An Analysis of the Effect of The Cote D'Ivoire-Ghana Cocoa Initiative's Living Income Differential on Farmer Welfare

By

Chris Lee

Presented in Partial Fulfillment of the Requirements of Junior Independent Study for the Economics Department at the College of Wooster

Advised by

Dr. Sookti Chaudhary

Department of Economics

Spring, 2023

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

Côte d'Ivoire and Ghana supply 44.4 and 16.3% of the world's cocoa, respectively, but only receive a small fraction of the profit generated by the cocoa sector and its derivatives globally, according to the World Bank. Virtually all cocoa in these two countries are produced by smallholder farmers, the vast majority of whom struggle to reach a livable income. To combat this inequity, Côte d'Ivoire and Ghana launched the joint partnership "Côte d'Ivoire – Ghana Cocoa Initiative" (CIGCI), that's been dubbed the Cocoa OPEC. CIGCI has attempted to leverage the two countries' combined dominance of the cocoa market to institute a $400 price premium (2019) for cocoa sold by the two countries, known as the Living Income Differential (LID). It is currently the central component of CIGCI's strategy to increase farmer economic well-being.

The goal of this paper is to evaluate the efficacy of the LID to achieve a livable income for farmers in Côte d'Ivoire and Ghana. We will first examine existing literature on the topic and identify the models that best reflect the market structure of CIGCI and the cocoa market. In our theory section, we will illustrate the market dynamics of and the impact of CIGCI forming, and establishment of the LID through the dominant firm model of leadership. We hypothesize that the market dominance of CIGCI will enable CIGCI to raise real prices via the LID for Cocoa in the short term. Given the compensation structure of the parastatal boards of both Côte d'Ivoire and Ghana, we expect the increased revenue to be primarily passed directly to cocoa farmers, leading to a more livable income. We expand our analysis on the long term implications of the LID through modeling the impact of free entry on price and CIGCI market share. This analysis investigates potential methods to protect increased prices and CIGCI market share through

qualitative analysis and the application of game theory to the outcomes of our dominant price leadership model. Finally, we will discuss our analysis and conclude our paper.

Chapter 2: Literature Review

2.1 Overview

The market dynamics of CIGCI are complex. It is at once a cartel, an international cooperative, two nationalized parastatal cocoa boards, a representative for millions of farmers, and the first step in a long cocoa value chain. Extensive research exists on both the theory of the firm and on measures implemented to improve living conditions in the cocoa market (such as the LID). However, little research exists that applies industrial organization models for commodity goods to these cocoa firms. Achieving an intersectional understanding of CIGCI and its LID price premium, modeled by IO theory and informed by existing cocoa research, is the goal of this project. Prior to developing a model for the LID and CIGCI as a price leader, I wanted to contextualize CIGCI's internal dynamics and the cocoa industry as a whole. Learning about what determines cartel success will contextualize the cartel behavior of Côte d'Ivoire and Ghana in regards to cocoa prices. The research article I chose to use to understand cartel behavior for my project is "What Determines Cartel Success" (Levenstein and Suslow, 2006). This article provides a framework to contextualize the cocoa collusion in terms of the existing economic research cartel — and provides insight into where that research might be strong and where it might be lacking. Next, I examined the theorized causes for substandard Cocoa production in the article "An Empirical Analysis of the Determinants of Cocoa Production in Côte d'Ivoire" (Coulibaly and Erbao, 2019) in order to bolster my analysis of challenges to the positive impact of the LID. Particularly, as I hypothesize Côte d'Ivoire and Ghana's market power is essential to

leverage a price premium such as the LID, it is imperative they maintain that market power. I had hoped to find a strong quantitative theory for the factors of production that lead to increased production of cocoa, allowing for sustained market dominance. Understanding the methods the authors used to measure efficient production, in addition to understanding potential challenges, also allows me to better understand what positive impacts of the LID would create. Finally, "The Dominant Firm and the Inverted Umbrella" (Stigler, 1965), gives us our model which best fits the hypothesized market dynamics of CIGCI, a model which is further developed in "How Applicable is the Dominant Firm Model of Price Leadership?" (Rassent and Wilson, 2004).

2.2 "What Determines Cartel Success" (Levenstein and Suslow, 2006)

"What Determines Cartel Success" by Levenstein and Suslow examines factors that determine cartel success and attempts to quantify success through four questions: whether cartels can succeed, how long they can last, what impact they have, and what causes them to break up. The authors argue the most important factors for success, as measured by long-term survival, are the flexibility of collusive agreements, interventions, and inter-cartel monitoring strategies. I found the theoretical analysis to be sound, but the assumption of survivability as the primary determinant of success to be inadequate. The authors acknowledge the fallibility of survivability as a dependent variable. The impact of cartels on prices and the "on-and-off cartel phenomenon" as adjusted measurements for success are discussed and to some degree incorporated, but struggle with consistent measurement. Throughout the article, the difficulty of finding reliable datasets (especially for illegal cartels) was an important and relevant touchpoint, and one major factor holding back the article's analysis. While the author's empirical methodology adequately tests the hypothesis within the scope set out, the article would ideally have included more

extensive analysis of the impact of cartel behavior on investment, productivity, and entry to fully address the initial four questions.

To rigorously analyze whether a rise in cocoa prices is causally linked to the growth of non-agricultural industries in Côte d'Ivoire, the data must be monitored and accurate. The challenges of proper data gathering in cartels have been highlighted in this article. A number of other aspects consequentially, remain unclear. Additional research will be needed to define the "concentration" of the cocoa industry in Côte d'Ivoire and Ghana and how "cheating" is defined within the scope of private firms in these countries. As the collaboration between Côte d'Ivoire and Ghana is still in its infancy, further research is also necessary to explore the benefits of collusion in contrast to the benefits that Côte d'Ivoire, Ghana, or any new members might gain from cheating. It may be difficult to predict the potential impact on other countries and how colluders might prevent entry on an international level across sovereign countries. This research project can build on existing literature on Cartel behavior in the context of Côte d'Ivoire, Ghana, and Cocoa, but it will require further research to understand how private market behavior will translate on a diplomatic level and determine the reliability of available datasets.

