

Causality and Comparative Advantage:
Vietnam's Role in the Post-ICA International Coffee Market

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1. Abstract

Although Vietnam comprised a miniscule portion of the international coffee market during the 1900s, its coffee production skyrocketed after the collapse of the ICA and surpassed Colombian production levels. This unmatched increase attributed the drastic decline in world coffee prices to the oversupply of coffee from Vietnam. Following the methods of Dodaro (1993), a Granger causality analysis between Vietnamese coffee exports and ICO composite price produced neither forward nor reverse causality between these two variables. Using the methodology of Carlin, Glyn, and Van Reenen (2001), labor productivity comparisons aimed to explain the shift of coffee export volume from Colombia to Vietnam. Results demonstrated Colombia's consistently higher labor productivity, thus the disparity in realized comparative advantage does not explain the shift in production. Although Vietnam's success in coffee production accompanied the Colombian coffee sector's demise, a direct link between the two economies does not appear to exist. Vietnam's success likely arose simply from the culmination of relevant government policies, trade agreements, and the collapse of the ICA.

2. Introduction

Through the consideration of historical events surrounding the restructuring of major coffee producers, this analysis predicted the rapid increase in Vietnamese coffee production as a significant causal factor in the recent decline in world coffee prices. Furthermore, this analysis hypothesized that the disparity between Vietnamese and Colombian comparative advantage is the prominent factor supporting the transfer of coffee export volume and market control between these two countries. The labor-intensive properties of the coffee crop suggest labor productivity as the needed measure to determine comparative advantage in coffee producing nations.

Since the collapse of the International Coffee Agreement (ICA) in 1989, the composition of the world's coffee producers drastically shifted. Colombia was one of the largest coffee producers in the world, second only to Brazil; however, within ten years of the collapse, the Vietnamese coffee sector overtook Colombia to become the second largest world producer. Throughout its existence, the ICA imposed quotas on coffee production to artificially uphold the world coffee prices. This created a tightly regulated coffee market in which non-members, such as Vietnam, faced greatly limited production. After the collapse of the ICA, the coffee market became fully competitive and open to all producers. (Luong & Tauer, 2006) The Vietnamese government viewed this event as an opportunity to implement market-oriented policies that promoted free and global coffee production and competition. Vietnam's coffee sector is widely believed to be the main cause leading to the coffee price crisis of 2001 due to its unmatched increase in coffee production between 1989 and 1999. (Luong & Tauer, 2006)

The following analysis focused on the coffee sectors of Colombia and Vietnam, as well as the events connecting these two large markets. Coffee production was relatively unimportant to the Vietnamese economy until the late 1980s (Thang & Shively, 2008), yet this small country

overtook one of the largest coffee producing nations in the world in a span of only ten years (see graph 1). The goal of this analysis was to determine whether Vietnam deserves the causal role in the world price decline, as well as the reasoning behind the radical shift in coffee export volume among producing nations. Following previous research, this paper presents a Granger causality analysis to evaluate the possible existence and direction of causality between the increased Vietnamese production and the declining world coffee prices. Furthermore, this paper includes a comparison of labor productivity between the coffee sectors of Vietnam and Colombia, which provides a method to examine Colombian and Vietnamese comparative advantages in the agriculture sector. The disparity between these countries would not be fully realized until the 1990s when the coffee market was deregulated; therefore, comparative advantage is predicted to explain the reallocation of coffee export volume to the more productive country, Vietnam.

3. Historical Background

3.1 The International Coffee Agreement

The international coffee market remained free of interventions before 1900, but many coffee producing nations were experiencing detrimental economic impacts from the persistent fluctuation of coffee prices. These negative impacts provided incentives to intervene in the international coffee market in order to sustain the world coffee price. The Brazilian Federal Government implemented the first market intervention in 1921 by preventing the export of large stocks of coffee. This policy lasted until 1940, when after destroying 78 million bags of stored coffee in a span of thirteen years, Brazil dropped this costly policy and increased its exports to regain 63% of the world coffee market. Many Latin American countries, such as Colombia, directly benefited from Brazil's reduced exports, which provided them with little interest in an export reduction agreement. However, when the European countries banned all coffee imports

during World War II, the negative impacts of low prices reverberated through all Latin American markets, thus initiating the producers' interest in international market regulations. (Pieterse & Silvis, 1988)

When the United States suggested the Inter-American Coffee Agreement (IACA), which sustained market prices through limiting coffee exports to the United States and Canada, fourteen Latin American countries immediately agreed and distributed the import quotas accordingly. The IACA's reign was short due to the increase in world coffee prices above the fixed quota price. After the war ended, the Latin American and African coffee producing nations attempted a few more price regulation schemes, yet these agreements also failed due to their inclusion of only the coffee producers. (Pieterse & Silvis, 1988)

The first International Coffee Agreement was signed in September 1963, including both coffee producing nations and the United States on the coffee consumer side. This agreement distributed export quotas to 36 producing nations based on their average exportable production in the previous four years and the application of a plan to reduce production. A major loophole existed in this ICA that allowed members to surpass their production quotas by exporting coffee to countries that were not typically large importers. The intent of the policy was to encourage more nations to consume and demand coffee; however, many members took advantage of this policy and used these countries as trans-shipment points. The members initially shipped their coffee to these new countries and then re-shipped it to the major coffee consuming nations in order to increase their profit. This loophole created major inadequacies in regulating coffee export volume and led to reevaluation of the ICA in the late 1960s. (Pieterse & Silvis, 1988)

The new ICA, signed in 1968, included several provisions holding members accountable for obeying the quota system. If nations surpassed their production limits, they were ineligible

for the annual quota increases, could have their voting rights suspended from the ICA council, and could be forced to withdraw completely from the ICA. This ICA faced its demise in 1972 when the agreement of Bretton Woods broke down and the dollar - the unit of denomination for coffee prices - depreciated against other major currencies. After the depreciation began, the producers attempted to form a cartel in order to receive a higher price for their exports. The United States, however, did not support any sort of producer cartel, thus the economic provisions of this ICA were suspended in December 1972. (Pieterse & Silvis, 1988)

After the suspension of ICA 1968, the coffee market experienced a rise in coffee prices due to an unexpected severe frost in Brazil, flooding in Colombia, and social unrest in Angola. A new ICA was negotiated in 1976, which implemented quota restrictions only when the coffee prices fell below a certain level. However, the unexpected situations in these three major producing countries allowed other countries to greatly increase production to fill the void in coffee exports, which rendered the quota system of ICA 1976 essentially useless. (Pieterse & Silvis, 1988)

The most recent ICA, signed in 1983, utilized export restrictions to stabilize world market prices in order to provide consistent coffee revenues for exporting members and consistent coffee payments for importing countries. Nearly all of the coffee exporting nations participated in this ICA along with 25 importing countries, thus 99% of the world coffee exports were covered by the provisions of ICA 1983. The ICA's reign severely limited the coffee exports from small non-member producers, such as Vietnam, since all coffee demand was met through the ICA controlled exports. The ICA provided member countries, such as Colombia, with appropriate coffee import demand at higher world prices, which were artificially created and upheld by the export restrictions.

All quotas distributed under this ICA required fulfillment on a quarterly basis to ensure a smooth flow of coffee in the world market. Each export shipment required an ICA approved certificate of origin, thus preventing the re-exportation of coffee from the trans-shipment countries. Under this ICA, the composite indicator price (CIP) was the main determining factor in the implementation of the quota system. When the 15-day moving average of the CIP moved out of the stabilization range of 1.20-1.40 US dollars per pound for a certain number of days, the quotas were automatically increased or decreased by fixed percentages depending upon how far out of the range the 15-day moving average CIP had gone. (Pieterse & Silvis, 1988)

Although many experts agree on the effectiveness of the ICA price band, the underlying problems of the ICA outweighed the benefits of the higher price (Ponte, 2001). Despite the typical free riding and quarreling over export quotas among members, the ICA's problems ran much deeper. During the last ICA, low-priced trade with non-member countries progressively increased, thus fragmenting the market between the countries that followed their quotas and those that did not. Importing countries further undermined the principles of the ICA by seeking out cheaper coffee to meet excess demand during the lag before the stable ICA quotas could be adjusted. Lastly, a major factor contributing to the termination of this ICA was the US Cold War politics that strained relations between the United States and Latin American countries including Brazil, Guatemala, and the Dominican Republic. (Ponte, 2001) When ICA 1983 reached its time for renewal, these four problems had reached a level in which the ICA was no longer feasible, and it was allowed to collapse in 1989.

After the collapse of the ICA, the world coffee price exhibited a new pattern of lower prices with much higher variability (see graph 2; Ponte, 2001). Although the lower prices are typical after the collapse of a price-fixing scheme, the unanticipated high variability stemmed

from the sudden loss of government involvement in producing countries. Many producing nations relied heavily on coffee exports as a main source of revenue, thus these governments were highly involved in their country's coffee sector during the reign of the ICA. After the collapse, the governments no longer participated in the price-fixing schemes of the coffee producers, and many grower organizations did not have enough power to effectively control the volume of coffee exports. This resulted in higher concentration of the coffee market since only the livelihoods of large growers could be sustained under the low coffee prices. (Ponte, 2001) Furthermore, the increased concentration directed more of the coffee income to remain in consuming countries while the producers received progressively smaller proportions of the income (Ponte, 2001). During the height of this inopportune environment, Vietnam unexpectedly increased its coffee production to become one of the major coffee producers in the world.

3.2 The Colombia Coffee Sector

Jesuit missionaries planted the first coffee plants in Colombia in 1732 (De Graaff, 1986). Colombia had ideal growing conditions for this cash crop due to its vast deposits of volcanic soil, mild temperatures, and abundant rainfall (Juan Valdez, 2008). Coffee production remained at fairly low levels in Colombia until a law was passed in 1821 that banned all coffee imports (De Graaff, 1986). Through this legislation, the Colombian government firmly established its prominent and lengthy role in coffee trade decisions. Colombian coffee production rapidly increased in the 1870s, which promoted the creation of railways and in turn further stimulated the expansion of production into new areas of the Colombian landscape (De Graaff, 1986).

Although Colombia was the second largest world coffee producer for several decades, this coffee industry experienced several booms and busts throughout its development. The Colombian coffee industry faced its first coffee price crisis in late 19th century; however, this

situation quickly reversed when Brazil implemented a policy to withhold exports from the market, thus forcing the coffee prices to rise in the 1920s. Colombia utilized Brazil's exportation policy as an opportunity to expand its share of the coffee market, thus tripling its planted area and exports during this period of Brazilian price fixing. The next bust in the coffee industry arose as a repercussion from World War II. At this time, Colombia joined many other coffee producing nations to form a quota system that ensured a higher price of coffee on the world market. Similar to the previous price crisis, this negative price trend reversed shortly after the conclusion of the war and by 1954, coffee comprised 83% of total exports from Colombia. (De Graaff, 1986)

Colombia's dependence on coffee fluctuated over time; however, through advancing technology, Colombia eventually produced higher yields on the same plots of land, thus furthering its dependence on revenue from coffee exports. The last major increase in coffee area occurred between 1975 and 1978, when investment money was applied to the cultivation of new land area instead of strictly applying the modern technology to existing coffee plots. This expansion of cultivated area resulted in an oversupply in the domestic economy given that the production level exceeded Colombia's allotted export quota. (De Graaff, 1986)

The National Federation of Coffee Growers (Federacafe), which controlled a major portion of the management, marketing, and price setting areas of the coffee industry, made the Colombia coffee sector unique from other coffee producing nations. Established in 1927, Federacafe began monitoring and controlling the coffee sector through government contracts (De Graaff, 1986). The uniqueness lies in that the government did not personally oversee the coffee sector, rather it delegated all responsibility to this private non-profit entity. Federacafe created the National Coffee Fund in 1940, which received revenues from coffee taxes and employed these revenues to benefit the coffee farmers and develop the Colombian coffee industry. The

Coffee Fund also protected compliant growers through a domestic minimum price, which assisted in the stabilization of farmer incomes despite any fluctuations in world coffee price. (Juan Valdez, 2008) This minimum price especially benefited farmers who traded through the cooperative system developed by Federacafe due to their guaranteed attainment of nearly 75% of this domestic minimum price as income. The effects of the post-ICA coffee crisis resounded across Colombia when the National Coffee Fund terminated this price stabilization, thus allowing the volatility in the internal market to increase and match the price volatility in the world market. (Giovannucci, 2002)

Federacafe's unparalleled marketing strategy included the creation of "Juan Valdez," a cartoon version of a Colombian *cafeteros*, to feature in advertisements and labels on 100% Colombia Coffee. Although this character was internationally known, Giovannucci (2002) argued that in the coffee crisis, the Colombian marketing strategy needed to change in order to more effectively deal with the impacts of the crisis. As of 2001, Federacafe officially retired Juan Valdez and pursued a more appropriate marketing strategy for its coffee (Ponte, 2001).

The extensive direct and indirect government involvement in the Colombian coffee industry positioned the sector to face drastic changes in the structure of production and farmer involvement upon the retraction of government and other price assistance. During the reign of the ICA, coffee was produced on more than 300,000 farms ranging in size from 1 hectare to 100 hectares. Families on farms no larger than 4 hectares controlled the largest number of coffee farms, yet more than 50% of the national coffee was produced on medium or large farms. Near the time of the ICA collapse, the scarcity of suitable land for coffee production significantly increased. In response, Colombian coffee officials promoted the cultivation of a new variety of higher-yielding coffee tree. Despite the good intentions of this policy, the tightening export

quotas coupled with increasing coffee yields led to an oversupply of coffee in the domestic market. (De Graaff, 1986)

In late 1989, the ICA collapsed, and its accompanying quota system was no longer relevant. This collapse encouraged coffee producing nations, including Colombia, to simultaneously export tremendous amounts of coffee on the world market. After the collapse of the National Coffee Fund and the ICA, the large growing organizations disappeared and the composition of producers shifted such that the majority of coffee trees were cultivated by over 500,000 independent coffee growers on small farms (Juan Valdez, 2008). The newly open world coffee market removed Colombia's previous advantage of providing high volumes of steady-quality coffee in favor of newer countries that produced adequate-quality coffees at lower prices. These countries attracted significant portions of Colombia's market in commercial blends, which demonstrates that the Colombian coffee industry did not have the competitive advantage in producing this lower cost coffee, but rather in the production of a variety of high-quality coffee beans (Giovannucci, 2002).

The Colombian coffee industry was likely to suffer after the removal of all protectionist measures due to its lack of competitive advantage in the lower cost coffee. As Giovannucci (2002) argued, the Colombian coffee producers' realization of their lack of competitive advantage in an open market was obvious from their progress toward on-farm diversification. This shift in production, however, occurred only on large farms since smallholders faced significant challenges in diversification due to limited resources and income. Although the Colombian government encouraged diversification through financial policies and sector programs, these incentives led to the production of inefficient crops instead of other cash crops that could ease the dependence upon coffee exports. (Giovannucci, 2002)

The governmental promotion of crop diversification in the early 2000s demonstrates its recognition of the Colombian coffee sector's lack of competitive advantage on the world market despite its position as second largest world coffee producer. Although unsuccessful, the government's attempts at diversification aimed to reduce the Colombian economy's dependence on coffee exports as the main source of export revenue. Only ten years after the collapse of the ICA and prior to the termination of the National Coffee Fund, Colombia unexpectedly dropped in rankings of the world's largest coffee producers, and became third to the previously insignificant Vietnam and Brazil (see graph 1).

3.3 The Vietnamese Coffee Sector

Although coffee was not an important export commodity in Vietnam until the 1990s, the original coffee cultivation in Indochina began in the early 19th century. Coffee was originally brought to this area by missionaries (Robequain, 1939, as cited in Doutriaux, Gesiler, & Shivley, 2008), and by the 1890s, coffee transitioned into a French plantation crop (Salemink, 2003, as cited in Doutriaux et al., 2008). Throughout colonial rule in Vietnam, the French strongly encouraged the cultivation of coffee and rubber for export. Coffee cultivation proved to be more difficult than anticipated, which severely limited the expansion of coffee production. (Doutriaux et al., 2008) The majority of coffee trees originally brought into Vietnam were of the Arabica variety; however, after World War II the *Hemileia vastatrix* attacked the Arabica plants and depleted the output from 64.5% in 1945 to 1.7% in 1957 (Teulieres, 1961, as cited in Doutriaux et al., 2008). The only coffee to survive this disease was the Robusta variety, *Canephora*, which is the type of coffee currently produced in Vietnam. After this disease eliminated nearly all of the coffee plants in Vietnam, the French colonial administration rescinded their encouragements of

coffee cultivation and instead suggested that its inhabitants concentrate on annual crops such as rice (Doutriaux et al., 2008).

