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

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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.

Keywords
Vietnam, Colombia, International Coffee Market, International Coffee Agreement, Comparative Advantage, Causality, Labor Productivity, Cost Competitiveness

1. 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.

Following 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 price. 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.

To accomplish this goal, this paper presents a Granger causality analysis to evaluate the possible existence and direction of causality between the increased Vietnamese coffee production and the declining world coffee prices. Furthermore, to examine the reasoning behind the radical shift in coffee production, this paper includes two analyses that compare labor productivity and cost competitiveness between Colombia and Vietnam in order to examine each country's comparative advantage in the labor-intensive coffee sector. Specifically, the first analysis utilizes the Classical Model to determine which country should dominate the

export market based on the relationship between each country's labor productivity and wage rate. Whereas, the second model analyzes each country's cost competitiveness in the coffee sector by examining the role of relative unit labor costs in determining its export market share. These two theories present different ways to determine the importance of labor productivity and comparative advantage in the reallocation of coffee export volume to the more productive country, which in this case is predicted to be Vietnam. The disparity in labor productivity between these countries would not be fully realized until the 1990s when the coffee market was deregulated, thus marking the importance of the collapse of the ICA in the vast reordering of producers in the international coffee market.

This paper begins by presenting the historical background of the International Coffee Agreement, as well as the history of the Colombian and Vietnamese coffee sectors. The next section will present the motivation and methodology behind each analysis and is followed by a section of computations. The following section will present results and implications for each analysis, and lastly, there is a section of overall conclusions.

2. HISTORICAL BACKGROUND

2.1 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, thus they had little incentive to participate 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)

After a series of failed producer-based price regulation agreements, 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 future production. Although well-intentioned, a policy allowing members to surpass production quotas by exporting coffee to countries that were not typically large coffee importers created a major loophole in this agreement that resulted in inadequacies in the regulation of coffee export volume and eventually led to the reevaluation of this ICA. The next ICA, signed in 1968, included several provisions holding members accountable for obeying the quota system. This ICA faced its demise in 1972 when the United States withdrew from the agreement after producers attempted to form a cartel to counteract the negative trend of export price that was caused by the depreciation of the dollar (the unit of denomination for coffee prices) against other major currencies. (Pieterse & Silvis, 1988)

The next ICA was negotiated in 1976 and implemented quota restrictions only when the coffee prices fell below a certain level. This quota system was quickly rendered useless when unexpected situations in three major coffee producing nations allowed other nations to increase production past their quota limits in order to fill the coffee shortage. (Pieterse & Silvis, 1988)

The most recent ICA, signed in 1983, covered 99% of the world coffee exports and utilized export restrictions to stabilize world market prices. 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 artificially created higher world prices. 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 adjusted by fixed percentages depending upon how far out of the range the CIP had gone. (Pieterse & Silvis, 1988)

Although many experts agree on the effectiveness of the ICA price band, the ICA's underlying problems of free riding and quarreling over export quotas outweighed the benefits of the higher price. During the final 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 fulfill excess demand during the lag before the stable ICA quotas could be adjusted. These and other problems culminated at such a level where the ICA was no longer feasible, thus it was allowed to collapse in 1989. (Ponte, 2001)

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 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 coffee producing countries. During the reign of the ICA, many producing nations had high government involvement in their coffee sectors due to the countries' heavy reliance on coffee exports as a main source of revenue. Along with the lack of government involvement, the instability of the coffee sector was exacerbated by the inability of many smaller grower organizations 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. 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.

2.2 The Colombian 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.

Although Colombia was the second largest world coffee producer for several decades, this coffee industry experienced several booms and busts throughout its development. The first Colombian coffee price crisis occurred during the 1920s, yet this crisis was quickly overcome when Brazil opted to withhold exports from the market in an effort to force the coffee prices to rise. Colombia utilized Brazil's policy as an opportunity to expand its share of the coffee market and tripled its planted area and exports during this period of Brazilian price fixing. During the next bust in the coffee industry, Colombia joined many other coffee producing nations to form a quota system that ensured a higher price of coffee in the world market. Similar to the previous price crisis, this negative price trend reversed shortly after the conclusion of World War II, and by 1954 coffee comprised 83% of total exports from Colombia. (De Graaff, 1986)

Although Colombia's dependence on coffee fluctuated over time, the implementation of advancing technology allowed Colombia to produce higher yields on the same plots of land. This discovery resulted in the furthering of Colombia's dependence on coffee export revenue. The last major increase in

cultivated coffee area occurred between 1975 and 1978 and resulted in an oversupply in the domestic economy given that the production level exceeded Colombia's allotted export quota. (De Graaff, 1986)

The Colombian coffee sector was unique from many other large coffee producing nations in that the government did not personally oversee the coffee sector; rather, it delegated all responsibility to a private non-profit entity called the National Federation of Coffee Growers (Federacafe). This non-profit entity, established in 1927, monitored and controlled the coffee sector through government contracts (De Graaff, 1986). Federacafe created the National Coffee Fund, which received revenues from coffee taxes and employed them 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 the world coffee price. (Juan Valdez, 2008) The effects of the post-ICA coffee crisis were felt 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)

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, yet more than 50% of the national coffee was produced on medium or large farms. Near the time of the ICA collapse, 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 high-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, thus demonstrating 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 negative impact of the removal of all protectionist measures became reality when the government began to promote crop diversification away from coffee. Following this promotion, coffee producers progressed toward on-farm diversification, thus demonstrating that both the government and the producers realized their lack of competitive advantage in an open market despite Colombia's position as the second largest world coffee producer. 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 country's dependence upon coffee exports. (Giovannucci, 2002) 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).

