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Coffee exports as ecological, social, and physical unequal exchange: A cross-national investigation of the java trade

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Abstract

This study employs an unequal exchange perspective to assess if dependency on coffee exports in less-developed nations significantly impacts rates of deforestation, secondary schooling, and malnutrition, capturing specific dimensions of environmental, social, and physical well-being. OLS regression analyses reveal that dependency on coffee exports is positively associated with deforestation, malnutrition, and low participation in secondary level education in coffee-producing nations, net of other relevant factors. The findings thus demonstrate that specialization in coffee cultivation is likely to produce limited developmental benefits in poor nations.

Keywords

coffee, environment, global social change, unequal exchange, well-being

Introduction

Coffee has been cultivated, harvested, and exported from less-developed regions since at least the 16th century (Paige, 1998; Pendergrast, 2000; Talbot, 2004, 2011). Coffee continues to represent one of the most important commodities on the world market today, earning Third World exporters over $16 billion US dollars in trade revenues each year (International Coffee Organization, 2011). In fact, coffee follows oil as the second most highly valued primary sector product exported by developing countries (International Coffee Organization, 2011; Talbot, 2004). While coffee's importance on the global market cannot be discounted, it also signifies a unique commodity because it is produced *exclusively* in poor nations.

Coffee growers reside in less-developed regions of Africa, Latin America, and Southeast Asia, whereas consumption of coffee takes place in Europe, the United States, and increasingly, rapidly developing areas of Asia (Myers and Kent, 2004; Talbot, 2004). The United States continues to

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import more coffee than any other country, amounting to the consumption of about 9 lbs of coffee per person each year, or two and a half cups of coffee each day for every man, woman, and child (FAO STAT, 2010; Waridel, 2002). The global coffee industry is extremely profitable, earning an estimated $60 billion annually; but less than 10 percent of those earnings end up in the hands of coffee farmers (Fair Trade International, 2011).

Researchers often examine the harmful effects of export-directed growth using the concept of unequal exchange, which highlights that inequality in the organization of the world economy leads to relatively high levels of primary sector exports from less-developed nations (Hornborg, 2001, 2009). Currently, empirical researchers most often apply the concept of unequal exchange to studies of environmental degradation, such as those which examine the causes of deforestation and biodiversity loss in less-developed nations (e.g. Jorgenson et al., 2009; Shandra et al., 2009). However, given the labor requirements of many agricultural commodities and the forms of social disorganization that accompany export-led development, it is likely that unequal trade relationships impact dimensions of social and physical well-being as well. Some of these aspects may be particularly relevant to the coffee trade, as this crop has especially immense labor requirements and cannot be consumed for nutritional or food value (e.g. Talbot, 2004).

While a considerable amount of case-study and descriptive research has been dedicated to analysis of the coffee commodity chain (e.g. Ponte, 2002; Talbot, 2004), the current literature is completely devoid of macro-comparative assessments of coffee exports. This article also adds to burgeoning research on unequal exchange by applying a trade-based dependency measure of coffee exports to an environmental, social, and physical well-being outcome. Coffee is arguably the ideal commodity to assess through an unequal exchange framework, and its production likely contributes to inequalities along multiple dimensions of sustainability and development in less-developed nations.

The characteristics of coffee production

Coffee is exclusively a tropical crop, only grown successfully in very warm, humid climates. The ecology of the coffee tree necessitates specific altitude, temperature, and rainfall amounts, where Arabica coffee requires annual temperatures of 17–25° Celsius, 1200–1500 millimeters rainfall per year, and altitudes of 3000–6500 feet; while Robusta coffee requires annual temperatures of 20–26° Celsius, 1500–2000 millimeters rainfall per year, and altitudes under 3000 feet (Institute for Scientific Information on Coffee, 2011; Talbot, 2004). Both Arabica and Robusta varieties of coffee were originally discovered in Africa, but colonial relations spread coffee seeds to every continent, trying to find appropriate ecological niches where it could be grown (Pendergrast, 2000; Rudel, 2005; Talbot, 2004, 2011). The higher altitudes of Latin America, the island nations of Southeast Asia, and West Africa became especially appropriate for Arabica varieties of coffee, which often grow on hillsides. Robusta varieties tend to be grown in the lower altitudes and more open areas of East and sub-Saharan Africa and the Asian mainland nations, such as Vietnam (International Coffee Organization, 2011; Pendergrast, 2000; Rudel, 2005; Talbot, 2004).

Arabica coffee is considered to have a superior taste, and thus is the kind of coffee found in quality US coffee houses, such as Starbucks (e.g. Jaffee, 2007; Talbot, 2004). Arabica coffee trees face more stringent growing conditions, with a preference for mountainous regions (International Coffee Organization, 2011). In comparison, Robusta coffee has a harsher taste and higher caffeine content; it tends to be regarded as lower quality, and is generally grown in lower-lying fields (Talbot, 2004). Arabica production is often more labor-intense than Robusta production, because the coffee cherries must be picked when they are perfectly ripe in order to maximize quality, which requires numerous passes through the same patch of coffee. Partly due to these conditions, Arabica coffee fetches a higher price on the world market relative to the Robusta variety (International Coffee Organization, 2011; Talbot, 2004; Waridel, 2002). In addition, these patterns begin to suggest that the different types of coffee (Robusta versus Arabica) may produce distinct effects on the environment or measures of social and physical well-being.

It takes three to five years to produce harvestable cherries from a coffee tree, and a mature tree crops on average enough cherries per year to yield less than one pound of roasted coffee (Institute for Scientific Information on Coffee, 2011; Waridel, 2002). Partly because it takes around five years for a coffee tree to bear fruit, coffee production experiences major price fluctuations and intense boom and bust cycles. Supply responds very slowly to price, creating 'tree crop price cycles' (Bacon et al., 2008; Talbot, 2004, 2011). When world market prices are high, growers across the globe plant more coffee; but this new coffee will not enter the market for several years. This leads to over-planting, followed by over-supply. Oversupply of green coffee on the market depresses prices for the next several years (Bacon et al., 2008; Ponte, 2002; Talbot, 2011). Not wanting to waste invested capital, growers will initially continue to harvest and cultivate trees as coffee prices fall. Slowly, production does decline as growers eventually stop maintaining their trees or planting new ones as their farms foreclose. At some point, demand once again supersedes supply, and the uneven cycle continues (Talbot, 2004, 2011).

In an attempt to balance demand and supply, coffee has historically been one of the most regulated commodities on the international market. Although other forms of regulation existed previously, a formal contract, the International Coffee Agreement (ICA), was established in 1962 and it included most producing and consuming countries (Fridell, 2007; Ponte, 2002; Talbot, 2004). The ICA regulatory system set a target price or price band for coffee, and allocated export quotas to each producer. In times where the indicator price rose over the set price, quotas were relaxed; when it fell below the set price, quotas were tightened. Although this system successfully raised and stabilized coffee prices in the past, it was abandoned in 1989 due to issues with free-riding, squabbling over quotas, and non-participation by some consuming nations, who bought 'non-quota' coffee at steep discounts and re-exported it ICA-member nations (Bacon et al., 2008; Fridell, 2007; Ponte, 2002). Coffee prices crashed immediately in 1989 and remained low throughout the early 2000s. Additionally, the proportion of income going to coffee growers in poor nations declined significantly since the abandonment of the ICA (Ambinakudige, 2009; Bacon et al., 2008; Jaffee, 2007; Ponte, 2002; Talbot, 2004).

Due to the labor requirements necessary to pick the cherries of the coffee tree, and the elevation requirements that lead to heavy planting on hillsides and rough terrain, production is difficult to mechanize and coffee cultivation is largely a small-holder crop (Fair Trade International, 2011; Jaffee, 2007; Talbot, 2004; Waridel, 2002). International agencies estimate that about 25 million farmers in less-developed countries depend directly upon coffee for their livelihoods (Fair Trade International, 2011; International Coffee Organization, 2011). There are more people involved in growing coffee than any another other crop worldwide (Fair Trade International, 2011).