After the end of French colonial rule in 1954, most of the Vietnamese coffee cultivation remained in large plantations. The new government in Vietnam also encouraged coffee cultivation, yet they did not desire to limit cultivation to only plantations. In the late 1970s, the government provided incentives of clear and fertile land to induce the ethnic majority to migrate to the less populated highland region. (Doutriaux et al., 2008) The government's promotion of coffee was much more successful than the French colonists' attempts, as seen in the increase in population density in the highlands from 3 persons per square kilometer in 1940 to 77 persons per square kilometer in 1997 (Doutriaux et al., 2008).

Through government encouragement, the cultivation of coffee transitioned from large plantations to large state owned farms and finally to small farmers with an average farm size of 1.2 hectares (Thanh & Shivley, 2008). Accompanying this shift toward small-plot land ownership, the Vietnamese government dismantled the system of state farms and progressed toward a market-based economy, which in turn stimulated an exponential increase in coffee cultivation area and output (Doutriaux et al., 2008). The new market-based economy and the increasing price of coffee on the world market attracted many new farmers to the Vietnamese highlands in the 1980s (see graph 2), thus increasing the number of planted coffee trees and the amount of output in the early 1990s.

This shift in government policy significantly contributed to the drastic increase in coffee cultivation in Vietnam in the late 1980s and early 1990s. Between 1986 and 1996, coffee cultivation areas grew at the rate of 21% annually, and yields grew 6% annually (Minot, 1998, as cited in Doutriaux et al., 2008). By the late 1990s, between 85% and 90% of the planted coffee

area was cultivated by small farmers (Luong & Tauer, 2006), which portrays the success of the Vietnamese government policies in transitioning from large state-owned farms to small market-based producers.

The collapse of the ICA's quota system further contributed to the increased coffee cultivation by removing all barriers on Vietnamese coffee exports and allowing the exportation of an unrestricted volume of coffee on the world market. Vietnam took full advantage of this favorable environment and by the late 1990s, coffee accounted for 6-12% of the total value of Vietnamese exports (see graph 3; Minot, 1998, as cited in Doutriaux et al., 2008). Vietnam's dependence on coffee exports became evident early after the ICA collapse, when Vietnamese GDP increased at an average of 7.7% per year during the period between 1991 and 2001, Vietnam's most prominent coffee exporting years (World Bank, 2002, as cited in Doutriaux et al., 2008).

Accompanying the shift to a market-based coffee sector, the collapse of the ICA contributed the final factors necessary for Vietnam to receive the full economic impact of coffee cultivation. Prior to 1989, Vietnam's market share was 1.2% of the world coffee market. Only ten years after the collapse, the market share jumped to 12.4%, and Vietnam surpassed Colombia to become the second largest world coffee producer. Coffee exports made up the majority of Vietnam's commodity exports at this time. (Luong & Tauer, 2006) The simultaneous government adoption of market oriented policies and the collapse of the ICA placed Vietnam in the prime position to expand the area under coffee cultivation, which resulted in unprecedented increases in the output of Vietnamese coffee.

From their entry and exit analysis, Luong and Tauer (2006) argued that between 1994 and 1999, Robusta coffee prices remained consistently above the entry level price, which

motivated Vietnamese producers to increase production. This new production resulted in an annual increase of 59% in planted area from 1995 to 2000, which occurred during the drastic decline in ICO composite price (see graph 2). The consistently increasing production area in Vietnam during the period of dropping ICO price provided ammunition to blame Vietnam for the drastic and continuous decline in world coffee prices. In the same analysis, Luong and Tauer (2006) also argued that the Robusta price fell back toward the exit level price during the years of 2000 to 2002, which theoretically should induce Vietnamese producers to decrease the planting area. Yet, the Vietnamese increased their production area by 3,400 hectares in 2001. The constant growth in Vietnamese cultivation area even during theoretically unprofitable periods provides a blatant reason for previous ICA members to attribute the cause of the dropping in world coffee prices in the 1990s and early 2000s to Vietnam.

Vietnam's unexpected surge in coffee production, despite the existence of coffee in Vietnam for nearly two hundred years prior, indicates that the country must have held desirable coffee producing attributes that were not initially realized due to the limitations of market interventions. Although the altered government policy and the collapsed ICA contributed to the increase in production, Vietnam's economy needed to possess the appropriate coffee characteristics in order to effectively take advantage of these events. Luong and Tauer (2006) described coffee as a labor-intensive crop because it involves the constant attention of labor forces throughout the year for different production stages, thus a large supply of labor is the main necessity in coffee cultivation. Vietnam had a large population in the late 1980s (63,263,000 people in 1988) which was readily available to migrate to the highlands at the suggestion of the government (The World Bank Group, 2006). These two conditions suggest that Vietnam may

have had higher labor productivity than other coffee producing nations, which would give this country a wide advantage with this labor-intensive crop.

4. Motivation and Methodology

4.1 Motivation

The drastic changes in Vietnamese coffee production throughout the 1990s contributed to a significantly higher volume of coffee exports in the international market. Vietnamese coffee production historically comprised a relatively constant and small proportion of the world coffee market (.041% in 1965, and .055% in 1984; FAO, 2008), thus minimizing the country's impact on market price fluctuations (see graph 4). However, after the collapse of the International Coffee Agreement in 1989, Vietnamese coffee production skyrocketed to surpass Colombia's export volume in a span of only ten years (see graph 1). Coffee producing nations have often blamed Vietnam for causing the recent coffee price crisis due to the fact that Vietnam was the only country to exhibit rapid increases in export volume after the ICA collapse (see graph 5).

Vietnam's causal role in the world coffee crisis is a frequently discussed topic, yet a causal analysis to determine Vietnam's true role has not been performed. The current paper conducted a Granger causality analysis to explore a potential causal relationship between the increase in Vietnamese coffee production and the decline in world coffee price (measured by the ICO composite price). The analysis included both forward and reverse causality.

General microeconomics predicts the existence of forward causality, where an increase in supply leads to a reduction in price through the shifting of the supply curve along the demand curve (see graph 6). The coffee market is mature, indicating that the demand and consumption levels are relatively stable (Ponte, 2001). Furthermore, coffee demand only changes under a significant increase in price, thus it can be assumed that the demand is stable. According to

simple microeconomics, when the supply curve shifts to the right, it will move along the demand curve and the price will decrease due to relatively inelastic demand (see graph 6). Reverse causality posits that the decrease in world coffee price causes an increase in Vietnamese coffee production. This is an illogical pattern since a decrease in price does not typically encourage production due to the impending decrease in potential profits. However, Vietnam's unique coffee export pattern provides motivation to test causality in both directions.

The increase in Vietnamese coffee production occurred after the collapse of the ICA in 1989, thus it is highly probable that the increase in production was a direct result of this collapse. Economic theories suggest that the disbanding of a price stabilizing mechanism, such as the ICA, negatively impacts member countries while non-member countries accumulate the benefits. The temporal proximity of the collapse and the increased Vietnamese coffee production complicates the ideal of placing causal blame on Vietnam for the plummeting world coffee prices. The fact that Vietnam was the only country to drastically increase its export volume after the collapse suggests the existence of another factor, such as comparative advantage, that assisted Vietnam in boosting its export volume at the expense of other nations (see graph 5).

Ricardo's comparative advantage theory suggests that a country should specialize in the production of goods and services that it can produce relatively most efficiently in order to maximize the gains from trade (Appleyard, Field, & Cobb, 2008). Labor productivity is often calculated to measure comparative advantage in a labor-intensive industry, such as the coffee sector. Following the Ricardian theory, if Vietnam had a comparative advantage in the production of coffee when compared to all other goods, then under free trade, the production among countries would adjust to allow Vietnam to specialize in coffee production. This adjustment would occur because, under this assumption, Vietnam would be able to produce

coffee relatively more efficiently than its trade partner in autarky, thus increasing its partner's desire to trade with Vietnam (see graph 7). The hypothesized difference in comparative advantage between Colombia and Vietnam in graph 7 implies higher labor productivity in Vietnam, which would explain Vietnam's increased coffee exports after the realization of free trade.

4.2 The Granger Causality Analysis

The Granger causality test implemented in this analysis was adopted from a previous study that examined the causality between export growth and GDP growth (Dodaro, 1993), which in turn acquired the methodology from Granger (1969). The equations presented in the paper are as follows:

$$GY_t = \alpha + a_1GY_{t-1} + a_2GY_{t-2} \quad (1a)$$

$$GY_t = \alpha + a_1GY_{t-1} + a_2GY_{t-2} + b_1GX_{t-1} + b_2GX_{t-2} \quad (1b)$$

$$GX_t = \beta + c_1GX_{t-1} + c_2GX_{t-2} \quad (2a)$$

$$GX_t = \beta + c_1GX_{t-1} + c_2GX_{t-2} + d_1GY_{t-1} + d_2GY_{t-2} \quad (2b)$$

where $GX_t = (X_t - X_{t-1}) / X_{t-1}$, $GY_t = (Y_t - Y_{t-1}) / Y_{t-1}$, and $t = \text{time}$. The corresponding measures of X and Y will be reassigned in the next section such that they are relevant to this analysis. The coefficients of these equations were calculated using an OLS regression with robust standard errors. In each case, the dependent variable is regressed against the past values of itself and the other variable. Similar to Dodaro (1993), this analysis specifies a two-year lag in each variable to allow a long enough period of time for a causal relationship to develop without losing too many degrees of freedom in the hypothesis testing. Specifically, this analysis estimated equations (1b) and (2b) using an OLS regression to determine whether a causal relationship exists between the two variables.

The Granger causality analysis utilized hypothesis tests to test for joint significance of the one and two year lagged versions of the posited causal regressors. Specifically, when testing

causality from X to Y, the hypothesis test examines the joint significance of the two lagged versions of X, and vice versa. Each type of causality – forward and reverse – has a specific regression model and thus requires a separate hypothesis test. The first scenario, equation (1b), presents a test to examine the causal relationship running from X to Y. In this case, letting $Z_1 = b_1 + b_2$, with the null hypothesis, $H_0: Z_1 = 0$, one can use a t-test to explore the joint significance of b_1 and b_2 .

If Z_1 is positive and significant, then H_0 can be rejected, implying that the growth in X causes the growth in Y. Similarly, if Z_1 is negative and significant, one can again reject H_0 , indicating that the growth in X hampers the growth in Y. The negative association implies that the two variables move in opposite directions through the causal relationship. In the current analysis, if X represented Vietnamese coffee exports and Y represented ICO composite price, then a negative Z_1 portrays that an increased growth in the supply of Vietnamese coffee exports causes a decrease in the growth of ICO composite price.

Alternatively, in the second scenario, equation (2b), the regression model tests for a causal relationship running from Y to X. In this case, letting $Z_2 = d_1 + d_2$, and creating the null hypothesis, $H_0: Z_2 = 0$, one can perform a t-test to explore the joint significance of d_1 and d_2 . Similar to the previous interpretations, if Z_2 is positive and significant, then H_0 can be rejected, indicating a positive relationship in the form of Y causing X. Moreover, if Z_2 is significant and negative, one can reject the H_0 , indicating a negative relationship in the form of Y causing X. In this analysis, with the values of X and Y as described above, a negative Z_2 portrays that the decreased growth in ICO composite price leads to an increase in the growth of the supply of Vietnamese coffee exports.

Following Dodaro (1993), if both null hypotheses are rejected, there is a causal feedback system between the two variables. In the fourth scenario, neither null hypothesis can be rejected due to insignificant values of Z_1 and Z_2 , thus no causal relationship is assumed to exist between these two variables.

Although Dodaro (1993) utilized an F-test in both hypothesis tests, the current analysis employed the t-test to test for joint significance of the one and two year lagged versions of the predicted causal regressor. In a one variable case, the t-test and the F-test produce identical results. Since this analysis is testing for joint significance, the two variables – either b_1 and b_2 or d_1 and d_2 – can be treated as one variable, thus making the t-test applicable to use in the current analysis. Joint significance of these two variables indicates that the dependent variable has a causal relationship with the independent variables in the regression. The formulas used to compute the t-statistics in each scenario are detailed as follows:

For the first null hypothesis, $H_0: Z_1 = b_1 + b_2 = 0$:

$$t = \frac{(b_1 + b_2) - 0}{se(b_1 + b_2)} \text{ where } se(b_1 + b_2) = \sqrt{Var(b_1 + b_2)} \text{ and}$$

$$Var(b_1 + b_2) = Var(b_1) + 2cov(b_1, b_2) + Var(b_2)$$

Similarly, for the second null hypothesis, $H_0: Z_2 = d_1 + d_2 = 0$:

$$t = \frac{(d_1 + d_2) - 0}{se(d_1 + d_2)} \text{ where } se(d_1 + d_2) = \sqrt{Var(d_1 + d_2)} \text{ and}$$

$$Var(d_1 + d_2) = Var(d_1) + 2cov(d_1, d_2) + Var(d_2)$$

If the resulting t-statistics have an absolute value greater than the corresponding two-sided critical value for the t-distribution with the appropriate degrees of freedom, the null hypothesis can be rejected and Z_1 or Z_2 would be considered significant.

4.3 Labor Productivity Comparisons

Due to the variety in types of labor, the measure of labor productivity is a vague concept. Depending upon the source and availability of data, there are several suggested ways to measure this value: Purchasing Power Parity (PPP) per worker, output per worker, and value added to GDP per worker (Carlin, Glyn, & Van Reenen, 2001; Ferreira & Rossi, 2003; International Labor Organization [ILO], 2009). The concept of ‘per worker’ represents the total labor force employed in the specific industry for which the labor productivity calculations are completed. This value can also be represented by examining the total work hours employed in production. (Carlin et al., 2001)

Data on the output per worker is unavailable in the coffee sectors of Colombia and Vietnam due to the fact that small farmers and their families conduct most of the coffee cultivation in both countries. These farmers do not have the resources to gather data on the total number of workers in the field per day or the number of hours of work put into the production of coffee. To further complicate the availability of this data, migrant workers who travel around South America and work in temporary positions harvest much of the coffee in Colombia (De Graaff, 1986). The Colombian government is unlikely to gather accurate statistics on the number of people employed in the coffee sector in a given year since the majority of these employees will have moved onto employment opportunities in other countries.

In Vietnam, the government strongly encouraged coffee production in the late 1970s by providing incentives to citizens who agreed to migrate to the highlands and produce coffee. The success of these policies is seen in the increase of the population density in Vietnamese coffee producing regions from around three persons per square kilometer in 1940 to seventy-seven persons per square kilometer in 1997 (Doutriaux et al., 2008). Although the availability of coffee output data is still minimal, the calculation of the number of workers employed is likely to be

more accurate due to the government's role in the initiation of coffee production. Vietnamese coffee production, contrary to the Colombian coffee sector, has not historically used migrant labor during the harvest season. Overall, many of the components used in the labor productivity and cost competitiveness calculations are proxies for the unavailable data. These proxies are described in detail in the following section.

Utilizing the methods presented in Carlin et al., (2001), this research included the following two analyses: labor productivity and the examination of cost competitiveness' role in determining the export market share. Labor productivity for each country is defined as the division of value added in the coffee industry at constant 2000 US\$ by the total employment in the coffee industry (Carlin et al., 2001).

$$\text{Labor Productivity} = \frac{\text{Value added at constant 2000 US\$}}{\text{Total Employment}}$$

The labor productivity of Vietnam and Colombia are graphically presented by plotting labor productivity against the year. This visual representation facilitates a comparison of the labor productivity trends over time for both countries. Moreover, this analysis includes an examination of the annual growth in labor productivity for each country. Following the conclusions of Ferreira and Rossi (2003), positive growth in labor productivity resulted from a reallocation of output to the more productive firm. In this case, positive growth would indicate that coffee production had been allocated to the more productive country.

In addition to this simple graphical comparison of labor productivity, methods of MacDougall (1951) presented in Appleyard et al. (2008) utilized the Classical Model to predict which country should dominate the export market based on wages and labor productivity.

Applying MacDougall's (1951, as cited in Appleyard et al., 2008) methodology to this analysis requires the following equation:

$$\frac{\text{Labor Productivity}_{\text{Vietnam}}}{\text{Labor Productivity}_{\text{Colombia}}} > \frac{w_{\text{Vietnam}}}{w_{\text{Colombia}}}$$

Where w = wage. Following MacDougall's (1951, as cited in Appleyard et al., 2008) results, if this inequality holds, Vietnam should dominate the coffee export market. If this inequality is flipped, Colombia should dominate the export market.

