fixed prices and trading margins were abolished. The main functions, thereon, of the COCOBOD became sector regulation and management of licenses. The new marketing chain consists of Commission Agents that buy coffee from farms and registered exporters (the Licensed Buying Companies). By 1994 forty six companies held export licenses (ICO 2011).

Ivory Coast

During the French colonial period before World War II, large plantations and accompanying agricultural experimental stations were created in support of cocoa, coffee, and oil palm production. By 1955 The ‘Caisse de Stuhilisution des Cows’ was established in and incorporated (after independence in 1960) as a parastatal under the complete control of the central government (Cardenas 2002). Parastatal bodies were a critical part of the transition from colonial to independent status. These organizations were funded in part or in full by the

government, and provided such services for specific commodities as extension, development and credit among others. Many parastatal bodies contracted with research stations to conduct research, and have been a significant source of income for funding of commodity research. The Caisse determined payments for all the stages along the marketing chain, including the producers' remuneration. Producers' prices were meant to 'reflect production cost' and provide 'equal remuneration for all crops' (Akiyama 1988). Consequently, the ratio of producers' prices for both coffee and cocoa has remained constant since the 1976/77 season, in spite of divergent world prices (Cardenas 2002). On paper, any surplus obtained by the Caisse at the end of a crop year should have been allocated to the Price Stabilization Reserve, expenditures for rural infrastructure, and agricultural credit schemes. As is documented in Ridler (1988), the Caisse, at one time, provided between one-half and two-thirds of public sector investment in Cote d'Ivoire. The return on those investments was at best insufficient (or nonexistent at worse) to support a stable price after the collapse in the world market during the 1980's.

Coffee (and cocoa) still dominate the country's agriculture, however the decline in growth rate of production of these commodities over the 1985-1994 period was partly responsible for the economic and financial problems of the country. The annual growth rate of coffee production fell from 0.7 percent in 1985-1989 to -7.9 percent in 1990-1994 (ICO 2011). This reduction in coffee production and mediocre performances were explained primarily by the behavior of the world prices of coffee (and cocoa).

The IMF became involved in Cote d'Ivoire in November 1989 on a stand-by arrangement where the government and the IMF agreed on an outline of economic policy changes. Following the initial stand-by arrangements, six World Bank Structural Adjustment Loans from 1989-1993 followed. Then, in 1994, Cote d'Ivoire entered into the IMF Enhanced Structural Adjustment Facility (ESAF), which is an IMF concessional lending facility for the least developed countries. Prior to the ESAF loan, the Cote d'Ivoire government had to first agree to a set of structural adjustment programs as dictated by the World Bank and IMF. It was a program of accelerated privatization, reduction in government expenditures followed by currency devaluation, and led to dismantling of marketing boards.

VIII. Concluding remarks on marketing boards, reforms and focus of this paper

Marketing boards, as discussed earlier, have been commonplace institutions in coffee producing countires. With few exceptions, countries exporting primary commodities had developed marketing and pricing systems for export crops that included a '*Board*' (as in Anglophone East and West Africa) or a '*Caisse* (as in francophone West Africa) , both being endowed with monopsony power in the purchase of coffee and the '*Institutios*' (in South American countries) which had a more diluted role. On one extreme when the country has some market power in the determination of world prices, the board can be used to regulate exports and, hence, control the world price. In this case, the marketing board is best regarded as a way of imposing an optimal tax on exports that allows the country to achieve the first-best outcome (Cardenas 1994). Marketing boards may also have important functions in cases where countries act as price-takers in the world market. Historically, national governments and ex-colonial powers have justified the existence of this institution on the grounds of stabilization of producers' incomes (Cardenas

1994). This argument hinges on the instability of world prices. If local producers do not have access to instruments for consumption smoothing (futures contracts for example), the first-best outcome, it is then a second-best solution to create an institution that is able to save (dis-save) during periods of high (low) world prices, allowing each individual producer to face a stable income.

However, marketing boards have often become instruments of taxation in spite of the stated objective to adequately pay producers (CFC 2000). There may be an incentive for politicians and officials with different objectives than those of the farmers to use the marketing board for redistribution purposes. In this case producers may benefit from dismantling the institution even if it represents a stable income. This has been pervasive in African countries where British and French officials were replaced after independence by urban political elites which derived financial and political leverage from managing the institution. At the other extreme, like in Colombia, which is the exception rather than the norm, the association of coffee growers, where producers exercise direct control over the institution, producers' prices are higher compared with the instances where producers do not run the institution and more stable compared to countries where the institution does not exist (Cardenas1994).

Various Structural Adjustment Programmes introduced in coffee producing countries, under the insistence of multilateral and bilateral aid agencies, and in other cases with the active participation of governments. As a result of reforms initiated in the mid-1980s, there has been a sea change on how agricultural export commodities are marketed and financed in many countries. For commodity markets, market reform has meant the reduction in government

involvement in marketing, increasing participation of the private sector in these activities and reducing distortions in producer prices. Though the measures to achieve these goals have varied, they have often included elimination or privatization of government marketing agencies, the introduction of competition in marketing sectors, the elimination of managed or administered prices, a reduction in taxes and the privatization of government-owned assets. Events triggering commodity market reforms were not independent of broader political and economic changes in most countries and the consequences of reform are often linked as well. One of the key objectives driving the reforms was to ensure that the farmer received a higher proportion of crop proceeds. The CFC 2000 Report concluded that "the key benefits of liberalisation is that increased competition throughout the marketing chain leads to a reduction in marketing costs and growers receiving a higher proportion of the export unit value" (CFC 2000).

This thesis investigates the impact of the structural adjustment programs on the share of international prices received by producers, providing a comparison prior to reforms and after reforms. The central idea of this study is to add to the existing literature on the transmission of prices in the coffee sector, given the background of a dynamic policy environment in Africa and South America. Using an Error Correction Model, I am able to examine not only how changes in international prices are transmitted to farmers in coffee exporting countries, but also how quickly these changes are passed on, which may help illustrating the efficiency of one model (marketing boards) juxtaposed with another (free market with the participation of more private entities). Chapter 1 outlines the background on the coffee sector globally as well as within the 3 focal countries. The chapter details the history and the environment prevalent during the times of government control and intervention through marketing boards and moves on to describe

possible reasons for liberalization. Chapter 2 discusses the empirical model and the data used. Chapter 3 discusses the steps and test involved in modeling non-stationary economic time series. Chapter 4 discusses the results and provides a brief conclusion to the thesis.

Chapter 2

I.Literature Review

There has been considerable attention and time devoted by researchers to price transmission in supply chains for agricultural commodities traded internationally. Observed usually at downstream stage of supply chain, Price transmission may be closely associated to market structure and market power. An extensive literature has evolved over time and several methods have been employed in the past to determine the degree of price transmission in agricultural commodities.

Hallam and Zanoli (1993) suggest the use of error-correction models to provide a more useful theoretical framework for studying agricultural supply response after detailed theoretical analyses of the prevailing frameworks. Studies by Theil (2000, 2002), Mackay et al. (1999) and Abdulai and Reider (1995) all lend support to the superiority of cointegration and error correction modelling. The superiority of the cointegration technique lies in its flexibility; the approach does not impose any restrictions on the short-run behaviour of prices and quantities, and it rather requires a co-movement of the variables in the long-run. In the standard ECM, the dependent variable responds identically to deviations from the long-run equilibrium regardless of the magnitude and, moreover, the adjustment occurs in every period (Balke and Fomby 1997).

Shepherd (2004) examines the impact of the elimination of ICA's on price transmission in the coffee market chain using a vector autoregression (VAR) model. The authors argue that elimination of the export quota system did not lead to improved price transmission due to the

market power exercised by large, well established coffee processors. Gemech and Struthers (2007), on the other hand find evidence of significant increases in coffee price volatility after the elimination of ICA.

Mundlak et.al (1992) estimate a direct relationship between domestic and world market prices using a simple logarithmic model, to represent the relationship between domestic and world market prices and exchange rates. The authors estimate price transmission elasticities for 58 countries and find evidence of almost perfect price transmission. However, the results appear to be distorted due to the lower estimates of price transmissions for individual commodities (wheat, coffee and cocoa) as compared to a pool of commodities which is close to unity. This indicated a high level of distortion in these particular markets, including coffee.

Similar results are reported by Baffes et.al (2003) who also use the error-correction model specification to estimate the responsiveness of the domestic prices to fluctuations on the world market. The authors analyze price transmissions for 10 commodities on a country-by-country basis for a period from 1970s to 1990s. The results of their study indicate that changes in the world prices cause only small variations in domestic prices. The authors go a step further, assessing whether policy reforms improved price transmission. Their approach introduces structural breaks corresponding to the years of substantial market reforms and the results show that in most countries the reforms have very limited effect on price transmission.

Krivonos (2004), using the standard ECM, studies price transmission of coffee prices in 14 countries. The author reports that short-run transmission of price signals from the world market

to domestic producers has improved after the re-structuring of coffee marketing boards, such that domestic prices adjust faster today to international price variations than they did before the reforms. The paper also reported some evidence of asymmetries in the way positive and negative world price changes are transmitted to domestic markets.

