The Cocoa Industry in Ghana: Investigating Policy Options to Maximize Domestic Welfare Derived from Cocoa Production, Exports, and Processing

By

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Abstract

The goal of this thesis is to determine which agronomic and market interventions maximize the welfare of cocoa farmers in West Africa, using Ghana as the key case study. First I look at methods to expand yields using econometric analysis of data on 200 cocoa farming households. Results suggest that the best way to increase cocoa production is by promoting fertilizer use. The Ghanaian government's CODAPEC spraying program, and access to extension services were also found to have a positive effect on yields.

However, due to cocoa pricing trends and market structures, increasing yields alone is not likely a sustainable way to improve farmer incomes, and it is important to consider other measures, like vertical integration into cocoa processing. Simulations run on a model of total Ghanaian welfare derived from cocoa surprisingly suggest that under current conditions Ghana should export 100% of beans in raw form. However, if a higher percentage of the industry were in the hands of Ghanaian interests, then it would be welfare optimizing to process more beans domestically.

Potential policies to promote such a situation include differential incentives for Ghanaian versus foreign processing firms and a marketing for Ghanaian processed cocoa. Another option is to change the law on cocoa purchasing by the government such that Kuapa Kokoo, Ghana's largest cooperative and the only one truly owned by farmers, can process and export their own cocoa directly. Such a move would likely have the highest and longest-lasting impact on the welfare of Ghanaian cocoa farmers.

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Ch. 1: Introduction

West Africa is the world's largest cocoa producing region, but cocoa farmers earn only a small fraction of the final retail price paid for chocolate products. Most of the profits from the chocolate industry are earned at higher levels of the value chain, and only a small percentage of total profits are captured within producer countries (UNCTAD 2008). Raw cocoa prices on world markets are relatively low, volatile, and have been declining over the past decade (ICCO 1979-2009). As a result, many cocoa farmers are not able or willing to invest in fertilizer, new trees, and other expensive inputs, and very few new farmers wish to enter the industry (Barrientos et al. 2007).

Recently, a great deal of attention has been directed toward efforts to increase yields and bolster cocoa farmer incomes in order to ensure continued adequate cocoa supplies (Matissek et al. 2012). Initiatives sponsored by multinational corporations (MNCs) in the chocolate and cocoa processing sectors are working to provide extension services, inputs, credit, and Fairtrade and other certifications (which earn price premiums) to farmers (TCC 2010). The thrust of these initiatives is, of course, to maintain and increase cocoa production within the existing market framework. The dominance of export, transport, and processing of beans by MNCs would not change under these initiatives.

There are alternatives to the existing framework, however, that have the potential to both increase sustainable cocoa production and increase the percentage of profits accruing to producers. The marketing structure in Ghana represents one challenge to the power of MNCs in the cocoa chain, for example, because that country has maintained its state trading enterprise (STE), the Ghana Cocoa Board. All local buying companies are legally required to sell their beans to the Cocoa Board, which acts as a monopoly exporter, sets a minimum producer price for cocoa, monitors and enforces strict quality standards, and operates a research and extension service (Williams 2009). Through its high degree of control over the domestic cocoa industry, and especially its export monopoly, the Cocoa Board exerts bargaining power in world markets such that Ghanaian beans earn a price premium.

The Cocoa Board is in a position to push for an increase in domestic processing of beans, by offering discounts and other incentives to factories located in Ghana. The Ghanaian government has a stated goal of processing 60% of its beans domestically within the next five years, though under status quo policies this goal will almost certainly not be attained (Akomeah 2011). This raises a few important questions. Would an increase in the percentage of processing definitely increase the profits derived by Ghana from the cocoa industry? If so, what policies are needed to accelerate the development of in-country processing? If not, what underlying conditions would need to change in order for processing development to become profitable for the country?

Another potential alternative to dominance of cocoa markets by both MNCs and government agencies like the Ghana Cocoa Board is direct processing and marketing of cocoa products and chocolate by producer cooperatives. If farmers themselves had a greater ownership over higher-value segments in the cocoa industry, then this could increase their welfare much more substantially than either initiatives to increase yields or government support programs. A few cocoa cooperatives, primarily in Latin America, have succeeded in vertical integration into cocoa processing and chocolate manufacture, but there are as of yet no such processing cooperatives in West Africa (Talbot 2002, Matienzo 2011).

The goal of this thesis is to determine which agronomic and market interventions would maximize the benefits accruing from the cocoa industry to cocoa farmers and to the broader economies of producer countries in West Africa. I look at three different approaches to expanding welfare: increasing cocoa production, increasing value-added industries in producer countries, and increasing market power and downstream control of the value chain by farmers themselves, through cooperatives. Ghana is used as the key case study for all three approaches, but an attempt is made to put the results into a broader regional context and to distill lessons that can be generalized to other countries.

Chapter 2 of this thesis is an overview of the world cocoa industry including trends in production, demand, and prices, as well as market concentration and barriers to entry for new processors. The chapter also includes background on Ghana's cocoa industry, specifically on the Cocoa Board and the relative success of its limited liberalization.

Chapter 3 is a detailed investigation of factors that affect cocoa yields and farmer welfare. The empirical analysis uses data collected from farmer interviews conducted in Ghana in the summer of 2011. Results lead to policy recommendations for the Ghana Cocoa Board and others whose goal is to increase cocoa production.

Chapter 4 reviews the obstacles to the development of processing in African countries, as well as what factors would be crucial for processing operations there to succeed. The chapter includes an investigation of the costs and benefits of operating a processing factory in Ghana, based on interviews with processing plant managers. A model is developed to determine the optimal amount of cocoa that should be exported in raw form versus processed domestically in order to maximize Ghana's welfare from the cocoa industry. The model is used to generate policy recommendations on whether and how Ghana should further stimulate domestic processing.

Chapter 5 examines the role of producer cooperatives in improving cocoa farmer welfare. It includes a review of theoretical, empirical and case-study literature on the benefits of cooperatives, as well as the factors expected to increase the success of a cooperative. There is a particular focus on the requirements for a cooperative to successfully integrate into downstream processing operations. Lessons distilled from this review are applied to a case study of the Kuapa Kukoo cooperative in Ghana, which suggests that the cooperative could successfully integrate into downstream processing, but only if several policy changes were made first.

Ch. 2: Background Information on the Cocoa Industry

2.1 Introduction

In order to determine the most effective ways that West African producers can harness the cocoa industry to maximize domestic welfare and development potential, it is important to understand the structure of the world cocoa industry in which they operate. To that end, section 2.2 provides background on the basics of cocoa production, processing and trade flows and West Africa's percentage of each. Section 2.3 discusses the concentration at each level of the cocoa value chain, as well as barriers to entry to the higher-value sections of that chain. This illuminates the obstacles faced by producing countries that either wish to bargain for higher raw bean prices or to vertically integrate into processing.

Section 2.4 shows that raw cocoa prices have declined substantially over the past 20 years and discusses several possible explanations of this decline. This shows that a focus on increasing cocoa production is not enough to ensure an increase in welfare for producing countries. The advent of Fairtrade and other certifications is supposed to help counter the fall in raw cocoa prices and to boost farmer welfare. Section 2.5 explores the four major certifications that exist today and the extent to which they can help farmers; the conclusion is that this is a short-term rather than a long-term way to improve the incomes of cocoa producers.

Section 2.6 undertakes an empirical analysis of integration at the different stages in the cocoa value chain, concluding that price integration is fairly high between bean and intermediate cocoa products, but not between those products and retail chocolate, possibly due to buyer market power. That section also finds only low integration between producer prices in several African countries and world cocoa prices. These results show that efforts to change the world price of cocoa and cocoa product may have only a limited effect on the welfare of cocoa farmers themselves.

Since Ghana is the primary case study country for this thesis, Section 2.7 provides background information on the cocoa industry in that country and particularly on the role of the Cocoa Board, how its role changed after liberalization, and how limiting the scope of that liberalization has made Ghana's cocoa industry successful relative to others in the region. The chapter concludes with a list of questions about how Ghana can best increase its welfare from the cocoa industry in the future. Essentially, should it continue the Cocoa Board's focus on quality exports, or focus on developing domestic processing? The lessons from this chapter will help to guide the remainder of the thesis as it seeks to answer this and other fundamental questions.

2.2 Cocoa Production and Processing in the World and in West Africa

West Africa is the world's largest cocoa producing region, accounting for 71% of world production in the 2011/2012 season (ICCO 2012). Within the region, four countries produce virtually that entire total: Côte d'Ivoire, Ghana, Cameroon, and Nigeria. There are 1.7 million cocoa farms in Côte d'Ivoire and Ghana alone, and cocoa is central to the economies of these West African countries. It accounted for 35% of Côte d'Ivoire's total exports in 2010 and 12% of total GDP (Kireyev 2010). In Ghana, cocoa made up 49% of export earnings in 2010 and 30% of GDP (GAIN 2012). However, only a tiny fraction of African cocoa is consumed locally; most is exported to the primary chocolate consuming regions of the world, in the U.S. and Europe, in raw form, for processing and chocolate manufacture near the final markets.

Processing operations are located mostly in Western Europe and North America. These countries account for 90% of raw cocoa imports, 88% of cocoa butter purchases, 81% of cocoa powder purchases, and 71% of cocoa liquor purchases (Dand 1995, Abbott 2002). Very little of the value-added processing and manufacture of cocoa products is done in West Africa. As a result, only 8% of the retail price paid for the average chocolate bar goes back to cocoa farmers, and cocoa generally constitutes less than 10% of the cost of manufactured chocolate (ul Haque 2004).

The vast majority of cocoa is exported in raw form—as dried, fermented beans—to Europe or America for roasting, grinding and further processing, and then sold to chocolate manufacturers. Europe has the largest number of grinding operations, with 42% of the world's total, and the US has the second largest, with 12% (UNCTAD 2008). Within Europe, grinding is geographically concentrated, with the largest number of grinding operations in the Amsterdam/Zaanstreek area. Amsterdam is actually the world's largest cocoa storage harbor, and accounts for 14% of global grinding (Fold 2002).

There are four different varieties of cocoa. Forestero is the dominant market cocoa variety, and is practically the only type grown in West Africa. The other three types—Criollo, Nacional, and Trinitaro (a hybrid between Criollo and Forestero) are sold only in small quantities, in niche markets, because their yields are much lower, but they have very high flavonoid levels that lend them distinctive flavors (Afoakwa 2011). Forestero beans produce the typical “chocolate” flavor and have much higher yields. Among the Forestero-type cocoa trees there are many different varieties that can have differences in terms of disease resistance and time to maturity; the two most well-known are the Amelonado and Amazonian varieties.

The Amelonado variety was dominant in West Africa, particularly Ghana, until the 1940s, when much of it was infected with Cocoa Swollen Shoot Virus (CSSV) and there was a big push by the Ghanaian government to switch to cultivation of the Amazonian variety, because it is more resistant to CSSV. Since that time, the Cocoa Research Institute of Ghana (CRIG) and other research institutions have developed several different types of Amazonian-Amelonado hybrids that are resistant to CSSV and also reach productive maturity in only three years. These hybrid types deplete soil nutrients more rapidly and require more sunlight than other cocoa types that thrive in shade. Thus, hybrid adoption has several negative consequences, including increased deforestation, soil depletion, and reliance on fertilizer in order to achieve yield potential. Many farmers in West Africa have adopted hybrid varieties but do not apply fertilizer because of its high cost and a lack of credit structures, so their trees produce far under their potential yield levels.

Cocoa pods are harvested in two cycles of six months throughout the year. The main harvest lasts from approximately October through March, and the light harvest lasts from May through August. In most West African countries, farmers themselves remove the cocoa beans from the pods, pile them up for five to seven days to allow them to ferment (a crucial step for the development of flavor), and then spread them out to dry in the sun for six to ten days. The fermented and dried beans are sold to local traders. Cocoa production is dominated by smallholder farmers; for example, in Ghana the average household farm size was only 5 acres (2 hectares) in 2006 (Barrientos et al. 2007).

In some areas of Côte d’Ivoire and in many Latin American cocoa regions beans are sold unfermented, and are fermented and dried in large facilities operated either by local buyers or cooperatives. Several different methods are used in such facilities, though the most common is the three-tier box method, in which one ton of beans is placed in the top-most of three stacked boxes, then poured into the next box down every 48 hours. However, small-scale fermentation done using the “heap” method—especially widespread in Ghana—leads to more effective mixing of the beans, more thorough fermentation and thus more intense chocolate flavors than cocoa fermented on a larger scale (Afoakwa 2011).

After fermentation and drying, beans are shipped to processing factories, primarily in Europe and the US, where they are roasted, de-shelled, and crushed to form nibs. The nibs are then milled into cocoa “liquor,” also known as cocoa paste. One ton of raw beans produces 0.8 tons of liquor. Some liquor is used directly to make chocolate, while the rest is further processed by one of two methods: pressing through a fine sieve, or using solvents. The pressing process requires more expensive machinery and produces cocoa butter and powder while the alternative process, known as “expellor-extraction,” produces cocoa butter and cake. Expeller cake cannot be processed into powder, so it is considered an inferior product and earns a much lower price than cocoa powder. Cohen (1986) used benefit-cost ratios of the different processes, based on market price data, to show that developing country processors tend to do better if they specialize in the expellor-extraction process.

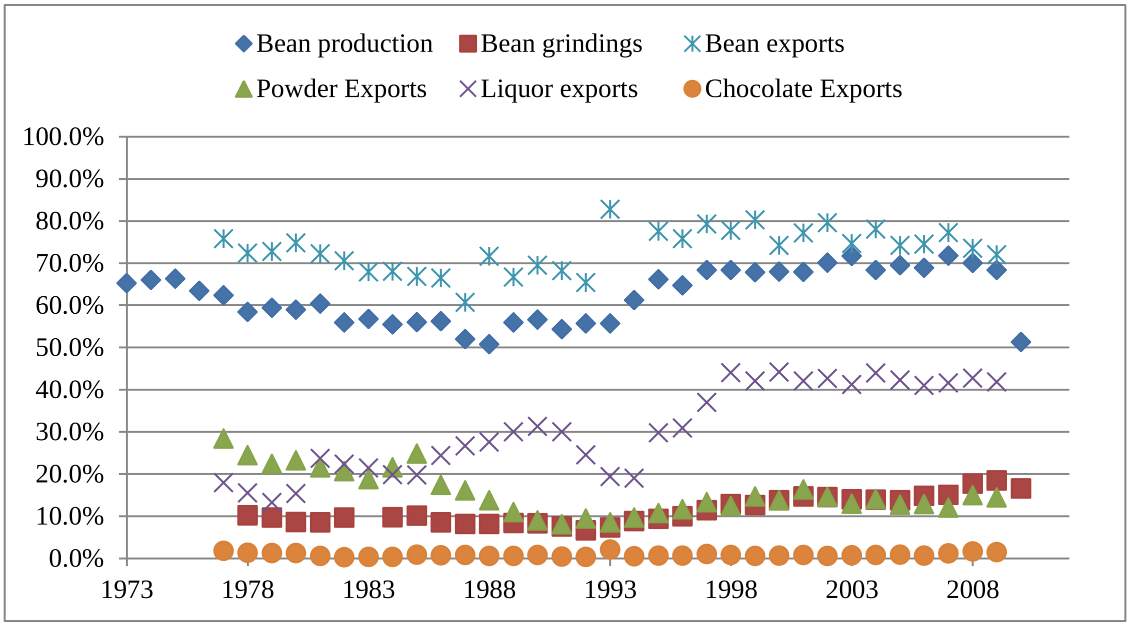
Cocoa liquor or powder is combined with cocoa butter and other inputs, including sugar and powdered milk and processed in a conching machine to produce industrial chocolate, also known as couverture. The couverture is then reworked to make specialty chocolate products. Cocoa powder can also be sold as an end product or processed slightly to make chocolate beverage products.

Vertically integrated processing firms might produce cocoa liquor, butter, powder, and couverture all in a single factory. Some firms even use these products in-house to produce their own specialty retail chocolate products, but it is more common for the grinding companies to produce cocoa powder and butter or couverture as their final products. These products are then sold to chocolate manufacturers who have outsourced all or part of their input demand for intermediate cocoa products.

Gilbert (2007) estimated that cocoa farmers' share of the cost of a typical chocolate bar sold in the UK was approximately 4%. Processor/manufacturer costs and profit amounted to 43%, retail costs and profits amounted to 24%, and other costs and taxes accounted for the remaining 29%. Lass (2004) also estimated these shares, and found slightly different results: manufacturing, packaging and distribution were found to account for 36%, and retail costs and profits for 32% of the cost of the final chocolate bar. In both cases the share going to farmers was low, and the preponderance of the profits was earned downstream by companies operating outside of producer countries.

Some cocoa processing and even chocolate manufacture does occur in West Africa, however. Africa's share of processed cocoa exports, out of the world total, has been increasing over time, albeit slowly. Its share of processed exports is far lower than for production and exports of raw beans, as shown in Figure 2.0 below. Though Africa's share of cocoa production has remained very high, particularly since the late 1990s, and its share of bean exports is even higher, the continent exports a very low proportion of processed cocoa products. Of those products, its export share is highest for cocoa liquor, at slightly over 40% for the past decade. Liquor exports are higher than those of butter, powder and especially chocolate because of the relative costs of production

Figure 2.0: Africa's Share of World Cocoa Production, Grindings, and Exports



Source: International Cocoa Organization. 1975-2009. Quarterly Bulletin of Cocoa Statistics, Vol. 1-35

Africa's share of powder exports has actually declined since the late 1970s. This is very likely related to the fall in raw cocoa prices; when bean prices were higher, producing countries were earning adequate profits to invest in cocoa powder manufacture. The 1970s were also the era of State Trading Enterprises (STEs), and a number of them heavily subsidized local processing plants, including the Cocoa Processing Company (CPC) in Ghana. Throughout the time period, however, Africa's share of total world grindings has remained low, and its share of chocolate manufacture has hovered at around 1% of the world total. The reasons for this, and the potential for increasing both intermediate processing and chocolate manufacture in Africa, will be discussed in detail in Ch. 4.

2.3 Concentration and Integration in the Cocoa Value Chain

The cocoa industry today is characterized by significant downstream market concentration and vertical integration. Cocoa processors began to consolidate and integrate into upstream purchasing and exporting markets in the 1980s. There has been a trend over the past several decades towards branded consumer chocolate companies outsourcing their cocoa and chocolate ingredient needs to a few selected processing companies. As a result, the major players in the cocoa value chain are currently large, vertically-integrated multinational corporations (MNCs) that engage in local purchasing, export, and processing of semi-finished products including couverture. The retail chocolate manufacturers themselves are also large, powerful MNCs. The cocoa value chain is often called "bipolar" because of these two significant centers of power (Fold 2002).

According to Daviron and Gibbon (2002), the dominance of MNCs in export and processing of cocoa was facilitated by widespread market liberalization in African countries in the late 1980s that led to the dissolution of most producer-country marketing boards. These STEs in most cases acted as monopoly exporters of their countries' beans, preventing foreign exporters from entering the market, and securing government revenue from the difference between the price paid to cocoa producers and the world price of beans. When STEs were dismantled under Structural Adjustment Programs in the 1980s and 1990s, private and especially MNC traders were able to seize a large part of the newly liberalized markets. Particularly in Côte d'Ivoire international trader-grinder firms took a large share of the market left behind by the dismantled state board, CAISTAB.

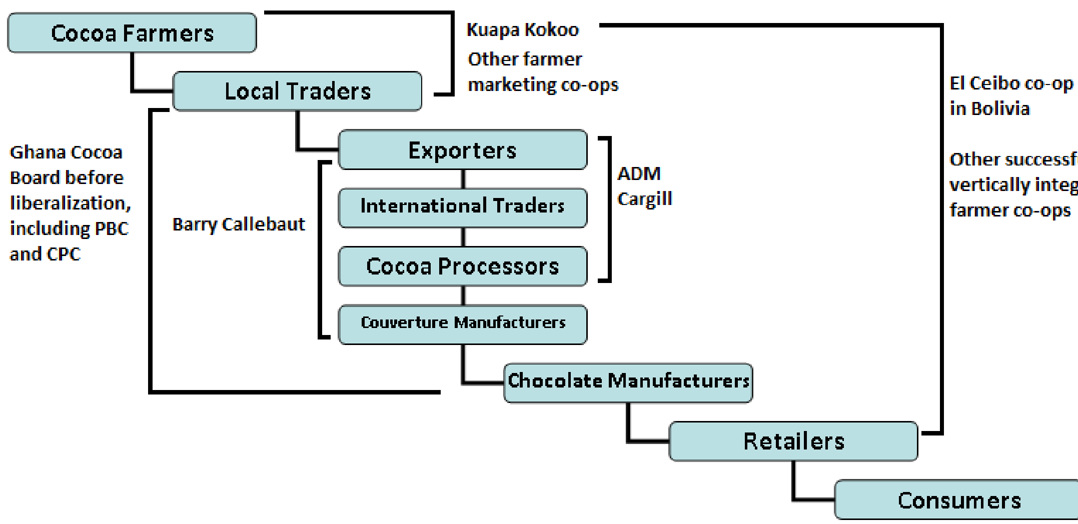
The cocoa industry is also fairly concentrated horizontally. Two-thirds of all grindings are done by the top ten firms. In 2008 the top four firms—Archer Daniels Midland (ADM), Cargill, Barry Callebaut, and Blommer— accounted for 47% of total grindings (UNCTAD 2008). The couverture industry is even more heavily concentrated: the top four firms in the industry (the same list as the top four grinders, but in a different order) accounted for 76% of production in 2008. It is important to note that the market for gourmet couverture is comparatively less concentrated; the top four firms only account for 43% of production. This suggests that a new entrant to processing might have more luck in the gourmet than in the conventional cocoa industry.

The chocolate manufacturing industry is likewise dominated by several large companies. In 2007 the top four firms—Mars, Nestle, Hershey, and Kraft—controlled 43.3% the global market for consumer chocolate products. In 2010 Kraft purchased the next-largest company, Cadbury, increasing the four-firm concentration ratio to over 50%. The concentration is even higher within the US market, where Hershey, Mars and Nestle account for 80% of sales (Oxfam 2008).

Figure 2.1 below shows the cocoa value chain. Within most producer countries, small-holder cocoa farmers sell raw beans to local traders, who then sell to exporters. International traders purchase the cocoa and ship it to cocoa processors, who produce liquor and/or cocoa butter and powder, if they have the more expensive equipment required to press the liquor. Some of these processors also go the next step, manufacturing couverture, or they sell to couverture manufacturers. Cocoa powder, butter, liquor, and couverture are then sold to manufacturers of consumer chocolate products, then to retailers, and finally to consumers.

As shown by the groupings in Figure 2.1, in recent years there has been substantial integration in the middle stages of the chain, between exporters, international traders, and cocoa processors. This has been reinforced by the outsourcing of intermediate processing by consumer chocolate companies; these companies have chosen to focus on branding and marketing, leaving the processing to the international trader/grinders. ADM, Cargill and Barry Callebaut are the three dominant integrated trader/grinders. All three also have some couverture manufacturing operations, though Barry Callebaut is by far the most dominant in this sector, with 40% market share (UNCTAD 2008).

Figure 2.1: The World Cocoa Value Chain, Showing Forms of Vertical Integration



State marketing boards like the Ghana Cocoa Board represent an alternative form of vertical integration. Prior to market reforms in the 1990s the Ghana Cocoa Board had a monopsony on domestic purchasing, through the Producer Buying Company (PBC), a monopoly on exports of raw beans through its Cocoa Marketing Company (CMC) and a subsidiary cocoa processing and chocolate manufacturing company called the Cocoa Processing Company (CPC). As a result, the Cocoa Board was vertically integrated from local trading through chocolate manufacture (Amoah 1998, Williams 2009).

Before the 1990s many other West African countries had similar vertically integrated marketing boards. The Structural Adjustment reforms of the 1980s and 1990s led to the dismantling of these structures in all of the West African states except for Ghana, paving the way for increasing dominance by the international/trader grinders in the intermediate steps of the cocoa chain (ul Haque 2004). In Ghana, the Cocoa Board was retained, but it lost control over the local trading sector, and though it is still the primary shareholder in the CPC, that organisation was partially privatized and has been losing profits and market share in recent years (Ansong 2011). This will be discussed in more detail in Section 2.8.

Producer cooperatives are another alternative form of vertical integration. In Ghana, Kuapa Kokoo is a large cocoa farmer union that operates a subsidiary local buying company, integrating the first two links in the value chain. Most cocoa cooperatives in West Africa have not integrated further down the chain at this point. However, elsewhere in the world there are producer cooperatives that process their own cocoa, manufacture chocolate, and even operate stores to sell chocolate directly to consumers. One of the most successful examples is El Ceibo in Bolivia. This will be discussed in more detail in Chapter 5.

The number of producing-country organizations—private companies owned by developing country nationals, government subsidiaries, and cooperatives— that have succeeded in vertical integration in the cocoa chain is very small, largely due to high barriers to entry which have risen over the past two decades. This is discussed by a number of studies of the cocoa industry, including Dand (1995), Gibbon and Ponte

(2005), Barrientos et al. (2007), Oxfam (2008), and UNCTAD (2008). Today, the powerful trader/grinders constituting the first-tier in the cocoa value chain are expected to import high volumes of cocoa from a number of different countries, produce customized cocoa liquors, butter and powders and to hold inventory on behalf of chocolate manufacturers for delivery on a just-in-time basis (Gibbon and Ponte 2005).
Larger firms are better able than small firms to carry low cocoa stocks for just-in-time deliveries because of inter-corporate agreements, contracts, and understandings with large customers (Dand 1995). As the dominant firms have reduced the stocks of cocoa that they hold at any given time, there has been a reduction in the amount of cocoa bought on forward markets, and cocoa purchasing has become primarily a spot market operation (UNCTAD 2008). Only Ghanaian cocoa is still purchased primarily on futures markets, because it is recognized as being of higher quality and firms want to ensure that they have guaranteed adequate supplies of this higher quality cocoa. However , it is often blended with lower quality cocoa from other sources in the manufacture of final chocolate products (Oxfam 2008).

Transportation of cocoa, in particular, has high increasing returns to scale, because shipping in bulk in the holds of ships is much cheaper per unit than traditional transport in 62.5 kg bags, but it can only be done in very large quantities (Abbott 2002). The most successful MNC trader/grinders have made huge capital investments to take advantage of scale economies. For example, since 1967 Cargill has owned and operated its own fleet of ships for bulk ocean transport, Cargill Ocean Transportation.

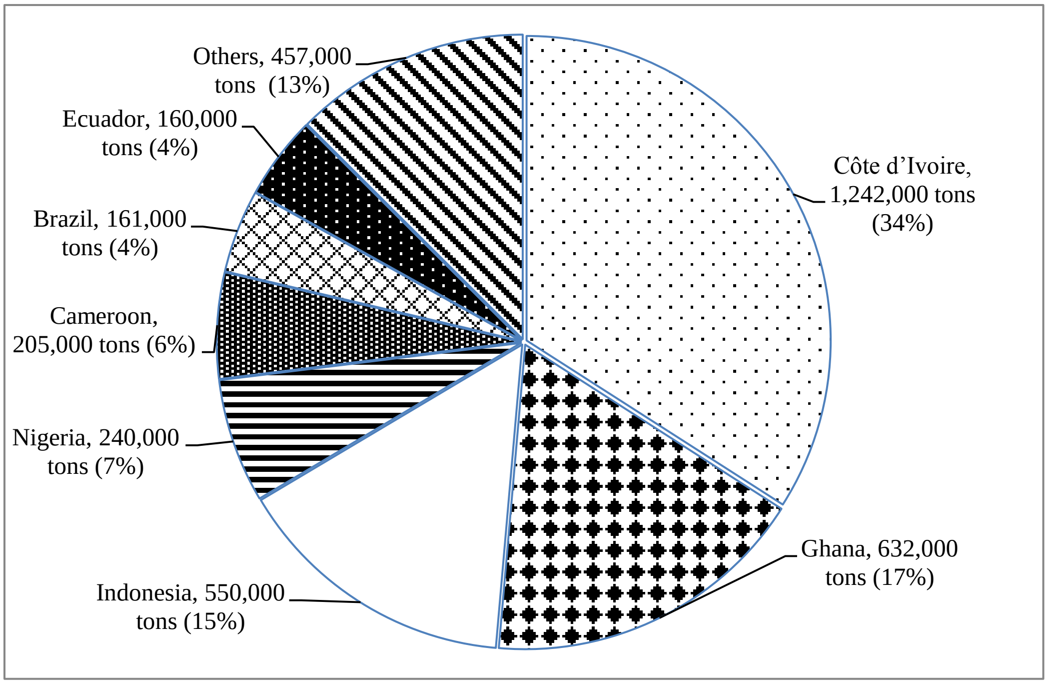
The trader/grinders have also been able to strengthen their buyer power through means like cross costing, which involves sharing price information for suppliers with other suppliers in order to pressure them to compete. Some trader/grinders also recruit suppliers based on price point, product type or another factor and will even nurse less-established suppliers in order to make them more dependent and to increase competition among suppliers (Gibbon and Ponte 2005).

At the same time, barriers to entry for raw bean suppliers have fallen, as cocoa quality has become less important (except in certain niche markets). Modern grinders can achieve high quality chocolate even without the best beans because of advances in processing technologies. With fewer barriers to entry, cocoa growers are increasing in number and their market power is thus decreasing. As they weaken, it becomes even less likely that they will manage to achieve downstream vertical integration (Gibbon and Ponte 2005).

2.4 Trends in Cocoa Production and Prices

The breakdown of world production in the 2009-2010 season, is shown in Figure 2.2 below. World production that year totaled 3,647,000 metric tons (hereafter "tons" will be used to refer to metric tons). Côte d'Ivoire was by far the largest producer, followed by Ghana, Indonesia, Nigeria, and Cameroon. Other producers in Africa accounted for just over 4% of remaining production.

Figure 2.2: World Cocoa Production, 2009-2010 Season

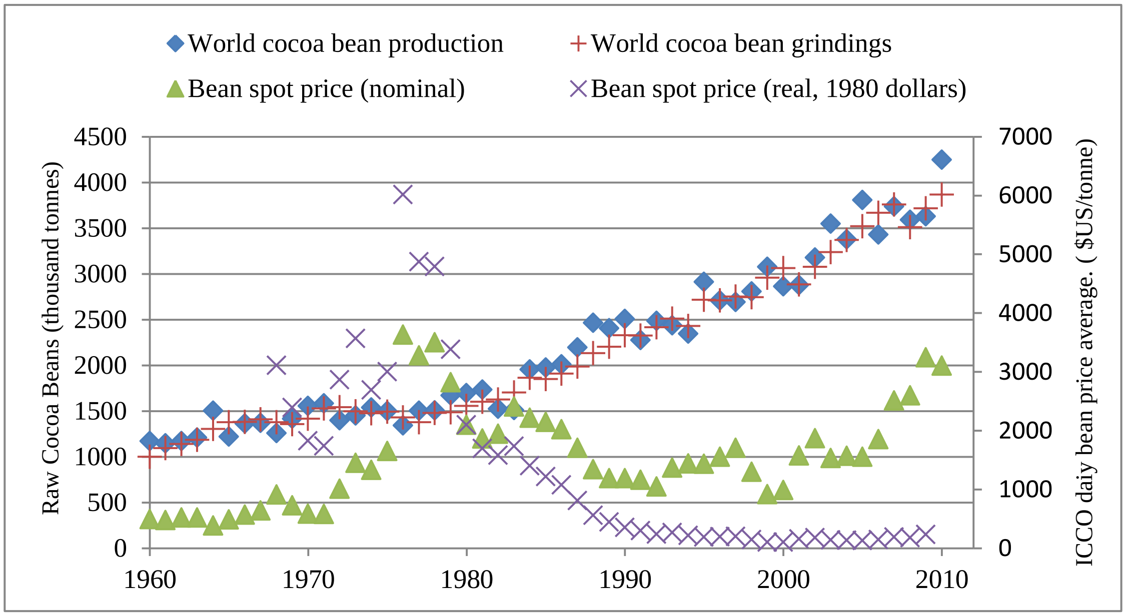


Source: International Cocoa Organization. 2012. Quarterly Bulletin of Cocoa Statistics, Vol. 38, No. 2.

The ICCO predicted an increase to a total of 3,938,000 tons of cocoa during the 2010/2011 season. It also predicted that production in Asia would decrease, that in the Americas it would increase slightly, and that production in Africa, particularly Ghana, would increase by the highest margin (ICCO 2012).

The difference between cocoa production and grindings in any given year determines that year's storage of cocoa. Both variables have increased steadily over the past 50 years, roughly in tandem, though in some years storage of cocoa is larger than others. This can be seen in Figure 2.3 below, which uses 1960-2010 price, production, and grinding data from the ICCO. There has been a steady growth in demand for cocoa, reflected in the increase in grindings over time of about 2-3% since 1996 (Barrientos et al. 2007). However, demand growth is much higher for high-quality niche chocolate ("fine" and "flavor" grades). From 2000 to 2004 alone, demand in those markets rose by over 30% (Barrientos et al. 2007).

Figure 2.3: Cocoa Bean Production, Grindings, and Price, 1960-2011



Source: International Cocoa Organization. 1975-2009. Quarterly Bulletin of Cocoa Statistics, Vol. I-XXXV

Real prices shown in Figure 2.3 are calculated using the World Bank's global wholesale price index, available for 1968-2009, as a deflator. In years when production exceeds grindings inventories increase, and in years when grindings exceed production inventories are drawn down to account for the deficit. This graph shows that the price of cocoa has been much more volatile than demand or supply of cocoa. Nominal and real bean prices both reached their peak in the late 1970s, then declined through the 80s and 90s. However, nominal prices have increased again over the past ten years while in real terms cocoa prices have been declining steadily and substantially since the early 1980s.

The two primary explanations in the literature for the decline in cocoa prices are increasing concentration at the downstream end of the cocoa value chain combined with decreasing concentration upstream (Morisset 1998, Kaplinsky 2004), and oversupply fuelled by liberalization and the entry of new producing countries, particularly in Asia (ul Haque 2004, Barrientos et al. 2007). Market liberalization also led to a decline in the quality of cocoa in many countries, because the STEs that previously oversaw quality control were dismantled (Fold and Ponte 2008). This both contributed to a decline in average cocoa prices and led to a price premium of about 10% for cocoa from Ghana, where the Cocoa Board still enforces strict quality control (Williams 2009). Downstream market actors were not initially very concerned with the decline in bean quality in Côte d`Ivoire and other liberalized markets, because processing technologies have developed for which bean quality is less crucial. However, by 2012 the problem had become so severe that improving the quality of Ivoirian cocoa became a major priority for the MNC chocolate companies and trader-grinders. They have taken measures like sponsoring training programs for farmers on quality, paying higher prices for quality beans (as part of the UTZ certification program) and pressuring the Ivoirian government to enact reforms, including a single-price system, to increase the incentives to produce quality beans.

In 2004 cocoa stocks were at a historically high level of 55% (the long-run average is 40%), but the need for stocks was at a historical low; the end result was depressed cocoa prices (ul Haque 2004). World cocoa production was stagnant at approximately 2.8 million tons from 1995-2004, largely because of low prices. Stocks are generally slow to adjust to downward price pressure, because the supply of cocoa is inelastic, though there has been some partial adjustment.

Inelasticity of supply is an important feature of cocoa markets and has a major effect on price trends. Hattink et al. (1998) estimated cocoa supply elasticity using individual farm-level, cross-section data and found that it was 0.13 in the short run. Past supply elasticity estimates had been done using aggregate time-series data and obtained estimates of 0.18-0.29 in the short-run and 0.42-0.72 in the long run (Abdulai and Reider 1995). Supply is inelastic, particularly in the short-run, because cocoa trees require 5-10 years from planting until they are ready to harvest. Cocoa supplies are difficult to increase in times of scarcity even if prices are high, and slow to reduce in times of abundance, because the trees take time to develop and because farmers are loathe to cut down trees in which they have invested time and money. As a result, cocoa prices are known for sharp peaks and long, flat troughs, and the price volatility of cocoa is historically higher than other major commodities (ul Haque 2004). Though this is a common pattern for perennial crops in general, the fact that cocoa is grown by many low-income, risk-averse smallholders who do not readily shift to other occupations, rather than large landowners or agribusinesses, causes the effect to be more exaggerated.

Producer prices for cocoa as a percentage of world prices have also varied over time. Prior to market liberalization the portion of world bean prices that was actually paid to farmers was set by the marketing boards in each producer country. In the period from 1985-1989, producer prices as a percent of world price were 75% in Cameroon, 68% in Côte d'Ivoire, 86% in Nigeria, and 46% in Ghana (UNCTAD 2008). Ghana was particularly notorious for setting low producer prices in order to extract as much revenue as possible (Williams 2009). Since market liberalization, producer prices are no longer set by an STE in most countries, but are determined by market forces.

There is mixed evidence about whether liberalization has led to an increase in the percentage of world cocoa prices going to producers. Some empirical studies show that after liberalization, producer prices have risen and assert that there is a causal relationship (Akiyama et al. 2001, Vigneri and Santos 2007). Other studies show a negative or neutral effect of cocoa liberalization on producer income (Gilbert and Varangis 2003, ul Haque 2004). Since world prices have declined since market liberalization, the level of producer prices has decreased in many cases even where the percentage paid to producers has increased (Barrientos et al. 2007).

UNCTAD (2008) shows a decrease in producer prices as a percentage of the world price for every country except for Ghana. During the 2001 through 2005 period in Côte d'Ivoire, which fully liberalized, farmers received only 48% of world prices, with the rest captured by market intermediaries (private buyers, transporters, exporters), which proliferated and grew in power following liberalization (UNCTAD 2008). Ghana is the only country that did not fully liberalize and whose government still sets its producer price. For the 2000 through 2011 period its producers earned between 70% and 76% of the world price for its beans, and that price was higher than for other countries due to its price premium (Williams 2009, Kpodo 2011). This increase in the portion of the world price paid to Ghanaian farmers represents a change in government policy, following reforms which increased the accountability of the Cocoa Board. The reasons for this shift will be explained further in section 2.7.

Though it is not reflected in Figure 2.3, there have been many reports written in recent years warning of stagnation or even declining cocoa production levels in the near future (Abbott 2002, Dormon et al. 2004, Barrientos et al. 2007, Afari-Sefa et al. 2010, Matissek et al. 2012). Many chocolate companies are worried that over the next decade there will be dramatic shortfall between the demand for grindings and cocoa supplies, since production will be slow to adjust to an increase in prices as demand increases, due to the highly inelastic nature of supply.

Even if world production remains high because of increased production in other areas, companies have an interest in maintaining high production in Ghana, because of its reputation for high quality cocoa. For example, in 2009 Cadbury committed to sourcing 100% of the cocoa in its Dairy Milk brand products from Fairtrade sources in Ghana (Bhat 2011), so it has a critical stake in ensuring that production there does not fall. Cadbury actually commissioned the Barrientos et al. (2007) report, the goal of which was to determine what interventions would be most likely to arrest the decline in cocoa production levels. Results suggested that increasing extension services would be the most effective intervention, and this led to the formation of the Cadbury Cocoa Partnership, discussed in much greater detail in Ch. 3.

Yields of cocoa on West African farms are much lower than yields in Asia and on research plots in Africa (ul Haque 2004). For example, the average yields per hectare in 2004 were only 360 kg/ha in Ghana and 800 kg/ha in Côte d'Ivoire, compared to 1800 kg/ha in Malaysia and 2471 kg/ha on experimental plots in Ghana (Dormon et al. 2004). Production is highest in Côte d'Ivoire and Ghana only because of the large amount of land planted to cocoa. As the amount of new land available for cocoa farming declines, a focus on increasing yields is crucial to maintain, or increase, production levels. The problem is exacerbated by the fact that new hybrid varieties and low-shade management methods deplete the soil rapidly when not accompanied by fertilizer, so existing cocoa land becomes less productive over time (Abbott 2002, Afari-Sefa et al. 2010).

A number of initiatives, many of them funded by MNC chocolate companies and trader-grinders, have recently been launched with the goal of increasing cocoa yields in West Africa. For example, the Cocoa Livelihoods Program, a joint initiative of the Gates Foundation and industrial market participants, has a goal of training 200,000 farmers in five African countries so that they are in a position to double their incomes (Matissek 2012). The Sustainable Tree Crops Program and the African Cocoa Initiative were both started and funded by the World Cocoa Federation (WCF), whose members include ADM, Barry Callebaut, Blommer, Cargill, Ferrero, Hershey, Kraft, Nestle and Olam (a major cocoa exporter and trader). There are also many smaller initiatives directly run by cocoa MNCs. These include the Cadbury Cocoa Partnership; the Vision for Change project, financed by Mars; Source Trust, run by Armajaro (another major trader and exporter of cocoa); Serap, run by ADM; Pacts, run by Blommer; Cemoi, run by Petra foods; and Partennaire de Qualité, run by Barry Callebaut (Matissek 2012).

The goal of the Africa Cocoa Initiative is to double the productivity of cocoa farms in West Africa and increase farmer incomes by 150-200% in five years (World Cocoa Foundation 2011). This and other initiatives focus on increasing adoption of high yielding varieties, use of fertilizer and pesticides, and other best management practices. They do so by supporting extension programs, directly supplying or subsidizing inputs, and improving access of farmers to credit. Many of these programs work in partnership with existing cocoa producer cooperatives and some have even helped to form cooperatives where they did not previously exist. Increasing farmer incomes is a crucial goal of these initiatives because it has been shown that low incomes lead to low investments by farmers in replanting, fertilizer applications, and other crucial inputs, and they also make the industry less attractive for entry by new, younger farmers (Barrientos et al. 2007).

It is curious that chocolate companies are working to promote increased productivity and cocoa quality among all smallholder cocoa farmers in targeted areas rather than via direct contracting or upstream vertical integration. The reason for this may be practical—it is difficult for chocolate companies to directly contract with farmers, since they purchase processed cocoa products from trader grinders rather than beans directly from producers, and this outsourcing of upstream operations to the trader-grinders was done explicitly as a cost-saving measure (Gibbon and Ponte 2005). Full vertical integration, to the level of owning large industrial cocoa plantations and operating them with hired labor, is not seen as an option in cocoa currently, because of the labor-intensive nature of cocoa production and the resulting moral hazard problems, plus the benefits of small-batch fermentation for increasing bean quality (Vigneri 2008). However, since some research suggests that the current drops in cocoa investment and production are related to the fall in raw cocoa prices partly brought about by the power of trader-grinders in the middle of the chain (Morisset 1998, Kaplinsky 2004, Gibbon and Ponte 2005), it is possible that chocolate companies could profit in the future from reinitiating in-house upstream operations and direct contracting with producer organizations for raw beans.

2.5 The Trend Toward Cocoa Certification

One major trend in the world cocoa market in recent years is a dramatic increase in interest in certified cocoa, both from the demand side and from the supply side. Certified cocoa sales expanded by 65% from 2002 to 2009 (FAO 2009). There are four major types of certifications currently available for cocoa: Fairtrade, Utz, Rainforest Alliance, and Organic.

Only small producer organizations, whose members are small family farmers who do not have permanent hired labor, can obtain a Fairtrade certification. The producer organizations are required to meet a number of "core" standards before they can obtain certification, but for other standards they must simply show progress toward implementation over the first five years of certification (Fairtrade International 2011a). Core standards include adhering to ILO conventions on child labor, paying fair wages to all workers, holding free and fair elections by members, and not using GM seeds or other prohibited materials (Fairtrade International 2011a). Standards that can be implemented gradually over time include writing a business development plan, keeping records, and offering training on best management practices to all members (Fairtrade International 2011a).

Fairtrade guarantees a minimum price to producers, set at $2,000 per ton in 2011, plus a premium above market price if it rises over the minimum. In recent years the world market price for cocoa has exceeded the Fairtrade minimum price, so only the premium has been earned. The premium was $200 per ton in 2011 (Fairtrade International 2011b). This premium is paid to the cooperatives, which then are required to make a decision on how to use the funds for common goals using a democratic process. This can take the form of community infrastructure projects, purchase of trucks or other assets to grow the cooperative business, or payment of bonuses to farmers (Fairtrade International 2011a).

One important fact is that Fairtrade-certified cocoa is not traceable. Farmer organizations earn the premium based on the amount of Fairtrade-certified cocoa that they supply, the rights to which are purchased by an interested consumer, but that actual cocoa is not physically delivered to the customer (Fairtrade International 2010). Chocolate bars labeled “Fairtrade” do not necessarily contain cocoa produced by Fairtrade-certified organizations. The label just means that the chocolate company paid for an amount of Fairtrade cocoa equivalent to the amount in the products that it sells (Fairtrade International 2010).