According to Carlin et al. (2001), examining the role of cost competitiveness in the determination of export market share requires two components: export market share and a measure of competitiveness - relative unit labor costs. Export market share (XMS) represents the proportion that each country holds of the world coffee export market. This is calculated by dividing each country's exports in current US dollars by the dollar sum of world exports.

$$XMS_j = \frac{\text{country}_j\text{'s exports in current US\$}}{\text{dollar sum of world exports}} \quad j = \text{Colombia, Vietnam}$$

Although Carlin et al. (2001) applied this formula to several different industries within one country, the XMS value strictly measured the coffee export market share of Colombia and Vietnam (XMS_{Col} and XMS_{Viet} , respectively) in the present analysis.

According to Carlin et al. (2001), competitiveness is typically measured either by export prices or unit labor costs. The unit labor cost methodology is applied in this analysis due to the lack of coffee export price series data for either country. The relative unit labor cost (RULC) is a weighted average of the unit labor costs (ULC) in each country. In order to calculate RULC, data on income, employment, real output, and trade is needed. Specifically, the calculation of ULC follows:

$$ULC_j = (W_j / E_j) * (e_j Q_j / N_j)$$

Where W = employee compensation, E = number of employees, e = dollar exchange rate (national currency/US\$), Q = volume of output (value added at constant prices), N = employment, and j = country. The RULC values are computed by dividing ULC_j by a weighted average of the unit labor costs for both countries in the sample. Following the Carlin et al. (2001) approach, the weighting factor is XMS_j in 1995, thus the specific calculation is:

$$RULC_j = \frac{ULC_j}{[XMS_{Viet,1995} * ULC_{Viet} + XMS_{Col,1995} * ULC_{Col}]}$$

The year 1995 was chosen as the weighting factor because this year better represents Vietnam's unhindered share of the coffee market. The data prior to 1990 is biased toward Colombia since Vietnam's exports were highly restricted during this period.

These two calculations provide the necessary components of the cost competitiveness analysis. In order to examine the role of cost competitiveness in determining the export market share, one must regress RULC on XMS using the following econometric model:

$$\log(XMS_{jt}) = \sum \alpha_k \log(RULC)_{jt-k} + v_{jt} \text{ where } k = 0, 1, \dots, L \text{ is a lag factor}$$

Although Carlin et al. (2001) utilized a five-year lag period, a two-year lag was chosen for the present analysis due to the limited number of data points and to maintain consistency with the lag time imposed in the Granger causality analysis. The specified models used in each analysis are presented in Appendices F and G. According to Carlin et al. (2001), the exogeneity of RULC can be assumed, thus an OLS regression was conducted. The coefficients of this log-log econometric model represent elasticities of the dependent variable (XMS) with respect to each parameter ($RULC_{j,0}$, $RULC_{j,1}$, or $RULC_{j,2}$). This model specification is used frequently in this type of analysis since it creates a constant elasticity. Moreover, if the estimated alpha values are

negative, the model exhibits the expected negative effects of cost on export market share in the long run. (Carlin et al., 2001)

5. Computations

5.1 Preparing the Granger Causality Analysis

Prior to conducting the Granger Causality analysis, it is necessary to designate the measure to which each variable corresponds. In the current analysis, X represents the real price in 2000 of Vietnamese Coffee Exports and Y represents the ICO composite price. The Granger causality analysis examines the causal relationship between the growth of two variables, therefore it is necessary to compute the annual change in X and Y using the following equations: $GX_t = (X_t - X_{t-1}) / X_{t-1}$ and $GY_t = (Y_t - Y_{t-1}) / Y_{t-1}$. If the estimated regression coefficients are significant, the growth in the explanatory variable influences the magnitude and direction of the growth of the dependent variable. The International Coffee Organization (ICO) published the ICO composite price data on the historical data section of its website (International Coffee Organization [ICO], 2008). The Food and Agricultural Organization of the United Nations (FAO) provided publicly available data on the annual export volume and price per good per nation; thus, the Vietnamese coffee export data was taken from the FAO statistics department's website (Food and Agriculture Organization of the United Nations [FAOSTAT], 2008).

This analysis used the statistical software, STATA, in all regressions and calculations of the variance and covariance needed in order to conduct the hypothesis tests. The lagged variables were created by applying the growth equations given above (see appendix A.1 for full data sets).

5.2 Application of the Granger Causality Analysis

The first regression examined forward causality, testing whether the increase in Vietnamese coffee production caused the decrease in the ICO composite price. The specific

equation utilized in this regression is equation (1b), where X = Vietnamese coffee exports and Y = ICO Composite price. A significant negative value of Z_1 would confirm the original hypothesis, which claimed that the increase in Vietnamese coffee production caused the rapid decline in ICO composite price. Appendix A presents the results of the STATA regressions and the corresponding t-test. As can be seen in this appendix, the t-statistic, $t = -0.8212$ is not significant when compared to the two-sided critical value, $t_{35,05} = \pm 1.6896$.

The second regression examined reverse causality, testing whether changes in ICO composite price caused the changes in Vietnamese coffee production. The original hypothesis did not predict any significant results in the reverse causality direction. If a significant test statistic was found, a negative value of Z_2 would indicate that the decrease in ICO composite price caused the increase in Vietnamese coffee production. Appendix B presents the results of the STATA regressions and the corresponding t-test. The t-statistic presented in this appendix, $t = .0046$, is also not significant when compared to the two-sided critical value, $t_{35,05} = \pm 1.6896$.

5.3 Application of the Labor Productivity Comparisons

The variables needed to precisely apply the labor productivity formula presented in the methodology section - the value added of coffee in constant US dollars and total employment in the coffee sector - are unavailable in both the Vietnamese and Colombian coffee sectors. The most specified form of agriculture value added is one step past the first ISIC classification, where agriculture was extracted from the 'A' classification, which represents agriculture, hunting, forestry, and fishing (ILO, 2008). In this analysis, Agriculture Value Added to GDP was used as a proxy for the coffee value added to GDP since the agriculture revenue of both countries relies heavily on coffee exports (see graph 8a and 8b). Similarly, the total employment in the coffee sector is an unknown value due to the lack of resources that are needed to accumulate this data.

The World Bank World Development Indicators (2006) includes a measure of Agriculture Value Added (in constant 2000US\$), as well as a measure of Agriculture Value Added per worker (in constant 2000 US\$). This second variable is used as a proxy for labor productivity because it most accurately represents the value added per coffee worker in constant prices for each country. This labor productivity data and its graphical representation are presented in Appendices D.1 and D.2.

Another important measure to examine is the annual growth in labor productivity. This measure is simply calculated by finding the percent difference in labor productivity between consecutive years for each country. These results are presented in Appendix D.4.

5.4 Application of the Classical Model

The application of the Classical Model, as presented in MacDougall (1951, as cited in Appleyard et al., 2008, p. 53-57), required only two variables per country: labor productivity and wage per worker. The labor productivity measure for this analysis utilized the same proxy as given above, the World Bank's (2006) Agriculture Value Added per worker. The coffee sector wage is calculated using the data on Price Paid to Producers from the ICO website (2008). This second measure is a representative proxy given that the majority of coffee is produced and harvested by small landowners in both countries. The results of this application are presented in Appendix E.

5.5 Application of the Cost Competitiveness Analysis

Several of the variables used in the calculation of RULC required the use of a proxy due to unavailable or unreliable data. In the calculation of ULC, employee compensation and number of employees (W/E) were jointly approximated using the International Coffee Organization's (ICO) measure of Prices Paid to Producers (ICO, 2008). The ICO's data provide an accurate

representation of the revenue producers receive for the production of coffee. This price varies between countries and type of coffee produced, Arabica or Robusta, thus it is not the same for Vietnam and Colombia. The other portion of the ULC is calculated by dividing the exchange rate and value added by the employment in that sector (eQ/N). This measure is the same as the labor productivity calculation described above, thus (eQ/N) is approximated by the World Bank's (2006) Agriculture Value Added per worker in constant 2000 US\$. Appendix F presents the calculations of ULC for Vietnam and Appendix G presents the calculations for Colombia.

The XMS component of RULC did not require a proxy in the calculations. The Food and Agriculture Organization (FAO) of the United Nations provides data on country specific and worldwide export commodities in terms of 1,000 US\$ and tonnes (FAO, 2008). The XMS values in Appendices F and G represent each country's actual share of the world coffee export market. Although this is the only component of RULC without a proxy, it is important to avoid approximating this value since the examination of the temporal trends in each country's export share is the main focus of this research. The major share that coffee comprises of each country's agriculture market supports the use of the approximations described above in conjunction with the true values of XMS (see graphs 8a and 8b). Appendices F.1 and G.1 include the final calculations of RULC using this combination of true and approximated variables.

The STATA output from the OLS regressions of the two-year lagged econometric models is provided in Appendices F.2 and G.2. In order to test for the significance of relative unit labor costs in determining the export market share, an F-test was conducted for each country. This specific F-test explores the significance of the model by determining if at least one of the parameters has a coefficient that is significantly different than zero. The output in Appendix F.2 demonstrates that relative unit labor costs are a significant determinant in export market share for

Vietnam (F-stat = 3.60, $p = 0.0406$, $R^2 = 0.4358$) at the 0.05 significance level, but not for Colombia (F-stat = 0.31, $p = 0.8175$, $R^2 = 0.0624$; see Appendix G.2).

6. Results

The inability to reject either null hypothesis in the causality analysis demonstrates that there is no causal link between these two variables. Although contrary to the original prediction, there is not enough evidence to blame the coffee price crisis on the Vietnamese government policies that promoted the rapid development of coffee production in the Vietnam's Central Highlands. According to the labor productivity analysis, Colombia has consistently higher labor productivity than Vietnam. This productivity remained higher in the years after the ICA collapse, which was the first time that Vietnam's coffee comparative advantage could be realized. The Classical Model analysis claims that Colombia should dominate the coffee export market. However, the cost competitiveness model suggests that Vietnam's export market share has a negative association with its relative unit labor costs.

6.1 Did the increase in Vietnamese coffee production lead to a decrease in world coffee prices?

The results suggest that there is not enough evidence to conclude that the increase in Vietnamese coffee production caused the decrease in world coffee prices (see Appendix A). The value of Z_1 is negative, yet it is highly insignificant since the t-statistic, $t = -0.8212$, is smaller in magnitude than the two-sided critical value at both the 5% and 10% level of significance ($t_{32,0.025} = \pm 2.0369$ and $t_{32,0.05} = \pm 1.6939$, respectively) with 32 degrees of freedom. According to Dodaro (1993), the null hypothesis cannot be rejected which suggests that the rapid decline in world coffee price was likely caused by factors other than the increase in Vietnamese coffee production.

Although simple microeconomics suggests that an increase in supply causes a decrease in price under inelastic demand (graph 6), one can assume that the collapse of the ICA was a major factor in the drastic decline in coffee price. The simple microeconomic concept of price decreasing after a supply curve shifts to the right, however, does not exactly apply under the existence of market interferences. The coffee price had been artificially upheld for most of the 20th century by various versions of the ICA, thus the true equilibrium price of coffee throughout this period is impossible to predict. This complicates the ability to blame Vietnam for causing the price drop. It is likely that the decline occurred because the coffee market was progressing toward the equilibrium that had not naturally occurred in nearly a century.

The collapse of the ICA also removed all export quotas. Several countries, including Vietnam, took advantage of this altered policy and increased their supply of coffee on the world market. Although Vietnam was a major contributor to the oversupply of coffee in the international coffee market, it was not the only country to increase export volume after the restrictions were removed (see graph 5). The insignificant Granger coefficients denote that there is not enough evidence to conclude that the increase in Vietnamese coffee production caused the decline in world coffee prices. This result suggests that other coffee producing nations should not blame Vietnam for the decreased prices. Rather, they can more accurately attribute the plummeting world prices to a general move of the ICO composite price toward equilibrium with the newly expanded export volume and lack of market interferences.

6.2 Did the decrease in world coffee prices lead to an increase in Vietnamese coffee production?

The t-statistic presented in Appendix B is not significant since this value, $t = 0.0046$, is smaller in magnitude than the two-sided critical value at both the 5% and 10% significance levels ($t_{32,.025} = \pm 2.0369$ and $t_{32,.05} = \pm 1.6939$, respectively) with 32 degrees of freedom.

Following the methodology presented in Dodaro (1993), the null hypothesis cannot be rejected, thus indicating that there is not enough evidence to conclude that the growth of Y causes the growth of X. This signifies that the growth in ICO composite price does not influence the growth in Vietnamese coffee production. This analysis originally predicted an insignificant test statistic in the reverse causality analysis due to the fact that the causal pattern is not logical according to any current economic theories. The value of Z_2 in this hypothesis test is positive, yet this is of no concern, as it is highly insignificant. Therefore, the original hypothesis of insignificant reverse causality is supported.

Although this pattern of causality is not significant, it is important to determine the reasons behind Vietnam's continuously increasing coffee export volume throughout this period of consistent declines in the ICO composite price. A factor in this unique pattern could be the existence of a lag between planting new trees and the actual increase in coffee production (Ponte, 2001). If the Vietnamese began planting more trees in the year of the ICA collapse, there would be a three-year gap before any drastic production increases would be seen in the export market. This could discourage continued increases in production since the country would have received low prices for its initial crop of expanded coffee exports.

However, the Vietnamese export rates increased immediately after this collapse since the ICA's quotas regulated only the amount of coffee exported (see graph 1), which suggests that the initial increases in production occurred prior to the ICA collapse. Vietnam had access to an unregulated coffee market for the first time since small farm coffee production began in Vietnam, and thus had the opportunity to export any excess stored green coffee that had been restricted under the ICA. However, the fact that the export rates increased so drastically even after the price began to drop in 1995 suggest the existence of another reason behind the

Vietnamese government's continued concentration of land and labor on a commodity with plummeting world prices.

6.3 Post-ICA Granger Causality Analysis

Under the reign of the ICA, Vietnam's coffee export volume faced strict regulation and nearly all coffee demand was fulfilled by exports from ICA member countries. The existence of this quota system produced a Vietnamese export volume that misrepresented the country's coffee supply. Similarly, the ICA artificially upheld the price, which would limit any causality between Vietnamese coffee production and ICO composite price during the reign of the ICA since the price was not allowed to move freely. In order to test for the casual relationship under a relatively open market, a post-ICA Granger causality analysis was conducted. The methodology and hypothesis testing correspond to the methods used in the previous Granger analyses; however, the data set in the regression only includes price and export data since 1990.

Although Vietnam's export volume increased while the ICO composite price simultaneously decreased, this post-ICA analysis demonstrates insignificant forward and reverse causality ($t_{9,05} = -1.8331 < t = 0.404 < t_{9,95} = 1.8331$; and $t_{9,05} = -1.8331 < t = 0.889 < t_{9,95} = 1.8331$, respectively; see appendix C). By failing to reject the null hypothesis test in both of these regressions, there is not enough evidence to conclude that the increased coffee production in Vietnam after the collapse of the ICA caused the decreased ICO composite price. Therefore, Vietnam does not hold a significant causal role in the decreasing ICO composite prices under ICA regulation or in an open market.

6.4 Did Vietnam have higher labor productivity than Colombia in the coffee sector?

Despite Vietnam's lack of causality in the declining world coffee prices, the unexpected shift of coffee production from Colombia to Vietnam provides motivation to explore the factors

behind this new production structure. The increase in Vietnamese coffee exports negatively impacted the Colombian economy by removing a portion of its coffee export volume, which was the main source of its export revenue at the time.

The labor productivity calculations display Colombia's consistently higher labor productivity over time (see Appendix D.1 and D.2). Although Vietnam's labor productivity presents a general increasing trend, it does not approach a comparable level to Colombia's labor productivity. The extreme disparity between the two nations' productivity raises concern regarding the validity of the proxy used in these calculations. The proxy used, Agriculture Value Added per worker, is likely to be partially representative of the coffee sector since this sector comprises a large share of agriculture in both economies (see graphs 8a and 8b). However, this measure is calculated by dividing output by the total number of workers in that sector, wherein lies the problem. As previously discussed, migrant workers harvest most of the Colombian coffee, and these workers are unlikely to be accounted for in any measure of employment in these coffee sectors.

This concern is further validated by the data on the percentage of labor force employed in the Colombian agricultural sector from the World Bank's World Development Indicators (2006) (see graph 9). This percentage is approximately 1% for two decades, and then jumps up to 20% in the early 2000s. Based on the history of the Colombian coffee sector, this drastic gap is illogical given that the country focused more on coffee and agriculture in the past than in the present.