Lord (2001) develops a theory-consistent market model for storable commodities and illustrates its characterization for a set of major traded commodities. Cointegrated variables in the demand functions are represented by the error correction mechanism (ECM), and expected prices in the stock demand relationship are generated by a rational expectations process. The performance of the model is then tested against the time-series model used to formulate expected prices, and is shown to have a smaller mean square error (higher efficiency) than that of the time-series model.

Ocran and Biekpe (2007) estimate agricultural commodity supply response at three levels of aggregation namely, all commodities, food commodities and exports commodities. Their study uses cointegration and error correction modeling techniques and construct aggregate price and quantity indices using the Tornqvist formula. The authors find that producers were responsive to price incentives in the long-run for all three non-oil commodity aggregates but in the short-run only producers of export commodities were responsive to price incentives. The study thus highlights that producers respond to price signals as predicted but structural features of the agricultural commodity sector that result in high transaction cost may account for the absence of

price response in the short-run. The authors recommendations state that interventions in lowering transaction cost in agricultural commodity production have the potential of stimulating a faster and considerable response to price incentives.

Akiyama and Varangis (1990) employ simulation method for global coffee model and demonstrate that the export quota system contributed to stabilize international coffee prices. Mehta and Chavas (2008) find mixed results in their study of the impact of the ICA on the relationship between farm prices in exporting countries, international prices, and retail prices in importing countries. They find that, in the short-run, retail prices respond asymmetrically to changes in international prices in the post-ICA period. However, in contrast, they find no evidence of asymmetric transmission between wholesale and farm prices.

More recently, Gómez, Lee and Körner (2010) examine price transmission from international to retail coffee prices in France, Germany and the United States in the post-ICA period during the period 1990- 2006. The authors employ an error correction model and find no evidence of long-run price transmission asymmetries. However they provide evidence of short-run asymmetries with substantial differences among countries.

This paper studies the impact of the Structural Adjustment Programs in Colombia, Ghana and Ivory Coast on the price transmission between international and domestic prices received by producers. I employ the standard ECM to determine if producers of coffee beans received a higher share of the international price after reforms compared to the period prior to reforms. The

contribution of this paper is to study the two different forms of marketing boards; the '*marketing board*' and the '*instutio'* and provide analysis on the price transmission in both.

II. Empirical Model

Following Engle and Granger (1987), I test for co-integration between domestic and international prices. The model proposed by Engle and Granger introduced the concept of an Error Correction (EC) specification which incorporate dynamic elements into the estimation of price transmission mechanisms. Thus including the EC term allows tracking the adjustment of domestic prices to their long term equilibrium in the period following the change in the international price.

Consider an autoregressive distributed lag model (ARDL) (1,1) with two non-stationary time series P_t^d, P_t^i and single lags: P_{t-1}^d, P_{t-1}^i,

$$P_t^d = a_0 + \alpha_1 P_{t-1}^d + \alpha_2 P_t^i + \alpha_4 P_{t-1}^i + \varepsilon_t \qquad (1)$$

Where P_t^d is the domestic price and P_t^i is the international / world price, P_{t-1}^d is the lag of the domestic price, and P_{t-1}^i is the lag of the international price. By assuming that P_t^d and P_t^i are co-integrated, re-rearranging equation (1), gives the general form for an EC model as follows (see appendix A for derivation):

$$\Delta P_t^d = \alpha_0 + \theta\left[P_{t-1}^d - \beta P_{t-1}^i\right] + \delta(P_t^i - P_{t-1}^i) + \varepsilon_t \qquad (2)$$

Where $\theta = (\alpha_2 - 1)$, $\beta = \frac{\alpha_1 + \alpha_3}{\alpha_2 - 1}$ and $\delta = \alpha_1$, and ΔP_t^d is the change in the domestic prices. The variation of the domestic price P_t^d in terms of its response to fluctuations in the world price P_t^i is

described in equation (2). The first term in brackets on the right hand side represents the error correction term (ECT) which, as mentioned earlier, represents the deviation from the equilibrium relation in the previous period.

An additional piece of information provided by equation is the adjustment of domestic price P_t^d to its long-term equilibrium. δ captures the immediate responsiveness of the domestic prices to changes in the world price, and θ is the 'error-correction' term, which measures the speed of adjustment of P_t^d to its long-run equilibrium βP_t^i. Prices dynamics should ensure that θ be negative, since θ implies correction downward when P_{t-1}^d exceeds βP_{t-1}^i and upward when βP_{t-1}^i exceeds P_{t-1}^d (Krivonos 2004).

Equations (1) and (2) assume an unidirectional relationship between P_t^d and P_t^i. However, it is possible that the two variables are determined simultaneously. Thus to examine whether the co-integrating equation influences both variables, a test for weak exogeneity is conducted. A simultaneous representation of equations yields:

$$\Delta P_t^d = a_0 + \alpha_1 ECT_{t-1} + \alpha_2 \Delta P_{t-1}^d + \alpha_3 \Delta P_t^i + \alpha_4 \Delta P_{t-1}^i + \alpha_5 \Delta Precip_t + \alpha_6 \Delta Precip_{t-1} + \varepsilon_t \quad (3)$$

$$\Delta P_t^i = a_0 + \alpha_1 ECT_{t-1} + \alpha_2 \Delta P_{t-1}^i + \alpha_3 \Delta P_t^d + \alpha_4 \Delta P_{t-1}^d + \alpha_5 \Delta RAIN_t + \alpha_6 \Delta RAIN_{t-1} + \varepsilon_t \quad (4)$$

Statistical inference requires identification of the short run dynamics, captured by dummy variables and variables for weather. For the international price equation, I employ the rain in Fortaleza, Brazil. The change in the monthly average of precipitation $(\Delta RAIN_t)$ and the lagged change in the monthly average of precipitation $(\Delta RAIN_{t-1})$ in Fortaleza, Brazil is used to

identify the short run dynamics of the international price equation because weather patterns affect international prices (National Centre for Atmospheric Research 2010) and Brazil is a large exporter. The identifying restriction on the domestic price equation is the change in the monthly average precipitation ($\Delta Precip_t$) and the lag of the change in the monthly average precipitation ($\Delta Precip_{t-1}$) because weather patterns can affect domestic prices as well. Satellite-derived Normalized Difference Vegetation Index (NDVI) is normally used as a proxy for precipitation to detect and control for variation in local agricultural (Brown et al. 2009) (For source and explanation of variable please see section on Data).

In order to capture the impact of the reforms on the parameters in the marketing chain, a set of dummies is used. The set of policy dummies reflect market liberalization:

$$D_t = \begin{cases} 0 \; if \; t \; indicates \; the \; period \; prior \; to \; market \; reforms \\ 1 \; if \; t \; indicates \; a \; period \; after \; market \; reforms \end{cases}$$

The period of reform is different for each country and determines the choice of when '0' is employed and when the series switches to '1'. In Colombia the year of reform is taken as 1995, when the artificially high producer prices were suspended, which should have, theoretically, brought the internal prices closer to the world market prices. In Ghana that year taken is 1992 since that is the year the COCOBOD was reformed and the government liberalized all internal and external marketing of coffee. Private traders were allowed to enter the market, and fixed prices and trading margins were abolished. The year of reform in Cote d'Ivoire is taken as 1994, when it entered into the IMF Enhanced Structural Adjustment Facility (ESAF). A precondition to entering ESAF was that the Cote d'Ivoire government had to first agree to a set of structural adjustment programs as dictated by the World Bank and IMF.

To ensure validity of the use of the error-correction model, one first needs to make sure that the time series used in the estimation are stationary or otherwise one risks estimating a relationship that is spurious. Such a mistake may lead us to conclude falsely that a relationship exists between the domestic and the International market prices. The stationarity properties of the price time series' (both domestic and international) are tested using the Augmented Dickey-Fuller procedure (ADF) on both levels and first differences. In each case the hypothesis tested is that the time series follow a non-stationary process with a unit root. Rejecting the null hypothesis allows treating the time series as stationary. For an ECM representation to exist, P_t^d and P_t^i must also be cointegrated. Once having established a co-integrating relationship between domestic and international prices, the final ECM model specification is proposed which allows to ascertain the results of the market liberalization prior to and after the reforms took place. To examine whether the co-integrating equation influences both variables; P_t^d and P_t^i, tests for weak exogeneity are carried out, by employing the likelihood ratio (LR) test. The LR test is used to compare the fit of two models [(3a) vs. (3b) and (4a) vs. (4b)], one of which (the null model) is a special case of the other (the alternative model). Whether the null model or the alternative fits significantly better, and should thus be preferred, is determined by deriving a probability or p-value.