Despite these numbers, the overall balance of power is still shifted to benefit TNCs headquartered in core nations, as the highest valuing-adding phases of the coffee production process – the roasting, packaging, marketing, and selling – are almost exclusively concentrated in high-income nations (Fridell, 2007; Talbot, 2004). In fact, only about 10 cents of every coffee dollar spent by affluent consumers ends up in the hands of the individual coffee growers, even though the entire coffee trade fundamentally depends on the hard work of the cultivators (e.g. Fair Trade International, 2011; Talbot, 2004). Indeed, commodity chain analysis is one of the most popular analytic strategies used in comparative coffee research, as there are such stark inequalities in the effects of participating in the coffee trade across space and actors (e.g. Bacon et al., 2008; Ponte, 2002; Talbot, 2004, 2011; Waridel, 2002).[1] The global commodity chain approach developed within the world-systems framework, as this perspective sees the world-economy as a social system with a single capitalist division of labor (e.g. Bair, 2009; Gereffi and Korzeniewicz, 1994). The chain conceptualization highlights the interrelated production processes and economic transactions that create a commodity such as coffee, bringing it from cultivation to the point where it is purchased by the consumer. Commodity chain analysis is unique as it draws focus to the global organization of production, processing, and distribution that transcends national boundaries (e.g. Bair, 2009; Gereffi and Korzeniewicz, 1994).[2] While commodity chain research is powerful in demonstrating the fundamental inequalities associated with organization of coffee production and distribution that spans national boundaries, cross-national analysis is also needed in order to make systematic comparisons in the overall effects of the coffee trade across nations (e.g. Bernstein and Campling, 2006b).

Analyzing the consequences of coffee production is especially relevant as new trends in cultivation could produce increasingly harmful influences on environmental, social, and physical well-being in less-developed nations. In particular, high-yielding coffee seed varieties drastically alter many coffee farming systems, making production especially damaging to the environment (Institute for Scientific Information on Coffee, 2011; Waridel, 2002). Traditionally, farmers plant coffee trees in semi-shade conditions which allow for the preservation of large tracts of forest, or, the trees are planted in mixed cultivation with other fruit trees, beans, or vegetables used for household consumption. But the new high-yielding trees are most productive in full sunlight, and in general, there is a shift to eliminating mixed cultivation in favor of mono-cropping techniques, where as many coffee trees as possible are planted together in order to maximize yields (e.g. Blackman et al., 2008; Gillison et al., 2004; Jaffee, 2007; Waridel, 2002). Case-study and agro-forestry research already links coffee production to heightened rates of deforestation in Brazil (e.g. Simon and Garagorry, 2005), Indonesia (e.g. Gaveau et al., 2009), Cameroon (e.g. Gbetnkom, 2005), and Ghana (e.g. Appiah et al., 2009), among other regions. In addition to spurring increased forest loss, mono-cropping techniques also increase reliance on pesticides and fertilizers, which further threatens biodiversity and ecosystem health (Gillison et al., 2004; Waridel, 2002).

Technology transfers, land tenure policies, and international and national loans used in rural development schemes help to diffuse these methods of production to small-scale cultivators (Gillison et al., 2004; Roberts and Thanos, 2003; Rudel, 2005; Talbot, 2004; Waridel, 2002). Since coffee faces such restrictive growing conditions and is so highly valued on the global market, where coffee cultivation is possible development agencies and core actors heavily promote its production. International development agencies (e.g. World Bank) and national governments continue to see increasing coffee exports as a means to increase economic growth and development, largely by improving ‘unproductive’ rural communities (Roberts and Thanos, 2003; Talbot, 2004; World Bank, 2008).

The fact that nations with historically high levels of dependence on coffee cultivation and export experience persistent poverty and remain in dependent positions in the world economy stands in stark contrast to these claims (e.g. Talbot, 2004, 2011).[3] Commodity chain analysis clearly demonstrates that core-based TNCs reap the majority of coffee profits through their control of the top of the coffee commodity chain; the most resource and labor intense phases of the production process are exclusively located in less-developed regions (Bacon et al., 2008; Talbot, 2004). Besides persistent poverty, coffee production is likely to have other adverse impacts on the social and physical welfare of growers. Many scholars point out that coffee is a unique agricultural commodity because it is not an essential food item; it does not sufficiently add to a person’s caloric intake or provide adequate energy or nutritional requirements necessary to survival (e.g. Talbot, 2004; Waridel, 2002).[4] Because coffee cannot be consumed as a food item, and with the expansion of monocropping which displaces mixed cultivation systems that contribute to increased household food production, coffee exports likely contribute to heightening rates of hunger and malnutrition in poor nations. A recent study by Messer and Cohen (2007) implicates certain export crops, including coffee and cotton, as key contributors to elevated rates of conflict and food insecurity in some less-developed regions due to their non-nutritional contribution and extreme price fluctuations that result from long plant maturation cycles.

In addition to hunger, case studies conducted in Mexico and Nigeria link coffee cultivation with lower rates of secondary schooling among rural households (e.g. Gitter and Barham, 2009; Gitter et al., 2010; Jaffee, 2007; Kruger, 2007). This research points to the heightened labor requirements of coffee production, which explain trends of lower school enrollment among high coffee-cultivating communities in comparison to low coffee-cultivating communities (e.g. Jaffee, 2007; Kruger, 2007). Indeed, it is likely that this is particularly relevant in regions that produce the Arabica variety of coffee, which demand that the cherries are picked at the peak of ripeness, greatly increasing the length of time for needed for harvest.

Many researchers hope that some of these detrimental patterns might change with expanding interest in fair trade and organic coffee as a means to help impoverished producers and enhance ecological sustainability (Bacon et al., 2008; Blackman et al., 2007; Fair Trade International, 2011; Fridell, 2007; Jaffee, 2007; Rudel, 2005; Talbot, 2004; Waridel, 2002). In particular, case-study and commodity chain analyses reveal that the organic and fair trade coffee movement benefits rural communities by returning a greater share of coffee proceeds to growers (e.g. Bacon et al., 2008; Jaffee, 2007). In addition, many fair trade producers receive several payments for their coffee that are spread out over time, while conventional producers are only paid once a year when they sell their coffee (Jaffee, 2007). Jaffee's (2007) analysis of the Michiza cooperative in Oaxaca, Mexico finds that the greater economic stability of fair trade producers translates into better housing conditions and increased food security, including more varied diets, in relation to conventional coffee producers. Jaffee (2007) is careful to point out that while fair trade and organic producers do receive higher prices for their coffee than conventional producers, they also face increased production and labor costs, largely because of the requirements of organic certification, which include weeding, pruning, and spreading compost, rather than using chemical inputs.

The fair trade and organic movement has also led to more environmentally friendly practices of cultivation in some areas, as consumers are willing to pay more knowing that their coffee was produced sustainably. Organic production in particular is been linked to increased use of natural shade cover or mixed cultivation to bolster biodiversity, as well as less reliance on chemical pesticide and fertilizers (e.g. Blackman et al., 2007; Jaffee, 2007). Indeed, Rudel (2005) demonstrates that reforestation trends in areas of Central America and Southeast Asia partially result from small-scale farmers engaging in green and fair trade coffee production for affluent markets. Despite these promising findings, Talbot (2004) cautiously points out that although the sustainable coffee movement benefits some growers, the unfair organization of the coffee commodity chain remains largely unaltered. Overall, the market share of fair trade and organic coffee is also very small, accounting for only around 3% of world coffee trade (Fair Trade International, 2011; Fridell, 2007).[5]

Unequal exchanges in the world-system

Research reveals that patterns in coffee production and consumption closely follow broader lines of international inequality. Within the field of macro-comparative sociology, the concept of unequal exchange has been used to capture systematic inequalities in international trade dynamics, as this phrase draws upon world-systems and dependency theorizing to illuminate asymmetrical political and economic relationships between peripheral or less-developed nations and core or highly developed countries (e.g. Bunker, 1985; Emmanuel, 1972; Hornborg, 2001, 2009; Rice, 2007, 2009). The phrase 'unequal exchange' was originally coined by Arghiri Emmanuel (1972), who emphasized that exchange of core products for peripheral products involves transfers in surplus value up the world-system from less-developed nations to more-developed nations, as core nations retain the most profitable production processes for themselves.

In many ways, the concept of unequal exchange lies at the heart of world-systems and dependency analysis, as inequalities in trade are a central mechanism for exploitation upon which the unfair relations between countries is upheld and global economic inequality is reproduced. Indeed, historical emphasis on the global division of labor by theorists such as Wallerstein (1974), Amin (1976) and Frank (1979), serves as a basis for this line of thinking. The global division of labor continues to characterize the organization of international production today, as the lowest-paying, most labor-intense, and environmentally damaging industries largely represent those located in and moving to less-developed nations (e.g. McMichael, 2004).