Currently, Fairtrade-labeled cocoa only represents 0.2% of the world’s cocoa. However, demand growth is high; it increased 23% annually between 1996 and 2006 (Barrientos et al. 2007). The two largest exporters of Fairtrade cocoa in 2006 were CONACADO in the Dominican Republic, which supplied 49%, and Kuapa Kokoo in Ghana, which supplied 45% of the world’s Fairtrade cocoa (Barrientos et al. 2007).

UTZ certification for cocoa, introduced in 2007, also includes fair labor standards, but its major focus is on product quality and quantity. Because ensuring quality is a primary goal, UTZ does require physical traceability of certified beans. Unlike Fairtrade, UTZ will certify medium- and large-scale producers, and where it works with cooperatives it does not have any standards for their organizational structure (TCC 2010). In Côte d`Ivoire, where UTZ is the most common form of certification, certification partnerships between MNCs like Barry Callebaut and Cargill and producer organizations are very common, but the MNC is actually the certificate holder. This is in contrast to Fairtrade, where the producer cooperative is always the certificate holder.

Most of the UTZ certification requirements are the same as those for Fairtrade, but unlike Fairtrade, UTZ places a big emphasis on post-harvest handling. The UTZ

Code of Conduct also includes provisions on environmental protection and fair labor practices. However, the standards are less strict than Fairtrade labor standards, simply specifying adherence to local labor laws rather than setting forth a clear set of norms common internationally (UTZ Certified 2009).

Also, UTZ certification offers producers no guaranteed minimum price; instead, premiums vary based on the demand for UTZ-certified cocoa at any given time. In 2011 in Ghana the UTZ premium earned by Cocoa Abrabopa Association (CAA) was $250, though only half of this was actually returned to producers; the other half was kept by CAA, a Dutch-NGO, which holds the certificate (Draijer 2011).

Rainforest Alliance-Sustainable Agriculture Network (RA-SAN) standards mainly include farm management practices to reduce deforestation and preserve biodiversity. Among other things, it requires that farmers switch from low- or no-shade to medium-shade cocoa production systems. Similar to UTZ but in contrast to Fairtrade, the RA-SAN certification can be obtained by a producer operation of any size that meets its production standards, including large plantation operations, and the certificate can be held by an NGO or MNC partner working with producers.

RA-SAN certification also does not guarantee a minimum price to producers, but relies on contracts with individual customers and the hope that they will offer a higher price. A 2011 report by the Rainforest Alliance claimed that certified farmers in Côte d'Ivoire earned $403 per hectare on average, compared to $113 for non-certified farmers. However, there was a major selection problem in the design of this study, because it did not account for ex-ante differences in yields and other characteristics between certified and non-certified farmers, and thus the results do not accurately estimate the effect of certification (Rainforest Alliance 2011).

Organic certification standards vary depending on the importing country, though essentially they all require that no chemical pesticides or fertilizers be used in production. Strict physical traceability is enforced, which means that processors who purchase organic cocoa beans tend to either specialize in organic cocoa products or at least operate separate factories for production of organic products.

Organic certification does not offer a guaranteed minimum price, and organic cocoa prices are highly volatile. Thus, it is difficult to quantify the organic price premium. ICCO (2006) found a premium of US$100–300 per ton, while Liu (2008) calculated premiums of up to $1,600 in 2006. There is a guaranteed minimum price for Fairtrade organic cocoa, of $2,300, but this is also below current conventional cocoa prices, and the premium is $200, the same as for conventional Fairtrade cocoa (Byrne 2010).

The Tropical Commodity Coalition assessed the strengths and weaknesses of each of the four different certifications (TCC 2010). It concluded that Fairtrade, UTZ, and Rainforest Alliance certifications are all fairly easy to acquire for small producer cooperatives, because there is a flexible time frame over which different standards must be met. It is much more difficult for such a group to obtain an organic certification, because of the strict technical standards that must be met, the higher costs of certification, and the difficulty in understanding all the complex regulations.

As of 2009 there were approximately 127,000 certified farmers and total sales of 104,000 tons cocoa certified by one of the four major standards bodies; this accounted for 3% of total world cocoa sales (TCC 2010). Plans and projections by the various certification bodies suggest that by 2020 approximately 1.7 million cocoa farmers will be certified, accounting for 43% of cocoa sales, assuming current average production continues and certified farmers can sell all of their production as certified cocoa (TCC 2010). One driver in the expansion of cocoa certification programs is increased demand by the major MNC trader/grinders and chocolate companies. This has been largely prompted by public attention and pressure on environmental and social/labor issues.

For example, there was a great deal of media attention on child labor abuses in the cocoa industry in West Africa, especially Côte d'Ivoire, in 2000 and 2001 (Matissek 2012). In the US, legislation was introduced in Congress to force the labeling of chocolate bars as slave-free. To forestall this, industry players convened a number of meetings that culminated in the Harkin-Engel Protocol, signed in 2001. In this agreement, chocolate companies agreed to voluntarily make efforts to eliminate the "worst forms of child labor" and adult forced labor, by establishing a joint foundation that would oversee efforts to build toward credible standards. The rise in industry demand for certified cocoa, was largely motivated by pressure on the child labor issue (Matissek 2012).

Mars was the first company to commit itself to purchasing certified cocoa, announcing in 2010 that it would source 100% of its beans, or 350,000 tons, from certified sources by 2020 (TCC 2010). In 2012, 8.3% of Kraft's sales were certified, with commitments to source more certified cocoa for specialty brands like Green & Black, Cadbury Dairy Milk, and Cote d'Or (TCC 2010). Nestle planned to purchase 30,000 tons of certified cocoa in 2012, and since 2010 has committed to paying for Fairtrade certified cocoa equivalent to the levels of cocoa used in Kit Kat bars sold in the UK and Ireland (TCC 2010).

However, though the demand for certified cocoa is on the rise, supply currently still outpaces demand, and is likely to continue doing so in the future. An over-supply of 150,000 tons of certified beans was expected in 2012 (TCC 2010). Currently, 30% of certified cocoa is sold through other channels and does not receive a premium price. In some cases the quality is not up to the required standards, but in other cases a buyer cannot be found.

Overall, this section has shown that while three certifications available for cocoa, Fairtrade, UTZ, and RA-SAN, are accessible to small farmer organizations, the benefits of obtaining such a certification are limited. The minimum Fairtrade price has been lower than the conventional world price for some years, while UTZ and RA-SAN don't even offer guaranteed minimum prices. The primary benefit of these certifications is the price premium, which is only $200/ton for Fairtrade. Organic certification potentially offers much higher prices, but it is much more difficult to obtain due to strict technical requirements. Finally, the benefits of all four certifications are only temporary, because as more and more farmers obtain certification this will almost certainly erode the associated price premiums. Thus, certification is likely only to help farmers in the short-run. It will likely detract from their incomes in the long-run, since changing one's practices to obtain certification raises operating costs but revenues will sink back to their initial levels after only a few years. Thus, certification is far from the best way to improve cocoa farmer welfare.

2.6 Integration of Different Cocoa Market Segments

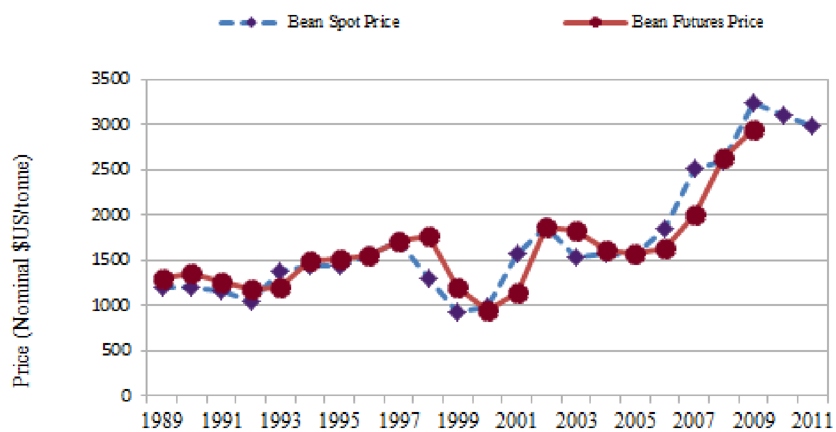
Wilcox and Abbott (2004) used a conjectural variations approach to estimate the degree of buyer/exporter market power present in post-liberalization cocoa markets in Côte d'Ivoire and Nigeria. They found strong evidence of market power between the farmgate and U.S. and EU imports for Côte d'Ivoire, though not for Nigeria. There were 61 exporters in Côte d'Ivoire in 2002, but the top fourteen controlled 90% of the market and the top five controlled 50%. Mark-ups on cocoa that accrue to MNC traders and to the government of Côte d'Ivoire range from 30-36%.

UNCTAD (2008) examined cocoa market concentration and power in Cameroon, where 60% of exports were controlled by the top four export companies. The study indicated a weak but existent level of correlation between cocoa bean prices in Cameroon and in Europe, very strong correlation between European cocoa bean prices and prices of intermediate cocoa products created during manufacturing, and no correlation at all between chocolate retail prices and cocoa bean prices. While cocoa bean and couverture prices were highly volatile and decreased slightly overall during the period from 1990-2006, chocolate retail prices actually showed a significant and steady increase.

Assuming that transport costs did not shift sporadically during this time, these results indicate that Cameroon's cocoa bean market is fairly well integrated with world cocoa bean markets but that the retail chocolate sector is imperfectly integrated with the rest of the cocoa value chain. The authors of the UNCTAD study suggest that the lack of correlation may be related to buyer power of the major chocolate companies. However, this conclusion is very weak, because no analysis was conducted to determine the causes of this lack of price correlation; the low integration in terms of prices could be due to shifts in transportation costs, barriers to trade that have changed over time, shifts in demand for chocolate, or any number of other factors other than market power.

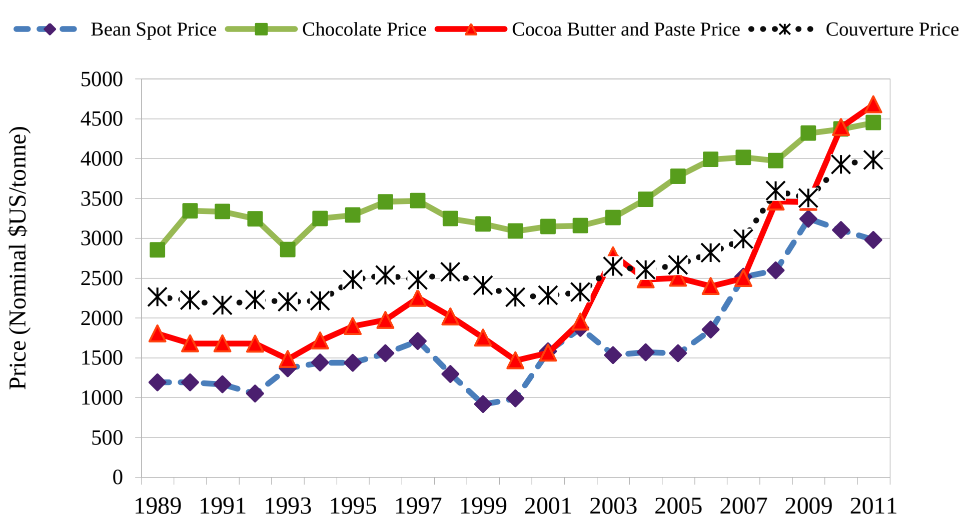
Figure 2.4 below shows the bean spot and futures prices since 1989, while Figure 2.5 shows spot bean price compared to the prices of processed cocoa and chocolate products. Figure 2.4 shows that there is a high correlation between bean spot and futures prices, as would be expected, and also shows that neither price is consistently higher than the other. Figure 2.5 confirms the finding from UNCTAD (2008) that raw bean prices are more volatile than the prices of processed products, particularly chocolate prices.

Figure 2.4: Spot and Future Prices of Cocoa Beans, 1989-2011



Source: International Cocoa Organization. 1990-2012. Quarterly Bulletin of Cocoa Statistics, Vol. 20-38.

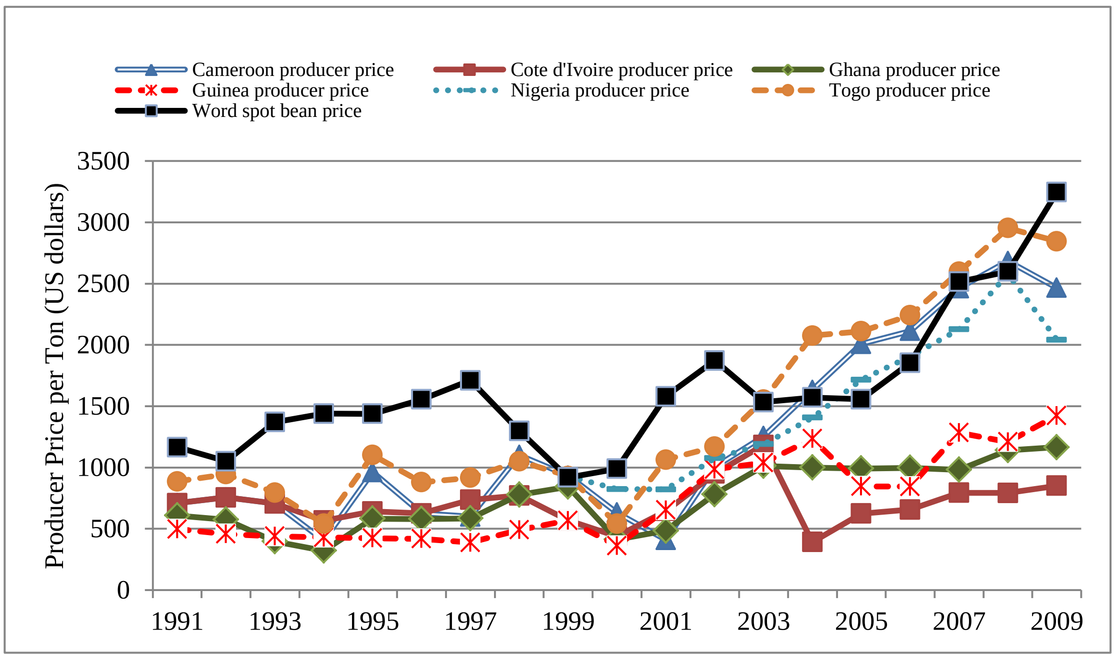
Figure 2.5: Prices of Cocoa Beans and Cocoa Products, 1989-2011



Source: USDA Foreign Agricultural Service. Global Agricultural Trading System (GATS) Dataset. 2012.

Figure 2.6 shows the producer prices earned for six West African cocoa producer countries for the period 1991-2009, compared to the world spot market bean price. These data come from the FAOStat database on world agricultural prices. All data are in nominal US dollars per ton of beans. Accurate data for Nigeria were only available after 1999. The producer price of cocoa paid in each country seems to have increased at least slightly over time for all countries except Côte d'Ivoire. Togo and Cameroon show the highest increases in cocoa prices; in fact, the graph indicates that between 2003 and 2008 the producer price in these countries actually exceeded world prices. This is unexpected and might indicate a difference in the measurement of prices across datasets.

Figure 2.6: Producer Prices in West Africa, 1991-2009**Source: FAOSTAT Database, 1991-2009.**



Available at <http://faostat.fao.org/>

I attempt a rough estimation of market integration using price correlations between the different segments of the market from the data in Figures 2.4-2.6. Without data on transactions costs between the different stages of cocoa production it is not possible to more accurately estimate integration, but simple pricing models have been used in the literature and can give a fairly accurate estimate of integration as long as transactions costs are not highly volatile over time (Stigler and Sherwin 1985, Barrett 1996). Running Augmented Dickey Fuller tests on all of the variables shows that they are non-stationary in their original forms, but all are stationary when first differences are taken. Thus, the model used to test the effect of prices at one level of the chain on another is of the form:

(2.1) $\Delta PriceDownstreamProduct_{t} = \alpha + \beta_1 \Delta PriceUpstreamProduct_{t} + \beta_2 \Delta PriceUpstreamProduct_{t-1}$

The results of these first-differenced regressions are shown in Table 2.0. Correlations between the different downstream product prices and each upstream product were tested one by one, with their lags; that is, all the explanatory variables were not included in the regressions simultaneously.

Results indicate that cocoa butter/paste prices are correlated with the lag of spot world bean prices and with the current world futures price for beans. Both results are consistent with the fact that cocoa paste prices are determined via contracts negotiated with customers and will depend partially on the expected bean price. Expectations on future bean prices are based on spot bean price in the previous period or on the current futures price, because the futures market price automatically accounts for future price expectations. Couverture prices are significantly correlated with the lag of spot bean prices, but not with futures market prices, and they are also significantly correlated with the price of butter and paste. The magnitude of correlation between couverture and its inputs is much lower than for cocoa paste and its inputs. Chocolate prices are not correlated with any upstream prices.

While these findings are similar to the results of the UNCTAD (2008) report, this still does not enable conclusions to be drawn about market power. It is possible that transactions costs between the cocoa paste and couverture, or the couverture and chocolate stages of the value chain vary over time, which would account for the low degree of correlation. This type of analysis and that done by UNCTAD (2008) provide interesting information about market integration and the lack thereof along the cocoa chain, but do nothing to explain its underlying causes.

Table 2.0: Correlations between prices at different stages of the cocoa value chain

Explanatory Variables	**Paste/Butter Price**	**Couverture Price**	**Chocolate Price**
World spot bean price	-0.27	-0.147	0.125
	(0.155)*	(0.094)	(0.139)
Lag World spot bean price	1.06	0.481	0.041
	(0.156)***	(0.095)**	(0.14)
Future bean price	0.69	0.288	0,075
	(0.201)***	(0.127)	(0.17)
Lag future bean price	0.141	0.224	0.22
	(0.171)	(0.134)	(0.131)
Paste Price		0.406	0,053
		(0.07)***	(0.11)
Lag Paste price		-0.008	0.114
		(0.07)	(0.11)
Couverture price			0.013
			(0.213)
Lag couverture price			0.346
			(0.117)

*** = 99% significance level, ** = 95% significance, * = 90% significance, _ = not significant

In the case of correlations between producer prices in individual countries, the model used is:

(2.2) $\Delta PriceCountryX_{t} = \alpha + \beta_1 \Delta WorldPrice_{t} + \beta_2 \Delta WorldPrice_{t-1}$

The results, displayed in Table 2.1, show that the producer prices in Côte d'Ivoire and Ghana are significantly correlated with world prices. This is not the case for the other West African countries. This seems to indicate that either the domestic buying market is integrated with the world market (likely the case in Côte d'Ivoire) or that the producer price is pegged to the world price using a set percentage (known to be the case in Ghana). However, even for these two countries the coefficients are low, indicating that price transmission from the world market to producers is partial at best.

Table 2.1: Correlations between cocoa prices in different countries

	Dependent Variable- Producer Price in Given Country					
Explanatory Variables	**Cameroon**	**Côte d'Ivoire**	**Ghana**	**Guinea**	**Nigeria**	**Togo**
World spot bean price	0.368 (0.26)	0.08 (0.169)	-0.184 (0.108)	0.258 (0.148)	0.759 (0.839)_	0.006 (0.239)
Lag World spot bean price	0.192 (0.26)	0.467 (0.182)**	0.375 (0.117)***	0.105 (0.159)	0.019 (0.907)	0.28 (0.258)

*** = 99% significance level, ** = 95% significance, * = 90% significance, _ = not significant

Overall, this section offers evidence that there may be market imperfections in the cocoa value chain, though a more rigorous analysis would be needed in order to fully test this hypothesis. Whether due to market power, changes in transport and other transactions costs over time, or other factors, the low levels of market integration shown in Table 2.1 suggest that a shock at one level of the cocoa chain is not likely to be fully transmitted to the next level of the chain. For example, if the Cocoa Board or a producer cooperative bargained to increase the price of raw beans substantially, this would likely lead to an increase in the price of cocoa liquor and butter in the next period, but it would have a much smaller impact on the price of couverture and almost no effect on chocolate price.

This suggests that policies to increase bean prices are not likely to cause a decrease in consumer demand for chocolate, which means they are more likely to increase welfare in the producer country than if there were a strong correlation between bean and chocolate prices. The results of the Table 2.1 analysis suggests that the price paid to farmers for their cocoa is not well integrated with world cocoa bean prices for any of the West African countries, so efforts to increase world bean price are unlikely to yield direct benefits for producers. Other mechanisms, like formation of producer cooperatives (to share price information and increase farmer bargaining power) may be necessary to increase the integration of producer prices with world prices.

2.7 The Cocoa Board in Ghana, and the Effects of Limited Liberalization

Though cocoa is Ghana's second largest export in terms of value and the second largest contributor to foreign exchange reserves after gold, cocoa's direct contribution to Ghana's economy is arguably much larger than that of gold. In 2009, gold earned Ghana $2.98 billion in foreign exchange while cocoa earned $1.87 billion; however, only $668 million of the money earned on gold came directly into the economy in terms of taxes, royalties, consumables and payment for workers, while $1.68 billion of the money earned on cocoa directly contributed to Ghana's economy (Tutu 2011). In 2005 there were four million cocoa growers in Ghana (out of a total population of 20 million), and the cocoa industry accounted for 60% of Ghana's total employment in 2006 (Williams 2009).

There are six cocoa production regions in Ghana: the Ashanti, Brong Ahafo, Eastern, Central, Volta and Western regions. The Western region is the most productive; it accounted for 52.2% of Ghana's cocoa market during the 2007/2008 season. Ashanti is the second most productive region, with 18.5% of the market (Anthio and Aikins 2009).

As has been referenced many times already in this chapter, Ghana is a special case among cocoa producing countries because it still operates an STE, the Ghana Cocoa Board, which retained a great deal of control over the cocoa industry even after liberalization in the 1990s. The Cocoa Board sets a minimum price that must be paid by Local Buying Companies (LBCs) to producers, it operates a strict Quality Control Division (QDC), and it also provides a number of services to cocoa farmers, including free pesticide spraying (CODAPEC), subsidized fertilizer and other inputs (the Hi-Tech Program), and research and extension services, through the Cocoa Research Institute of Ghana (CRIG) and the Cadbury Cocoa Partnership. An arm of the Cocoa Board, the Cocoa Marketing Company (CMC) holds a monopoly on cocoa exports out of Ghana. A 1992 law said that LBCs could export 30% of their cocoa beans directly if they met certain criteria; however, this has never been put into practice, so the Cocoa Board still effectively has an export monopoly (Anthio and Aikins 2009, Akomeah 2011).

Since 1992 the domestic buying system in Ghana has been liberalized; previously the government-run Producer Buying Company (PBC) was the sole buyer, and scholars concur that it exercised monopsony power over farmers (Shepard and Onumah 1997, Gilbert 2007, Williams 2009). Now, the PBC is a parastatal company and operates alongside approximately 20 other Licensed Buying Companies (LBCs), though the PBC still has the largest market share and is required to act as the buyer of last resort (Anthio and Aikins 2009).

After purchase by the LBCs, cocoa is transported in large quantities to one of three take-over points, in Takoradi, Tema, or Kumasi. The truckloads of cocoa are subjected to quality and weight tests by the QCD. Rejected cocoa must be "reconditioned" at the expense of the LBC before it can be reconsidered for purchase. In order to prevent corruption, the QCD checks the quality of cocoa, both at the point of sale and then again at port, before shipment, and each cocoa shipment is sealed with information on the LBC of origin and the name of the quality control officer who graded it. In other countries, cocoa is graded later in the chain and can often not be traced back to its origin (Williams 2009).

If the cocoa passes inspection, then the CMC purchases the cocoa at a price fixed at the beginning of the cocoa season. The CMC sells cocoa on international markets primarily using forward contracts that are agreed upon even before the cocoa harvest occurs (Williams, 2009). Past research has suggested that there are several benefits afforded by using forward contracts: more stable and often higher prices; more reliable balance-of-payments planning; increased ability to secure trade finance; greater flexibility in shipping; reduced risks in setting farm prices; and greater countervailing power in price negotiations (LMC International 1996, Amoah 1998, Tiffen et al. 2004).

In the 1990s the World Bank and other international donors pressured the Cocoa Board to scale back a number of its operations. They succeeded in removing the monopsony power of the PBC, but the Cocoa Board resisted full liberalization. It is now generally regarded as a highly successful example of strategic state-led organization of commodity marketing, and it is widely credited with maintaining high cocoa quality, reliable supplies, and support for farmers in Ghana (Amoah 1998, Tiffen et al. 2004, Williams 2009). In fact, when the World Bank was pushing for full liberalization of the cocoa sector in Ghana in the mid-1990s, it hired a consultancy to evaluate Ghana's cocoa marketing system. To the chagrin of the World Bank, that consultancy concluded that the Cocoa Board was doing a very successful job regulating and supporting the cocoa industry, with only a few small inefficiencies vis-à-vis private systems. The overall conclusion was that Ghana's cocoa industry should not be further liberalized (LMC International 1996), and this decision stood.

The Cocoa Board was not always so successful. It was founded in 1947 under British colonial rule as a means to mollify cocoa farmers who went on strike for 8 months in protest against low prices set by European merchants. Its scope and mandate expanded over time, and by 1980 it accounted for 25% of employment in Ghana and operated a full monopsony on the purchase of cocoa and a monopoly on its export (Hutchful 2002). By that time major problems had arisen, including over-taxation of cocoa farmers, by setting the producer price far below the world market level in order to extract revenues. This was very tempting because cocoa was one of few sources of foreign exchange available to the government, which needed such revenue to finance industrialization schemes.

As a result, in the 1970s Ghana's cocoa farmers were some of the lowest paid in the world, earning only 30-50% of world prices, compared to 60-80% in Malaysia, Cameroon and Côte d'Ivoire; this caused a precipitous drop in cocoa production, losing Ghana its position as the world's top producer (Williams 2009). Politicization, such as providing jobs with the Cocoa Board as political favors, was also rampant and led to over-employment and inefficiency: there were 100,000 government cocoa sector employees in 1985, 25,000 of whom were “ghost” workers. A number of scholars cite the Ghana Cocoa Board of the 1970s and early 1980s as one of the most corrupt and inefficient in the world (Killick 1990, Herbst 1993, Bates 2005).

The 1983 structural adjustment program initiated by the military government of Jerry Rawlings, the Economic Recovery Program (ERP I) actually helped to break this cycle. The crux of ERP I’s cocoa reforms was to significantly reduce Cocoa Board staff and to use the freed-up resources to increase the producer price of cocoa (Osei-Akom 2001). After these reforms the Cocoa Board was streamlined, operating costs were reduced, and producer prices rose substantially to 56% of the world price by 1998 and then to 70% in 2006. The operating margin of the Cocoa Board and the producer price of cocoa have generally stayed high since that time (Tiffen et al. 2004, Williams 2009). In 1993 the internal purchasing system for cocoa was also opened to private competition, ending the 15-year monopsony of the PBC, though there have been mixed reports about the effect of this reform.

Between 2001 and 2004 the producer price of cocoa in Ghana increased by 45%, and cocoa production doubled (Teal et al. 2006). Can this success be attributed to liberalization, or to the fact that the Cocoa Board resisted full liberalization and retained centralized support and marketing structures? Or are there other factors at work? During the same 2001-2004 period fertilizer use by cocoa farmers increased significantly (from 10% applying fertilizer to 48%), there was a very large (129%) increase in labor days devoted to cocoa, and there was a marked increase in the coverage and the depth of the government pesticide spraying program (Teal et al. 2006). However, these changes are not exogenous, but have in large part been stimulated by the rise in producer prices and by the allocation of input support and credit by private companies or the Cocoa Board.

A key question is whether free market competition or control by a central government organization like the Cocoa Board is more likely to increase producer cocoa prices. Several papers have suggested that liberalization causes an increase in producer prices (Varangis and Schreiber 2001, Vigneri and Santos 2007), though their results rest on the fact that export prices were historically higher in countries free of state marketing, like Brazil, Indonesia and Malaysia, than in countries with a state marketing board like Ghana and Côte d'Ivoire. This conclusion is undermined by the fact that state-controlled Ghanaian cocoa industry paid its farmers 70% of world prices by 2009, while in fully liberalized Côte d'Ivoire producer prices were 41% of the world price in the same year (Williams 2009). In Côte d`Ivoire government taxes are only 22%, but exporters, transporters and other intermediaries, who came to dominate the industry after liberalization, capture a large part of the remaining cocoa revenue (Mieu 2011). In 2012 Côte d`Ivoire reintroduced a fixed price system, and set the producer price at 60% of the world price, partly in order to reduce the portion of revenues earned by middlemen (Silue 2012).

Though Ghana did undergo some liberalization, the producer price is still set by political decision and not through the free market. Since 1984 a collaborative body called the Producer Price Review Committee (PPRC) has met once a year to determine what percent of cocoa revenues will go to farmers, LBCs, and the government itself during the following season (Amoah 1998, Fold 2002). If revenues are higher than expected, then the surplus is shared with farmers, and if there is a loss then it comes out of the government's share, which means that in some years farmers actually get higher than the official 70% allocated to them; this happened in 2004/2005, when the world price fell and farmers received 73% so that the nine million cedi per ton target price would still be paid (ISSER 2005).

Increased producer prices have helped to boost production, supported the health of the cocoa sector, and increased political support for the government in key regions of Ghana, so this has reinforced the government's incentive to offer higher prices. Furthermore, the Ghanaian state is now far less reliant on cocoa revenues than it used to be, as revenue from the value-added tax and other sources have increased, so there is less of an incentive to overtax cocoa producers (Williams 2009).

Several studies have suggested other benefits to market liberalization. Varangis and Schreiber (2001) argued that competitive cocoa markets stimulate efficiency and reduce the costs of delivery to port. Anthio and Aikins (2009) conducted interviews of many employees in the cocoa industry, including regional port managers, who said that they preferred the multiple-buyer system to the unitary buyer system that was in place previously because the competition increases efficiency. Farmer interviews by Knudsen and Fold (2011) also recorded positive views of the purchasing liberalization, particularly because it has led to a denser network of cocoa-buying sheds. Several empirical studies of cocoa in Ghana showed that competition causes buyers to offer credit, input supports, scholarships, and other services to farmers in an effort to secure their loyal patronage, and that this has helped to increase productivity (Zeitlin 2005, Laven 2007).

However, a number of other sources have suggested that too much liberalization in a number of countries resulted in significant negative effects, while the partial liberalization in Ghana, with the maintenance of a centralized marketing board, has been the most successful model (ul Haque 2004, Fold and Ponte 2008, Williams 2009). A study by ul Haque (2004) compared a number of economic indicators for the major cocoa-producing countries during the period surrounding market liberalization. Results showed no significant positive correlation between liberalization and long-run producer price or production efficiency; on the contrary, liberalization dramatically increased price volatility of exported cocoa.

Market liberalization also has been shown to have a detrimental effect on cocoa quality (Fold and Ponte 2008, Williams 2009). Fold and Ponte (2008) discussed how liberalization led to a decrease in quality in a number of cases, including Nigeria, Cameroon and Côte d'Ivoire for cocoa and Uganda and Tanzania for coffee.

Williams (2009) concluded that Ghana became so successful because reforms overhauled the detrimental parts of the Cocoa Board system while preserving the effective parts. West African cocoa has a number of characteristics that make it particularly well-suited to the type of coordination that marketing boards can provide, including the fact that cocoa production requires a long time-horizon, that it is dominated by smallholder farmers, that cocoa is a crop for which quality matters, that it is purely an export crop, and that prices on the world market tend to be volatile (LMC 1996, Amoah 1998, Tiffen et al. 2004). Centralization through the Cocoa Board has enabled smallholder dominance to continue, while providing the scale economies that come with large-scale marketing. These include provision of marginally cheaper services to farmers, easier quality monitoring (the export monopoly means that there is one exit point for final quality checks), increased bargaining power, and the ability to sell forward, which help to reduce price volatility and increase the overall level of prices. These benefits are similar to those provided by producer cooperatives, as will be discussed in Ch. 5.

Overall, the evidence suggests that limited liberalizations in the 1980s helped to eliminate the inefficiencies of the Cocoa Board and its over-taxation of farmers, and return the organization to profitability. However, the evidence also strongly suggests that further liberalization of Ghana's cocoa market would have been detrimental, and that much of the success of Ghana's cocoa industry can be attributed to the substantial control over research, quality monitoring, price setting, and exports that the Cocoa Board has retained. The key issue moving forward is how to maintain the very positive effects of Cocoa Board's control over cocoa marketing in Ghana while making some small policy adjustments to extend and deepen the successes.

2.8 Conclusion

This chapter on the background of the cocoa industry has shown that raw cocoa bean prices have declined substantially over time, causing a slow-down in cocoa production. Efforts, championed by MNC cocoa industry interests, to increase cocoa yields and the number of certified farmers do not represent long-term solutions to the fundamental problem, which is that raw bean production only accounts for a small percentage of the value of final chocolate products. Strategic management of Ghana's cocoa industry by the Cocoa Board has made that country more successful than others, but even their current methods only offer limited benefits. A more enduring way to increase the welfare of producer countries, especially the welfare of the farmers themselves, may be for producer countries to take control of higher links in the cocoa value chain, via vertical integration.

West African countries constitute the largest producers and exporters of raw cocoa in the world, yet they still lag far behind in terms of production of value-added cocoa products.

West African producer countries now face a number of important questions. I will focus specifically on the dilemmas that Ghana's Cocoa Board must confront, though conclusions for Ghana will ultimately provide some guidance to others in the region as well. Should the Cocoa Board prioritize increasing cocoa yields and total production, as cocoa MNCs desire? If so, what are the most cost-effective interventions to increase yields? Or, should Ghana make a bigger effort to increase domestic cocoa processing? Would doing so erode or bolster its power in the raw bean market? What would be the best strategy for maximizing total profits generated by the cocoa industry?

These questions all focus on maximizing the total profits accruing to Ghana from the cocoa industry but do not address the distribution of those profits. Can producer cooperatives have a significant impact on improving farmers' share of the "cocoa pie"? Could cooperatives succeed in taking over downstream operations like local buying, processing and exporting? What government policies would need to change in order to maximize their chances of success? Would the required policy changes lead to other negative side effects, like eroding the country's power on the export market? Also, how can cooperatives profit from the attention and support of cocoa MNCs without losing their ability to make the best decisions for their members? The remaining chapters of this thesis seek to answer these questions.

Chapter 3: Determinants of Cocoa Yields and Farmer Well-being in Ghana

3.1 Introduction

Because increasing farm productivity is seen as crucial for increasing welfare derived from the cocoa industry in West Africa, an understanding of the factors affecting cocoa yields and other components of farmer welfare can help to guide policy interventions. This chapter uses data collected from interviews with 200 cocoa farmers in the six cocoa regions of Ghana in summer 2011 in order to analyze these factors.

Section 3.2 of this chapter outlines a model for jointly determining the effect on cocoa yields of fertilizer use, frequency of spraying by the government, receipt of extension services, and cooperative membership. Results are used both to roughly assess the effects of existing programs, and to provide recommendations for further investment in each factor, based on cost-benefit analysis.

In order to supplement this core analysis, in Section 3.3 estimates of the factors affecting the likelihood of fertilizer use, frequency of government spraying, and receipt of extension are obtained using logistic regressions. This helps to reveal unequal patterns in the implementation of services as well as barriers to adoption of important inputs.

Section 3.5 analyzes the effects of various inputs and services, demographic factors, and marketing structures on farmer well-being as measured by means other than yield. These indicators of well-being include farmer opinions on the future of cocoa farming, farmer opinion of treatment by their buyer, availability of credit and input support, and the likelihood of receiving the end-of-season mandated bonus. Past research has looked at the effect of market liberalization on cocoa farmer well-being, but this is the first model to use these specific indicators. Results provide evidence of the impact of the liberalization of domestic buying and other factors on farmers, and guide policy recommendations about how to reduce cheating and increase farmer welfare, outside of solely increasing yields, in the future.

3.2 Model of Inputs and Services Affecting Cocoa Yields

In 2001, Ghana's Cocoa Board introduced the National Cocoa Diseases and Pest Control program (CODAPEC), which mandates spraying of all productive fields 3-4 times annually, free of charge to farmers (Opoku et al. 2007). Also, from 2003 through 2006 the government supplied fertilizer on credit to farmers in order to encourage application of at least 2 bags per acre, through the Cocoa High Technology Program (CHTP) (Kolavalli and Vigneri 2011). The government continues to subsidize the cost of fertilizer, and some private LBCs and associations like Cocoa Abrabopa supply fertilizer and other inputs on credit.

The four primary variables of interest in the cocoa yield model in this section are the use of fertilizer, the frequency of CODAPEC spraying, assistance from some type of extension agent, and membership in one of the three active cocoa cooperatives. Section 3.2.1 provides background on past studies which have tested the effect of similar variables on agricultural production. Tables 3.0 and 3.1 summarize the results of the key existing studies of the effects of these variables. Results of the model itself will help to provide an assessment of the relative impacts of these four different inputs and services, to guide future policy.

3.2.1 Past Studies on the Key Variables of Interest Expected to Impact Cocoa Yields

3.2.1.i Extension Services

A number of studies have estimated a positive impact of extension services on agricultural production, though no such study has been conducted for Ghana (Bindlish et al. 1993, Evenson and Mwabu 1998, Owens et al. 2003). Several papers examined the effect of extension services on the adoption of technologies expected to increase yields, such as fertilizer or high-yielding varieties, but did not directly test the yield or production outcomes (Isham 2002, Chirwa 2005). A fairly comprehensive review of older literature on the effects of extension by Birkhauser (1991) showed that most models were set up as a Cobb-Douglas production function and used the natural log of total production as the dependent variable, although two studies (Feder et al. 1985, Owens et al. 2003) were found which used yields as the dependent variable.

Only one paper (Deaton and Benjamin 1988) looked at the effect of extension specifically on cocoa productivity, in Cote d'Ivoire. That paper used a dummy variable for the availability of extension services in the village in which a given farm was located as the key explanatory variable and found no significant impact of extension.

No past study of cocoa production in Ghana has included extension as an explanatory variable. The Cadbury report (Barrientos et al. 2007) included regression analysis with extension as a right-hand-side variable, but their model used net cocoa income as the dependent variable and actually included yield as another explanatory variable. The model in this paper will estimate the impact of extension services, at the household level, directly on Ghanaian cocoa yields for the first time.

Table 3.0: Lit Summary, Extension and Cooperative Membership

Study	Location, crop(s)	Dependent variable	Independent variable	Regression Type	Coefficient (t-value)	Sample Size
Bindlish et al. (1993)	Burkina Faso, multiple crops	ln (aggregated farm output)	ln (ratio ext. agents: producers)	OLS	0.02 (6.53)	3600
			ln (ratio ext. agents: producers)	3SLS	0.0736 (5.5)	
			% membership T&V group	OLS	0.51 (4.47)	
			% membership other ext.	OLS	0.24 (2.38)	
Barrientos et al (2007)	Ghana, cocoa	ln (net income from cocoa)	member of coop dummy	OLS	0.901 (not reported)	32
		ln (net income from cocoa)	access to extension dummy	OLS	-1.814 (not reported)	
Evenson and Mwabu (1998)	Kenya, multiple food and cash crops	ln (crop yield per ha)	Ln (number of extension workers per farm)	OLS	0.13 (4.72)	3600
				Quantile 0.25	0.097 (1.86)	
				Quantile 0.5	0.052 (1.24)	
				Quantile 0.75	0.094 (3.62)	
Owens et al. (2003)	Zimbabwe, multiple crops	ln (crop yield per ha)	dummy, 1-2 ext. visits	OLS	0.165 (3.863)	1281
			dummy, 1-2 ext. visits	Fixed Effects	0.135 (2.69)	
			dummy, 3+ ext. visits	OLS	-0.009 (0.15)	
			dummy, 3+ ext. visits	Fixed Effects	-0.15 (0.31)	
Deaton and Benjamin (1988)	Côte d'Ivoire, cocoa	ln (output per ha for mature trees)	dummy, extension agent available	OLS	0.023 (0.20)	340
Feder et al. (1985)	India, wheat	ln (output)	traditional extension = 1, T&V extension = 0	OLS	-0.892 (2.086)	365
	India, rice	ln (output)	traditional extension = 1, T&V extension = 0	OLS	-0.074 (1.415)	305
Calkins and Ngo (2005)	Côte d'Ivoire, cocoa	cocoa yield per ha	difference btwn coop members and non-members	Comparison of means	19 kg or 6.8%, not significant	213
	Ghana, cocoa				67.9 kg or 33.8%, signif. to 5%	220

Table 3.1: Lit Summary, Fertilizer and Pesticide Use in Ghanaian Cocoa

Study	Dependent variable	Independent variable	Regression Type	Coefficient (t-value)	Sample Size
Edwin and Masters (2005)	ln (cocoa yield per ha)	fertilizer use (50 lb bags per ha)	2SLS (with instruments for fertilizer use)	0.19 (5.43)	192
		pesticide use (liters per ha)		-0.00 (0.00)	
Teal et al. 2006	ln (kg cocoa output)	ln (50 kg bags fertilizer used)	OLS	0.233 (3.585)	443
		dummy, no fertilizer used		-0.351 (5.484)	
		dummy, insecticide used		0.112 (0.918)	
		dummy, any spray machine used		0.143 (1.083)	
Vigneri (2008)	ln (kg cocoa output)	kg fertilizer used	pooled OLS	0.08 (1.33)	856
			fixed effects	0.06 (1.00)	
			2SLS first diff	0.54 (2.16)	428
		litres insecticide used	pooled OLS	0.19 (3.8)	856
			fixed effects	0.09 (1.8)	
			2SLS first diff	0.02 (0.33)	428
	ln (cocoa yield per ha)	ln (fertilizer liters/ha)	pooled OLS	0.14 (2.33)	795
			fixed effects	0.04 (0.44)	
		ln (insecticide litres/ha)	pooled OLS	0.29 (4.14)	
			fixed effects	0.16 (2.29)	
Vigneri and Santos (2008)	ln (kg cocoa output)	ln (kg fertilizer)	OLS	0.06 (1.00)	882
		ln (litres insecticide)		0.19 (3.8)	
Aneani et al. (2011)	ln (kg cocoa output)	ln (bags fertilizer)	OLS	0.35 (2.96)	49
		bags fertilizer	MLE	0.411 (3.19)	43
		ln (liters insecticide)	OLS	0.273 (3.29)	49
		liters insecticide	MLE	0.24 (2.61)	43
		ln (sachets fungicide)	OLS	0.09 (1.44)	49
		sachets fungicide	MLE	0.132 (1.87)	43
Bosempem (2011)	cocoa yield, bags/acre	CHTP program participation	difference in averages, 2002 vs. 2003-2005	3.05 (11.32)	200
	perceived impact on livelihood (1-5 scale)	fertilizer application	stepwise OLS	0.327 (not reported)	
		fungicide application		0.248 (not reported)	

3.2.1.ii Fertilizer

Several past studies have attempted to estimate the effect of fertilizer use on cocoa production in Ghana specifically (Edwin and Masters 2005, Teal et al. 2006, Vigneri 2008, Vigneri and Santos 2008, Aneani et al. 2011, Bosempem 2011). Similar to the extension studies, most of these papers used a production function framework for analysis. Aneani et al. (2011) looked at the effect on production of farm size, insecticides, fungicides, and fertilizer using a sample of 300 cocoa farmers throughout Ghana. All these factors were found to have a significant, positive correlation with cocoa production, but fertilizer had the highest marginal physical product, with an increase of 133.11 kg cocoa (32.5%) per bag of fertilizer.

Bosempem (2011) looked at the effects of the entire Cocoa High Technology Program (CHTP) in Ghana, of which increased fertilizer application was just one component; other components included cultural practices, insecticide application, fungicide application, and improved fermentation and drying practices. The mean yield increase for participants in the program was 72%, three years after initiation of the program. However, this figure is not compared via difference-in-differences or another method to a control group, so it is very likely that a significant portion of this huge yield increase is due to outside factors and not only participation in the CHTP.

Three different papers used data from the Ghana Cocoa Farmers Survey, which looked at farm households throughout Ghana in the 2001-2002 season, then again in the 2003-2004 season (Teal et al. 2006, Vigneri 2008, Vigneri and Santos 2008). Each paper estimated a slightly different model of cocoa production, and all found a significant impact of fertilizer on production except for Vigneri and Santos (2008).