The World Bank's (2006) data on the percentage of labor force employed in the Vietnamese agricultural sector is likely to be more accurate due to the government's motivating measures that encouraged the production of coffee. The government's involvement in coffee

production increases the probability that the government created more accurate statistic measures that are used to monitor the coffee sector. More accurate statistical methods would account for a higher number of laborers in the production of crops, which in turn would lower the labor productivity value since the output would be spread over a larger number of workers.

Moreover, from the World Bank's World Development Indicators (2006), the majority of Vietnam's population is employed in the agriculture sector (see graph 9). This large percentage of agricultural workers could reduce the accuracy of using the Agriculture Value Added per worker as a proxy for the Vietnamese coffee sector. The majority of Vietnam's citizens are working to produce some type of agricultural crop, thus it is possible that the productivity of the less efficient crops is affecting the labor productivity measure of the more efficient crops, such as coffee and rice. Other agricultural crops that require a higher amount of labor may reduce the overall agriculture value added per worker. Without accounting for the differences in number of workers and output among Vietnam's crops, it is impossible to determine if the proxy is applying a downward bias to the labor productivity calculations. A downward bias, in this case, would suggest higher labor productivity for the coffee sector through either a higher output or lower number of workers. In the future, labor productivity should be calculated using data specific to the coffee industry in order to avoid the described limitations.

Despite Colombia's consistently higher labor productivity, Vietnam's labor productivity displays a comparatively steady pattern of positive growth after the collapse of the ICA (see Appendices D.3 and D.4). Although this growth did not significantly narrow the gap between Vietnamese and Colombian labor productivity levels, labor productivity growth indicates that output was reallocated to the more productive producers (Ferreira & Rossi, 2003). Following this logic, Vietnam may have been attracting production from Colombia even though Colombia had

higher absolute labor productivity. From Appendix D.4, it can be seen that Colombia did not have any periods of steady positive growth, which supports the idea that output could transfer to the more productive producer. However, Vietnam also experienced volatility in productivity, although slight in comparison to Colombia, thus one cannot conclude that differences in labor productivity growth resulted in the transference of output from Colombia to Vietnam.

6.5 Does the Classical Model accurately predict the controller of the export market?

The comparison of the ratio of labor productivity between Vietnam and Colombia to the ratio of wage between these two countries produces results contrary to the original prediction. According to MacDougall (1951, as cited in Appleyard et al., 2008), the ratio of labor productivity should be larger than the ratio of wages in order for Vietnam to dominate the coffee export market. However, the table in Appendix E indicates that the labor productivity ratio has been consistently smaller than the wage ratio since 1985, which suggests that Colombia should dominate the export market.

This analysis also utilized Agriculture Value Added per worker as a proxy for labor productivity. The lack of accurate worker counts and the lack of differentiation between agricultural subsectors complicates the ability to claim accuracy for this proxy. The Prices Paid to Producers remains a fairly accurate method to estimate wages since it describes the typical income received per producer on each coffee farm. Overall, the inability to examine the Value Added Per Worker in the coffee sector severely limits the accuracy of this comparison. However, the general decreasing trend in the difference between the ratios supports Vietnam's continued increase in export market share (see Appendix E). Thus, in the future, if this analysis is conducted using strictly coffee value added, it is likely that the Classical Model could correctly predict Vietnam's export market dominance over Colombia.

6.6 Does cost competitiveness determine a country's export market share?

The OLS econometric model examined the relationship between a country's cost competitiveness (RULC) and its export market share. Specifically, the model tested for the role, if any, that cost competitiveness had in determining export market share. The Colombian regression and significance of the model test produced insignificant results. There is not enough evidence to conclude that the elasticity of Colombia's coffee export market share is impacted by the elasticity of cost competitiveness in the Colombian coffee sector. The model utilized several data proxies, indicating that the insignificant results could be influenced by a non-representative proxy. Moreover, the concerns regarding the labor productivity calculations also apply to this analysis as labor productivity (eQ/N) is a term in the regression model. This econometric model does not control for any country-specific factors, so it is highly probable that other factors are influencing the coefficients of the RULC terms.

This regression did not produce a significant result, hence it cannot be claimed that the relative cost competitiveness is a major determinant in Colombia's coffee export share. However, the notable limitations could severely bias the results of this analysis. As mentioned, the lack of a significant relationship between RULC and XMS in Colombia is likely to be a result of poor data and unrepresentative proxies. After the initial impact of the coffee price crisis, the Colombian government encouraged diversification among crops. The use of Agriculture Value Added per worker as a measure of labor productivity could bias the RULC calculations since these workers would still be in the agricultural sector, but not in the coffee realm.

Secondly, the increased prevalence in the Colombia drug trade post-ICA initiated the calculation of several inaccurate statistics due to the existence of a "black market" on which this trade occurs (see graph 10). Many workers may have switched to this other "cash crop" in hopes

to regain their livelihood, yet this switch could have resulted in an inaccurate measure of the agriculture labor force. Although this is merely a conjecture, it is possible that these two factors contributed to the relatively stable RULC in the agriculture sector and minimized the appearance of any shifts in the coffee sector's RULC. However, the fact that the RULC and labor productivity measures are fairly consistent over time suggests that the ICA collapse explains Colombia's drop in export market share (see graph 1).

Contrarily, the OLS regression produced significant results at the 0.05 level for Vietnam. The significance implies that the elasticity in cost competitiveness ($\log(\text{RULC})$) significantly influences the elasticity of Vietnam's export market share ($\log(\text{XMS})$). Two of the estimated coefficients are negative, which produces a negative relationship between $\log(\text{XMS})$ and the sum of $\log(\text{RULC}_k)$. As described in Carlin et al. (2001), these expected negative values show the negative effects of cost on market share in the long run. Specifically, since cost competitiveness is measured in relative terms (RULC), when the cost of production increases in Colombia, all other things equal, Vietnam experiences a drop in RULC, and thus an increase in market share.

Assuming that the model is correctly specified, it can be concluded that the Vietnamese export market share is moderately influenced by its relative unit labor costs in agriculture ($R^2=0.4358$). After the collapse of the ICA, Vietnam realized its full competitiveness in the coffee market, which had been minimized by the ICA's quota system. Graphs 11a and 11b display Colombia's fairly stable relative unit labor costs over time, while Vietnam portrays more of a decreasing trend. This trend indicates that the Vietnamese agricultural unit labor cost is decreasing relative to the Colombian unit labor costs. According to Carlin et al. (2001), this drop in relative cost – a decline in competitiveness – resulted in immediate improvement in the export market share (in tonnes), which is portrayed in graph 1.

The RULC measure represents each nation's cost competitiveness in the coffee market. This measure is similar to comparative advantage in that it measures the relative cost for each country to produce coffee. Comparative advantage is a fairly stable statistic for a country, thus it does not greatly change over time. However, Vietnam's coffee exports were limited in the world market until after the ICA collapse when Vietnam's relative cost competitiveness in the coffee sector could be realized for the first time. Although the Vietnamese regression indicates a moderate relationship between RULC and export market share, it cannot be concluded that Vietnam's realized comparative advantage explains the shift in coffee production from Colombia to Vietnam. Colombia's export market share falls markedly after the ICA collapse (see graph 1), yet its relative unit labor costs remain fairly stable. This observation supports the insignificant regression results ($R^2=0.0624$).

Although no strong conclusions can be made from this cost competitiveness analysis, the fact that Vietnam's unit labor costs relative to Colombia produced a decreasing trend while its export market share increased indicates that under the realization of free trade, some output may have initially transferred between countries. However, the fact that Colombia did not display the opposite pattern of increasing RULC with decreasing export market share complicates the ability to claim that realized relative unit labor costs explained the shift in production.

7. Conclusion

The coffee plant has existed in Colombia and Vietnam for nearly two hundred years, yet these two countries experienced vastly different economic impacts and trends in their respective coffee sectors. Specifically, Colombia was a member of the International Coffee Agreement (ICA), thus its coffee sector flourished throughout the 1900s due to appropriate import demand and artificially stabilized world coffee prices. Vietnam, however, was not a member of the ICA,

which resulted in a narrow market and limited coffee export volume. After the collapse of the ICA in 1989, these two countries interacted for the first time in the international coffee market.

Upon receiving unhindered access to the international market, Vietnam increased its previously insignificant coffee exports and overtook Colombia's share of the coffee export market. This unprecedented increase shocked the world's coffee producing nations as Vietnam had held only minimal portions of the world market prior to the collapse. As a result of the rapid increases in export volumes from all producing nations, oversupply was created on the world market, which imposed detrimental impacts upon the nations whose economics relied heavily on coffee export revenue, such as Colombia.

This paper conducted three main analyses to examine Vietnam's role in the international coffee market: a Granger causality analysis, labor productivity comparisons, and the influence of cost competitiveness on the country's export market share. The Granger causality analysis did not produce significant results for forward, reverse, or post-ICA causality. The original hypothesis predicted significant forward causality, which would indicate that the increase in Vietnamese coffee exports caused the decline in the ICO composite price. However, the insignificant result suggests that there is not enough evidence to conclude that the increased exports caused the drop in world prices, thus the original hypothesis is not supported.

The labor productivity of each country's coffee sector was calculated in order to compare the countries' comparative advantages in coffee production. The original hypothesis predicted that Vietnam would have higher labor productivity than Colombia, which would motivate trade partners to prefer trade with Vietnam to Colombia due to the existence of greater potential gains. Labor productivity, and thus comparative advantage, is a relatively stable measure over time; however, Vietnam's comparative advantage was effectively barred from the international coffee

market during the reign of the ICA. The realization of Vietnam's comparative advantage post-ICA was predicted to explain the shift in export volume from Colombia to Vietnam.

The labor productivity comparisons displayed Colombia's consistently higher labor productivity in the coffee sector, thus providing no support for the original hypothesis. By examining annual labor productivity growth, results demonstrated that Vietnam had increasing and less volatile trends in labor productivity, yet this is not enough to conclude the significance of comparative advantage in explaining the shift in export volume between countries. The Classical Model's comparison of labor productivity ratios to the wage ratios also presented results contrary to the original hypothesis.

Similarly, the analysis of the influence of cost competitiveness on export market share did not provide the anticipated results. Although this regression produced significant results for Vietnam ($F = 3.60$, $p = 0.0406$, $R^2 = 0.4358$), the lack of significant Colombian results indicates that no strong conclusions can be made regarding the role that relative unit labor costs hold in determining the shift of coffee exports from Colombia to Vietnam. Thus, it can be concluded that the original hypothesis regarding labor productivity's role in explaining the transfer of coffee export volume is not supported.

Although no significant or predicted results were obtained in this paper, the Classical Model displayed trends toward explaining the observed shift in world coffee exports. In the future, heeding the limitations discussed, it is likely that an analysis examining the true labor productivity of the Colombian and Vietnamese coffee sectors would produce results from the Classical Model that correspond to the events observed in reality.

Without further research, no conclusions can be made regarding Vietnam's role in the world coffee market. During the reign of the ICA, Vietnam's coffee production comprised a

miniscule portion of its export revenue, thus coffee was considered relatively unimportant to the country. However, the government provided incentives in the late 1970s that motivated citizens to increase the coffee production (Doutriaux et al., 2008). The government, previously communist, also progressed toward a market-based coffee sector, which further encouraged the production of coffee on small farms (Doutriaux et al., 2008). To accompany this increased production and shift toward a market based economy, the ICA collapsed in 1989, thus placing Vietnam in the prime position to take advantage of the newly opened market.

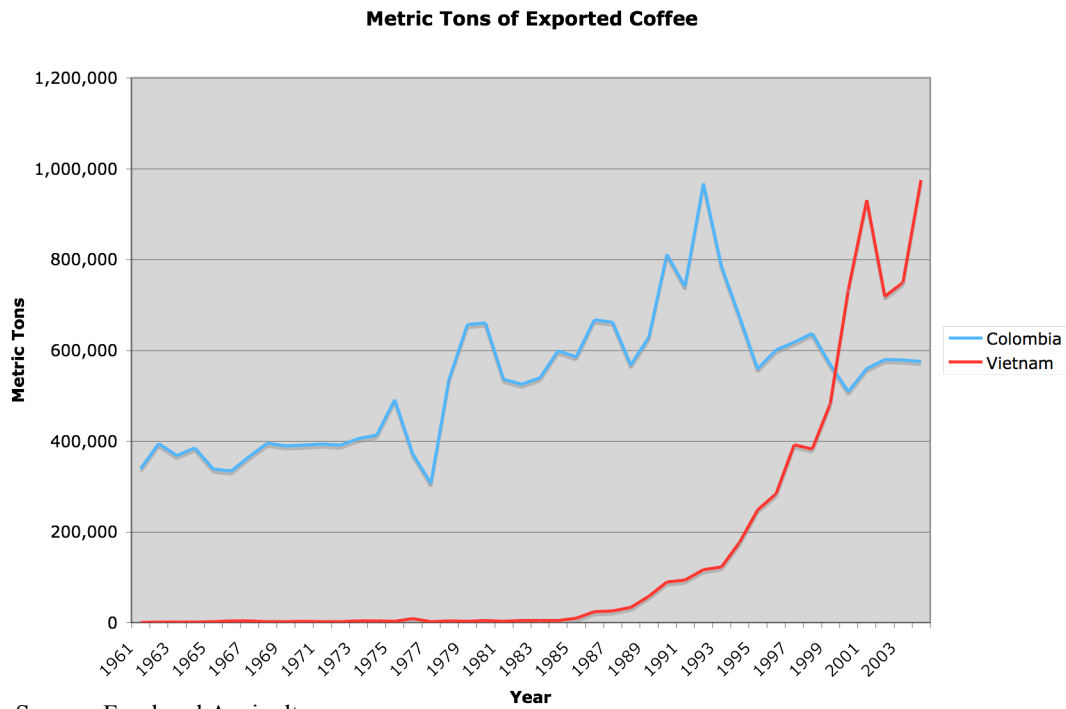
After escaping from the rigidities of a centrally-planned economy, many more coffee importing nations were willing to engage in trade with Vietnam. Specifically, Vietnam became a member of the ASEAN Free Trade Area (AFTA) and signed the US-Vietnam Bilateral Trade Agreement in December 2001, which led to significantly more changes in Vietnam's trade regime (The Central Intelligence Agency [CIA], 2009). The culmination of these three main events – government encouraged market-based coffee production, the collapse of the ICA, and the increased willingness of other nations to trade with this no longer communist country – placed Vietnam in the right place at the right time. Although it cannot be determined, it is likely that this coincidence is what truly explains the reason behind Vietnam's unique drastic increase in world coffee exports.

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- ¹¹ International Labor Organization. (2009). Labour productivity and unit labour costs indicator (KILM 18). Retrieved March 15, 2009, from the International Labor Organization Website: <http://www.ilo.org/public/english/employment/strat/kilm/download/kilm18.pdf>
- ¹² Juan Valdez (2008). Café de Colombia – Quality of life: Advertising Colombian coffee. Retrieved December 26, 2008, from the National Federation of Coffee Growers of Colombia Website: http://juanvaldez.com/menu/advertising/more_quality.html#CULTIVATING

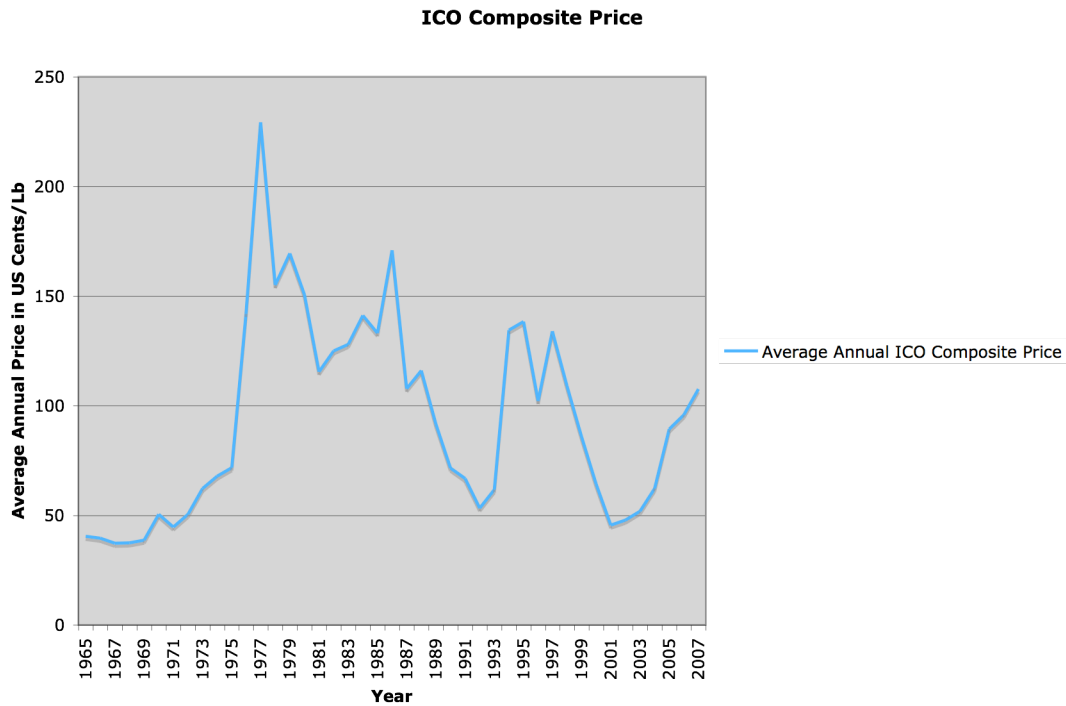
- ¹³ Luong, Q.V., & Tauer, L.W. (2006). A real options analysis of coffee planting in Vietnam. *Agricultural Economics*, 35, 49-57.
- ¹⁴ Pieterse, M.Th.A., & Silvis, H.J. (1988). *The World Coffee Market and the International Coffee Agreement*. Wageningen, the Netherlands: Pudoc.
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<https://www.cia.gov/library/publications/the-world-factbook/geos/vm.html#Govt>
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Graph 1.