As an alternative view, comparative advantage perspectives argue that poor, tropical nations have an edge in the global market on agricultural and raw material goods, especially for products like coffee, due in part to their natural climates and characteristics of the labor force, which allow these nations to produce agricultural commodities most efficiently and cheaply (Ricardo, 1817; Smith, 1776). Thus, the export of highly valued primary sector products to foreign nations can spur development and economic growth (e.g. World Bank, 2008). Dependency approaches drawing attention to unequal exchange dynamics partly arose as a reaction to these arguments, highlighting that export-led development in primary sector production can only lead to limited developmental gains, given the differences in profitability between core and periphery production processes outlined above (e.g. Rice, 2009).

Although early thinking on unequal exchange dynamics focused on economic factors, based on Marxian assumptions about surplus value flows from the periphery to the core, more recent assessments emphasize that unequal exchange also entails an ecological dimension (e.g. Hornborg, 2001, 2009; Rice, 2009). The ecological aspect to unequal exchange was spurred by Bunker's research in the 1980s on the consequences of extractive industries in the Amazon (1985). Bunker built upon prior unequal exchange theorization by arguing that there were also increased environmental and human costs to periphery production processes relative to core production patterns. As peripheral economies become integrated into international systems of exchange, production systems become altered. Changes in technology, markets, transport and production capacity, and power or ownership structures, greatly disrupts the environmental and social conditions of less-developed nations, where the drive to harvest more and more resources often compromises the local well-being of rural communities (Bunker, 1985; Bunker and Ciccantell, 2005).

Thus, many recent empirical assessments of unequal exchange (e.g. Austin, 2010a, 2010b; Jorgenson, 2006; Jorgenson et al., 2009, 2010; Lawrence, 2009; Shandra et al., 2009) have used Bunker's work to articulate patterns in 'ecological unequal exchange'. These studies highlight that the global organization of production facilitates greater resource degradation in peripheral areas relative to core zones, especially for outcomes related to deforestation and biodiversity loss (e.g. Austin, 2010a, 2010b; Jorgenson et al., 2009, 2010; Shandra et al., 2009).

Coffee represents an exceptional case through which to asses unequal exchange relationships. Not only does this product have clear ecological implications for forests, given the scale and new patterns in cultivation, but it has obvious social and health impacts as well, given its lack of nutritional value, decreasing use of mixed cultivation, and intense labor requirements that are likely to impact dimensions of hunger and schooling specifically. Indeed, the global organization of production can disadvantage periphery nations in economic, ecological, and social realms, and considering processes of unequal exchange more broadly allows for comprehensive notions about how patterns in international trade impact various dimensions of sustainability and development in less-developed nations.

Hypotheses

Review of the existing literature on coffee reveals that heightened dependence on coffee exports can have negative effects on the welfare of the people and environment in producing nations. As coffee is largely sent to more-developed nations, while the negative ecological, social, and physical well-being effects remain concentrated in poor nations, coffee exports can be analyzed through the lens of unequal exchange. (H_1) I therefore predict that dependence on coffee exports is associated with increased levels of deforestation, heightened rates of malnutrition, and depressed enrollment in secondary schooling in producing nations, net of other relevant factors.

Emerging case-study and commodity chain research also emphasizes the role of organic and fair trade production in reducing some of the negative social and environmental externalities associated with coffee cultivation in certain regions (e.g. Jaffee, 2007). I will therefore also test the extent to which participation in fair trade and organic organizations influences well-being cross-nationally; (H_2) I predict that membership in fair trade and organic organizations reduces deforestation and malnutrition rates, and increases secondary school enrollment in coffee-producing nations.

In addition, it is likely that there are significant differences in some of these relationships across the different types of coffee produced, as Arabica and Robusta coffee varieties differ in terms of labor requirements and some growing characteristics. (H_3) I thus predict that there are significant differences in the effects of coffee export dependency across Arabica and Robusta producers on deforestation, malnutrition, and secondary schooling in less-developed nations.

Methods

To test the relationship between coffee export dependence and measures of ecological, social, and physical well-being, I employ OLS (ordinary least squares) regression, as is consistent with current macro-comparative unequal exchange research (e.g. Austin, 2010a, 2010b; Jorgenson, 2006). OLS regression is an appropriate analytic technique as this method allows for clear and rigorous hypothesis testing of direct effect relationships. In analyzing the data, I use the statistical program STATA. This program offers regression analysis, as well as the appropriate diagnostic functions for testing adherence to OLS regression assumptions.[6]

A major weakness of this study is the use of a cross-sectional design; however, reliable and expansive longitudinal data on a variety of indicators used, including deforestation and percent undernourished, are not available. Despite this, the variables are time-ordered, where the independent variables are measured before the dependent variables, to help adhere to assumptions of causality. In particular, in the schooling and hunger analyses, all independent variables are measured for the year 2006, while the dependent variables are measured at 2007, as the effects of coffee exports on hunger and schooling should be immediately evident. In contrast, in the deforestation models, coffee exports are also measured at 2006, but, deforestation is measured using a change score from 1990–2005, as coffee trees take around three to five years to produce harvestable fruit. Thus, coffee exports in 2006 are likely to be linked to deforestation rates in the 1990s, and to a lesser extent, the early 2000s, as this is when the coffee trees were initially planted.[7] All other independent variables in the deforestation analyses (e.g. GDP per capita) are measured at 1990.

Sample

The samples include all coffee producing nations for which there are available data across all indicators for each set of analyses. There are three sets of analyses based on the three dependent variables under investigation, yielding the creation of three different samples (Deforestation analyses $N = 59$, Hunger analyses $N = 51$, Secondary schooling analyses $N = 61$).[8] Although some inferences are limited because the samples are not completely consistent across each dependent variable, there is an extremely high degree of overlap, and this technique maximizes the sample size in each investigation.[9]

As coffee production occurs exclusively in nations located in the lower three quartiles of the World Bank Income Classification of Countries, the sample is naturally comprised of less-developed nations.[10] The sample sizes are somewhat limited due to restricted data availability on the dependent variables, as well as the key independent variable, coffee export dependence. Although imputation procedures could have been employed to boost sample size, listwise deletion is preferred as it produces more conservative estimates.[11]

Dependent variables

Deforestation. The deforestation score represents a percent change score, calculated using FAO estimates of natural forest area from 1990–2005.[12] These data were collected for the Global Forest Resource Assessment (GFRA) and represent point estimates for natural forest stock measured in thousand square hectares for 1990 and 2005 (FAO STAT, 2010).[13] The natural forest area measure includes land area that is more than 0.5 hectares which contains trees higher than 5 meters and a canopy cover of more than 10 percent. The forest cover change score is multiplied by -1, thus a positive coefficient in the model indicates that deforestation is taking place, while a negative score indicates that expansion in forest size is occurring.

Secondary school enrollment. This measure represents the total secondary school enrollment, regardless of age, expressed as a percentage of the total secondary school-aged population for the year 2007. Enrollment ratio values can be over 100 percent due to the inclusion of overage and underage students in enrollment statistics (World Bank Database, 2011).

Percent undernourished. The influence of coffee exports on rates of hunger is examined using a measure of percent undernourished for the year 2007. This indicator refers to the proportion of the population with food intake that is continuously below a minimum dietary energy requirement for maintaining a healthy life and carrying out light physical activity (World Bank Database, 2011).

Key independent variables

Coffee export dependence. I measure coffee export dependence as the value of green coffee exports as a percentage of the value of all agricultural exports for the year 2006. Looking at a ratio of exports is a common way for researchers to measure export dependence in the world-systems literature (e.g. Ragin and Bradshaw, 1992; Brady et al., 2007), and looking at the level of coffee exports within the agricultural sector, in particular, helps to set up some crude comparisons, as coffee may have even more pronounced effects on the outcomes under investigation than most other agricultural commodities given the scale and characteristics of coffee production.[14] Measuring coffee export dependence in this way also allows for inclusion of a measure of overall dependence on agricultural exports, which is an important control variable as the findings for coffee export dependence could be spurious to overall dependence on agricultural exports. The fact that the overwhelming majority of green, unprocessed coffee is exported to more affluent nations (FAO STAT, 2010) affirms that this indicator appropriately captures unequal exchange dynamics. Data on coffee exports and total agricultural exports were obtained from the FAO Database (FAO STAT, 2010). Export data are measured in constant 2000 US dollars, and the coffee export dependency measure was log-transformed to reduce the influence of extreme cases and to adhere to the assumptions of the analytic technique.[15]

The fair trade and organic movement. Organic and fair trade production may reduce some of the harmful social and ecological effects of coffee cultivation (e.g. Jaffee, 2007). I measure participation in the fair trade and organic movement by creating a count variable that represents the number of fair trade or organic organizations for a given nation for the years 1990 and 2006.[16] The data were collected from the Yearbook of International Associations (Union of International Associations, 1991, 2007). The measure was log-transformed to reduce the influence of extreme observations.[17]

Robusta and Arabica coffee. To test for variation across Robusta and Arabica producers, a dummy or binary variable is created.[18] In particular, a dummy variable is created for nations that primarily produce Robusta coffee, where nations that primarily produce the Robusta variety are coded with a 1, and nations that primarily produce Arabica coffee are coded with a 0.[19] Slope-dummy interaction terms are created by multiplying the coffee export dependence indicator by the dummy variable (Hamilton, 1992).[20] Including the main effects of interest (e.g. coffee export dependency and dummy variable for Robusta) and the slope-dummy interaction term (coffee export dependency * Robusta) as predictors tests for heterogeneity of slopes across the two types of producers (Hamilton, 1992). A significant coefficient for any slope-dummy variable in this type of analysis indicates that the slope for Robusta producers differs significantly from Arabica producers (the reference category). For example, a significant positive coefficient for Robusta coffee dependence (the interaction term) on percent undernourished would indicate that the effects of coffee export dependence on hunger are especially pronounced in Robusta-producing nations in relation to Arabica-producing nations.