Vigneri (2008) estimated the impact of fertilizer quantity, insecticide quantity, farm size, labor, ownership of spray machines and other equipment, rainfall, farmer age and sex, and region on farm-level production. The paper included both Cobb-Douglass production functions in log form, similar to Aneani et al. 2011, and yield models. Several different production model specifications were run, including OLS, fixed effects, first differences, and two-stage least squares. This latter specification used two instruments for fertilizer use: whether the farmer had a bank account, as a proxy for being credit constrained, and number of spraying applications, as a proxy for good farming practices. Only the 2004 OLS and the 2SLS specifications showed a significant effect of fertilizer on yields. The former showed that a 10% increase in fertilizer use would increase production by 1.3%, while the latter indicated that it would increase production by 5.4%.

However, number of spray applications was a poor choice of instrument for fertilizer use, because it is clearly correlated with production independent of its correlation with using good farming methods and thus fails the exclusion restriction. It would have been more accurate to include this as an explanatory variable in the OLS regression. Thus, Vigneri (2008) did not properly test for endogeneity of fertilizer use, and his 2SLS estimate should not be more accurate than his OLS estimate. Furthermore, omitting the number of spray applications in the OLS model likely biased those results upward.

Vigneri's (2008) models with log of yield as the dependent variable were likely more accurate; they used a slightly different set of explanatory variables, which included fertilizer and number of spray applications in the same regression. No attempt was made to instrument for fertilizer in the yield model; only OLS and fixed effects regressions were performed. Results indicate that increasing fertilizer by 10% should increase yields by 1.4-1.8%.

Vigneri and Santos (2008) estimated a production model similar to that in Vigneri (2008) and found that fertilizer use was not significant. However, it is possible that this result is biased downward by the fact that it used the log of fertilizer use, even though this dropped all zero values. If the authors replaced all zero values with 0.01 then this would prevent the value from being dropped, but not mention is made that this procedure was done. The results in Aneani et al. (2011) might be biased downward for the same reason.

Teal et al. (2006) corrected for this problem by using a log variable for fertilizer use above zero and also including an indicator variable to account for the effect of zero fertilizer use. Results shows that farmers who used no fertilizer had 30% lower total production than those who did use fertilizer, and that applying 10% more fertilizer would increase production by 2.3%. Vigneri (2008) also included a dummy variable to account for zero use of fertilizer and pesticides, but did not report the coefficients for these dummies.

Edwin and Masters (2005) focused mostly on the yield increases seen after the adoption of improved cocoa varieties in Ghana, but also included fertilizer application in their model. They found that planting cocoa varieties released after 1980 was associated with at least 42% higher yields, and that fertilizer use was associated with 19% higher yields per 50 kg bag of fertilizer. Because this model was in semi-log form, the issue of censoring fertilizer quantity values of zero did not arise.

3.2.1.iii Cooperative Membership

Only three studies were found which attempted to estimate the impact of farmer membership in a cooperative or association on production levels in any agricultural system (Bindlish et al. 1993, Francesconi 2009, Calkins and Ngo 2010). Additionally, Chirwa (2005) looked at the effect of association membership on fertilizer adoption, and Bosempem (2011) included association membership as part of social livelihood in the dependent variable.

Calkins and Ngo (2010) looked at cocoa yields per hectare in both Ghana and Côte d'Ivoire, comparing both members and non-members of cooperatives in villages with active cooperatives to residents of nearby villages with similar climatic conditions but no cooperative presence. Results show that average yields for cooperative members in Ghana were 269 kg/ha, compared to 201 kg/ha for residents of comparable non-cooperative villages.

A study in Ethiopia by Francesconi (2009) found that membership in a dairy cooperative had a significant positive impact on milk production per cow, but a negative effect on milk quality. The positive impact on production was explained by the fact that cooperatives provided access to subsidies for purchasing animals and for artificial insemination.

Bindlish et al. (1993) studied the effects of a new “Training and Visit” (T&V) extension service introduced into Burkina Faso in the early 1990's on a few different outcomes, including yields. Results clearly showed that one important determinant of production increases was the proportion of farmers in a village who were members of a T&V contact group, suggesting that farmer associations help to increase yields by improving the effectiveness of extension services.

3.2.1.iv Pesticide Spraying Programs

Many of the production or yield models already mentioned include spraying of pesticides as an explanatory variable, either as a dummy (Teal et al. 2006, Bosempem 2011) or in continuous form (Edwin and Masters 2005, Vigneri 2008, Vigneri and Santos 2008, Aneani 2011). Aneani 2011 found that both the quantity of insecticides and fungicides applied had significant positive impacts on cocoa production. Vigneri (2008) and Vigneri and Santos (2008) did not include fungicides, but found that quantity of insecticide used had a significant, positive effect on production. However, Edwin and Masters (2005) looked at insecticides and fungicides grouped together and did not find a significant effect on yields.

A few papers attempt to specifically estimate the impact of the Ghanaian government's pesticide spraying program (CODAPEC) on farmer yields. Abankwah et al. (2010) suggested that CODAPEC, which began in 2001, was responsible or the dramatic 54% increase in production from 2001 to 2004. However, the paper used a simple before and after comparison and made no attempt to control for other factors, so it is impossible to attribute the production increase to the CODAPEC program. No direct, rigorous study has yet been done to directly assess the effects of CODAPEC.

Teal et al. (2006) included several variables in their econometric model of cocoa production which indirectly capture the effects of CODAPEC. In one of their OLS model specifications they included a dummy for whether the government sprayed a farm three or more times annually, a dummy for whether only a government spray machine was used on the farm, and a dummy for whether both a private and a government spray machine were used. Results show a positive, significant effect on yields of using only a government spray machine, but no significant effect for the other variables.

Vigneri (2008) included a “farm sprayed” dummy variable. He reported that about half of the applications captured by this variable were made by the government under the CODAPEC program. Thus, the variable is a partial proxy for the effectiveness of CODAPEC. Results showed a significant effect of spraying on production in only one of the six specifications.

3.2.1.v Summary of Literature on the Four Factors of Interest

This literature review suggests that fertilizer use should be a major determinant of cocoa yields, and that extension services should also show a significant impact. The limited number and rigor of past studies on cooperatives and the CODAPEC program mean that the expected effect of these variables is less clear. The model estimated in this paper will constitute the first rigorous test of these two factors in the Ghanaian cocoa industry. Including all four of these variables in one model for the first time will be a valuable test of their respective impacts on yields.

3.2.2 Other Determinants of Cocoa Production and Endogeneity Concerns

3.2.2.i Farm Size

In designing a model to test the effect of various factors on cocoa productivity, it is crucial to consider the potential difference in these effects for farms of varying size. There is a large theoretical and empirical literature on the inverse relationship between farm size and yields in certain agricultural industries (Berry and Cline 1979, Carter 1984, Cornia 1985, Bhalla and Roy 1988). Findings suggest that farm yields decline by about

20% as farm size doubles, even when intra-village quality differences and other farm assets are taken into account (Carter 1984). The primary explanation suggested for this relationship is that inputs, especially labor, are used more intensely on smaller farms. This is partially due to a reduction in shirking on smaller farms, because often the farmer owns his own land and thus has a higher incentive to make investments to increase productivity, and/or supervision of labor is less difficult on a smaller land area.

Vigneri (2008) looked at the farm size-yield relationship specifically for Ghanaian cocoa and found a highly significant negative correlation in all models. A fixed effects specification accounted for the potential confounding effect of varying land quality. Results for the OLS estimation suggested that doubling farm size would decrease yields by 20%, while the fixed effects estimation suggested a much more dramatic 45% yield decrease. This inverse relationship especially dramatic for cocoa (when compared to field and vegetable crops, and even some tropical perennials like palm oil) because of the labor-intensive nature of proper cocoa maintenance and harvest, moral hazard problem when labor is hired-in, the impossibility of mechanizing most tasks, and the fact that industrial-scale post-harvest handling have been found to yield lower quality beans than traditional, small-scale methods.

Well-designed contracts might help to solve the moral hazard problem, but even then large-scale plantations would not be at a significant advantage, because there simply are not significant economies of scale to be captured in cocoa maintenance and harvest. Economies of scale only enter the picture at the point of transport, stocking and commercialization, and in the input supply market. These results suggest that there may be advantages to maintaining smaller farm sizes in the cocoa industry and indicate that it is crucial to include land size in a model of cocoa yields. Furthermore, this suggests the possibility that different inputs and policies, like extension services, might affect the yields on small versus large farms in different ways.

3.2.2.ii Separate Analysis by Level of Yield

Similarly, the effects of inputs and policy on production may vary at the different extremes of yield, because of differences in unobserved farmer ability. Evenson and Mwabu (1998) ran a quantile regression in their model of the effect of extension services on yields, in order to test the hypothesis that extension and other inputs have different marginal effects at different levels of yield. They found that the productivity effect of agricultural extension is highest for farmers at the extreme ends of distribution of yield residuals, because of diminishing returns to the extension input at middle values of unobserved ability, and the complementarity of ability with extension at the highest yield residuals.

3.2.2.iii Land Tenure and Migration

Though not explicitly included in any past empirical studies, another potentially important factor is whether a farmer is indigenous to the area where he farms, or is a migrant. A number of cocoa farmers, particularly in the Western region, are migrants from other areas where no more land was available for farming; they move west, work as caretakers for a number of years, and eventually earn ownership rights to the land they have been working (Knudsen and Fold 2011).

It is unclear how migrant status would affect yields; on the one hand, migrants might have higher yields because farmers willing to move across the country to secure land may be harder workers or more skilled farmers. On the other hand, migrants might also be more marginalized in their new region and have less social support, and thus may have lower yields. Furthermore, Knudsen and Fold (2011) found that migrants are proportionally much more likely to be caretakers than land owners, and that is likely to affect production because of moral hazard problems confronted with hired labor. Owner-operators have an incentive to work harder and invest more in their land since they earn 100% of the value of their production (compared to 1/3 for caretakers under the abusa system, or 1/2 under the abunu system), so in that way land ownership may affect yields. Whatever the case may be, because migration is a major feature of Ghana's cocoa industry, this seems an important variable to include.

3.2.2.iv Buyer Competition and Other Factors

Other factors commonly included in production and yield regressions are: household size, farmer age, education level, amount of labor, rainfall, gender of household head, and dummy variables for regions or soil types (Evenson and Mwabu 1998, Owens et al. 2003, Teal and Vigneri 2004, Edwin and Masters 2005, Zeitlin 2005, Teal et al. 2006, Vigneri 2008, Vigneri and Santos 2008, Aneani 2011). A few more recent papers in Ghana also included the number of LBCs to which farmers sold their beans or the Herfindahl-Herschman Index (HHI) among the buyers in order to look at the effect of non-price competition (supply of credit and other services to producers) among buyers on cocoa production (Zeitlin 2005, Teal et al. 2006, Vigneri and Santos 2008).

3.2.2.v Dealing with Endogeneity

Endogeneity is a concern in all of the models covered in this literature review, because the level of output produced by a farmer is very likely to increase his income and thus his ability to purchase inputs like fertilizer and pesticides. With regard to external services like extension programs, government spraying, and cooperatives, these programs might be targeted at farmers or at villages with either below average or above average production. Several of the papers mentioned above made no mention of correction for endogeneity, and thus their estimates are likely to be biased. They include Boehene (1999), Calkins and Ngo (2005), Chirwa (2005), Teal et al. (2006), Aneani (2011), Bosompem (2011).

Edwin and Masters (2005) corrected for endogeneity by running a two-stage least squares regression with two instruments for choice of new or old cocoa variety: farmer education and access to credit. Owens et al. (2003) used a fixed-effects model of yields in Zimbabwe over time in order to partially control for the endogeneity of extension services to yields; they also sought to use instrumental variables, but did not succeed in finding a good instrument for extension. Teal and Vigneri (2004) ran both OLS models and 2SLS models with instruments for all the explanatory variables except land. Instruments included log household size, number of crops grown by the household, log of input loans plus 1, a dummy if the household owned any land, log of age, and the log value of all farms operated by the household. A Hausman test failed to reject weak exogeneity, so OLS remained the preferred specification in that paper. All of the chosen instruments are questionable, however, because they should have been used as explanatory variables in the main regression.

Zeitlin (2005) used fixed effects as well as 2SLS with lagged variables as instruments to correct for endogeneity, and the presence of endogeneity was confirmed using a Hansen j-test. Fertilizer, labor, land ownership, and LBC competition all still had a significant, positive effect on production under 2SLS, though the dummy variable for spraying by the government loses its significance.

Vigneri (2008) used both fixed effects estimation and 2SLS with instruments for fertilizer use (whether the farmer had a bank account and number of spray applications) in order to correct for endogeneity. A Hausman test in that case provided evidence of endogeneity, suggesting that 2SLS was the better model. That model actually raised the value of the fertilizer coefficient, suggesting a more prominent contribution of fertilizer to production once farming practices and financial constraints are taken into account.

Vigneri and Santos (2008) focused on the effect of LBC competition on production, but recognized that the number of LBCs to which a farmer sold his output could be endogeneous to the size of output. They corrected for endogeneity using two alternative methods. First, they ran 2SLS using the presence of a bank in the village, distance to the closest market, and a dummy for farmers who borrow money as instruments for LBC competition. A Hansen j-test confirmed the presence of endogeneity and the robustness of the selected instruments. Even in this 2SLS model, a positive effect of LBC competition on production was found. The other alternative method was to use OLS but include as a proxy for LBC competition a variable for selling only to the PBC, to a combination of the PBC and other buyers, or to only non-PBC buyers. This model showed that farmers who sold to the PBC and another buyer rather than just the PBC had higher output.

3.2.2.vi Implications for Current Model

Overall, the literature suggests that control variables in the yield regression should include farm size, labor, farmer age, gender, application of pesticides, use of spray machines, number of buyers in a village, and migration status. Much of the literature recognizes the potential endogeneity problem inherent in including variable inputs as explanatory variables for production. However, no study deals with endogeneity adequately. Poor instruments, which could themselves be explanatory variables, are chosen, and so it is difficult to trust the validity of those models. The most accurate models are those which use panel data and fixed effects. In the absence of such data, efforts must be taken to test and correct for endogeneity by use of appropriate instrumental variables.

3.2.3 New Model of Cocoa Yields in Ghana

The yield model used in this chapter combines the four key explanatory variables and all the control variables listed in section 3.2.2.vi. I chose to use cocoa yield as the dependent variable, rather than total production, because this reduces the risk of endogeneity of inputs somewhat. That is, total production is highly correlated with land size and thus wealth, which is a major determinant of the use of inputs; this relationship is less direct when dealing with yields per hectare. This also enables an examination of the inverse acreage-yield relationship found in Ghanaian cocoa by Vigneri (2008), but with more control variables than were included in that study. Also, years of experience is used instead of farmer age, as in past studies, because it is highly correlated with age, yet it is likely a more accurate measure of farming ability and knowledge.

As in much of the past literature, all continuous variables in the model are log transformed, enabling interpretation of coefficients as percentage changes. In order to avoid eliminating values of zeros, 0.001 is substituted for all zero values before the natural log is taken. Data on the amount of fertilizer applied and pesticide sprayed were not collected, so these are only included as dummy variables. Although this precludes conclusions about the marginal effect of the amount of such inputs, it does reduce endogeneity concerns. The full model is shown below, with ε equal to the unobserved, residual effects on yield:

(3.1) $\ln\ (yield) =$
$\beta_0 + \beta_1 \ln(mature\ acres) + \beta_2 \ln(total\ labor) + \beta_3(spray\ over\ 1) + \beta_4(extension) +$
$\beta_5(fertilizer) + \beta_6(cooperative\ member) +$
$\beta_7 \ln(experience) + \beta_8 \ln(school) + \beta_9\ (indigenous) + \beta_{10}(other\ income) +$
$\beta_{11}(spray\ machine\ used) + \beta_{12}\ (additional\ spray) + \beta_{13}(male) + \beta_{14}\ (total\ buyers\ in\ village) +$
$\beta_{15}\ (west) + \varepsilon$

Because the data used for this model were collected in roughly six different villages, representing six different cocoa growing regions, the clustering of individuals within each given village must be taken into account. If this clustering is not accounted for in the OLS regression then this will affect the standard error measures and lead to inaccurate conclusions about the significance of the coefficients. In standard OLS it is assumed that the entire sample is randomly distributed; the fact that they are instead grouped into six different villages means that we would expect a significant degree of covariance within the villages. In order to correct for this all regressions are run using the vce (cluster) command in Stata, with region as the cluster variable.

Before examining the results of this initial model, it is worth briefly mentioning the lingering endogeneity concerns. The goal of this analysis is to make conclusions about the effect on cocoa yields of using fertilizer, receiving government extension services, having one's land sprayed twice or more by the government, and belonging to a cooperative. However, it is possible that the choice of inputs is endogenous to yields, because a farmer with higher yields will earn more money and be able to afford more inputs. Additionally, input use is likely to be correlated with farmers' management skill level, which is very difficult to measure directly and thus is part of the residual. If skill and input use are complementary, as is likely to be the case according to a classic paper by Mundlak (1961), then the input coefficients would be likely biased upwards unless the influence of management skill were specifically corrected for. Another possible issue for pesticide use in particular is the potential for being biased downward because in areas with high disease pressure farmers are both likely to spray more and to experience lower yields; this is less often a concern for fertilizer use because that decision is made in advance and not in direct response to yields in the given season.

In this specific model, bias caused by such endogeneity is less of a concern for the pesticide variable included, since it is the amount of times that the government sprays a farmer's land and is thus uncorrelated with farmer skill level (as opposed to quantity of pesticide applied). It is possible that the local government decides to spray fields more often in areas with higher disease pressure, in which case the concern about downward bias may still apply somewhat, but the statistical effect should be smaller. The endogeneity concern applies more to the fertilizer-use variable in the model, since it is actually a decision by the farmer. However, because it is a dummy variable indicating fertilizer use versus non-use, the risk of endogeneity is less acute than if the variable were continuous.

Many of the past studies of cocoa production in Ghana (Zeitlin 2005, Teal et al. 2006, Vigneri 2008, Vigneri and Santos 2008) used panel data and were thus able to run first-differences and fixed effects models in order to correct for endogeneity. Unfortunately, the data collected for this study are just cross-sectional, so it is not possible to run these types of models. The only option is to use instrumental variable analysis, which is also common in the literature. Thus, I tested for endogeneity of the model by running a two-stage least squares regression using the same base model but with an instrument for fertilizer use. The instrument was a dummy variable for whether the farmer received input support or credit from either a cooperative or an LBC; this accounts for 41% of farmers in the sample. A simple logit regression shows that receiving such support increases the odds of applying fertilizer by a factor of 2.79, a result significant to the 99% level. Using this instrument and then testing for endogeneity fails to reject the null hypothesis of exogeneity (F-stat = 0.871, with p = 0.394), so the cluster-robust OLS estimate is actually a better measure of the effect of fertilizer use on yields.

As for the frequency of government spraying, this variable is almost certainly exogenous to yields. Publications about the program and summary statistics indicate that the frequency of spraying per year will be the same for all farmers in a given region, regardless of their yields (Opoku et al. 2007, Abankwah et al. 2010). All fields are supposed to be sprayed 3-4 times annually; where differences have occurred this is because the district government, to whom inputs and funding for spraying are allocated by the national government, either spent the money elsewhere or did not spray all fields equally, perhaps for political reasons. Because the government spray decision is heavily dependent on regional politics, it is very likely to be exogenous to yields.

A similar argument can be made about extension services and cooperative membership. If extension services were specifically targeted at low yielding areas, then there would be endogeneity inherent in the program set up. However, this is not the case, at least not at the village level. The primary extension services in 2011 were run through the Cadbury Cocoa Partnership, the first stage of which was rolled out in 100 communities scattered around the cocoa growing areas of Ghana. These villages were not selected by average cocoa yields, but based on whether one of the implementing partner NGOs already had workers stationed in the village or nearby (Boateng 2011).

There may be a degree of inherent endogeneity to the cooperative member variable because of eligibility rules. The CAA only allows farmers with a minimum number of acres and ideal spacing of cocoa trees to join (Draijer 2011), so members may have higher yields. The KKL selects member villages based on an application supported by many farmers in those villages and only allows owner-operators and landlords who live in the village to join, but not caretakers (Kyere 2011). These membership selection procedures may mean that KKL members tend to have higher yields, since owner-operators are expected to work harder than caretakers, or they might have lower yields, because those villages which apply for membership are likely to be the most in need, due to remoteness or other issues (Calkins and Ngo 2005).

However, the CCP does not have any eligibility criteria, and as previously mentioned CCP villages were selected for reasons unrelated to yields (Boateng 2011). This suggests that the effect on cooperative membership as a whole and on coefficients for CAA and KKL membership separately may be biased, but that an estimated coefficient for CCP membership alone is less likely to be exogenous and unbiased. Furthermore, the majority of cooperative members in the sample are CCP rather than KKL or CAA members, so the potential problems with the endogeneity of CAA and KKL membership are less relevant.

As on final comment on the identification problem of this model, it is worth briefly discussing the potential for using the dual formulation of the production function.

Using duality would enable inputs to be instrumented using factor prices. This would include the costs of labor, land, spray machines, and seedlings for replanting, though they are not among the key variables, in addition to those for fertilizer use. Data probably could be found on the market prices for all these variables, but this data was not gathered during the 2011survey. A duality model would also need to include the costs of extension, the CODAPEC spraying program, and cooperative membership, all of which are difficult to measure considering that the major costs of each are in terms of the opportunity cost of time. Also, shadow prices for labor, land, and seeds for replanting are really what underlie use of these resources since their markets are underdeveloped, but it is impossible to measure these shadow prices for inclusion in the model.

If it were somehow possible to gather the requisite data to use the duality theory approach, with involves simultaneously estimating the production function while including a cost-minimization requirement, this would entail full instrumentation of the input variables and eliminate the problem of endogeneity of input use outputs. However, Mundlak (1996) argued that using the duality approach means that not all available information is utilized and there can be a substantial loss in statistical inefficiency, so a standard production function approach might be better. Furthermore, the fact that the government pays the costs for the CODAPEC spraying program and that fertilizer is sold for a fixed, subsidized price throughout Ghana would make it more difficult and less necessary to use the duality approach.

3.2.4 Yield Model Data:

The data for this empirical analysis were collected in the summer of 2011, through surveys with approximately 200 cocoa farmers from the five different major cocoa-producing regions of Ghana. The number of farmers interviewed in each region was chosen roughly in proportion to the cocoa market share of their respective regions. In the full sample 19.8% of farmers lived in the Eastern region, 19.8% in the Central region, 11.4% in the Ashanti region, 5% in the Brong Ahafo region, 30% in the upper Western region, and 13.9% in the lower Western region (for a total of 44.5% from the Western region as a whole). Interviews took place in one village in each region, except for the Eastern region, where two different villages were visited. This interview method weakens the statistical analysis, but this is mitigated somewhat by the use of cluster-robust standard errors for all regressions.

The mean, standard deviation, median, minimum and maximum values of each of the continuous variables used in the initial yield regression models are shown in Table 3.2 below. Only the mean is provided for the dummy variables, showing the proportion of the sample for which each dummy equals 1. The table also shows the number of farmers in the sample for which data were collected on each of these variables, because errors in administration of the survey meant that some questions were not asked of every farmer.

Yields per acre were determined by dividing the total production in kg by the number of mature acres for each farmer. The sample mean yield was 199 kg/acre. Because of high variation, the median yield, 158 kg/acre, is likely a better measure of central tendency. This is consistent with past research, which says that the average cocoa yield in Ghana is 178.1 kg/acre (Aneani 2011).

Though not shown in Table 3.2, 92% of the farmers surveyed had their land sprayed by the government as part of the CODAPEC program at least one time per year.

The other 8% tended to be farmers who had only been farming for a few years and whose trees had not yet reached full maturity; apparently the government only begins spraying the trees when they reach productive maturity. The mean frequency of spraying by the government was 1.8 times per year and the median was 2 times per year. As shown in Table 3.2, 66.5% of farmers in the sample had their land sprayed twice or more annually. The frequency of spraying tended to be divided by region.

Over 67% of farmers reported receiving visits by extension agents; 47.5% received visits or trainings by the CCP-sponsored Cocoa Board extension agents which began operating in 2009, while 21.8% received visits by Ministry of Food and Agriculture extension agents, which have been operating for a much longer period of time. Though not used in regressions or shown in Table 3.2, the mean frequency of extension visits was 16.6 times per year, though the median and mode was just 12 times per year.

Approximately 73% of farmers surveyed reported using fertilizer, and almost half of those surveyed (46.5%) were members of cooperatives: 26.5% were members of the CCP, 8.5% were members of KKL and 8.5% were also members of the CAA.

Table 3.2: Summary Statistics for Variables in Yield Regressions						
	Obs	**Mean**	**Std. Dev**	**Min**	**Max**	**Median**
cocoa yield (kg/acre)	179	199.009	145.519	19.79	833.33	162.5
mature acres	200	6.508	5.523	0	38	5
total labor	200	6.525	5.616	1	61	5
gov spray over 1 time per year	200	0.665				
extension	200	0.675				
fertilizer	199	0.729				
cooperative member	200	0.47				
years of experience	199	17.975	13.047	1	61	15
years of school	196	7.592	4.682	0	16	10
indigenous	200	0.515				
other income	198	0.419				
machinery	191	0.812				
additional spray	199	0.764				
male	200	0.845				
total buyers in village	188	3.968	0.947	2	8	4
western region	200	0.445				
CCP member	200	0.265				
KKL member	200	0.085				
CAA member	200	0.085				

3.2.5 Yield Model Results

The results of the cluster-robust OLS yield model specification run on the full sample are shown in the first column of Table 3.3 below. The next two columns show the same model run for farmers with productive acres above and below the median[1] level of 5 acres, recognizing that there may be a difference in the yield function based on farm size (Vigneri 2008). The final two columns show the model run for farmers with yields above and below the median level of 162.5 kg/acre, recognizing that there may be a difference in the way farmers of different skill levels respond to inputs and program (Evenson and Mwabu 2005)[2]. For all specifications, a test of multicollinearity yielded tolerance (1/variance inflation factor) levels which were significantly higher than 0.1, indicating that multicollinearity is not a serious concern.

3.2.5.i Fertilizer Results

For the full sample, the coefficient indicates that using fertilizer increases one's yields by 50.4%. This effect is greater for small farms (46.4%) than for larger farms (19.6%), though in both cases fertilizer use significantly impacts yields. When the sample is split according to median yield, fertilizer use increases yields by 37% for higher-yielding farms but only 23.8% for lower-yielding farms. This result may mean that lower-yielding farmers who reported using fertilizer applied it at lower rates.

These results are comparable to those of Teal et al. (2006), which reported a 30% production increase due to fertilizer use, and Edwin and Masters (2005) which estimated a 19% yield increase per 50 lb. bag of fertilizer applied. However, clearly the effect of fertilizer found for the full sample and for farms smaller than 5 acres in this study is much larger than both these past studies of Ghanaian cocoa. In the case of Teal et al., the

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[1] Median was chosen for ease, but might have been more appropriate to use a threshold estimator to determine a less arbitrary break.

[2] A better way to do this analysis would have been with a quantile regression, like that done by Evenson and Mwabu (2005). Splitting the sample by median regression only was a simpler, faster way to get a general idea of the differences in the equation at different yield levels.

Table 3.3: OLS Regressions on Natural Log of Cocoa Yields in kg/acre

	Full sample	Acreage > 5	Acreage ≤ 5	Yield > 162.5	Yield ≤ 162.5
ln(mature acres)	-0.304 (0.089)**	-0.165 (0.10)	-0.046 (0.15)	-0.134 (0.023)***	-0.104 (0.09)
ln(total labor)	0.161 (0.035)***	0.010 (0.07)	0.311 (0.106)**	0.162 (0.047)**	0.059 (0.10)
gov spray over 1 time per year	0.274 (0.21)	-0.054 (0.18)	0.480 (0.15)**	-0.121 (0.12)	0.360 (0.128)**
extension	0.100 (0.032)**	0.333 (0.118)**	-0.079 (0.02)	0.023 (0.09)	0.020 (0.12)
fertilizer	0.504 (0.087)***	0.196 (0.091)*	0.464 (0.137)**	0.370 (0.06)***	0.238 (0.093)*
cooperative member	0.029 (0.08)	0.015 (0.13)	0.012 (0.05)	-0.009 (0.08)	0.060 (0.11)
ln (experience)	0.238 (0.12)	-0.022 (0.11)	0.394 (0.054)***	0.076 (0.07)	0.108 (0.04)**
ln (years of school)	-0.015 (0.01)	-0.020 (0.02)	-0.004 (0.02)	-0.004 (0.01)	-0.018 (0.01)
indigenous	0.339 (0.103)**	0.181 (0.11)	0.203 (0.16)	0.158 (0.055)**	0.191 (0.17)
other income	-0.099 (0.22)	-0.088 (0.21)	-0.167 (0.27)	0.008 (0.07)	-0.209 (0.19)
machinery	0.513 (0.099)***	0.765 (0.087)***	0.423 (0.206)*	0.381 (0.114)**	0.195 (0.092)*
additional spray	-0.555 (0.096)***	-0.403 (0.182)*	-0.646 (0.228)**	-0.471 (0.097)***	-0.183 (0.13)
Male	0.409 (0.136)**	0.091 (0.30)	0.291 (0.18)	0.286 (0.092)**	0.353 (0.154)*
total buyers in village	0.048 (0.08)	-0.076 (0.11)	0.086 (0.10)	-0.017 (0.04)	-0.156 (0.074)*
western region	0.328 (0.23)	0.411 (0.112)**	0.283 (0.27)	0.118 (0.054)*	-0.017 (0.21)
constant	3.152 (0.377)***	4.674 (0.531)***	2.577 (0.28)***	4.807 (0.284)***	4.137 (0.217)***
Number of observations	167	85	82	84	83
R squared	0.320	0.368	0.533	0.295	0.392
Root MSE	0.624	0.548	0.610	0.378	0.428

Note: all results reported with cluster-robust standard errors.

*** = 99% significance level, ** = 95% significance, * = 90% significance

difference is probably due to the fact that their model included both a dummy and a continuous quantity variable for fertilizer use, while my model only has a dummy variable. The results of Edwin and Masters (2005) are not even directly comparable to this paper, because their model used only a continuous variable for fertilizer. Furthermore, their model included improved cocoa variety as a key explanatory variable, while my model did not; thus, it is possible that my estimate of the effect of fertilizer is biased upwards because of the omission of cocoa variety, on which data were not collected.

3.2.5.ii Extension Services Results

Results show a significant, positive effect of extension services on yields for the full sample and for farms larger than 5 acres. For the full sample, receiving extension services increased yields by 10%, while for larger farms it increased yields by 33.3%. Both of these estimates are statistically significant. However, extension services did not have a significant impact on yields for smaller farms or for either of the samples split according to yield. This result seems to support the hypothesis that the impact of extension differs by farm size, which might be because large farmers have higher incomes, and thus greater ability to purchase inputs and implement recommendations of the extension agents.

The results do not support the hypothesis that extension impact differs by yield level, as was found by Evenson and Mwabu (1998). The difference between my results and those of Evenson and Mwabu may stem from the fact that they used a conditional quantile regression, which split the sample statistically along quantiles of the error term, while I split the sample artificially along the median yield level, more along the lines of a unconditional quantile regression. Additional differences are that Evenson and Mwaby (2005) used a continuous variable, the number of extension workers per farm, while I only used a dummy variable for receipt of extension services and that they used data on 13 crops in Kenya, while I looked only at cocoa in Ghana.

3.2.5.iii Pesticide Spraying Program Results

With regard to the CODAPEC spraying program, results indicate that there is no significant impact of the program when the full sample of farmers is examined, or for farmers with acreage and yields above the median levels. However, there is a highly significant impact of the program on farmers with smaller acreage and smaller yields. Among farmers with 5 acres or less, having one's land sprayed by the government two or more times in a year increases yields by 48%. Among farmers with yields below 162.5 kg/acre, the effect is a 36% increase in yields. This is an interesting result, because it suggests that the government spraying program has the largest marginal impact on smaller farms and those with lower initial yields.

This seems to make sense, because farmers with more land and higher yields are more likely to be able to afford to purchase pesticides and spray their own land, so the government spraying program will be less important to them. However, an examination of the data shows a significant positive correlation between having one's land sprayed two or more times by CODAPEC and applying additional pesticides, rather than the opposite. Furthermore, the additional spray variable is significantly negatively correlated with yields in all but one of the specifications shown in Table 3.3. This is very counterintuitive, and might indicate that there is an important omitted variable, the severity of pests and disease on a given farm. If a farm has a significant capsid or black pod problem, then the region may be sprayed more often by CODAPEC and the farmer will be more likely to spray additional chemicals, but yields may still be lower.

In general, these results seem somewhat at odds with past studies which have estimated a significant positive effect of pesticide use on production or yields (Teal et al. 2006, Vigneri 2008, Vigneri and Santos 2008, Aneani 2011), though a few other studies have failed to find significant effects (Edwin and Masters 2005). However, all of those studies used a continuous variable for the amount of insecticides used rather than a dummy variable, so the results are difficult to directly compare. The study most directly comparable to this study, in terms of the spray variables used, is Teal et al. (2006). They included a dummy for CODAPEC spraying three times or more per year, which is very similar to the variable used in this paper, and they did not find a significant correlation with production. However, their "government spray machine used" dummy variable was significant, increasing production by 77%. These two dummy variables likely had high covariance, because every time the CODAPEC program sprayed a farmer's land they would have used a spray machine. Thus, the CODAPEC variable in Teal et al. (2006) was almost certainly biased downwards.

In contrast, my model includes a "spray machine" variable which takes a value of 1 only if the farmer herself owns a spray machine for use on her land. This variable is much less likely to be correlated with the CODAPEC variable; it also differs from the "additional spray" variable, because many farmers rent or borrow machines to spray their land, or hire sprayers who supply their own machinery for the job. My results show that farmers who own a spray machine have 51.3% higher yields in the full sample and 76.5% higher yields in the sample of only farmers with over 5 acres. The magnitude of the importance of spray machines is consistent with Teal et al.'s results.

The dramatic effect of owning a spray machine on yields may exist because farmers who own a spray machine are more likely to spray when needed, since they do not first have to rent a machine or hire a spraying gang. It could also be due to the fact that a farmer who can afford to purchase machinery has more capital which she can use for a number of different farm inputs. The variable could also be a proxy for ability. However, higher wealth and ability are somewhat controlled for in the regression by inclusion of education, experience, and other income variables, as well as other variables which are manifestations of good practices that can be increased with higher wealth, such as fertilizer use, total labor and additional spray.

The similarity of my results using the full sample to those of Teal et al. (2006) lends more support to my model. However, Teal et al. (2006) did not go the extra step of dividing their sample by acreage and yields; it is possible that if they had done so, then they might have also found a significant impact of their "government sprays 3x or more per year" variable on production for small and low-yielding farmers. This paper has thus uncovered a potential important avenue for future study, because if the CODAPEC program has a greater marginal impact on smaller, lower-yielding farmers, this suggests that targeting such farmers more deliberately might make the program more cost-effective.

3.2.5.iv Farm Size Results

The coefficient on productive acreage was found to be significant and negative for the full sample, suggesting that doubling farm size would decrease yields by 30.4% This is higher than the 20% decrease estimated by Carter (1984) and Vigneri (2008) using OLS models. However, it is smaller than the 45% decrease in yields estimated by Vigneri (2008) when a fixed effects model was used. Within each sub-sample split according to acreage, farm size does not have a significant effect on yields, indicating that the major variation is across rather than within these two sub-samples. For lower-yielding farms, farm size does not have a significant impact on yields, but for higher-yielding farms it has a significant impact: doubling farm size leads to a decrease in yields of 13.4%.

3.2.5.v Other Control Variable Results

Other variables in the model which have a significant impact on yields in the full sample regression include total labor, being indigenous to a village, and gender of the head of household. A 10% increase in labor on the farm correlates with an increase in yields of 1.6%. This is very likely endogenous, because with higher yields more labor needs to be hired for harvest; however, despite this endogeneity it is still important to include labor as a control variable to isolate the effects of the variables of interest. Farmers born in their village tend to have yields 33.9% higher than those who migrate into the village.

Households headed by males have yields 40.9% higher than female-headed households, which is likely due to the fact that females have lower wealth and are more marginalized in terms of access to services. For example, in the sample 55% of female farmers received extension services, compared to 77% of men, and 62% of females used some type of machinery while farming, compared to 85% of men. It is also possible that women have lower quality land on average, though data was not collected on land quality in this study to test this hypothesis.

These results are consistent with expectations from past literature. Experience, school, other income, the Western region dummy variable, and the number of total LBCs in a village (which represents level of buyer competition) are all found not to be significant for the full sample, though past studies have estimated significant positive impacts of all of these variables. However, no past study has included all these variables in the same model before. All have the expected positive sign except for years of school and other income.

Interestingly, some of these control variables which are not significant in the full sample model become significant in one or more of the sub-sample models. Living in the Western region has a significant positive effect on yields for farmers with higher acreage (a 41.1% increase) and higher yields (an 11.8% increase). This suggests that the higher production reported for the Western region as a whole in past studies (Zeitlin 2005, Teal et al. 2006) might have been accounted for primarily by larger farms and that there are still a substantial number of small farms in the Western region which have yields below the average for Ghana.

For farmers with less than 5 acres, years of experience do have a significant impact on yields: a 10% increase in experience increases yields by 3.94%. Similarly, for farmers with yields under 162.5 kg/acre, a 10% increase in experience increases yields by 10.8%. This suggests that experience and the skill and knowledge associated with it are important inputs, but that they can be outweighed by other costly inputs which are more easily accessed by larger farmers, such as fertilizer and machinery. A similar pattern is seen for labor. Among the sub-samples, labor is only a significant contributor to yields for small farmers. On farms of less than 5 acres, a 10% increase in labor actually increases yields by 31.1%, while it has no significant impact on yields for larger farmers. This reinforces the conclusions of the inverse acreage-yield literature, which suggests that small farms have higher yields because of a more intensive application of labor and fewer moral hazard concerns.

3.2.5.vi Cooperative Membership Results

Table 3.3 results show that cooperative membership does not have a significant impact on cocoa yields, either in the full sample model or when it is split by acreage or yields. This is not completely surprising, given that the past study which estimated a positive effect of cooperative membership on cocoa yields (Calkins and Ngo 2010) did not make an effort to separate the effects of cooperative associations from the services they help to supply. In fact, the literature suggests that the primary effect of cooperative membership is to increase access to and effectiveness of extension services (Bindlish et al. 1993, Chirwa 2005). A simple logit regression of the receipt of extension services on cooperative membership using my full sample shows that being a cooperative member increases the odds of receiving extension by a factor of 3.75, a highly significant result (this will be further investigated in section 3.3.4). Thus, it might be more accurate to include cooperative membership separately from extension. Also, membership in the three different cooperative associations in the sample may have different effects on yield, both because their programs are very different, but also because endogeneity concerns are more severe for CAA and KKL than for CCP. Thus, it is worth examining membership in these cooperatives separately.

Table 3.4 shows the results of supplemental regressions run in order to look at cooperative membership effects in more detail. When the extension variable is dropped but the other variables are left unchanged, as shown in Model 1, the effect of cooperative membership is still insignificant. However, if only a dummy for being a member of the

Table 3.4: Alternative OLS Yield Regressions to Examine Cooperative Membership Effects							
	Model 1, Full Sample	**Model 2, Full Sample**	**Model 3, Full Sample**	**Model 4, Full Sample**	**Model 5, Full Sample**	**Model 6, Full Sample**	**Model 6, Acreage > 5**
ln(mature acres)	-0.302 (0.09)**	-0.284 (0.065)***	-0.28 (0.068)***	-0.299 (0.089)**	-0.27 (0.056)***	-0.286 (0.066)**	-0.271 (0.078)**
ln(total labor)	0.173 (0.035)***	0.169 (0.03)***	0.154 (0.036)***	0.178 (0.034)***	0.156 (0.034)***	0.164 (0.028)***	0.054 (0.05)
gov spray over 1 time per year	0.266 (0.21)	0.256 (0.21)	0.21 (0.21)	0.268 (0.21)	0.22 (0.21)	0.259 (0.204)	-0.02 (0.21)
extension						0.035 (0.035)	0.226 (0.16)
fertilizer	0.52 (0.09)***	0.476 (0.072)***	0.592 (0.092)***	0.53 (0.083)***	0.532 (0.092)***	0.471 (0.068)***	0.177 (0.14)
cooperative member	0.051 (0.09)						
CCP member		0.322 (0.131)*			0.251 (0.14)	0.312 (0.13)*	0.575 (0.124)***
KKL member			-0.424 (0.105)***		-0.313 (0.13)*		
CAA member				-0.031 (0.07)	-0.048 (0.07)		
ln (exp.)	0.223 (0.12)	0.234 (0.13)	0.238 (0.11)*	0.227 (0.12)	0.242 (0.12)*	0.239 (0.128)	-0.008 (0.10)
ln (years of school)	-0.015 (0.01)	-0.015 (0.01)	-0.013 (0.01)	-0.014 (0.01)	-0.014 (0.01)	-0.015 (0.014)	-0.017 (0.01)
indigenous	0.341 (0.114)**	0.328 (0.1)**	0.348 (0.11)**	0.344 (0.11)**	0.334 (0.102)**	0.327 (0.096)**	0.16 (0.10)
other income	-0.091 (0.22)	-0.072 (0.22)	-0.082 (0.22)	-0.088 (0.22)	-0.069 (0.23)	-0.075 (0.022)	-0.057 (0.20)
machinery	0.53 (0.092)***	0.546 (0.076)***	0.4 (0.11)**	0.523 (0.078)***	0.459 (0.1)***	0.541 (0.082)***	0.665 (0.12)***
additional spray	-0.573 (0.087)***	-0.609 (0.079)***	-0.565 (0.08)***	-0.575 (0.084)***	-0.605 (0.073)***	-0.602 (0.083)***	-0.534 (0.178)**
male	0.422 (0.128)**	0.398 (0.137)**	0.457 (0.129)**	0.427 (0.13)	0.424 (0.14)**	0.393 (0.135)***	0.104 (0.24)
total buyers in village	0.038 (0.08)	0.124 (0.07)	0.05 (0.09)	0.03 (0.09)	0.121 (0.07)	0.125 (0.073)	0.126 (0.07)
western region	0.319 (0.23)	0.451 (0.26)	0.216 (0.23)	0.301 (0.25)	0.368 (0.25)	0.453 (0.259)	0.68 (0.089)***
constant	3.253 (0.375)***	2.809 (0.231)***	3.325 (0.393)***	3.288 (0.421)***	2.912 (0.213)***	2.783 (0.25)***	3.972 (0.452)***
# Obs.	167	167	167	167	167	167	85
R squared	0.317	0.341	0.338	0.316	0.352	0.341	0.424
Root MSE	0.623	0.612	0.614	0.624	0.611	0.614	0.523
Note: all results reported with cluster-robust standard errors.							
*** = 99% significance level. ** = 95% significance. * = 90% significance							

CCP cooperative is used rather than the general cooperative member dummy, as in Model 2, then there is a significant, positive effect. Results suggest that members of the CCP cooperative have yields 32.2% higher than non-members.

Model 3 looks at the effect of KKL membership only and yields a significant, negative effect. Members in KKL have yields 42.4% lower than non-members. This is very surprising and difficult to explain. Unlike the CCP program, KKL does not have a large extension and training component, so if extension is very crucial for increasing yields, as suggested by Barrientos et al. (2007), then that might partially explain the lower yields of KKL members. KKL also requires that members sell all their produce exclusively to the LBC run by KKL, and guarantees benefits to its members derived from shared fair trade bonuses. It is possible that under these circumstances farmers have lower incentives to increase yields. Finally, this might be the result of endogeneity; as suggested in section 3.2.2.

The results of Model 4 show that CAA membership does not have a significant effect on yields, and Model 5 results show that when all three of the cooperatives are included simultaneously in the regression, only the KKL variable is significant, reducing yields by 31.3%. The final two models include the CCP membership variable, which is the only cooperative variable which is believed to be exogenous, but reintroduce the extension variable. Interestingly, when both CCP membership and extension are included for the full sample, as in Model 6, the extension variable loses its significance, and CCP membership seems to have a significant 31.2% effect on yields.

This result is further strengthened when the sample is limited only to those farmers with over 5 acres: CCP membership increases yields by 57.5%. These results are both substantially higher than the analogous coefficients for extension in Table 3.3. This suggests that CCP membership offers benefits to farmers above just extension services which help them to increase yields, and that CCP membership is more beneficial to farmers with larger plots of land. An alternative explanation is that CCP targets farmers with higher acreage and higher yields, though an understanding of how the program has been rolled out suggests that this is unlikely.