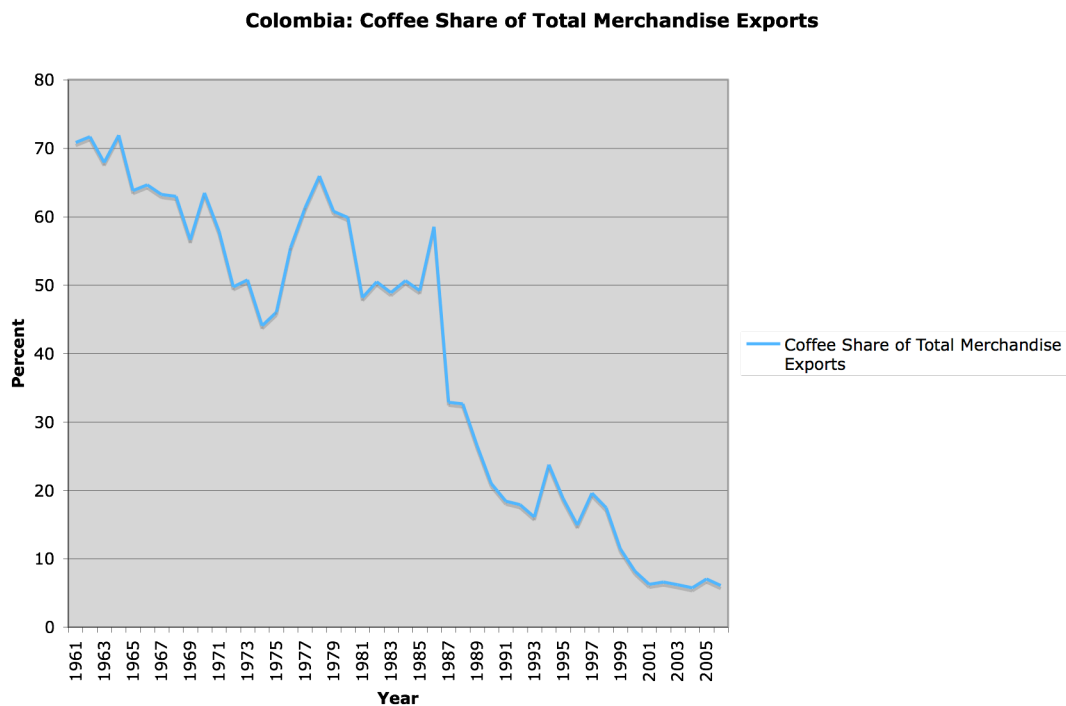
Source: Food and Agriculture
Organization of the United Nations:
Statistics Department

Graph 2.



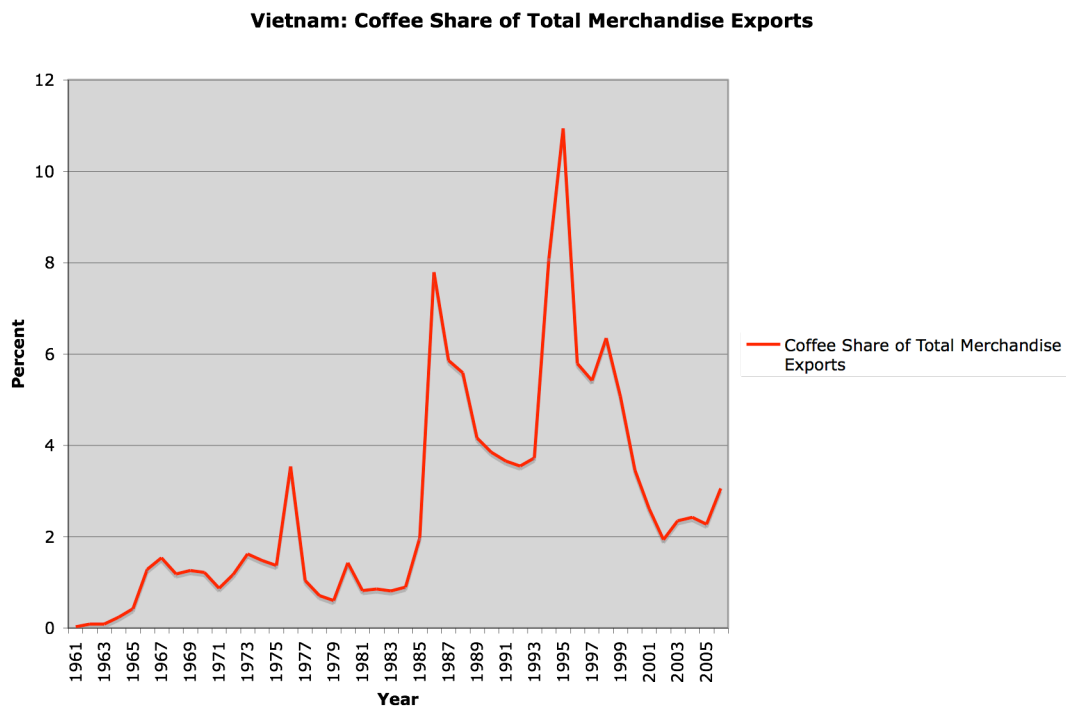
Source: International Coffee
Organization

Graph 3.
(a)



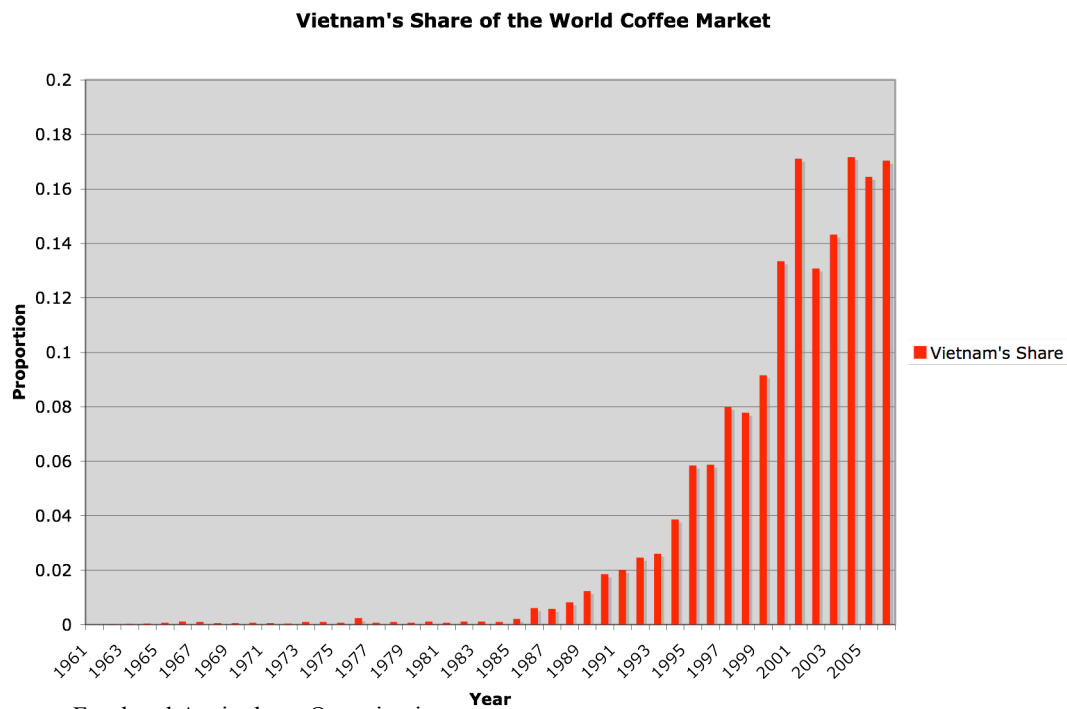
Source: Food and Agriculture Organization
of the United Nations: Statistics Department

(b)



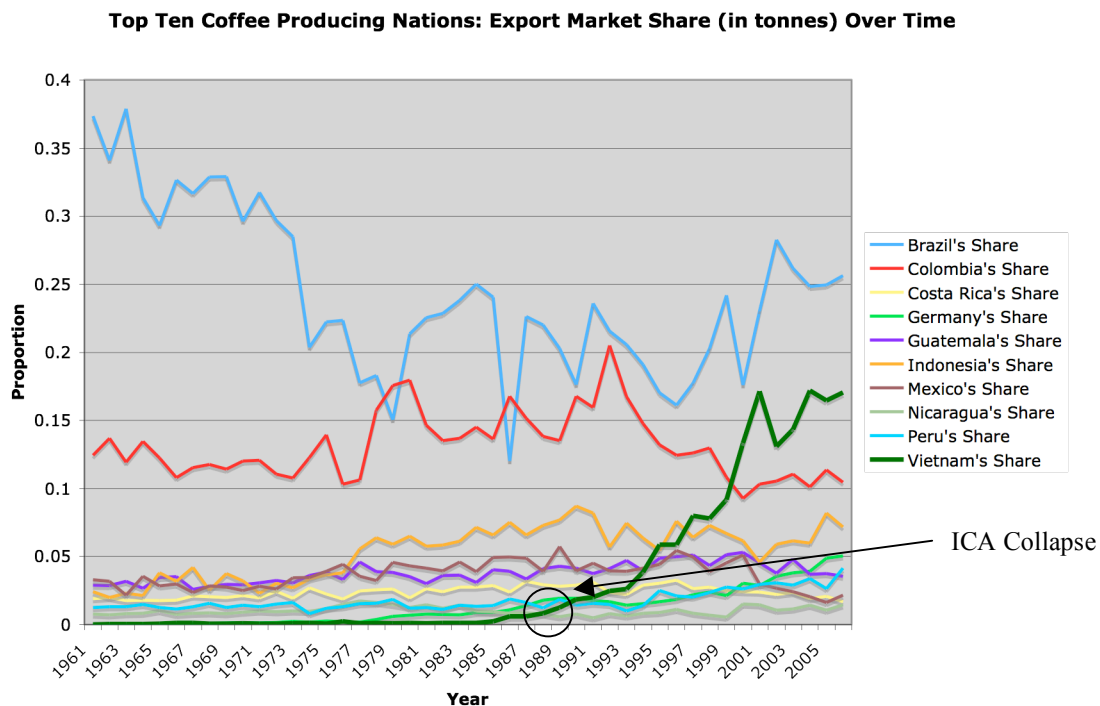
Source: Food and Agriculture Organization
of the United Nations: Statistics Department

Graph 4.



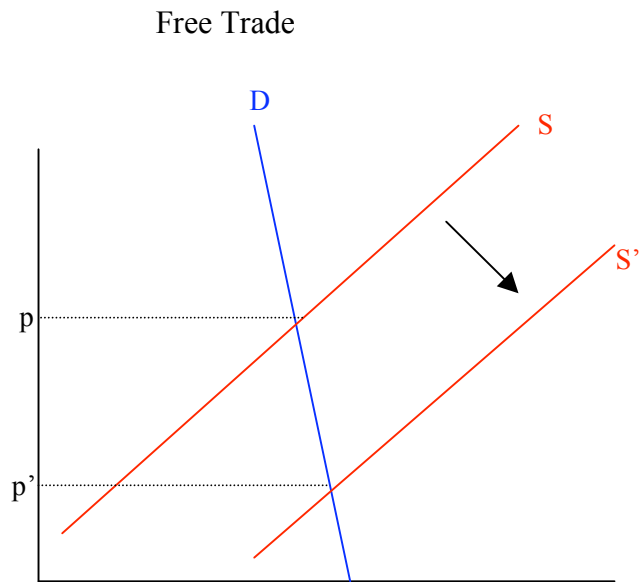
Source: Food and Agriculture Organization of the United Nations: Statistics Department

Graph 5.



Source: Food and Agriculture Organization of the United Nations: Statistics Department

Graph 6.



Graph 7.
Comparative Advantage Example

AUTARKY

Colombia and United States

| Units of labor per unit of output | Coffee | Other Commodities |
|-----------------------------------|--------|-------------------|
| Colombia | 2 | 6 |
| United States | 8 | 16 |

Vietnam and United States

| Units of labor per unit of output | Coffee | Other Commodities |
|-----------------------------------|--------|-------------------|
| Vietnam | 1 | 5 |
| United States | 8 | 16 |

INTERNATIONAL TRADE

Colombia and the United States

| | Coffee | Other Commodities |
|----------------------|--------|-------------------|
| Colombia | $1/3$ | 3 |
| United States | $1/2$ | 2 |

Vietnam and the United States

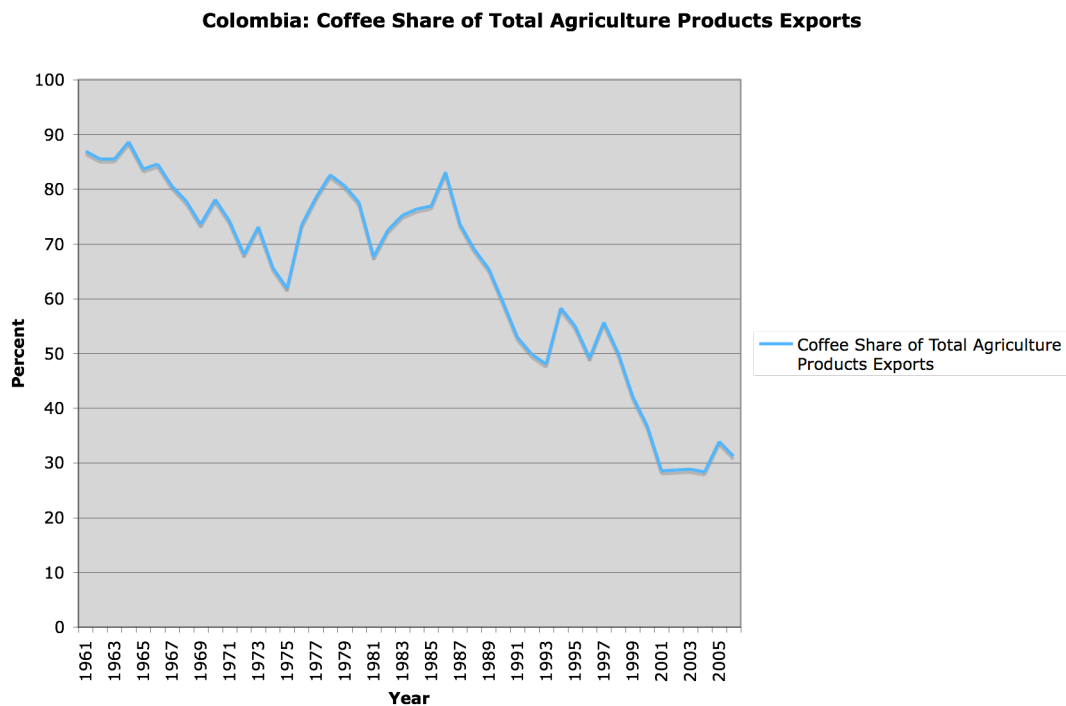
| | Coffee | Other Commodities |
|----------------------|--------|-------------------|
| Vietnam | $1/5$ | 5 |
| United States | $1/2$ | 2 |

According to this example of comparative advantage, both Colombia and Vietnam have a comparative advantage in the production of coffee over the United States. Although Colombia and Vietnam both have absolute advantage in the production of coffee and all other commodities (assuming this example is correct), the two trading partners, in both scenarios, stand to gain from trade if they each specialize in the good that they can produce with the lowest opportunity cost. In comparing these two scenarios, the United States has a better chance to gain from trade by

trading with Vietnam, because “the closer the terms of trade are to a country’s internal autarky price ratio, the smaller the gain for that country from international trade” (Appleyard et al., 2008, p. 32). If the United States traded with Colombia, the terms of trade would fall between Colombia’s autarky price ratio, $1/3$, and the United States’ autarky price ratio, $1/2$. If the United States traded with Vietnam, the terms of trade would fall between Vietnam’s autarky price ratio, $1/5$, and the United States’ autarky price ratio, $1/2$. The second case is a larger interval in which the terms of trade could fall, thus the United States has a greater chance of gaining more from trade by trading with Vietnam. If this example were correct in reality, then the United States, and any other coffee importing nation, would choose to import coffee from Vietnam over Colombia after the collapse of the ICA due to the potential for greater gains from trade.