Control variables

Prior research and theorization illuminates other important factors that contribute to forest loss, hunger, and participation in schooling in less-developed nations. In particular, *Gross Domestic Product (GDP)* per capita is included in every model as an important control variable.[21] GDP per capita, or level of economic development, represents one of the most consistent predictors of social, health, and ecological outcomes, as national economic growth is linked to improvement in a wide range of measures, including higher rates of schooling, lowering hunger, and reductions in deforestation (e.g. Brady et al., 2007; Burns et al., 2003; Jorgenson et al., 2010; Schofer and Meyer, 2005). GDP per capita represents the total annual output of a country's economy, in current international dollars, per person, for the years 1990 and 2006 (World Bank, 2011). GDP per capita is the total market value of all final goods and services produced in a country in a given year, equal to total consumer, investment, and government spending, divided by the mid-year population. It is converted into current international dollars using Purchasing Power Parity (PPP) rates.[22] This variable was log-transformed to reduce the influence of extreme cases.

A second prominent factor is overall dependency on agricultural exports. I thus include *Agricultural Exports as Percent of all Exports*, which quantifies the value of agricultural exports as a ratio of the value of all exports for the years 1990 and 2006 (FAO STAT, 2010; World Bank Database, 2011).[23] This variable was log-transformed to reduce the influence of extreme cases. Controlling for agricultural exports allows for more rigorous testing of the proposed hypotheses as many of the nations that have high dependency on coffee exports also specialize in exporting other agricultural commodities. Prior research in general finds that specialization in agriculture tends to be associated with lower rates of schooling and higher levels of deforestation (e.g. Jorgenson et al., 2009, 2010; Rudel, 2005; Schofer and Meyer, 2005). The influence of agricultural exports on hunger is not as clear-cut; agricultural exports indicate a high degree of food production, but not necessarily local food consumption (e.g. Jenkins and Scanlan, 2001). Thus examining the role of coffee exports and agricultural exports may help to illuminate specific patterns in food distribution that influence hunger.

I also include the *Population Growth Rate* in each analysis, measured as the annual percent change in total population for 1990 or 2006. Population growth is important to consider as high rates of population growth strain public and natural resources and have been linked to increases in hunger and deforestation and decreases in secondary schooling in less-developed nations (e.g. Brady et al., 2007; Burns et al., 2003; Jorgenson and Burns, 2007; Rudel, 1989). Additionally, the deforestation analyses also test for the influence of rural population growth (e.g. Jorgenson and Burns, 2007); I thus include the *Rural Population Growth Rate*, measured as the annual percent change in the rural population for 1990 (World Bank Database, 2011).

Participation in education will also be considered for all three sets of analyses. *Secondary School Enrollment* is included in the deforestation and hunger analyses (for the years 1990 and 2006, respectively). Secondary schooling increases awareness of environmental issues, and also is associated with shifts in the economy into higher value production processes, which decreases forest loss and rates of hunger (e.g. Brady et al., 2007; Jenkins and Scanlan, 2001; Rudel, 1989). Additionally, *Primary School Enrollment* is included in the models that predict secondary schooling (for the year 2006), as earlier participation in schooling is a key predictor of higher levels of education cross-nationally (e.g. Schofer and Meyer, 2005). The school enrollment indicators are gross enrollment ratios, which capture the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to that level of education (World Bank Database, 2011).

Several of the analyses also include *Percent Urban*, which is measured as the proportion of a country's total national population that resides in urban areas, for the year 2006 (World Bank Database, 2011). Urbanization is an important component of modernization that is generally linked to improvements in social and physical well-being measures in particular (e.g. Brady et al., 2007), as urban populations tend to have increased access to schooling and other public resources that improve health.

Prior research on deforestation identifies that in addition to the factors outlined above, certain geographical characteristics can greatly influence forest loss. In particular, a measure of *Forest Stock* is utilized in the deforestation analyses as scarcity or abundance of forests could condition deforestation rates (e.g. Rudel, 1989). Forest stock is measured as the total square hectares of natural forest area for the year 1990 (World Bank Database, 2011). This measure was log-transformed to reduce the influence of extreme cases. Additionally, some studies note that deforestation rates are highest in more tropical regions (e.g. Jorgenson et al., 2009). I therefore include *Latitude*, where I take the absolute value of average latitude scores for each nation in order to capture distance from tropical zones.

Analyses of hunger also find that warfare contributes to cross-national patterns in malnutrition; warfare can disrupt food production and distribution in poor nations, commonly referred to as the 'military famine' hypothesis (Jenkins and Scanlan, 2001; Scanlan, 2001). In the hunger analyses I therefore include *Military Expenditures as a Percent of GDP* which includes all current and capital expenditures on the armed forces, including peacekeeping forces; defense ministries and other government agencies engaged in defense projects; paramilitary forces; and military space activities (World Bank Database, 2011). Such expenditures include military and civil personnel, including retirement pensions of military personnel and social services for personnel; operation and maintenance; procurement; military research and development; and military aid (in the military expenditures of the donor country). Food production represents another key factor explaining global patterns in hunger, and current arguments debate issues of food production versus food distribution in explaining global hunger trends (Jenkins and Scanlan, 2001), thus making this an important control along with the agricultural export measures under investigation. I include *Cereal Yield per capita* for the year 2006, measured as kilograms per hectare of harvested land. This includes wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains. Production data on cereals relate to crops harvested for dry grain only; cereal crops harvested for hay or harvested green for food, feed, or silage and those used for grazing are excluded.[24]

Prior research also demonstrates that political characteristics are especially relevant to some of the outcomes under examination, such as secondary schooling and deforestation. Studies find that nations which are more integrated into the world-polity tend to have higher participation in schooling and lower levels of deforestation (e.g. Schofer and Hironaka, 2005; Schofer and Meyer, 2005; Shandra, 2007). Participation in the world-polity is measured with *INGO Membership*, which captures the total number of INGOs in a country for 2006 or 1990 (UIA, 1991, 2007). This measure was log-transformed to reduce the influence of extreme outliers. Additionally, more democratic nations tend to have higher participation in education (Schofer and Meyer, 2005); the *Democracy Index* is measured on a scale from -10 to +10, where score of +10 indicates a strongly democratic state; a score of -10 indicates a strongly autocratic state.