3.2.6 Alternative Evaluation of the Effects of the CCP Program:

In the summer of 2009, researchers conducted a baseline study of 90 villages participating in the CCP program and 200 nearby non-CCP villages as a control group, which will be compared in the future to data on those same villages in order to estimate the effect of the CCP over time (Hainmueller et al. 2011). Ultimately the results of that study will provide a much more accurate estimate of the CCP/extension treatment effect than my study. However, a basic comparison of the yields during that baseline study with yields in my data, conducted exactly two years later, might provide some idea of the preliminary treatment effect. The baseline study found that farmers in the CCP villages had yields of 312 kg/hectare on average. Converting land area into hectares instead of acres, the average reported yields for residents of CCP villages in my sample is 451.05 kg/ha. This suggests a 44.6% increase in yields from 2009 to 2011.

However, this is not an accurate measure of the CCP treatment effect, because it is possible that yields in villages not participating in the CCP program also increased during that time, and that yield increases throughout Ghana were caused by other factors. In order to determine the actual treatment effect, a difference-in-differences calculation is necessary to compare the change in yields over time for the CCP villages with the non-CCP villages. The average yields in the baseline survey for non-CCP villages were 406.2 kg/ha. Compared with yields in my study of 522.46 kg/ha for non-CCP villages, this represents a 28.6% increase, which is clearly less than the yield increase in the CCP villages. The difference-in-difference is determined by: ($Yield_{2011CCP} - Yield_{2009CCP}$) – ($Yield2011_{NonCCP} - Yield2009_{NonCCP}$). This results in a value of 22.79 kg/ha, which is 6% of the average yield for the full sample in the 2009 baseline survey. This indicates that farmers living in a CCP village saw an increase in yields between 2009 and 2011 that was 6% higher than that of farmers in non-CCP villages.

Of course, this analysis is different from the CCP membership effect estimated in Table 3.4, because it relies on village-level effects and does not take into account the fact that many farmers living in a CCP village do not join the cooperative. Also, the analysis is weak because the samples used in the baseline study and in this study dealt with completely different villages. However, the CCP villages and non-CCP villages in both surveys were chosen randomly, which increases the validity of the comparison.

3.2.7 Cost-Benefit Estimation of Each Policy Factor Affecting Yields:

The results outlined above show that there is a 50.4% increase in cocoa yields when a farmer with mean acreage who was previously not using fertilizer begins to use fertilizer. The mean yield for farmers with no fertilizer in the sample was 151 kg/ acre, so this translates into an increase in yields of 76 kg/acre. Because each 62.5 kg bag of cocoa is worth 200 cedis per bag, this means that each kg earns the farmer 3.2 cedis. Thus, using fertilizer increases farmers’ gross incomes by 243 cedis per acre.

Asase Wura and Cocofed fertilizers, the two main types which the farmers I interviewed reported using, both cost 29 cedis per 50 kg bag in 2011, a 50% subsidy off the total price of 54 cedis (Yawson et al. 2010). The Cocoa Research Institute of Ghana (CRIG) recommends use of three 50 kg bags per acre (Baah 2010), meaning that if these recommendations were followed the total cost to farmers for fertilizer would be 87 cedis, while the cost to the government would be 75 cedis, for a total social cost of 162 cedis per acre. Comparing this to the 243 cedi benefit estimated from the full sample in Table 3.3, this shows that a farmer would see a net benefit of 156 cedis. In total social terms, including the cost of the government subsidy, the net benefit would be only 81 cedis. This is still a very substantial benefit. Also, it is very likely that not all farmers in the sample actually applied the full three recommended bags of fertilizer, so it is possible that the amount and thus cost of fertilizer needed to achieve the observed yield increase is actually smaller. Therefore, the net benefit of fertilizer use to both farmers and to society as a whole is likely even higher than what is estimated here.

Budget figures for the government spraying (CODAPEC) program, the CCP program, and other extension services were not readily available. Therefore, it is only possible to quantify the benefits of those services and compare them to their direct cost to farmers; this is shown below. Access to budget figures would permit a full cost-benefit comparison for the government.

The results also show that if a farm of less than 5 acres is sprayed by the government two or more times annually this leads to an increase in yields of 48%. In the sample, farms of 5 acres or less which were only sprayed one time annually or not sprayed at all had an average yield of 163 kg/acre. Thus, yields would increase by 78 kg/acre if spraying were increased, leading to an increase in revenue of 251 cedis. The CODAPEC program is completely free to the farmers whose land is sprayed, so they would receive this full revenue increase as profits. From the farmer's point of view, this is definitely the most cost-effective and beneficial of the four examined services. This is reflected in the fact that over 50% of farmers in the sample identified an increase in government spraying as one of their biggest needs.

The regression results also show that receiving extension services leads to an increase in yields between 10% for the average sized farm. Given that the mean yields for a farmer currently not receiving extension are 183 kg per acre, this would equate to an increase in yields of 18 kg/acre, which would yield gross revenue increases of 58.5 cedis per acre. The benefit of extension is even more substantial for the average larger (over 5 acre) farm in the sample, which sees a 33.3% increase in yields due to extension. The mean yield for farms over 5 acres that currently receive no extension in the sample is 134 kg/acre. This equates to an increase in yields of 44 kg/acre, and a gross revenue increase of 141 cedis for the farmer. The net benefits of extension to the farmer are likely to be somewhat less than this value, because it does take time on the part of the farmer to attend trainings. However, this is very difficult to quantify.

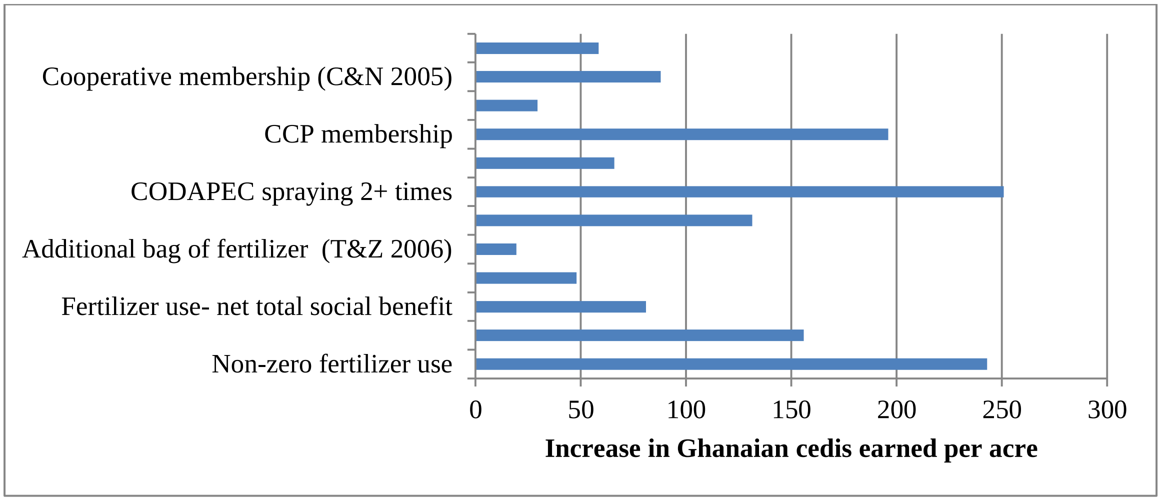
Finally, the effect of membership in the CCP for the average farmer, shown in Model 6, is to increase yields by 31.2%. The mean yield of a non-CCP member is 196 kg/acre, so this would equate to an increase of 61 kg/acre. Thus, joining the CCP seems to correlate with an increase in revenues of 196 cedis per acre. However, it appears from the results of Model 6 that these benefits will not be realized by farmers with less than 5 acres, though the effect will be even more dramatic—a 57.5% increase—for farmers with more than 5 acres. The mean yield for non-CCP members with over 5 acres in the sample was 166, so would mean an increase of 95.5 kg/acre or 306 cedis/acre.

In the sample the median level of dues charged by a cooperative was 1 cedi per month, for a total cost of 12 cedis per year of cooperative membership; the maximum cost was 5 cedis per month, or 60 cedis per year. The time required for membership in a cooperative will also have an opportunity cost to the farmer which cannot be easily quantified, but even despite this additional cost, it appears that revenue benefits of cooperative membership would greatly exceed the costs to farmers.

The alternative estimate of the treatment effect of the CCP program, determined at the village level using a comparison with the baseline study by Hainmeuller et al. (2009), was a 6% increase. This is equivalent to an increase of 9 kg/acre (over the average for non-CCP villages of 23 kg/acre), or 29.5 cedis/acre in annual revenue. Clearly this is a much lower estimate of the benefit of the CCP program than that calculated above. However, this estimate is for all members of a village in which there is an active CCP program, and not just the dues-paying CCP members. Significantly, even this lower estimate of benefits exceeds the 12 cedi annual cost of the median cooperative.

Figure 3.0 below summarizes the key calculated benefits for the four factors of interest and compares the results to those from several past studies. All values are in terms of gross increases in cedis earned per acre unless otherwise noted, in the case of net benefits to fertilizer. Some calculation had to be done in order to convert the values from past studies for comparison. That is, the calculated increases in yields or production from those studies was multiplied by the average yields in the studies, and the resulting value was converted into cedis earned using the 200 cedi per 62.5 kg bag price. In all cases the values also had to be converted from hectares to acres. Note that there is not a comparable past study on extension services in Ghanaian cocoa, so only the gross benefit calculated in this study is displayed in Figure 3.0.

Figure 3.0: Comparison of Economics Benefits to the Four Yield Factors of Interest



3.3 Factors Affecting the Likelihood of Receiving Key Inputs and Support

This section will model the effect of a number of demographic factors, regional variables, and cooperative membership on the likelihood that a farmer applies fertilizer, the likelihood that they receive extension services, and the likelihood of receiving two or more annual sprays by the CODAPEC program. This will show whether such inputs and services are available to all farmers on a fair and equal basis or not, and will provide guidance on which farmers should be targeted by the government or cooperatives or NGOs for additional assistance.

This section also serves as a deeper explanation of potential endogeneity and collinearity issues and thus reveals some of the limitations of the results explored in section 3.2. That is, if there are variables which are significant underlying determinants of the four factors of interest and which are also correlated separately with yields, this will reveal weaknesses in the regression models used above. If time had permitted, this information could have been used to determine better models for more accurately measuring the factors of interest, but unfortunately such corrections were not made.

Another concern regarding this section is that these regressions may not accurately represent a causal relationship between the independent variables and the use of inputs because the different variables are both correlated with an outside factor, namely yields. Thus, inherently these regressions are somewhat flawed. However, they do enable the articulation of some of the potential mechanisms by which the different variables ultimately influence yields. The key problem is that these regressions raise a number of questions but provide no definitive answers. Perhaps in the future further research can be done to improve these models and better answer these questions.

3.3.1 Data for Input and Support Regressions

Table 3.5 below shows the summary statistics for the demographic variables which are included in the subsequent models, in addition to the variables from section 3.2. Because the dependent variables in these models are right-hand side variables in the models from section 3.2, they are not included in Table 3.5.

Table 3.5: Summary Statistics for Variables in Regressions on Receipt of Services						
	Obs	**Mean**	**Std. Dev**	**Min**	**Max**	**Median**
input support	200	0.465				
own farm	200	0.665				
landlord	200	0.115				
akan	200	0.68				
christian	200	0.925				
chief relative	200	0.355				
leader in village	200	0.505				
wealth index	187	3.123	1.24	0	8	3

3.3.2 Fertilizer Use Model

A few past studies have attempted to estimate the determinants of fertilizer use, using technology adoption models. Chirwa (2005) found that the probability of fertilizer adoption in Malawi increased with the level of education, size of the cultivated plot and level of non-farm incomes, but was a decreasing function of female headship of the households and distance of the plot from central markets. Isham (2002) showed that the probability of adoption of fertilizer in Tanzania was increasing in land under cultivation, ethnically-based social affiliations, the adoption of improved seeds, the availability of credit and extension services, and the average years of residence in the village. Barrientos et al. (2007) reported that adoption of fertilizer and improved cocoa varieties were affected by the cost of labor, the cost of other inputs, whether a farmer is a caretaker or an owner-operator, gender of the farmer, whether they were indigenous to an area or had migrated, and age of the farmer.

This paper's model of fertilizer includes all the explanatory variables used in these three studies for which data were available in my sample. Table 3.6 above shows the results of a logit regression of fertilizer use on these explanatory variables, reported as average marginal effects.[3] Results are shown with cluster-robust standard errors. The second column shows the same regression as column one, but with an indicator variable for each separate region.

Results of the first regression, without the region indicator, show that farmers in the sample who receive input support are 20.6% more likely to use fertilizer than those who do not receive input support. A one unit increase in the wealth index increases the likelihood of fertilizer use by 12.8%. Farmers living in the Western region are 22.8% more likely to use fertilizer than those who do not. Contrary to expectations, the results also show that an additional year of schooling decreases the likelihoods of using fertilizer by 1%, that being a member of the CAA decreases the likelihood by 22%, and that indigenous farmers are 14% less likely to use fertilizer than migrants.

However, the most dramatic variation in fertilizer use is across villages rather than within each village, and thus differences in the regions might be masking individual level effects on fertilizer use. When the region indicator variable is included, which causes the other coefficients to reflect intra-village variations, this changes the results substantially. The level of schooling and the indigenous variable lose their significance.

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[3] Average marginal effects (AMEs) are calculated automatically in Stata using the "margins dydx" command. In order to calculate the AME of input support, for example, Stata takes each individual farmer and treats that farmer as if s/he received input support, leaving all other independent variable values as is, and computes the probability that the farmer would use fertilizer. Then it does the same thing, this time treating the farmer as if s/he did not receive input support. The process is repeated for each farmer in the sample, and the average of all the marginal effects gives the AME for input support. In contrast, calculating marginal effects at the mean (MEM) for input support tells us the difference in the probability of using fertilizer for two farmers, one who receives input support and one who does not, with all other variables set at the average for the total sample. AMEs are superior to MEMs for this paper because most of the variables are dummy variables and mean values of such variables have no real-world meaning (for example, no farmer is a 47% cooperative member).

Table 3.6: Logit regression on Likelihood of Using Fertilizer		
	Average Marginal Effect, No Region Indicator	Average Marginal Effect, With Region Indicator
input support	0.206 (0.08)**	0.216 (0.064)***
mature acres	0.009 (0.01)	0.006 (0.01)
school	-0.011 (0.007)*	-0.004 (0.01)
experience	-0.003 (0.00)	-0.002 (0.00)
indigenous	-0.139 (0.065)**	-0.073 (0.06)
owns farm	-0.055 (0.07)	-0.141 (0.10)
land lord	-0.095 (0.08)	-0.058 (0.13)
extension	-0.014 (0.10)	0.263 (0.08)***
wealth index	0.128 (0.03)***	0.117 (0.011)***
CCP member	0.118 (0.09)	0.208 (0.084)**
KKL member	0.056 (0.06)	0.093 (0.09)
CAA member	-0.219 (0.106)**	-0.454 (0.096)***
male	-0.097 (0.10)	-0.216 (0.099)**
west	0.228 (0.13)*	i.region used
Note: all results reported with cluster-robust standard errors.		
*** = 99% significance level, ** = 95% significance, * = 90% significance		

All the results of the regression with region indicators conform to expectations based on past research except for the coefficients on the CAA and male variables. These results are surprising, given that past studies have shown that male farmers are more likely to apply fertilizer (Chirwa 2005), and that the primary function of the CAA is to supply a package of inputs, including fertilizer, on credit to its members. These strange results might be due to the small number of female farmers and CAA members in the sample.

Overall, the results show strong evidence that extension services, wealth, access to credit and other input support, and CCP membership lead to an increase in fertilizer use. Because fertilizer was shown in the Section 3.2 yield regressions to have the largest impact on yields for the full sample, this suggests that an increase in cooperatives and extension, as well as provision of input supports and credit for poorer farmers, is crucial for increasing fertilizer use and therefore yields and farmer income.

The fact that fertilizer use is significantly correlated with extension, gender, membership in the separate cooperatives, and the wealth index, all of which are included in the yield regressions from section 3.2 could be problematic. This suggests that multicollinearity may be a problem, even though tests performed for multicollinearity in section 3.2 suggested that it was not substantial. Take extension and fertilizer, for example: one explanation of the results is that extension impacts yields through both its impact on fertilizer use due to increased farmer knowledge of its importance, and outside of fertilizer use through its impacts on other agronomic practices. However, it is not clear that the model structure enables us to accurately parse out these different results. Furthermore, the results also indicate potential endogeneity problems. For example, the level of input support received by a farmer, which significantly impacts use of fertilizer, could very well be partly determined by yields, since more successful farmers may attract more services from buyers desirous of their patronage. There was not time to adequately deal with these potential concerns, but if future research conducted is conducted in this area it would be a good idea to preform additional tests and consider restructuring the yield model to account for these concerns.

3.3.3 Government Spray Likelihood Model

Barrientos et al. (2007) surveyed farmer opinions of the CODAPEC spraying program. They found that farmers generally praised CODAPEC as useful, but favoritism and corruption were identified as key problems. Some farmers complained that the gangs never reached their farms; others complained of having to pay the gangs. Thus, a model of the likelihood of receiving two or more sprays per year must include factors that might increase favoritism or ability to pay bribes. This includes ethnicity, experience/age, cooperative membership, migration status, land size, land tenure, relationship to the village chief, gender, holding a leadership position in the village, and a dummy for the Western region. The wealth index is not included in the regression, because it includes dummies for spraying additional pesticides and owning a spray machine which might be endogenous to the level of CODAPEC spraying received.

Table 3.7 shows the results of a logit regression of the "government spray over one time annually" variable on this list of explanatory variables. Results are average marginal effects with cluster-robust standard errors, and the second column regression includes an indicator variable for each separate region.

Results in the specification without regional indicators show that when farm size increases by one acre, the likelihood of receiving more than one annual CODAPEC spraying increases by a factor of 1%. Being Christian increases the likelihood by 32%, and being a member of the CAA increases the likelihood by 12.8%. These results match expectations, since farmers in the Christian majority are more likely to be well connected politically and thus better able to secure services from the local government. This is likely also true for farmers with larger land holdings.

There are only 17 members of the CAA in the sample, most living in a single region, the central West. Thus, the positive effect of CAA membership could be an anomaly. However, the central West region in general has a lower probability of being sprayed frequently by CODAPEC, so if anything the odds ratio on CAA should be biased downwards. This might indicate that the CAA exerts political influence to ensure that its members' farms are sprayed more often, or it could indicate endogeneity, if farmers who receive more frequent spraying have higher production and wealth and thus find it more affordable to join the CAA.

On the other hand, being of the majority Akan ethnic group, being a member of the KKL cooperative, being a leader in the village, and living in the Western region all seem to decrease the likelihood of receiving frequent spraying by CODAPEC. The Western region is more remote and the CODAPEC program has only recently expanded to the area, so that negative correlation matches expectations. However, it seems that the other three variables should increase local political influence, and so their negative impact on the likelihood of frequent spraying is unexpected.

With regard to the Akan variable, the results might be affected by the presence of the "indigenous" variable in the model. There is a high correlation between being indigenous and being Akan, and when both are included the effect of being Akan is limited to those who are both Akan and migrants, a small minority group (thus at high risk of marginalization). If "indigenous" is dropped from the model, then the effect of Akan is no longer significant.

Table 3.7: Logit regression on Likelihood of Receiving CODAPEC Spraying >1 Time Annually

	Average Marginal Effect, No Region Indicator	Average Marginal Effect, With Region Indicator
mature acres	0.013 (0.006)**	0.004 (0.00)
experience	-0.0002 (0.00)	0.002 (0.00)
akan	-0.131 (0.075)*	-0.033 (0.05)
Christian	0.317 (0.12)***	0.13 (0.13)
indigenous	-0.069 (0.13)	-0.042 (0.12)
CCP member	-0.043 (0.14)	0.083 (0.06)
KKL member	-0.373 (0.164)**	-0.244 (0.087)***
CAA member	0.128 (0.062)**	0.026 (0.07)
own farm	0.121 (0.08)	0.025 (0.05)
chief relative	0.094 (0.10)	0.025 (0.13)
leader in village	-0.099 (0.05)**	-0.131 (0.051)**
male	0.215 (0.13)	0.28 (0.121)**
west	-0.353 (0.188)*	i.region used

Note: all results reported with cluster-robust standard errors.

*** = 99% significance level, ** = 95% significance, * = 90% significance

The negative result for leaders in the village is much more puzzling. It might also be biased due to collinearity with other variables, though a test of the data showed that there are not serious multicollinearity problems between any of the explanatory variables. It is also possible that the result is valid, and indicates that leaders in the village use their political influence over the CODAPEC allocation to direct resources to other farmers, perhaps to increase their political support, because their families can afford to spray their land on their own, or for altruistic reasons.

The negative effect of KKL membership on the likelihood of frequent spraying is also puzzling. One primary goal of Kuapa Kokoo is to increase the political power of farmers, and it seems that this would translate into an increase in provision of government services like CODAPEC to KKL members. However, evidence from Calkins and Ngo (2005) suggests that Kuapa Kokoo societies are located in more remote and poorer villages, and that farmers living near larger towns from which CODAPEC resources are distributed are less likely to see the necessity in joining the cooperative. Thus, the KKL members might be less likely to receive frequent government sprayings because they tend to be poorer and more in need of services to begin with, which is why they join the KKL. However, there are not enough KKL members in the sample to draw any accurate conclusions either way.

When the region indicator dummy is included in this regression model, many of the significant effects disappear. Those which remain reflect differences within regions instead of across regions. The sample size for this regression decreases to 171, because the entire Western south region is dropped, since no farmers in that region received government spraying more than once annually. This means that an important degree of explanatory power is lost in this model, but it can still illuminate a few interesting results.

Within the remaining regions, KKL members and village leaders still have significantly lower likelihoods of receiving frequent spraying by CODAPEC, though the marginal effect is reduced from -37% to -24%. In this regression, the marginal effect of being male becomes significant, and male farmers are found to have a 28% higher chance of having their land sprayed more than once compared with female farmers.

Overall, these results suggest that there is significant inequality in the provision of the CODAPEC program, with members of the majority religious group, males, and larger farmers more likely to receive frequent spraying, while farmers in the Western region are less likely to receive frequent spraying. This suggests a major inefficiency in the program, since the yield analysis showed that CODAPEC spraying has the largest marginal effect on small farms. Also, the analysis shows that the most significant inequality in provision of CODAPEC services is on a gender basis. Policies aimed at remedying the unfair distribution of CODAPEC spraying may help to achieve higher productivity levels in the cocoa sector, because disproportionate neglect of minority and marginalized farmers constitutes an inefficient allocation of resources.

These results also shed some light on the question of endogeneity of the CODAPEC spraying program. Variables which are correlated with more frequent CODAPEC spraying in the first model but not the second indicate correlations with village-level factors. This includes membership in CAA, being Christian, being Akan, larger land size, and living in the Western region. This shows resources from the CODAPEC program are targeted unevenly at different villages based largely on social political factors, thus supporting the earlier argument that the program does not target farmers based on yield levels. However, in the case of the KKL membership variable, the high negative correlation with CODAPEC might indicate endogeneity for one or both of these variables. As discussed previously, since KKL membership is also negatively correlated with yields, it is possible that KKL societies are formed in isolated areas without good access to services like CODAPEC, extension, and input suppliers (and thus with lower yields). An alternative explanation is that CODAPEC resources are devoted to wealthier, more influential areas which also have higher yields, and they specifically avoid the KKL villages because they have lower average yields. More work should have been done to eludicate the direction of causality in these cases, but there was not adequate time for such further analysis.

3.3.4 Extension Services Model

No past studies were found which analyzed the factors correlated with provision of extension services. However, a good starting point is to look at the same factors which are hypothesized to affect the likelihood of applying fertilizer and of receiving government spray services. Extension shares components with each of these variables, because it requires a choice by the farmer to consume the service (to take time to attend trainings, or contact extension agent) similar to fertilizer adoption, but it also has an exogenous component wherein the government might target certain groups of farmers, for political or other reasons, similar to the CODAPEC program.

The variables chosen for this regression were mature acres, experience, education, being Christian, being Akan, being indigenous, membership in the three cooperatives, farm ownership, being a landlord, being a relative of the chief, being a village leader, gender, the Western region dummy, the wealth index, and the availability of input supports. Results, shown in Table 3.8, are reported as average marginal effects with cluster-robust standard errors. The second column shows the same regression as the first, but with an indicator variable for each region rather than only a dummy for the West.

Results of the first regression show that CCP membership increases the likelihood of receiving extension services by 37%. Being a member of the KKL or CAA, owning and operating one's farm, being a village leader, and being male also have a significant positive impact. These results support expectations. Farmers who own their land should be more likely to spend time on extension activities, because they will reap the full benefit of the knowledge that they gain, and members of cooperatives are more easily reached by extension services (Bindlish et al. 1993).

The significant effects of gender and village leadership support the hypothesis that allocation of extension services is at least partially determined by social and political influence. One additional year of experience decreases the likelihood of receiving extension by 0.8%. This may indicate a self-selection effect: farmers with enough experience do not need extension services as much as less experienced farmers.

The results for the regression when the region indicator variable is included are mostly the same, with slight changes in the magnitude of the effects. CCP membership only increases the likelihood of receiving extension by 30.5% (compared to 37% in the first model). The coefficients on farm ownership and being male increase, leadership and experience remain roughly the same, but KKL and CAA membership lose their significance. Thus, with the exception of CAA and KKL membership, these factors are determinants of the likelihood of receiving extension both across and within villages.

Table 3.8: Logit regression on Likelihood of Receiving Extension Services

	Average Marginal Effect, No Region Indicator	Average Marginal Effect. With Region Indicator
mature acres	-0.002 (0.01)	0.003 (0.01)
experience	-0.008 (0.001)***	-0.007 (0.001)***
school	0.005 (0.01)	-0.002 (0.01)
Christian	-0.014 (0.10)	0.21 (0.047)***
Akan	0.081 (0.14)	0.002 (0.11)
indigenous	-0.013 (0.13)	-0.027 (0.17)
CCP member	0.37 (0.053)***	0.305 (0.086)***
KKL member	0.123 (0.066)*	0.078 (0.11)
CAA member	0.114 (0.068)*	0.097 (0.09)
own farm	0.144 (0.038)***	0.158 (0.032)***
landlord	-0.06 (0.10)	-0.072 (0.12)
chief relative	-0.111 (0.09)	-0.124 (0.09)
leader in village	0.102 (0.052)**	0.149 (0.076)*
male	0.195 (0.096)**	0.396 (0.055)***
wealth index	0.007 (0.02)	0.023 (0.02)
input support	-0.033 (0.10)	0.008 (0.12)
west	0.018 (0.11)	i.region used

Note: all results reported with cluster-robust standard errors.

*** = 99% significance level, ** = 95% significance, * = 90% significance

In conclusion, the CCP program seems to have been very successful in increasing access to extension services, and KKL and CAA might have also helped to increase extension to farmers, though the evidence of success is weaker. However, extension seems to be available disproportionately to male farmers, to land owners, and to influential members of the village community. This suggests that more efforts are needed to increase equality of access to extension, and perhaps to specifically target services at female farmers, caretakers, and more marginalized members of cocoa farming communities. This is especially important for increasing cocoa production and farmer incomes, given the significant direct effect of extension on yields found in Section 3.2, and the indirect impact of extension on yields via an increase in fertilizer use, found in Table 3.3.2.

With regard to endogeneity concerns, this section has shown that there are several different channels through which extension services might be endogenous to yields, despite the argument made earlier in this paper that they are provided exogenously. Land-owners, males, and owner-operators of farms all have significantly higher likelihoods of receiving extension services, and these groups are also recognized as having higher yields. It is possible that their higher yields are the reason that they participate in more trainings, either because they are specifically targeting by extension programs who see them as the most promising producers with which to work or because those with higher yields have more money and thus more time to devote to attending trainings, which would create self-selection bias. However, these results also have showed that one of the highest correlations is between extension and CCP membership, thus bolstering the line of reasoning presented earlier in this thesis that most the CCP is the main form of extension currently and that it has been rolled out in 100 villages chosen for reasons other than yield, and thus extension should be exogenous to yields. In the end the endogeneity question is not clearly resolved, however, and more work should have been done to explore and correct this problem, but time was lacking.

3.4 Factors Affecting Several Measures of Farmer Well-being

The preferred measure of farmer welfare would have been net income, taking into account gross revenue from cocoa, costs of cocoa production and marketing, income from other sources (cultivation of other crops, credit, labor on others' land, non-agricultural entreprises, etc.), and other household costs. This would have permitted an investigation of the relative effect of factors affecting cocoa production versus costs of inputs, time spend by the household on other activities, and general cost of living in a given area. An analysis with all this information would be ideal, since it would enable a determination of the relative importance of changes to cocoa production practices and marketing structures on the holistic welfare of cocoa households. Another way of measuring farmer welfare would have been to look at per capita consumption, a variable for which data is somewhat more readily available (farmers will recall this more accurately than costs incurred) but also is a good proxy for net revenue. Both of these measures of welfare were investigated by Barrientos et al. (2007) and Hainmueller et al. (2011).

Unfortunately, I did not collect data on costs of cocoa production, household consumption, or details on outside income sources (I merely asked whether an outside income existed and what other crops were grown). The failure to collect this data was partly due to a lack of foresight and partly due to difficulty in collecting such data. In the first interviews conducted questions were posed on total fertilizer and pesticide use and cost, total estimated costs and profits, but the question took a very long time to answer and in many cases the farmers said they did not know or could not remember because they did not keep records. It would have been possible to ask about amount of use of various inputs and then use prevailing market prices to determine total costs, but this was not done. It may be a good avenue for future research.

Instead, I attempted to proxy for welfare with several other measures. First, I asked farmers to rate their personal perception of the current and future profitability of the cocoa industry in Ghana. Results are shown in Table 3.10. Second, I calculated gross income from cocoa and regress this variable on a number of potential determining factors. Results are shown in Table 3.11.

Net income also depends on the availability and cost of inputs, and the viability and fairness of the marketing structures for selling cocoa beans. A farmer's income will be reduced if his LBC attempts to cheat him by weighting the scales improperly or if it does not pay the farmer the legally mandated, end-of-season bonus. A farmer's income will be increased if he has ready access to cash advances or other forms or credit to purchase inputs, or direct provision of such inputs. Credit and input support might come from an LBC, the government, a cooperative, or another NGO. The regression in Table 3.12 look at the effect of a slightly different set of factors on likelihood of receiving input support, perception of buyer treatment, and likelihood of receiving the mandated bonus. As a whole, Tables 3.10-3.12 permit some limited conclusions on the effect of various factors on farmer welfare.

3.4.1 Welfare Model Data

Summary statistics of the new dependent and independent variables used in the regressions in this section are shown in Table 3.9 below.

Prior to data collection, it was suspected that quality issues and distance to the nearest cocoa buyer might be important factors in farmer well-being, but this turned out not to be the case. The vast majority of farmers (94.55%) do their own fermentation and drying of cocoa, spending a mean of 6.1 days on fermentation and 6.6 days on drying, which conforms to best practices recommended by CRIG and other cocoa research bodies. There was very little variation in both these variables, indicating that there is a widespread knowledge and acceptance among cocoa farmers about the "best" way to cure cocoa beans. Furthermore, every farmer interviewed reported that buyers had never rejected their beans as low quality.

Table 3.9: Summary Statistics for Variables Regressions on Farmer Welfare

	Obs	Mean	Std. Dev	Min	Max	Median
government bonus	168	0.86				
opinion of future	200	12.69	2.03	3	15	13
opinion of LBC	193	2.67	1.36	1	5	2
LBCs sold to	187	1.273	0.503	0	4	1
wealth index	187	3.123	1.24	0	8	3
labor cost (cedis/hr)	143	8.3	3.97	0	20	7
household size	200	7.66	3.43	1	23	7

The mean distance that farmers had to travel in order to sell their produce was only 0.3 km, while the mode and median were 0 km, and there was very little variation in this variable. Most farmers transported the beans to their homes for fermentation and drying in any case, and no additional transport was needed (beyond a few hundred meters) to get to the LBC shed in their village. Because of this, quality issues and distance to market were left out of all regressions on the Ghanaian data, though they are likely still significant to farmer welfare in other countries.

3.4.2 Model of Perceived Farmer Well-Being

It seems logical that farmers with high total production or high yields would have a more positive perspective on the viability of cocoa farming. However, in my sample, a simple regression of the index for farmer's opinion of the future on production results in a negative but insignificant coefficient, and the same is true for yields. Thus, it will be more illuminating to include the various factors that are known to impact yields, plus several other demographic and marketing variables, in the regression. A list of these factors based partly on Barrientos et al. (2007) include farmer age/experience, education level, household size (number of children), farm size, extension, fertilizer use, CODAPEC spraying, cooperative membership, the price of labor, availability of input supports and credit, and the wealth index.

Because there is a hypothesized relationship between buyer competition and cheating of farmers (which will likely affect their perceived well-being), as discussed below, I also include the number of LBCs in the village and whether the farmer sold only to the PBC as explanatory variables. Another important factor might be farm ownership: caretakers might have a different perception of the viability of cocoa farming than owner operators, because land owners shoulder more costs of operation.

Table 3.10: OLS Regressions on Farmers' Opinion of the Future

ln (experience)	0.008 (.013)
ln (years of school)	-0.003 (0.003)
ln (house hold size)	0.003 (0.019)
ln (mature acres)	0.041 (0.013)**
ln (total buyers)	-0.094 (0.064)
PBC buyer	-0.052 (0.006)***
extension	0.09 (0.047)
fertilizer	0.018 (0.021)
ln (labor cost)	-0.064 (0.024)**
cooperative member	-0.002 (0.042)
input support	0.054 (0.029)
wealth index	0.009 (0.015)
own farm	-0.048 (0.048)
gov spray over 1 time	0.123 (0.093)
constant	2.589 (0.066)***
# Obs.	121
R-squared	0.236
Root MSE	0.168

Note: all results reported with cluster-robust standard errors.

*** = 99% significance level, ** = 95% significance, * = 90% significance

Results of this model are shown in Table 3.10. The dependent variable itself is the sum of the farmer's responses to three statements each of which was scored from 1-5 (with 1= strongly disagree). A simple sum was used to save time, but it would have been more accurate (and thus would have permitted more firm conclusions) to run separate regressions on these three responses, or to construct a more sophisticated weighted index. The three statements were: “cocoa farming is a good way to earn a living in Ghana”; “I plan to continue farming cocoa in the future”; and “I believe that my children will also farm cocoa”. Thus, the index variable ranges in value from 3 to 15. All continuous variables, including this dependent variable, are log-transformed, and the standard errors reported are cluster-robust.

The results of the farmer opinion variable in Table 3.10 show that there is a significant negative correlation between the cost of labor and the farmer’s opinion of the future. This supports the hypothesis from Barrientos et al. (2007) that farmers’ perceived well-being will decrease when input costs increase. There is also a significant negative correlation between farmers’ opinions of the future and selling only to the PBC, This supports hypotheses from the literature on the liberalization of domestic buying in Ghana (Varangis and Schreiber 2001, ul Haque 2004, Vigneri and Santos 2008) which state that the PBC, as the former state monopsony buyer and which still operates as the sole buyer in several villages, is more likely to cheat farmers. Farm size also has a significant positive effect on perceived farmer well-being, likely because those with more land are wealthier. The extension coefficient is not significant to the 90% level, though it is close.

Although they are not significant, most of the other variables in the regression do have the expected signs. Education level has a negative sign, probably because a more educated farmer is more likely to want his children to get out of cocoa farming in the future. Experience, input support, extension, fertilizer use, the wealth index, and frequent

CODAPEC spraying also have positive signs, as expected. It is unexpected that the number of total buyers has a negative sign, since the literature on liberalization suggests that greater competition by LBCs should result in increased farmer welfare.

Overall, these results suggest that initial wealth levels have a large role in improving farmers' opinions on the viability of cocoa farming in the future, while higher input costs have the opposite effects. These results support the prescriptions of Barrientos et al. (2007) that increasing the availability of credit and input supports, and perhaps extension services, can help to improve farmer well-being and prevent a decline in the number of cocoa farmers in the future.

3.4.3 Model of Gross Income from Cocoa

In the absence of analysis on the more informative net total income, looking at the determinants of gross cocoa income might still be somewhat informative. The gross income variable was calculated by using total production (in bags) multiplied by the fixed 200 cedi price per bag, plus the total production multiplied by the 2 cedi per bag bonus mandated by the government for those farmers who reported that they received the bonus. The independent variables chosen for analysis are generally those which would be expected to influence non-price competition by buyers (see section 3.4.4 below for the list and explanation of these variables), mature acres since that is a major determinant of production, and in the second model specification, yield itself, so that its effect on gross revenue can be isolated from the others.

Table 3.11: Regressions on Gross Cocoa Income

	Model 1	Model 2
ln (yield in kg)		1.00 (0.003)***
ln(total buyers in village)	0.472 (0.32)	0.005 (0.002)**
ln(LBCs sold to)	0.533 (0.146)**	-0.00 (0.00)
PBC buyer	0.222 (0.131)	-0.001 (0.001)
cooperative member	0.103 (0.142)	-0.0007 (0.0003)*
male	0.267 (0.248)	0.002 (0.0008)**
own farm	0.251 (0.127)	0.00 (0.00)
land lord	-0.249 (0.079)**	-0.001 (0.001)
wealth index	0.077 (0.073)	0.00 (0.00)
ln(mature acres)	0.712 (0.073)***	1.00 (0.0004)***
chief relative	-0.054 (0.145)	-0.001 (0.0003)*
leader in village	0.183 (0.145)	0.001 (0.001)
ln(school)	-0.28 (0.019)	-0.00 (0.00)
ln(experience)	0.184 (0.094)	0.001 (0.0004)*
christian	0.137 (0.285)	0.003 (0.002)
akan	-0.302 (0.129)*	0.00 (0.00)
indigenous	0.06 (0.158)	0.00 (0.00)
constant	4.722 (0.449)***	1.153 (0.004)***
# Obs.	151	151
R-squared	0.639	1.00
Root MSE	0.666	0.003

Note: all results reported with cluster-robust standard errors.

*** = 99% significance level, ** = 95% significance, * = 90% significance

Results of the gross income regressions, shown in Table 3.11, show when yields are not included in the model mature acres has the largest effect on gross incomes. The number of LBCs to which the farmer sold her cocoa is also positively correlated with gross income, while being a landlord and being Akan are negatively correlated.

The more interesting results are shown in model 2, where yields are included as an independent variable. In this case mature acres and yields have an equal effect on yields, though the coefficient for mature acres is more highly significant. This is as to be expected, since total production is a function of mature acres times yields, and gross income has almost a one-to-one relationship with production. The only variation from this one-to-one correlation is captured by the additional revenue earned if the mandated government bonus is paid at the end of the season.

Thus, the remaining significant variables in the regression are likely those which affect the likelihood of receiving this government bonus from one's buyer, though it could also take into account some of the effects that the variable might have on yields. The additional significant, positive coefficients estimated for model 2 include those for total village buyers, being male, and experience, while being a cooperative member and being a relative of the village chief seem to have a negative effect on gross cocoa income. These results will be explored and analyzed in more detail in section 3.4.4, where the effect of the variables on the likelihood of receiving the government bonus is calculated directly.

3.4.4 Model of Farmer Treatment by Buyers

Several studies in the past have looked at factors affecting the fairness of marketing structures for farmers. Calkins and Ngo (2005) found that cooperative members received fairer weight and quality evaluations on beans, as well as superior marketing and transport services. A number of other studies concluded that a higher number of LBCs in a given region increased farmer welfare by decreasing cheating and stimulating LBCs to offer scholarships, inputs on credit, and other services in order to attract and retain farmer business (Varangis and Schreiber 2001, ul Haque 2004, Teal et al. 2006, Vigneri and Santos 2008).

Based on these studies and an understanding of the situation in Ghana, it seems important to include a combination of variables relating to market competition, farmer political influence, production volume, and wealth. The new variable introduced, in addition to several from previous regressions, is the total number of LBCs to which a farmer sold his produce in the preceding five years. The full list of explanatory variables chosen can be seen in Table 3.12. Three different dependent variables which represent farmer welfare are examined using this model: farmer opinion of treatment by his LBC, likelihood of receiving the government bonus, and availability of credit or other support to acquire inputs.

Results of these three regressions are shown in Table 3.12. The first and third columns show logit regressions with results displayed as average marginal effects, while the center column is an OLS regression with all continuous variables, including the dependent variable, in log form. In order to take the log of the wealth index, which takes values from 0 to 4, the zeros were first replaced with 0.001.

Table 3.12: Regressions on Farmer Treatment by Buyers			
	Avg. Marginal Effect on likelihood of Receiving Bonus	OLS on Farmer opinion of treatment by LBC	Avg. Marginal Effect on likelihood of receiving input support
total buyers in village	0.156 (0.081)*	0.259 (0.20)	0.155 (0.077)**
LBCs sold to	0.01 (0.036)	-0.472 (0.097)***	-0.09 (0.068)
PBC buyer	-0.012 (0.014)***	-0.115 (0.11)	-0.006 (0.173)
cooperative member	-0.086 (0.009)***	0.39 (0.10)	0.375 (0.127)***
male	0.088 (0.079)	0.017 (0.12)	0.141 (0.064)**
own farm	0.041 (0.064)	0.224 (0.16)	0.031 (0.053)
land lord	-0.052 (0.125)	0.07 (0.06)	0.148 (0.107)
wealth index	0.023 (0.042)	-0.026 (0.013)*	0.048 (0.019)***
mature acres	0.006 (0.004)	0.127 (0.02)***	-0.006 (0.008)
chief relative	-0.132 (0.026)***	0.037 (0.08)	-0.014 (0.040)
leader in village	0.06 (0.014)***	0.272 (0.107)*	0.005 (0.061)
school	0.003 (0.008)	0.009 (0.01)	-0.008 (0.005)
experience	0.006 (0.007)	-0.19 (0.16)	-0.003 (0.003)
christian	0.164 (0.141)	-0.19 (0.16)	-0.122 (0.04)***
akan	-0.05 (0.071)	0.22 (0.12)	-0.015 (0.103)
indigenous	0.008 (0.069)	0.053 (0.04)	-0.147 (0.052)***
constant		-0.129 (0.30)	
# Obs.		181	
R-squared		0.32	
Root MSE		0.512	
Note: all results reported with cluster-robust standard errors. *** = 99% significance level, ** = 95% significance, * = 90% significance			

Results of the first regression show that a one unit increase in the number of total buyers in a village significantly increases the likelihood of receiving the bonus, by 15.6%. This offers strong additional support for the past studies that found that competition between LBCs reduces cheating of farmers. Results also show being a leader in the village increase the likelihood receiving the bonus by 6%, which supports the hypothesis that social influence will reduce the likelihood of being cheated.

On the other hand, selling to the PBC only, being a cooperative member, and being a relative of the village chief significantly decrease the likelihood of receiving the bonus. The negative effect of selling only to the PBC supports the hypothesis that lack of competition reduces welfare. But the negative effects of cooperative membership and being related to the village chief contradict normal expectations. It is possible that multicollinearity, measurement error, or omitted variables might be biasing the results.

The results of the OLS regression on farmers' opinions of LBC treatment show that farm size and being a leader in the village both lead to a more positive view of LBCs, while the number of LBCs to which an individual has sold beans in the past year and the wealth index are negatively correlated with opinion of LBC treatment. All other variables do not have a significant impact on opinion of LBC treatment. The negative correlation with the number of LBCs to which a farmer sold her production seems to undermine the hypothesis of a positive effect of competition on LBC treatment of producers. One possible explanation is that causality is reversed: because the farmer perceived that one buyer was cheating her, she decided to sell beans to switch buyers, but her perception remained negative overall because of the first incidence of cheating.

The results on farm size and village leadership further support the hypothesis that social power reduces the likelihood of being cheated. The negative coefficient on the wealth index undermines this somewhat, because wealthier farmers should have more social influence. This might be explained by the fact that farmers with other commercial crops and outside income (both components of the wealth index) might be less involved in the cocoa industry than those for whom cocoa constitutes 100% of their income, and thus their social influence within the local cocoa industry might be lower. Also, wealthier farmers may be more aware of being cheated. Whatever the case, the coefficient on the wealth index is very small and only significant to the 90% level, so its effects are not all that important.