2.3 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 and was organized by missionaries (Robequain, 1939, as cited in Doutriaux, Gesiler, & Shivley, 2008). Throughout French colonial rule in Vietnam, coffee production occurred mainly on plantations as the French strongly encouraged the cultivation of coffee for export. Relative to lowland rice, the prominent export of the time, coffee cultivation proved to be more difficult than anticipated, which severely limited the expansion of coffee production. (Doutriaux et al., 2008) The majority of the original coffee trees in Vietnam were of the Arabica variety; however, 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 encouragement 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, the new government in Vietnam began to again encourage coffee cultivation. 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 and produce coffee. (Doutriaux et al., 2008) This policy proved to be successful 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 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. 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), thus exemplifying 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). Although this increase in GDP was not a direct result of coffee exports, it is clear that Vietnam was becoming progressively dependent upon coffee as a main source of revenue as seen in the concurrent increase in GDP and coffee exports.

Accompanying the shift to a market-based coffee sector, the collapse of the ICA contributed the final factors necessary for Vietnam to experience 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%, which made Vietnam one of the largest world coffee producers second only to Brazil. Coffee exports comprised 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, thus resulting 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 further support for previous ICA members when they attribute the cause of the dropping 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.

3. Motivation and Methodology

3.1 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 - 0.041% in 1965 and 0.055% 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 (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).

Although Vietnam is often viewed as a causal factor in the world coffee crisis, 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 a mature market - the demand and consumption levels are relatively stable - and in this state coffee demand only changes under a significant increase in price (Ponte, 2001). 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. Although this is an illogical pattern since a decrease in price does not typically encourage production due to the decrease in potential profits, 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, like Vietnam, 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.

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 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.

3.2 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:

$$GY_t = \alpha + a_1 GY_{t-1} + a_2 GY_{t-2} \qquad (1a)$$
$$GY_t = \alpha + a_1 GY_{t-1} + a_2 GY_{t-2} + b_1 GX_{t-1} + b_2 GX_{t-2} \qquad (1b)$$
$$GX_t = \beta + c_1 GX_{t-1} + c_2 GX_{t-2} \qquad (2a)$$
$$GX_t = \beta + c_1 GX_{t-1} + c_2 GX_{t-2} + d_1 GY_{t-1} + d_2 GY_{t-2} \qquad (2b)$$

where $GX_t = (X_t - X_{t-1}) / X_{t-1}$, $GY_t = (Y_t - Y_{t-1}) / Y_{t-1}$, and t = 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 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 if 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 this case of 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 the results of the t-test and the F-test will be identical. 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: $Z_1 = b_1 + b_2 = 0$:

$$t = \frac{(b_1 + b_2) - 0}{se(b_1 + b_2)} \text{ where } se(b_1 + b_2) = \sqrt{Var(b_1 + b_2)} \quad (3a) \text{ and}$$

$$Var(b_1 + b_2) = Var(b_1) + 2\text{cov}(b_1, b_2) + Var(b_2) \quad (4a)$$

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

$$t = \frac{(d_1 + d_2) - 0}{se(d_1 + d_2)} \text{ where } se(d_1 + d_2) = \sqrt{Var(d_1 + d_2)} \quad (3b) \text{ and}$$

$$Var(d_1 + d_2) = Var(d_1) + 2\text{cov}(d_1, d_2) + Var(d_2) \quad (4b)$$

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.

3.3 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, such as: 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. (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 needed to obtain an accurate measurement of the total number of workers in the field per day. 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). It is unlikely that the Colombian government is able 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 or sectors. 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. Although the availability of coffee output data is still minimal, the calculation of the number of workers employed in Vietnamese coffee production is likely to be more accurate than in Columbia due to the government's role in the recent initiation of coffee production. Vietnamese coffee production, contrary to the Colombian coffee sector, has not historically employed migrant labor during the harvest season.

Due to the limited availability of data for both the Vietnamese and Colombian coffee sectors, many of the measures used in the labor productivity and cost competitiveness calculations may not be completely accurate for either nation. Thus, proxies are utilized in the following analysis in place of the unreliable 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).

$$Labor\ Productivity = \frac{Value\ added\ at\ constant\ 2000\ US\$}{Total\ Employment} \quad (5)$$

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. According to Ferreira and Rossi (2003), positive growth in labor productivity results from a reallocation of output to the more productive firm. Thus, in this case, positive growth would indicate that coffee production had been reallocated to the more productive country.

In addition to this simple graphical comparison of labor productivity, the analysis followed the methods of MacDougall (1951) as presented in Appleyard et al. (2008) and utilized the Classical Model to predict which country should dominate the export market based on wages and labor productivity. Specifically, a nation should be more competitive in the world market when it has higher labor productivity relative to another nation, after accounting for the differences in wage rate. Applying MacDougall's (1951, as cited in Appleyard et al., 2008) methodology to this analysis requires the following inequality:

$$\frac{Labor\ Productivity_{Vietnam}}{Labor\ Productivity_{Colombia}} > \frac{w_{Vietnam}}{w_{Colombia}} \quad (6)$$

Where w = wage. It is important to take the wage rate into account in this inequality due to the fact that wage rates vary greatly between nations, thus making it impossible to determine market dominance based solely on labor productivity. 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 reversed, Colombia should dominate the export market.

3.4 Cost Competitiveness

According to Carlin et al. (2001), examining the role of cost competitiveness in the determination of export market share requires two components: a measure of 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.

$$XMS_j = \frac{country_j\text{'s exports in current US\$}}{\text{dollar sum of world exports}} \quad j = Colombia, Vietnam \quad (7)$$

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 employee compensation, employment, real output, and trade is needed. Specifically, the calculation of ULC is as follows:

$$ULC_j = (W_j / E_j)*(e_jQ_j / N_j) \quad (8)$$

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 approach given by Carlin et al. (2001), the weighting factor is XMS_j in 1995, thus the specific calculation is:

$$RULC_j = \frac{ULC_j}{[XMS_{Viet,1995}*ULC_{Viet} + XMS_{Col,1995}*ULC_{Col}]} \quad (9)$$

The year 1995 was chosen as the weighting factor because it more accurately 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 by the policies of the ICA 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:

$$log(XMS_{jt}) = \Sigma\, \alpha_k\, log(RULC)_{jt-k} + v_{jt} \quad where\ k = 0, 1, \ldots, L\ is\ a\ lag\ factor \qquad (10)$$

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 in this analysis. 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)

4. COMPUTATIONS

4.1 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 data for the ICO composite price was obtained from the "Historical Data" section of the International Coffee Organization's 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. 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).