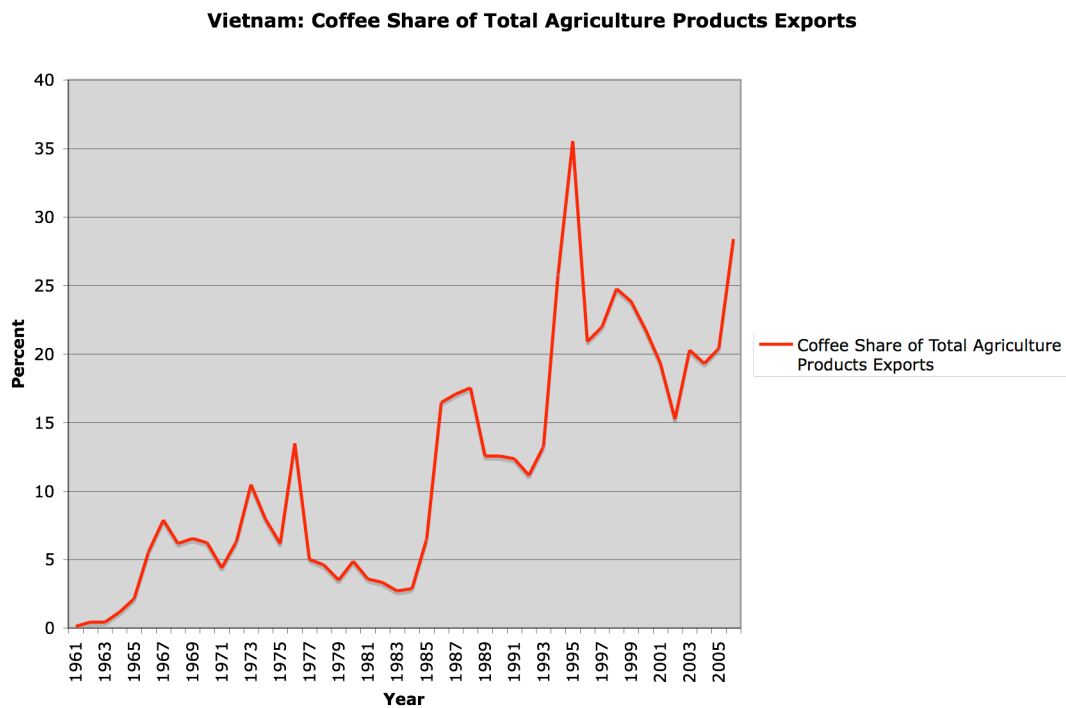
Specifically, if Vietnam had originally been barricaded from participation in international trade, upon gaining access to the market, many nations would choose to trade with Vietnam over Colombia since Vietnam’s comparative advantage offers greater potential gains from trade. Neither country’s comparative advantage would not change over time; however, it is only after the removal of trade barriers that potential trade partners could realize the disparity between Vietnamese and Colombian comparative advantage. This newly realized disparity would motivate importing countries to shift from Colombia to Vietnam in order to conduct their coffee trade transactions.

Graph 8.
(a)



Source: Food and Agriculture Organization
of the United Nations: Statistics Department

(b)



Source: Food and Agriculture Organization
of the United Nations: Statistics Department

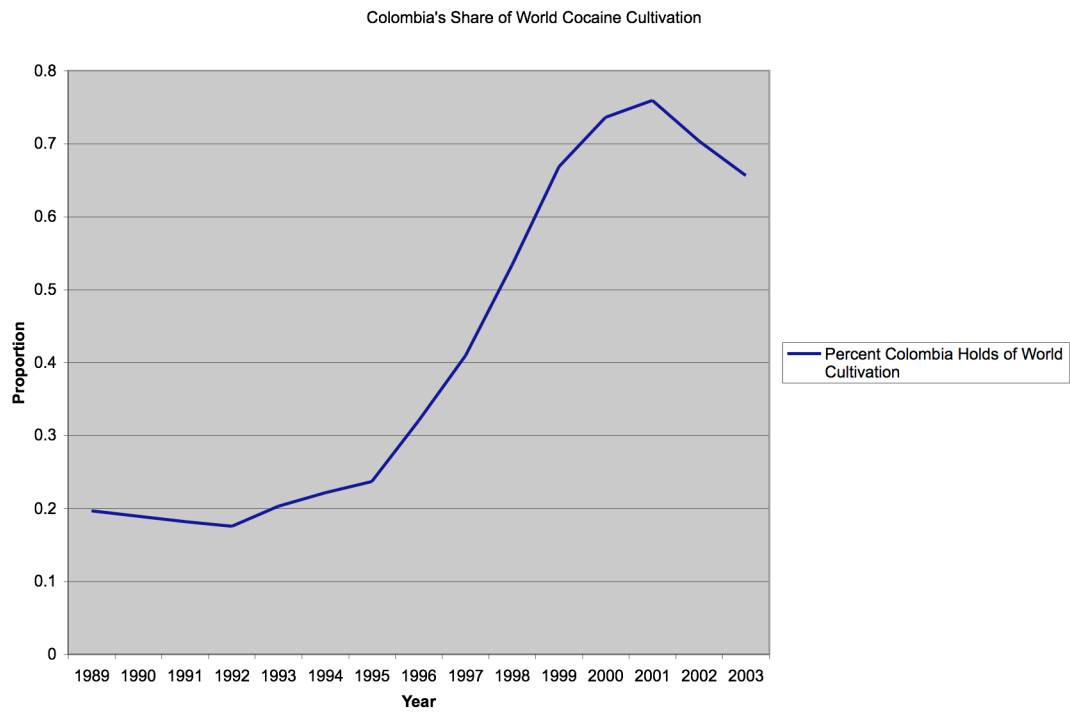
Graph 9.

Published Data for Percentage of Labor Force Employed in Agriculture

| Year | Colombia (%) | Vietnam (%) |
|------|--------------|-------------|
| 1985 | 1.399999976 | - |
| 1986 | 1.399999976 | - |
| 1987 | 1.399999976 | - |
| 1988 | 1.299999952 | - |
| 1989 | 1.299999952 | - |
| 1990 | 1.399999976 | - |
| 1991 | 1.299999952 | 74.69999695 |
| 1992 | 1.399999976 | 72.80000305 |
| 1993 | 1.100000024 | 71.59999847 |
| 1994 | 1.299999952 | 70.00000000 |
| 1995 | 1.000000000 | - |
| 1996 | 1.200000048 | 70.00000000 |
| 1997 | 1.000000000 | 65.30000305 |
| 1998 | 1.000000000 | 64.80000305 |
| 1999 | 1.100000024 | 65.00000000 |
| 2000 | 1.100000024 | 65.30000305 |
| 2001 | 22.20000076 | 64.00000000 |
| 2002 | 20.39999962 | 62.00000000 |
| 2003 | 21.10000038 | 59.70000076 |
| 2004 | 20.29999924 | 57.90000153 |
| 2005 | 22.39999962 | - |

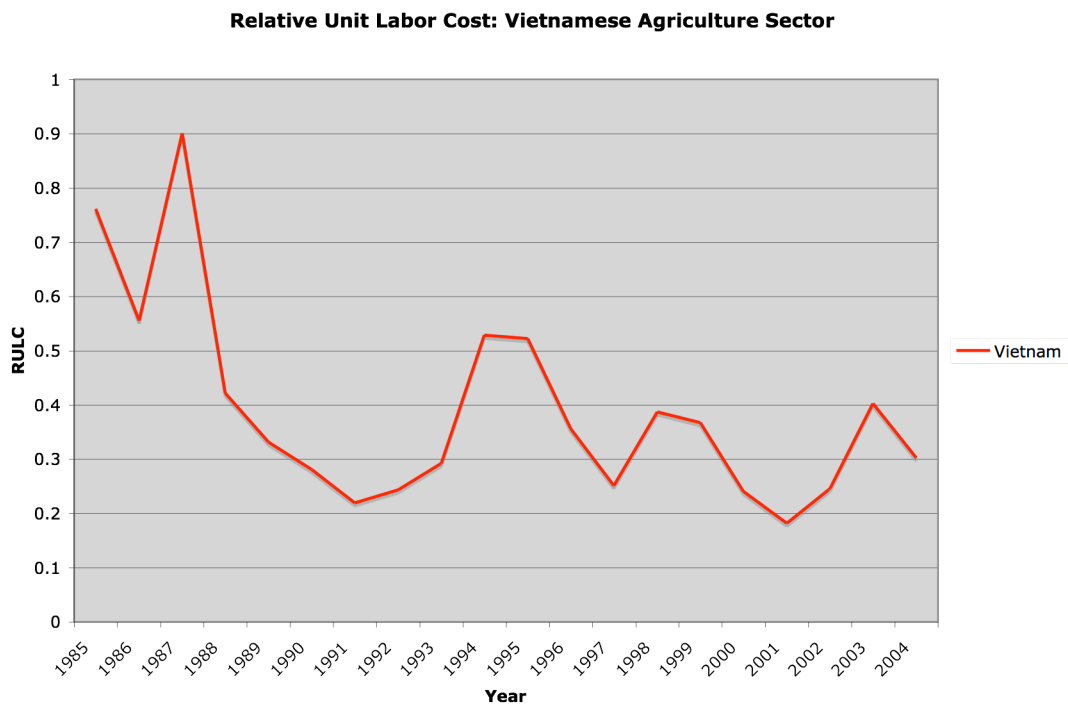
Source: The World Bank Group World Development Indicators

Graph 10.



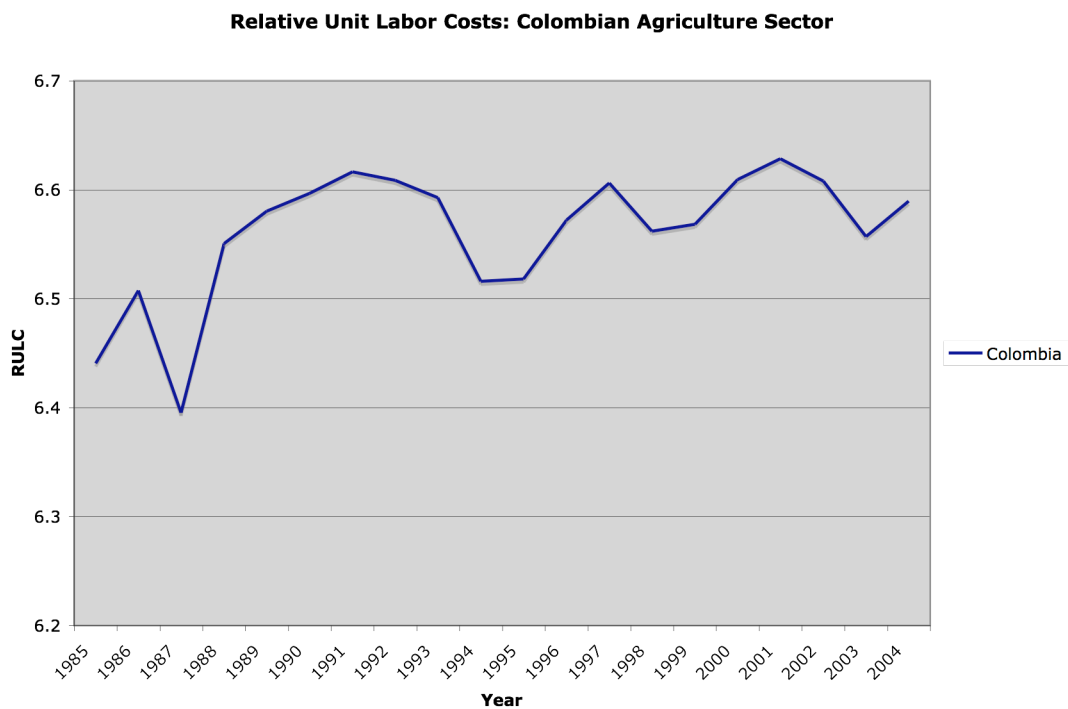
Bureau of International Narcotics
and Law Enforcement Affairs

Graph 11.
(a)



Source: International Coffee Organization, The World Bank Group World Development Indicators, Food and Agricultural Organization of the United Nations: Statistics Department

(b)



Source: International Coffee Organization, The World Bank Group World Development Indicators, Food and Agricultural Organization of the United Nations: Statistics Department

Appendix A

Causality from Vietnamese coffee exportation to ICO Composite Price

A.1 Granger Causality Data

X=Vietnam Coffee Exports (000US\$); Y=ICO Composite Price

Vietnamese Coffee Export Volume and ICO Composite Price

| Year | $(Y_t - Y_{t-1})/Y_{t-1}$ | $(Y_{t-1} - Y_{t-2})/Y_{t-2}$ | $(Y_{t-2} - Y_{t-3})/Y_{t-3}$ | $(X_t - X_{t-1})/X_{t-1}$ | $(X_{t-1} - X_{t-2})/X_{t-2}$ | $(X_{t-2} - X_{t-3})/X_{t-3}$ |
|------|---------------------------|-------------------------------|-------------------------------|---------------------------|-------------------------------|-------------------------------|
| 1968 | -0.485900217 | -0.044559585 | 1.123212321 | 0.003761419 | -0.060338300 | -0.018825861 |
| 1969 | 0.191983122 | -0.485900217 | -0.044559585 | 0.036134904 | 0.003761419 | -0.060338298 |
| 1970 | 0.185840708 | 0.191983122 | -0.485900217 | 0.305089124 | 0.036134904 | 0.003761419 |
| 1971 | -0.156716418 | 0.185840708 | 0.191983122 | -0.115993670 | 0.305089124 | 0.036134904 |
| 1972 | 0.038938053 | -0.156716418 | 0.185840708 | 0.128750560 | -0.115993670 | 0.305089124 |
| 1973 | 1.753833049 | 0.038938053 | -0.156716418 | 0.233088673 | 0.128750560 | -0.115993666 |
| 1974 | 0.051654810 | 1.753833049 | 0.038938053 | 0.093146718 | 0.233088673 | 0.128750560 |
| 1975 | -0.058823529 | 0.051654810 | 1.753833049 | 0.055629139 | 0.093146718 | 0.233088673 |
| 1976 | 2.750000000 | -0.058823529 | 0.051654810 | 0.979088248 | 0.055629139 | 0.093146718 |
| 1977 | -0.583333333 | 2.750000000 | -0.058823529 | 0.614609749 | 0.979088248 | 0.055629139 |
| 1978 | -0.100000000 | -0.583333333 | 2.750000000 | -0.323109810 | 0.614609749 | 0.979088248 |
| 1979 | -0.288888889 | -0.100000000 | -0.583333333 | 0.092491138 | -0.323109810 | 0.614609749 |
| 1980 | 0.510000000 | -0.288888889 | -0.100000000 | -0.111091450 | 0.092491138 | -0.323109812 |
| 1981 | -0.317052980 | 0.510000000 | -0.288888889 | -0.233955000 | -0.111091450 | 0.092491138 |
| 1982 | 0.363636364 | -0.317052980 | 0.510000000 | 0.083001213 | -0.233955000 | -0.111091445 |
| 1983 | 0.111111111 | 0.363636364 | -0.317052980 | 0.023840000 | 0.083001213 | -0.233955001 |
| 1984 | 0.160000000 | 0.111111111 | 0.363636364 | 0.103219253 | 0.023840000 | 0.083001213 |
| 1985 | 1.379310345 | 0.160000000 | 0.111111111 | -0.057298680 | 0.103219253 | 0.023840000 |
| 1986 | 3.454637681 | 1.379310345 | 0.160000000 | 0.284222389 | -0.057298680 | 0.103219253 |
| 1987 | -0.186534145 | 3.454637681 | 1.379310345 | -0.369273970 | 0.284222389 | -0.057298676 |
| 1988 | 0.160897474 | -0.186534145 | 3.454637681 | 0.075595956 | -0.369273970 | 0.284222389 |
| 1989 | 0.395345632 | 0.160897474 | -0.186534145 | -0.209468780 | 0.075595956 | -0.369273972 |
| 1990 | 0.141832502 | 0.395345632 | 0.160897474 | -0.219701100 | -0.209468780 | 0.075595956 |
| 1991 | -0.175602478 | 0.141832502 | 0.395345632 | -0.066126100 | -0.219701100 | -0.209468782 |
| 1992 | 0.199879346 | -0.175602478 | 0.141832502 | -0.201347310 | -0.066126100 | -0.219701102 |
| 1993 | 0.213220828 | 0.199879346 | -0.175602478 | 0.155201500 | -0.201347310 | -0.066126101 |
| 1994 | 1.954954955 | 0.213220828 | 0.199879346 | 1.181567418 | 0.155201500 | -0.201347305 |
| 1995 | 0.817073171 | 1.954954955 | 0.213220828 | 0.029527705 | 1.181567418 | 0.155201500 |