2.2 "An Empirical Analysis of the Determinants of Cocoa Production in Côte d'Ivoire" (Coulibaly and Erbao, 2019)

This article by Coulibaly and Erbao identifies the strengths and weaknesses of various factors of production for cocoa in Côte d'Ivoire. The authors extrapolated a future increase in cocoa demand from the growing consumption of cocoa's main products in 2019, given at 2% per annum. While demand temporarily contracted in 2020 due to the pandemic, this theory generally holds. The authors argued they anticipated continued growth despite potential slowdowns in

consumption from mature economies, due to a counterbalanced increase in consumption from emerging economies. Thus, the authors sought to "estimate the quantitative effect of the production factors that lead to insufficient production [of cocoa]" as well as identify their significance. I found the reasoning and proposed methods for analysis to be compelling. However, I was dissatisfied with the conflicting results and my own inability to fully understand their methods. The authors developed a Cobb-Douglas production function to build a model for Côte d'Ivoire's cocoa production and used an ARDL approach for analysis. This was to better capture the short-run and long-run impact of the independent variables on the production function. The authors found a statistically significant coefficient of -1.91 for labor, indicating that a 1% increase in labor decreases production by 1.91 in the long run. They found a statistically significant coefficient of -0.88 for land use, and a zero effect of the political instability dummy variable. The authors stated their findings generally go "against the work of previous researchers," though they did not specify which, and their findings did not logically make sense to me. I was not convinced by the argument of marginal production decreases being sufficient to decrease overall production, nor the theory that "a massive increase in production can decrease production." Moreover, I did not find the quantitative analysis satisfactory to justify these arguments.

Despite my hesitancy to accept the findings of this research article, working to understand their methodology and choice of variables provided good insight into what quantitative analysis I might perform for my research question. I found the ARDL approach to be an interesting choice, and will need to look further into whether the immediate impact of market shocks (such as civil wars or sudden price drops) are fully and accurately captured given the lags. The lack of arable land and efficient production will continue to be an issue in upcoming

years as other nations challenge the market dominance of Côte d'Ivoire. It is important for me to have a strong understanding of the market factors that allow CIGCI to implement the LID. Even if the LID has a strong positive impact in the short-term, either other nations must join the cartel or Côte d'Ivoire/Ghana's factors of production must continue to improve in order to make that impact long-term.

2.3 "The Dominant Firm and the Inverted Umbrella" (Stigler, 1965)

This article by Stigler in 1965 was a flagship application of the model of the dominant firm to the dominant firm U.S. Steel, and gives us a framework for dominant leadership pricing. His study improved upon previous research by providing a more rigorous and structured analysis of dominant price leadership, applied to U.S. Steel and the steel industry. Stigler's model determined the total supply of competitors determines the demand curve of the dominant firm, and consequently the dominant firm's adjusted MC and MR functions determined the price. Stigler found the empirical impact of this price leadership to be hugely beneficial to the dominant firm, using financial returns as a measure of company success. He notes that, from 1901 to 1925, the accumulated market value of U.S. Steel grew to double that of the average competitor.

This brief but historically significant paper provided one of the first clear applications of the Dominant Theory of Price leadership. While I found the underlying assumptions sound and analysis well reasoned, the findings would have more weight if controlled for other factors, such as market conditions or company specific qualities, that could have potentially affected returns.

2.4 "How Applicable is the Dominant Firm Model of Price Leadership" (Rassent and Wilson, 2004)

This article builds on Stigler's model, adding a broader scope of assumptions and specifically incorporating competitors of the dominant firm to be operating in perfect competition under a collective "competitive fringe" of firms. The article's expanded set of assumptions are as follows: 1. A single firm dominates the homogeneous product industry due to its lower production costs. 2. The number of smaller firms, collectively referred to as the competitive fringe, is fixed, i.e., there is no entry. 3. The members of the competitive fringe behave as price-takers, taking the industry price as given. 4. The dominant firm knows the industry's market demand and the supply curve of the competitive fringe. These set of assumptions help us build out our dominant firm model of price leadership into a quantitative framework to evaluate the impact of the LID.

2.5 Conclusion

Using the dominant firm model of price leadership used in Stigler's flagship article and developed by Rassent and Wilson, we can predict the impact and efficacy of the LID in the short term. Our understanding of the determinants of cartel success and substandard Cocoa production informs the model, and allows us to theorize its long term applicability. The continued discussion on the importance of reliable data and accurate assumptions reflected in each of the articles was a reminder to thoroughly evaluate the assumptions of my model and their applicability to the cocoa market. These studies support our analysis of the LID by providing past examples of analysis in the cocoa market, past applications of our model, and evidence to inform our conclusions.

Chapter 3: Theory

3.1 Dominant Firm Model of Price Leadership

Price leadership has had a long evolution in economic discourse. Economist Yoshiyasu Ono in his paper "Price Leadership: A Theoretical Analysis," attributes the primary contributors as Forchheimer (1908), Nichol (1930), Stigler (1947b), Markham (1951), Lanzillotti (1957), Bain (1960), and Scherer (1970). Ono identified three primary forms of price leadership for firms — collusive, barometric and dominant. These forms of price leadership are differentiated by market structure and conduct. In the collusive type, the principal firms set prices which are either explicitly or implicitly followed by other firms in the market, and as a result price is set very close to monopoly price. In the barometric type, the price leader is identified by their superior ability to predict and react to market trends — essentially acting as the trailblazer as the price level drifts towards marginal cost. Finally, in the dominant type, the leading firm utilizes their market dominance to set prices and influence the behavior of other firms in the market.

The specific dominant firm model of price leadership for CIGCI we will reference throughout this paper is sourced from "Modern Industrial Organization, 4th Edition" (Carlton and Perloff, 2005), and informed by the assumptions developed in "How Applicable is the Dominant Firm Model of Price Leadership?" by Rassenti and Wilson. This model assumes a single dominant, price-leading firm and a competitive fringe of smaller, price-taking firms.