$$\Delta P_t^d = a_0 + \alpha_1 ECT_{t-1} + \alpha_2 \Delta P_{t-1}^d + \alpha_3 \Delta P_t^i + \alpha_4 \Delta P_{t-1}^i + \alpha_5 \Delta Precip_t + \alpha_6 \Delta Precip_{t-1} + \varepsilon_t \quad (3a)$$

$$\Delta P_t^d = a_0 + \alpha_1 \Delta P_{t-1}^d + \alpha_2 \Delta P_t^i + \alpha_3 P_{t-1}^i + \alpha_4 \Delta Precip_t + \alpha_5 \Delta Precip_{t-1} + \varepsilon_t \quad (3b)$$

$$\Delta P_t^i = a_0 + \alpha_1 ECT_{t-1} + \alpha_2 \Delta P_{t-1}^i + \alpha_3 \Delta P_t^d + \alpha_4 \Delta P_{t-1}^d + \alpha_5 \Delta RAIN_t + \alpha_6 \Delta RAIN_{t-1} + \varepsilon_t \quad (4a)$$

$$\Delta P_t^i = a_0 + \alpha_1 \Delta P_{t-1}^i + \alpha_2 \Delta P_t^d + \alpha_3 \Delta P_{t-1}^d + \alpha_4 \Delta RAIN_t + \Delta RAIN_{t-1} + \varepsilon_t \quad (4b)$$

III.Data

Monthly data on international coffee prices and prices paid to growers in Colombia, Côte d'Ivoire during the period January-1980 to December-2009, and Ghana during the period January-1980 to December-2006 is employed. I compile national domestic prices of coffee (farm gate level) and international prices of coffee; both received from the International Coffee Organization (ICO). Two international coffee prices are used; one for Robusta and one for Arabica. Colombia exports Arabica coffee beans while Ghana and Ivory Coast produce and export Robusta coffee beans. Arabica and Robusta prices are different and Robusta prices are, on average, lower than Arabica prices (Figure 2). It was thus important to use two different prices to accurately account for domestic coffee prices in Colombia (Arabica) and Ghana and Ivory Coast (Robusta). The Arabica price is calculated based on the weighted market share of exports of each group of coffee. Prices paid to growers represent the average price paid to the grower at farm-gate level.

[Figure 2 here]

Monthly Normalized Difference Vegetation Index[4] in Colombia, Côte d'Ivoire, and Ghana is used to identify the short run dynamics of the domestic price equation because weather patterns affect domestic prices (Ackerman 2006). Satellite-derived Normalized Difference Vegetation

[4] The Normalized Difference Vegetation Index (NDVI) provides a measure of the amount and vigor of vegetation at the land surface. The magnitude of NDVI is related to the level of photosynthetic activity in the observed vegetation. In general, higher values of NDVI indicate greater vigor and amounts of vegetation. NDVI is derived from data collected by National Oceanic and Atmospheric Administration (NOAA) satellites, and processed by the Global Inventory Monitoring and Modeling Studies group (GIMMS) at the National Aeronautical and Space Administration (NASA). For a detailed discussion on NNDVI please refer to product documentation (http://earlywarning.usgs.gov/fews/africa/web/readme.php?symbol=nd) and references 26,28,30,35 and 36 listed at the end of this paper. Copies of these papers are made available by authors upon request.

Index (NDVI) has previously been used as a proxy for precipitation to detect and control for variation in local agriculture[5] (Brown et al. 2009). NDVI data have been used extensively in the Sahel to detect variations in vegetation production, and have been shown by a number of authors to be correlated to both NPP, crop yields (Tucker, 1985; Prince, 1991; Fuller, 1998), and precipitation (Nicholson 1993). The identifying restriction on the international price equations (4, 4a and 4b) is the monthly average precipitation in Fortaleza, Brazil. Brazil is the largest producer of coffee in the world (ICO 2011) and thus changes in the production and stock levels of coffee beans in Brazil may affect world prices. Descriptive statistics of the data are provided in Table 1. The mean domestic price in Ivory Coast and Ghana are almost identical, at 41 and 42 cents per pound, respectively, and almost half of the mean International Robusta price which is 83 cents per pound. Robusta prices have historically been lower than Arabica prices and the same is reflected in the data. The mean domestic price for Colombia is 83 cents per pound and the international Arabica price is 101 cents per pound.

[Table 1 here]

[5] For a unique application of NDVI to price forecasting please refer to Brown et al. 2009

Chapter 3

I. Modeling Non-stationary Economic Time Series

A time series is a collection of observations measured sequentially over time. For a time series since the order or time sequence is critical, classical statistical procedures are not always appropriate, and thus different techniques have to be applied. Time series analysis techniques range from descriptive methods to inferential techniques. Inferential techniques range from stationarity test, co-integration analysis to various model specifications. In the following section, a brief overview of time series modeling approaches is presented.

Analysis of Unit Root (Non-stationarity)

For time series analysis, it is important to check whether a series is stationary or not before using it in modeling since the standard inference procedures can only be applied to stationary series. A stochastic time series Y_t is said to be covariance stationary if, for all *t* and any *s*, it satisfies the following conditions

$$E(y_t) = E(y_{t-s}) = \mu \quad (1)$$

$$E[(y_t - \mu)(y_{t-s} - \mu)] = r_s \quad (2)$$

Where r_s is the sth lag autocovariance, and μ is the expected value of the time series, y_t. A data series is difference-stationary if it is not covariance stationary in levels, but its first difference is covariance stationary. A difference stationary series is also called a unit root or *I(1)* process. More generally, a difference stationary series can be denoted as *I(d)* where d is the order of

integration, which is the number of differencing operations it takes to make the series stationary. Unit root test is the formal method for testing for the stationarity of a time series. A simple AR*(1)* model is as follows;

$$y_t = \rho y_{t-1} + u_t \quad (5)$$

where *yt* is the variable of interest, t is the time index, ρ is a coefficient, and *ut* is the error term. A unit root is present if $\rho = 1$, in which case the model would be non-stationary. There are a variety of unit root tests, and the most popular is the Dickey-Fuller (DF) test. The equation for DF unit root test is given as DF test is specified as follows;

$$\Delta y_t = (\rho - 1) y_{t-1} + u_t = \delta y_{t-1} + u_t \quad (5a)$$

where Δ is the first difference operator. This model can be estimated and testing for a unit root is equivalent to testing $\delta = 0$ (where $\delta = \rho - 1$). Since the test is done over the residual term rather than on the raw data, it is not possible to use on the standard t-distribution to provide critical values. Therefore this τ statistic has a specific distribution simply known as the Dickey–Fuller Table.

There are three main versions of the test:

Test for a unit root:
$$\Delta y_t = \delta y_{t-1} + u_t \quad (5b)$$

Test for a unit root with drift:
$$\Delta y_t = \alpha_0 + \delta y_{t-1} + u_t \quad (5c)$$

Test for a unit root with drift and deterministic time trend:
$$\Delta y_t = \alpha_0 + \alpha_1 t + \delta y_{t-1} + u_t \quad (5d)$$

Each version of the test has its own critical value which also depends on the size of the sample. In each case, the null hypothesis is that there is a unit root or that $\delta = 0$. An extension to the DF test is the Augmented Dickey-Fuller (ADF) test which constructs a parametric correction for higher-order serial correlation by assuming that the time series follows an AR(p) process and adding p lagged difference terms of the dependent variable to the right-hand side of the test regression (Gujarati 2003). Since in practice, most time series tend to contain higher order lags, ADF test is more popularly used than DF test. The testing procedure for the ADF test is the same as for the Dickey–Fuller test but it is applied to the model

$$\Delta y_t = \beta_1 + \beta_2 t + \gamma y_{t-1} + \delta \sum_{i=1}^{m} \Delta y_{t-i} + \varepsilon_t \qquad (6)$$

where α is a constant, β the coefficient on a time trend and p the lag order of the autoregressive process. By including lags of the order ρ, the ADF formulation allows for higher-order autoregressive processes. This means that the lag length ρ has to be determined when applying the test. The unit root test is then carried out under the null hypothesis $\gamma = 0$ against the alternative hypothesis of $\gamma < 0$. Once a value for the test statistic is computed it can be compared to the relevant critical value for the Dickey–Fuller Test. If the test statistic is less than (a larger negative) the critical value, then the null hypothesis of $\gamma = 0$ is rejected and no unit root is present.

I construct ADF tests with non-stationarity under the null hypothesis. Test results are exhibited in Table 2. The results suggest that all domestic price series as well as the international price series contain unit roots with and without a constant term. Comparing the τ statistic obtained from the unit root tests with the critical values from the DF Table [-2.88 (with constant) and –

1.95 (no constant)], I fail to reject the null that $\gamma = 0$ (non-stationary). Thus, in levels, a unit root is present for each time series. Once differenced the results were different. Since the absolute values of all τ statistics were greater than the critical values from the DF Table, I reject the null that $\gamma = 0$, thus concluding that no unit root remains in the time series transformed in first differences.

[Table 2 here]

Co-integration Analysis

Typically, most economic time series are *I(1)* process which requires us to take the first difference for the series to make it stationary. The presence of a co-integration relationship forms the basis for the error correction model specification. Therefore, with an *I(1)* time series, prior to further empirical analysis, it is important to test for co-integration. All *I(1)* time series are said to be co-integrated if there exists a linear combination of the variables being stationary. Different tests for co-integration are used to determine whether a group of *I(1)* series are co-integrated or not. Engle and Granger (1987) proposed a procedure for testing the existence of a co-integrating vector. The following simple co-integration equation is used to examine the co-integration relationship between any two variables, Y_t and X. An *I(1)* time series are said to be cointegrated if there exists a linear combination of the (stationary) variables being stationary. A cointegration relationship can be interpreted as long run equilibrium.

$$Y_t = \alpha_0 + \alpha_1 X_t + \tau_t \quad (7)$$

The results from the co-integrating tests are presented in Ttable 3. The unit root test reveal that the residuals from each co-integrating relationship are stationary for Ghana and the Ivory Coast but not for Colombia and thus validate the use of an ECM for the models for Ghana and the Ivory Coast but not for Colombia.