Finally, the results of the logit regression on the likelihood that credit and input supports are available to the farmer show that being a cooperative member increases likelihood of access by 37%, that being male increases it by 14%, that a one unit increase in the wealth index increases it by 5%, and that the presence of one additional buyer in the village increases it by 15.5%.

These results show that cooperatives in Ghana do help farmers to secure access to inputs and credit. It further supports past findings that market liberalization can improve provision of services to farmers, as LBCs compete for farmer business but are not able to offer higher prices. It also shows that credit is disproportionately given to male farmers and to those with a higher level of existing wealth, which makes it likely that female farmers and those without initial wealth (which likely means little or no credit history and collateral) are credit constrained. Thus, the allocation of credit is inefficient. Policies to improve equal access to credit could potentially make a big impact on cocoa production, by giving credit-constrained farmers the opportunity to increase their inputs and investments.

The results also show that Christians are 12% less likely and indigenous farmers are 15% less likely to receive input support. These results contradict the expectation that migrants and non-Christians would tend to be more marginalized and thus less likely to receive credit or input support. It is possible that these results indicate that an effort has been made by the government, LBCs, or NGOs operating in Ghana to target migrants and minority ethnic groups with credit and input support. However, it is more likely that this result is influenced by fact that there are very few non-Christians in the data set.

Overall, these models suggest a few interesting conclusions. There is strong evidence that competition between more LBCs in a village decreases the likelihood of a farmer being cheated. Results show that female farmers have a higher chance of being cheated and of lacking access to input support and credit. There is fairly strong evidence that when a farmer sells solely to the PBC that they have a higher chance of being cheated, and that village leaders are treated better by LBCs. The mixed results on cooperative membership suggest that while cooperatives in Ghana have a positive role to play, for example by providing farmers with credit opportunities, they have not yet done enough to improve farmer marketing power.

3.5 Conclusion

Results for the four variables of interest reveal that all four have a significant impact on yields under certain circumstances, that the estimated economic benefits of each factor far outweigh direct costs to farmers, and that fertilizer use even outweighs total social cost (including the subsidy paid by the government). There is currently not adequate data to determine total social cost for the other variables, though this would be a useful topic for further research.

Of the four variables of interest, fertilizer has the highest and least ambiguous impact on yields, though it is more dramatic on small farms. This may be because producers can afford to apply fertilizer at a higher rate on a smaller land area, but since data on quantity of fertilizer was not collected, it is impossible to test this directly. The regressions on factors affecting fertilizer use suggest that in order to increase fertilizer application, the government or other interested parties should promote extension programs and the availability of cash advances, credit, or input subsidies to farmers.

The fact that extension services only have a significant positive effect for larger farmers might mean that the wealthier farmers have more resources to implement the practices suggested by extension, and perhaps the curriculum needs to be adjusted to be more suited to the needs and capabilities of small farmers. The regressions on the likelihood of receiving extension suggest that cooperatives are making extension services widely available to all members, but that female farmers, caretakers, and less influential farmers are less likely to receive extension. Thus, extension programs ought to try harder to target these groups.

More frequent spraying by the CODAPEC has a significant, positive effect on yields for small farms only. However, it was also found that the program disproportionately favors more influential farmers and those with more land. The frequency of spraying needs to be increased for smaller, less powerful farmers, particularly since the program has the highest marginal effect on small farm yields.

The effect of cooperative membership on yields was not significant, though when separated out from the other cooperatives, CCP membership did have a significant, positive effect. The primary mechanism through which CCP membership affects yields is by increasing availability of extension services. However, the effect of CCP membership is larger than that estimated for extension alone, suggesting that the cooperative helps to increase farmer yields through means other than just extension.

The KKL membership variable was not significant, likely because that cooperative's primary benefit to members is the supply of social infrastructure projects, which would not be expected to have a direct impact on yields. The CAA, on the other hand, prioritizes supplying inputs on credit and training, and so it is more surprising that no significant effect was found on yields for CAA membership. However, the results for both KKL and CAA are questionable because there were very few members of these two cooperatives included in the sample.

Results also showed that use of spray machines has a large positive effect on yields. However, farmers with higher yields may be more able to afford to buy or rent spray machines, so the estimated coefficient may be biased due to endogeneity. Because spray- machine use was not a key variable of interest, efforts were not made to address this problem, but this would be another useful topic for future research.

The significant inverse relationship found between farm size and yields is consistent with past research, but it is difficult to make firm conclusions about the mechanisms underlying the relationship, and thus policy recommendations. Do small farms face fewer moral hazard problems, since they hire in fewer wage laborers? Are farmers with less land more able to apply inputs intensively? Or are their other dynamics at work? Future studies could test these questions, but data would first need to be collected on quantity of fertilizer and other inputs, hours of labor, and type of labor used. Depending on the results of future research, the inverse farm size-yield relationship may suggest that efforts should be made to keep farm size small, or that large farms could be more successful if they were able to design and finance contracts which reduced moral hazard for contract labor.

Regressions on the other measures of farmer welfare suggest cooperative membership, buyer competition, and having more influence and wealth (being male, being a land owner, and having higher acreage) significantly increase positive perceptions of the future, fair treatment by buyers, and access to financing. However, the number of buyers in a village did not significantly increase the likelihood of receiving input support. This fails to support the hypothesis that buyers compete by offering input support to loyal customers, though perhaps distributing bonuses reliably can be considered a form of non-price competition. Also, perhaps there are unobserved types of non-price competition which are picked up only by the increase in perceived farmer welfare. Overall, the well-being regressions suggest that the government ought to promote cooperatives, increased local buyer competition, and credit facilities which target marginalized farmers (females, sharecroppers), in particular since they are currently underserved.

This is the first analysis to look at the effect of fertilizer use, pesticide spraying programs, extension services and cooperatives at the same time, for Ghanaian cocoa, or actually for any agricultural system. An additional contribution of this paper is to look at the effects of these variables divided by farm size. This is also the first paper to look at the effects of several different demographic and marketing factors on farmer well-being using receipt of the government bonus as a proxy for cheating, as well as farmer perception of treatment by buyers and receipt of input support. Overall, the regressions in the chapter suggest that the most important factors which increase cocoa yields and farmer welfare are input supports and credit, use of fertilizer, keeping farm size small, receipt of extension services, and increased use of spray machines.

This chapter has focused on factors that might and increase farmer welfare through increased productivity. However, yield is not the only factor affecting farmer income. The costs of inputs, price of cocoa, and infrastructure and services provided to producers are also crucial, so yield should not be the only focus of policy. Increasing vertical integration into higher-value segments in the cocoa industry and strengthening producer cooperatives may be just as crucial to increasing farmer well-being. These two issues will be explored in chapters 4 and 5.

Chapter 4: Evaluation of Cocoa Processing in Ghana

4.1 Introduction

Even with the formation of cooperatives and marketing associations like the Cocoa Board which capture scale economies and increase the bargaining power of producers, the portion of revenues from the cocoa chain which can be captured by these producers will always be limited if they only sell raw cocoa beans. In order to derive the highest profits from the cocoa industry, it may be crucial to integrate downstream into cocoa processing and perhaps ultimately into chocolate manufacture and retail.

The goal of this chapter is to review the advantages and disadvantages of developing agricultural processing operations in developing countries in general, and cocoa processing in Ghana in particular. Under what circumstances is it optimal to pursue domestic processing, and what policies are needed to promote it?

Section 4.2 is a review of the literature on agricultural processing in developing countries. It covers the current state of these industries, theories on when and why processing is desirable, and studies of various successes and failures in processing industry development. It also reviews literature on cocoa processing in origin countries, particularly in Ghana. A list of hypothesized success and failure factors for cocoa processing operations is developed from this literature.

Section 4.3 is a case study of the existing cocoa processing operations in Ghana, based upon interview data collected in September 2011. I analyze the state of the industry and identify the costs and benefits facing existing manufacturing operations, comparing these to the list of expected success factors generated in Section 4.2.

Section 4.4 develops a formal model of welfare earned by the cocoa industry in Ghana, with the percentage of beans to be exported as the key choice variable. An expression is derived for the optimal level of exports in terms of other exogenous variables. Simulations suggest that under current conditions, with many processing plants owned by foreign MNCs, it is actually optimal for the Cocoa Board to export all of cocoa in raw form, which suggests that it should end efforts to promote domestic processing. However, this result changes dramatically when the percentage of processor profits that are earned by Ghanaians increases. Higher domestic processing when factories are owned by Ghanaians does lead to substantial increases in welfare over the current scenario.

Section 4.5 is a discussion of the different policy options which might be used to increase the proportion of processing operations owned by Ghanaian interests, as well as to increase the other exogenous factors which make domestic processing more favorable. Finally, assuming that conditions change so as to favor an increase in the portion of beans processed domestically, policy options for how to achieve that increase are discussed.

4.2 Literature Review

Africa as a whole has seen exports to developed countries, even those of traditional agricultural products, collapse since the 1960s and 1970s. Cocoa, coffee and tea are the primary sources of export income in the region, and among the few vibrant sectors of the economy. It may be possible to build on the success of these industries, to increase export income substantially, if a higher amount of intermediate and final processing were done in Africa prior to export.

During the 1960s-70s a number of Sub-Saharan African governments sought to develop local manufacturing through Import Substitution Industrialization (ISI), but inefficiency, corruption and budget deficits led to the abandonment of many such enterprises, under Structural Adjustment programs which began in the 1980s (van de Walle, et al. 2003). Despite some growth in a few countries, the manufacturing industry in Sub-Saharan Africa still lags far behind the rest of the world. While that region contains around 12% of the world population, its share of world manufacturing exports is less than 1% (King 2010). Today there are only three countries in the region– Mauritius, Madagascar and Cape Verde – for which manufactured goods constitute more than 30% of total exports (King 2010).

More recently, developing agricultural processing industries in Africa has been suggested as a growth strategy by several researchers, because this would build on the abundance of certain raw agricultural products in the region and would not be as expensive to develop as manufacturing (Cramer 1999, Gibbon 2001). Africa may have a relative advantage in this sector, because agricultural processing tends to be more labor than capital intensive (Cornelisse et al. 2008). Local processing adds value to the local economy through extra wages, high value-added export revenues, and tax revenue. It can stimulate development of production techniques, sanitary standards, and worker training which can carry over into other industries (LeBlond 1993). So why is more processing not done in African countries?

4.2.1 Obstacles to the development of processing in Africa

A number of different theoretical, empirical and case-study analyses discuss the reasons why African countries tend to fail in the development of manufacturing industries, even for agro-processing. These reasons include the low skill-to-land ratio in most African countries, higher operating costs, poor infrastructure and incentives, trade policies in the developed world that discourage value-added products, and the technical inefficiency of African firms. Other research suggests that such weaknesses are not inherent in African countries and can be overcome if intermediate processing industries are developed which build on a strong performance in the primary commodity sector, particularly when the raw goods are perishable and the commodity chain is short, when some costs (labor and transport) are lower for origin-processing operations, when lower quality products which could not be exported in raw form are used as inputs, and when there is support from well-targeted state intervention.

Owens and Wood (1997) and Mayer (1997), using a revised version of the Hecksher-Ohlin factor endowment model, showed that the share of processed primary products in exports tends to be increased by greater skill per worker and land per capita. Based on these results, they concluded that Africa has a low level of both and thus should continue to export primary products. Other studies have criticized these papers on the grounds that the skill-to-land ratio does not explain a significant portion of the variation in processing industry outcomes (Cramer 1999, Teal 1999). Teal (1999) actually calculated the Ghana's predicted percent of manufacturing based on factor endowments was 30%, while its actual value was only 3%, indicating that factor endowments are far from the only determinant of the success of processing.

Many African processing industries face higher costs than their competitors located outside of Africa. This can include corruption and higher transactions costs which make it more difficult to set up a business. Three sets of case studies of successful and failed processing industries in developing nations all confirmed that those firms which failed had high costs relative to their competitors and to their own revenues (Abbott 1988, Mittendorf 1993, Talbot 2002). This is particularly a concern in the cocoa industry. Cocoa processors in Africa must deal with expensive imported machinery, difficulty in acquiring spare parts for maintenance, problems preserving beans due to the tropical climate, certifications to meet stringent EU and U.S. phytosanitary standards, and high costs of electricity (Abbiw 1993). Chocolate factories in Africa have particularly high costs relative to European and American competitors, including difficulties with refrigeration, high costs of acquiring milk and sugar inputs, and lack of ability to mix beans of different origins to enhance variety and decrease costs (Leblond 1993).

Another weakness inherent in African processing industries is that crucial public services, including infrastructure, are often lacking in African countries, particularly since the liberalizations of the 1990s (Sautier et al. 2006, ul Haque 2004).

Another key obstacle for African processing development is import policy in developed countries, which includes higher duties on final and intermediate products (Cornelisse et al. 1981). For example, though many of these policies have been changed in recent years, historically the EU charged just a 0.5% tariff on raw cocoa, but a 9.7% tariff on intermediate products and a 30.6% tariff on final cocoa products, and similar scaled tariffs exist in the U.S. and Japan (ul Haque 2004). Golub and Finger (1979) and Sharma et al. (1996) both ran simulation models which showed that agricultural processing in developing countries would increase substantially if distortionary trade policies in the developed world were removed.

Another view is that the most important reason for the failure of African manufacturing is the technical inefficiency of African firms, caused by patronage, few incentives for innovation, and a lack of exposure to foreign competition. In a comparison of manufacturing firms and economic conditions in Ghana and Mauritius, Teal (1999) found that firms in Mauritius were four times as efficient as Ghanaian firms, while wages were only three times higher in Mauritius, indicating that wages in Ghana were too high to enable firms to operate efficiently relative to competitors.

4.2.2 Success factors for developing-country processing

However, other research suggests that the weaknesses which have historically kept processed exports low can be overcome. There have been a number of successful domestic agricultural processing firms in Africa, and in other developing regions, which face many of the same challenges.

One key to success is to build on an already-thriving raw commodity industry. This was a key conclusion of a case study of cashew processing in Mozambique (Cramer 1999). Furthermore, processing is more successful in developing countries if there is a sizable domestic market for the final product in the value chain, so that the country can first produce at home, then move into exports (Abbot 1988, Talbot 2002).

The development of origin-processing operations has been found to be especially successful for raw products which have low storability and transportability and for which the value chain from raw to finished product is shorter, because there is a cost advantage to processing such products close to the source (Harrigan 1986, Talbot 2002). Coffee, for example, can be stored green for several years, but if roasted will quickly go stale, so it is often transported in green form. Traditionally, producer countries only engage in preliminary processing, which includes de-hulling and drying the coffee cherries.

Processing operations in African and other developing countries may also be at an advantage in terms of some costs. First, labor costs are lower in developing countries. Second, locating in the origin country might make it easier for the processor to acquire high quality raw inputs more reliably, with reduced transactions costs. This is a major motivation for the cocoa processing companies which have already located factories in Ghana, to have more reliable access to high quality Ghanaian beans at a partial discount (Fold 2002). If trans-ocean transportation costs of the raw products are higher than transport costs of the processed products, then this also confers a major advantage on processing companies at origin.

If a processing company can develop the technology to produce export-quality products using low-quality raw inputs, which can be obtained at a significant discount and only at origin, then this can also confer a major advantage. Several studies have shown, for example, that the most successful cocoa processing factories in origin countries, in Malaysia and Côte d'Ivoire, started by processing sub-grade beans which were rejected for export (Fold 2002, Gibbon and Ponte 2005, UNCTAD 2008).

Several studies have shown that appropriate, aggressive government support is one of the most crucial determinants of the success of a processing industry, though state support must build on the capacity of a local capitalist class to undertake investment (Bellur et al. 1990, Talbot 2002, Sautier et al. 2006). This was the case for the highly successful development of local processing of coffee in Ecuador and India, cocoa in Brazil and Malaysia, and tea in India (Talbot 2002). One way in which governments can foster private entrepreneurship to support the development of domestic processing industries is through the use of Export Processing Zones (EPZ). When developing an EPZ, a government can focus on improving the transport and power infrastructure, reducing bureaucratic red tape, and providing better services in a limited geographic area rather than countrywide (Watson 2001).

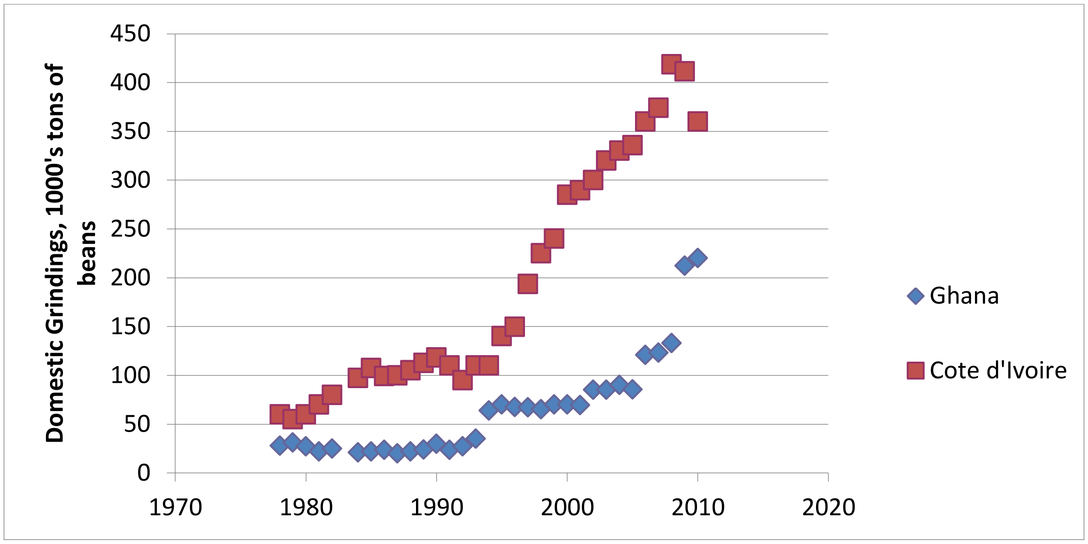
4.2.3 Origin cocoa processing

Because of advantages in terms of costs and access to reliable supplies, and because of government policies to promote processing, the share of processing by cocoa-producing countries has increased over the past few years, to roughly 37% in 2006.

Both Malaysia and Brazil have been successful in developing domestic cocoa processing, having benefitted from regional markets for finished cocoa products and sizable local capitalist classes that took advantage of government incentives to invest in cocoa processing. By 2002, 50% of cocoa produced in Brazil was processed there and two of its four plants were fully Brazilian-owned (Talbot 2002, ul Haque 2004). In Malaysia the state actively supported the cocoa industry in the 1970s, and by the mid-1990s Malaysia had become the world's second largest exporter of cocoa butter and was exporting 75% of its cocoa in processed form (Talbot 2002).

In contrast, Côte d’Ivoire and Ghana have historically been less successful in efforts to develop domestic cocoa processing. The amount of raw beans processed domestically in both of these countries from 1978-2010 is shown in Figure 4.0 (ICCO 1980-2011). Both countries have seen an increase in processing since the late 1990s, though the amount of processing in Côte d’Ivoire is much higher, and has grown faster, than that in Ghana. By 2012 Côte d’Ivoire had actually become the top cocoa processing country in the world, ahead of the Netherlands for the first time ever, though all of the processing operations in Côte d'Ivoire are owned by foreign MNCs.

Figure 4.0: Amount of Domestic Processing Over Time in Ghana and Côte d'Ivoire



Source: International Cocoa Organization. 1975-2009. ICCO Quarterly Bulletin of Cocoa Statistics, 1-35.

According to Talbot (2002), though Ghana's government aggressively supported cocoa processing, setting up the state-run Cocoa Processing Company (CPC) in 1964, the country lacked the requisite managerial capacity and infrastructure to sustain the industry. There were three local cocoa processing plants in Ghana by 1980, but mismanagement and a decline in cocoa production made these plants unprofitable.

The industry has seen a resurgence in the past decade, however, as the Cocoa Board has implemented a number of policies to attract private processors to the country, including tax incentives, a discount on smaller grades of beans, and supportive research. For example, CRIG is currently investigating profitable uses of three different cocoa by-products: cocoa husks to make animal feedstuff; cocoa sweating to make soft drinks, pectin, jam, wine, industrial alcohol, and alcoholic beverages; and substandard cocoa beans to produce toilet soaps, cosmetics, and pharmaceutical products (ICCO 2011). By the 2010-2011 season, 22.4% of Ghana's total production was processed in the county, amounting to 230,000 tons of raw beans (ICCO 2012). Increasing interest by the Ghanaian government and multinational corporations in setting up cocoa processing facilities in West Africa indicate that the profitability of such operations is increasing.

Côte d'Ivoire's government did far less to promote in-country cocoa processing in the 1960s-80s. However, because of the sheer volume of cocoa produced there, some MNCs were still attracted and set up operations, particularly for the processing of sub-export-grade beans (Talbot 2002). In the 1990s one Ivoirian-owned processing company, SIFCA, was very successful, and it even managed to buy out a chocolate factory in Spain and to set up another plant in France. However, by 2003 all the Ivoirian processors had been bought out by MNCs, including SIFCA, which was purchased by ADM in 2000. In 2010-2011. Côte d'Ivoire a slightly higher proportion of local grindings (23.9%) when compared to Ghana, but this represented a much higher absolute number, at 361,000 tons (ICCO 2012).

This review suggests that the most important factors for processing industry success in Africa are having a strong primary commodity industry upon which to build, product characteristics like low storability, transport cost advantages for processed over raw products, and aggressive but well-targeted government support which fosters local entrepreneurial capacity. Several of the case studies mentioned showed that cocoa processing has succeeded in the producer countries which were able to harness these advantages. Though cocoa processing has historically been only marginally successful in Ghana and other West African countries, there is reason to believe that due to changing conditions and government policies they might be more successful in the future.

4.3 Case Study of Cocoa Processing in Ghana

The following section outlines facts on existing cocoa processing operations in Ghana, the advantages and disadvantages which they face, and current government policies which support them.

4.3.1 Survey of Cocoa Processing Operations in Ghana:

Currently there are seven major cocoa processing companies operating in Ghana: Cargill Ghana, Ltd., WAMCO, Plot Enterprise, Ltd, the Cocoa Processing Company (CPC), and Commodity Processing Industries (CPI), Ltd, ADM Ghana, Ltd. and Barry Callebaut Ghana Ltd. The following information was compiled from in-person interviews conducted in September 2011 with managers of the first five companies (Amoo-Gottfreid 2011, Ansong 2011, Sampong 2011, Diesterweg 2011, Nijssen 2011), and a combination of secondary sources for the latter two companies (Modern Ghana 2001, Barry Callebaut 2007, Oxfam 2008, ADM 2009, Byrne 2011, ADM 2012). To improve the readability of the following summary, the sources of all facts will not be directly cited, but can be assumed to originate from one of these sources.

According to interview data, the total annual processing capacity of these seven domestic companies was 343,000 metric tons in 2011. However, several of the companies were not operating at full capacity, notably the CPC, which was operating at only about one-third of capacity. Taking this into account, the total actual processing volume in

Ghana in 2011 was 293,250 metric tons of raw beans per year. This represents a significant increase since 2008, when the total amount of domestically processed beans was 116,595 tons (Oxfam 2008). This is partly because in the intervening period both Plot Enterprise and ADM have set up operations, and also because existing processors increased their utilized capacity. The most dramatic of these was WAMCO, which increased processing from 33,276 tons in 2008 to 75,000 tons of raw beans in 2011.

The largest processor in terms of utilized capacity is WAMCO, accounting for over 25% of total processed tonnage. Cargill Ghana (22%) and Barry Callebaut Ghana (20%) are not far behind. All three of these companies are majority foreign-owned, though WAMCO is still 40% owned by the Ghana Cocoa Board and only 60% owned by Hamester, a German company. Barry Callebaut Ghana, Cargill Ghana, and ADM Ghana (with 9.2% of country grindings) are subsidiaries of the three major MNC trader-grinders.

The remaining companies are majority Ghanaian-owned. Plot Enterprise is a private company founded and solely owned by a Ghanaian woman, Patricia Poku-Diaby. CPI Ltd. is a small organic cocoa processor that is a private joint venture between a group of Ghanaians and several foreign interests. The CPC is publicly traded on the Ghanaian stock market, but its majority shareholders are all affiliates of the government of Ghana; the Cocoa Board is the largest shareholder, with a 77% share.

These processors specialize in the manufacture of several different cocoa products. The largest output volume is in cocoa liquor, partly because the machinery required to make liquor is simpler and less expensive than that for cocoa butter and powder, as previously explained. Ghana produced 207,125 tons of cocoa liquor in 2011, a 286% increase in production from 2008. The annual average total production of cocoa butter is 27,606 tons (up 129% since 2008), that of cocoa powder is 25,519 tons (up over 13000%, from a base of only 185 tons in 2008), and that of cocoa cake is 35,933 tons (up 81% since 2008).

Barry Callebaut is the dominant liquor producer, followed by ADM; both specialize only in liquor and do not make butter and power. CPI Ltd. also produces only liquor, albeit in much smaller quantities, for the organic market. By contrast, Cargill Ghana produces only cocoa butter and powder, and sells no liquor. Plot Enterprise and WAMCO both sell cocoa butter and cake, which is essentially a less processed and more easily transportable version of cocoa powder, and also sell some of their unpressed liquor. The CPC is unique in that it produces the full range of cocoa products: liquor, butter, cake, powder, nibs, and also couverture and finished chocolate confections. The CPC produced 720 tons of couverture and finished chocolate in 2010, 63% below the company's target level of production of 1,971 tons.

Many of the processors, including the CPC, Cargill, Barry Callebaut and CPI Ltd., are located in Tema, an industrial port city 30 km from Accra. The location was chosen because of the proximity to the port, supplies from other domestic industries, and the largest pool of educated labor in the country.

Plot Enterprise Ltd. and WAMCO are both located in Takoradi, which is another port town, 215 km west of Accra. Tema's port suffers from a high degree of congestion, and this is less of a problem in Takoradi (Nijssen 2011). However, there are disadvantages to locating in Takoradi. Certain specialized equipment is still only shipped through Accra, and Takoradi does not have access to natural gas pipes and so companies there must roast beans using electricity, which is more expensive (Diesterweg 2011).

Only ADM has a plant located in Kumasi, which is far inland. Clearly transport costs to the ports are higher for ADM, but they are the only processor located near the Cocoa Board's depot in Kumasi, in the Ashanti region, which may provide them more reliable access to limited light-crop sized beans.

All seven of the domestic processors are Free Trade Zone companies, even those which are not physically located in the Free Zone enclave, which means that they are completely exempt from duties on imports of intermediate goods, never have to pay taxes on dividends, and are protected from expropriation (Akomeah 2011). Companies also are not required to pay taxes on profits for the first ten years of operation, and this still applies to all the processing companies except for WAMCO, which now pays an 8% tax on profits (Diesterweg 2011). Although the CPC is an older company, it only acquired free zone status in 2004, so the tax holiday still applies. The tax holiday is set to expire for Barry Callebaut in 2013.

The total number of employees in the cocoa industry in Ghana today is 1,268, and over 98% of those employees are Ghanaian nationals. The workforces at the various processing plants vary in size from 95 to 368 employees. Dividing total domestic grindings by the total number of employees suggests that, on average, one employee is needed for every 274 tons of raw bean capacity utilized. Almost all processed products are exported; even the CPC only retains 5% of its processed cocoa for use in its confectionery factory. The largest share of these exports goes to Europe, though in recent years exports to Asia and the US have been expanding.

A few calculations on recent data demonstrate that there is a transport cost advantage for cocoa liquor. In 2011 the cost of ocean shipping for one ton of processed cocoa liquor from Ghana to Europe was $44, approximately $35.20 per raw ton equivalent (Akomeah 2011). By contrast, a 2008 report gave the cost of shipping raw beans as $43 per ton (Teravaninthorn and Raballand 2008). Thus, it can be concluded that transport costs of processed products are at least $7.80 less expensive than raw beans per ton. Of course, this differential is likely much higher because the price of raw bean transport in 2011 is likely higher than that from 2008 due to inflation, and because this does not account for on-the-ground transport and port handling cost differences.

The different companies pay for transport costs in dramatically different ways. All the Ghanaian-owned firms use Free on Board (FOB) pricing, meaning that they are only responsible for transport costs to the port in Ghana, at which point the product is loaded onto a nominated vessel paid for by the customer. The wholly or partly foreign-owned firms on which I had data, Cargill and WAMCO, both shoulder a much larger portion of transport costs. The manager of Cargill reported that they pay for every stage of transport, until it reaches the customer at its final destination (Amoo-Gottfreid 2011). Almost 100% of WAMCO's sales use Cost, Insurance and Freight (CIF) pricing, which means that WAMCO pays all transport costs until the product is delivered to the port abroad, after which the customer takes ownership and pays for ground transport (Diesterweg 2011).

This difference in transport cost mechanisms is due to the fact that the larger, MNC processing firms can arrange ocean transport at lower marginal cost because of economies of scale. They may have their own fleet of ships, like Cargill, but even where this is not the case they can contract with large shipping companies at lower prices than smaller firms. Having offices throughout the world and shipping in large quantities makes it easier to negotiate low-cost transport contracts. All this gives the MNCs an advantage in terms of transport, which can also give them an advantage in terms of marketing.

ADM, Cargill and Barry Callebaut tend to sell directly to the major chocolate companies, whereas the smaller, Ghanaian-owned companies tend to sell their products to one of the major trading houses, including ADM, Cargill, Barry Callebaut and Touton S.A., rather than directly to chocolate manufacturers. All companies sell products on a short-term (1-3 month) contract basis, and contracts tend to stipulate the type and quantity of cocoa product, required quality standards (ideal pH, moisture level, maximum allowable microbes, etc.), and price, as determined by the world market at the time.

Table 4.0: Costs and Benefits of Locating Processing Operations in Ghana

Benefits to Locating in Ghana	**# of Interviewees who listed**	**Costs of Locating in Ghana**	**# of Interviewees who listed**
Access to high quality cocoa	6	Not enough discounted beans, main-crop beans more expensive than in other countries.	5
Specific FTZ incentive	6	Lack of skilled labor, esp. engineers	3
Specific light-crop bean discount incentive	5	Expensive electricity	3
Government support and partnership	4	Difficulties acquiring spare parts, need to keep large inventories	2
Low labor costs	2	Water supply and cost issues	1
0% import tariff on processed cocoa products from Ghana into the EU and US	2	Can't buy beans directly from farmers.	1
Can process low-grade beans that would not be exported	1	Very expensive refrigeration (2x cost of Europe)	1
Beans fresher when used in Ghana vs. shipped to Europe or US (not as much now)	1	Customer prejudice against African companies, lower willingness to pay	1
Political stability compared with other African countries.	1	Increasing competition from other domestic processors	1
Can take advantage of economic nationalism in Ghana	1	Other energy costs (gas)	1
Changing market environment creating origin-country advantage	1		

Table 4.0 above summarizes the major benefits and costs of locating operations in Ghana, as identified during the manager interviews. Benefits listed by all the processors included access to high quality cocoa beans, tax incentives offered by the government of Ghana, and a 20% discount on light-crop beans offered to domestic processors. This latter benefit will be discussed in greater detail in section 4.3.2.

The lack of adequate discounted light-crop beans to meet capacity was identified as the key constraint of locating in Ghana. Other widely identified constraints included the high cost of energy, especially electricity, and the lack of skilled labor for factory maintenance. This latter problem has been exacerbated recently due to the discovery of oil in Ghana and the subsequent loss of many engineers to the petroleum industry.

In interviews, managers stated that the estimated minimum scale of profitable operation for a cocoa butter and powder plant would be 65,000 tons of raw beans, for an initial invesment cost of $100 million (Amoo-Gottfreid 2011), while the minimum capacity of a liquor plant could be much smaller, around 30,000 tons of beans, for an initial investment of $25 million (Nijssen 2011). However, an organic cocoa plant could profitably operate at a much smaller capacity, because the price earned per ton of product is much higher. A rough minimum estimate is 16,000 tons, the size of CPI Ltd., which required an initial investment of $7.5 million (Sampong 2011).

Cargill has been considering expanding capacity to 120,000 tons, and could do so with relative ease, without needing to build a new plant. However they are hesitant to expand given the current cost structure in the market, with the shortage of discounted light-crop beans (Amoo-Gottfreid 2011). ADM Ghana is considering expanding into the manufacture of cocoa powder and butter in the future, though there is no clear time horizon on that decision. It will likely also depend on the availability of light-crop beans, particularly since the company considered closing its existing factory early in 2011 because of the shortage of light-crop beans (Byrne 2011).

Barry Callebaut added a new factory which doubled capacity from 30,000 to 60,000 tons of beans as recently as 2007, so they are unlikely to expand further in the near future (Barry Callebaut 2007). WAMCO expanded capacity from 60,000 tons to 75,000 tons in 1992 when the joint venture with Hamester was first set up. They are still profitable but also unlikely to expand in the near future (Diesterweg 2011).

Plot Enterprise only opened in the beginning of 2010 and has not had time for any expansions yet, nor are they planning any for the immediate future. The managing director stressed that future profitability and expansion is heavily reliant on the availability of discounted beans (Nijssen 2011). In 2002 the CPC expanded their capacity from 35,000 to 65,000 tons and operated profitably for a few years, but due to the shortage of discounted beans and competition from new processors they have been operating at a loss ($12.5 million in 2010) and far below full capacity (33% in 2010) for several years now. Their dramatic expansion has proved to be more of a liability than a boon (Ansong 2011). Finally, CPI Ltd. increased its output from an initial level of 1 ton per hour in 2007 to 1.5 tons per hour by 2011, and they planned to reach 2 tons per hour later by the end of 2012. In the next few years they are looking to expand into organic cocoa butter and powder production, instead of just making liquor (Sampong 2011).

The prospects for expansion of these existing companies, and the profitability of such expansions, depends on expected profits, which in turn depends heavily on how the cost and availability of beans changes over the next few years, as well as costs of inputs like electricity, gas and water. In order to incentivize future expansion, it is especially crucial to reduce these costs, since tax holidays are set to expire for these companies in the next several years.

4.3.2 Summary of Cocoa Buying in Ghana

The Cocoa Marketing Company (CMC) branch of the Ghana Cocoa Board purchases beans of all sizes from Licensed Buying Companies, all for the same price, provided that the beans meet certain minimum quality standards. After purchase the CMC divides beans into several size categories which are defined by the number of beans required to make 100 grams of total weight. The largest portion of beans falls into the category of "main-crop" size beans, defined as 100 beans or less per 100 g (Awua 2002). Main-crop beans constituted approximately 510,000 metric tons, or about 81%, of total bean production in the 2009-2010 season.

"Light-crop" beans are the next size-grade down, requiring 101-120 beans per 100grams (Abaka-Ewusi 2010, CountrySTAT Ghana 2011). There were approximately 70,000 metric tons of light-crop beans in 2010, accounting for about 11% of production. The remaining three categories are "small beans" (121-130 beans per 100 g), "type 4" beans (131-150 beans per 100 g) and "remnant" beans (151-180 beans per 100 g). Together these size categories accounted for the remaining 8% of bean production.

The absolute and relative amount of main-crop sized beans in the cocoa harvest has been increasing over the past six years, while production of light-crop and smaller sized beans has been declining. In 2004-2005, for example, 400,000 metric tons of main-crop beans were produced, accounting for 67% of the total, compared with 165,000 metric tons of light-crop beans, accounting for 28% of the total (Abaka-Ewusi 2010, CountrySTAT Ghana 2011). Cocoa powder, liquor and other products produced from light-crop beans can be sold for the same price as those produced from main-crop beans, but light-crop beans are generally not marketed internationally because the large international companies want uniformity in bean size to make roasting operation easier, and only the larger beans meet the industry standard.

Under current Cocoa Board policy all beans that fall into the light-crop bean category and below are not exported, but are instead sold exclusively to domestic processing companies. Light-crop beans are offered at a 20% discount off the baseline main-crop bean price, small beans are offered at a 30% discount, and type 4 beans are offered at a 40% discount (Akomeah 2011). The price of main-crop cocoa beans is determined via forward contracts negotiated by the CMC on the world market.

Along with tax incentives, the system of cocoa bean discounts is one of the primary mechanisms that the Cocoa Board uses to make domestic cocoa processing attractive. The issue is that the world price of Ghana's beans includes its price premium, so when domestic processors purchase main-crop beans at full price they incur higher costs than competitors in other regions of the world, including neighboring West African countries. In an effort to mitigate the high bean cost, the Cocoa Board does allow domestic processors to import foreign cocoa beans free of import tariffs. However, very few processors take advantage of this incentive, preferring to process 100% Ghanaian beans in an effort to capitalize on their reputation of quality (Amoo-Gottfried 2011, Barry Callebaut Ghana Ltd. 2011, Nijssen 2011).

In the past the CMC offered a discount on main-crop beans to the CPC, when it was still fully owned by the Cocoa Board. From 1992-1997 the CPC purchased main-crop beans at a 5% discount off the world FOB price, and then from 1998-2000 the discount increased to 11% off FOB prices. However, since 2000 no discount has been offered on main-crop beans to the CPC or to any other domestic processor (Awua 2004).

One worrisome fact, and a possible motivation for ending the discount, is that in the 1997/1998 and 1999/2000 seasons the CMC was able to earn a higher price on the world market for raw cocoa beans per metric ton than the price earned by the CPC for products processed using an equivalent quantity of beans (Awua 2002). This has not been the case under market conditions for the past several years, however; in 2011 the raw-bean equivalent price for cocoa liquor was $4,616, compared to $2,660 for raw bean exports. Given such a dramatic price differential, it may be time to revive the main-crop bean discount.

As shown in Table 4.1, the light-crop bean discount was universally cited as a primary reason for investing in operations in Ghana, while the shortage of light-crop beans (which surfaced later, once investments had been made) was identified as the key disadvantage. The installed processing capacity in Ghana in 2010/2011 was 398,500 tons (NDPC 2011). The 70,000 tons of light-crop beans produced in Ghana that year fell far short of meeting this demand.

Processors respond to this challenge in various ways. The CPC buys about 25% light-crop beans and 75% main-crop beans, though they would purchase more of the light-crop beans if they were available. Occasionally the CPC is forced to shut down operations when it cannot acquire enough discounted light-crop beans, and in general it is currently operating at only around 30% of total capacity (Ansong 2011). Previously, when the CMC sold main-crop beans at a discount to the CPC, the company consistently operated at a profit (Awua 2002), but it suffered a 12.5 million Ghana cedi loss in 2010, mostly because of the loss of the main-crop bean discount and steep competition for the discounted light-crop beans (Ansong 2011).

Plot Enterprise has a policy that it will only purchase light-crop beans. When there are not enough available, the plant scales back its operations or closes down completely for a period of time, as occurred for one month in 2010. The managing director of that company stated that the profitability of cocoa processing in Ghana in the future depends primarily on increasing the availability of discounted beans (Nijssen 2011). The ADM Ghana plant came close to shutting down completely in early 2011 due to concerns over the lack of availability of light-crop beans (Byrne 2011). Cargill Ghana always tries to operate at full capacity, and will purchase as many main-crop beans as needed to meet this goal, but this significantly cuts down on the company's profits. Also, this creates a difficult management issue, because the decision on how many main-crop beans to purchase must be made before the company knows how many light-crop beans are available for purchase (Amoo-Gottfried 2011).

Two other cocoa processing companies in Ghana have suffered less from the dearth of light-crop beans because of unique features of their operations. One of these companies is WAMCO, which processes 40% main-crop beans, 20% light-crop beans, and 40% small beans. Processing small beans involves a completely different method, expellor-extraction, which requires specialized (though generally less expensive) machinery. WAMCO is the only large processor in Ghana that uses this production method, so it does not have to worry about competition for purchases of these types of beans. The fact that the company can purchase small beans at the steeper 30% discount helps to allay the cost of the main-crop beans that it must purchase. Furthermore, WAMCO is the only company which reported that it does sometimes purchase beans from other countries of origin, primarily the Ivory Coast, Sierra Leone and Cameroon. By keeping costs low in these ways WAMCO has been able to continue operating at full capacity, processing about 75,000 tons of raw cocoa per year (Diesterweg 2011). The example of WAMCO seems to support the hypothesis of Cohen (1986) that developing countries might have a comparative advantage in expellor-exraction cocoa processing.

The second unique company is Commodity Processing Industries (CPI) Ltd., which is a relatively small producer of organic cocoa liquor. Because the company only processes 16,000 metric tons a year and is the sole purchaser of organic cocoa beans in the country, it is able to use 81.4% of light-crop beans for its operations. The company also buys 0.5% main-crop beans, 15.2% small beans, and 2.9% type 4 beans.

The Ghana Cocoa Board is currently in the process of reviewing its package of concessions for domestic cocoa processors, in response to complaints from companies that they cannot make profits because of the shortage of discounted light-crop beans (Akomeah 2011). The companies themselves have asked for discounts on main-crop beans or perhaps a system of rebates for the times when they are forced to purchase main-crop beans at full price (Nijssen 2011). It remains to be seen whether the Cocoa Board will make such concessions. But, overall, they are wary of any decision which might affect the price premium that Ghana earns on the world market.

The Cocoa Board has three major strategic goals. First, and most important, is maintaining Ghana's price premium on raw exports by sustaining its reputation for high quality beans. The second priority is maintaining production at one million tons of raw cocoa over a long period of time, and eventually increasing it further. The third goal is to increase the percentage of cocoa processed in the country to 60% of total production (Akomeah 2011).

However, the Cocoa Board's ultimate overall goal is more fundamental: to maximize the profits earned by Ghana on its cocoa. Do the three sub-goals actually complement one another in reaching this fundamental goal, or do they work at cross purposes? Money spent to stimulate processing decreases the amount of revenues remaining for efforts to increase yields and maintain quality, like the CODAPEC programs and the operations of the QCD. Is the expected windfall from domestic processing enough to justify these costs? Furthermore, if more beans were sold to local producers at a discount, would this damage Ghana's position in the export market, and/or decrease their total export revenues? It is important to analyze the trade-offs of these different policies in order to determine the best way to deal with domestic processing.

4.4 Model of Optimal Percentage of Raw Bean Exports

The purpose of this section is to develop a formal model of Ghana's cocoa economy in order to determine what percent of beans should be exported in raw form versus processed domestically to maximize Ghanaian welfare. Simulations are conducted on the model and policy implications are outlined.

4.4.1 Model set-up

Under certain conditions, such as high processing costs and relatively low prices for processed products, it might be optimal to export 100% of beans, and thus no policy should be enacted to stimulate the development of a domestic processing sector. However, under other conditions it might be optimal to process 30%, 60% or even 100% of beans domestically. The model developed here can be used to quantitatively analyze the effects of changes in processing company ownership, underlying costs, prices, world cocoa demand, and other conditions on the optimal proportion of beans which the Cocoa Board should export in raw form.

When making the decision about how to allocate the country`s cocoa production, the Cocoa Board considers total welfare earned on cocoa after production, which is the sum of domestic processor profits, the revenues earned by the Cocoa Board on sales of raw beans, and the portion of the domestic processors' costs which accrue to the Ghanaian economy. The costs of growing the cocoa are omitted from the equation because they are already sunk. The welfare function seen by the Cocoa Board is thus:

(4.1) $W = \alpha\pi^{PD} + P^{E}X^{E} + ((P^{E} - \delta)X^{PD} + \tau c X^{PD}$

In this model α is a number between 0 and 1 which indicates the percentage of domestic processor profits, π^{PD}, which accrue to Ghanaian interests, as opposed to foreign shareholders. P^{E} represents the price earned on the world market per ton of exported Ghanaian beans, X^{E} represents the amount of beans that are exported in tons, X^{PD} is the amount of beans that are processed domestically, *c* represents the costs of domestic processing per ton apart from raw bean costs, and τ is a number between 0 and 1 which represents the percentage of these payments which are received by Ghanaian interests.

The δ variable is the discount offered to domestic processors on any bean purchases that they make. Its units are dollars per ton by which the Cocoa Board subsidizes the bean price. Structuring the discount in this way represents a policy change, since currently only light-crop beans are discounted but the discount in this model applies to all beans. Varying the discount enables us to investigate the effects of the discounting all beans, as is currently demanded by processing firms in Ghana. The δ term was made additive rather than multiplicative because a multiplicative discount would lead to a mathematical solution in which the optimum was a very high level of exports, since that would create a low export price and lower subsidy cost to the government. An additive discount avoids this perverse incentive.