I posit that CIGCI (representing both Côte d'Ivoire and Ghana) in the Cocoa Market is best represented in this model of dominant price leadership. The low cost of entry to cocoa production and large numbers of firms (both private and public) are not conducive to a collusive leadership type. Meanwhile, CIGCI is clearly utilizing its market dominance to increase cocoa prices to well past competitive levels, as shown by their application of the LID. Thus, a

barometric leadership type is ruled out as well. Furthermore, the treatment of a commodity cartel (which CIGCI, although only consisting of two members two members, could still be classified as), as a dominant firm has a historical precedent in the Philippine coconut-oil cartel. In "The Creation of Dominant Firm Market Power in the Coconut Oil Export Market," (Buschena and Perloff, 1990) the authors apply a similar model of dominant firm-competitive fringe market structure to the Philippine coconut-oil cartel in the context of the coconut oil export market. Like CIGCI's domination of the Cocoa market, the Philippines produced >60% of the world supply of coconut oil, which Buschena and Perloff believed allowed the Philippines to exercise dominant firm market power. Applying our model to the Cocoa Market, we assume the role of the single dominant, price-leading firm for CIGCI and the competitive fringe of smaller, price-taking firms for the remaining cocoa producing firms and parastatal boards.

In this paper, we will utilize the assumptions of the dominant price leadership model developed in Rassenti and Wilson's paper "How Applicable is the Dominant Firm Model of Price Leadership," to inform our analysis. The assumptions of the this model of price leadership are as follows:

1. A single firm dominates the homogeneous product industry due to its lower production costs.
2. The number of smaller firms, collectively referred to as the competitive fringe, is fixed, i.e., there is no entry
3. The members of the competitive fringe behave as price-takers, taking the industry price as given.
4. The dominant firm knows the industry's market demand.
5. The dominant firm also knows the supply curve of the competitive fringe.

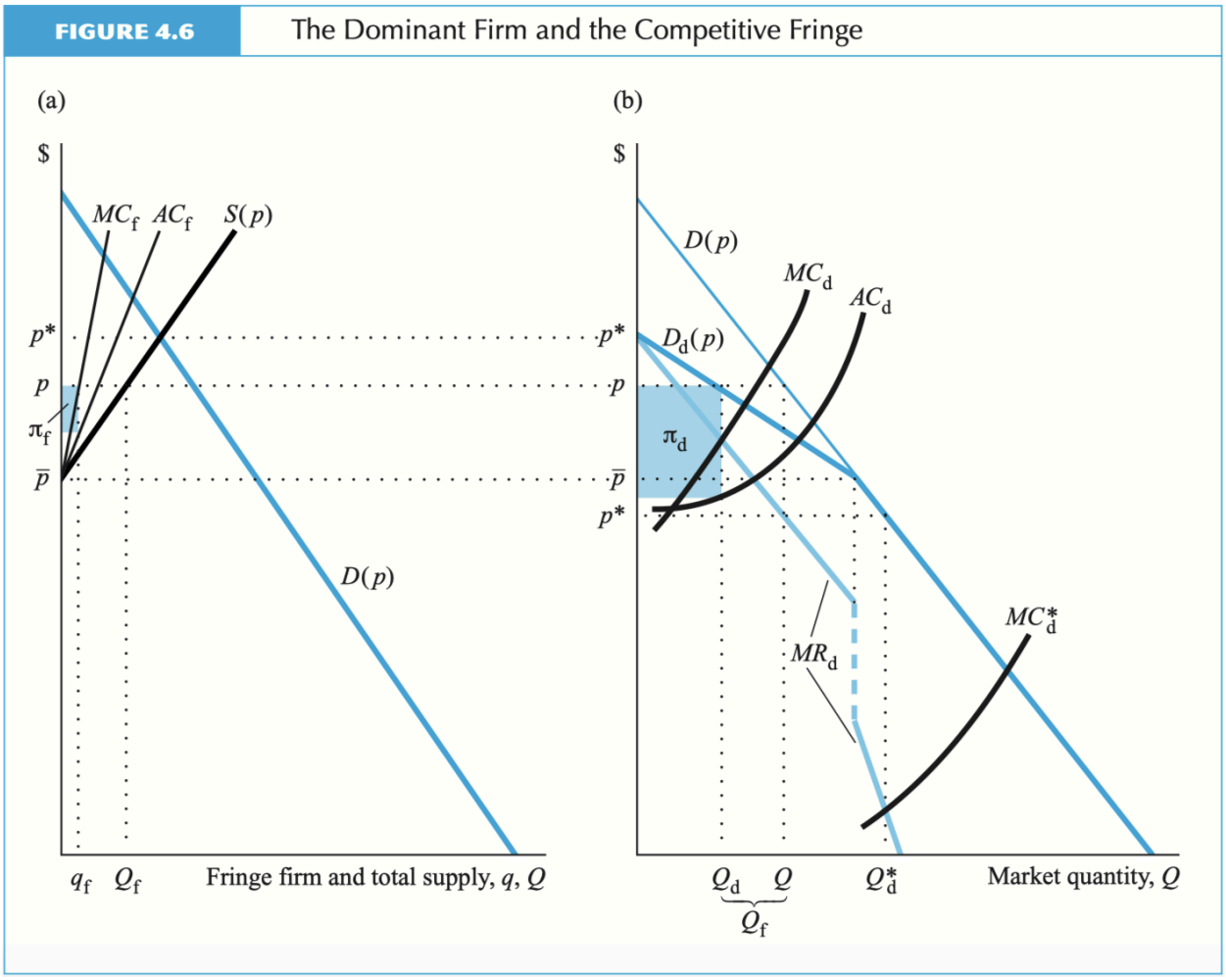
These assumptions can be transposed to CIGCI as follows:

1. CIGCI dominates the homogeneous cocoa industry due to its lower production costs and agricultural commodity economies of scale.
2. In the short-term, the number of smaller firms, collectively referred to as the competitive fringe, is fixed, i.e., there is no entry.
3. The members of the competitive fringe behave as price-takers, taking the industry price as given. The industry price is determined by CIGCI's price.
4. CIGCI has knowledge of the industry's market demand and supply curve of the competitive fringe.

Since the LID is a price premium specifically applied to CIGCI members — and thus functions ostensibly differently than either a monopoly or competitive price, we must apply two additional conditions to the model. First, the $400 price premium applies on top of the global price of cocoa, and only to cocoa bought from members of CIGCI. This means CIGCI will have a higher price than the competitive fringe, who are assumed to be price-takers. Second, to simplify the relationship between price changes for cocoa sold by CIGCI member states and farmer income, we assume that these price increases are passed primarily to the farmers. This assumption is grounded in the founding policy of CIGCI, in which the governments of Ghana and Côte d'Ivoire guaranteed 70% of cocoa's export price of USD 2,600 (USD 1,820/metric ton) to cocoa farmers. (Grohs, Grumiller, and Peham 2023)

3.2 Application of the Dominant Firm Model

The following graphic, figure 4.6, illustrates the behavior of firms in the dominant price leadership model. The fringe competitive firm in our model, a typical cocoa producing firm that is not in CIGCI, is shown on the left side, while the dominant firm, CIGCI as a collective whole, is represented on the right side.