[Table 3 here]

However, one limitation of this approach is that it can only be used to estimate one co-integrating relation at a time. The Johansen VAR-based maximum likelihood (ML) co-integration test, which was developed based on the methodology proposed by Johansen (1988) and Johansen and Juselius (1990) allows for multiple co-integrating vectors to be tested at a time. Johansen's multivariate co-integration model is based on the error correction representation given by

$$\Delta X_t = \mu + \sum_{i=1}^{p-i} \mathrm{T}_i \Delta X_{t-1} + \prod X_{t-1} + e_t \quad (8)$$

where X_t is an *(n x 1)* column vector of *p* variables, μ is an *(n x 1)* vector of constant terms, *T* and $\prod$ represent coefficient matrices, *k* denotes the lag length, and e_t is a white noise disturbance term. The co-integrating rank can be tested with two statistics: the trace test and the maximal eigenvalue test. These two test statistics for co-integration are formulated

$$Trace = -T \sum_{i=r+1}^{n} \ln(1 - \lambda_i) \quad (9)$$

$$\lambda_{max} = -Tln(1 - \lambda_r) \quad (10)$$

Trace tests the null that the number of co-integrating vectors is less than or equal to r (the number of co-integrating ranks) against an unspecified alternative. $\lambda_{Trace} = 0$ when all the $\lambda_i = 0$, so it is a joint test. λ_{max} tests the null that the number of co-integrating vectors is *r* against an alternative of *r+1*. If the co-integration test indicates that co-integration exists, then the appropriate model specification is an error correction model (Awokuse, 2003). I test co-integration using both, the Engle and Granger method and the Johansen approach. Critical values for this test are reported in (Osterwald-Lenum 1992). For each country I conducted λmax as well as λtrace tests for domestic price with respect to the international price. These results are reported in Tables 4.1-4.3, where r is the number of co-integrating vectors.

[Tables 4.1-4.3 here]

Since the test generated values exceed the critical values for the *λmax* and *λtrace*, it is possible to reject the null hypothesis of no co- integrating vectors and thus conclude that each country has at least 1 co-integrating vector with the international price series. I am thus satisfied that the ECM representation is a valid one to express the relationship between the international price and the domestic price series for each country.

Weak Exogeneity

To define weak exogeneity, first note that a joint distribution of the variables in $y_t^{`}$ and $x_t^{`}$ conditional on past values of $x^{`}$ and $y^{`}$ can be expressed as the product of the joint distribution of $y_t^{`}$ conditional on $x_t^{`}$ and past values of $x_t^{`}$ and $y_t^{`}$ and the joint distribution of $x_t^{`}$ conditional on past values of $x_t^{`}$ and $y_t^{`}$. The intuition behind the concept of weak exogeneity is that $y_t^{`}$ has no

"feedback" into the current (marginal) distribution of $x_t^{`}$ over and above what past values of y` and x` have. Weak exogeneity is less restrictive than strict exogeneity as the researcher can use past values of y as regressors and is only relevant for models that have some kind of time series element to them. Weak exogeneity requires that there is no loss of information about the parameters of interest in reducing the analysis from the joint distribution to a conditional model (Banerjee et al). For my analysis weak exogeniety is important because if P_t^i is weak-exogenous, then I can estimate a single equation as the final model instead a series of equations.

For the test for weak exogeneity I estimate the equations (3a) vs (3b) and (4a) vs (4b) using the likelihood ratio (LR) test. The short run dynamics are captured by dummy variables and variables for weather.

$$\Delta P_t^d = a_0 + \alpha_1 ECT_{t-1} + \alpha_2 \Delta P_{t-1}^d + \alpha_3 \Delta P_t^i + \alpha_4 \Delta P_{t-1}^i + \alpha_5 \Delta Precip_t + \alpha_6 \Delta Precip_{t-1} + \varepsilon_t \quad (3a)$$

$$\Delta P_t^d = a_0 + \alpha_1 \Delta P_{t-1}^d + \alpha_2 \Delta P_t^i + \alpha_3 P_{t-1}^i + \alpha_4 \Delta Precip_t + \alpha_5 \Delta Precip_{t-1} + \varepsilon_t \quad (3b)$$

$$\Delta P_t^i = a_0 + \alpha_1 ECT_{t-1} + \alpha_2 \Delta P_{t-1}^i + \alpha_3 \Delta P_t^d + \alpha_4 \Delta P_{t-1}^d + \alpha_5 \Delta RAIN_t + \alpha_6 \Delta RAIN_{t-1} + \varepsilon_t \quad (4a)$$

$$\Delta P_t^i = a_0 + \alpha_1 \Delta P_{t-1}^i + \alpha_2 \Delta P_t^d + \alpha_3 \Delta P_{t-1}^d + \alpha_4 \Delta RAIN_t + \Delta RAIN_{t-1} + \varepsilon_t \quad (4b)$$

The statistical method employed to test for weak exogeneity is the likelihood ratio (LR) test. The LR test is used to compare the fit of two models, one of which (the null model) is a special case of the other (the alternative model) or in other words is nested in the second model. The test is based on the likelihood ratio, which expresses how many times more likely the data are under

one model than the other. This likelihood ratio, or equivalently its logarithm, can then be used to compute a p-value, or compared to a critical value to decide whether to reject the null model in favor of the alternative model. Both models are fitted to the data and their log-likelihood recorded. The test statistic (usually denoted D) is twice the difference in these log-likelihoods

$$D = -2[\ln(Liklihood\ for\ null\ model) - (likelihood for\ alternative\ model)]$$
$$= -2ln\ \left(\frac{\ln(Liklihood\ for\ null\ model}{likelihood for\ alternative\ model}\right) \qquad (11)$$

The model with more parameters will always fit at least as well (have a greater log-likelihood). Whether it fits significantly better and should thus be preferred can be determined by deriving the probability or p-value of the obtained difference D.

Test results exhibited in Table 5 indicate that the international price is weak exogenous in the bivariate model for in all three countries. Weak exogeneity in the international price implies that deviations from the equilibrium cause price adjustments in domestic prices only. Furthermore, given that each country, P_t^i is weak-exogenous, a single equation can be estimated.

[Table 5 here]

II. Final Model

There is more than one strategy to estimate the ECM. Engle and Granger (1987) suggest a two-stage method in which estimation of a simple but asymptotically efficient two-stage estimator is proposed. As suggested by Gómez, Lee and Körner (2010), the 2 two-stage method is better

suited to large samples and if the long-run relationship shows asymmetries in the error correction term. An alternative, especially if one is dealing with smaller samples, is to use a one-stage model in which the components of the error correction term are employed directly in the estimating equation. That is the approach followed here. Having tested for stationarity, satisfying the condition of a co-integrating relationship and of weak exogeneity andbased on tests presented in Table 5, I modify equations (3a) and (4a) and estimate the following model for each country.

$$\Delta P_t^d = a_0 + \alpha_1 ECT_{t-1} + \alpha_2 \Delta P_{t-1}^d + \alpha_3 \Delta P_t^i + \alpha_4 \Delta P_{t-1}^i + \alpha_5 \Delta Precip_t + \alpha_6 \Delta Precip_{t-1} + \alpha_7 D_t + \alpha_8 ECT_{t-1} * D_t + \alpha_9 D_t * \Delta P_t^i + \varepsilon_t \quad (12)$$

Where Δ represents change and ΔP_t^d is equal to change in domestic prices paid to producer, ECT_{t-1} is equal to Lag of the Error Correction Term, ΔP_t^i is equal to the change in International Prices, ΔP_{t-1}^d is equal to the lag of change in domestic prices, $\Delta P_{t-1}^i$is equal to the lag of change in International Prices, $\Delta Precip_t$= change in precipitation within the country, $\Delta Precip_{t-1}$ = lag in change in precipitation within the country, D_t is the dummy variable for reform , $ECT_{t-1} * D_t$ is an interaction term and accounts for the interaction between the Error Correction term with the dummy variable, $D_t * \Delta P_t^i$ is an interaction term and accounts for the interaction between the International price term with the dummy variable, ε_t is the error term.

Assuming that $E(\varepsilon_i) = 0$ I can obtain the differential slope coefficients for the different parameters $ECT_{t-1}, \Delta P_t^i, \Delta P_{t-1}^d, \Delta P_{t-1}^i$.

$$\frac{\partial \Delta P_t^d}{\partial ECT_{t-1}} = \alpha_1 + \alpha_8 * D_t \quad (11a)$$

From 11 one can see that the period prior to reform, $D_t = 0$ and $\frac{\partial \Delta P_t^d}{\partial ECT_{t-1}} = \alpha_1$, while in the period after the reform $D_t = 1$ and $\frac{\partial \Delta P_t^d}{\partial ECT_{t-1}} = \alpha_1 + \alpha_8$. The same can be done for the other parameters in equation 11. α_8 is the differential slope coefficient indicating by how much the slope coefficient of the second period (after reforms which receives the dummy variable of 1) differs from the first period (before reforms which receives the dummy value of 0).