4.2 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, $t_{32,.05} = \pm 1.6939$.

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, $t_{32,.05} = \pm 1.6939$.

4.3 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 ISIC's '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 a lack of resources that are needed in order 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 among the available data 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.

4.4 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.

4.5 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 provided 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 these 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).

5. 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 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.

5.1 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% significance levels ($t_{32,.025} = \pm 2.0369$ and $t_{32,.05} = \pm 1.6939$, respectively) with 32 degrees of freedom. According to Dodaro (1993), the null hypothesis cannot be rejected, which suggests that the 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 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 difficult 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 been allowed to naturally occur 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.

5.2 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 caused the growth of X. This signifies that the growth in ICO composite price did 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 illogical 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 suggests the existence of another reason behind the Vietnamese government's continued concentration of land and labor on a commodity with plummeting world prices.

5.3 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 underrepresented 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.

5.4 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 the problem lies. 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 before 2000.

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 statistical measures that are used to monitor the coffee sector. More accurate statistical methods would identify a greater

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.

Furthermore, 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 per unit output 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 actual labor productivity for the coffee sector through either a higher output or lower number of workers than is indicated by the proxy. 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 away 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 firmly conclude that differences in labor productivity growth resulted in the transference of output from Colombia to Vietnam.

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

The comparison of the ratio of labor productivities between Vietnam and Colombia to the ratio of wages 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 productivities 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, if this analysis is repeated in the future using strictly coffee value added, it is likely that the Classical Model could correctly predict Vietnam's export market dominance over Colombia.

5.6 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. Both the Colombian regression and test of significance of the model produced insignificant results. There is not enough evidence to conclude that the elasticity of Colombia's coffee export market share (log(XMS)) is impacted by the elasticity of cost competitiveness (log(RULC)) in the 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(RULC)) significantly influences the elasticity of Vietnam's export market share (log(XMS)). Two of the estimated coefficients are negative, which produces a negative relationship between log(XMS) and the sum of $\log(RULC_k)$. 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 a decreasing trend. This trend indicates that the Vietnamese agricultural unit labor cost decreased relative to the Colombian unit labor costs. According to Carlin et al. (2001), this drop in relative cost – a decline in external competition – resulted in immediate improvement in Vietnam's 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 tends to be a fairly stable statistic for a country over time; however, Vietnam is a unique case. Vietnam's coffee exports were limited in the world market until after the ICA collapse, which is when its 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 for Colombia (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.

6. 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 in the world market, which imposed detrimental impacts upon the nations whose economies 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, which predicted significant forward causality, led to insignificant results, suggesting 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 the labor productivity ratio to the wage ratio 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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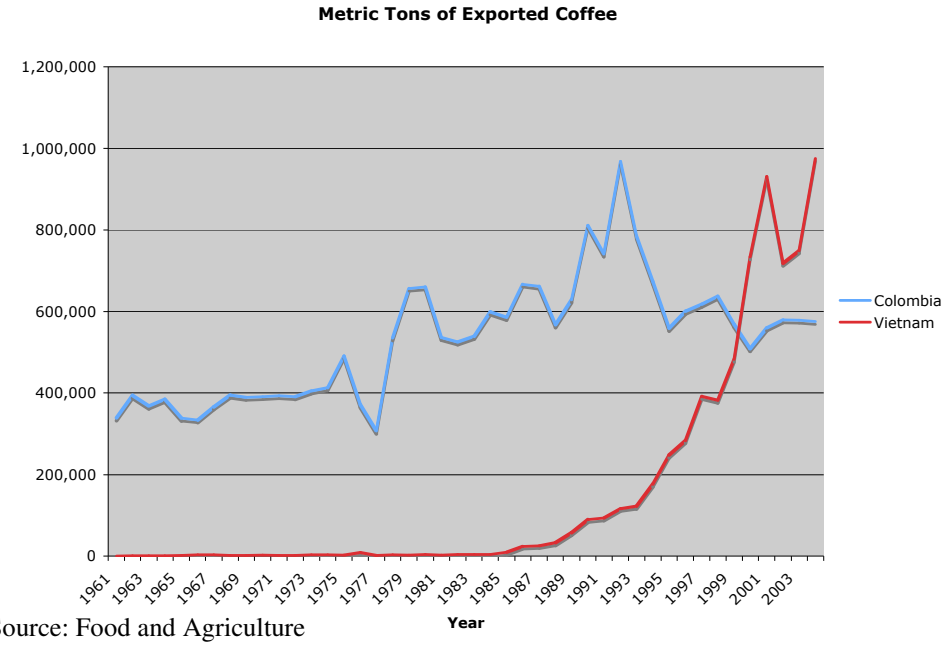
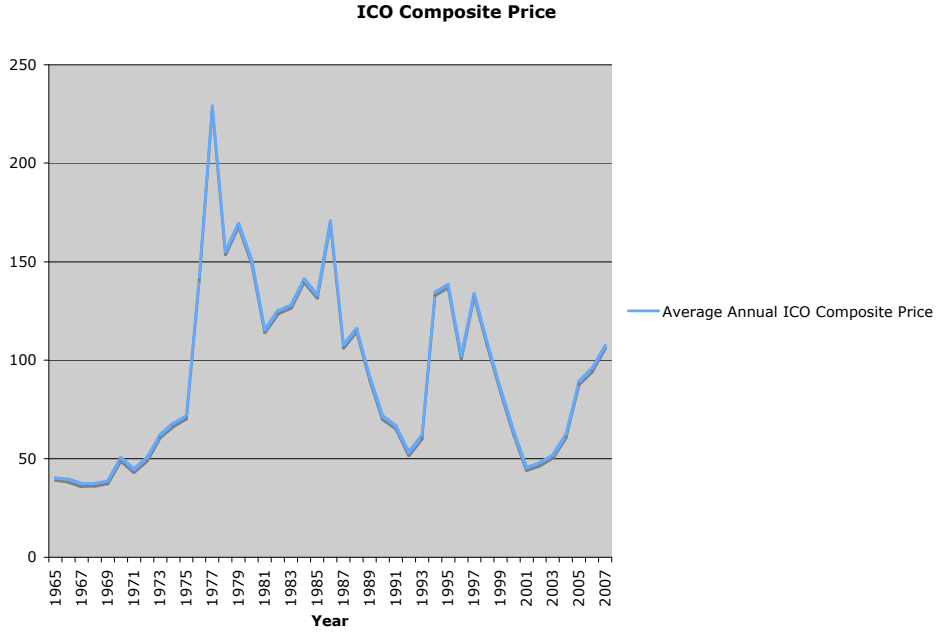
Graph 1.