Source: Modern industrial organization, Carlton & Perloff

On both sides, D(p) denotes the total market demand curve. Since the fringe competitive firms operate in perfect competition, an individual firm does not have access to the total market

demand curve. The typical fringe firm's supply function is its marginal cost curve above the minimum of its average cost curve $\bar{p}$, and the gross output of all fringe firms is denoted by S(p). $S(p) = nq_f(p)$, where n is the number of firms and q f is the output of a typical fringe firm. (Carlton & Perloff)

Unlike a monopolist, the dominant firm does not have complete access to the total market demand curve. However, as noted earlier in our assumptions section, the competitive fringe does not produce enough output to supply the total market. Thus, the dominant firm has total access to the remaining market demand unmet by the competitive fringe. This function is the residual demand curve $D_d(p)$, and is calculated by subtracting the competitive fringe's supply curve S(p), from the total market demand curve D(p). The kink in the demand curve for the dominant firm, where the slope shifts from that of the residual demand curve to that of the total market demand curve, represents the shutdown point for fringe firms, where price falls below $\bar{p}$. Since the LID is a price premium on top of the existing market price for Cocoa, only the residual demand curve is relevant for our discussion of the model. Since the dominant firm has total access to the residual demand curve, the dominant firm acts as a monopolist with respect to the residual demand curve, setting MR = MC. The quantity demanded from the dominant firm for this price is denoted as Q_q.

Using this framework for understanding the market structure of the raw cocoa market, we can generically model the cocoa industry. We will establish a sequence for finding equilibrium price, then we will run through examples to specifically estimate the impact of the LID. Here are the market demand curve and market supply quantity, derived from figure 4.6:

1. Market Demand Curve: D(p) where $\frac{\alpha D(p)}{\alpha p} > 0$.
2. Market supply quantity: $Q = Q_f + Q_d$

CIGCI determines their residual demand by subtracting the supply of the competitive fringe from the market demand:

1. Residual Demand Curve: $D_d(p) = D(p) - S(p)$

Since CIGCI acts as a monopolist over the residual demand, we can determine CIGCI's profit maximizing price by setting $MR_d = MC_d$. Since fringe firms are price takers, this adjusted price will determine the output of the competitive fringe, and thus the total market output. This allows us to determine the optimal quantity Q_d, and thus the optimal price p_d, in the following steps:

1. Given the residual demand curve $D_d(p)$, We can also write the inverse residual demand curve as some function of CIGCI's residual demand curve. We can denote this as $p(D_d(p))$.
2. The dominant firm's revenue function is denoted as $R_d = Q_d * p(D_d(p))$. To find the MR_d, we take the derivative of CIGCI's revenue function with respect to the quantity demanded, $\frac{\alpha Rd}{\alpha Qd}$. $MR_d = \frac{\alpha Rd}{\alpha Qd} = \frac{\alpha\,(Qd * p(Dd(p)))}{\alpha Qd}$.
3. The dominant firm's cost function is denoted as $TC = FC + VC * Q_d$. To find the marginal cost, MC_d, we take the derivative of CIGCI's cost function with respect to quantity demanded, $\frac{\alpha Rd}{\alpha Qd} = VC$.
4. Setting the marginal revenue of CIGCI equal to their marginal cost, we have $\frac{\alpha\,(Qd * p(Dd(p)))}{\alpha Qd} = VC$.

Solving this equation for Q_d will give us the optimal quantity, which we can plug into the inverse residual demand function to find the optimal price for CIGCI, p_d. The new price of cocoa bought from Côte d'Ivoire and Ghana, p_d, becomes the industry price, and the competitive fringe adjusts their output and price to the industry price. The competitive fringe supply curve remains the same, since they are still price-takers. This difference between the competitive price and the

price determined by CIGCI represents the price premium added to cocoa bought from Côte d'Ivoire and Ghana.

Let us now take an example to illustrate. Using the following total market demand and fringe supply curves, we will show how equilibrium price is higher with CIGCI as a dominant firm than in perfect competition. Take for example some arbitrary market demand curve to represent the cocoa market.

1. Market Demand Curve: $D(p) = Q = 30 - 3p$

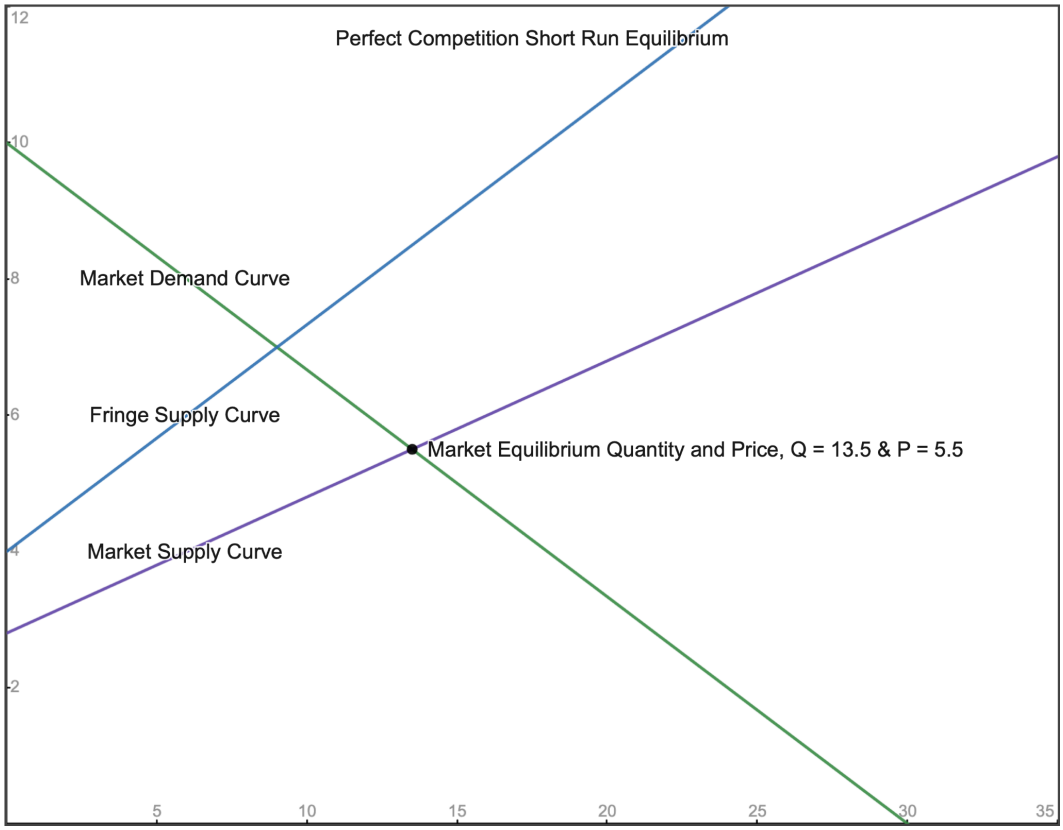
Let us also assume an arbitrary market supply curve and fringe supply curve