Several of the terms in equation (4.1) can be expressed in terms of other variables. Processors profits can be written as $\pi^{PD} = (P^M - c - P^E + \delta)\, X^{PD}$ where P^M is the price earned for processed cocoa products on the world market in dollars per ton of raw bean equivalent. The amount of exports can be expressed as a percentage (e) of total beans produced in the country (X). That is, $X^E = eX$. Likewise, the amount of beans processed domestically can be expressed as $X^{PD} = (1 - e)X$.

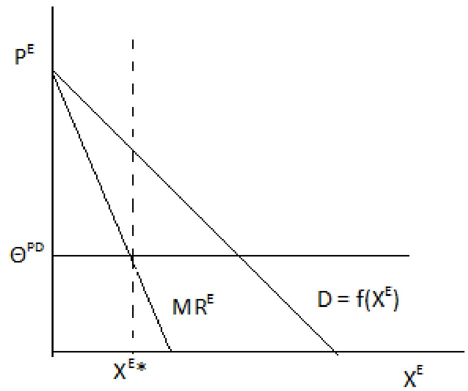
Also, the price of Ghana's bean exports will be a function of the amount of exports, since Ghana is a large-country producer of cocoa, and its level of production can therefore influence the price. Furthermore, Ghana's cocoa earns a price premium over other Forastero cocoa every year because of its reputation for quality, so it can be partly viewed as a distinct product with its own demand. Because Ghana's cocoa price is still very strongly correlated to predominant world prices, the most accurate way to reflect this relationship may be to model Ghana's export price as a function of the world cocoa price plus a bonus which is a linear function of Ghana's level of exports and a number of other factors. That is, $P^E = P^W + B + mX^E$ where P^W is the average world cocoa price, B is an intercept parameter for the bonus Ghana earn' s over world prices, and m is a slope parameter reflecting how a one unit increase in Ghana's bean exports changes the bonus. It is assumed to be negative, an assumption which is backed up by the empirical data in Figure 4.4. All these parameters will be estimated econometrically using data on Ghana's price premium, exports, and a several other covariates. Plugging in these different expressions into equation (4.1), the new form of the model is:

(4.2) $$W= \alpha(P^M - c - (P^W + B + meX) + \delta)((1-e)X) + (P^W + B + meX)eX + (P^W + B + meX - \delta)((1-e)X) + \tau c(1-e)X$$

The optimal percent of exports versus domestic processing which would maximize Ghana's total welfare from cocoa will occur when the marginal revenue earned on exports equals the net marginal benefit earned by Ghana for domestic processing. The expression for total revenue from exports is: $TR^E = X^E(P^W + B + mX^E)$. Marginal revenue from exports is the derivative of TR^E, thus $MR^E = P^W + B + 2mX^E$. Marginal revenue from domestic processing can be represented by: $\theta^{PD} = \alpha(P^M - c - P^E) + \tau c - (1 - \alpha)\delta$. That is, the per-ton benefit of processing in Ghana is the processors' profit margin per unit multiplied by the percentage of profits earned by Ghanaians, plus the amount of input costs captured by Ghanaians, minus the portion of the raw bean subsidy paid by the government which is captured by non-Ghanaian firms. The part of the subsidy earned by Ghanaian firms is just an internal transfer from the Cocoa Board to processors, so it has no direct effect on the net benefit of processing per-unit.

Thus, the optimum level of exports, and the optimal level of domestic processing, will occur when $\theta^{PD} = MR^E$, which is illustrated graphically in Figure 4.1. This is shown in expanded form in equation 4.3.

Figure 4.1: The Optimal Level of Cocoa Bean Exports



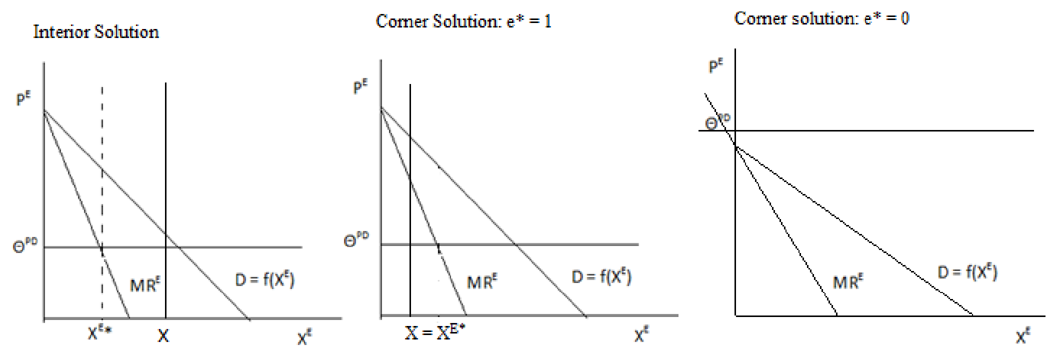
(4.3) $\alpha(P^M - c - (P^w + B + meX)) + \tau c - (1 - \alpha)\delta = P^W + B + 2meX$

Solving this equation for e yields the optimal percentage of beans produced in Ghana which should be exported, e*. This solution is shown in equation 4.4 below.

(4.4) $e^* = \frac{-B - P^W - B\alpha - c\alpha + P^M\alpha - P^W\alpha - \delta + \alpha\delta - c\tau}{mX(2+\alpha)}$

However, this equation is only accurate when an interior solution is obtained, that is, when the optimum value of X^E found at the point of intersection $\theta^{PD} = MR^E$ is less than the total production of beans that year, represented by X, and is also not a negative value. Figure 4.2 below shows the graphical representation of an interior solution versus these two potential corner solutions.

Figure 4.2: Graphical Illustration of a Corner vs. Interior Solution



To account for these corner solutions, we have to set additional parameters on the solution outlined above. There are in fact three separate conditions for an optimum:

(4.5) $\theta^{PD} - MR^{E} \leq 0$;

$(1 - e)(\theta^{PD} - MR^{E}) = 0$;

$(1 - e) \geq 0$

Under the condition wherein $\theta^{PD} = MR^{E}$ results in an optimal value of exports $X^{E}*$ that would exceed the total production of beans, X, in the country, the mathematical solution would be a value of e* that exceeds 1, meaning that (1 – e*), the optimal value of domestic processing, would have to be negative. This clearly is not possible in the real world. Instead, the solution would be a corner solution with e* = 1. That is, if the point at which the point of intersection for marginal benefits of domestic processing and exports seems to indicate an optimum of over 100% of bean exports, then the real-world optimum is to export exactly 100% of beans.

Under the condition when $\theta^{PD} = MR^{E}$ results in a negative value of $X^{E}*$, this would mean that exports were negative and domestic processing should be over 100%.

Instead, the corner solution e* = 0 would hold. That is, if marginal the marginal benefit of domestic processing and exports are equal at a point where exports are negative, this means that the real-world solution is to export 0% of beans and process them all domestically.

4.4.2 Comparative Statics

Assuming an interior solution, i.e., $0 < e^* < 1$, we can perform comparative statics based upon equation 4.4. Table 4.1 summarizes all the partial derivatives of (4.4) with respect to each exogenous variable, and the formal comparative statics themselves, as well as an explanation of their expected sign, is given below.

Table 4.1: Summary of Comparative Statics

Comparative Static	Sign
$de^*/d\alpha$	negative
de^*/dc	negative if $\tau > \alpha$, positive if $\tau < \alpha$
$de^*/d\delta$	positive, unless $\alpha = 1$ (then zero)
de^*/dPm	negative
de^*/dPw	positive
$de^*/d\tau$	negative
de^*/dX	negative
de^*/dB	positive

The partial derivative of e* from (4.4) with respect to the percent of domestic processor profits which are actually captured by Ghanaians yields expression (4.6) below. Intuitively, one would expect that as the profits accruing to Ghanaians increase it would be more profitable to process beans domestically, so the optimal level of exports should decrease. Thus, the sign on (4.6) is expected to be negative. An examination of the equation shows that this will be the case under normal circumstances. We assume that the inverse demand function for Ghana's bean exports will slope downwards, so m will be negative, because Ghana is a large country exporter. This is a reasonable assumption since Ghana is the second largest producer of cocoa in the world, with 17% of world production. Thus the numerator of (4.6) will need to be negative to yield an overall negative sign. This will be true when the magnitude of $B+P^W+c(2+\tau)$ is less than $2P^M+3\delta$. The base price of Ghana's raw bean exports, $B+P^W$ should be far outweighed by the price of processed products in raw bean equivalent, P^M, and even more so by $2P^M$.

At its largest, $c(2+\tau)$ will equal 3c. It is very probable that $3c > 3\delta$, but it is also probable that the margin by which $2P^M > B+P^W$ is even greater. Thus, this result shows that under reasonable estimates of the exogenous parameters the sign on (4.6) will be negative, but the opposite will be true if the costs of processing are much higher than the discount offered, and/or if the price of processed cocoa products is low compared to the price of Ghana's raw bean exports. In this case, the corner solution wherein e* = 1 and all beans are exported will likely be obtained. Whenever an interior solution is obtained, the sign of $de^*/d\alpha$ will be negative.

Furthermore, the magnitude of this negative effect will be greater if the export demand curve is more elastic, if X is smaller, and if α is smaller. These three parameters constitute the denominator of all the partial derivatives which follow, so this holds true for all of the comparative statics.

(4.6) $$\frac{de*}{d\alpha} = -\frac{B-2\,P^M+P^W-3\delta+c\,(2+\tau)}{mX\,(2+\alpha)^2}$$

The partial derivative of the optimal export function with respect to per-unit, non-bean processing costs (c) is shown in equation (4.7) below. The sign of the denominator is determined by the sign of m, which is assumed to be negative. Thus, the sign of the overall derivative depends on the relative magnitude of τ and α. If the proportion of processor costs retained in the country, in the form of wages, taxes, etc., is larger than the proportion of processor profits earned by Ghanaians, then the overall sign will be negative, and an increase in costs will decrease the optimal level of exports. This is logical, because if higher processing costs add proportionally more to the economy, then the percent of domestic processing should increase as costs increase. The opposite is also logical: when $\alpha > \tau$ the sign of (4.7) is positive, and an increase in costs decreases the optimal percentage of domestic processing because it decreases processing profits, which have a higher weight in the total welfare of the economy.

(4.7) $$\frac{de*}{dc} = \frac{\tau-\alpha}{mX(2+\alpha)}$$

The partial derivative of the optimal export function with respect to the discount off of the world bean price offered to domestic processing factories is shown in equation (4.8) below. This discount factor could be treated as an endogenous choice variable, since the government of Ghana sets the discount, but this alternative approach, treating the discount as exogenous, is also reasonable and provides some interesting information. Domestic processing companies, many of which are powerful MNCs, have significant lobbying power in Ghana. If they are able to successfully lobby for a change in the discount rate, then it is as if the policy is exogenous to the Cocoa Board. In such a case, this model shows the optimal response by the Cocoa Board to an exogenous increase in δ in order to maintain the highest level of total welfare from handling a given crop. This might be unrealistic, because if domestic processors can lobby to implement a discount, they will certainly not stand by and let the Cocoa Board export all beans in raw form and refuse to sell them any beans for processing. But it is still an interesting counterfactual, showing what the interests of the country as a whole would be under such circumstances.

The denominator of $de^*/d\delta$ the same as in (4.7) and is expected to be negative. Since $0 \leq \alpha \leq 1$, the numerator must be between -1 (if Ghanaians capture none of the processing profits) and 0 (if they capture all the profits). Since there are currently several MNC processors and thus $\alpha < 1$, the numerator will be negative and the overall sign of (4.8) will be positive. As the subsidy on domestic processing increases, the percent of beans which are exported should increase at the expense of domestic processing. The magnitude of this effect will decrease as α increases, and if Ghana established control over all of its processing such that $\alpha = 1$, then changing the subsidy would have a net neutral effect on the optimal level of exports.

Overall, thus suggests that there is huge discord between the goals of optimizing welfare with respect to percentage of exports and maximizing the profits of domestic processors by providing them with a discount. The contradiction between these two policies is especially high when the domestic processors are primarily foreign MNCs. This seems to potentially justify the Cocoa Board's reticence in extending the existing domestic processor discount to main crop beans. Furthermore, the variable δ is likely to have very different short-run versus long-run effects on welfare.

The current model is only set up to capture the short-run effects, which will be negative when δ is increased, since this represents a full and direct increase in costs incurred by the government and only a partial increase in processor profits (or when processing is 100% Ghanaian owned the processor profit increase will be exactly canceled out by the cost incurred by the government). However, in the long-run a discount might have additional positive effects on the economy, if the higher processor profits incentivize expansion of processing capacity. Under conditions where higher domestic processing were optimal (higher domestic ownership of factories, higher processed product versus raw cocoa price differentials, etc.) then incentivizing higher domestic cocoa production via such a discount could be significantly welfare-enhancing. Modeling such a dynamic requires a two-stage framework, however, and is outside the scope of this analysis.

(4.8) $$\frac{de*}{d\delta} = \frac{\alpha-1}{mX(2+\alpha)}$$

The partial derivative of the optimal export function with respect to the output price for processed cocoa products on the world market is given by equation (4.9) below. This derivative will be strictly negative, or zero, if m is negative, because α is between 0 and 1. That is, as the price of processed cocoa products on the world market increases, the optimal level of exports will decline in favor of domestic processing. This is logical, and it is also logical that the magnitude of the effect will be higher if α is higher, meaning that more of the processor profits are earned by Ghanaians.

It might be argued that it is impossible to do ceteris paribus analysis of P^M, since the price of processed cocoa will inherently be linked to that of raw cocoa. However, when the Ghanaian bean premium rises, it does not correspond to an increase in liquor and powder prices shipped out of Ghana, and cocoa processed in Ghana does not earn any type of price premium on the market. In interviews, this was actually a major complaint of domestic processors. A change in the world price of cocoa liquor is also unlikely to affect Ghanaian raw bean prices, for the same reason, and because Ghana is a much smaller exporter of these products (currently) than it is of raw beans. Furthermore, Ch. 2 showed a disconnect between raw and processed cocoa prices over time. In the future, if Ghanaian processors are able to establish a brand reputation similar to that which exists for raw Ghanaian beans, and/or if processed exports increased substantially in the future, then the disconnect between P^W, B, and P^M might disappear. Under current conditions, however, a ceteris paribus analysis is reasonable.

(4.9) $$\frac{de*}{dP^M} = \frac{\alpha}{mX(2+\alpha)}$$

The partial derivative of the optimal export function with respect to the average world cocoa price is shown in equation (4.10) below. The sign of this derivative is strictly positive, because the denominator will be negative if m is negative, and the numerator will vary between -2 and -1, depending on the value of α. That is, as the world price of raw beans increases, the optimal percentage of exports will increase.

(4.10) $$\frac{de*}{dP^W} = \frac{-1-\alpha}{mX(2+\alpha)}$$

The partial derivative of the optimal export function with respect to the portion of processing firm costs which return to the Ghanaian economy in the form of wages, taxes, etc. is given by equation (4.11) below. Cost per ton, c, will be positive, and the denominator is suspected to be negative, therefore the sign of (4.11) is negative. That is, as the percent of costs retained in Ghana increases, the optimal value of exports decreases in favor of more domestic processing, just as would be expected.

(4.11) $$\frac{de*}{d\,\tau} = \frac{c}{mX(2+\alpha)}$$

The partial derivative of the optimal export function with respect to the total production of raw cocoa beans in the country is given by equation (4.12) below. As in the other comparative statics, the denominator will be negative since m is negative. The sign of the numerator depends on the size of $(B+P^W)(1+\alpha)+c\alpha+\delta$ compared to $P^M\alpha+\alpha\delta+c\tau$. Although P^M is almost certainly greater than $B+P^W$, it is very likely that $(B+P^W)(1+\alpha) > P^M\alpha$, and thus the numerator is positive and the overall sign of the expression is negative. This is only not the case under very small values of α, and when this occurs then it is almost certain to be a case of the corner solution, with e* = 1. It is reasonable to conclude that in all cases of an interior solution an increase in X will result in a decrease in the optimal export share. Logically, if there is an optimal level of exports X^E*, as shown in Figures 4.1 and 4.2, then if X increases e* must decrease to maintain the same level X^E*, and vice versa.

(4.12) $$\frac{de*}{dX} = \frac{B+P^W+B\alpha+c\alpha-P^M\alpha+P^W\alpha+\delta-\alpha\delta-c\tau}{mX^2(2+\alpha)}$$

Finally, the partial derivative of the optimal export function with respect to B, the intercept parameter of the inverse demand function for Ghanaian cocoa, is given by equation (4.13). Since m is negative this derivative is strictly positive, since α is between 0 and 1. Thus, as the demand for exports expands outward, the optimal percentage of beans which should be exported increases, which is logical.

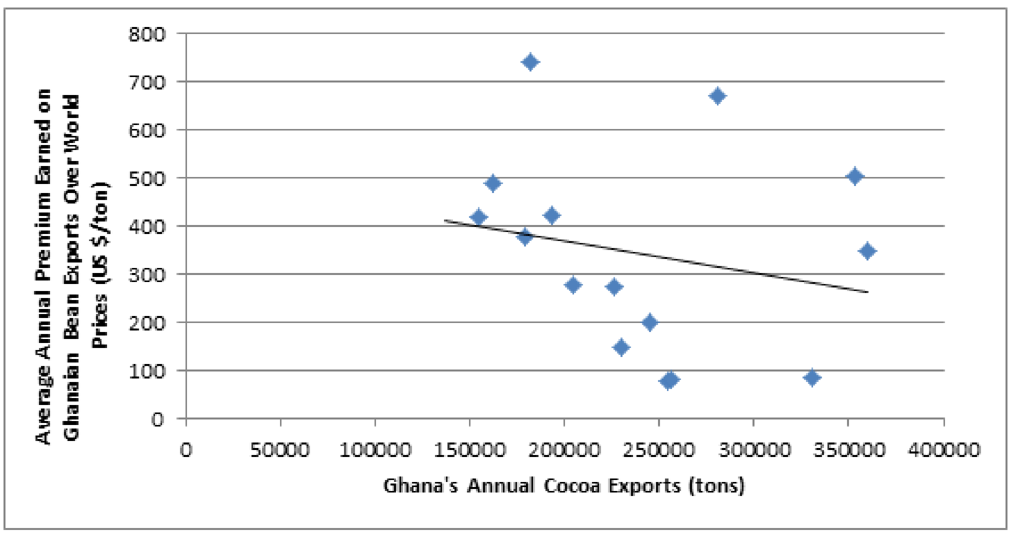
(4.13) $$\frac{de*}{dB} = \frac{-1-\alpha}{mX(2+\alpha)}$$

4.4.3: Simulations- Initial Value Selection

In order to simulate the results of this model in the current situation for Ghana, I plugged probable initial values for the exogenous variables into equation (4.4). Then I tested several different values for each of the variables to see how this affected the resulting value for e*. The results of these simulations are shown in Table 4.2. I have listed the initial values chosen for each exogenous variable below, along with an explanation of how each number was chosen.

First, I need to econometrically estimate values for the parameters B and m in the equation $P^E = P^W + B + mX^E$. Figure 4.4 below shows that there is an overall negative correlation between the quantity of bean exports by Ghana and Ghana's price premium over the world cocoa price, as was suspected.

Figure 4.4: Ghanaian Cocoa Price Premium and Volume of Exports



However, in order to better estimate B and m, it is important to include a few other factors which are likely to affect the size of Ghana's price premium. The model which I estimate econometrically is of the form:

(4.14) Ln(Premium) = $\beta_0 + \beta_1$Ln(Ghana's exports)+ β_2Ln(Côte d'Ivoire's exports) + β_3Ln(Exchange rate for cedis)

That is, the premium the Ghana earns on its beans should be a function of its level of exports, the level of exports of competitor countries, the primary of which is Côte d'Ivoire, and the exchange rate for Ghana's cocoa in terms of cedis per U.S. dollar. A higher value for the exchange rate should correlate with an increase in demand for Ghana's beans and thus a higher premium, because the beans would be relatively cheaper for foreign customers. Another factors which would affect Ghana's premium is the quality level of its beans, but it is impossible to obtain data on this variable. This and unobserved factors are included in the β_0 term.

In order to generate the premium data, I subtracted the annual world average spot cocoa price from the London spot price for Ghanaian beans, both from the ICCO Quarterly Bulletin of Cocoa Statistics. The Ghana bean prices were given in UK pounds, so I used the pound-US dollar exchange rate (OECD statistics extracts) to convert them into US dollars. The Ghanaian export price data were unfortunately only available for 1976-1999, although all other variables were available through 2009. The calculated premiums showed that Ghanaian price exceeded the world price by 11.5% on average over that period, which roughly corresponds to the reported 10% price premium mentioned in the literature (Williams 2009). For the key independent variable I used data on Ghanaian exports of cocoa beans from the ICCO Quarterly Bulletin of Cocoa Statistics, and I took data on exports from Côte d'Ivoire from the same source. Official cedi-dollar exchange rates were obtained from the World Bank's World Development Indicators Databank.

The results of the regression shown in (4.14) give an elasticity of Ghana's exports on its premium of -1.313 for the 1976-1999 period. Assuming that this elasticity has remained constant over time, I use it and data on Ghana's exports and price premium for 2009/2010 to derive estimates for B and m. Exports for 2009/2010 were 526,761 tons (GAIN 2012). The price premium for that period was $297, calculated using the average world spot price (ICCO 2011) subtracted from Ghana's export price, determined by the producer price paid by the Cocoa Board that season, divided by the reported percent of FOB price that this represented (ICCO 2010, GAIN 2012).

First, since $\frac{dpremium}{dexports} * \frac{exports}{premium}$ = -1.313, I plug in exports = 526,761 and premium = $297 per ton to solve for $\frac{dpremium}{dexports}$ = -0.00074. This is the value of m. Then, I plug these values in the equation Premium = B – m(exports) and solve for B. That is, 297 = 0.00074(526,761), which yields B = 687 when solved. Thus, the initial values for the parameters of the export demand function are B = 687 and m = -0.00074.

The variable P^W has an initial value of $2,300 per ton, because this was the average cocoa price on world markets in 2010 (ICCO 2012). I give the variable δ an initial value of 230, which is 10% the level of world prices. I chose 10% because the current discount placed on light-crop beans by the Cocoa Board is 20% and if the discount were extended to cover all beans sold domestically then it is likely that the Cocoa Board would want to decrease the percentage of the discount.

The value of c, the non-bean cost of processing, includes labor, packaging, electricity and transport. To estimate c, first I used an estimate from Pinnamang-Tutu & Armah (2011) that processing in Ghana cost 2,700 cedis per ton of beans in 2008. Using the real $US-cedi exchange rate in 2008, this is equal to $2,214. The cost of Ghanaian beans that year on the world market was $1,908 (Ghana CountyStat 2012), but since domestic companies were not just purchasing full priced beans, I must compute a weighted average with discounted light-crop beans. I assume that 50% of beans purchased are main-crop while the other 50% are light-crop beans sold at 20% off. This gives a weighted average cost of raw beans of $1,717. Thus, the total remaining costs (c) are: $2,214 - $1,717, or $497 per ton. Thus, I use c = 500 as the initial value for costs.

The value of α would be 1 for companies owned by private Ghanaian businessmen or public Ghanaian interests (CPC, Plot). It would be close to zero for profits to the large MNCs processors, although this will change when the tax holiday expires, and would be somewhere in between for joint-ventures like WAMCO and CPI Ltd. As a rough initial approximation of the overall value of α, I use α=0.6, i.e., 60% of processing profits were earned by Ghanaians.

The parameter τ is also hard to quantify, since it is difficult to trace all the costs paid by processing companies. The weight of return to Ghanaians for labor costs will depend on what percentage of employees at the processing companies are Ghanaian nationals. This was found to be around 98% for the existing factories in the country. I assume that most of the other costs are paid to the Ghanaian government or a Ghanaian company (this should be true of electricity, water, gas, taxes, packaging, and transport to the Ghanaian port), though costs paid for ocean shipping and capital expenditures would likely accrue to foreign companies. I thus begin with a rough approximation of $\tau = 0.9$.

I use the price of cocoa liquor on the world market to determine the price of P^M, the price received by Ghanaian companies for their processed products. I use cocoa liquor as a simplification because it would be too difficult to include all the different products sold, and because by far the largest volume of processed products sold is cocoa liquor. The price for cocoa liquor (not defatted) on the world market in 2011 was $5,770 per ton

(FAOSTAT), and since every ton of raw beans yields 0.8 tons of liquor, this means that the price in raw bean equivalent form is $5,770*.8 = $4,616 per ton.

The final variable, X is the amount of total raw cocoa beans produced in Ghana in the second period. Production in the 2010/2011 season was estimated at approximately 1.025 million tons (ICCO 2012). Thus, I use an initial value of X = 1,000,000.

4.4.4: Simulations- Results and Discussion

The resulting optimal export level when the initial values for the exogenous variables, as described above, are plugged into equation (4.4) turns out to be a corner solution: 100% of beans should be exported. This implies that in order to maximize profits from the cocoa industry, Ghana should export all of its beans a process none domestically. This result is contrary to both the expectations set forth in this paper, and current policy in Ghana, since about 30% of beans are currently processed domestically and the Cocoa Board has an official goal of achieving 60% domestic processing in the next several years. It is possible that the exogenous values were chosen incorrectly, which may account for this unexpected result. However, it is also possible that the logic that increasing domestic processing should increase Ghanaian welfare will only hold under certain conditions, such as domestic control of the processing companies, and under other conditions encouraging domestic processing is not in fact optimal. Additional simulations support this idea.

Table 4.2 below shows the simulation results for the initial values, followed by the results under the given variations in the exogenous variables. In addition to the resulting value for e*, the table displays the corresponding export price and several calculated welfare outcomes under the conditions in each simulation. The four welfare measures shown are: profits to domestic processors (the term $\alpha\pi^{PD}$ from equation 4.1), revenues earned by the Cocoa Board ($P^E X^E + ((P^E - \delta)X^{PD})$, retained processing costs (wages, etc. which contribute to Ghana's economy, represented by $\tau c X^{PD}$), and total welfare, which is a sum of these three measures. The expanded mathematical representation of total welfare and of the three individual components is shown in equation (4.2).

In the initial case, with 100% exports, there are no domestic processor profits or retained costs on processing. Cocoa Board revenues total $2.25 billion, and this is the same as total welfare earned.

It is also important to note that the export price which would result under these conditions is $2,247, which is lower than the initial value used for the world price, $2,300. That is, given the estimated value for Ghana's price premium as a function of exports, at very high export levels (here the full supply of 1 million beans) the "premium" value becomes negative, and Ghana earns a price lower than the world market price for its beans.

As the values of the exogenous variables are increased and decreased slightly, one by one, the resulting values of e* change precisely as predicted in the formal comparative static analysis shown in Table 4.2. For example, that table shows that the sign on de*/dc should be positive if $\tau < \alpha$ and negative if $\tau > \alpha$. Table 4.2 shows that an increase in costs from $500 per ton to $700 per ton leads to a decrease in optimal exports from 100% to 98%, so the sign is negative; this matches expectations, because the initial value of τ is

0.9, which is greater than the value of α, which is 0.6. All the other comparative statics were also found to have the predicted sign.

Note that in the table the highest resulting value for e* is 1. In fact, the numerical optimum value for e* found in those simulations was greater than one, with the lowest at 1.01(the actual value of the base case) and the highest at 1.88. However, since these numbers have no real-world meaning and actually just signal that optimum is the corner solution, hence they were replaced by e* =1, or 100% exports.

The results of Table 4.2 show that the optimal level of exports decreases most dramatically, meaning that domestic processing should be increased, when there is a ceteris paribus fall in the world raw bean price or when the percentage of processor profits earned by Ghanaians increases. A $500 drop in raw bean prices and an increase to 100% Ghanaian ownership of the country's domestic processing both cause optimal exports to fall to around 60%, which means that about 40% of beans should be processed in Ghana. Optimal processing also increases, though less so, when the price of processed cocoa products increases, when the export demand curve shifts down to a lower intercept, and when total bean production increases. Changes in δ, τ and c have an effect on e* that is much smaller in magnitude, though the signs are still as expected.

Note that having P^M and P^W vary completely independently might be accurate, since the world price or raw cocoa does tend to be correlate with the world price of processored liquor. However, the overall price for raw Ghanaian beans, as determined by $P^W + B – mX$, is not strongly correlated with world liquor prices and thus such ceteris paribus analysis may still be appropriate, as explained above, in the description of equation (4.9).

Table 4.2: Model Simulation Results, Optimal Percent of Cocoa Bean Exports

				Resulting welfare measures (millions of US $)			
Initial Values		**e***	**Export Price**	**Processor profits**	**Cocoa Board Revenue**	**Retained costs**	**Total Welfare**
B = 687, m= -0.00074, Pw = 2300, δ = 230, c = 500, α = 0.6, τ = 0.9, Pm = 4616, X = 1 mill.		1	2247	0.0	2247.0	0.0	2247.0
Δ in intercept of demand fn							
B	550	0.9	2184	129.7	2161.0	45.0	2335.7
B	800	1	2360	0.0	2360.0	0.0	2360.0
Δ in world bean price							
Pw	1800	0.599	2043	552.7	1951.0	180.0	2683.7
Pw	2800	1	2747	0.0	2747.0	0.0	2747.0
Δ in domestic bean discount							
δ	0	0.967	2269.2	33.2	2269.0	13.5	2315.7
δ	460	1	2247	0.0	2247.0	0.0	2247.0
Δin processing costs							
c	100	1	2247	0.0	2247.0	0.0	2247.0
c	700	0.983	2261.8	22.6	2257.0	12.6	2292.2
Δ in weight of processor profits							
α^{PD}	0.5	1	2247	0.0	2247.0	0.0	2247.0
α^{PD}	0.7	0.909	2313.6	128.0	2293.0	40.5	2461.5
α^{PD}	0.8	0.811	2387.6	297.7	2344.0	85.5	2727.2
α^{PD}	0.9	0.719	2454.2	476.7	2390.0	126.0	2992.7
α^{PD}	1	0.634	2520.8	675.3	2436.0	166.5	3277.8
Δ in weight of processor costs							
τ	0.8	1	2247	0.0	2247.0	0.0	2247.0
τ	1	0.988	2254.4	12.6	2252.0	5.0	2269.6
Δ in world liquor price							
P^M	4000	1	2247	0.0	2247.0	0.0	2247.0
P^M	5200	0.832	2372.8	260.8	2334.0	68.0	2662.8
Δ in total bean production							
X	900,000	1	2321	0.0	2088.9	0.0	2088.9
X	1,100,000	0.922	2238.1	111.3	2442.0	35.2	2588.5

With the given values chosen for the initial levels and marginal changes, only the decrease in P^W and the increase in α give values for optimal domestic processing that are higher than the 30% current level of processing. Thus, if the chosen initial values, particularly the estimates of the export demand function parameters, are accurate, then this suggests that the Cocoa Board ought to prioritize raw bean exports more than it does currently, and that tax incentives and discounts which currently exist to increase processing should be eliminated, unless α increases or P^W decreases significantly.The results might be very different if the model were to take into account the long-run situation wherein higher domestic processing profits increased future processing capacity; under such a situation tax incentives and bean discounts might have a significant positive effect, especially if α were high. However, such long-run dynamics are not captured in this model.

Because α emerged as the main exogenous variable of interest in the current model, I ran more than the standard two simulations with that variable. Results show that if Ghanaian companies owned 90% of the processing industry in Ghana, then the current amount of domestic processing of about 30% would be optimal. If Ghanaian companies increase their share any higher, then it will be optimal to increase domestic processing further relative to imports.

In addition to looking at the effects of the different variable changes on e*, it is important to determine under what conditions the total level of welfare increases with respect to the base scenario. Assuming that a change in a given exogenous parameter was accompanied by an adjustment in exports to the corresponding e*, increases in τ, P^M, X, α, and c were all found to increase the level of total welfare, while a decreases in δ increased welfare above its initial level of $2.25 billion. For B and P^W, both an increase and a decrease in these exogenous parameters increased total welfare in comparison with the base case. Increasing the values caused an increase in welfare because in all those cases the corner solution held, and so changing B and P^W only meant an increase in demand and price for Ghana's beans, respectively. When B and P^W were decreased, the result was an interior solution in both cases. Although decreasing B represented a drop in export demand and decreasing P^W represented a drop in world cocoa price, when Ghanaian exports were decreased accordingly higher welfare was achieved on balance.

Of course, these changes cause an increase in total welfare through different mechanisms. The decrease in B actually lowers Cocoa Board revenues, but increases processor profits and retained costs by an amount that outweighs that decline. This is also the case for the decrease in P^W. Increases in X, α, τ, and P^M actually cause an increase in the value of each of the three components of welfare, though the biggest effects are on processor profits and retained costs. A decrease in the discount to domestic producers increases Cocoa Board revenues, but it also increases processor profits and retained costs if the value of e* is adjusted to the new optimum (a higher level of domestic processing). An increase in processing costs (c) causes a decrease in processor profits and only a very small increase in Cocoa Board revenues; the major effect on welfare is caused by the increase in retained costs.

4.5 Policy Implications and Conclusion

The results of the model developed in section 4.4 illustrate that the optimal level of domestic cocoa processing in Ghana is heavily dependent upon the underlying demand conditions for raw bean exports, the relative prices of raw and processed cocoa, and most importantly, the level of Ghanaian ownership of the domestic industry. When these underlying conditions favor domestic processing and it is expanded, then a higher level of total welfare can be achieved than under the status quo. Thus, policy recommendations on how to increase domestic processing are conditional on the values of these "exogenous" variables, and it is also important to consider policies which can help to change the values of these variables.

Assuming the validity of the other chosen exogenous parameters, the simulations in Table 4.2 show that if 60% or less of processor profits are earned by Ghanaian interests, then the country's welfare would maximized by exporting all of its beans in raw form and eliminating domestic processing completely. Considering that the largest bean processors in Ghana currently are all MNCs (ADM, Cargill, Barry Callebaut) or joint-ventures with majority foreign ownership (WAMCO), it is not in Ghana's interest to offer further incentives, like a main-crop bean discount, to increase processor profits. This is likely the case even if it would incentivize expansion of future processing capacity, though this was not analyzed in this model. In fact, the simulation results suggest that Ghana would do better to reduce its level of domestic processing and focus on exporting all of its beans in raw form. The Cocoa Board should cut back on the incentives that it already offers to these companies, like tax holidays and the light-crop bean discount, and allow them to shut down if they threaten to do so.

However, if 100% of the processing industry were controlled by Ghanaians, then welfare would be maximized by retaining 37% of beans for domestic processing and exporting only 63%. Under this latter scenario total welfare was calculated to be $3.28

billion, compared to $2.25 billion when 100% of beans are exported. As the level of α increases and the level of exports are decreased, all three measures of welfare including Cocoa Board revenue increases. If the level of α were higher, then providing a discount on raw beans to stimulate expansion of processing capacity would likely be welfare enhancing, though again, a two-period model would be needed to fully analyze such long-term dynamics.

It is clearly in Ghana's interest to make an effort to increase the level of local ownership over processing factories, which could be accomplished through several different policies. First, the government itself could buy out some or all of those factories, or provide incentives for private Ghanaian companies to do so. Second, the Cocoa Board could offer discounts and tax incentives only to Ghanaian-owned processors but not to foreign-owned processors, potentially enabling the former to out-compete the latter. Third, the Cocoa Board could modify its cocoa purchasing laws to make it easier for cooperatives like Kuapa Kokoo to retain and processes their own beans, and it could also provide other support such as start-up grants or low-interest loans to assist with the initial costs of capital.

However, it may be necessary to accept some degree of foreign ownership of the processing industry, because the large MNC companies have better market access, lower marginal costs because of economies of scale, and easier access to capital for large initial investments. If these MNCs are likely to out-compete Ghanaian firms no matter what due to such cost advantages, then it may be better to have these competitors in Ghana, where they provide jobs and pay for electricity, etc. than to face all these competitors in Europe and other countries, where they offer no benefits to Ghana at all. Given all this, one way to still increase α may be pushing for joint-ventures between the largest cocoa MNCs and Ghanaians. For example, the Cocoa Board might offer a package of additional incentives to Barry Callebaut if it enters into a 50% partnership with Plot Enterprise or another locally-owned firm (alternatively, threats could be made to sanction Barry Callebaut if they do not agree to a joint-venture).

The optimal level of domestic processing and total welfare derived from cocoa both increase with changes in several exogenous variables that might be manipulated via Ghanaian government policies, particularly P^M. The fact that currently Ghana can earn a price premium on its raw beans but cannot earn a comparable price premium on processed cocoa is likely one of the major reasons why a high level of raw bean exports is found to be optimal. Though it may be difficult and costly, Ghana might be able to increase the price that it earns for cocoa liquor and other processed products with an advertising campaign emphasizing the use of 100% high-quality Ghanaian beans, particularly if it can capitalize on niche markets for product made in source countries. It might be easier to harness the Fairtrade sentiment in order to achieve a higher P^M if the processing operations are owned by farmer cooperatives. In general, investing in a marketing campaign and in other efforts to secure a price premium on Ghana's raw products would likely be one of the best ways to increase the profitability of domestic processing.

Other variables which could be modified to increase the relative profitability of domestic processing include X, c and δ. Strategies to increase production, X, were covered extensively in Chapter 3, and include programs to increase fertilizer use, access to extension services, access to credit, membership in cooperatives, and coverage by the government spraying program.

Results of the simulation show that while increasing the discount offered to domestic processors for beans increased their profits, it actually decreases total welfare because of the revenue lost by the Cocoa Board, at least in this short-run model. However, the negative effect on welfare decreases as α increases, since domestic processor profits make a higher contribution to welfare. The relationship between δ and α suggests that it may be optimal to offer a differential discount to Ghanaian-owned versus foreign-owned processors, if such price discrimination is possible and the differential is not eliminated by arbitrage. The discount parameter might be especially important in the long-run, if Ghanaian ownership over processing increased and it became optimal to increase processing capacity, since it is likely that a discount would help to incentivize an expansion in local processing capacity. A useful avenue for further research would be to rigorously analyze this question using a two-period model.

Finally, policies to increase τ might include promotion of more Ghanaian-run transport companies and higher taxes on imported machinery and other inputs. As seen by the results for the cost variable, c, in the simulations above, the money earned on retained costs from such taxes might contribute more to the Ghanaian economy than the profits earned by processing companies from elimination of these taxes.

If the level of Ghanaian ownership of cocoa processing factories increases and/or other underlying conditions change such that a higher level of domestic processing is optimal, what policies should the Cocoa Board consider in order to increase local processing capacity to that optimum level?

Companies base their decisions to invest in new facilities or expand their operations on expected profits, so any policies which help to boost profits would help to increase domestic processing capacity. This could include efforts to increase P^M through a promotion campaign, as mentioned above, or to decrease costs through measures like research on technological development, training of maintenance workers, a reduction in electricity prices by the state-run utility, or a discount on main-crop beans.

In the simulation, a decrease in costs and an increase in the bean discount (to a higher level of δ) were found to decrease the optimal level of domestic processing, but the effect on processor profits of such changes is unambiguously positive. Thus, these policies could help to increase the level of investment in processing, if this is determined to be desirable for other reasons. That is, X^{PD} is not just (1-e)X, but is also a function of investment in a previous period, which is a function of profits and depends partially on the discount. This endogeneity was not captured in the model specification in section 4.4, but could be captured in a different model framework.

These conclusions should be further tested using more reliable data for the exogenous variables, particularly for the parameters of the exogenous demand function. Also, if accurate data could be found on levels of utilized capacity of cocoa factories and factory profits, then this could be used to derive an investment function, which would help to predict the effect of discounts and changes in marginal costs and prices on the production capacity in the country. This would assist in the generation of more concrete policy recommendations.

The major conclusion of this chapter is the fact that Ghana and other West African should not necessarily expend their resources on stimulating development of a local processing sector. This will only benefit them if the gap between raw bean and processed cocoa prices are high enough, if export demand is sufficiently inelastic such that higher exports decreases the price earned substantially, and most importantly, if processing operations are owned by local interests.

Ch. 5: The Role of Cocoa Producer Cooperatives in Increasing Farmer Welfare

5.1 Introduction

Even if aggregated Ghanaian cocoa welfare is maximized through increased production and/or domestic processing, this does not mean that cocoa farmers themselves will necessarily see an increase in their welfare. Producer cooperatives are one mechanism which can help to increase farmer welfare, though several mechanisms. Cooperatives can help to increase yields, expanding the size of the cocoa pie, but they can also help farmers to obtain a larger slice of that pie, through bargaining power and vertical integration.

Once they build up successful operations and generate enough equity, cooperatives could even consider expansion into processing of their own cocoa, competing directly with cocoa trader/grinders, and perhaps eventually with chocolate manufacturers. Such a shift would be costly and challenging, but if done successfully it would enable cocoa farmers to capture higher profits than under the current industry set-up, wherein MNCs dominate cocoa processing. The question becomes, under what circumstances could producer cooperatives succeed in undertaking cocoa processing, and particularly, what types of support would they need from the governments of their respective countries?

Section 5.2 provides a review of the literature on the benefits which can be provided by non-processing producer cooperatives as well as the general factors which make such cooperatives successful. It includes a number of examples of successful and failed cooperatives which support the conclusions of the theoretical and empirical literature.

Section 5.3 provides a more detailed case study of the cooperative structure in Ghana and case studies of the three major cocoa producer groups in the country.

Section 5.4 then discusses the prospect of expansion by cocoa producer cooperatives into downstream processing through a review of theoretical and empirical literature. A number of examples of successful and failed IOF and cooperative processing operations in developing countries are analyzed, leading to general conclusions about the factors which would make expansion into processing by an existing cooperative more likely to succeed

In Section 5.5, I use information from the previous section in a case study of the prospects of future integration into local processing by Kuapa Kokoo, the only existing producer cooperative in West Africa with adequate production volumes and market power to consider expanding into processing in the near future. I analyze a potential policy change by the Ghana Cocoa Board which I believe would be necessary in order for Kuapa Kokoo to succeed in vertical integration into processing.

5.2 Producer Marketing Cooperatives: Potential Benefits and Success Factors

This section discusses the benefits offered by farmer associations, as well as the factors which tend to make some more successful than others. It will focus primarily on cooperatives legally registered in their respective countries and controlled by members. In Ghana, Kuapa Kokoo is the only true producer-controlled cocoa cooperative, but I will also discuss two other cocoa farmer organizations in the cocoa sector which are controlled by external agencies at the national level but which include several legally-registered, farmer-controlled cooperative societies at the village level.

5.2.1 Background on Producer Cooperatives in Industrialized and Developing Countries

Agricultural cooperatives play an important role in the economies of industrialized countries. In the EU in 2006, for example, there were approximately 30,000 agricultural cooperatives with 9 million members, accounting for 50% of the overall market for inputs and 60% of the market for products (Mercoiret et al. 2006). In the U.S., in 2005 there were 48,000 cooperatives with 120 million members (Ortmann and King 2007).

Although there are fewer agricultural cooperatives in developing countries—particularly long-lived, successful ones—these institutions are on the rise and have recently received a great deal of attention by international development agencies and donors (Uphoff 1993, Berdegue 2001, World Bank 2002). Today, approximately 7% of the population of Africa belongs to some type of cooperative, and 50% of all cooperative societies are for agricultural marketing purposes (Develtere et al. 2008).

There is a small empirical literature on the economic effects of producer cooperatives in developing countries. A few older studies estimate that cooperatives have had no substantial impact (Hussi et al. 1993, Porvali 1993). However, a number of other reports provide evidence that cooperatives in developing countries have increased member incomes and benefitted the economy more broadly by directly creating new employment opportunities (Schwettmann 1997, Develtere et al. 2008).

Research on cooperatives in Sub-Saharan Africa suggests that the structure and role of cooperatives in that region has shifted substantially since the period of market liberalization in the 1990 (Mercoiret and Mfou'ou 2006, Develtere et al. 2008, Wanyama et al. 2008). Prior to that time, cooperatives were often founded and strongly supported by national governments, as organizations through which state marketing boards could work with small farmers. Now many of them are supported by international donors or NGOs and are used as a mechanism for channeling services to farmers in order to meet programmatic goals of these organizations (World Bank 2002, Mansuri and Rao 2004).

There are, of course, still some successful, autonomous producer cooperatives in developing countries which are more than a channel for NGO services and interests. For example, the largest cooperative in the world, the Amul Dairy Cooperative, is located in India. It markets and processes its members' milk, generating substantial profits which are shared with members. Founded in 1946, it had over 3.1 million members by 2012, and an annual turnover of $2.2 billion. The cooperative is widely credited with having spurred a "white revolution" in India, wherein milk production tripled between 1971 and 1996, and India became the world's largest producer of milk and milk products (Bellur et al. 1990).