Chapter 4

I. **Results**

The estimates of producer prices, pre and post-liberalization, as a share of world prices are presented in Figure 1, together with the results of the error-correction model in Tables 6.1, 6.2 and 6.3. The general conclusion from Figure 1 is that reforms did not result in producer price shares increases in Ghana and the Ivory Coast, but did result in greater integration of domestic and world prices in Colombia. The same is exhibited in Figures 3, 5 and 7. The individual time series' show that in Colombia prices moved closer together and towards what may be identified as a long term equilibrium. In Ghana and the Ivory Coast the prices series exhibit a divergence. However, a deeper analysis is required for a complete picture.

[Table 6.1, 6.2 and 6.3 here]

[Figure 1 here]

While discussing the estimation results for each of the countries the focus will remain on the speed of adjustment and the change in domestic prices caused by the aggregate effect of change in international prices. The speed of adjustment is measured before and after reforms; before by (ECT_{t-1}) and after by $(ECT_{t-1} * D_t)$ and the changes in domestic prices caused by the aggregate effect of change in international prices are measured by ΔP_t^i and $D_t * \Delta P_t^i$.

Colombia

Colombia is a great example of how a board that works for the benefit of the producers sets prices that reflect more closely the changes in international prices (Figure 3). From 1980 to 1990 domestic prices were below the international price after which domestic prices were in some cases 120% (Figure 4) of the international price. In 1995 the artificially high prices were reduced to lowest levels on the back of falling international prices (Figure 3) and in some cases were as low as 40% (Figure 4) of international price levels. What is interesting is that while domestic prices followed suit with international prices and continuously fell from 1997 to 2003, domestic prices as a percentage of international prices actually increased from 1995 to 2003 (Figure 4).

[Figure 3 here]

[Figure 4 here]

The domestic price equation for Colombia explains 53 percent of the variation in international prices (Table 6.1). In other words the independent variables in the domestic price equation explain 53% of the variance in the change in domestic prices of coffee in Colombia. The F-test, which determines whether the proposed relationship between the change in domestic price and the set of predictors in the domestic price equation is statistically reliable, is 32.07 of a 1 percent level of significance. This indicates that the overall reliability of the model is strong.

In Colombia, the speed of adjustment before market liberalization (1980-1995) was 8% per month, however results indicate that after reforms (1995 to 2009), there is no change in the speed of adjustment in response to a change in international prices. This result suggests that the speed at which changes in international prices were being passed on through domestic prices to farmers was not different in both, pre and post structural adjustment periods. The regression also

provides information on the responsiveness of domestic prices to international prices (current and lagged) before and after reforms. Before reforms, the net increase in domestic prices 10.1 cents for a 1 dollar increase in international prices while after reforms the net increase in domestic prices is 94 cents for a 1 dollar increase in in international prices. By disentangling the aggregate effect of international prices changes into instantaneous (current price) and prior period (lagged) affects one can determine the individual effect of each period. While the effect of changes in current international prices on domestic prices is not statistically different from 0 before reforms, the instantaneous effect of a 1 dollar change in current international prices after reforms causes domestic prices to increase by 70 cents. Prior period or lagged international prices cause domestic prices to rise by 10 cents for every dollar increase before reforms and 35 cents for every dollar increase after reforms. Though international prices in both periods impact domestic prices, it is evident that the current period international prices have a more significant affect than prior period international prices. The Colombian price setting system in other words treats current international prices are more important than prior periods, reflecting degree of price transmission. Prior to reforms current domestic prices increase about 27 cents for every 1 dollar increase in prior period domestic prices but fall 14 cents for every 1 dollar increase in prior period domestic prices after market liberalization. Precipitation, both current and past, has no effect on the domestic price of coffee in Colombia. The numbers suggest that while farmers received a higher share of changing international prices, a clear indication of greater integration with international markets, the speed of transmission indicates that the farmers were receiving these prices increases did not improve.

Ghana

Producers in Ghana have not had the same fortune as those in Colombia. From Figure 5 it is clear that domestic prices of coffee beans have consistently been lower than the Robusta international price from 1983 onwards. Agricultural policy in 1983 was fundamental to the dissolution of the Ghanaian economy. The overvaluation of the cedi (Brooks 2007) implied that the domestic currency equivalent of the free on board (f.o.b.) price of coffee would fall fast. Export earnings fell to a low of 7 percent of GDP, and external financing dried up (Brooks 2007).Domestic prices were higher than international prices from 1981 to 1983 (Figure 5) but then consistently fell till 1992, incidentally, when market reforms took place. Prices rose then till 1995 before falling again. In 1992 and 1995 domestic prices were 80% and 100%, respectively, of international prices (Figure 6). From 2000 onwards domestic prices, both in absolute terms and as a percentage of international prices have fallen consistently.

[Figure 5 here]

[Figure 6 here]

The independent variables in the domestic price equation explain about 11 % of the variance in the change in domestic prices of coffee in Ghana. The F-value, is 3.11 with a probability of 0.0006, indicates a strong overall reliability of the model. A fewer number of observations are used in the regression analysis than in the analysis for Colombia and the Ivory Coast, because coffee data from Ghana was available only from for 2006 onwards.

In Ghana, the speed of adjustment after reforms (1995 to 2006) has not changed when compared to the period before market liberalization (1980-1992). This result suggests that the speed at which changes in international prices were being passed on through domestic prices to farmers was the same as in the period before reforms. These results are consistent with Krivonos (2004). The regression also provides information on the responsiveness of domestic prices to international prices before and after reforms. The numbers suggest that, in a given month, before reforms the net decrease in domestic prices is 6 cents for a 1 dollar increase in international prices while after reforms there is a net increase of 5 cents in domestic prices for a 1 dollar increase in in international prices. However, given that all but one international price variable are not statistically different from zero, I conclude that the there is no net change in domestic prices caused by changes in international prices in both, pre and post, reform periods. By disentangling the aggregate effect of international price changes into instantaneous (current effect) and prior period (lagged effect) affects one can determine the individual effect of each period. Results exhibit that the instantaneous effect of changes in current international prices to domestic prices is not statistically different from 0 prior to reforms. Similarly, changes in international prices cause no instantaneous change in domestic prices after reforms as well (the coefficient is not statistically different from 0). While a dollar change in the prior period international prices causes no change in domestic prices before reforms, after reforms an increase of every dollar in prior period international prices causes current domestic prices to increase by 13 cents. In Ghana, while a dollar change in prior period domestic prices cause domestic prices to rise 0.10 cents before reforms, it causes current domestic prices to fall by 31cents. The numbers suggest that farmers are slightly better off in terms of share of international prices passed on to them, but no better or worse off in terms of the speed at which these price changes are passed on them. The

results of the reforms, while not as pronounced as those in Colombia, were also not as intended by policy makers. Precipitation, both current and past, has no affect on the domestic price of coffee in Ghana.

Ivory Coast

Producers in the Ivory Coast seem to be the worst off in terms of domestic prices as a percentage of international prices. Domestic prices have consistently been significantly lower than international prices (Figure 7) except in briefly in 2000, where domestic prices were nearly 200 percent of international prices (Figure 8). In 1999 global supply of coffee rose leading to a fall in the global prices (Gilbert at.al.2004), which may explain why in 2000 domestic prices were higher. However, immediately after that prices fell sharply and since then, domestic prices as a percentage of international prices have been hovering around the 50% mark, spiking only occasionally (Figure 8).

The independent variables in the domestic price equation explain 8 % of the variance in the change in domestic prices of coffee in The Ivory Coast. The F-value, is 2.47 with a probability of 0.006, indicates a weak overall reliability of the model. Based on the overall weak fit of the model one cannot determine conclusively both the magnitude as well as the direction of partial change of the variables.

II. Cross country comparison

The findings in this paper exhibit that farmers received a higher share of changing international prices in Colombia, while in Ghana farmers are no better or worse off in terms of the share of

international prices passed on to them. The results thus indicate that with private enterprises simply taking the place of government run marketing boards liberalization does not necessarily ensure higher prices for producers. While reforms led to more integration in Colombia, the opening up of the Ghanian market is thus inconsistent with what the policy target was. However, in terms of the speed of adjustment, farmers from Ghana no better off than the farmers from Colombia. While Ghanaian coffee producers were no worse off in terms of the speed at which price change was passed on to them after reforms, the speed of adjustment of domestic prices to international prices was slower for Colombian farmers.

Prior period domestic prices in both Ghana and Colombia play a more positive role in the price setting mechanism before reforms than after. In both Colombia and Ghana, before reforms current domestic prices increase for every 1 dollar increase in prior period domestic prices but fall for every 1 dollar increase in prior period domestic prices after market liberalization. Precipitation has no impact on domestic prices in both Colombia and Ghana.