Results

Table 1 reports the univariate statistics and correlation matrix for all of the indicators included in the deforestation analyses; Table 2 reports these for the hunger analyses; and Table 3 reports these for the secondary schooling analyses. Multicollinearity is often a concern and limitation when using aggregate-level data with small sample sizes. Overall, Tables 1–3 suggest that many of the indicators utilized are moderately correlated, and that model specification should be undertaken with caution. I thus grouped indicators in theoretically and technically justified ways, where independent variables are added in a step-wise fashion. I also estimate a more saturated model for each outcome, which includes all predictors found to be significant from the prior models.[25] This modeling strategy is consistent with how researchers in this tradition address concerns of multicollinearity (e.g. Austin, 2010a, 2010b; Jorgenson et al., 2010; Shandra et al., 2009).[26]

Table 4 reports the regression results for the deforestation analyses. Along with the key independent variable, dependence on coffee exports, GDP per capita is included in every model as an important control for level of economic development. The results from the deforestation analyses reveal that coffee export dependency is positively associated with deforestation rates in

Table 1. Univariate statistics and correlation matrix for deforestation analyses

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Natural deforestation rate, 1990–2005	1.00												
2. Coffee export dependence (ln), 2006	.43	1.00											
3. GDP per capita (ln), 1990	−.29	−.17	1.00										
4. Ag. exports % all exports (ln), 1990	.49	.27	−.36	1.00									
5. Forest stock (ln), 1990	−.02	.05	−.06	.25	1.00								
6. Latitude (distance from equator)	−.42	−.41	.04	−.13	−.13	1.00							
7. Rural population growth, 1990	.31	.31	−.47	.43	−.01	−.23	1.00						
8. Total population growth, 1990	.38	.26	−.34	.45	.34	−.20	.69	1.00					
9. Secondary school enrollmt, 1990	−.42	−.41	.49	−.47	−.14	.33	−.69	−.64	1.00				
10. INGO membership (ln), 1990	−.03	.01	.16	−.09	.37	.00	−.30	−.17	.35	1.00			
11. Fair trade/ organic orgs (ln), 1990	.12	.04	−.07	.03	.44	−.07	.01	.10	.08	.61	1.00		
12. Robusta	.25	−.08	−.11	.22	−.02	−.27	.20	.20	−.34	−.18	−.19	1.00	
13. Coffee exports (ln) * Robusta	.10	.62	−.15	.10	.00	−.08	.09	.03	−.18	−.08	−.12	−.34	1.00
Mean	7.01	−.67	7.28	1.46	10.91	13.72	1.21	2.17	57.63	6.35	−2.25	.39	−.33
SD	11.6	1.80	1.41	1.38	2.34	7.91	1.42	.96	26.71	.75	3.02	.49	1.22

coffee-producing nations, net of other relevant factors. The influence of coffee export dependency on deforestation rates remains strong and consistent across the models, including the saturated model presented in Model 7. In addition to coffee export dependence, the deforestation analyses also reveal that dependence on agricultural exports is highly associated with forest loss rates in less-developed nations. This provides clear evidence that coffee export dependence in particular leads to elevated rates of deforestation, even when controlling for export dependence on other types of agricultural commodities.

In addition to the harmful effects of coffee and agricultural export dependency, the results presented in Table 3 illustrate that close proximity to the equator is strongly associated with higher deforestation rates. The early models also suggest that total population growth and low levels of schooling increase rates of forest loss in less-developed nations, although these indicators did not retain significance in the saturated model. There is also some evidence that level of economic development is negatively associated with deforestation rates, as GDP per capita is a significant predictor of forest loss in many of the models. Rural population growth and INGO membership were not found to significantly impact deforestation rates in coffee-producing nations, net of the effects of the other included predictors. Specifically considering the role of participation in fair

Table 2. Univariate statistics and correlation matrix for percent undernourished analyses

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Percent undernourished, 2007	1.00											
2. Coffee export dependence (ln), 2006	.52	1.00										
3. GDP per capita (ln), 2006	−.45	−.17	1.00									
4. Ag. exports % all exports (ln), 2006	.22	.25	−.38	1.00								
5. Secondary school enrollment, 2006	−.71	−.41	.51	−.46	1.00							
6. Percent urban, 2006	−.54	−.27	.45	−.39	.64	1.00						
7. Population growth, 2006	.42	.20	−.11	.40	−.67	−.39	1.00					
8. Military expenditures as % of GDP, 2006	.38	.09	−.23	−.07	−.16	−.14	.04	1.00				
9. Cereal yield per capita, 2006	−.39	−.08	.40	−.23	.48	.20	−.53	−.23	1.00			
10. Fair trade/organic orgs (ln), 2006	−.38	.05	−.02	−.05	.12	.17	.03	.08	−.02	1.00		
11. Robusta	.04	−.18	−.01	.25	−.25	−.19	.31	.13	−.08	−.15	1.00	
12. Coffee exports (ln) * Robusta	.16	.66	−.19	.08	−.23	−.18	.05	.18	.06	.04	−.35	1.00
Mean	20.8	−.52	7.75	1.22	53.6	44.1	1.81	1.61	2338.9	1.28	.43	−.39
SD	12.7	1.92	1.59	1.18	26.7	20.6	.95	1.06	1434.8	1.48	.50	1.30

trade and organic organizations, the results presented in Model 5 suggest that participation in fair trade and organic organizations does not alleviate deforestation rates from 1990–2005. In considering the possibility of differences across Robusta producers and Arabica producers, Model 6 illustrates that while Robusta producing nations tend to have higher rates of forest loss than Arabica producers (the reference category), these two types of producers do not have significantly different slopes for the effects of coffee export dependence on deforestation rates.[27]

Turing attention to the analyses of hunger, results presented in Table 5 illustrate that coffee export dependency greatly contributes to rates of undernourishment in coffee-producing nations. Specifically, the results reveal that coffee export dependency is positively associated with percent undernourished, net of the effects of other factors known to contribute to hunger in less-developed nations. In addition to the influence of coffee exports, the results demonstrate that military expenditures and secondary school enrollment represent strong and consistent predictors of hunger in the models, where warfare increases hunger and schooling reduces it. The less saturated models also suggest that population growth positively influences rates hunger, while economic development, urbanization, agricultural exports, and cereal yields lower rates of hunger. These latter findings with regards to agricultural exports and cereal yields further demonstrate that coffee exports are substantively different than other forms of agricultural production in terms of their effects on food security in poor nations.

In considering the predictions regarding fair trade and organic organizations, the analyses of hunger reveal that participation in the fair trade and organic movement is associated with lower rates of undernourishment in coffee-producing nations, net of other relevant factors. This finding

Table 3. Univariate statistics and correlation matrix for secondary schooling analyses

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Secondary school enrollment, 2007	1.00											
2. Coffee export dependence (ln), 2006	−.41	1.00										
3. GDP per capita (ln), 2006	.53	−.17	1.00									
4. Ag. exports % all exports (ln), 2006	−.48	.31	−.41	1.00								
5. Primary school enrollment, 2006	.27	.27	.25	−.14	1.00							
6. Percent urban, 2006	.55	−.20	.47	−.43	.15	1.00						
7. Population growth, 2006	−.69	.23	−.15	.39	−.17	−.32	1.00					
8. INGO membership (ln), 2006	.34	−.23	.15	−.24	−.01	.13	−.16	1.00				
9. Democracy index, 2006	.42	−.10	.44	−.17	.11	.32	−.09	.19	1.00			
10. Fair trade/organic orgs (ln), 2006	.02	.14	−.01	−.02	−.02	.19	.06	−.31	.19	1.00		
11. Robusta	−.29	−.13	−.09	.27	−.20	−.25	.31	−.06	−.24	−.20	1.00	
12. Coffee exports (ln) * Robusta	−.18	.63	−.15	.04	.33	−.09	.02	−.12	−.25	.16	−.37	1.00
Mean	54.7	−.64	7.77	1.10	103.8	44.2	1.79	4.51	3.31	1.04	.43	−.39
SD	27.3	1.85	1.52	1.62	19.3	21.5	.95	1.42	3.97	1.73	.50	1.24

confirms prior case-studies which find that the added economic benefits to this type of production are most immediately used for enhancing household food security (e.g. Jaffee, 2007). Additionally, organic growers tend to use more mixed cultivation techniques in the absence of chemical inputs to reduce soil degradation, potentially signaling another avenue by which participation in this type of production reduces hunger in coffee-producing nations. Model 5 of the hunger analyses also includes predictors which test for differences in the effects of coffee export dependence across Robusta versus Arabica producers; both the dummy indicator for Robusta and the interaction term are not significant in predicting rates of undernourishment in coffee-producing nations.[28]

Table 6 presents the results for the OLS regression analyses predicting participation in secondary schooling. Consistent with the prior analyses, coffee export dependence is demonstrated to have significant influences on schooling in coffee-producing nations. In particular, coffee export dependence is negatively associated with participation in secondary schooling, net of the effects of other important factors. The results also illustrate that GDP per capita, primary school enrollment, percent urban, INGO membership, and democracy represent prominent factors which promote secondary school enrollment in coffee-producing nations, while population growth reduces secondary school enrollment. The first model also suggests that agricultural export dependency reduces participation in secondary schooling, but this finding did not hold in the saturated model (Model 7).

