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Chocolate and the Consumption of Forests:

A Cross-National Examination of Ecologically Unequal Exchange in Cocoa Exports

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Abstract

This study explores the potential links between specialization in cocoa exports and deforestation in developing nations through the lens of ecologically unequal exchange. Although chocolate production was once considered to have only minimal impacts on forests, recent reports suggest damaging trends due to increased demand and changing cultivation strategies. I use two sets of regression analyses to show the increased impact of cocoa export concentration on deforestation over time for less-developed nations. Overall, the results confirm that cocoa exports are associated with deforestation in the most recent time period, and suggest that specialization in cocoa exports is an important form of ecologically unequal exchange, where the environmental costs of chocolate consumption in the Global North are externalized to nations in the Global South, further impairing possibilities for successful or sustainable development.

Keywords: Chocolate, Environment, Unequal Exchange, Ecologically Unequal Exchange, deforestation

Chocolate is ubiquitous in American culture and is associated with major commercial holidays such as Valentine's Day, Easter, and Christmas. People in the United States enjoy a significant amount of chocolate and each year Americans consume on average 9.5 pounds of chocolate per person (Confectionery News 2014). Yet, Americans are not alone in their love for chocolate and it is consumed in even greater quantities in Western Europe. In fact, Switzerland, Germany and

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Austria lead the world in yearly chocolate consumption, eating 19.8, 17.4, and 17.2 pounds of chocolate a year per person, respectively (Confectionery News 2014). Worldwide demand for chocolate treats is at an all-time high (World Resources Institute 2015). Most of this demand is driven by the Western world, but the popularity of chocolate is quickly rising in rapidly developing nations, such as China and India, and this fact is not lost on confectionary companies (Reuters 2015). For example, Hershey has recently invested $250 million into a strategically-placed manufacturing plant in Malaysia, looking to these countries for the future expansion of their products (Business Wire 2013).

Despite high levels of chocolate consumption in the United States and other developed nations, people rarely consider where chocolate comes from, or the conditions under which the cocoa[1] trees, which produce the beans to make chocolate, are grown. Chocolate production involves a long and highly unequal commodity chain that transforms the raw cocoa bean into the chocolate treats we love and crave (Fairtrade Foundation 2016). In fact, these commodity chains have been restructured in recent years with increased economic globalization and become even more unequal. As an example, despite millions of cocoa growers, just nine companies now control the processing and manufacturing of chocolate worldwide (Fairtrade Foundation 2016). This concentration has the potential to distort the market and drive profit down for small cocoa growers (Fairtrade Foundation 2016). The production of chocolate likely entails environmental costs in the regions in which the cocoa in grown, which are typically far from the sites of consumption facilitating processes of ecologically unequal exchange (Bunker and Ciccantell 2005; Jorgenson et al. 2009).

This paper examines the environmental costs of chocolate through the lens of ecologically unequal exchange, specifically focusing on links between cocoa exports and deforestation. World-systems theory, which espouses thinking on ecologically unequal exchange, provides an excellent theoretical lens from which to view the environmental consequences of chocolate production. While chocolate is a luxury item almost exclusively enjoyed in the developed world, cocoa is exclusively grown in places such as West Africa, Asia, and Central and South America; regions that on average have extremely small demand for the product that they often depend on for their livelihoods (Confectionery News 2014; Fairtrade Foundation 2016). Although ecologically unequal exchange has been used to examine links between agricultural products more generally (e.g. Jorgenson, 2006; Jorgenson et al., 2009, 2010; Shandra et al., 2009), as well as key commodities, such as coffee and beef (Austin 2010a, 2012), the potential role of cocoa exports specifically in promoting deforestation in developing nations has not been empirically examined

[1] I use the term cocoa throughout this analysis despite the fact that Theobroma cacao is the scientific name of the cocoa tree. The terms cocoa tree and cacao tree are used interchangeably in the literature. This is not to be confused with the coca plant that is used as the main ingredient in cocaine.

in comparative analyses. Furthermore, the extent to which cocoa negatively impacts forests may represent a newly emerging phenomenon; while traditional approaches relied on semi-shade conditions that preserved primary forests, recent pressures have propelled small-holders and some large-scale farmers to search for new forested lands to expand cocoa cultivation and there has been a transition to hybrid varieties of high-yield trees that grow in monocultures without shade (e.g. CNN 2008). Specifically, the Amazon hybrids that tolerate full sun are now expanding to famers in West Africa who are trying to meet growing world-demand, where about 70 percent of the world's cocoa is grown (Wessel and Quist-Wessel 2015). Thus, this paper is timely and seeks to fill this lacuna by providing an empirical examination of the connections between cocoa production and deforestation.