1. Market Supply Curve: $S(p) = Q = 14 + 5p$
2. Fringe Supply Curve: $S(p) = Q = 10 + 3p$

We can form the following inverse market demand, supply, and fringe supply curves to graphically represent their relationship and find the equilibrium price.

1. Inverse Market Demand Curve: $P = (30 - Q)/3$
2. Inverse Market Supply Curve: $p = (Q + 14)/5$
3. Inverse Fringe Supply Curve: $p = (Q + 10)/3$

The following figure illustrates this relationship:



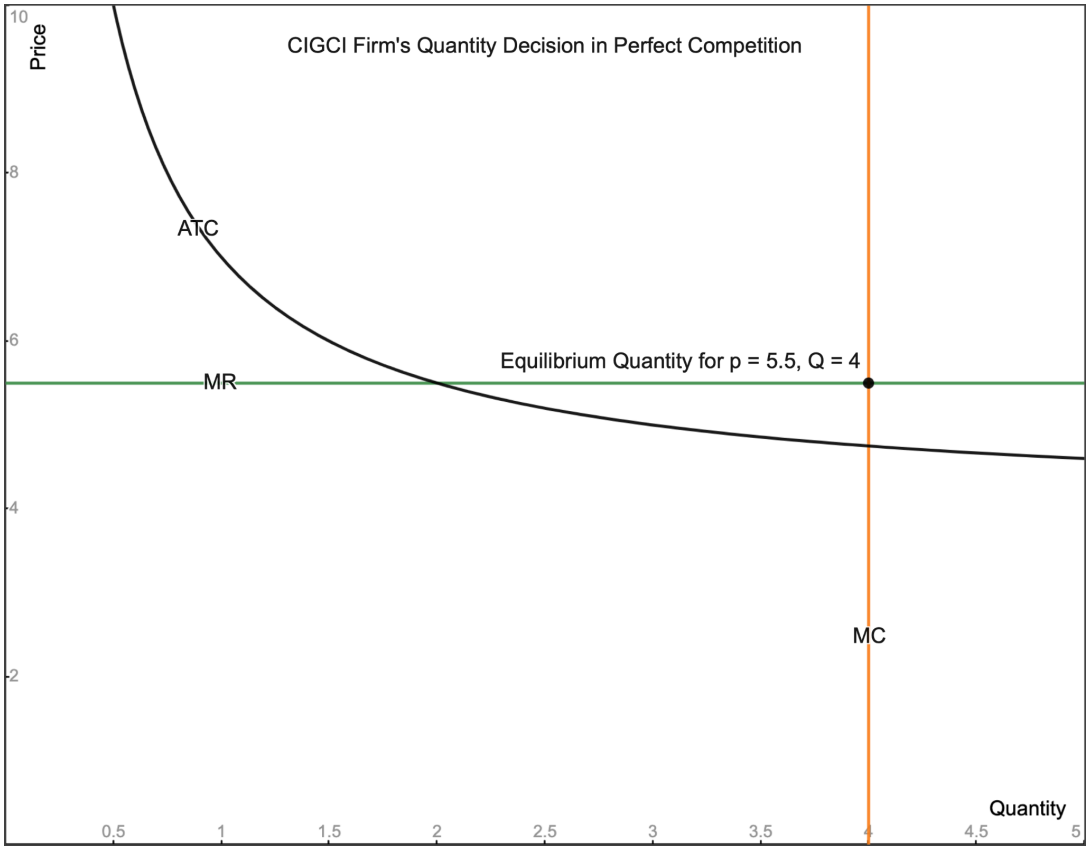
Since all firms in perfect competition are price takers, our CIGCI firm takes the equilibrium market price as given, so MR = P. Let us assume an arbitrary linear cost function for our CIGCI firm:

1. TC = (FC) + (VC) * (Q) = (3) + (4) * (Q)

To determine optimal output, our firm takes the derivative of TC to find MC, and sets output to where MC = P.

1. $MC = \frac{\alpha\,(1 + 4 * Q)}{\alpha Q} = 4$
2. ATC = $\frac{3}{Q} + 4$

The following figure illustrates this relationship:



To calculate profit, we subtract TC from TR:

1. Profit = TR - TC = P * Q - TC = 5.5 * Q - (3 + 4Q) = 5.5(4) - 3 - 4(4) = 3 units

Now let us compare this to the CIGCI firm utilizing the residual demand curve to implement an LID, taking the same inverse market demand, supply, and fringe supply curves:

1. Inverse Market Demand Curve: P = (30 - Q)/3
2. Inverse Market Supply Curve: p = (Q + 14)/5
3. Inverse Fringe Supply Curve: p = (Q + 10)/3

We take the previously discussed steps to calculate optimal price and quantity. CIGCI first determines their inverse residual demand curve by subtracting the supply of the competitive fringe from the market demand:

1. Inverse Residual Demand Curve: $p(D_d(p)) = D(p) - S(p) = (30 - Q)/3 - (Q + 10)/3 = 20/3 - (2Q)/3$

The dominant firm's revenue function is denoted as $R_d = Q_d * p(D_d(p))$. To find the MR_d, we take the derivative of CIGCI's revenue function with respect to the quantity demanded, $\frac{\alpha Rd}{\alpha Qd}$.