III. Concluding remarks

Using an error-correction model (ECM), this study examines price transmission from the world coffee market to local markets. The results show that the share of producer price in the world price has increased substantially for Colombia since reforms were introduced, but not for Ghana and the Ivory Coast. There may be several reasons for the lack of results in Ghana. The impact of the liberalization process could have been limited due to lack of an adequate market information system, poor access to credit and high marketing costs. In general, dismantling market parastatals

may be necessary but not sufficient conditions for efficient private markets to evolve. In the absence of appropriate infrastructure, institutions and legal reforms, spatially distributed markets may continue to lack integration. The extent of liberalization and the type of infrastructure in place prior to liberalization was different in Colombia and Ghana and this may explain the variation in the results. The producer friendly approach adopted in Colombia prior to reforms drastically contrasts with the set up found in both Ghana and Ivory Coast, where government agencies controlled the operation of the coffee marketing chains. In Colombia integration of domestic prices with international prices was already high and reforms only served to reinforce the status quo. In the West African countries, while the aim was to correct the existing institutional failures, it seems reforms have failed and that the status quo remained.

It should be noted that I have simply looked at prices in this analysis. Taking into account the increased costs and changing margins (Amsalu et.al. 2010, Ponte 2002) after reforms one may arrive at another result, i.e. farmers were either worse off or better after reforms. There are other factors (Commodity substitution at the farm level, inventory levels and smuggling) that may play into the analysis of domestic prices, but are beyond the scope of this paper and thus not part of the analysis.

Based on the findings of this thesis, it is reasonable to conclude that a one size-fits-all strategy does not work in policy making. Policy makers have the obligation to assess the difference in culture, existing marketing board set-ups and the impact of blanket policies within different states before implementation of adjustment programs. Policymakers, thus face the onerous task

of studying each economy in detail in order to be mindful of the effects of its policies on, not only the sector at hand but even on others that either feed into or rely on the coffee sector.

My thesis reveals important insights into the structural adjustments and their impact on the coffee producers in Colombia and Ghana, but several limitations indicate the need for future research, especially where Ivory Coast is concerned. Obtaining accurate month-end inventory data will be key to assessing the impact of inventory levels current on domestic prices. Going a step further there is opportunity to study the asymmetries in the price transmission mechanism in the countries analyzed.

TABLES AND FIGURES

Table 1 : Descriptive statistics of the estimating sample, 1980-2009

Descriptive Statistics				
	min	max	Stdev	Mean
Domestic Price-Ivory Coast	12	78	14	41
Precipitation-Ivory Coast	-3180	21830	2277	5117
Domestic price-Ghana	8	137	33	42
Precipitation-Ghana	1484	6709	1212	4723
International Robusta Price	21	183	37	83
Domestic Price- Colombia	45	172	23	81
Precipitation-Colombia	4021	7006	534	5634
International Arabica Price	41	204	37	101
Rain	0.00	8.31	1.53	1.35

Source: Author's calculations

Table 2 : ADF test on Pooled Data

Variables in Levels		Critical Value *	International Price	Columbia	Ghana	Ivory Coast
ADF-t	Ho : ~ I (1)	-2.88	-2.55	-1.79	-2.52	-2.14
	Ho : ~ I (1) - No Constant	-1.95	-1.08	0.053	-1.09	-1.47
Variables in Differences		Critical Value *	International Price	Columbia	Ghana	Ivory Coast
ADF-t	Ho : ~ I (1)	-2.88	-15.04	-17.34	-18.46	-17.24
	Ho : ~ I (1) - No Constant	-1.95	-15.06	-17.35	-18.48	-17.24

* at 95% significance

Source: Author's calculations

Table 3: Co-integration test on residuals[pooled]

Variables in Levels		Critical Value *	Columbia	Ghana	Ivory Coast
ADF-t	Ho : ~ I (1)	-2.88	-2.072	-3.014	-4.693
	Ho : ~ I (1) -No Constant	-1.95	-2.080	-3.019	-4.687

* at 95% significance

Source: Author's calculations

Table 4.1 -4.3: Test for Co-integration-[pooled] (Johansen Test),1 lag

Table 4.1 –Ivory Coast

The λ_{max} and λ_{trace} Tests (1 lag)				
H_0	H_1	Statistic	5 % Critical Value	1 % Critical
λ_{trace} Tests		λ_{trace} Value		
r =0	r > 0	154.6689	94.15	103.18
r ≤ 1	r >1	76.2658	68.52	76.07
λ_{max} Tests		λ_{max} Value		
r =0	r=1	78.4031	39.37	45.1
r =1	r =2	39.5856	33.46	38.77

Source: Author's calculations

Table 4.2-Ghana

The λ_{max} and λ_{trace} Tests (1 lag)				
H_0	H_1	Statistic	5 % Critical Value	1 % Critical Value
λ_{trace} Tests		λ_{trace} Value		
r =0	r > 0	170.7262	94.15	103.18
r ≤ 1	r >1	79.4683	68.52	76.07
λ_{max} Tests		λ_{max} Value		
r =0	r=1	91.2579	39.37	45.1
r =1	r =2	41.8844	33.46	38.77

Source: Author's calculations

Table 4.3-Colombia

The λ_{max} and λ_{trace} Tests (1 lag)				
H_0	H_1	Statistic	5 % Critical Value	1 % Critical
λ_{trace} Tests		λ_{trace} Value		
r =0	r > 0	165.8981	94.15	103.18
r ≤ 1	r >1	90.3606	68.52	76.07
λ_{max} Tests		λ_{max} Value		
r =0	r=1	75.5375	39.37	45.1
r =1	r =2	37.4465	33.46	38.77

Source: Author's calculations

Table 5 : Test for Weak Exogeneity -[pooled]

Test for Weak Exongeneity-Consolidated				
Weak Exogeneity Test H0 :co-integrating vector has no influence on endogenous variable)	$\chi 2$ (1) Critical Value at 5 %	Colombia	Ghana	Ivory Coast
Domestic price as endogenous variable	3.84	11.79	7.78	14.65
	Prob > chi2	0.0006	0.0053	0.000
International price as endogenous variable	3.84	0.37	1.01	1.92
	Prob > chi2	0.5436	0.314	0.1659

Source: Author's calculations

Table 6.1 : Estimation results

Colombia		
	ECM -1 Lag	
	b	se
Constant	-0.82	(0.52)
ECT_{t-1}	-0.078*	(0.03)
$D*ECT_{t-1}$	0.02	(0.04)
$\Delta Arabica\_itl\_price_t$	0.001	(0.04)
$D*\Delta Arabica\_itl\_price_t$	0.691***	(0.06)
$\Delta domestic\_price_{t-1}$	0.270**	(0.01)
$D*\Delta domestic\_price_{t-1}$	-0.405***	(0.12)
$\Delta Arabica\_itl\_price_{t-1}$	0.100**	(0.04)
$D*\Delta Arabica\_itl\_price_{t-1}$	0.244**	(0.07)
Dummy for reforms (D)	1.591*	(0.64)
$\Delta precipitation$	0.001	(0.00)
$\Delta precipitation_{t-1}$	-0.001	(0.00)
No.Of observations	328.00	-
R^2	0.5275	-
Adj R^2	0.5111	-
F(11, 316)	32.07	-
Prob > F	0.000	-

[a] Standard errors in parenthesis; *** significant at 1% level, ** significant at 5% level, * significant at 10% level.

Source: Author's calculations

Table 6.2 : Estimation results

Ghana		
	ECM -1 Lag	
	b	se
Constant	0.108	(0.85)
ECT_{t-1}	-0.039	(0.02)
$D*ECT_{t-1}$	-0.088	(0.04)
$\Delta Robusta\_itl\_price_t$	0.177	(0.13)
$D*\Delta Robusta\_itl\_price_t$	-0.315	(0.17)
$\Delta domestic\_price_{t-1}$	0.095	(0.07)
$D*\Delta domestic\_price_{t-1}$	-0.405***	(0.12)
$\Delta Robusta\_itl\_price_{t-1}$	-0.234	(0.04)
$D*\Delta Robusta\_itl\_price_{t-1}$	0.362*	(0.07)
$\Delta precipitation$	0.001	(0.00)
$\Delta precipitation_{t-1}$	0.000	(0.00)
Dummy for reforms (D)	-0.869	(1.14)
No.Of observations	291.00	-
R^2	0.1091	-
Adj R^2	0.0739	-
F(11, 279)	3.11	-
Prob > F	0.001	-

[a] Standard errors in parenthesis; *** significant at 1% level, ** significant at 5% level, * significant at 10% level.

Source: Author's calculations

Table 6.3 : Estimation results

Ivory Coast		
	ECM -1 Lag	
	b	se
Constant	-0.236	(0.34)
ECT_{t-1}	-0.05	(0.03)
$D*ECT_{t-1}$	-0.037	(0.04)
$\Delta Robusta\_itl\_price_t$	0.033	(0.04)
$D*\Delta Robusta\_itl\_price_t$	0.028	(0.06)
$\Delta domestic\_price_{t-1}$	0.069	(0.12)
$D*\Delta domestic\_price_{t-1}$	-0.068	(0.13)
$\Delta Robusta\_itl\_price_{t-1}$	-0.028	(0.04)
$D*\Delta Robusta\_itl\_price_{t-1}$	0.031	(0.06)
$\Delta precipitation$	0.004	(0.43)
$\Delta precipitation_{t-1}$	0.000	(0.00)
Dummy for reforms (D)	0.000	(0.00)
No.Of observations	316.00	-
R^2	0.082	-
Adj R^2	0.0488	-
F(11, 316)	2.47	-
Prob > F	0.006	-

[a] Standard errors in parenthesis; *** significant at 1% level, ** significant at 5% level, * significant at 10% level.