| | | | | | | |
|------|--------------|--------------|--------------|--------------|--------------|--------------|
| 1996 | -0.295302013 | 0.817073171 | 1.954954955 | -0.262606560 | 0.029527705 | 1.181567418 |
| 1997 | 0.184609524 | -0.295302013 | 0.817073171 | 0.311942784 | -0.262606560 | 0.029527705 |
| 1998 | 0.193467407 | 0.184609524 | -0.295302013 | -0.186393850 | 0.311942784 | -0.262606560 |
| 1999 | -0.014971547 | 0.193467407 | 0.184609524 | -0.213308860 | -0.186393850 | 0.311942784 |
| 2000 | -0.145754082 | -0.014971547 | 0.193467407 | -0.250495860 | -0.213308860 | -0.186393847 |
| 2001 | -0.216795323 | -0.145754082 | -0.014971547 | -0.290317560 | -0.250495860 | -0.213308857 |
| 2002 | -0.176370778 | -0.216795323 | -0.145754082 | 0.047159465 | -0.290317560 | -0.250495858 |
| 2003 | 0.566479476 | -0.176370778 | -0.216795323 | 0.087138668 | 0.047159465 | -0.290317559 |
| 2004 | 0.269622018 | 0.566479476 | -0.176370778 | 0.197495183 | 0.087138668 | 0.047159465 |

Source: United Nations Food and Agriculture Organization; International Coffee Organization

A.2 STATA Robust OLS Regression

```
. regress GICOpri ce GICOpri ce_lag1 GICOpri ce_lag2 GVietnam ex port_lag1 GVietnam ex port_lag2,
robust
```

$$GY_t = \alpha + a_1 GY_{t-1} + a_2 GY_{t-2} + b_1 GX_{t-1} + b_2 GX_{t-2}$$

Linear regression

Number of obs = 37
F(4, 32) = 0.60
Prob > F = 0.6678
R-squared = 0.0563
Root MSE = .33662

| GICOpri ce | Coef. | Robust Std. Err. | t | P> t | [95% Conf. Interval] | |
|----------------|-----------|---------------------|-------|-------|----------------------|----------|
| GICOpri ce_~1 | .1669969 | .1898713 | 0.88 | 0.386 | -.2197583 | .553752 |
| GICOpri ce_~2 | -.0477248 | .1663265 | -0.29 | 0.776 | -.3865208 | .2910712 |
| GVietnam ex ~1 | -.0242984 | .0782956 | -0.31 | 0.758 | -.1837813 | .1351845 |
| GVietnam ex ~2 | -.0627301 | .0621745 | -1.01 | 0.321 | -.1893754 | .0639152 |
| _cons | .0789892 | .064487 | 1.22 | 0.230 | -.0523664 | .2103448 |

A.3 STATA Variance and Covariance Calculations for Use in T-Test

```
. correlate, _coef cov
```

| | GICOpri ~1 | GICOpri ~2 | GVietn ~1 | GVietn ~2 | _cons |
|----------------|------------|------------|-----------|-----------|---------|
| GICOpri ce_~1 | .036051 | | | | |
| GICOpri ce_~2 | -.002708 | .027665 | | | |
| GVietnam ex ~1 | -.007945 | -.00117 | .00613 | | |
| GVietnam ex ~2 | -.000996 | -.005373 | .000617 | .003866 | |
| _cons | .005194 | -.001993 | -.002537 | -.00093 | .004159 |

A.4 Computations

$$Z_1 = b_1 + b_2 = 0$$

→

$$t = \frac{\widehat{b}_1 + \widehat{b}_2 - 0}{se(\widehat{b}_1 + \widehat{b}_2)} = \frac{-.0242984 - .0627301}{.1059716943} = -0.8212$$

$$\begin{aligned} \text{where } se(\widehat{b}_1 + \widehat{b}_2) &= [\text{Var}(\widehat{b}_1 + \widehat{b}_2)]^{1/2} = [\text{Var}(\widehat{b}_1) + 2\text{cov}(\widehat{b}_1, \widehat{b}_2) + \text{Var}(\widehat{b}_2)]^{1/2} \\ &= [.00613 + 2(-.000617) + .003866]^{1/2} = [.01123]^{1/2} = .1059716943 \end{aligned}$$

Appendix B
Causality from ICO Composite Price to Vietnamese coffee exportation

B.1 Granger Causality Data

See above data in appendix A.1. X=Vietnam Coffee Exports (000US\$); Y=ICO Composite Price

B.2 STATA Robust OLS Regression

$$GX_t = \alpha + c_1 GX_{t-1} + c_2 GX_{t-2} + d_1 GY_{t-1} + d_2 GY_{t-2}$$

```
. regress GVietnamexport GVietnamexport_lag1 GVietnamexport_lag2 GICOprice_lag1
GICOprice_lag2, robust
```

Linear regression

Number of obs = 37
F(4, 32) = 1.84
Prob > F = 0.1462
R-squared = 0.0372
Root MSE = .89822

| GVietnamex~t | Coef. | Robust Std. Err. | t | P> t | [95% Conf. Interval] | |
|--------------|-----------|---------------------|-------|-------|----------------------|----------|
| GVietnamex~1 | -.0487753 | .253131 | -0.19 | 0.848 | -.5643863 | .4668357 |
| GVietnamex~2 | -.1157751 | .1230982 | -0.94 | 0.354 | -.3665179 | .1349677 |
| GICOprice_~1 | .2404705 | .5481534 | 0.44 | 0.664 | -.8760815 | 1.357022 |
| GICOprice_~2 | -.2381764 | .3369078 | -0.71 | 0.485 | -.9244353 | .4480824 |
| _cons | .4038822 | .1526087 | 2.65 | 0.013 | .0930283 | .714736 |

B.3 STATA Variance and Covariance Calculations for Use in T-Test

```
. correlate, _coef cov
```

| | GVietn~1 | GVietn~2 | GICOpr~1 | GICOpr~2 | _cons |
|--------------|----------|----------|----------|----------|---------|
| GVietnamex~1 | .064075 | | | | |
| GVietnamex~2 | -.008417 | .015153 | | | |
| GICOprice_~1 | -.105933 | .017175 | .300472 | | |
| GICOprice_~2 | .031696 | -.03354 | -.084761 | .113507 | |
| _cons | .001071 | -.010886 | -.005517 | .013121 | .023289 |

B.4 Computations

$$Z_2 = d_1 + d_2 = 0$$

→

$$t = \frac{\widehat{d_1} + \widehat{d_2} - 0}{se(\widehat{d_1} + \widehat{d_2})} = \frac{.2404705 - .2381764}{.4944259297} = 0.0046$$

$$\begin{aligned} \text{where } se(\widehat{d_1} + \widehat{d_2}) &= [\text{Var}(\widehat{d_1} + \widehat{d_2})]^{1/2} = [\text{Var}(\widehat{d_1}) + 2\text{cov}(\widehat{d_1}, \widehat{d_2}) + \text{Var}(\widehat{d_2})]^{1/2} \\ &= [.300472 + 2(-.084761) + .113507]^{1/2} = [.244457]^{1/2} = .4944259297 \end{aligned}$$

Appendix C
Post-ICA Granger Causality Analysis

C.1 Causality from Vietnamese Coffee Exportation to ICO Composite Price

```
. regress GICOpri ce GICOpri ce_lag1 GICOpri ce_lag2 GVietnam ex port_lag1 GVietnam ex port_lag2,
robust
```

$$GY_t = \alpha + a_1 GY_{t-1} + a_2 GY_{t-2} + b_1 GX_{t-1} + b_2 GX_{t-2}$$

Linear regression

Number of obs = 14
F(4, 9) = 0.53
Prob > F = 0.7153
R-squared = 0.1097
Root MSE = .4321

| GICOpri ce | Coef. | Robust Std. Err. | t | P> t | [95% Conf. Interval] | |
|---------------|-----------|---------------------|-------|-------|----------------------|----------|
| GICOpri ce~1 | .2575647 | .6395155 | 0.40 | 0.697 | -1.18912 | 1.704249 |
| GICOpri ce~2 | -.5282056 | .5715245 | -0.92 | 0.379 | -1.821084 | .7646727 |
| GVietnam ex~1 | -.0350061 | .4148301 | -0.08 | 0.935 | -.9734171 | .9034048 |
| GVietnam ex~2 | .2420801 | .3479887 | 0.70 | 0.504 | -.5451251 | 1.029285 |
| _cons | -.0153595 | .1423496 | -0.11 | 0.916 | -.3373767 | .3066577 |

```
. correlate, _coef cov
```

| | GICOpri~1 | GICOpri~2 | GVietn~1 | GVietn~2 | _cons |
|---------------|-----------|-----------|----------|----------|---------|
| GICOpri ce~1 | .40898 | | | | |
| GICOpri ce~2 | -.004973 | .32664 | | | |
| GVietnam ex~1 | -.248742 | -.049814 | .172084 | | |
| GVietnam ex~2 | .066369 | -.183647 | -.015169 | .121096 | |
| _cons | .066713 | .014505 | -.044778 | -.002591 | .020263 |

Computations:

$$Z_1 = b_1 + b_2 = 0$$

→

$$t = \frac{\widehat{b}_1 + \widehat{b}_2 - 0}{se(\widehat{b}_1 + \widehat{b}_2)} = \frac{-.0350061 + .2420801}{.51268} = 0.404$$

$$\begin{aligned} \text{where } se(\widehat{b}_1 + \widehat{b}_2) &= [\text{Var}(\widehat{b}_1 + \widehat{b}_2)]^{1/2} = [\text{Var}(\widehat{b}_1) + 2\text{cov}(\widehat{b}_1, \widehat{b}_2) + \text{Var}(\widehat{b}_2)]^{1/2} \\ &= [.172084 + 2(-.015169) + .121096]^{1/2} = [.262842]^{1/2} = .51268 \end{aligned}$$

C.2 Causality from ICO Composite Price to Vietnamese Coffee Exportation

$$GX_t = \alpha + c_1 GX_{t-1} + c_2 GX_{t-2} + d_1 GY_{t-1} + d_2 GY_{t-2}$$

```
. regress GVietnamexport GVietnamexport_lag1 GVietnamexport_lag2 GICOpriprice_lag1
GICOpriprice_lag2, robust
```

Linear regression

Number of obs = 14
F(4, 9) = 3.02
Prob > F = 0.0779
R-squared = 0.3698
Root MSE = .55783

| GVietnamex~t | Coef. | Robust Std. Err. | t | P> t | [95% Conf. Interval] | |
|----------------|-----------|---------------------|-------|-------|----------------------|----------|
| GVietnamex~1 | -.4827336 | .5417448 | -0.89 | 0.396 | -1.708246 | .7427783 |
| GVietnamex~2 | .1804349 | .4431983 | 0.41 | 0.693 | -.8221493 | 1.183019 |
| GICOpriprice~1 | 1.443071 | .8619732 | 1.67 | 0.128 | -.5068483 | 3.392989 |
| GICOpriprice~2 | -.4213448 | .7615072 | -0.55 | 0.594 | -2.143994 | 1.301304 |
| _cons | .2954999 | .2047185 | 1.44 | 0.183 | -.1676055 | .7586053 |

```
. correlate, _coef cov
```

| | GVietn~1 | GVietn~2 | GICOpri~1 | GICOpri~2 | _cons |
|----------------|----------|----------|-----------|-----------|--------|
| GVietnamex~1 | .293487 | | | | |
| GVietnamex~2 | .00677 | .196425 | | | |
| GICOpriprice~1 | -.437533 | .087477 | .742998 | | |
| GICOpriprice~2 | -.110164 | -.320654 | -.000417 | .579893 | |
| _cons | -.094504 | -.010211 | .14288 | .036703 | .04191 |

Computations:

$$Z_2 = d_1 + d_2 = 0$$

→

$$t = \frac{\widehat{d_1} + \widehat{d_2} - 0}{se(\widehat{d_1} + \widehat{d_2})} = \frac{1.443071 - .4213448}{1.149807375} = 0.8886$$

$$\begin{aligned} \text{where } se(\widehat{d_1} + \widehat{d_2}) &= [\text{Var}(\widehat{d_1} + \widehat{d_2})]^{1/2} = [\text{Var}(\widehat{d_1}) + 2\text{cov}(\widehat{d_1}, \widehat{d_2}) + \text{Var}(\widehat{d_2})]^{1/2} \\ &= [.742998 + 2(-.000417) + .579893]^{1/2} = [1.322057]^{1/2} = 1.149807375 \end{aligned}$$

Appendix D

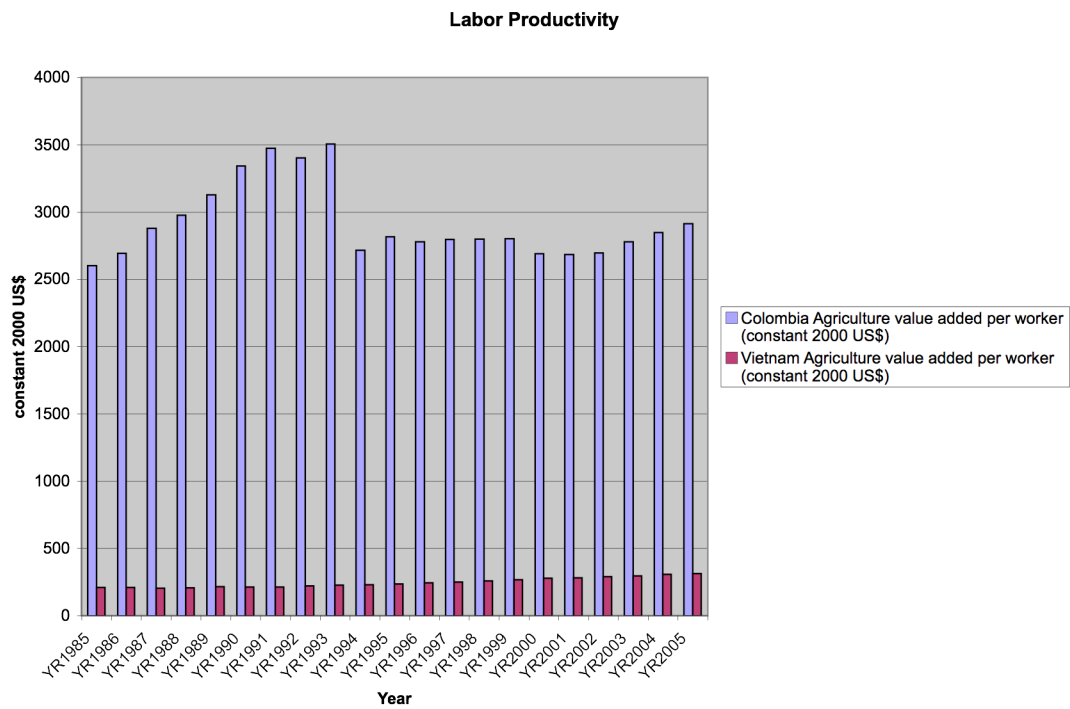
D.1 Labor Productivity Data

Colombian and Vietnamese Labor Productivity

| Year | Colombia Agriculture Value Added per worker (constant 2000 US\$) | Vietnam Agriculture Value Added per worker (constant 2000 US\$) |
|------|--|---|
| 1985 | 2599.908048 | 209.0801699 |
| 1986 | 2693.270866 | 209.9914798 |
| 1987 | 2877.770331 | 202.4222486 |
| 1988 | 2975.278818 | 204.6078737 |
| 1989 | 3127.260605 | 213.5519233 |
| 1990 | 3341.260745 | 210.4735516 |
| 1991 | 3472.545684 | 210.9842621 |
| 1992 | 3400.703724 | 221.3623725 |
| 1993 | 3504.185806 | 224.6287443 |
| 1994 | 2715.617769 | 228.4288468 |
| 1995 | 2814.725835 | 235.8577393 |
| 1996 | 2778.466324 | 242.9699018 |
| 1997 | 2796.528905 | 250.3177672 |
| 1998 | 2799.114023 | 256.4708048 |
| 1999 | 2800.786246 | 267.0655904 |
| 2000 | 2688.187007 | 276.5320571 |
| 2001 | 2683.187007 | 281.1130901 |
| 2002 | 2695.126453 | 289.0702896 |
| 2003 | 2779.228029 | 295.7341886 |
| 2004 | 2847.460843 | 304.7876375 |
| 2005 | 2913.932274 | 313.2078420 |