1. $MR_d = \frac{\alpha Rd}{\alpha Qd} = \frac{\alpha\,(Qd * p(Dd(p)))}{\alpha Qd} = \frac{\alpha\,(Qd * (20/3 - (2Q)/3)}{\alpha Qd} = 20/3 - 4Q_d/3$

Taking the same marginal cost function as before and setting the marginal revenue of CIGCI equal to their marginal cost, we have

1. $MR = 20/3 - 4Q_d/3$
2. $MC = 4$
3. $20/3 - 4Q_d/3 = 4$
4. $Q_d = 2$
5. $P = 20/3 - (2Q)/3 = 20/3 - (4)/3 = 16/3$

To calculate profit, we subtract TC from TR:

2. Profit = TR - TC = P * Q - TC = 2*16/3 - (3) + (4) * (2) = 47/3

Using this framework and the given assumptions, we can see that the introduction of the LID by CIGCI has significant positive implications on the equilibrium price and quantity in the cocoa market. CIGCI is able to utilize their dominant position in the industry and assume lower production costs to leverage their market power and raise prices. By acting as a monopolist over the residual demand, CIGCI may set a price premium that determines the output (and price) of the competitive fringe. The competitive fringe adjusts their output and price to the higher industry price, which leads to an increase in their output and an increase in their price. The Cocoa bought from Côte d'Ivoire and Ghana is higher than the industry price, which is also

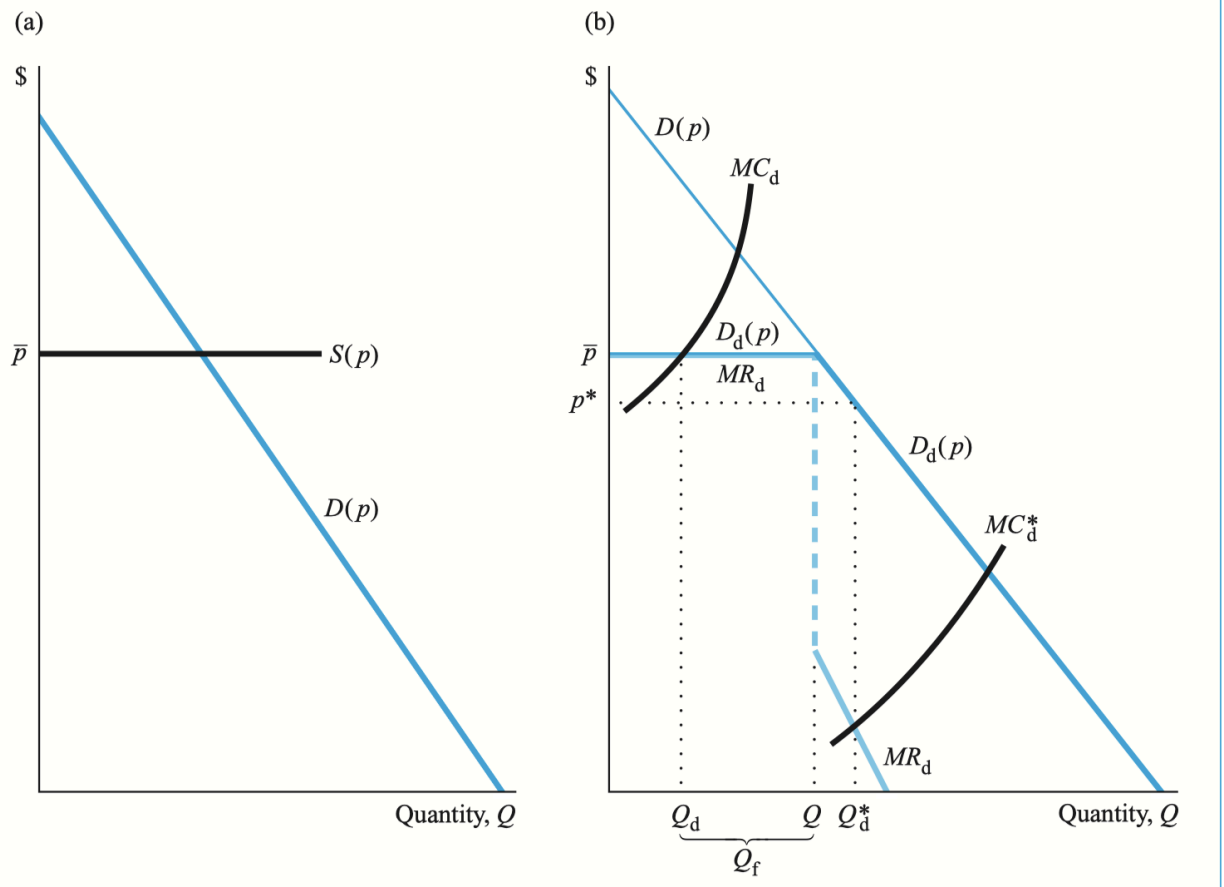
higher than the original industry price without the LID. Higher prices result in higher profits for both the competitive fringe and CIGCI, even though CIGCI produces a lower percentage of the total market quantity.

Assuming these profits are passed directly to the farmers, the impact of the LID would lead to improved economic outcomes in the form of increased income for Ivorian and Ghanaian cocoa farmers. We can assume this translates to other members of the competitive fringe with nationalized cocoa industries, who experience the windfall of the increased global prices.

3.3 Long Term Implications

It is important to note that while this model indicates a positive impact of integrating of CIGCI's LID into the market in the short term, it does necessarily indicate the LID will remain impactful in the long term. The long impact of the LID on the economic well-being of cocoa farmers in Côte d'Ivoire and Ghana is dependent on several factors, including the level of adoption of the initiative, the efficiency of its implementation, the distribution of the premium among farmers, and the ability of CIGCI to prevent cheating. Perhaps most importantly, the long term impact of increased prices may create shifts in the market structure of cocoa. Increased prices would create incentives for farmers and firms to enter the competitive fringe, assuming firms are making positive profits. Unlimited entry to the fringe would negate the market influence of CIGCI to increase prices above the competitive equilibrium. The following graphic, figure 4.7, illustrates the impact of unlimited entry:

FIGURE 4.7 Dominant Firm with Free, Instantaneous Entry by Fringe Firms



Source: Modern industrial organization, Carlton & Perloff

With unlimited entry, the supply curve of the competitive fringe is nearly flat, and thus the residual demand curve is also flat above the shutdown price for a fringe firm, $\bar{p}$, whereafter it becomes the market demand curve. Due to the dominant firm's lower cost of production, the dominant firm can still make profits, and even set prices below the shutdown price for a fringe firm at p* to push fringe firms out of the market. Nevertheless, if fringe firms flood the market whenever positive profits are being made, the dominant firm cannot dictate a higher price than the competitive equilibrium. As market demand and fringe supply elasticity increase, the market

power of the dominant firm decreases. This relationship is shown in the following derivation from Carlton and Perloff, where ϵ_d = residual demand elasticity, ϵ = market demand elasticity, and η_f = supply elasticity of the fringe.

$$\epsilon_d = \frac{Q}{Q_d}\epsilon - \frac{Q_f}{Q_d}\eta_f$$

If the supply curve of the competitive fringe is inelastic, then their response to the price increase will be limited, meaning the impact on global supply would be limited and the competitive fringe is unable to increase their output to take advantage of the higher price. However, if the competitive fringe has a highly elastic supply curve, then their response to the price increase could increase the overall supply of cocoa in the market, as smaller firms increase their output to take advantage of the higher price. This relationship and threat of entry is a significant barrier to the long term implementation of the LID and improving the economic well being of farmers.

3.4 Production and Limit-Pricing Games

Given the negative impact of unlimited entry on long term equilibrium price and CIGCI's market power, CIGCI would be best served increasing barriers to entry in the cocoa market. I see two primary ways this can be accomplished. First, CIGCI can pair the LID with increased advocacy for sustainability standards in cocoa production. This would both serve to increase the cost of entry, and provide further structure for profits to be passed to farmers. Although sustainability standards, such as Fairtrade or Rainforest Alliance, have been contested in the past, recent research has indicated positive economic benefits for farmers. (Sellare, Meemken, Kouamé, and Qaim, 2020) Second, countries whose parastatal boards are members of CIGCI can

leverage their supply networks and influence across the cocoa value chain to offer preferential treatment to CIGCI member firms. Côte d'Ivoire, for example, is already investing in increasing national cocoa grinding capacity. (Person & Aboa, 2023) This would theoretically allow Côte d'Ivoire and other CIGCI member firms a greater share in the value chain profits, as well as leverage in price negotiation. By continually and jointly investing in multiple aspects of the cocoa value chain, CIGCI may gain a greater capacity to dictate terms and improve farmer welfare. Combined with sustainability standards to increase costs of production, these barriers to entry and advantages in cost could empower CIGCI to prevent the negative effects of free entry on price and the CIGCI's market share, and even incentivize existing firms to join CIGCI and further strengthen the cartel's market dominance.

We will examine two games to illustrate the challenges and importance of these measures. Game theory is, in short, the study of strategic interactions between rational agents. The field was founded by mathematician John von Neumann, who wrote his first paper on game theory in 1928, and popularized it in his collaboration with economist Oskar Morgenstern in their groundbreaking book "Theory of Games and Economic Behavior." (Stanford, 2023) In the context of our paper, game theory is particularly useful to examine incentives to cooperate or compete in the Cocoa market.

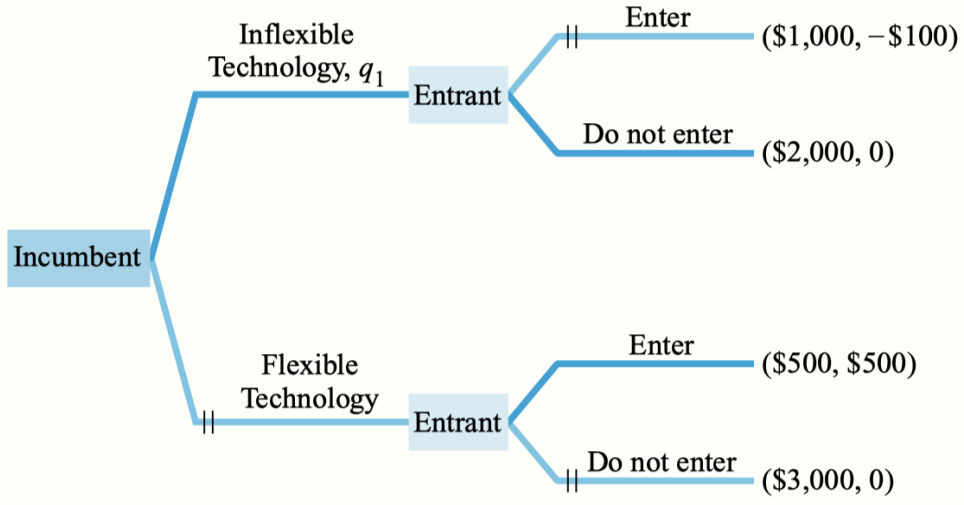
This payoff matrix with symbolic values for CIGCI and an existing fringe firm operating in perfect competition, illustrates the benefits of the LID, and incentives for a fringe firm to increase output (or enter the market):

	CIGCI Implements LID	CIGCI Does Not Implement LID
Fringe Firm Maintains Output	+Profits for CIGCI +Profits for Fringe Firm (+2, +2)	Flat Profits for CIGCI Flat Profits for Fringe Firm No Change in Market Share (0,0)
Fringe Firm Increases Output	+Profits for CIGCI -Market Share for CIGCI +Profits for Fringe Firm +Market Share for Fringe Firm (+2.5, +1.5)	-Profits for CIGCI -Profits for Fringe Firm -Market Share for CIGCI (-1, -1)

As shown, both the fringe firm and CIGCI gain an economic advantage from the LID. Because CIGCI acts as a monopoly over the residual demand curve, increased prices are maintained even as the fringe firm increases output to match MC and P. However, as discussed in the previous subchapter, these profits also incentivize firms to enter the market.

The following figure 11.3, an extensive-form representation of the limit pricing game, illustrates why a firm should utilize means of increasing barriers to entry to maintain high prices and market share:

FIGURE 11.3 Extensive-Form Representation of Limit Pricing Game



Note: The incumbent's profit is the first in the pair of payoffs.