Source: Author's calculations

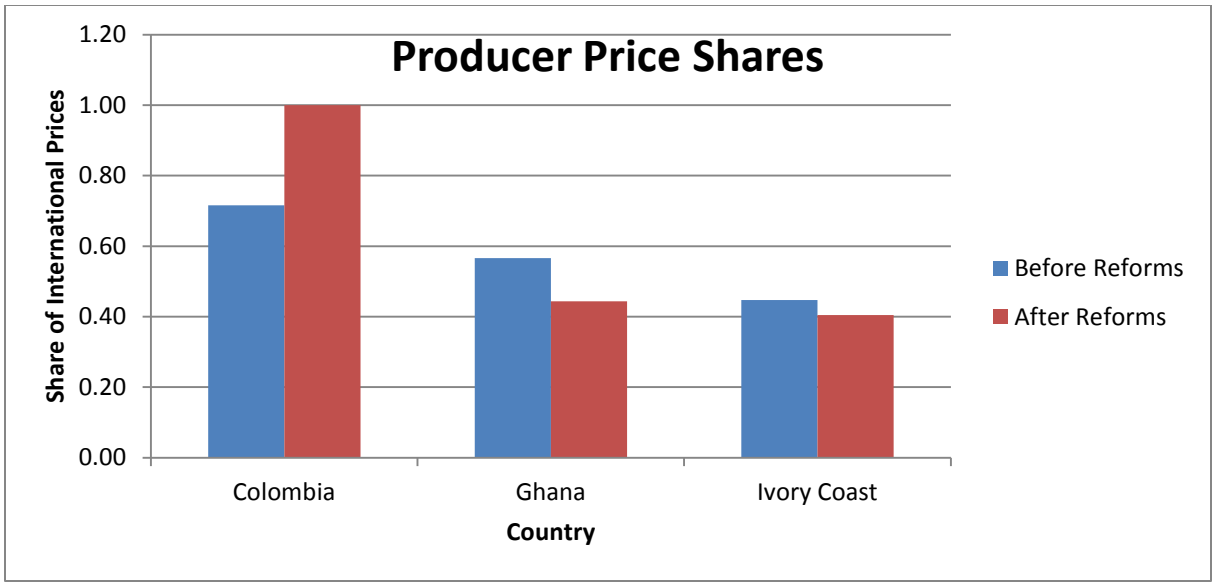

Figure 1:Share of producer prices in international prices

Source: Author's calculations

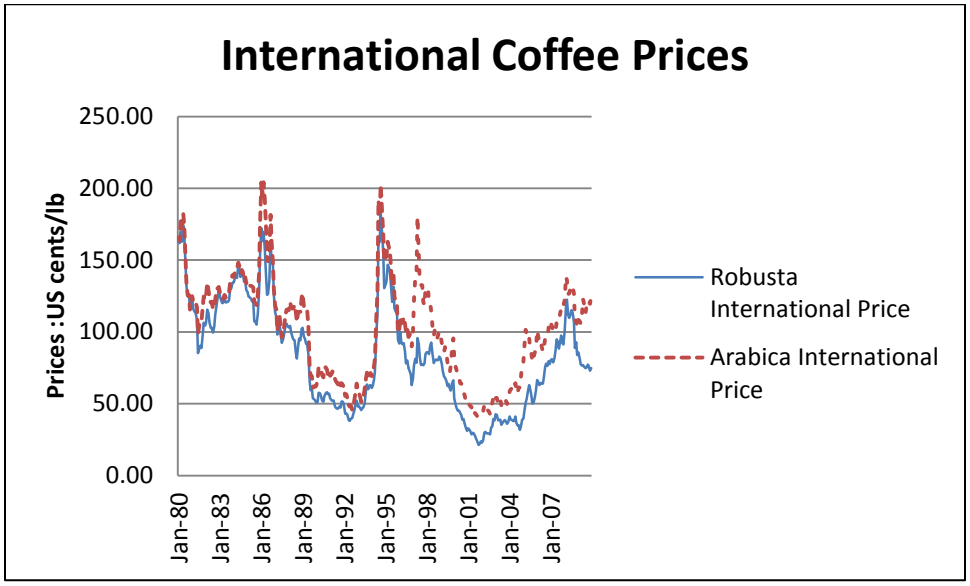

Figure 2:Price series – Robusta International prices and Arabica international prices