El Ceibo cocoa cooperative federation, established in 1977 in Bolivia, is recognized as one of the most successful cocoa cooperatives in the world (Rapunzel Naturcost 2012). Today the cooperative serves 1,200 cocoa farming families and has succeeded in vertically integrating into both cocoa processing and chocolate manufacture. It even operates retail stores in La Paz and Paris, selling gourmet Fairtrade, organic chocolate, allowing them to pay farmer members a high price for their beans (Bebbington et al. 1996, Matienzo 2011).

These two successful cooperative networks—Amul and El Ceibo—will be referenced throughout the following three sections in order to provide specific examples of the benefits and success factors that I discuss.

5.2.2 The Purposes and Benefits of Producer Cooperatives

A number of studies assert that the primary rationale for cooperative marketing of agricultural products is to make up for the disparity of size and power between farmers and the buyers they face in the market (Berdegue 2001, Torgerson 2004). Through cooperatives, smallholder producers are able to remain small and still take advantage of economies of scale in transportation, quality control, marketing, credit allocation, and input purchasing (Bienabe and Sautier 2005, Bernard and Spielman 2009). According to Pingali et al. (2005), in today's global agrifood system, with its proliferation of standards for food quality and safety, transactions costs are even higher than in the past, so small farmers cannot survive without some collaboration or consolidation.

Empirical evidence from the milk industry in Ethiopia and the grain industry in the U.S. support these conclusions (Schroeder 1992, Holloway et al. 2000). Furthermore, the Amul dairy cooperative, by pooling its members' resources, growing membership over time, and attracting government support, has been able to make huge investments in transport, storage, and dairy processing factories which individual farmers and even small cooperative societies alone could never have afforded (Bellur et al. 1990).

Group lending, which can be facilitated by cooperatives, is now well-recognized as a way to make lending to small farmers profitable, because group members monitor each other, reducing transactions costs (Huppi and Feder 1990). Financial institutions are now recognizing the positive role that cooperatives can play in transforming previously “unbankable” farmers into profitable investments (Rabobank 2010). Bedegue (2001) studied agricultural cooperatives in Chile and concluded that they were able to substantially increase farmer incomes by stimulating diversification away from undifferentiated products. Many studies have demonstrated that by providing collective bulking, storage, grading and sorting facilities, cooperatives have lowered costs and increased member incomes (Shiferaw et al. 2008, Oxfam GB 2011).

However, where cooperatives are most successful there must be advantages not only to cooperation, but also to independent agricultural production, or the farmers would fully consolidate into large plantations or agribusinesses (Valentinov 2007). This is certainly true for crops, like cocoa, in which there is an inverse relationship between farm size and yield (Carter 1984, Vigneri 2008). By perpetuating the smallholder production model while also increasing the capture of economies of scale cooperatives can help to make the cocoa industry more efficient and sustainable.

Cooperatives also benefit members if they are able to influence the consumer prices of member goods, by pooling products and restricting their supply (Sexton and Iskow 1988, Torgerson 2004). Cooperatives can smooth price volatility by storing outputs in periods of excess supply and selling it when prices improve (Shiferaw et al. 2008). Also, cooperatives can allow farmers to take advantage of asset specificity in the downstream processing industry. That is, when a buyer has invested in very industry-specific equipment for processing, the cooperative has substantial bargaining power and can threaten to hold-up supplies unless they pay farmers a high price (Staatz 1987, Ortmann and King 2007). However, these strategies only work if the cooperative supplies all or a large portion of raw product to buyers in a given market.

Another common way that cooperatives have influenced output price is through improving production practices of members and increasing quality monitoring in order to earn a quality premium on the market (Sexton and Iskow 1988, Ollila 1994). Similarly, some cooperatives have created cooperative brands or obtained Fairtrade or other certification to increase the consumer price of member goods (Raynolds et al. 2004).

Empirical studies of the entire cooperative sector in Chile (Berdegue 2001) and Kenya (Shiferaw et al. 2008), cereal cooperatives in Ethiopia (Bernard et al. 2008), a dairy cooperative in Haiti (Oxfam GB 2011), and Fairtrade coffee in Latin America (Raynolds et al. 2004, Arnould et al. 2006) all provided evidence that cooperatives helped to increase the consumer price earned by their members. Through member training, El Ceibo increased the quality of its members' cocoa substantially, enabling it to obtain an export license in 1985, which allowed members to earn a much higher price for cocoa (Healy 1993). El Ceibo has also provided both Fairtrade and organic certification for its members' cocoa since 1988.

Cooperatives will neither be competitive, nor will they offer any benefits to members in excess of what they could find elsewhere, in perfectly competitive markets with equal availability of information (Sexton and Iskow 1988, Berdegue 2001). This is a key reason why there are many more successful marketing cooperatives for high-value produce rather than undifferentiated grains and staple crops (Stringfellow et al. 1997, Coulter 2008).

Integrating around market power is one of the primary historical reasons for cooperative formation (Nilsson and van Dijk 1997, Fulton and Andreson 2001, Leistritz 2004). The Amul dairy cooperative was originally founded to counter the monopsony power of a local private dairy; overcoming this monopsony served as a focal point to unify members from the beginning (Bellur et al. 1990).

Another major purpose of cooperatives has been to provide needed goods and services to members when the marketplace has failed to do so (Ortmann and King 2007). Cooperatives can, under certain conditions, successfully serve markets which IOFs would not touch, because they can overcome information problems and because under certain conditions they can operate more efficiently than IOFs (Sexton and Iskow 1988). In the case of the El Ceibo cocoa cooperative, the Alto Beni region in which it was founded was very remote and had poor infrastructure, so no private cocoa buyer was willing to operate there, yet the cooperative was able to succeed (Healy 1993).

Theoretical papers by Sexton (1986) and Sexton and Iskow (1988) have shown that cooperatives may be able to operate more efficiently than non-cooperatives, because they can set prices determined by the net-marginal-revenue-product curve instead of the net-average-revenue-product curve. This means that they can pay farmers a higher price for their product but then recover marketing costs by charging members an annual membership fee. This type of flexible pricing is often not possible for a non-cooperative firm.

Several empirical studies found that cooperatives were less efficient than IOFs (French et al. 1980, Porter and Scully 1987) while others found that the cooperatives were more efficient than IOFs in the same industry (Lerman and Parliament 1990, Hardesty and Salgia 2004, Terreros and Gorriz 2011, Soboh et al. 2012). In the U.S., one potential source of decreased costs for cooperatives versus IOFs is that cooperatives are only subject to income tax at the personal level, while IOFs are subject to double taxation, at corporate level and then again at the personal level (Caves and Petersen 1986). However, this is not the case in Ghana (NLCD 1968).

Other government incentives include subsidies, provision of low-interest credit and start-up grants, and government contracts which guarantee markets to cooperatives. According to Young et al. (1981), governments are often favorable towards cooperatives, because coordinating with the leaders of the cooperatives instead of individual farmers reduces the strain on their limited field staff, and because they believe that cooperatives are more susceptible to government control than private businesses.

A number of papers have emphasized that the main goal of cooperatives since market liberalization has been provision of services, particularly extension services (Deininger 1995, Wanyama et al. 2008). A study of Ethiopian marketing cooperatives by Bernard and Tafesse (2012) found that 40% of cooperatives had not sold any of their members' produce in the 12 months before data collection, but that on average the cooperatives offered 3.6 additional services to members, including HIV prevention and literacy programs that had no link to produce marketing. Cooperatives also have a higher incentive to train farmers in order to increase yields than IOF buyers would, because training generates non-excludable benefits, a major disincentive to private companies but not to cooperatives (Ollila 1994).

El Ceibo cocoa cooperative provides technical assistance through an extension program, Coopeagro, as well as access to low-cost cocoa seedlings and other inputs (Bebbington et al. 1996). Several case study analyses in the literature found that cooperatives improved farmer well-being because of the provision of services like training and subsidies for input purchases (Holloway et al. 2000, Calkins and Ngo 2005, Francesconi 2009). Cocoa buyers and iniatives sponsored by government or industry also provide training and input assistance to farmers, but often they do this through the auspices of a cooperative, since it is too cumbersome to work with smallholder farmers on an individual basis. Also, it is possible that producer-owned-and-operated cooperatives would see a higher direct payoff from investments in training and input support, because cooperatives may have fewer problems with members cheating and selling cocoa to other buyers than IOF buying firms who attempt to provide services on a contratural basis.

Cooperatives can also organize political lobbying efforts to secure services from local and national governments (Staatz 1987, Berdegue 2001). Furthermore, a "competitive yardstick" effect sometimes arises, wherein IOF buyers are forced to provide services to farmers, or offer higher prices, in order to compete with cooperatives for market share. This can lead to gains in productivity, farmer well-being, and market efficiency (Staatz 1984, Sexton 1986, Sexton 1990, Ollila 1994, Deininger 1995).

5.2.3 Success Factors of Producer Marketing Cooperatives

A number of empirical studies have shown that larger cooperatives are more likely to be successful, and that large membership is especially important at formation (Sexton and Iskow 1988, Lerman and Parliament 1990, Bruynis et al. 2001, Banaszak 2008, Francesconi 2009, Francesconi and Wouterse 2011). A study of historical cooperatives in Ghana (Cazzuffi and Moradi 2010) found that larger cooperatives had higher sales per member and a higher chance of survival.

A different set of theories suggests that large membership may decrease the success of a cooperative, because with size often comes increased heterogeneity of member interests, which can lead to coordination problems like free riding. Most emphasized is the horizon problem, wherein the residual claims of different members expire at different times, increasing division and favoring investments with short-term payoff horizons (Cook and Iliopoulos 1999, Staatz 1987, Porter and Scully 1987). Because the preponderance of empirical evidence shows that large cooperatives are more successful, this may indicate that the horizon problem is not a serious concern even with increased heterogeneity, as Fahlbeck (2007) has concluded.

A number of the empirical studies have shown that other factors within successful large cooperatives helped to mitigate the horizon problem. Banaszak (2008), for example, found that leadership strength, whether members were previous business acquaintances, and whether there was a membership selection process all correlated with success, indicating that these factors may increase internal cohesion and help to overcome the horizon and free rider problems. Other studies also found a correlation between self-selection of cooperative members and market performance (Hendrikse and Bijman 2002, Bernard and Speilman 2009). Both Banaszak (2008) and Golovina and Nilsson (2011) found a negative correlation between formation of a cooperative by an outside group (the government or extension service) and success. In these cooperatives members were not able to select their fellows, leading to lower cohesion and trust.

The Amul dairy cooperative, with its 3.1 million members, clearly must deal with heterogeneous members' interests, but it has been able to avoid coordination problems because of its strong three-tiered organizational structure, which has helped to increase connectedness and trust (Naik and Abraham 2009). A number of observers also say that strong early leadership, particularly by Verghese Kurien, who led Amul from 1950 until

2005, played a major role in the success of the cooperative.

The El Ceibo cocoa cooperative is not large in absolute terms, but it does control 70% of Bolivia's organic cocoa market (Matienzo 2011). It also has strong internal cohesion, partly because it has a strict set of membership criteria and a year-long trial period for local cooperatives which wish to join the El Ceibo federation (Bebbington et al. 1996).

Many researchers suggest that sufficient capital at start-up is a crucial success factor, because without substantial initial capital cooperatives will not be able to overcome barriers to entry (Sexton and Iskow 1988, Hardesty 1994, Bruynis et al. 2001). There is divided evidence on the effects of various sources of finance. Sexton and Iskow (1988) theorized that acquiring internal finance through member equity is preferable to taking external loans, because it is desirable to avoid a high debt burden. That paper found a positive correlation between internal equity and success, but no significant correlation between the receipt of grants and loans and success. Salifu et al. (2010) theorized that there may be a negative effect of external finance on cooperative success because it can cause dependence on external resources and attract members who join solely to gain access to those external resources. However, the empirical study in that paper was fraught with endogeneity concerns, so the theory was not substantiated.

El Ceibo has attracted a large amount of funding from the Inter-American Foundation and Oikocredit (a German microfinance organization), totaling over $2 million (Bebbington et al. 1996, Matienzo 2011). Many of these loans have been interest-free, and the El Ceibo earns high revenues on its chocolate sales, so it has maintained a relatively low debt burden. This example seems to indicate that relying on external finance is not necessarily negative for a cooperative.

Support from local governments, in the form of finance, marketing support, tax incentives, or services also tends to be a crucial success factor. In a study of six African countries, Lele (1981) found that cooperatives only worked if they operated alongside a marketing board and obtained state support. Berdegue (2001) found that one-fifth of the cooperatives in Chile would not survive without government subsidies. The Ethiopian government has offered technical assistance to cooperatives and helped them to develop marketing channels, facilitating expansion of cooperatives in that country (Bernard et al. 2008, Bernard and Spielman 2009).

Support from the Indian government was perhaps the most crucial element in the success of the Amul dairy cooperative: the government gave Amul the sole contract to supply Bombay for the first five years of its existence, and the cooperative received $7 million in grants and $10.5 million in loans from the government between 1946 and 1984 (Bellur et al. 1990). Initial government support played a crucial role in the founding of El Ceibo as well (Healy 1993, Bebbington et al. 1996).

The initial success of a cooperative also depends on the size of demand for the cooperative's product(s) and the degree of competition. According to Cross and Buccola (2004) a high degree of competition can put cooperatives at a disadvantage in the market, because as markets become more competitive, traditional cooperative structures encourage lower investment and higher probability of bankruptcy compared to IOFs. On the other hand, a cooperative has an advantage under certain demand conditions, such as when flexible pricing or a high degree of supply reliability is crucial for success (Attwood and Baviskar 1987, Sexton and Iskow 1988).

The Amul dairy cooperative was largely successful because of the high initial local demand for fluid milk in India, and because at founding it was able to secure a guaranteed market through a government contract. El Ceibo has formed partnerships and signed contracts with a number of international Fairtrade organizations and chocolate companies, including Charo and Chloe Chocolate, in order to secure reliable demand for its products (Matienzo 2011).

Both theory and empirical evidence suggests that hiring professional management staff for a cooperative is crucial for success, in part because professional management is likely to better understand and determine how to address competition (Sexton and Iskow 1988, Bruynis et al. 2001). An empirical study of cooperatives in Greece showed that brand orientation, market orientation, and entrepreneurial orientation (innovativeness, proactiveness and risk taking) all had a significant, positive correlation with performance of cooperatives (Benos et al. 2007).

Professional management and a marketing orientation have been critical in the success of the Amul dairy cooperative, which has had a marketing arm since the 1950s and whose brand is now well-known throughout India and South Asia. Marketing efforts stimulated local milk demand, increasing consumption from 112 grams per day in 1968 to over 226 grams per day in 2002, and over time the cooperative's product mix has been strategically diversified and expanded (Ali 2009).

Finally, perhaps the most important success factor is reliability of supply of member output to the cooperative. Bruynis et al. (2001) directly tested the effect of adequate business volume and found that it had a significant effect on cooperative success. According to Sexton and Iskow (1988), membership contracts should be written to encourage long-term commitment of members and penalties should be set up, and enforced, when commitments are not met; this is one way to create a more reliable supply of raw goods and to prevent the horizon problem. One example of this is the inclusion of a “liquidated damages” clause in the contract between the cooperative and its members; if one party in the contract breaks the contract then they are legally obligated to pay an agreed-upon amount of money to the other party. Sugar beet processing cooperatives in the US use such contracts to ensure reliable supply, as do some dairy cooperatives.

Sexton and Iskow (1988) also suggested that cooperatives should be willing to accept non-member business, to further reduce the risk of supply problems. However, cooperatives should pay patronage refunds only to members and not offer a guarantee that they will buy non-member output from year-to-year, so as to maintain an incentive for membership. Acceptance of nonmember business was found to be a statistically significant determinant of cooperative success in Sexton and Iskow's (1988) empirical analysis. El Ceibo accepts conventional beans from non-members, though it only pays the organic and Fairtrade premium prices to its members (Bebbington et al. 1996).

5.3 Cocoa Cooperatives in Ghana- Benefits Provided and Success Factors

This section outlines a general history and background on agricultural cooperatives in Ghana, followed by case studies of the three major cocoa cooperatives in Ghana, the benefits that they provide, and an assessment of their successes and failures.

5.3.1 Background

According to estimates by the government of Ghana, there were 4,777 registered cooperatives in Ghana in 2008, a three-fold increase from 1998. Of that total 64%, or 3,069, were agricultural cooperatives (Salifu et al. 2010). Cooperatives and other farmer-based organizations (FBOs) in Ghana are overseen by the Department of Cooperatives (DOC), a division of the Ministry of Manpower Development and Employment. In order to be eligible for public support, FBOs must formally register with the DOC or Ministry of Food and Agriculture (MoFA) and must have evidence of by-laws, a collective bank account, regular meetings and active leadership (Salifu et al. 2010).

Historically, cooperatives have formed a very important component of the agricultural economy in Ghana, particularly in the cocoa sector. Agricultural cooperatives were introduced by the British colonial government in the 1920s as an instrument to assist and control farmers in their activities and to channel cocoa more effectively toward the UK (deGraft-Johnson 1958). Following independence in 1957 the new government continued to promote cooperatives, and by 1960 they were marketing 40% of total cocoa produced in the country (Cazzufi and Moradi 2010).

Cocoa cooperatives at the time served as savings and loan institutions, and they also collected member beans, fermented and dried them in centralized facilities, and sold them in local buying centers. Member farmers received on average a 6% mark-up over the standard producer price. Farmers tended to join cooperatives not for this meager price premium, but to secure loans which had a maximum interest rate of 10%, compared to 50-100% interest charge by private money lenders and cocoa brokers (Cazzuffi and Moradi 2010).

However, the first president of Ghana after independence, Kwame Nkrumah dissolved all cooperatives in 1961 and confiscated their assets (Develtere et al. 2008, Salifu et al. 2010). At this time prices paid to cocoa farmers, as a percent of world prices, were the lowest ever in Ghana's history. Nkrumah's government essentially over-taxed the cocoa industry in order to obtain currency reserves to pay for industrialization projects. The cooperatives were dissolved mainly so that they could not organize farmers to oppose these tax policies (Develtere et al. 2008, Williams 2009).

Although some cooperatives were revived in 1966 after the fall of the Nkrumah regime, the number of cooperatives remained low through the 1990s. In 1991 there were 10,000 cooperative organizations registered with the DOC, but only 10% of that total and 4% of the agricultural cooperatives were active (Le Coq 2003).

The 1968 Cooperative Societies Decree, which remains in force as the current law governing cooperatives in Ghana, enacted severe restrictions on the autonomy of cooperative organizations. For example, it stipulated that the DOC must approve the granting of loans to members, all decisions about the use of surplus production, and any payments issued by a cooperative. The DOC is entitled to dissolve the board of directors of a cooperative at any time. Clearly, this law was not enacted to foster the formation and growth of cooperatives, but to prevent a reemergence of their political power.

In 2001 a bill was drafted by the Ghana Cooperative Council which would reform the 1968 law and give cooperatives a much higher degree of autonomy from the DOC, but this bill has not yet been passed by the legislature (Develtere et al. 2008). But even in the absence of a new legal structure that is more favorable to cooperatives, the number of FOBs in Ghana has been growing because of a rise in NGO and international donor support. One major initiative promoting farmer groups was the Agricultural Services Sub-Sector Investment Project (AgSSIP) which ran from 2000 to 2009. It was funded by the

World Bank and implemented through Ghana's MoFA. One component of this project, funded with $9.9 million, aimed to strengthen the capacity of FBOs to provide extension services and access to inputs, credit, and markets (Le Coq 2003).

A 2011 survey of 500 FBOs in Ghana found that the average group was small (38 members) and newly established (7 years old), though the largest group surveyed had 500 members and the oldest was 50 years old (Francesconi and Wouterse 2011). That same study found that only 38% of FBOs had managed to mobilize collective action. Regression analysis showed that collective action was more likely to occur in cooperative located in districts with existing land markets and basic infrastructure, as well as larger villages (Francesconi and Wouterse 2011).

Calkins and Ngo (2005) found that members of cocoa cooperatives in Ghana had 19% higher yields than non-members, that their incomes per capita were 26% higher, and that they received a fairer weight and quality evaluation on beans. The study also found that the standard of living, defined by weight and nutrition levels of, was lower for cooperative members in Ghana, though the difference was not large. This finding was explained by the fact that most members lived much farther from major towns with medical facilities than did people in the control group. That is, cooperatives in Ghana tend to form in poorer, more remote rural areas, and fewer farmers near larger cities feel that joining a cooperative is necessary.

Data from Ch. 3 of this thesis showed that farmers in the sample who were members of one of the three largest cocoa FBOs reported that the primary benefits they received from their cooperatives were training/extension (84%), input support (49%), and community investments (39%). Receiving extension services was a key reason for joining for 59% of cooperative members in the sample, while 37% were attracted by the prospect of gaining inputs and other support, and 29% wanted to show solidarity with other farmers. About 86% of members reported that they were satisfied with services received from their cooperatives.

Results from Ch. 3 showed that cooperative members in Ghana were 37.5% more likely to receive credit or input support than non-members in the sample. However, the aggregated cooperative member variable was not found to be significantly correlated with yields, the likelihood of using fertilizer, farmer opinion of the future, or opinion of treatment by one's LBC. Ch. 3 also showed that cooperative members were 30% more likely to receive extension when the regional indicator variable was not included in the regression and 17% more likely when it was included (indicating the inter-villager versus intra-village effects). Also, cooperative members were 9% more likely to receive spraying by CODAPEC when the region indicator was included, though there was no significant correlation found when it was not included. Results for most of the dependent variables were not the same for the three separate cooperatives, however, and so it is more informative to look at their effects separately.

The following case studies provide details on the three major cocoa producer operations currently operating in Ghana—Kuapa Kokoo, the Cadbury Cocoa Partnership, and Cocoa Abrobapa—which supplement the quantitative results from Ch. 3 to provide a clearer picture of the benefits provided by each organization, their relative degrees of success or lack thereof, and the reasons behind their success or failure. The case studies draw on secondary-source literature as well as in-person interviews conducted with representatives of the three organizations in Ghana in the summer of 2011.

5.3.2 Kuapa Kokoo

The Kuapa Kokoo Farmers Union (KKFU) was formed in 1993, shortly after liberalization of the Ghanaian domestic cocoa purchasing market. The goal was to buy cocoa directly from farmers and to obtain a Fairtrade certification, which was earned in 1995, so that higher prices and premiums could be used to improve farmer welfare. The cooperative was formed by a group of cocoa farmers in partnership with Twin Trading, Ltd., a Fairtrade company based in the UK. Twin offered technical support, assistance obtaining Fairtrade certification and finding customers, and a start-up loan. Other early partners included the UK's Department for International Development (DFID), which provided a $671,000 loan in 1998, and the Body Shop, which purchases Kuapa Kokoo's Fairtrade cocoa for use in its products (Shuman 2009).

The cooperative began with 200 farmer members in 22 villages. By 2011 its membership had expanded to over 64,000 cocoa farmers, in 1,400 village-level societies (Kyere 2011). Kuapa Kokoo members produced 35,000 tons of cocoa beans in 2008, representing 5% of Ghana's total production of 700,000 tons (Fairtrade Foundation 2010). Kuapa Kokoo is still growing each year, but this growth is slowing, by design. According to the cooperative's Executive Director, they do not wish to grow too large for fear of becoming impossible to manage. Though there is no official hold on membership, they aren't pushing to expand, and they turn down some villages that apply (Arthur 2011).

Kuapa Kokoo has a large and diverse membership, but the organization has control over selection of its member villages, as well as eligibility criteria for individual members. Farmers are only eligible to join if they own land and are present in their communities, meaning that caretakers and absentee landlords are not eligible (Kyere

2011). If a village wishes to join Kuapa Kokoo, then farmers in that community must come to KKFU and request that they open a branch. Then the Development Department of KKFU goes to that community to assess it, checking if they have the necessary structures (general egalitarian organization and an adequate number of eligible members) and a willingness to follow the rules of the KKFU. If the assessment is determined in their favor, then the village goes through a one-year probationary period after which the national executive board decides whether to accept the village into KKFU or not (Kyere 2011). This long process for joining the cooperative, as well as the member eligibility criteria, has limited heterogeneity of interests to some extent and has increased internal cohesion.

KKFU is the second largest Fairtrade cocoa producer in the world, supplying 45% of Fairtrade cocoa in 2006 (Barrientos et al. 2007). The cooperative owns its Fairtrade certificate, and all of its members are considered certified, but the cooperative is only able to sell 30% of its total output on the Fairtrade market (Kyere 2011). This is due to a shortage in demand for Fairtrade cocoa in the world. Until recently KKFU was the only Fairtrade cocoa cooperative in Ghana, but in 2011 two new, small organizations—the Elikem Welfare Association and the Aponoapono Biakoye Organic Cocoa Farmer' Association—obtained Fairtrade certifications (Fairtrade Africa 2012).

This increase in competition, in an already-saturated Fairtrade market, might prove damaging to the profits of Kuapa Kokoo and may mean that these new Fairtrade producers have a lower likelihood of success. Only Aponoapono Biakoye will operate in a separate, niche, market, for organic cocoa. Kuapa Kokoo has itself expressed an interest in expanding into the organic market (Shuman 2009), but if this does happen in the future then it will only work for a small subset of farmer members. Most cooperative members are heavily reliant on pesticides, particularly the government's CODAPEC spraying program, to maintain adequate yields. Because organic certification is unlikely, or many years away at best, the fortunes of Kuapa Kokoo in the near future will be heavily dependent on the Fairtrade cocoa demand, and how much it continues to grow. It has been expanding: the 30% of Kuapa Kokoo's output which was sold as Fairtrade in 2011 was much higher than the 18% sold in 2009 (Shuman 2009). This growth in demand is almost completely driven by Cadbury, which is the primary buyer of Fairtrade cocoa from Ghana (Adwell 2012). The future of Fairtrade demand remains uncertain, however, as Cadury's demand has its limits, and other competing certifications are also on the rise. The fortunes of Kuapa Kokoo and other Fairtrade cooperatives may hinge on whether Mars, which has committed to sourcing 100% certified cocoa by 2020 but has not yet committed to a set type of certification, decides to go with Fairtrade or not.

Despite partnerships with outside organizations, Kuapa Kokoo is fully owned by its cooperative members. It is organized according to a three-tiered structure much like the Amul Dairy Cooperative. At the village level, an elected 5-member executive is charged with purchasing members' cocoa beans, keeping records of sales, organizing meetings and community initiatives. There are also elected District-level councils, and an elected national executive body. A portion of financing for Kuapa Kokoo is obtained from membership dues, while another portion is obtained from outside donors, including Twin Trading (which helps promote Fairtrade cooperatives with funding from DFID), ComicRelief (a charity organization), and the Body Shop (a cosmetics company that has committed to sourcing all its cocoa inputs from Kuapa Kokoo).

The KKFU is an umbrella cooperative organization which actually owns several subsidiary companies. These include: Kuapa Kokoo Ltd. (KKL), the purchasing wing of the cooperative, which operates as an LBC; the Kuapa Kokoo Credit Union (KKCU), the Kuapa Kokoo Farmers Trust (KKFT), and Divine Chocolate. KKL is composed of approximately 200 professional management staff. They are charged with buying the farmers' cocoa, selling it to the CMC, and trying to make profits for the farmers in the process. The KKL is also in charge of transporting cocoa from the district depots to the main three CMC warehouses and then to the port, under contract with the CMC, just like other LBCs operating in Ghana (Fairtrade Foundation 2010, Kyere 2011).

The KKCU has branches in all the 1,400 different communities, and each region has a credit committee to help direct its projects. It provides loans and inputs on credit to farmers. The KKFT is charged with determining how to allocate money earned from Fairtrade premiums. It takes applications for different projects from all the societies and determines which to fund. The most active societies— those with more members, which sell a lot of cocoa to KKL, and follow all the rules— and those that are organized enough to submit detailed project proposals are rewarded with funding (Fairtrade Foundation 2010, Kyere 2011).

Divine Chocolate is a company headquartered in Britain which makes chocolate bars, at one large factory in Germany, for sale in Europe and the U.S., which contain only cocoa purchased from KKFU.[4] Formation of Divine Chocolate was voted on at the KKFU annual meeting in 1997. Kuapa Kokoo owns 45% of the ordinary shares in Divine

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[4] This is not strictly true, because of the lack of physical traceability in the cocoa chain, as has been explained, but the KKFU does receive all the Fairtrade premiums for these purchases.

Chocolate Ltd in the UK, and 33% of the U.S. branch of Divine. Members holds a further 283,605 preference shares earning interest at 7%. The value of total shares owned by Kuapa Kokoo and its members is $2.82 million (Social Innovator 2012). In 2007 Kuapa Kokoo farmers were paid their first dividends on Divine Chocolate profits, amounting to $93,000 (Salmanowitz 2007).

When Divine was first founded in 1997, an effort was made to retain as much ownership in the hands of producers as possible by limiting the number of ordinary shares issued, and raising the majority of start-up capital through preferred shares and loans. As a result, the company was heavily indebted for the first few years of its life, but in 2007, after years of successful trading, it paid off that debt (Social Innovator 2012).

The Divine Chocolate Board of Directors includes several farmer representatives. At these meetings the Board decides what to do with its profits. There is not always a set amount or percent returned to the farmers. They may choose instead to use the money for expansion of Divine's facilities or for “producer support and development” which amounts to investing in the farmers' training and inputs.

The KKFU provides a number of benefits to its members. First, it guarantees the purchase of all its members' cocoa production if it meets minimum quality standards. Because the purchasing clerk is elected by local members, farmers are less likely to be cheated. Second, revenues from the Fairtrade premiums are used to finance community projects. Thus far, eight schools have been built using these funds, for example (Arthur 2011). Third, at the Annual General Meeting (AGM), representatives voted to return an extra bonus to all members at the end of the cocoa season: at the end of the 2010 season, the bonus was 2 cedis per bag sold, and one machete per farmer (Kyere 2011).

Kuapa Kokoo also supplies operational tools at the District level, to be divided amongst the societies. These include tarps, scales, and metal plates for sorting beans. The cooperative currently supplies farmers with fertilizer on credit, through a project funded by the Gates Foundation. Finally, Kuapa Kokoo's Development Department employs extension officers, who they hire from the Cocoa Swollen Shoot Virus Disease Control Unit (CSSVD), a division of the Cocoa Board. These extension agents stay in cocoa villages and visit each farm 1-3 times per month (Kyere 2011).

Female empowerment is also a key goal of KKFU. Every society sends two representatives to the AGM each year, one of whom is male and one of whom is female, and at least two of the executives at the societal, district and national level are supposed to be female, according to KKFU by-laws (Social Innovator 2012). In 2002 it was found that this goal was not being met, and that only 57% of societies had women in a leadership role (Ronchi, 2002), but according to Kyere (2011) that number has increased in more recent years. One more impact of the KKFU has been to put pressure on the Cocoa Board to increase the producer price of cocoa. According to Executive Director Emmanuel Arthur (2011), KKFU funds lobbying efforts each year to increase the cocoa price, and in some years they have succeeded.

Kuapa Kokoo has at this point paid off its original loans from Twin Trading and DFID, though it continues to take out smaller loans from local banks, and one current loan has a 28% interest rate (Shuman 2009). An additional concern for Kuapa Kokoo is the weakness of Ghana's currency; in 2006 the value of the currency on world markets collapsed, quadrupling Kuapa Kokoo's debt burden and affecting its capital and financial overlay. It recovered by 2007, but posted a weak performance that year (Shuman 2009).

The cooperative's primary need for loans is to finance credit offered to its farmer members, and to have adequate cash on hand so that its purchasing arm can pay farmers promptly for their beans.

When the KKL cannot pay cash to farmers immediately for their beans, this does not cause large numbers of members to cheat and sell to another buyer, according to Kyere (2011). Members sign one-year contracts saying that they will only sell beans to Kuapa Kokoo and tend to honor these contracts. The problem is that failure to pay promptly in cash causes the cooperative to lose the patronage of non-member farmers, who constitute a sizeable portion of KKL's business (Kyere 2011). No precise figures are available on the amount of non-member purchases made by KKL, but data indicate that member production accounted for 5% of total production in Ghana in 2008 (Fairtrade Foundation 2010), while Kuapa Kokoo, Ltd.'s purchases accounted for 22% of cocoa sales just a few years earlier (Zeitlin 2005), suggesting that non-member business might be quite substantial.

Results from Ch. 3 indicated that members of the Kuapa Kokoo cooperative have yields that are 31.3% lower than non-members and were between 24% and 37% less likely to have their land sprayed frequently by CODAPEC. It seems very unlikely that membership in the KKFU caused a lower provision of services and lower yields; more likely, this reflects the fact that KKFU tends to locate in more remote villages, as was found by Calkins and Ngo (2005).

Additional regressions run using the data from Ch. 3 showed that KKFU members were 40% more likely to receive credit and input support than non-members, and the membership increased a farmer's positive view of her cocoa buyer by 0.69 points out of the 5-point scale. These two results were larger for KKFU than for any of the other two cooperatives. Membership in KKFU did not show a significant correlation with the likelihood of receiving extension services or using fertilizer, and statistical analysis could not be used to test its effect on the likelihood of receiving the government bonus, because all KKFU members in the sample received the bonus.

The quantitative findings from Ch. 3 in combination with the qualitative explanation of Kuapa Kokoo above indicate that the primary benefits offered to members of the cooperative include fairer treatment by one’s buyer, access to credit and input supports, and the benefits of community development projects financed by Fairtrade premiums. Members of the KKFU do not receive extension services or a higher frequency of spraying by CODAPEC, as might be expected if the cooperative were able to exert political power to secure greater provision of these services by the government. However, extension services and increasing cocoa yields are not the primary goals of Kuapa Kokoo, so it is not surprising that no significant correlation was found between these variables and KKFU membership.

This case study also shows that Kuapa Kokoo has been fairly successful as a marketing cooperative for its members produce, because of features like large membership, strong internal cohesion through organizational and membership selection structures, professional and market-oriented management, premiums earned in the niche Fairtrade market, availability of low-cost finance from partner organizations, and a reliable demand for cocoa production from the Cocoa Board's CMC.

Kuapa Kokoo has not yet succeeded in accomplishing true vertical integration, however. The cooperative does derive some benefits from downstream operations through its 45% ownership in Divine Chocolate, but this does not fully qualify as vertical integration, because Divine is still required to purchase Kuapa Kokoo's beans through the Cocoa Board, at the price mark-up. Despite the lack of an input cost advantage, Divine Chocolate has been able to succeed because of strong management; the Fairtrade niche market and the growth of that market in the UK; creation of the Divine brand, which is growing in popularity; and the availability of loans from both private and public sources because of the nature of the company as a partial development project. The prospect of further vertical integration by Kuapa Kokoo will be discussed in Section 5.3.4.

5.3.3 Cocoa Abrobopa Association

The other two producer cooperatives in Ghana, the Cadbury Cocoa Partnership and Cocoa Abrapopa Association (CAA), are much different than the KKFU in that they were both only founded in January 2008, were created and continue to be run primarily by foreign organizations, and they do not actually purchase cocoa.

The CAA was founded by two Dutch men, with a pilot project in the town of Bunso Nkwanta in the Western Region in 2006. It became a national cooperative association in 2008. The primary sponsors of CAA are the Dutch Embassy, RaboBank, and Wienco Agriculture, all of which are primarily Dutch organizations. Money for the Rainforest Alliance and UTZ certifications comes from these funding sources, as does the money for staff and administrative costs (Draijer 2011).

The primary mission of CAA is to increase the yields of Ghanaian cocoa farmers by supplying them with a package of inputs via an interest-free loan. The package includes two types of fertilizer, two fungicides and an insecticide, as well as training on how to use the inputs and on general good management practices (Draijer 2011). For example, CAA puts a big emphasis on pruning and proper spacing of cocoa trees, because many farmers plant their trees too densely and this lowers their yields. In fact, in order to be eligible for CAA membership, a farmer must thin his stand to the ideal 435-450 plants per acre spacing and show that they have begun to implement pruning and weeding. Other requirements are that farmers must be between 18 to 65 years of age, and they must have at least 5 acres of mature cocoa, because the input package is only designed to work on an area of 5 acres or more (Opoku et al. 2010, Draijer 2011).

The CAA is much smaller than the KKFU, with only 20,000 farmer members as of 2011 (Opoku et al. 2010). Unlike the KKFU, the CAA is currently actively recruiting new members and plans to expand to 40,000 members by 2013 (Draijer 2011). It sends extension agents into new villages to hold meetings with farmers and explain their package. They then tell interested farmers to form groups and prepare their land per the guidelines explained above. Sometimes it takes up to seven repeat visits by extension agents in order to fully explain CAA's package and the science behind it, to convince enough farmers to join (Draijer 2011).

If and when they decide to join, farmers form groups of 8-12 and sign a one-year contract that all group members will accept the package at the beginning of the cocoa season and pay the full cost for the inputs by the end of the season, on December 15. If any group member does not repay the loan, which had a cost of 82 Ghana cedis in 2010, within 30 days of December 15, then none of the members can take loans in the following season (Draijer 2011). In the past, groups which were dropped from the program because of failure to repay could never rejoin CAA. However, due to attrition problems, CAA has amended this policy such that old members can now be readmitted after redemption of outstanding debts (Opoku et al. 2010)

Nonetheless, there is a degree of attrition each year: 14% of members have trouble repaying their loans and lose eligibility, while an additional 18% chose not to re-enroll; these tend to be the farmers who experienced the lowest returns from the CAA package (Opoku et al. 2009). This sizeable rate of attrition is troubling. A higher repayment rate is necessary if the CAA model is to be sustainable. Small groups of 10 members or less were found to have significantly higher retention rates than large groups, and groups with no female members had by far the lowest retention rates (Opoku et al. 2009). This suggests that to maximize its probability of success, the CAA ought to encourage farmers to form smaller groups with more female members. However, it is possible that both group size and gender composition are correlated with other, unobserved determinants of repayment.

The CAA also works to secure Rainforest Alliance/UTZ certification for its members, though currently only 8,000 members are certified. These farmers are advised to bring their cocoa to a particular LBC, depending on the region where they live, which has agreed to keep the certified cocoa separate for sale to the CMC and then abroad at the premium price. Only those farmers who are certified and sell to the designated LBC receive their premium, in contrast to Fairtrade premiums, which are shared at the community level. The premium is returned to the individual farmers by the LBC at the end of the season. In 2010 the premium amounted to 10 cedis per bag. Actually, this only represents 50% of the Rainforest Alliance/UTZ premium, as the other 50% is kept by CAA, because they are the certificate holder and must pay the costs of maintaining the certification (Draijer 2011).

The member loan groups, of which there are currently about 2,500, are grouped into clusters of about 50 people for ease of communication with CAA staff. The organization tends to be more staff-led than farmer-led, unlike the KKFU. There are around about 90 staff members who work out of the CAA headquarters in Dunkwa-on-Offin in the Central region (Draijer 2011). Major decisions about changes in the operation of CAA are made by a 13-member board, which includes two farmers elected from each of the cocoa regions, the two Dutch founders, and an appointed chairman. Like the KKFU, CAA also holds an AGM, attended by a large number of members, which also makes policy recommendations and can influence the decisions of the Board.

Results from Ch. 3 of this thesis showed that there is no significant impact of CAA membership on yields, that members of CAA are between 22% and 45% less likely to use fertilizer, that members are 13% more likely to receive frequent CODAPEC spraying and 11% more likely to receive extensions services than non-members (without inclusion of the region dummy), and that membership raised farmers' opinions of treatment by LBCs by 0.42 points on the 5-point scale. Membership in the CAA was found to have no significant effect on farmers' opinions of the future. The effect of CAA membership on the receipt of the government bonus and the likelihood of receiving credit and other support could not be tested statistically because all CAA members in the sample received input support and the government bonus.

Unfortunately, no robust conclusions can be made based on these results, however, because only 17 of the 200 farmers in the sample were members of the CAA. However, there is an existing past study of the effects of CAA membership which was conducted with more rigorous methods (Opoku et al. 2009). According that study, CAA members' output increased by 638.5 kg relative to what it would have been if they had not participated in CAA; this represents a 20% in total production of the average member cocoa farm in the sample. This suggests a rate of return on CAA loans of approximately 176%. Results also showed that membership caused a significant increase in the amount of fertilizer and insecticides used by members.

Opoku et al. (2009) sampled existing members of CAA in 2008 and future members, who were eligible for and had registered for the program but not yet received the input package. Because farmers were interviewed at the same time, in the same region, and all were eligible and had chosen to join CAA, comparing the current and future member groups should have correctly identified the effects of the CAA program.

Overall, this case study shows that the primary benefits of CAA membership are access to inputs (fertilizer and pesticides) on credit, access to training, and increases in income due to higher production. The farmers who are UTZ and Rainforest Alliance certified also receive higher prices, though the level of the premium is not guaranteed from year to year. The CAA is not a grassroots farmer organization, so it does not increase the political empowerment of farmers, as a farmer-led group like KKFU has the ability to do. Membership in the CAA is also limited to farmers with enough land and wealth to meet the CAA's strict eligibility criteria, so this model will not be able to reach the most marginalized farmers.

Also, because CAA does not itself purchase member cocoa it misses many of the advantages and benefits of true marketing cooperatives. It has no way of increasing the bargaining position of members in the cocoa industry, it does nothing to circumvent market power, and it cannot contemplate vertical integration into processing since it has not yet even integrated into purchasing. The CAA is only able to earn UTZ and Rainforest Alliance premiums for its members because of ad-hoc agreements with existing LBCs, but this means that they are at the mercy of those LBCs, and if they cannot secure a lasting LBC partnership in a given region then these premiums are in jeopardy. Furthermore, farmers sometimes must travel long distances to deliver their beans to the designated LBC (Draijer 2011), and the risk of being cheated out of their bonus by these LBCs is much higher than if they were selling to an actual cooperative buyer.

The CAA is a quintessential example of a post-liberalization cooperative in Africa. This is, it is not much more than a channel for the implementation of an NGO program. In fact, the CAA might even be viewed as a mechanism for implementing the MNC cocoa industry’s agenda: it helps to increase farmer yields and the supply of certified cocoa without threatening the status quo orientation of power in the cocoa value chain. Farmers might still benefit from membership in CAA, at least in the short term, but a cooperative like Kuapa Kokoo that is controlled by farmers is likely to better serve their interests in the long-term.

5.3.4 Cadbury Cocoa Partnership

The final organization, the Cadbury Cocoa Partnership (CCP), is the smallest, with about 10,000 farmer members in 100 communities (Bhat 2011). The national staff of CCP is very tiny, with only 5 permanent members, because its primary operations are carried out by three implementing partners and by the Cocoa Board (CCP 2012). In some ways the

CCP is not a cooperative at all. It is a program for channeling Cadbury funding into Ghana in an effort to maintain and increase Ghanaian cocoa production. At the national level the CCP is controlled by representatives of Cadbury and the Cocoa Board. However, many of the village-level societies that operate under the umbrella of the CCP are registered cooperatives.

The CCP was founded in 2008 when the Cadbury Company pledged $73 million of investment in the Ghanaian cocoa industry. This was done in reaction to a report that showed that the average production for a cocoa farmer had dropped to only 40% of potential production and that cocoa farming had become less attractive to the next potential generation of farmers (Barrientos et al., 2007). Goals of the CCP include increasing crop yields for the one million participating farmers 20% by 2012 and 100% by 2018, to 1,000 kg/ha and creating new sources of income in the 100 targeted cocoa communities (Business Call to Action 2010).

In order to reach these goals Cadbury, in partnership with the Cocoa Board, developed a plan to revitalize the cocoa extension services offered to farmers in the country. Decades before, the Cocoa Board had offered cocoa extension services, but the program was cut in the 1990s and all extension was put into the hands of the MoFA (Bhat 2011). However, MoFA agents were not trained specifically on best practices in cocoa production, and they were assigned to all farmers of every crop grown in a particular region. As a result, very few cocoa farmers received visits from extension agents for a period of about 15 years, and those that did only saw the extension agent once or twice per year (Barrientos et al. 2007).

Under the new CCP plan, cocoa extension has been moved back under the auspices of the Cocoa Board. The Cocoa Board hires extension agents, who are supported by three different "implementing partners": Volunteer Services Overseas (VSO), CARE International, and World Vision International (Business Call to Action 2010). Essentially, Cocoa Board-hired extension agents and staff of the three implementing partners use Cocoa Board facilities and are paid through the Cocoa Board with money supplied by Cadbury.