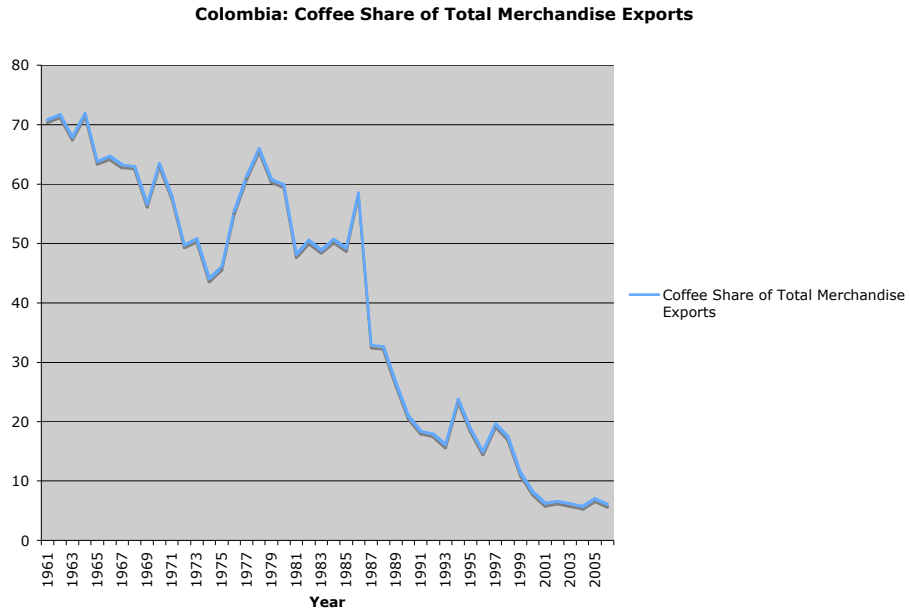
Source: Food and Agriculture Organization of the United Nations: Statistics Department

Graph 2.



Source: International Coffee Organization

Graph 3.
(a)

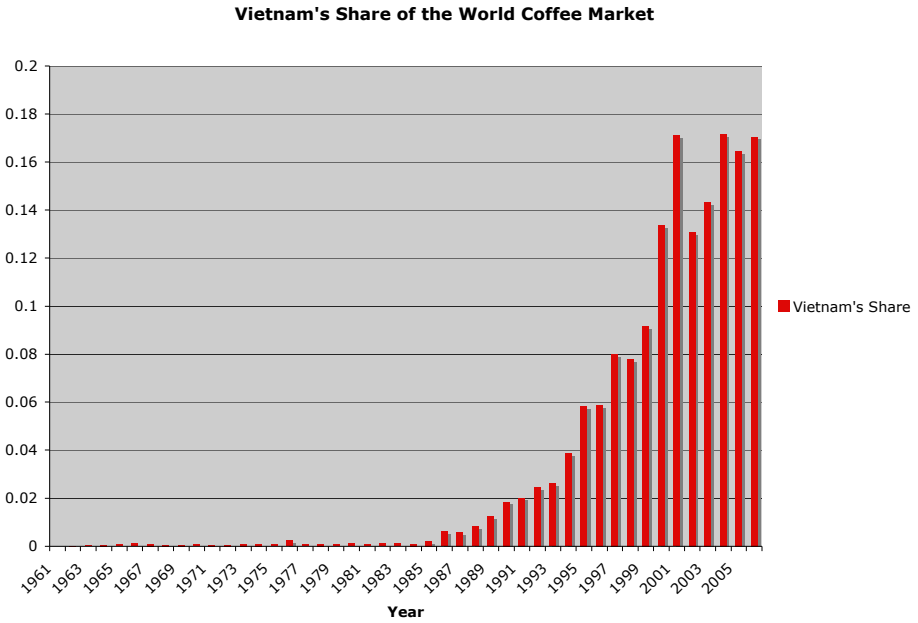


Source: Food and Agriculture Organization of the United Nations: Statistics Department

(b)

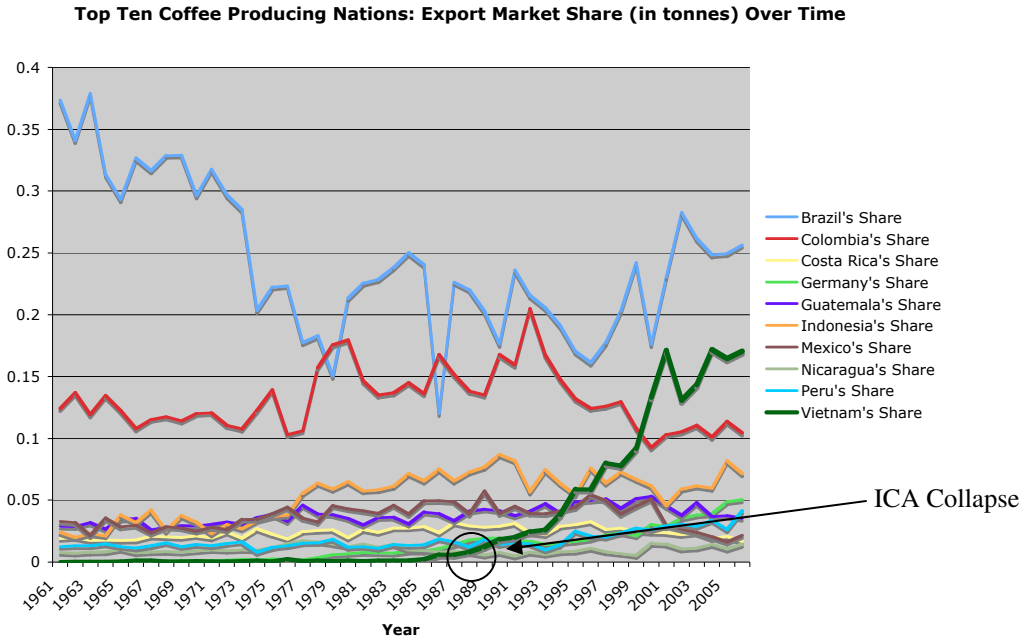
Source: Food and Agriculture Organization of the United Nations: Statistics Department

Graph 4.