Source: Author's calculations

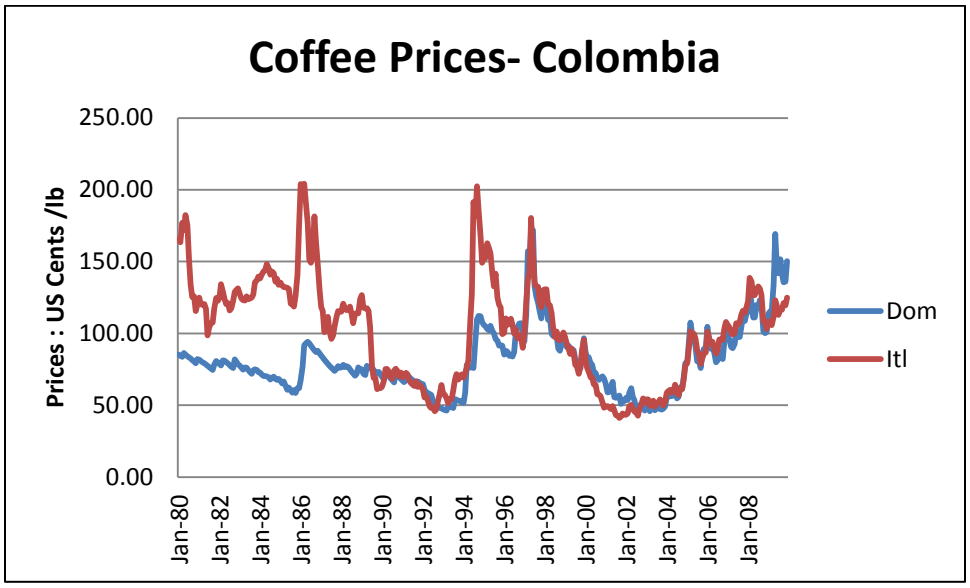

Figure 3:Price series – Colombia-domestic prices and international prices

Source: Author's calculations

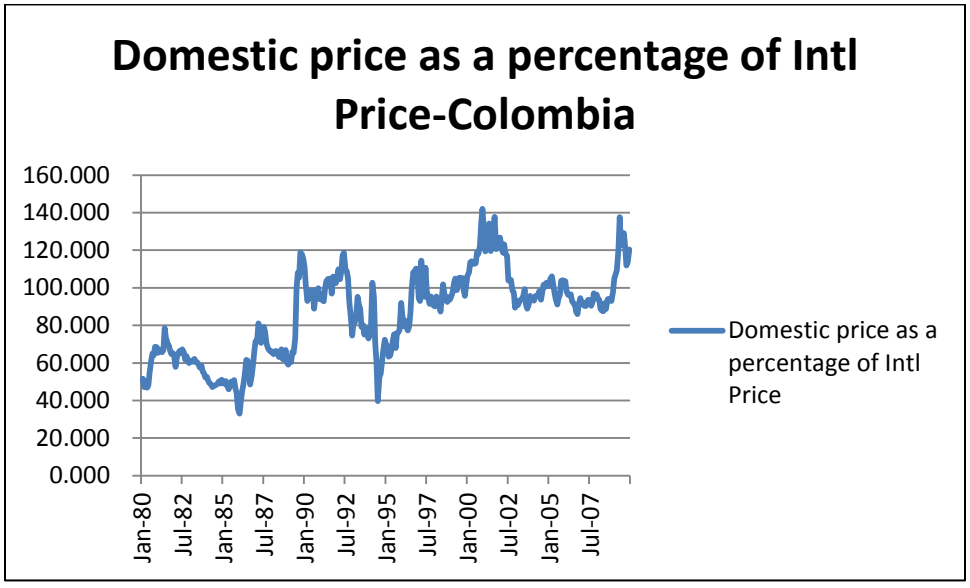

Figure 4: Domestic price as a percentage of International prices –Colombia

Source: Author's calculations

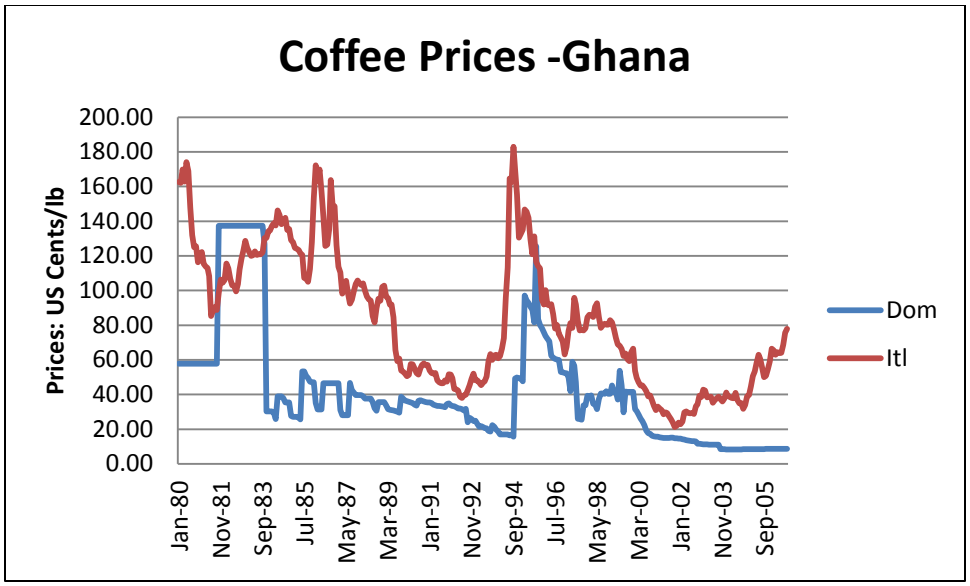

Figure 5:Price series – Ivory Coast-domestic prices and international prices

Source: Author's calculations

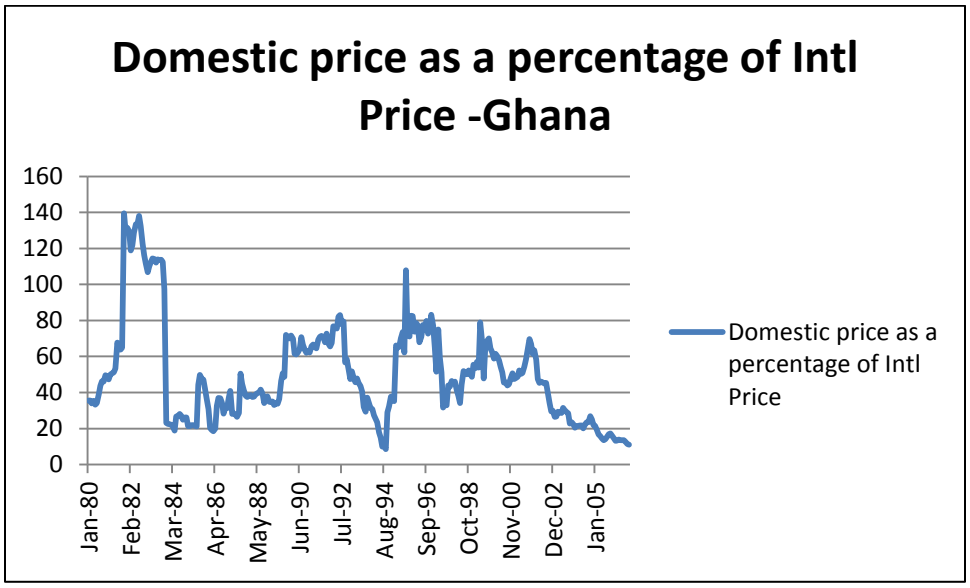

Figure 6: Domestic price as a percentage of International prices –Ghana

Source: Author's calculations

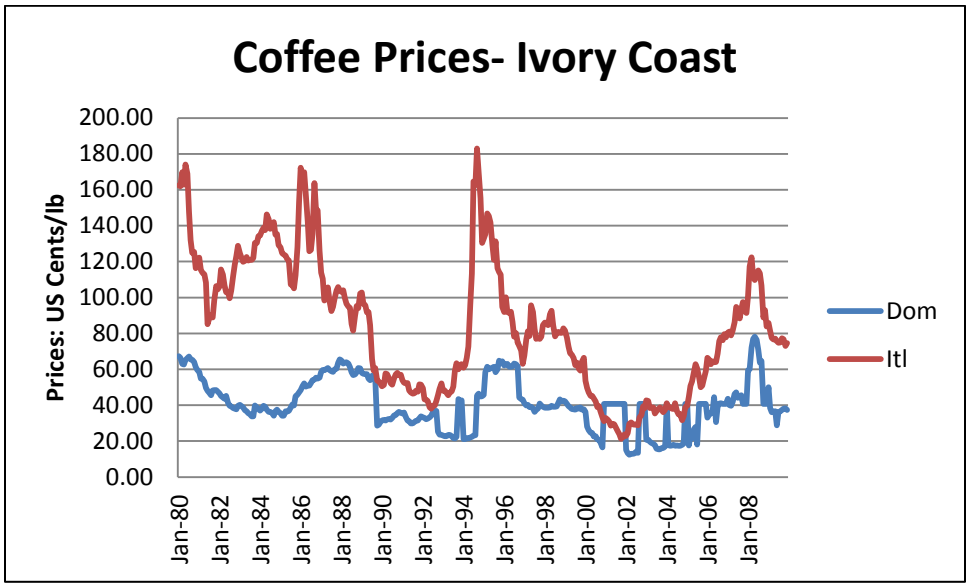

Figure 7:Price series – Ghana-domestic prices and international prices

Source: Author's calculations

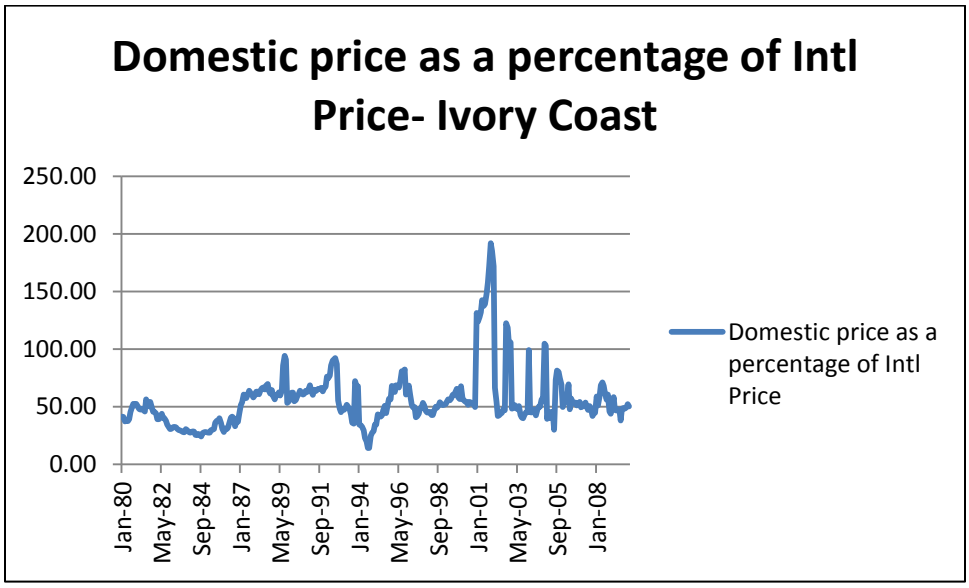

Figure 8: Domestic price as a percentage of International prices –Ivory Coast

Source: Author's calculations

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Appendix A

$$P_t^d = a_0 + \alpha_1 P_{t-1}^d + \alpha_2 P_t^i + \alpha_3 P_{t-1}^i + \varepsilon_t \quad (1)$$

$$P_t^d - P_{t-1}^d = a_0 + \alpha_1 P_{t-1}^d - P_{t-1}^d + \alpha_2 P_t^i + \alpha_3 P_{t-1}^i + \varepsilon_t \quad (2)$$

$$\Delta P_t^d = \alpha_0 + (\alpha_1 - 1) P_{t-1}^d + \alpha_2 \Delta P_t^i + \alpha_3 P_{t-1}^i + \alpha_3 P_{t-1}^i - \alpha_3 P_{t-1}^i + \varepsilon_t \quad (3)$$

$$\Delta P_t^d = \alpha_0 + (\alpha_1 - 1) P_{t-1}^d + \alpha_2 \Delta P_t^i + (\alpha_3 + \alpha_3) P_{t-1}^i + \varepsilon_t \quad (4)$$

$$\Delta P_t^d = \alpha_0 + (\alpha_1 - 1) P_{t-1}^d + \alpha_2 \Delta P_t^i + (\alpha_3 + \alpha_4) P_{t-1}^i + (\alpha_1 - 1) P_{t-1}^i - (\alpha_1 - 1) P_{t-1}^i + \varepsilon_t \quad (5)$$

$$\Delta P_t^d = \alpha_0 + (\alpha_1 - 1) P_{t-1}^d - (\alpha_1 - 1) P_{t-1}^i + \alpha_2 \Delta P_t^i + (\alpha_3 + \alpha_4) P_{t-1}^i + (\alpha_1 - 1) P_{t-1}^i + \varepsilon_t \quad (6)$$

$$\Delta P_t^d = \alpha_0 + (\alpha_1 - 1)(P_{t-1}^d - P_{t-1}^i) + \alpha_2 \Delta P_t^i + (\alpha_3 + \alpha_4 + \alpha_1 - 1) P_{t-1}^i + \varepsilon_t \quad (7)$$

$$\Delta P_t^d = \alpha_0 + \theta\left[P_{t-1}^d - \beta P_{t-1}^i\right] + \delta(P_t^i - P_{t-1}^i) + \varepsilon_t \quad (8)$$

Where $\theta = (\alpha_2 - 1)$, $\beta = \frac{\alpha_1 + \alpha_3}{\alpha_2 - 1}$ and $\delta = \alpha_1$