Cocoa: History, Characteristics, and New Production Patterns

History

Chocolate consists of cocoa, sugar, and milk, but it is the cocoa that is the main ingredient. The cocoa tree's scientific name, Theobroma Cacao, means "food of the gods" (World Cocoa Foundation 2017a). Although most cocoa grown today comes from West African countries such as Cote d'Ivoire, Ghana, and Nigeria, cocoa originated in Central and South America. The regions around the Orinoco (in present day Venezuela and Colombia) and Amazon Rivers (in present day Brazil) are thought to be the evolutionary birthplace of Theobroma Cacao (Young 2007:2-3).

The earliest harvesting of cocoa by the Amazonian Indians was for the sweet tasting white pulp (Young 2007:11-12), and several indigenous peoples of Mesoamerica also cultivated cocoa. Cocoa cultivation has a long history, as the Olmec Indians were cultivating cocoa by the time of Christ and perhaps even a thousand years before this (Coe and Coe 2013; Young 2007). Cocoa was held in high esteem by indigenous peoples, as evidenced by a jadeite carving depicting a Maya lord holding a cocoa tree found in the cenote of Chichén Itzá. (Young 2007). Other examples abound as images of warrior-priests and nobles with cocoa trees dating back to 200 A.D. have been found throughout the Mayan territories of Mexico and Central America (Young 2007). Other indigenous peoples of the region (e.g., Aztecs and their descendants, the Pipil-Nicarao Indians) had several uses for cocoa. It was consumed in a drink, used for currency, and used as tributes to rulers of the Aztec empire (Coe and Coe 2013; Young 2007). Although early indigenous groups in Mexico and Central America farmed cocoa intensively, their respect for nature helped them develop environmentally sustainable methods of agriculture. Cocoa was part of a diversified agricultural plan that included other taller trees that provided the needed shade for the cocoa tree (Coe and Coe 2013; Young 2007).

Although Columbus brought cocoa beans back from the new world around 1502, they went largely unnoticed (Cadbury 2017). Hernando Cortés witnessed Montezuma II being offered a chocolate drink made from cocoa in fifty gold chalices and tributes being paid to him in the form of cocoa beans in 1519 (Young 2007). Realizing that it held the potential for commercial value he took it back and introduced it to the Spanish royal court circa 1530 (Cadbury 2017; Young 2007). Cocoa did not become immediately popular in this form as it was too bitter. It was not until a decade later when cocoa was mixed with sugar and cinnamon that it began to increase in appeal (Cadbury 2017; Coe and Coe 2013). However, broad popularity had to wait until the late 19th century when the Swiss candle maker Daniel Porter worked with Henri Nestle to perfect the process of making milk chocolate (Cargill 2017; Coe and Coe 2013).

Cocoa Production Today

Approximately 90 percent of the world's cocoa is grown by five to six million small farmers. In total, 40 to 50 million people in the developing world rely on the cultivation of cocoa as their main source of livelihood (Afoakwa 2014). Since the 1930s, West African farmers have been world leaders in cocoa production led by Côte d'Ivoire, Ghana, Nigeria, and Cameroon (Afoakwa 2010). The average size of the small cocoa farms is around one to four hectares (Barrrientos 2016; Wessel and Quist-Wessel 2015). Despite a majority of the world's cocoa being grown in West Africa, it has recently expanded to other countries where different growing methods are used. In India, for instance, cocoa is grown on a mix of small and large-scale farms, and in Indonesia it is mostly grown on large-scale farms using monoculture techniques (Barrrientos 2016). While it is easy to link large-scale agri-businesses to deforestation practices, there are also several reasons for small farmers to increase pressures on forests as well, such as expanding cultivation sites into new areas due to rising world demand, older cocoa trees becoming less productive, and new government-led initiatives in several West African countries to increase production (Wessel and Quist-Wessel 2015).