Implementing partner representatives arrived in late 2008 and early 2009 in the targeted villages, encouraging farmers to organize themselves into cooperative societies. The goal was to make it easier to communicate with farmers and offer them training. The newly formed cooperatives were also encouraged to collect their own dues and pool money for community initiatives like funeral accounts. The implementing partners also developed curricula with production and business management trainings for the farmers (Bhat 2011).

Then, in early 2010, the first extension agents were hired and sent to the villages. The general model is that the extension agent will live in a given village for 1-3 years, providing trainings and visiting farms in the nearby area to train farmers in good management practices. Major lessons pushed in the trainings include techniques for measuring land area; ideal spacing for trees; pruning; integrated pest control methods; monitoring of production, costs, and revenues; and the benefits of using fertilizer and other inputs (Boateng 2011). After the 1-3 year period ends, the CCP model stipulates that extension agents will move to a new village and run trainings there for 1-3 years. This rotation will continue until all the cocoa growing communities have been covered (Bhat 2011).

Provision of these extensions services is thus the key mission of and service offered by the CCP. There is currently not a component for supplying inputs (free or on credit), obtaining Fairtrade certifications for farmers, or purchasing cocoa. On a district-by-district basis some implementing partners have provided other benefits to CCP farmers, including offering solar lanterns to all dues-paying members of the local cooperative societies. This is important as an incentive for membership in the societies, because the trainings and extension services are provided to all farmers in a village, whether they are cooperative society members or not (Boateng 2011). Without additional services there would be a major free-rider problem.

Currently, the CCP program villages are not Fairtrade certified, and Cadbury actually contracts with Kuapa Kokoo for its Fairtrade purchases. In addition to sourcing Fairtrade beans from the KKFU, the CCP also partners with them to offer trainings to their members and to ensure that production in these previously certified villages does not decline (Arthur 2011, Bhat 2011).

Cadbury's demand for Fairtrade Ghanaian cocoa is set to increase in the next several years because it has committed to sourcing Fairtrade beans for Dairy Milk bars for markets in the UK, Ireland, Canada, Australia, New Zealand and Japan (Business Call to Action 2010). KKFU can accommodate a large part of that demand, since it currently only sells 30% of its certified beans as Fairtrade. However, the CCP is planning to expand Fairtrade certification among some participant villages (Boateng 2011), which indicates that Cadbury considers this a profitable investment and might be planning to substantially expand Fairtrade purchases in Ghana in the future. One estimate claimed that investments in Fairtrade cocoa in Ghana through the CCP and agreements with the KKFU could help the Cadbury generate as much as $350 million in additional revenue annually (Business Call to Action 2010).

Decisions at the CCP are made by an international and a national board. The international board includes representatives of Cadbury, the government of Ghana, the UNDP, the International Cocoa Initiative, and Anti-Slavery International, while the National Board consists of representatives of the Ghanaian government, the UNDP, and the farmer societies (Business Call to Action 2011). Also, there are informal meetings and workshops organized throughout the year with attendance by the three implementing partners, farmer representatives, Cadbury and others involved in the cocoa industry (Bhat 2011).

Even so, it is clear that CCP provides much less formal power to farmers than either KKFU or CAA. For example, there is no AGM held by CCP like those held by the other two cooperatives. Farmers have initiative and autonomy within their local societies, but the national-level organizational structure is essentially run in a top-down manner. Few reports address the impacts of the CCP in its first four years of operation, though some sources report positive effects on gender equality and community infrastructure (Business Call to Action 2010, BICT International 2010).

Thus far there are no published quantitative research studies that estimate the impacts of the CCP on farmer yields and incomes. Chapter 3 might be the first such attempt to quantitatively estimate the impact of the CCP program on farmers. Although there are many econometric weaknesses in the Ch. 3 cooperative analysis, the results are strongest for the CCP member variable, because there were 53 CCP members in the sample (26.5% of the total) and the design of the CCP program suggests that membership should be exogenous to yields.

Results of the regression analysis in Ch. 3 showed that CCP membership increased yields by 31.2% for the full sample and 57.5% for farmers with more than 5 acres. The alternative analysis, using the difference-in-differences comparison with data from a previous baseline survey of CCP villages (Hainmueller et al. 2011), showed a 6% increase in yields among CCP villages between 2009 and 2011. However, this estimate is likely biased downwards because both members and non-members of the CCP are included in the 2011 figure. It thus seems plausible that the CCP program has met its goal of increasing yields for participating farmers by 20% by 2012.

Further results from Ch. 3 showed that CCP members are significantly more likely to use fertilizer than non-members (by 21% when region indicator is included) and far more likely to receive extension services (by 37% including region indicators, and by 31% without them). However, CCP members were less likely to receive the government bonus (by 9%), and that they had more negative opinions on treatment by their LBC (by 0.31 points on a 5-point scale). CCP membership had no effect on the frequency of CODAPEC spraying, farmer opinion of the future, and the likelihood of receiving credit.

These results suggest that the CCP has been fairly successful in its primary mission of providing members with extensions services and helping them to increase their yields. The fact that CCP members were more likely to use fertilizer might be a consequence of extension, because farmers have learned about the importance of fertilizer. It is not due to direct assistance from the CCP in securing inputs, because the farmers surveyed indicated that their CCP societies did not provide inputs, whether on credit or subsidized. The results also show that the CCP has had no effect on the market power of members to reduce cheating by buyers. However, this was never a goal of the CCP.

The CCP, like the CAA, is primarily a forum through which cocoa farmers are organized for implementation of a program designed to serve the interests of the international chocolate industry. In this case, the CCP is a self-serving initiative designed by Cadbury to increase the reliability of its cocoa supplies from Ghana. The program seems to be making strides toward this overall goal. At the level of the individual village cooperative society, the CCP organization is less successful, however. Members of the CCP said that their primary motivation for joining was to gain access to extension services, but their second motivation was to gain access to credit and inputs. Thus far the CCP has not provided these benefits to its members. It also seems not to have given them any degree of political or market power, as genuine farmer-owned cooperative like Kuapa Kokoo have done.

The CCP has been successful in its goals of increasing extension services and farmer yields because it has substantial financial resources from Cadbury, a well-organized implementation system and training program, and both professional management staff and professional extension agents. Support of the government has also been crucial, because it is the Cocoa Board which actually hires extension agents and provides training facilities and housing, though Cadbury foots the bill and the three implementing partner NGOs provide the curricula and support services.

One weakness of the program is that extension services are provided to all members in a village and not just dues-paying members of the local cooperative society. This does not undermine Cadbury’s primary goal for the CCP, because they are happy to purchase production of both members and non-members, but it does undermine the local societies, by weakening the incentives to join officially, attend meetings, and pay dues.

If the local cooperative societies were stronger, then they would be able to raise their own internal equity for use on community projects and initiatives. Some have already done this, but only on very small initiatives, like helping to pay for funerals, which very important community events in many African countries (Boateng 2011). The cooperative societies have the potential to create fertilizer-supply schemes, obtain their own Fairtrade certifications, and purchase spray machines for use by members, but almost no such initiatives have been attempted. It is likely that the cooperatives societies have not been more successful in expansion into such activities because they were formed by an outside organization and have from the beginning been dependent on external financing.

5.4 Vertical Integration into Processing by Cooperatives

A review of the literature, as well as a number of case studies, suggests that there are several factors which make vertical integration by an existing cooperative into downstream processing more likely to succeed. The most important are supply side factors. How important is the reliability of raw input supply in the processing industry? What proportion of the input market is controlled by the cooperative? Are there structures in place to guarantee reliability of supply from members to the cooperative? Supply factors are related to industry characteristics, specifically perishability versus storability of the product in question. Other important industry factors include the costs of processing for the given product, the length of the supply chain from raw to finished product, and the presence and extent of market power. Favorable government policies and incentives can also play a major role in successful producer-country processing, whether by domestic cooperatives or IOFs.

Several studies find empirical evidence that cooperative processors lag behind traditional firms in terms of product development, efficiency, advertising and profitability (French et al. 1980, Porter and Scully 1987). However, other studies have found that cooperatives and investor-owned processors have comparable financial performance and efficiency levels (Lerman and Parliament 1990, Hardesty and Salgia 2004, Terreros and Gorriz 2011, Soboh et al. 2012).

A number of papers suggest that cooperative processors face lower transactions costs than IOF processors because there are lower perceived information asymmetries between cooperatives and their input suppliers, and there is a greater deal of trust because producer-owned processors seek to maximize joint farmer and factory profits (Abbott 1988, Mittendorf 1993, Royer and Bhuyan 1995, Balbach 1998, Sykuta and Cook 2001, Bijmann and Wollni 2008). These theories suggest that cooperatives should have less trouble with reliability of supply, giving them an advantage in the market.

This is particularly true in industries with high asset specificity and behavioral uncertainty, because the higher level of risk makes reliable input supply particularly important (Bijmann and Wollni 2008). Reliable supplies are also very important in industries with highly perishable commodities, because products cannot be stored and used as needed to keep a factory in continual operation. Several case study analyses of different processing industries have concluded that cooperatives have an advantage in the dairy, sugar, and tea industries for this very reason (Attwood and Baviskar 1987, Abbott

1988, Talbot 2002, Develtere et al. 2008).

Sugar processing cooperatives in Maharashtra, India, gained an advantage over IOFs and were producing 90% of processed sugar in the region in the 1980 both because sugar must be processed within 24 hours of harvest and because the expensive processing equipment must be used continuously in order to maximize profits, so reliability of supply is crucial. Processing must be coordinated with planting and harvesting, and this is much more easily accomplished in the framework of a cooperative (Attwood and Baviskar 1987).

Sugar beet processing in the U.S., which operates under similar conditions, is also dominated by cooperatives. By 2011 all the nine major sugar beet processors were cooperatives. This success is due to the fact that sugar beet farmers trust cooperative processors not to cheat them by underreporting delivered sugar content, so they have an incentive to grow higher quality beets (Balbach 1998).

The success of the Amul dairy cooperative is partly explained by the perishability of milk and the difficulty and expense of transporting it in unprocessed form. Amul gained an advantage in milk processing in India because its distinctive three-tiered structure helped to generate trust and connectedness between its processing factories and dairy farmers, and thus increased the reliability of milk supplies (Naik and Abraham 2009).

Sexton and Iskow (1988) theorized that cooperatives are most successful if they integrate to the stage or stages in the production flow where market failure is occurring. If the market failure is at the buyer level, not the processing level, then cooperatives should remain as simple marketing cooperatives and not attempt to vertically integrate.

However, if the market failure is at the processing level then a cooperative that integrates into processing will be able to provide far more benefits to members than one that does not. This theory is supported by several empirical analyses (Harrigan 1986, Talbot 2002).

Harrigan (1986) found that most firms that performed poorly after vertical integration were those that possessed the bargaining power to obtain higher raw good prices, and they would have been better off doing so rather than attempting vertical integration. Furthermore, in the case of many failed integration attempts, the firm in question had tried to integrate far down a long value chain too rapidly.

Talbot (2002) determined that the relative point along the value chain when the intermediate product becomes storable and transportable, and when economies of scale become relevant, is crucial, because that is the point at which MNCs will have an interest and an advantage in entering the market. Cooperatives which integrate to that point can prevent the dominance of MNCs. This is much easier if the length of the value chain from raw to processed product is short and if the product does not become transportable and storable until after processing has occurred, because then there will be an advantage to processing close to the source. For this reason there have been far fewer successful cocoa processing cooperatives than tea and coffee cooperatives (Talbot 2002).

Amul's processing operations were successful because the cooperative first integrated into the production of simple products like ghee and paneer and only gradually introduced more complex products like milk powder and cheese (Ali 2009). Today it operates 30 dairy plants and has expanded into production of yogurt, ready-made coffee, ice cream, and pizza. The key to success was gradual, phased integration into products farther down the value chain.

El Ceibo cocoa cooperative has managed to succeed in vertical integration all the way through retail chocolate manufacture and sale despite the fact that dried, fermented cocoa beans are storable for long periods and easy to transport and the value chain to finished chocolate is very long. Other success factors discussed elsewhere in this chapter (the high-value organic niche market, strong local demand, etc.) served to outweigh the inherent disadvantages facing cooperative cocoa processing (Bebbington et al. 1996). Just like Amul, El Ceibo gradually integrated farther and farther down the value chain. The cooperative first expanded into downstream processing in 1984, establishing a small factory in La Paz. The factory was expanded over time, and today over 50% of the cocoa produced by El Ceibo members is processed in its local plant. The plant also expanded into chocolate production, both for export and for domestic sale in five retail shops which it operates in La Paz.

Another crucial component of successful vertical integration is a well thought-out strategic plan which includes an accurate estimate of prospective demand and competition, and a focus on niche markets (Abbott 1988, Hardesty 1992, Mittendorf 1993). Both Abbott (1988) and Talbot (2002) concluded that that processing firms tend to do better when there is a sizeable local market for the processed product. A processing firm that seeks only to export its production is likely to fail, unless it enters as part of a joint venture with a transnational corporation which already has a base in the target market, is aware of entry requirements and quality standards, and might already have an established brand.

A major factor behind Amul’s success was the high initial demand for milk and milk products in India, a demand which increased over time as India’s income per capita increased and Amul engaged in aggressive marketing (Amu 2012). El Ceibo also benefited from a sizeable domestic demand for chocolate products in Bolivia. Currently, 40% of El Ceibo's profits come from sales in Bolivia and the nearby region. The goal is to increase this to 50% in the next few years. The marketing department of El Ceibo has also been highly strategic in their choice of products and marketing channels; it even hired a private international consultant to develop a product line suited for European tastes (Rapunzel Naturcost 2012).

Abbott (1988) and Mittendorf (1993) both found that successful processors were able to acquire timely financing and suitable processing equipment with reliable access to maintenance. They also had strong management which properly handled procurement of inputs, recruitment of staff, quality control, storage, distribution, and marketing.

In the case of Amul, machinery needed for initial milk processing was not very complex or expensive, and processing did not rely on a great deal of other imported inputs. The cooperative’s professional management conducted marketing feasibility studies each time that it expanded its product range. Recognizing the importance of quality control for market expansion, Amul established a Total Quality Management (TQM) system in 1994, which worked to acquire ISO 2200:2005 and ISO 9001 certifications for all of its dairy plants and many of its village level societies (Ali 2009).

The cocoa processing and chocolate manufacturing machinery that El Ceibo needed to establish domestic factories was very expensive and complex, but the marginal benefits of the investment still outweighed the costs because revenues in the niche market for organic, gourmet chocolate are very high. Cooperative members grow Trinitario-type cocao trees, which are known for their unique flavor notes and are thus favored in gourmet chocolates (Matienzo 2011). Because of the higher prices earned in the organic, gourmet chocolate market, El Ceibo is able to maintain smaller production volumes and plant capacity than conventional cocoa processing factories, and thus it can accept higher cost investments. El Ceibo also benefitted from being able to secure large low-interest loans from Oikocredit and the IAF for the construction of its factories.

As explained in Ch. 4, Talbot (2002) found that the single most important factor in the success of developing-country processing operations was the existence of aggressive but appropriate state support building on local capacities. Thus, this factor is also crucial for the success of processing cooperatives. The substantial government support which Amul dairy cooperative received from the Indian government was a perfect example of what Talbot would classify as appropriate state support, because the cooperative was itself run by private Indian dairy farmer interests, but the state fostered the emergence of cooperative processing by providing huge grants and loans, as well as guaranteed markets for milk products in the early years of the cooperative (Ali 2009).

5.5 Case Study of Potential Cocoa Processing in Ghana by Kuapa Kokoo

This section applies lessons derived from the literature on success factors of cooperative processing to an assessment of whether Kuapa Kokoo should vertically integrate into local cocoa processing. I conclude that opening a Kuapa Kokoo processing factory in Ghana could succeed, but only if the Cocoa Board first makes a major policy change.

5.5.1 Prospects for Vertical Integration by Kuapa Kokoo

The Kuapa Kokoo Farmer's Union does not operate any processing facilities inside

Ghana, though there is strong interest among the managers and members of the cooperative to open local processing plants in the future (Shuman 2009, Arthur 2011, Kyere 2011). There are a number of obstacles to this plan. First, a processing operation would require a large initial capital investment, and would certainly need to be funded with outside loans and grants. At the moment, Kuapa Kokoo has already taken a number of loans, and incurring further debt is undesirable. If the Fairtrade market expands dramatically in the next several years and Kuapa Kokoo can increase its Fairtrade sales, then this might help, but even in that case substantial outside funds would be needed to finance processing operations.

Second, the nature of the cocoa marketing system in Ghana is a barrier to processing by Kuapa Kokoo. The KKL, just like all other LBCs, is mandated to sell its cocoa to the Cocoa Board's CMC, which then sells the cocoa at a mark-up on the international market and to domestic processors. If Kuapa Kokoo opened a factory, it would be subject to these same rules, meaning that it would have to sell its own beans to the CMC, and then buy them back at a higher price for processing.

Representatives from both the Cocoa Board and Kuapa Kokoo identified this as the major obstacle for development of a KKFU-owned domestic processing factory (Akomeah 2011, Arthur 2011). If the law were rewritten, providing an exception to cooperative-owned processors such that they could simply process their own beans, without going through the CMC, and then export the processed products directly, this would provide a huge advantage over IOF domestic and foreign processors. The Cocoa Board is not currently considering such a policy change, partly due to concerns that by skirting the CMC and the QCD, this would undermine the quality control mechanisms and the bargaining power established by the Cocoa Board which has been of great benefit to Ghana (Akomeah 2011). If such a policy change were made in the future, however, it would mean that Kuapa Kokoo could avoid the number one problem identified by existing processors in Ghana, the high cost of main crop beans/shortage of discounted light crop beans.

Given the status quo marketing structure set up in Ghana by the Cocoa Board, there are no advantages to cooperative processors in terms of higher reliability of supply, as there are in the tea, sugar and dairy industries. All processing companies wishing to purchase Ghanaian cocoa, including MNCs, are able to acquire steady, reliable supplies of high-quality beans because of the Cocoa Board's strict quality control and the high degree of reliability with which these delivery contracts have been fulfilled. This has been good for Ghana in that it has helped to obtain a price premium. But the fact that the Cocoa Board has already addressed these traditional market weaknesses which can put cooperatives at an advantage has had the side effect of reducing the likelihood of establishing a successful cocoa cooperative processor in the country.

Furthermore, the nature of the processing of cocoa does not give an advantage to local processing such as that which exists in the dairy and tea industries, as discussed by Talbot (2002). When cocoa is harvested, the beans must be immediately removed from the pods, and to ensure the best flavor, they should also be fermented and dried immediately. However, after the beans are fermented and dried, they can be stored for up to 6 months and are easily transportable; thus, this is the point along the chain when most beans leave the country of origin and are transported for processing closer to the point of sale (Talbot 2002).

However, cocoa liquor, powder, and butter can also be stored and transported easily, with no need for refrigeration, and the cost of transport per unit is lower for processed cocoa. As shown in Ch. 4, the cost of ocean shipping was $43/ ton for raw beans and $35.20/ton of raw bean equivalent for cocoa liquor, a differential of at least $7.80 per ton.

The results in Ch. 4 also showed that high capital costs and the costs of other inputs are formidable obstacles to any cocoa processing operations in Ghana. Major costs identified by managers of existing processing operations in Ghana included expensive electricity, other energy costs (gas for roasting), and maintenance. The latter is particularly problematic, because cocoa-processing machinery is highly complex and must be imported, so spare parts and knowledgeable maintenance workers are hard to come by (Amoo-Gottfried 2011, Ansong 2011, Diesterweg 2011, Njissen 2011).

If Kuapa Kokoo were to invest in a processing plant in the near future, it would probably need to start with a 30,000 ton capacity liquor plant, because it could neither afford the larger butter and powder plant, nor do its members produce adequate cocoa capacity to support such a large operation.

Even 30,000 tons is a large amount for a cooperative whose total member output was 35,000 tons in 2008. In order to meet its full capacity, almost all production would need to be processed, with only about 5,000 ton sold for export. This would be a detriment to its business with customers who currently purchase its raw Fairtrade beans, primarily Cadbury and Divine Chocolate. A smaller, organic cocoa plant would be ideal, but Kuapa Kokoo is still a long way from being able to certify enough of its members as organic. Thus, Kuapa Kokoo members could supply adequate raw beans for its own conventional cocoa factory only if member output increases substantially, which would need to occur via member production increases, since they do not plan to expand membership.

Yields across Ghana are increasing over time, particularly in response to fertilizer use and extension services (as discussed in Chapter 3) so it might be possible to increase member output, but that would require the cooperative to focus a lot of attention on increasing inputs and services supplied to farmers. However, KKL already purchases substantial beans from non-members, so the actual production available to a Kuapa Kokoo factory would be higher than 35,000 tons if the Cocoa Board policy change exempting the cooperative from the need to sell to the CMC also covered these non-member purchases.

If the legal and financial obstacles could be overcome, then operating a domestic processing factory could be very lucrative for Kuapa Kokoo. If it could process its own beans, rather than selling them to the CMC first, then it would be at a dramatic cost advantage compared to IOF domestic processors, and especially to foreign processors, who must purchase Ghanaian beans at the full world price, with its 10% price premium. Futhermore, the price that Kuapa Kokoo could obtain for processed cocoa is much higher than the price it currently obtains for its raw beans, even with the Fairtrade premium, and the market for processed cocoa is much less volatile.

The raw cocoa price in the world has fallen over dramatically time, while chocolate and processed cocoa prices have risen. In 2011, the cocoa liquor price was $4,616/ton of raw bean equivalent compared to Ghana's producer price of $1,677/ton raw beans, and Ghana's FOB price of $2,660/ton. This sizeable price differential might make it affordable for a Kuapa Kokoo factory to purchase some portion of its beans from other producers at full price through the CMC, at least initially, so that it could maintain some level of raw bean exports while it buildt up a customer base for its processed products.

Kuapa Kokoo should certainly not jump immediately into trying to produce chocolate, and should probably start with cocoa liquor rather than butter or powder. Only if a domestic liquor-processing factory were established and operated profitably for a number of years could Kuapa Kokoo begin to consider further vertical integration. This conclusion is supported by empirical work in the literature (Harrigan 1986, Talbot 2002) and the successful example of phased vertical integration by the Amul Dairy Cooperative and El Ceibo. Furthermore, the need for gradual integration is proven by the fact that Ghana's CPC, which integrated into chocolate manufacture immediately upon founding, has faced profit losses and been forced to operate below capacity to reduce costs, both historically and currently. Chocolate manufacture is much more expensive due to more complex machinery, the expense of imported inputs like sugar and milk, and the need for refrigeration, and there is almost no domestic demand for chocolate in Ghana.

There are a number of factors which point toward the probable success of a Kuapa Kokoo liquor-processing plant, if the Cocoa Board policies were changed. First, Kuapa Kokoo has a strong, unified membership with an interest in establishing a processing factory. Secondly, it has a reliable supply of beans from its members (and the ability to expand membership and increase that supply if it so chooses, or purchase beans from non-members). Thirdly, the price differential between raw beans and cocoa liquor is dramatic, and there are also cost savings in terms of transport for liquor versus bean exports.

Additionally, Kuapa Kokoo would be able to enter a new niche market, for direct-sourced Ghanaian Fairtrade liquor, and could likely attract very high premiums with the right marketing campaign. Furthermore, the Ghanaian government is highly supportive of domestic processing operations, offering tax-free status and duty-free imports. Another advantage is the fact that Kuapa Kokoo already has a number of strong partner organizations which could support it in raising the initial financial costs for such a venture. Most importantly, the proposed factory would face a huge advantage in terms of acquiring high-quality Ghanaian beans at a price much lower than all other processors in Ghana or the world.

Potential disadvantages include the high cost of energy and maintenance for machinery, the fact that the minimum efficient plant capacity is 30,000 tons of raw cocoa per year while Kuapa Kokoo members currently produce only slightly more than that, and the fact that Kuapa Kokoo does not have several of the most important traditional cooperative advantages. That is, reliability of supply is not a huge problem in the Ghanaian cocoa industry and Kuapa Kokoo has no flexibility in the price they can offer to their members, since the Cocoa Board has set a minimum price.

These obstacles could be overcome, however, and are likely outweighed by the expected benefits. The biggest obstacle is the potential shortfall in cocoa supplies, but this might not actually be a problem since the 35,000 ton figure for Kuapa Kokoo production was from 2008, and only dealt with member output, not total purchases by KKL, including that from non-members. One source even suggested that the 35,000 ton number only referred to main crop production, and did not take into account smaller size grades, which could also be processed in a local factory (Kyere 2011).

In order to finance construction of a domestic liquor plant, the KKFU would likely need to take loans, or sell some percentage of shares to partner organizations, to raise the initial $25 million investment. However, the benefits from even a majority but not full ownership would still be substantial, and loans would likely be paid off after just a few years of successful operation, as was the case with Divine Chocolate. Of course, a feasibility study would be needed to investigate the feasibility of this proposal, since it depends on the price which could be obtained for the final product, the number of customers who would be interested in purchasing it, and the exact costs of inputs, transport, and financing.

5.5.2 Analysis of Potential Cocoa Board Policy Change

The primary conclusion of Ch. 4, that Ghana's total welfare would be increased substantially if the percent of domestic processing operations owned by Ghanaians were to increase, supports this policy recommendation. Supporting the development of a cooperative-owned processor would help to increase the α parameter and make the optimal value of domestic processing higher. Furthermore, because there is a positive perception of cooperative-made products in niche markets in a number of industrialized nations, a factory owned and operated by Kuapa Kokoo in Ghana (using 100% Fairtrade beans) would probably be able to attract a high price premium, with a well-targeted advertising campaign.

In the Ch. 4 simulations, increasing α and P^M were both shown to benefit not only processors themselves but also to increase Cocoa Board revenues and retained costs, contributing to the local economy. If Kuapa Kokoo retained all of its beans and never sold them to the Cocoa Board, then the revenue earned on those bean sales would be lost to the Cocoa Board, though processor profits earned by Ghanaians would increase. Thus, it is not completely clear a priori whether this policy change would increase total welfare or not. A modified version of the model is needed in order to more accurately assess the effects of this policy change.

The expression for e* would change slightly, because the marginal benefit derived from processing one ton of cocoa at Kuapa Kokoo would not include the subtracted P^E term, since the cooperative would not need to pay for its beans. The new expression for θ^{PD} would be:

(5.1) $\theta^{PD} = \alpha(P^M - c - P^E) + k(P^M - c) + \tau c - (1 - k - \alpha)\delta$

All terms in this equation are defined as before, except that the $k(P^M - c)$ term represents the per-unit benefit of processing at Kuapa Kokoo. P^E is not subtracted from the expression because the cooperative does not have to pay for its own beans. Although 100% of the profits go back into Ghana's economy, the weight k is needed in order to reflect the relative contribution of Kuapa's operations to the per-unit benefit. This will be limited since Kuapa's current production is 35,000, so this is the maximum that it can process. To make matters simpler, we assume that Kuapa Kokoo will process all of its beans. If X is assumed to have an initial value of 1 million tons as in Ch. 4, then k would be 0.035, since Kuapa Kokoo's maximum processing capacity is 3.5% of that total production.

Note that here the variable α has a slightly different meaning than it did before, namely the percentage of domestic processing controlled by Ghanaian companies aside from Kuapa Kokoo. The maximum value α can take, therefore, is 0.965. The parameter k must be subtracted from the final term, since the government does not pay a discount to Kuapa Kokoo (and even if it did, that money would have a neutral effect on marginal Ghanaian welfare, just like that of the other domestic processors, captured by α). Since Kuapa Kokoo is currently not processing any beans, we will assume the same initial α = 0.6 value used in Ch. 4 and so the percentage of processing done by foreign companies, for which the Cocoa Board loses δ, will be 0.365.With this set up, then the expanded version of $\theta^{PD} = MR^{E}$ is solved for the value of e, the resulting expression for e* is:

(5.2) $$e^* = \frac{-B-ck+kP^{M}-P^{W}-\alpha(B+c-P^{M}-P^{W})-\delta+\alpha\delta+c\tau}{mX(2+\alpha)}$$

Using the same initial values from the simulations in Ch. 4, plus k = 0.035, the value of e* is found to be 0.95. Thus, even when given a low weight in the marginal benefit expression, processing by Kuapa Kokoo increases the optimal amount of domestic processing from 0% to 5%. The effect of allowing Kuapa Kokoo to process its own beans can also be analyzed by looking at its effect on the components of welfare. The retained cost equation will remain unchanged, determined according to equation (5.3) below, where R represents the processing costs that are retained in Ghana's economy. Note that none of the three welfare equations (5.3-5.5) are written in expanded form, but they could be, by plugging in $X^{E} = eX$, $X^{PD} = (1\text{-}e)X$ and $P^{E} = P^{W} + B + mX^{E}$.

(5.3) $R = \tau c X^{PD}$

The expression for processor profits must be modified, since Kuapa Kokoo faces different costs, and might face a higher output price, than the other processors. This is shown in (5.4) below, where X^{KK} is the amount of beans processed in the Kuapa Kokoo factory (equal to X*k if we assume that Kuapa Kokoo processes all its beans), and all the other parameters have the same meanings as those in Ch. 4. Thus, the first term in (5.5) shows the profits of all those processors except Kuapa Kokoo, and the second term shows the per-unit profits of the Kuapa Kokoo factory, which does not pay for beans and also does not earn the discount.

(5.5) $\Pi^{PD} = \alpha(X^{PD} - X^{KK})(P^{M} - c - P^{E} + \delta) + X^{KK}(P^{M} - c)$

Equation (5.6) shows the revenue earned by the Cocoa Board on bean sales when Kuapa Kokoo is allowed to circumvent the CMC and process its own beans. There will be a loss in revenue by the amount of bean sales lost, reflected in the $X^{PD} - X^{KK}$ term.

(5.6) $\Pi^{CB} = P^{E}X^{E} + (P^{E} - \delta)(X^{PD} - X^{KK})$

When all the initial values from the simulation in Ch. 4, plus k = 0.035, or X^{KK} = 35,000, and e* = 0.87 as calculated above are plugged into these expressions, the result is that the bean export price is $2284 (up from $2247 in the base case), processor profits equal $162.6 million, Cocoa Board revenue equals $2.2 billion, and retained costs equal $20 million, for a total welfare value of $2.38 billion. This represents a decrease in Cocoa Board revenues from the $2.25 billion base value from Table 4.2, as would be expected, but substantial increase in processor profits (which were zero in the base case), retained costs (also zero in the base case), and overall total welfare (from a base of $2.25 billion). These results offer strong support for the suggested policy change.

The Cocoa Board may still be resistant to the change based on personal interests, since it would see a decline in revenue of $500,000, but the policy would increase overall welfare in the country by a substantial amount. Furthermore, this simulation does not take into account the fact that the Cocoa Board could still collect some revenues on Kuapa Kokoo, perhaps via taxation of profits earned. The Cocoa Board might also be worried about Kuapa Kokoo cheating and selling its raw beans directly on the export market, or to other domestic processors, undermining thhe Board's export monopoly, eroding its bargaining power, and potentially lowering the export price. However, it seems that this would be relatively easy to legislate against and monitor.

Finally, the Cocoa Board might be concerned that if Kuapa Kokoo retains and processes all its own beans, circumventing the QCD, that the quality of those beans and thus of the processed products made with them will decline, damaging Ghana's reputation for quality cocoa. This would also be easy to avoid, if the QCD structures that are in place for monitoring beans purchased by the CMC and resold to domestic producers were kept in place for Kuapa Kokoo beans, with slight modifications. That is, quality monitoring would be done by the QCD during transfer of beans from KKL village collection centers to the processing factory, even though the beans would technically still be owned by Kuapa Kokoo. The Cocoa Board could charge a service fee for this quality monitoring, even if it were mandated by law, because even then the cooperative processor would have a huge cost advantage over other firms.

While non-cooperative processors would obviously object to any policies put in place which favored Kuapa Kokoo or other cooperatives, it is unlikely that they could exert enough political influence to derail such a policy change. An MNC processor seeking to push for a policy change has only a few options available, including reducing future investments, closing factories periodically during the year, and closing factories completely. The latter is not a very credible threat, since the investments to set up factories in the first place are so expensive. By way of comparison, in 2012 the government of Côte d'Ivoire ended a long-standing tax incentive to multinational domestic processors, and though many of these companies objected and even threatened to move their operations (to Ghana), in the end the measure passed and no domestic processors closed their doors (Dow Jones Business News 2012). As evidenced by their different paths vis-a-vis liberalization, Ghana is even more likely than Côte d`Ivoire to resist MNC and international pressure regarding its cocoa policy. Finally, the analysis in Ch. 4 shows that Ghana's cocoa welfare is determined almost completely by its raw bean sales, and that domestic processing only has a significant impact on welfare when factories are owned by Ghanaian interests, so even if some MNC grinders lower their investments or pull out of Ghana, the welfare gain from increasing domestic, cooperative-owned processing will likely be worth it.

5.6 Conclusion

This chapter has shown that agricultural producer cooperatives can play a major role in enhancing the welfare of members, by enabling them to retain the advantages of smallholder production while obtaining the benefits of scale economies. Many cooperatives today, particularly in the cocoa sector, are organizational tools for outside organizations to implement programs among farmers; the Cocoa Abrabopa Association and Cadbury Cocoa Partnerships in Ghana are examples of these types of cooperatives. However, other cooperatives represent genuine producer-led organizations which are working to build the market and political power of their members. El Ceibo in Bolivia is perhaps the most successful of these types of cooperatives in the cocoa industry. Kuapa Kokoo in Ghana has also been fairly successful in enhancing its member power and well-being, though there is still much room for improvement.

Success factors of producer cooperatives, particularly those that expand into processing, include reliable supply of the raw product (through member contracts or commitments, accepting non-member business, and a large membership base which accounts for substantial production); strong support from the government, though without excessive interference; professional management with a strategic, market-oriented outlook; and underlying product and/or market characteristics which favor cooperatives over IOFs (i.e., perishable products with long value chains).

In general, cocoa processing cooperatives do not face the same advantages as industries like dairy, because cocoa beans are storable and relatively easy to transport in raw form, plus they require expensive machinery to process and the majority of consumption of the final chocolate product takes place outside the producer country. El Ceibo has been able to overcome many of these challenges because it has many of the other success factors, there is strong local demand for its chocolate products, and it operates the high-value gourmet chocolate niche market. Kuapa Kokoo does not have all the advantages of El Ceibo, but it does have a very large membership base which provides a reliable source of beans, a reputation as the world's second-largest Fairtrade producer, supplies of Ghanaian beans which are recognized as the highest quality bulk-type beans in the world and earn a 10% price premium, a solid base of support from the Cocoa Board and from foreign partners, and professional staff in the KKL and Divine Cocoa who are able to make smart strategic marketing decisions.

Given Kuapa Kokoo's organizational strengths, as well as the fact that the Ghana Cocoa Board is currently seeking to develop domestic processing capacity and that the differential between raw and processed cocoa products is currently rather high, the cooperative could probably be successful if it expanded into processing cocoa liquor inside Ghana. This would require, however, that Kuapa Kokoo not have to first sell its beans to the CMC. If this policy exception were made, a Kuapa Kokoo processing plant would face huge cost advantages and generate sizeable profits within a short period of time. Simulations of this change using the Ch. 4 model show that while some Cocoa Board revenue would be lost as a result of such a policy shift, the gains in terms of processor profits earned in Ghana and retained costs that go back into the economy would outweigh this loss.

If the Cocoa Board changed this policy in order to make it more feasible for Kuapa Kokoo to set up a processing plant, this would constitute the "right" kind of government intervention discussed by Talbot (2002). It might be possible to create a highly successful operation with low costs and high revenues (particularly if Kuapa Kokoo-processed liquor could attract a special niche price among the Fairtrade-conscious) which would be more successful that the government-led CPC ever was and which would distribute many more of the cocoa chain profits to actual farmers.

Yield increases are not enough to improve farmer welfare in a lasting sense, because prices are volatile and generally declining over time, and even when production increases buyers can easily cheat farmers. Increasing domestic processing can potentially do more to help Ghanaian welfare, but the extent to which this is true depends on what proportion of the industry is owned by actual Ghanaians. Furthermore, even if 100% of the processing sector is controlled by private Ghanaian companies, this does not mean that farmers will ever see a share of those increased profits. The best way for farmers to improve their own welfare is to join together into cooperative organizations in order to increase their bargaining power and then to seize control of higher and higher levels of the cocoa chain, when conditions are right. If the Cocoa Board would allow an exception to its raw bean export monopoly for Kuapa Kokoo so that it could process without first buying back its own beans, then conditions would be perfect for the cooperative to open a processing plant. If this can be done it will represent the most long-term and impactful method for increasing the benefits of cocoa to farmers and to the economy as a whole in Ghana.

Chapter 6: Conclusion

The objective of this thesis was to explore several different potential policy options for increasing welfare in the cocoa industry for individual producers and for producer countries. Over the past several decades there have been many changes in the cocoa industry, including a dramatic increase the buyer power of chocolate companies and especially of trader-grinders in the middle of the chain. Cocoa producers have always earned only a small fraction of the value in the chocolate industry, but this gap is widening further and further as chocolate and processed cocoa prices rise but raw cocoa prices fall. As a result, investment at the farm level has dropped, and production of cocoa is expected to drop in the near future, unless something changes. This crisis has attracted the attention of the industry, including the trader-grinders and chocolate companies, which are helping to fund initiatives to increase cocoa yields. However, in order to see a sustainable improvement in the vitality of cocoa production, it is crucial to take into account real, long-term producer welfare. Yield increases alone are unlikely to generate such long-term, sustained welfare improvements.

In order to analyze what policies might generate a long-term producer welfare increase, this thesis was divided into three substantive sections, which examined three different broad policy options. The first, in Ch. 3, looked at measures to increase yields, the second, in Ch. 4, examined the notion of increasing local vertical integration into cocoa processing, and the last, in Ch. 5, looked at increasing cocoa producer market power through the formation of cooperatives, and potentially vertical integration by such cooperatives into processing as well. These different policy measures were all examined in the context of Ghana, which was chosen because it is both the second-largest cocoa producer in the world and the country with the highest level of government control over the cocoa industry, and thus ability to make decisions which enhance producer welfare.

The results of Ch. 3 showed that use of fertilizer has the highest marginal effect on cocoa yields, though the Ghanaian government's CODAPEC spraying program, access to extension services, and membership in the CCP cooperative also has significant positive effects on yields. Interestingly, fertilizer and CODAPEC spraying had a higher marginal effect on smaller farms, though wealthier farmers and those with more land tended to have higher access to both services. This suggests that efforts to better target poor, more marginalized farmers with CODAPEC and fertilizer access programs could significantly increase production.

Also, both directly and indirectly, through its impact on machinery and fertilizer use, access to input support and credit was found to be significant. Membership in cooperatives was found to increase access to such support, but so did being male, having higher levels of wealth, and having more land. Thus, the government should consider promoting formation of cooperatives, but could also work to target credit programs at more marginalized farmers, like females, sharecroppers, and those with less acreage. Additionally, though it did not have a significant effect on input support allocation, higher local buyer competition resulted in a more positive perception of the future and less cheating by buyers, and so it is recommended that the Ghanaian government continue to promote such competition between local buyers.

If farmers are not cheated, receive credit so that they can buy inputs, and receive access to promised government services like the CODAPEC spraying, subsidized fertilizer, and extension, then they will be able to earn higher incomes from cocoa. This will increase the probability that they continue farming in the future and make investments to increase cocoa yields.

However, policies which merely aim to increase cocoa production do not necessarily provide the highest long-term welfare for cocoa-producing countries. When a country exports cocoa beans exclusively in raw form, it is missing out on the majority of profits earned in the value chain. The Ghanaian government has long realized this. They set up the government-run CPC factory to produce intermediate processed cocoa products as well as chocolate, as early as 1965, and have a current goal of processing 60% of their beans domestically by 2016 (up from 30% in 2011). However, the CPC has faced many financial problems throughout its history and today operates far below capacity. The Ghanaian government maintains a majority ownership in the CPC (which is technically privatized), but its policies to increase domestic processing have shifted.

Currently the focus tends to be on attracting private, mostly foreign, processing companies to set up shop in Ghana, though various tax incentives and a discount on light crop beans available only to domestic processors. This has attracted a number of companies, especially large MNCs, over the past decade. However, there are still a number of challenges that face cocoa processing operations in Ghana, including high energy costs, distance from the major markets and customers, difficulties in acquiring and maintaining expensive equipment, and above all, the shortage of discounted light crop beans. Main crops beans from Ghana attract a 10% price premium on the world market, and domestic processors complain that they cannot compete with processors in other countries if they also must pay full price for most of their beans.

A model was developed to optimize total Ghanaian welfare from cocoa in terms of the percent of beans exported versus processed at home. Results of simulations run on the welfare optimization model, using reasonable real-world estimates of the exogenous variables, surprisingly showed that under current circumstances, Ghana is actually better off exporting all of its beans in raw form. Only if 60% or more of the profits derived from local processing accrue to local Ghanaian interests does it become optimal to process part of the cocoa harvest domestically. Other circumstances in which local processing was found to make sense were when processed cocoa prices are dramatically higher than raw prices, and when the export demand for cocoa is highly inelastic. However, the major conclusion was that increasing domestic processing is not actually welfare enhancing when most of the processing factories are owned by foreign interests.

This analysis suggested that rather than focus on tax incentives and discounts to attract any processing companies, including foreign MNCs, to Ghana, the government ought to focus on promoting locally owned processing companies. Several ways to do this include differential incentives (tax cuts, subsidies, discounts) for locally owned versus foreign companies, promotion of joint ventures between local companies and MNCs, and efforts to revive the flagging CPC.

Another option is to encourage the largest cocoa cooperative in the county, Kuapa Kokoo, to vertically integrate into processing, which would require a policy change wherein the cooperative could retain and process its own beans rather than selling them first to the Cocoa Board. This was investigated in Ch. 5, which first looked more generally at the benefits and success factors of cooperatives, then focuses more narrowly on cocoa and on vertical integration by cooperatives.

The cocoa industry is composed of a few genuine, farmer-owned and -operated cooperatives, but many more “cooperatives” are set up and run primarily by outside organizations, in order to facilitate working with smallholder farmers for that organization’s own ends (the CAA and CPP in Ghana can both be characterized in this way). This latter type of cooperative can still be effective in channeling extension and other services to farmers, and in obtaining certification and price premiums, but they do not create the type of long-term market power which genuine cooperatives have the capacity to generate.

When a cooperative is actually operated by its members, who act as shareholders and decision markers, then it has a much higher chance of improving its members’ long-term welfare. Such a cooperative might even be able to vertically integrate into transportation, marketing, processing, and export, sharing the increased profits with its members. Success factors which make such a scenario more likely include reliable raw material supply (ensured by enforceable contracts with members, a large member base, commitment and loyalty, and structures to purchase from non-members when supplies are low), strong government support without interference, professional management with a strategic market focus, and underlying market and product characteristics that favor cooperative buyers over IOFs (for example perishability and a preference by consumers for Fairtrade).

Unfortunately, cocoa is easily storable and transportable after initial fermentation and drying, plus its processing requires expensive machinery, so cooperatives are at a major disadvantage if they wish to vertically integrate. However, the El Ceibo cooperative in Bolivia has succeeded in full vertical integration, through chocolate manufacture and retailing, and it might be possible to replicate this success in West Africa. Though El Ceibo has advantages which Kuapa Kokoo in Ghana lacks, there are still a number of favorable circumstances which mean the time may be ripe for Kuapa Kokoo to set up a factory in Ghana. The key is the policy change previously mentioned, allowing the cooperative to process its beans directly without selling them first to the Cocoa Board. This would provide Kuapa Kokoo with a significant cost advantage vis-à-vis its competition both domestically and abroad, so it would have a high chance of succeeding.

Overall, this thesis has shown that multiple policies are necessary in order to increase cocoa producer welfare in Ghana and the other countries of West Africa. Increasing yields is important, and above all requires structures to train and provide inputs (or credit for inputs) to farmers. But more important are measures to sustain high prices, prevent cheating, and enable farmers to earn a higher share of the profits in the whole cocoa value chain. To that end, this thesis provides strong evidence that only locally owned, and not foreign-owned domestic processing is important, and that processing operations run by producer cooperatives would have the highest impact on farmer welfare. This notion is not as far-fetched as it may appear, at least in Ghana, where Kuapa Kokoo could probably succeed in setting up such a factory given adequate support from the government. Such a scenario would have the highest direct and sustainable impact on cocoa producer welfare.

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