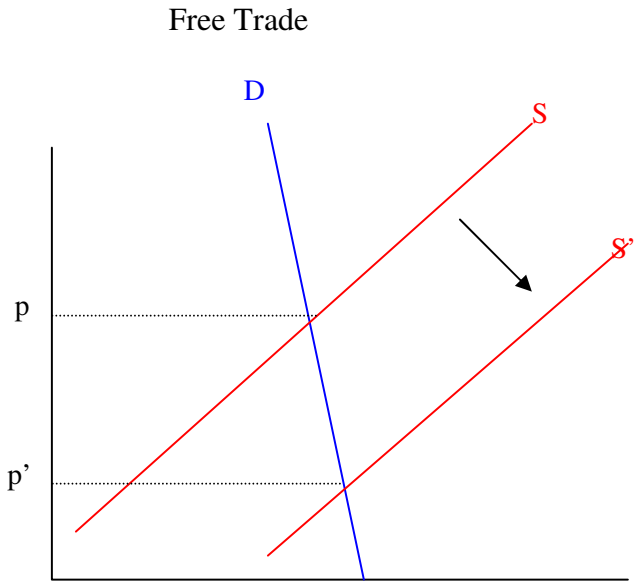
Source: Food and Agriculture Organization
of the United Nations: Statistics Department

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

Units of labor per unit of output	**Coffee**	**Other Commodities**
Colombia	1/3	3
United States	½	2

Vietnam and the United States

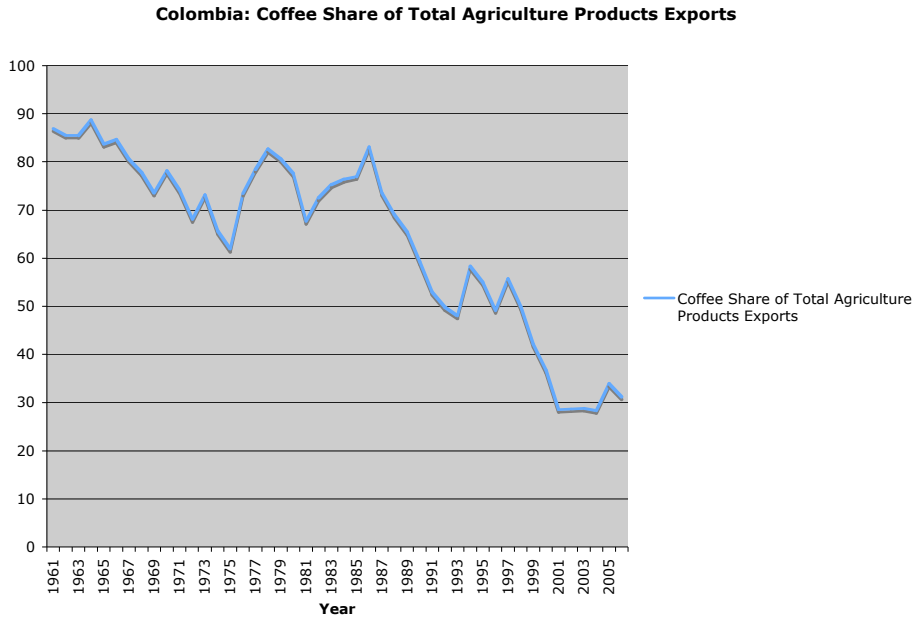
Units of labor per unit of output	**Coffee**	**Other Commodities**
Vietnam	1/5	5
United States	½	2

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, ½. 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, ½. 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.

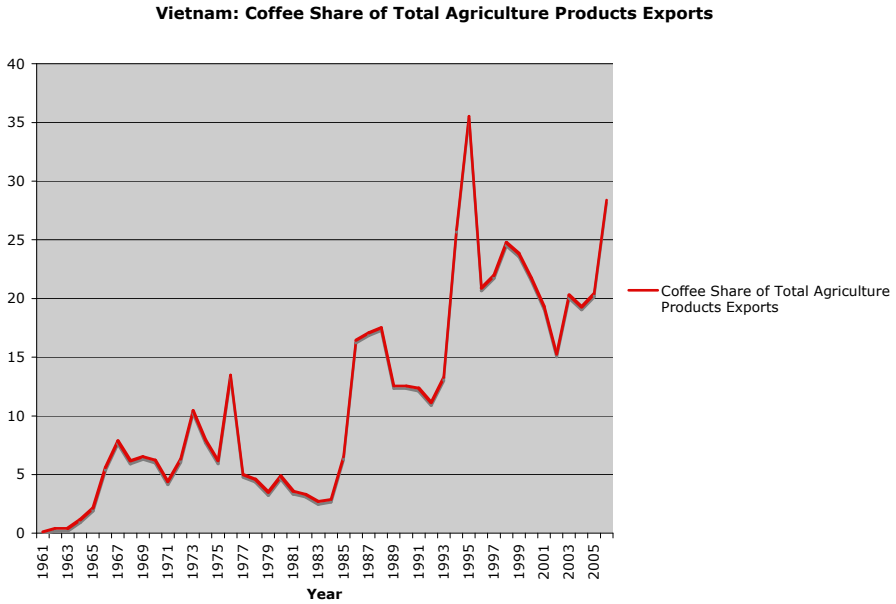
Specifically, if Vietnam had originally been barricaded from participation in international trade, upon gaining access to the market, many nations would choose to trade with Vietnam over Colombia since Vietnam's comparative advantage offers greater potential gains from trade. Neither country's comparative advantage would 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