Today the process of making chocolate begins with the cocoa tree. Cocoa trees only grow within a 20-degree swatch of the equator (Cadbury 2017; World Cocoa Foundation 2017) and are highly fragile and unproductive in climates that are too hot or too windy (ICCO 2015). These trees typically take three to four years to mature before producing the colorful pods, and tend to produce fruit or pods for about 10 years. Cocoa pods are rather distinct in that they grow directly from the trunk and large branches of the tree (Cadbury 2017). A typical tree is less than 25 feet high which traditionally made it ideal to grow under the shade of larger trees in its natural rainforest habitat. There are typically two growing seasons for cocoa and the average yield is about 30 cocoa pods per tree. The pods are about 7 to 8 inches long and weigh about one pound each. Once these pods are harvested, usually by hand with a machete, they are split to reveal about 20 to 50 almond-sized beans encased in a whitish pulp (World Cocoa Foundation 2017). Once removed from the pulp, the beans begin a multi-stage process of fermentation and drying in the countries where they are grown before the dried beans are bagged and shipped to processing plants where they are winnowed, roasted, grinded, and pressed (World Cocoa Foundation 2017). The typical tree produces only enough cocoa to make 450 grams or approximately 16 ounces of chocolate in a year (Cadbury 2017).

Today, there are three main segments of the chocolate market: the high quantity but low-quality chocolate, a good quality chocolate for the mainstream market, and a niche market consisting of fair trade and organic chocolate. The largest growth has been in the niche markets, but overall it is estimated that less than one percent of the chocolate market is designated as fair trade (ICCO 2016). Over the last 15 years, the chocolate industry has grown by about 3 percent per year, but since the market liberalizations of the 1980s, the world chocolate prices have been quite volatile. From the mid-1980s to the late 1990s there was a pronounced downward trend in prices. Some recovery took place in the early 2000s but prices in 2005 were still about 13 percent lower than in 1995. Since then there has been rising prices (Barrrientos 2016).

Cocoa represents an important commodity in the world economy; for example, in 2010, the value of the global cocoa crop was over $5 billion (Afoakwa 2014). To some, especially poor economies in West Africa, the role it plays in generating export revenues cannot be overstated. For example, in countries such as Cote d'Ivoire and Ghana it represents a significant share of their total export earnings. While cocoa trees are grown in several world regions including Africa, Asia and Oceania, and Central and South America, about 75 percent of the world's cocoa exports come from Africa, 16 percent from Asia and Oceania and 6 percent from Central and South America (Afoakwa 2014).

Since the vast majority of cocoa produced in the world today is done by small farmers, it is important to examine recent developments in the way in which small farmers in West Africa have been integrated into the world economy, which is relevant for understanding unequal exchange. In West Africa from the 1950s to 1980s, the cocoa industry was organized by the state through export marketing boards. These boards set prices, held a monopoly on export cocoa, allowed for stable prices, and ensured the uniform quality cocoa bean (Barrrientos 2016). However, in the 1980s, these marketing boards were abolished and the world market was liberalized as exporting countries fell under the structural adjustment policies of the World Bank and International Monetary Fund (Barrrientos 2016). While the goals of these liberal policies may have been to increase efficiency of production and increase profits from cultivation, this has not been the result (Oxfam 2009). Instead small-scale farmers are subject to global fluctuations and market volatility as layers of protections were removed (Barrrientos 2016).

Since the 1980s there has also been a trend toward increased concentration in the cocoa commodity chain in terms of processing (grinding) and manufacturing (Barrrientos 2016; Fold 2002). Producing countries now export cocoa beans to be processed in other, more developed countries (Barrrientos 2016; Fold 2002). By the early 2000s, corporations within six more-developed countries, including the United States, controlled about 60 percent of the chocolate manufacturing market (Oxfam 2009). Thus, the world has seen significant changes in the global commodity chain of chocolate since the 1980s. On the one hand, small cocoa farmers are now directly linked to the world economy and on the other, there has been increased concentration of production and manufacturing processes (Barrrientos 2016; Fold 2002).

While the chocolate industry is big business today for corporations of the Global North involved in the processing, marketing, and distribution of chocolate, many of the small farmers growing cocoa live in poverty, as only about 3 percent of the price of each chocolate bar goes to the famer (Oxfam 2013). Many cocoa farmers are food insecure; for example, one study indicates that about 60 percent of households who farm cocoa in Nigeria's top cocoa producing state were food insecure (Oluyole et al. 2009). Thus, it is possible that households that specialize in cocoa cultivation do so at the expense of producing other local food products, as we see with other products such as coffee (e.g., Austin 2012). These trends are consistent with the discussion of the commoditization of food and inequitable access to food in the new global economy (Scalan 2003).