Inclusion of the fair trade/organic organizations predictor in the secondary schooling analyses in Model 4 does not yield significant results, suggesting that membership in organizations specifically dedicated to fair trade or organic production does not benefit schooling rates cross-nationally. The results of the schooling analyses also suggest that the effects of coffee export dependence on

Table 4. OLS regression predicting natural deforestation rate (*N* = 59)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Coffee export dependence (ln)	0.306**	0.249*	0.339**	0.294*	0.387***	0.524***	0.228*
	(1.972)	(1.604)	(2.187)	(1.893)	(2.493)	(3.379)	(1.469)
	0.729	*0.824*	*0.767*	*0.834*	*0.768*	*0.943*	*0.846*
	[1.087]	[1.288]	[1.083]	[1.248]	[1.029]	[1.703]	[1.555]
GDP per capita (ln)	–0.106	–0.209	–0.159	–0.127	–0.223*	–0.211*	–0.117
	(–0.871)	(–1.717)	(–1.307)	(–1.037)	(–1.832)	(–1.732)	(–0.961)
	0.957	*1.049*	*1.000*	*1.089*	*0.978*	*0.946*	*1.017*
	[1.155]	[1.289]	[1.135]	[1.316]	[1.033]	[1.058]	[1.387]
Agricultural exports (ln)	0.405***						0.311**
	(3.393)						(2.604)
	1.033						*1.057*
	[1.287]						[1.431]
Forest stock (ln)	–0.138						
	(–0.685)						
	0.556						
	[1.067]						
Latitude		–0.297**					–0.250*
		(–0.435)					(–0.366)
		0.183					*0.182*
		[1.231]					[1.388]
Rural population growth		0.067					
		(0.542)					
		1.086					
		[1.404]					
Total population growth			0.233*				0.102
			(2.820)				(1.238)
			1.508				*1.709*
			[1.186]				[1.798]
Secondary school enrollment				–0.271*			0.062
				(–0.118)			(0.027)
				0.067			*0.074*
				[1.771]			[2.591]
INGO membership (ln)				0.084			
				(1.308)			
				1.952			
				[1.182]			
Fair trade/organic organizations (ln)					0.089		
					(0.341)		
					0.451		
					[1.006]		
Robusta producer						0.207*	0.123
						(4.887)	(2.905)
						2.897	*2.885*
						[1.202]	[1.352]

(Continued)

Table 4. (Continued)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Coffee export dependence * Robusta						–0.187 (−1.777) *1.485* [1.931]	
Constant	9.418	8.966	8.960	13.321	7.183	7.173	9.762
R-squared	0.3163	0.2635	0.2403	0.2216	0.2003	0.2700	0.3563

Notes: ****p* < .001; ***p* < .01; **p* < .05 (one-tailed tests); standardized coefficients flagged for statistical significance; unstandardized coefficients reported in parentheses; standard errors reported in italics; VIFs reported in brackets.

Table 5. OLS regression predicting percent undernourished (*N* = 51)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Coffee export dependence (ln)	0.298** (1.970) *0.671* [1.216]	0.369*** (2.439) *0.695* [1.093]	0.445*** (2.939) *0.695* [1.031]	0.471*** (3.110) *0.726* [1.030]	0.466*** (3.077) *0.989* [1.775]	0.322*** (2.127) *0.647* [1.295]
GDP per capita (ln)	−0.168 (−1.338) *0.870* [1.401]	−0.250* (−1.996) *0.902* [1.260]	−0.237* (−1.888) *0.919* [1.237]	−0.371*** (−2.963) *0.876* [1.028]	−0.361*** (−2.879) *0.917* [1.046]	−0.134 (−1.073) *1.011* [2.165]
Agricultural exports (ln)	−0.188* (−2.029) *1.146* [1.326]					−0.164 (−1.775) *1.141* [1.508]
Secondary school enrollment	−0.592*** (−0.282) *0.057* [1.711]					−0.377* (−0.180) *0.082* [3.998]
Percent urban		−0.247* (−0.152) *0.076* [1.502]				−0.117 (−0.072) *0.073* [1.921]
Population growth rate		0.227* (3.028) *1.470* [1.202]				0.086 (1.143) *1.986* [3.001]
Military expenditures as % of GDP			0.242* (2.884) *1.288* [1.086]			0.234** (2.795) *1.105* [1.157]
Cereal yield per capita			−0.201* (−0.002) *0.001* [1.217]			−0.043 (−0.000) *0.001* [1.852]

Table 5. (Continued)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Fair trade/ organic organizations (ln)				−0.213* (−1.831) *0.931* [1.003]		−0.167* (−1.433) *0.785* [1.127]
Robusta producer					0.132 (3.351) *3.063* [1.153]	
Coffee export dependence * Robusta					0.030 (0.293) *1.544* [1.982]	
Constant	6.888	7.183	7.458	6.991	7.356	8.067
R-squared	0.5760	0.4934	0.4639	0.4139	0.3687	0.6298

Notes: ***$p < .001$; **$p < .01$; *$p < .05$ (one-tailed tests); standardized coefficients flagged for statistical significance; unstandardized coefficients reported in parentheses; standard errors reported in italics; VIFs reported in brackets.

secondary schooling rates do not differ significantly across Robusta and Arabica producers; however, the main effect for Robusta demonstrates that Robusta producing nations in general experience lower participation in secondary education in comparison to Arabica producer nations.[29]

Discussion

Taken together, the results presented in Tables 4, 5, and 6 illustrate that coffee export dependence among less-developed nations is associated with heightened rates of deforestation and undernourishment, and depressed enrollment in secondary level education, net of the effects of other relevant predictors. This set of findings confirms the first hypothesis; coffee export dependence decreases components of environmental, social, and physical well-being in coffee-producing nations. The harmful effects of coffee export dependency were remarkably consistent and robust across the analyses, especially in the models predicting hunger and secondary schooling. The fact that coffee export dependency produced strong effects, net of the influence of overall agricultural export dependency, further suggests that coffee export dependence produces unique and especially harmful to patterns in deforestation, hunger, and schooling in poor nations in comparison to other forms of agricultural production.

While the first hypothesis is ultimately supported, the results only provide partial support for the second set of hypotheses concerning the role of fair trade and organic organizations. Participation in fair trade and organic organizations does not seem to impact rates of schooling or deforestation, but this movement is significant in reducing rates of undernourishment in coffee-producing nations. This study thus provides cross-national evidence that participation in fair trade and organic organizations does bring some important benefits to producers; it is likely that the enhanced incomes of fair trade growers translates most directly into improved household food security, as the case-studies suggest (e.g. Jaffee, 2007). These prior examinations also give some explanation to the non-finding for the schooling analyses. Jaffee (2007) points out that organic production is often

Table 6. OLS regression predicting secondary school enrollment ($N = 61$)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Coffee export dependence (ln)	−0.367**	−0.196**	−0.289**	−0.343**	−0.392**	−0.241**
	(−5.411)	(−2.886)	(−4.263)	(−5.060)	(−5.769)	(−3.544)
	1.587	*1.072*	*1.505*	*1.561*	*1.859*	*1.125*
	[1.256]	[1.085]	[1.077]	[1.049]	[1.693]	[1.420]
GDP per capita (ln)	0.320**	0.329**	0.364**	0.470**	0.439**	0.229**
	(5.748)	(5.916)	(6.544)	(8.450)	(7.893)	(4.110)
	1.955	*1.430*	*1.995*	*1.887*	*1.791*	*1.506*
	[1.280]	[1.297]	[1.270]	[1.029]	[1.055]	[1.708]
Agricultural exports (ln)	−0.198*					0.039
	(−3.343)					(0.658)
	1.859					*1.375*
	[1.311]					[1.614]
Primary school enrollment	0.257**					0.148*
	(0.365)					(0.210)
	0.150					*0.102*
	[1.215]					[1.268]
Percent urban		0.181*				0.150*
		(0.230)				(0.191)
		0.105				*0.100*
		[1.409]				[1.523]
Population growth rate		−0.541**				−0.495**
		(−15.549)				(−14.219)
		2.151				*2.150*
		[1.148]				[1.362]
INGO membership (ln)			0.186*			0.136*
			(3.575)			(2.616)
			1.980			*1.307*
			[1.092]			[1.122]
Democracy index			0.196*			0.155*
			(0.895)			(0.708)
			0.507			*0.344*
			[1.269]			[1.376]
Fair trade/organic organizations (ln)				0.068		
				(1.074)		
				1.645		
				[1.020]		
Robusta producer					−0.293**	−0.048
					(−16.054)	(−2.644)
					5.830	*4.046*
					[1.206]	[1.331]
Coffee export dependence * Robusta					0.022	
					(0.490)	
					2.966	
					[1.942]	
Constant	20.137	11.181	16.883	14.891	14.508	16.013
R-squared	0.4456	0.7075	0.4186	0.3580	0.4356	0.7536

Notes: ***$p < .001$; **$p < .01$; *$p < .05$ (one-tailed tests); standardized coefficients flagged for statistical significance; unstandardized coefficients reported in parentheses; standard errors reported in italics; VIFs reported in brackets.

more labor intense; perhaps the labor demands of organic coffee are an obstacle in enhancing participation in schooling in producing nations. The fact that fair trade/organic membership did not impact rates of deforestation is somewhat surprising given the favorable case-study evidence (e.g. Blackman et al., 2007; Rudel, 2005); this non-finding should be interpreted with caution, however, as a methodological weakness concerning the early time points for the independent variables in the deforestation models could be a factor, as the number of fair trade and organic producers was very low in 1990. The organic and fair trade movement has become more prominent over the years (e.g. Jaffee, 2007), and is most likely to be influencing current or more recent deforestation rates, as compared to rates in the 1990s.