Source: The World Bank Group World Development Indicators

D.2 Graphical Comparison of Labor Productivity



Source: The World Bank Group World Development Indicators

D.3 Labor Productivity Growth

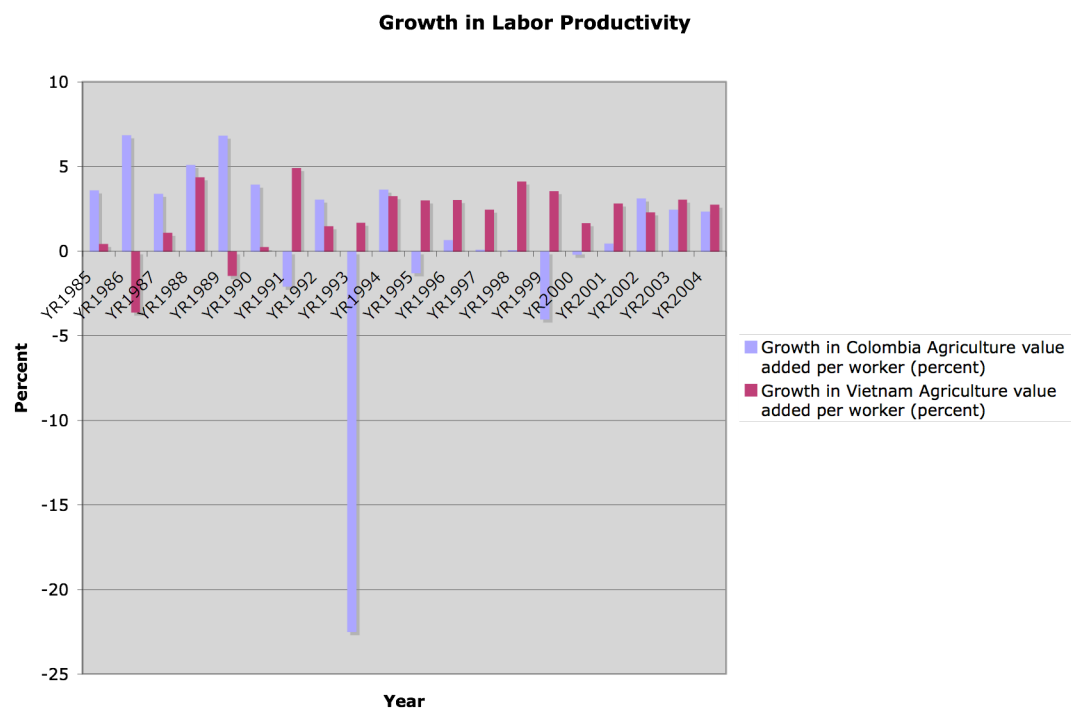
Growth in Labor Productivity in Colombia and Vietnam

| Year* | Colombia Growth in Agriculture Value Added per worker (%) | Vietnam Growth in Agriculture Value Added per worker (%) |
|-------|---|--|
| 1985 | 3.591004587 | 0.435866241 |
| 1986 | 6.850386573 | -3.60454203 |
| 1987 | 3.388334548 | 1.079735602 |
| 1988 | 5.108152754 | 4.371312545 |
| 1989 | 6.843054262 | -1.441509705 |
| 1990 | 3.929203665 | 0.242648294 |
| 1991 | -2.068855719 | 4.918902595 |
| 1992 | 3.042960829 | 1.475576788 |
| 1993 | -22.50360229 | 1.691725839 |
| 1994 | 3.649558759 | 3.252169152 |
| 1995 | -1.288207561 | 3.015445896 |
| 1996 | 0.650091757 | 3.024187511 |
| 1997 | 0.092440246 | 2.458090647 |
| 1998 | 0.059741167 | 4.130990896 |
| 1999 | -4.018268758 | 3.544622391 |
| 2000 | -0.188082727 | 1.656601074 |
| 2001 | 0.444972565 | 2.830604388 |
| 2002 | 3.120505772 | 2.305286717 |
| 2003 | 2.455099515 | 3.061346726 |
| 2004 | 2.334410706 | 2.762646328 |

Source: The World Bank Group World Development Indicators

* Each year represents the growth between the stated year and the following year [e.g. $(x_t - x_{t-1}) / x_{t-1}$]

D.4 Graphical Comparison of Labor Productivity Growth



Source: The World Bank Group World Development Indicators

Appendix E Classical Model Analysis

$$\frac{Labor\ Productivity_{Vietnam}}{Labor\ Productivity_{Colombia}} > \frac{W_{Vietnam}}{W_{Colombia}}$$

Labor Productivity and Wage Determination of Export Market Domination

| Year | (A) Labor Productivity _{Vietnam} | (B) wage _{Vietnam} | (A) – (B)* |
|------|--|--------------------------------|------------|
| | Labor Productivity _{Colombia} | wage _{Colombia} | |
| 1985 | 0.08041829 | 1.46884565 | -1.3895274 |
| 1986 | 0.07796894 | 1.09447939 | -1.0165105 |
| 1987 | 0.07033996 | 2.00225494 | -1.9319150 |
| 1988 | 0.06876831 | 0.93628639 | -0.8675171 |
| 1989 | 0.06828722 | 0.73640977 | -0.6681226 |
| 1990 | 0.06299226 | 0.67586777 | -0.6128755 |
| 1991 | 0.06075781 | 0.54562270 | -0.4848649 |
| 1992 | 0.06509311 | 0.56538585 | -0.5002927 |
| 1993 | 0.06410298 | 0.69234222 | -0.6282392 |
| 1994 | 0.08411672 | 0.96420716 | -0.8800904 |
| 1995 | 0.08379421 | 0.95637765 | -0.8725834 |
| 1996 | 0.08744749 | 0.61912832 | -0.5316808 |
| 1997 | 0.08951017 | 0.42436382 | -0.3348537 |
| 1998 | 0.09162571 | 0.64350399 | -0.5518783 |
| 1999 | 0.09535379 | 0.58670654 | -0.4913527 |
| 2000 | 0.10286721 | 0.35410784 | -0.2512406 |
| 2001 | 0.10476836 | 0.26172754 | -0.1569592 |
| 2002 | 0.10725667 | 0.34603891 | -0.2387822 |
| 2003 | 0.10640875 | 0.57754564 | -0.4711369 |
| 2004 | 0.10703839 | 0.42801956 | -0.3209812 |
| 2005 | 0.10748631 | 0.40235373 | -0.2948674 |

Source: The World Bank Group's World Development Indicators, International Coffee Organization

*Note: the negative values of (A) – (B) indicate that Colombia, not Vietnam, should dominate the world coffee export market.

Appendix F
Cost Competitiveness for Vietnam

F.1 Data Components of the regression equation

XMS and RULC Data

| Year | XMS | W/E | eQ/N | ULC | RULC |
|------|-------------|------------|------------|-------------|------------|
| 1985 | 0.00127518 | 91.5016667 | 209.08017 | 19131.18401 | 0.76134937 |
| 1986 | 0.004221 | 95.5416667 | 209.99148 | 20062.93596 | 0.55521666 |
| 1987 | 0.00510277 | 156.87 | 202.422249 | 31753.97814 | 0.90072028 |
| 1988 | 0.00583884 | 70.1575 | 204.607874 | 14354.77690 | 0.42178983 |
| 1989 | 0.00896637 | 54.5366667 | 213.551923 | 11646.41006 | 0.33090394 |
| 1990 | 0.01320452 | 46.9908333 | 210.473552 | 9890.327586 | 0.28084221 |
| 1991 | 0.01150466 | 36.6258333 | 210.984262 | 7727.474420 | 0.21934086 |
| 1992 | 0.01707245 | 30.8875 | 221.362372 | 6837.330280 | 0.24321829 |
| 1993 | 0.01918129 | 34.7025 | 224.628744 | 7795.178997 | 0.29259136 |
| 1994 | 0.030418129 | 82.9258333 | 228.428847 | 18942.65248 | 0.52849920 |
| 1995 | 0.04850753 | 94.7483333 | 235.857739 | 22347.12770 | 0.52235757 |
| 1996 | 0.040351 | 57.84 | 242.969902 | 14053.37912 | 0.35582551 |
| 1997 | 0.03766655 | 55.8791667 | 250.317767 | 13987.54823 | 0.25093570 |
| 1998 | 0.0496488 | 65.6116667 | 256.470805 | 16827.47696 | 0.38691074 |
| 1999 | 0.0597665 | 50.6816667 | 267.065590 | 13535.32923 | 0.36746700 |
| 2000 | 0.05905979 | 26.5433333 | 276.532057 | 7340.082570 | 0.24075827 |
| 2001 | 0.07199897 | 15.12 | 281.113090 | 4250.429923 | 0.18176238 |
| 2002 | 0.06336321 | 18.1416667 | 289.070290 | 5244.216838 | 0.24525737 |
| 2003 | 0.08840501 | 27.92 | 295.734189 | 8256.898546 | 0.40295929 |
| 2004 | 0.09045975 | 26.0375 | 304.787638 | 7935.908112 | 0.30190247 |

Sources: International Coffee Organization, The World Bank Group World Development Indicators, Food and Agriculture Organization of the United Nations: Statistics Department

F.2 STATA Regression Results for Vietnam

Specific Regression Model:

$$\log(\text{XMS}) = \alpha_1 \log(\text{RULC}_t) + \alpha_2 \log(\text{RULC}_{t-1}) + \alpha_3 \log(\text{RULC}_{t-2}) + v_k$$

```
. regress logXMSv logRULCv logRULCv_lag1 logRULCv_lag2
```

| Source | SS | df | MS | Number of obs = 18 | | |
|----------|------------|----|------------|------------------------|--|--|
| Model | 6.37444653 | 3 | 2.12481551 | F(3, 14) = 3.60 | | |
| Residual | 8.25265828 | 14 | .589475591 | Prob > F = 0.0406 | | |
| | | | | R-squared = 0.4358 | | |
| | | | | Adj R-squared = 0.3149 | | |
| | | | | Root MSE = .76777 | | |
| Total | 14.6271048 | 17 | .86041793 | | | |

| logXMSv | Coef. | Std. Err. | t | P> t | [95% Conf. Interval] | |
|---------------|-----------|-----------|-------|-------|----------------------|-----------|
| logRULCv | -.5304175 | .579216 | -0.92 | 0.375 | -1.772712 | .7118773 |
| logRULCv_lag1 | .1262881 | .6737602 | 0.19 | 0.854 | -1.318784 | 1.57136 |
| logRULCv_lag2 | -1.295814 | .5300737 | -2.44 | 0.028 | -2.432709 | -.1589188 |
| _cons | -5.330354 | .6569586 | -8.11 | 0.000 | -6.73939 | -3.921318 |

```
. test (logRULCv=0) (logRULCv_lag1=0) (logRULCv_lag2=0)
```

(1) logRULCv = 0

(2) logRULCv_lag1 = 0

(3) logRULCv_lag2 = 0

F(3, 14) = 3.60

Prob > F = 0.0406

Appendix G

Cost Competitiveness for Colombia

G.1 Data Components of the regression equation

XMS and RULC Data

| Year | XMS | W/E | eQ/N | ULC | RULC |
|------|------------|------------|------------|-------------|------------|
| 1985 | 0.16129366 | 62.2483333 | 2599.90805 | 161839.9428 | 6.44062271 |
| 1986 | 0.20518667 | 87.2941667 | 2693.28087 | 235106.8358 | 6.50745953 |
| 1987 | 0.16843407 | 78.3466667 | 2877.77033 | 225463.7129 | 6.39541090 |
| 1988 | 0.16501347 | 74.9316667 | 2975.27882 | 222942.6006 | 6.55077552 |
| 1989 | 0.16869129 | 74.0575 | 3127.26060 | 231597.1022 | 6.58025883 |
| 1990 | 0.20196961 | 69.5266667 | 3341.26074 | 232306.7220 | 6.59649880 |
| 1991 | 0.20163903 | 67.1266667 | 3472.54568 | 233100.4166 | 6.61644979 |
| 1992 | 0.23512948 | 54.6308333 | 3400.70372 | 185783.2784 | 6.60870397 |
| 1993 | 0.19752966 | 50.1233333 | 3504.18581 | 175641.4732 | 6.59268739 |
| 1994 | 0.18483909 | 86.0041667 | 2715.61777 | 233554.4432 | 6.51615909 |
| 1995 | 0.14953039 | 99.07 | 2814.72584 | 278854.8885 | 6.51815143 |
| 1996 | 0.15152263 | 93.4216667 | 2778.46632 | 259568.9548 | 6.57217429 |
| 1997 | 0.17106377 | 131.6775 | 2796.52890 | 368239.9349 | 6.60620045 |
| 1998 | 0.15824341 | 101.96 | 2799.11402 | 285397.6658 | 6.56209027 |
| 1999 | 0.13533032 | 86.3833333 | 2800.78625 | 241941.2519 | 6.56839780 |
| 2000 | 0.12640059 | 74.9583333 | 2688.24313 | 201506.2244 | 6.60950200 |
| 2001 | 0.14140649 | 57.77 | 2683.18701 | 155007.7134 | 6.62864021 |
| 2002 | 0.15360196 | 52.4266667 | 2695.12645 | 141296.4962 | 6.60804249 |
| 2003 | 0.14212054 | 48.3425 | 2779.22803 | 134354.8310 | 6.55688413 |
| 2004 | 0.13558858 | 60.8325 | 2847.46084 | 173218.1617 | 6.58966688 |

Sources: International Coffee Organization, The World Bank Group World Development Indicators, Food and Agriculture Organization of the United Nations: Statistics Department

G.2 STATA Regression Results for Colombia

Specific Regression Model:

$$\log(\text{XMS}) = \alpha_1 \log(\text{RULC}_t) + \alpha_2 \log(\text{RULC}_{t-1}) + \alpha_3 \log(\text{RULC}_{t-2}) + v_k$$

. regress logXMSc logRULCc logRULCc_lag1 logRULCc_lag2

| Source | SS | df | MS | Number of obs = 18 |
|----------|------------|----|------------|-------------------------|
| Model | .02943561 | 3 | .00981187 | F(3, 14) = 0.31 |
| Residual | .442382842 | 14 | .031598774 | Prob > F = 0.8175 |
| Total | .471818453 | 17 | .027754027 | R-squared = 0.0624 |
| | | | | Adj R-squared = -0.1385 |
| | | | | Root MSE = .17776 |

| logXMSc | Coef. | Std. Err. | t | P> t | [95% Conf. Interval] | |
|---------------|-----------|-----------|-------|-------|----------------------|----------|
| logRULCc | -.4828017 | 5.882221 | -0.08 | 0.936 | -13.09891 | 12.13331 |
| logRULCc_lag1 | 5.62824 | 6.22384 | 0.90 | 0.381 | -7.72057 | 18.97705 |
| logRULCc_lag2 | -3.455862 | 5.228506 | -0.66 | 0.519 | -14.66989 | 7.758169 |
| _cons | -4.991919 | 11.74741 | -0.42 | 0.677 | -30.1876 | 20.20376 |

. test (logRULCc=0) (logRULCc_lag1=0) (logRULCc_lag2=0)

(1) logRULCc = 0

(2) logRULCc_lag1 = 0

(3) logRULCc_lag2 = 0

F(3, 14) = 0.31

Prob > F = 0.8175