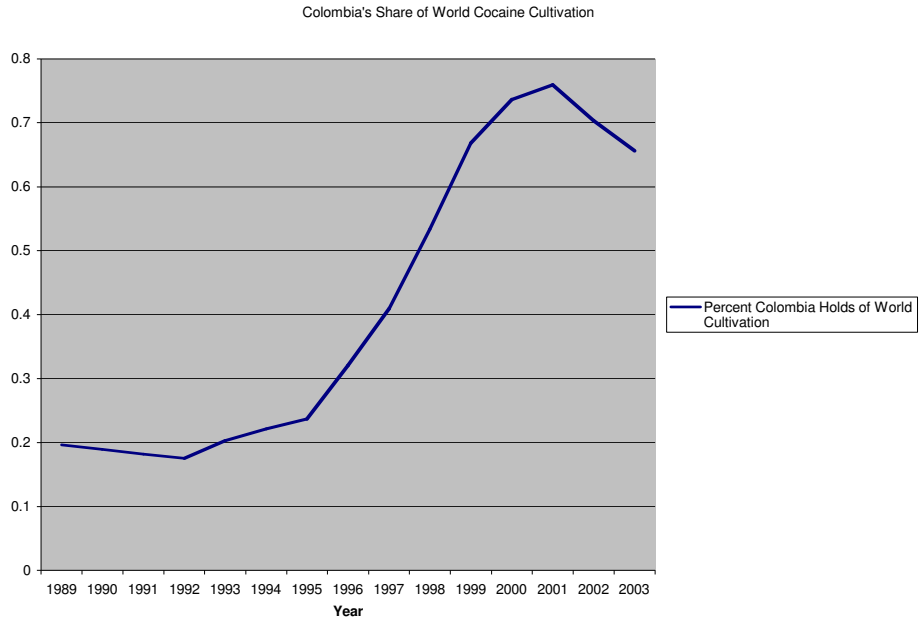
Graph 9.

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.

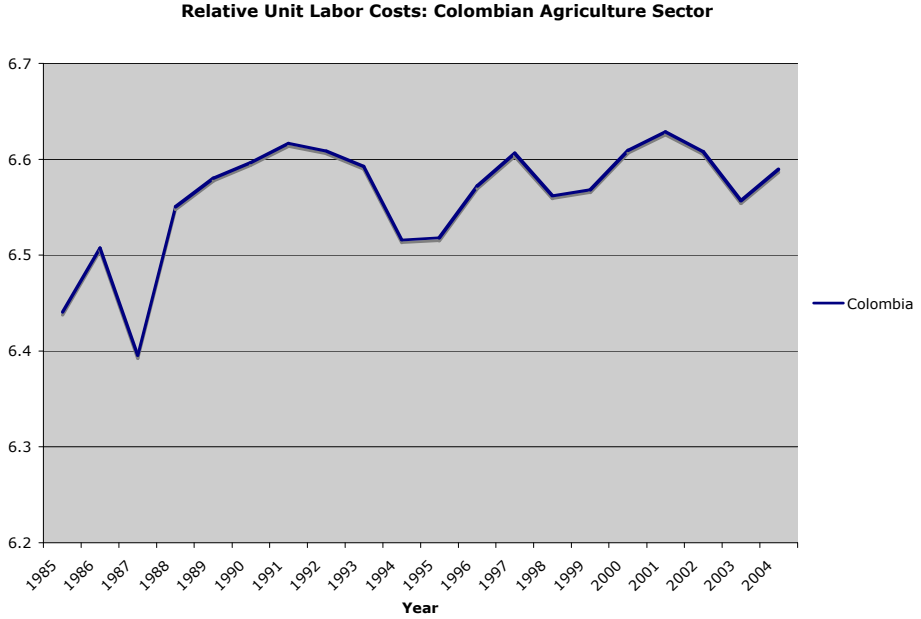


Bureau of International Narcotics and Law Enforcement Affairs

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	$\frac{(Y_t-Y_{t-1})}{Y_{t-1}}$	$\frac{(Y_{t-1}-Y_{t-2})}{Y_{t-2}}$	$\frac{(Y_{t-2}-Y_{t-3})}{Y_{t-3}}$	$\frac{(X_t-X_{t-1})}{X_{t-1}}$	$\frac{(X_{t-1}-X_{t-2})}{X_{t-2}}$	$\frac{(X_{t-2}-X_{t-3})}{X_{t-3}}$
1968	-0.4859	-0.0446	1.1232	0.0038	-0.0603	-0.0188
1969	0.1920	-0.4859	-0.0446	0.0361	0.0038	-0.0603
1970	0.1858	0.1920	-0.4859	0.3051	0.0361	0.0038
1971	-0.1567	0.1858	0.1920	-0.1160	0.3051	0.0361
1972	0.0389	-0.1567	0.1858	0.1288	-0.1160	0.3051
1973	1.7538	0.0389	-0.1567	0.2331	0.1288	-0.1160
1974	0.0517	1.7538	0.0389	0.0931	0.2331	0.1288
1975	-0.0588	0.0517	1.7538	0.0556	0.0931	0.2331
1976	2.7500	-0.0588	0.0517	0.9791	0.0556	0.0931
1977	-0.5833	2.7500	-0.0588	0.6146	0.9791	0.0556
1978	-0.1000	-0.5833	2.7500	-0.3231	0.6146	0.9791
1979	-0.2889	-0.1000	-0.5833	0.0925	-0.3231	0.6146
1980	0.5100	-0.2889	-0.1000	-0.1111	0.0925	-0.3231
1981	-0.3171	0.5100	-0.2889	-0.2340	-0.1111	0.0925
1982	0.3636	-0.3171	0.5100	0.0830	-0.2340	-0.1111
1983	0.1111	0.3636	-0.3171	0.0238	0.0830	-0.2340
1984	0.1600	0.1111	0.3636	0.1032	0.0238	0.0830
1985	1.3793	0.1600	0.1111	-0.0573	0.1032	0.0238
1986	3.4546	1.3793	0.1600	0.2842	-0.0573	0.1032
1987	-0.1865	3.4546	1.3793	-0.3693	0.2842	-0.0573
1988	0.1609	-0.1865	3.4546	0.0756	-0.3693	0.2842
1989	0.3953	0.1609	-0.1865	-0.2095	0.0756	-0.3693
1990	0.1418	0.3953	0.1609	-0.2197	-0.2095	0.0756
1991	-0.1756	0.1418	0.3953	-0.0661	-0.2197	-0.2095