The results also failed to garner support for the third set of hypotheses concerning differences in the effects of production across Robusta and Arabica producers. Although the main effect for Robusta production was significant in some models, the slope-dummy interaction term was not significant in any of the analyses, suggesting that the influence of Robusta versus Arabica export dependence on deforestation, hunger, and schooling are not considerably different from one another. Even though there may be some important differences in the specific characteristics of Robusta and Arabica production, these differences do not seem to be great enough to alter how coffee export dependence influences the specific dimensions of environmental, social, and physical well-being examined here.[30] What appears to be more significant is the pronounced effects of coffee export dependence in general; reliance on coffee exports stands out as being unique from trade dependence on other agricultural commodities, given its especially notable effects on multiple dimensions of well-being in less-developed nations.

In addition to the harmful effects of coffee export dependency, many factors related to modernization and development, such as GDP per capita, schooling, urbanization, and population growth represent important factors which contribute to rates of deforestation, hunger, and secondary schooling in coffee-producing nations. Military famine arguments were also relevant in explaining patterns in hunger, and the beneficial effects of agricultural exports and cereal yields in some of the hunger models further suggests that coffee exports are distinctive in furthering food insecurity, while other forms of agricultural specialization may abate it. It is important to note that the non-economic developmental controls often produced larger effects on the outcomes of interest than GDP per capita. When combined with the persistently harmful consequences of dependence on coffee exports, these findings confirm broader arguments which suggest that a near-excusive focus on economic growth and trade integration is not likely to foster successful development in poor nations (e.g. Amin, 1976; Bunker, 1985).

Conclusion

Coffee represents an affluent global commodity that is produced and traded on a larger scale than any other agricultural product, where there is over 10 million hectares of land in the developing world dedicated to coffee cultivation (International Coffee Organization, 2011). While a substantial amount of case-study and descriptive research explores the structure and inequalities of the coffee commodity chain, this study fills an important gap by analyzing coffee exports in a cross-national, empirical context, where the consequences of production are considered as forms of unequal exchange. As coffee exports represent up to 80 percent of foreign exchange earnings in some nations (International Coffee Organization, 2011; Waridel, 2002), examining the effects of the java trade warrants careful scrutiny.

Theorization on unequal exchange is embedded in world-systems and dependency perspectives, where the global division of labor concentrates low-wage, low-skill, and labor-intensive forms of production in poor nations. In this way, export-orientated development is likely to undermine elements of economic, ecological, *and* social sustainability. Indeed, a major contribution of this research includes extending the concept of unequal exchange to dimensions of sustainability or development that go beyond ecological and economic outcomes. A nuanced look at coffee in particular illuminates that unequal exchange relationships can operate at the level of specific commodity types, and that certain global commodities may be especially influential in reproducing conditions of underdevelopment.

The principal limitations of this study concern sample size, temporal scope, and measurement of some variables. Small sample sizes are attributed to limited data availability on the key predictors, as well as the dependent variables. As previously mentioned, many of the variables of interest are not available at multiple points in time, making longitudinal assessments unfeasible. Additionally, necessary temporal ordering for the deforestation models (where all other independent variables besides coffee export dependence are measured at 1990) could be a factor contributing to non-significance for some of the independent variables, including the fair trade/organic predictor. The measurement of Robusta and Arabica exports using a slope-dummy interaction is also somewhat crude, perhaps contributing to non-significant findings for the interaction terms. While raw export values by coffee type would be more appropriate in testing for differences across the types of coffee production, this data is not available for a wide number of cases or for past time points. The International Coffee Organization is beginning to provide more detailed coffee statistics for current years, so hopefully in the future this can be a direction for further research. Although limitations such as these are common in cross-national analyses, using available information to make systematic comparisons can provide valuable insights and helps to illuminate structural patterns across nations.

Coffee is regarded as the most important of the tropical commodities (e.g. Talbot, 2004), as it is the largest revenue source for poor nations among all agricultural products (FAO STAT, 2008; Waridel, 2002). Thus many less-developed nations' economies fundamentally depend on coffee income, and in recent decades this has been a devastating situation as coffee prices have been extremely low. However, coffee prices are increasing in the most recent years (International Coffee Organization, 2011), which makes monitoring the effects of coffee exports on developmental outcomes extremely important, as better coffee prices could lead to increased emphasis on promoting coffee cultivation in poor nations.

While there may be some limited economic gains for coffee producers, the results presented here suggest that integration into foreign coffee markets re-organizes production processes in less-developed nations, where unequal exchanges in the world-system compromise successful development across multiple realms. Many poor nations have a comparative advantage for producing coffee; however, specializing in coffee exports can impair important dimensions of environmental, social, and physical well-being, which in the end limits prospects for future development. Indeed, schooling and physical health are two dimensions of human capital that are especially important to the modernization and advancement of societies. While coffee is a profitable product for core-based TNCs, growers in poor nations receive few benefits (e.g. Talbot, 2004). Dependence on coffee production in rural communities undermines ecological, social, and human resources that are intrinsic to successful development, thus reproducing patterns of underdevelopment in poor nations.

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Notes

1. In addition to the global commodity chain framework, there has been a rise of a second commodity approach, called the global value chains approach. The global value chain approach can be distinguished by is greater influence of the international business literature in analyzing global production networks (e.g. Daviron and Ponte, 2005).
2. Some critiques of global commodity chain and global value chain approaches include: an overall lack of systematic analysis; neglect of fully considering the structures of class inequality within nations or the 'nationality' of capital; questions about whether these analyses are truly 'global' in scope (see for example, Bernstein and Campling, 2006a, 2006b).
3. Although some producing nations have historically profited from coffee production, namely Brazil, Colombia, Costa Rice, and Cote d'Ivoire, at certain time points (most notably in the 1970s before the crash of the ICA), nations that are most dependent on coffee exports, such as many sub-Saharan African nations, are marked by persistent poverty and growers continue to realize only a very small proportion of coffee profits (e.g. Talbot, 2004). This is especially relevant in the most recent decades of very low green coffee bean prices (International Coffee Organization, 2011).
4. Although some other agricultural items share this characteristic, such as tea and cocoa, coffee is undeniably the most prominent small-holder crop across less-developed regions and new trends in monocropping are likely to reduce mixed cultivation with edible crops; thus coffee's effects on food security are likely to be most substantial and relevant.
5. Indeed while many argue that this movement is informed by dependency perspectives, the efforts made by Fridell (2007) demonstrate that these strategies rely on trade reform and state intervention to overcome unequal structures of the world-economy. Fridell's analysis (2007) further highlights that fair trade and other certification systems are symptomatic of the shift from public to private regulation under neoliberalism.
6. One key assumption of OLS regression requires that all variables are normally distributed. Skewness statistics revealed that many of the variables, including the key independent variable, where highly skewed; thus many of the indicators were log-transformed to address this concern. Results from the Breush-Pagan and Modified White's tests reveal no problems with heteroskedasticity, thus conventional standard errors are used.
7. Models were also tested where deforestation is measured from 1990 to 2000; the substantive results were consistent with those presented here.
8. The deforestation analyses include the following nations in the sample ($N = 59$): Angola, Belize, Benin, Bolivia, Botswana, Brazil, Burundi, Cambodia, Cameroon, Central African Republic, China, Colombia, Comoros, Congo Rep, Costa Rica, Cuba, Dominican Republic, Dominica, Ecuador, El Salvador, Ethiopia, Fiji, Ghana, Guatemala, Guyana, India, Indonesia, Jamaica, Kenya, Lao People's Democratic Republic, Madagascar, Malawi, Mauritius, Mexico, Nepal, Nicaragua, Niger, Nigeria, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Samoa, Senegal, South Africa, Sri Lanka, Suriname, Swaziland, Tanzania, Thailand, Togo, Tonga, Uganda, Uruguay, Venezuela, Vietnam, Zambia, Zimbabwe.