Source: Modern industrial organization, Carlton & Perloff

For this incumbent to determine its optimal strategy, it works backwards to determine the moves for the entrant. The pathways with two lines through them are nonoptimal for the incumbent. Thus, although choosing an inflexible technology results in lower overall profits for the incumbent, the credible risk of an entrant makes the choice subgame perfect. This is applicable to CIGCI in the sense that, at least initially, sustainability standards and investment in the cocoa value chain will incur additional costs on CIGCI members. Nonetheless, the threat of entry is a credible enough threat to price and CIGCI market share to make those choices optimal.

Chapter 4: Conclusion

4.1 Limitations

The assumptions in the model introduce a number of limitations in attempting to capture the full dynamics of the cocoa market. Firstly, the model cannot capture the full pricing dynamics of Cocoa. While global Cocoa prices are generally reflected in London Cocoa Futures, certain beans are considered “premium” and may be sold for a higher price. However, given the general homogeneity of the market, I elected not to create additional complexity in the model by attempting to add this. This is a strong possible area for further research in terms of understanding areas for cocoa sector sustainability growth in CIGCI members. Our model also assumes the sustained dominance of CIGCI fundamentally stems from its lower production costs. However, this does not take into account the colonial legacy of Cocoa production in Côte d'Ivoire and to a lesser extent Ghana. In the future, it may be useful to perform a more in depth examination of the root causes of dominance in the cocoa market. This research could significantly alter the model and potentially lead to important insights on how to increase farmer wellbeing and maintain dominance. Finally, in future research I would aim to more thoroughly integrate the internal dynamics of CIGCI, using cartel theory and payoff matrices for cheating. This would more accurately reflect the internal challenges CIGCI faces in the widescape adoption of the initiative and the efficiency of its implementation.

4.2 Conclusion

In this paper, we set out to model the complex market dynamics of CIGCI and the cocoa industry, using the dominant firm model of price leadership for CIGCI sourced from “Modern Industrial Organization, 4th Edition” (Carlton and Perloff, 2005), and informed by the assumptions developed in “How Applicable is the Dominant Firm Model of Price Leadership?” by Rassenti and Wilson. We identified a gap in the literature between the theory of the firm and

on measures implemented to improve living conditions in the cocoa market. By quantitatively applying this model towards CIGCI and its LID price premium, we determined the LID would be effective in the short term in increasing farmer economic well being, assuming profits are passed directly from parastatal boards to farmers. We further expanded our analysis of the LID in the long term by modeling the impact of free entry on price and CIGCI market share. The significant negative correlation market elasticity had to prices and market share indicated a need for further efforts to create barriers to entry and advantages for cartel members. We theorized that through investment in the cocoa value chain and advocating for sustainability standards to increase costs of production, CIGCI could potentially prevent the negative effects of free entry on price and the CIGCI's market share. We further demonstrated these conclusions through a short series of production and limit-pricing games. While its long term efficacy remains to be seen, our model indicates the LID's implementation may lead to significant improvements to the income of cocoa farmers in the short term. Given the dire need for improved economic conditions and liveable wages for cocoa farmers, the LID is a step in the right direction.

Proposed Senior I.S. Timeline

Week 1: Re-examine Junior topic for Senior IS and flush out research proposal.

Week 2: Meet with assigned advisor to transition proposal into a finalized topic, research question, and areas to dive into literature.

Weeks 3 –4: Identify and review relevant literature and brainstorm how to connect theory models to real world data.

Weeks 5 –6: Redevelop and develop a first draft of the theory chapter. Begin to draft updated literature review and gather datasets.

Weeks 7 –8: Finalize proposal for first and second reader. Complete full draft of theory and critical reviews of each literature source. Identify gaps in data (if applicable), and close them.

Weeks 9 –11: Finalize theory section and complete full draft of literature review. Clean datasets and begin to think about empirical methodology.

Weeks 12 –13: Complete revisions of theory section and literature review.

Week 14: Connect theory models to empirical methodology, begin to write methods and data.

Weeks 15-16: Flush out methods and apply data. Verify validity of results.

Week 17: Draft analysis of results and develop a full outline of methods and data chapter.

Weeks 18 : Complete draft of methods and data chapter.

Week 19: Finalize introduction and draft conclusion.

Weeks 20 –21: Update theory and literature review as needed. Finalize all chapters.

Week 22: Final Revisions- IS Due by 03/25 by 5 pm.

Weeks 23-25: Prepare for oral defense and symposium presentation.

Works Cited

Bermudez, S., Voora, V., Larrea, C., & Luna, E. (2022). Cocoa Prices and Sustainability. The Sustainable Commodities Marketplace Series. Retrieved April 24, 2023, from https://www.iisd.org/publications/report/global-market-report-cocoa.

Rassenti, S.J., Wilson, B.J. How Applicable is the Dominant Firm Model of Price Leadership?. Experimental Economics 7, 271–288 (2004). https://doi.org/10.1023/B:EXEC.0000040561.02540.3f

Carlton, D. W., & Perloff, J. M. (2005). Modern Industrial Organization (4th ed., ISBN 9780321223418). The Addison-Wesley Series in Economics. Pearson/Addison Wesley.

Cabral, L. M. B. (2017). Introduction to Industrial Organization (2nd ed.). Cambridge, MA: MIT Press.

Grohs, H., Grumiller, J., & Peham, A. (2023). Potentials for improving the socioeconomic situation of Ghanaian cocoa farmers: The role of sustainability initiatives. Austrian Foundation for Development Research (ÖFSE) Research Reports, (16/2023).

Ono, Y. (1982). Price Leadership: A Theoretical Analysis. Economica, 49(193), 11–20. https://doi.org/10.2307/2553520

Sellare, J., Meemken, E.-M., Kouamé, C. and Qaim, M. (2020), Do Sustainability Standards Benefit Smallholder Farmers Also When Accounting For Cooperative Effects? Evidence from Côte d'Ivoire. Amer. J. Agr. Econ., 102: 681-695. https://doi.org/10.1002/ajae.12015

Person, & Aboa, A. (2023, January 27). Ivory Coast to boost cocoa grinding capacity with new plants. Reuters. Retrieved May 8, 2023, from https://www.reuters.com/world/africa/ivory-coast-boost-cocoa-grinding-capacity-with-new-plants-2023-01-27/

Von Neumann and the Development of Game Theory . (2023). Retrieved 8 May 2023, from https://cs.stanford.edu/people/eroberts/courses/soco/projects/1998-99/game-theory/neumann.html