1992	0.1999	-0.1756	0.1418	-0.2013	-0.0661	-0.2197
1993	0.2132	0.1999	-0.1756	0.1552	-0.2013	-0.0661
1994	1.9550	0.2132	0.1999	1.1816	0.1552	-0.2013
1995	0.8171	1.9550	0.2132	0.0295	1.1816	0.1552
1996	-0.2953	0.8171	1.9550	-0.2626	0.0295	1.1816
1997	0.1846	-0.2953	0.8171	0.3119	-0.2626	0.0295
1998	0.1935	0.1846	-0.2953	-0.1864	0.3119	-0.2626
1999	-0.0150	0.1935	0.1846	-0.2133	-0.1864	0.3119
2000	-0.1458	-0.0150	0.1935	-0.2505	-0.2133	-0.1864
2001	-0.2168	-0.1458	-0.0150	-0.2903	-0.2505	-0.2133
2002	-0.1764	-0.2168	-0.1458	0.0472	-0.2903	-0.2505
2003	0.5665	-0.1764	-0.2168	0.0871	0.0472	-0.2903
2004	0.2696	0.5665	-0.1764	0.1975	0.0871	0.0472

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

A.2 STATA Robust OLS Regression

. regress GICOprice GICOprice_lag1 GICOprice_lag2 GVietnamexport_lag1 GVietnamexport_lag2, robust

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

Linear regression
Number of obs = 37

F(4, 32) = 0.60
b > F = 0.6678
R-squared = 0.0563
Root MSE = .33662

GICOprice	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
GICOprice_~1	.1669969	.1898713	0.88	0.386	-.2197583	.553752
GICOprice_~2	-.0477248	.1663265	-0.29	0.776	-.3865208	.2910712
GVietnamex~1	-.0242984	.0782956	-0.31	0.758	-.1837813	.1351845
GVietnamex~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

	GICOpr~1	GICOpr~2	GVietn~1	GVietn~2	_cons
GICOprice_~1	.036051				
GICOprice_~2	-.002708	.027665			
GVietnamex~1	-.007945	-.00117	.00613		
GVietnamex~2	-.000996	-.005373	.000617	.003866	
_cons	.005194	-.001993	-.002537	-.00093	.004159

A.4 Computations

$Z_1 = b_1+b_2 = 0 \quad \rightarrow$

$$t = \frac{\hat{b_1} + \hat{b_2} - 0}{se(\hat{b_1} + \hat{b_2})} = \frac{\text{-.0242984 - .0627301}}{.1059716943} = -0.8212$$

where $se(\hat{b_1} + \hat{b_2}) = [Var(\hat{b_1} + \hat{b_2})]^{1/2} = [Var(\hat{b_1}) + 2cov(\hat{b_1}, \hat{b_2}) + Var(\hat{b_2})]^{1/2}$
$= [.00613 + 2(.000617) + .003866]^{1/2} = [.01123]^{1/2} = .1059716943$

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
$GX_t = \alpha + c_1GX_{t-1} + c_2GX_{t-2} + d_1GY_{t-1} + d_2GY_{t-2}$

. 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

$Z_2 = d_1 + d_2 = 0 \quad \rightarrow \quad t = \dfrac{\widehat{d_1} + \widehat{d_2} - 0}{se(\widehat{d_1} + \widehat{d_2})} = \dfrac{.2404705 - .2381764}{.4944259297} = 0.0046$

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

Appendix C
Post-ICA Granger Causality Analysis

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

. regress GICOprice GICOprice_lag1 GICOprice_lag2 GVietnamexport_lag1 GVietnamexport_lag2, robust

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

Linear regression
Number of obs = 14

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

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

. correlate, _coef cov

	GICOpr~1	GICOpr~2	GVietn~1	GVietn~2	_cons
GICOprice_~1	.40898				
GICOprice_~2	-.004973	.32664			
GVietnamex~1	-.248742	-.049814	.172084		
GVietnamex~2	.066369	-.183647	-.015169	.121096	
_cons	.066713	.014505	-.044778	-.002591	.020263

Computations:

$Z_1 = b_1+b_2 = 0 \rightarrow$

$$t = \frac{\hat{b_1} + \hat{b_2} - 0}{se(\hat{b_1} + \hat{b_2})} = \frac{-.0350061 + .2420801}{.51268} = 0.404$$

where $se(\hat{b_1} + \hat{b_2}) = [Var(\hat{b_1} + \hat{b_2})]^{1/2} = [Var(\hat{b_1}) + 2cov(\hat{b_1}, \hat{b_2}) + Var(\hat{b_2})]^{1/2}$
$= [.172084 + 2(-.015169) + .121096]^{1/2} = [.262842]^{1/2} = .51268$

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

$GX_t = \alpha + c_1GX_{t-1} + c_2GX_{t-2} + d_1GY_{t-1} + d_2GY_{t-2}$

. regress GVietnamexport GVietnamexport_lag1 GVietnamexport_lag2 GICOprice_lag1 GICOprice_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
GICOprice_~1	1.443071	.8619732	1.67	0.128	-.5068483	3.392989
GICOprice_~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	GICOpr~1	GICOpr~2	_cons
GVietnamex~1	.293487				
GVietnamex~2	.00677	.196425			
GICOprice_~1	-.437533	.087477	.742998		
GICOprice_~2	-.110164	-.320654	-.000417	.579893	
_cons	-.094504	-.010211	.14288	.036703	.04191

Computations:

$Z_2 = d_1+d_2 = 0 \rightarrow$

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

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

Appendix D

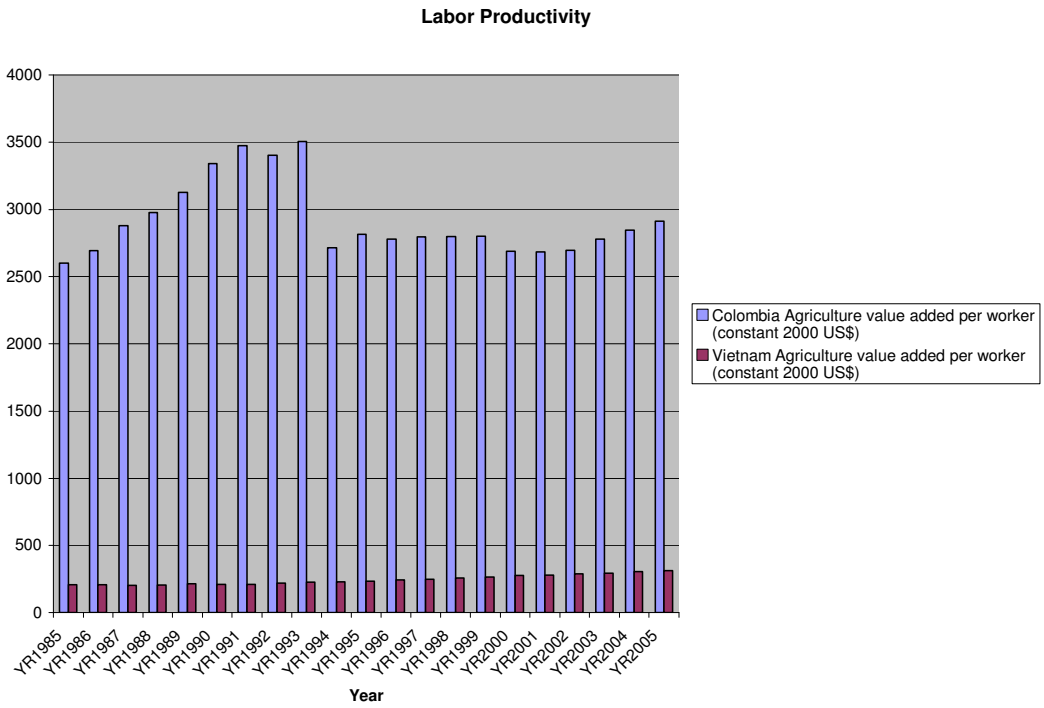
D.1 Labor Productivity Data

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

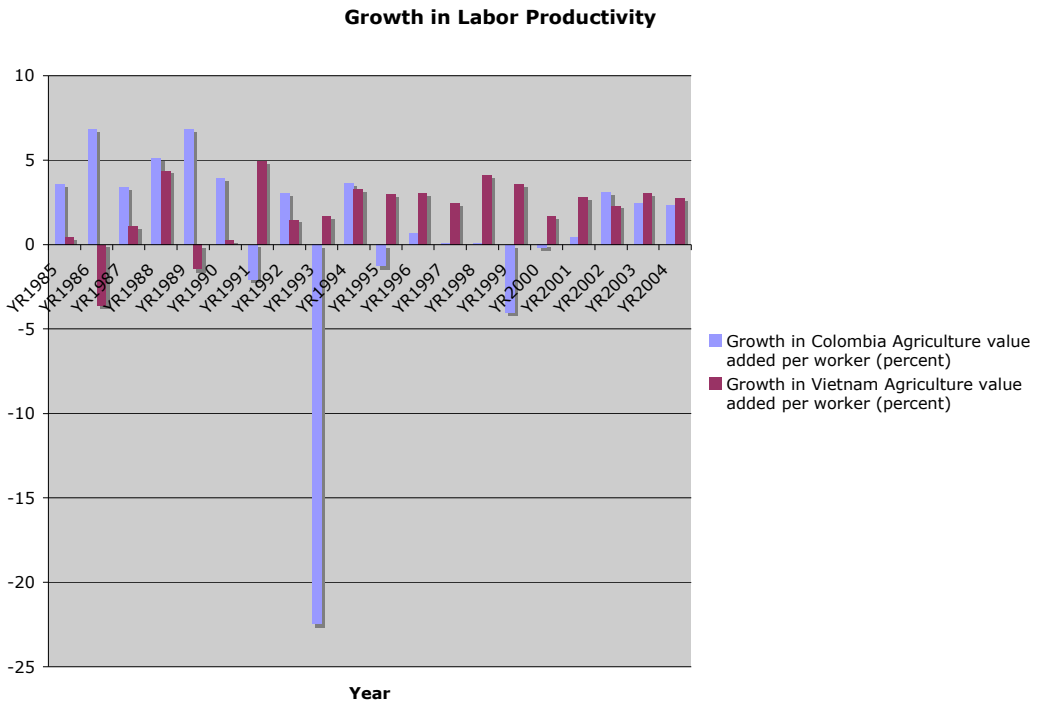
Growth in Labor Productivity in Colombia and Vietnam

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) $\frac{\text{Labor Productivity}_{\text{Vietnam}}}{\text{Labor Productivity}_{\text{Colombia}}}$	(B) $\frac{\text{wage}_{\text{Vietnam}}}{\text{wage}_{\text{Colombia}}}$	(A) – (B)*
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	-0.294867

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:
$\log(XMS) = \alpha_1 \log(RULC_t) + \alpha_2 \log(RULC_{t-1}) + \alpha_3 \log(RULC_{t-2}) + v_k$

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

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

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	368239.934	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:

$\log(XMS) = \alpha_1 \log(RULC_t) + \alpha_2 \log(RULC_{t-1}) + \alpha_3 \log(RULC_{t-2}) + v_k$

```
. regress logXMSc logRULCc logRULCc_lag1 logRULCc_lag2
```

Source	SS	df	MS	
Model	.02943561	3	.00981187	Number of obs = 18
Residual	.442382842	14	.031598774	F(3, 14) = 0.31
Total	.471818453	17	.027754027	Prob > F = 0.8175
				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
```