   The hunger analyses include the following nations in the sample ($N = 51$): Angola, Belize, Benin, Bolivia, Botswana, Brazil, Burundi, Cambodia, Cameroon, China, Colombia, Congo Rep, Cuba, Dominican Republic, Ecuador, El Salvador, Ethiopia, Fiji, Gambia, Ghana, Guatemala, India, Indonesia, Jamaica, Kenya, Lao People's Democratic Republic, Madagascar, Malawi, Mauritius, Mexico, Mozambique, Nepal, Nicaragua, Nigeria, Papua New Guinea, Peru, Philippines, Rwanda, Senegal, Sierra Leone, South Africa, Sri Lanka, Sudan, Swaziland, Tanzania, Thailand, Uganda, Uruguay, Vietnam, Zambia, Zimbabwe.

The schooling analyses include the following nations in the sample ($N = 61$): Angola, Belize, Benin, Bolivia, Botswana, Brazil, Burundi, Cambodia, Cameroon, Central African Republic, China, Colombia, Comoros, Congo Rep, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Ethiopia, Fiji, Gambia, Ghana, Guatemala, Guyana, India, Indonesia, Kenya, Lao People's Democratic Republic, Madagascar, Malawi, Mauritius, Mexico, Mozambique, Nepal, Nicaragua, Niger, Nigeria, Panama, Papua New Guinea, Peru, Philippines, Rwanda, Samoa, Senegal, Sierra Leone, South Africa, Sri Lanka, Sudan, Suriname, Swaziland, Tanzania, Thailand, Togo, Tonga, Uganda, Uruguay, Venezuela, Vietnam, Zambia, Zimbabwe.

9. I also tested a uniform sample across all three dependent variables, and the substantive results were consistent. I choose to present the results for the non-uniform samples here, as I prefer to use as much information (data) as possible when reporting models and drawing conclusions.
10. This is consistent with how prior researchers define less-developed nations. See for example, Austin (2010a, 2010b); Brady et al. (2007); Jorgenson et al. (2009, 2010); Shandra et al. (2009).
11. Listwise deletion is considered a more 'conservative' method for dealing with missing data as decreased sample size may inflate the standard error estimates.
12. For the following nations, data on natural forest stocks were not available, so a deforestation rate based on total forest estimates was used in order to bolster sample size: Botswana, Burundi, Costa Rica, Dominica, Ecuador, Guyana, Mexico, and Venezuela.
13. The natural deforestation rate reflects the annual percent change in natural forest cover, which does not include forest plantations or areas used for forestry and other related purposes, only native vegetation.
14. I also measure coffee export dependence as a percentage of agricultural exports to avoid confounding with overall dependence on agricultural exports, which is measured as the value of agricultural exports as the percentage of all exports. Because the denominators are different across these two trade measures, it avoids including redundant independent variables in the same model. Indeed, the bivariate correlation matrices depict only a weak correlation between coffee export dependence within the agricultural sector and overall agricultural export dependence; this further confirms that including both of these variables in a model does not bias the results.
15. I also tested models using coffee exports as a percentage of all exports, and the substantive results were consistent. However, the need to also control for overall dependence on agricultural exports necessitates that dependence on coffee exports be measured as a percent of agricultural exports.
16. It is appropriate to combine organic and fair trade organizations as most fair trade cooperatives also practice organic practices (e.g. Jaffee, 2007). Fair trade and organic organizations were identified by examining the names and mission of the INGOs to assess commitment to fair trade or organic issues. As export data on fair trade and organic coffee is not available for a wide number of nations, this represents one of the best ways to capture participation in this type of production in cross-national analysis.
17. I also tried weighting the number of fair trade/organic organizations by the population size; this did not alter the substantive results.
18. A dummy-variable is at this time the only way to measure differences across the types of coffee in cross-national analysis as annual export data broken down by Robusta and Arabica varieties for a wide number of nations is not publically available (e.g. FAO STAT, 2010; International Coffee Organization, 2011).
19. This measure is based on information from the International Coffee Organization (2011), which classifies producing nations as either Robusta producers, Arabica producers, or Mixed producers. For mixed producers, the volumes of coffee production by type are reported, and nations were classified as Robusta or Arabica based on the production estimates. I also tried categories for Robusta, Arabica, and Mixed producers; the substantive results are consistent with those presented here.
20. More specifically, a slope-dummy variable is a type of interaction term created by multiplying a continuous measurement variable (e.g. x1 = coffee exports) by a dichotomous dummy variable (e.g. x2 = Robusta), which creates a new variable (e.g. coffee exports * Robusta = x1x2). The newly constructed variable x1x2 has the values of x1 for all cases for which the dummy variable (i.e. x2) is coded as '1', and a '0' for all the remaining cases (see Austin, 2010a, 2010b; Burns et al., 2003; Hamilton, 1992).

This approach is somewhat different than those most common in social scientific studies that generally construct interaction terms between two categorical and/or discrete variables (e.g. gender and ethnicity).

21. This represents an especially important control variable given that the labor requirements and other characteristics of coffee mean that coffee cultivation is also going to be attracted to poorer nations. There indeed are likely to be some recursive processes, as poverty likely leads to coffee production, and coffee production also leads to more poverty (e.g. Talbot, 2004). The focus of the current study however concerns the latter, principally in the context of how coffee exports influence non-economic indicators of poverty or underdevelopment (namely, deforestation, hunger, and low participation in secondary schooling). In order to adhere to requirements of causality and confirm that coffee exports influence the outcomes under investigation in light of the fact that agricultural production is also drawn to impoverished nations, I include several of the most important control variables, such as overall dependency on agricultural exports, GDP per capita, population growth, and schooling, in each analysis, in addition to relevant predictors that are specific to the outcome under investigation. This careful attention to possible spurious factors reduces the influence of effects that might arise from the fact that economic poverty may also lead to increased coffee export dependency. Surely, the extent to which poverty may further increase coffee exports deserves more attention in cross-national research.
22. Many macro-sociologists argue that PPP estimates of GDP are more appropriate than dollars estimates based on exchange rates, as PPP rates provide a standard measure allowing comparisons of real price levels between countries.
23. In its current form, this measure also includes coffee exports in the numerator. I also constructed this indicator subtracting out coffee exports, and the substantive results were consistent. I prefer to measure dependency on agricultural exports with coffee included, as this provides even stronger evidence that dependency on coffee within the agricultural sector influences the outcomes of interest, net of the effects of dependency on agricultural exports in general.
24. I also tried many other measures of food production, but cereal yield produced the most consistent and robust effects on percent undernourished, and thus is the measure presented here. It is likely that cereal yield is one of the most prominent predictors of hunger as many cereals are used for local consumption. This measure clearly excludes cocoa, tea, and other 'food' products that would not be consumed locally or that lack nutritional value. Cereals can also usually be stored for a significant amount of time without spoiling.
25. Most standards suggest that multicollinearity does not significantly bias the results when VIFs do not exceed 10, and most conservative thresholds argue that VIFs should be below 2.5 (e.g. Tabachnick and Fidell, 2001).
26. In any quantitative, cross-national study of this sort, there is a potential problem of multicollinearity. Kennedy (2001) suggests a test for multicollinearity in which each independent variable is regressed on all other independent variables. It is common not to worry about collinearity unless the *R*-squares from these equations exceed the *R*-squares in the original analysis (Kennedy, 2001; Rudel, 1989). This procedure was used for the present analyses, and the results did not suggest issues of multicollinearity. Nonetheless, the models were constructed with caution and with careful attention to the VIFs and patterns in significance.
27. Elsewhere I include measures of urbanization, democratization, GDP generated by agriculture, urban population change, deforestation data quality indicators, and coffee consumption as additional controls on deforestation. The effects of these predictors on deforestation were non-significant, and/or their inclusion did not substantively alter the reported findings.
28. Elsewhere I include measures of democratization, rural population change, urban population change, INGO membership, food production index, and coffee consumption as additional predictors of percent undernourished. The effects of all the additional predictors on percent undernourished were non-significant, and their inclusions do not substantively alter the reported findings.
29. Elsewhere I include measures of gross capital formation, public expenditures on education, the teacher to pupil ratio, rural population change, urban population change, and coffee consumption as additional

predictors. The effects of all the additional predictors on secondary school enrollment were non-significant, and/or their inclusions do not substantively alter the reported findings.

30. Some of this may also be due to limitations of the data, as a dummy variable was used to estimate Robusta versus Arabica production. Although export data by coffee type would be ideal, these data do not exist for a sizeable number of nations. The International Coffee Organization does have some export and production data by coffee type, but this is only available for a small handful of nations. Hopefully as more nuanced estimates continue to be collected this line of research can be further developed.

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