Unique qualities of cocoa trees create pressures on the industry and may enhance negative impacts on the environment. Importantly, cocoa trees are highly fragile and are plagued by several diseases such as Witches' Broom, Frosty Pod Rot, and Phytophthora Pod Rot that have been harmful to yields (ICCO 2015). It is not uncommon to lose anywhere from 30 to 40 percent of a cocoa crop in a given year due to one or more of these diseases (World Cocoa Foundation 2017a). Climatic changes, such as a lack of rainfall, and the depletion of soil nutrients over time, reduce yields (Bloomberg 2015). Further, reliance on aging trees and political instability in West African countries also has negative impacts on cocoa production (World Resources Institute 2015). The marked increase in worldwide demand in recent years intensifies these factors (World Resources Institute 2015). Deficits in production yields from prior years are being carried forward to create enhanced pressure on farmers to produce and export more cocoa and search for ways to increase their output (Fairtrade Foundation 2016). One such solution is the call for increased use of fertilizers (Gockowski and Sonwa 2011). While fertilizer use often leads to impressive increases in cocoa yields, small farmers are often reluctant to use them. Wessel and Quist-Wessel (2015) document that fertilizer is shown to increase cocoa yields by as much as 50 percent in 5-year trials in Ghana, however, they have little effect on the yields during the first two years of use and are expensive. Thus, it is hard for poor farmers to invest in a solution that does not produce timely results (Wessel and Quist-Wessel 2015).

Instead of using fertilizers, small plot farmers are increasingly felling new forests as a solution to older, unproductive areas with poor soil fertility (CNN 2008). Recent policy and news reports provide numerous examples, such as the rainforests in the Peruvian Amazon and Cavally Forest in Côte d'Ivoire, which have been sacrificed for additional lands to grow cocoa trees (allAfrica 2016; Bloomberg 2016; World Resources Institute 2015). Farmers are increasingly encroaching onto these forests, felling trees, selling off the timber and undertaking slash and burn strategies to eliminate the forest undergrowth. These recently cleared areas are then planted with Amazon hybrid seeds in monoculture plantations (Bloomberg 2016).

Although typically a smallholder crop, production is increasingly coming under the control of larger multinational agribusinesses (e.g. Bloomberg 2016; World Resources Institute 2015), and large-holders commonly use plantation agriculture techniques that create increased pressure on forests. A look at the recent trends of cocoa production in Peru, for example, demonstrates that agribusinesses have sought out new parts of the Peruvian Amazon for cultivation, leading to great increases in cocoa production in Peru over the last 30 years (World Resources Institute 2015). While the expansion into the Amazon is unauthorized, satellite technology from NASA documents the harmful impacts of cocoa plantations on forests in the region (World Resources Institute 2015).

While the research presented here focuses on one of the main environmental consequences of cocoa farming, deforestation, it is important to point out that there are also other negative environmental consequences, such as increases in countries' carbon footprints, changing weather patterns, soil depletion, and the creation of other metabolic rifts (World Resources Institute 2015). Further, the negative social consequences of cocoa cultivation are well-documented, including the displacement of indigenous peoples, the continued reliance on child labor, and the trafficking of children in modern-day slavery (Business Wire 2016, Tulane University 2015).

Some actors in the chocolate industry are working hard to find other ways to keep up with demand. Cocoa research labs are looking for genetically modified cocoa strains that are more resistant to diseases (Bloomberg 2014). In addition, some are also calling for increased use of pesticides and fertilizers to enhance yields (Gockowski and Sonwa 2011). Others promote continuation of the more traditional methods of production, mixing cocoa trees with larger shade trees, which could help offset some of the carbon deficient being created by clear-cutting of forests. However, there are real costs and economic limits associated with each of these potential solutions, such as the costs of planting or maintaining larger trees, producing inferior quality cocoa, and the obvious environmental consequences associated with the use of pesticides and fertilizers.

Cocoa is perhaps the prototypical commodity to view through the lens of world-systems analysis. Although chocolate is consumed almost entirely in core nations, the natural resources needed to produce it come from poor, less developed nations. Spatial inequalities between the providers or growers of cocoa and the corporations and countries who profit most from chocolate processing, manufacturing, and distribution facilitate increased environmental degradation at the sites of production (e.g. Bunker and Ciccantell 2005). Inequalities in global power and development are attenuated through unequal exchange relationships and the unequal commodity chain of cocoa cultivation and processing obscures the potential negative consequences to forests out of the view of consumers in the Global North (Bunker and Ciccantell 2005). World-systems theory and related concepts of unequal exchange and ecologically unequal exchange provide insight into the global processes in which the benefits of chocolate consumption are enjoyed in highly developed nations while the negative environmental consequences, especially forest loss, are experienced in peripheral nations.

World-Systems Theory and Ecologically Unequal Exchange

World-systems theory is heavily influenced by Marxist political economic thought, dependency theory, and by the writings of the United Nation’s Economic Commission for Latin America headed by Raúl Prebisch in the 1970s (Timmons and Grimes 2002). World-systems theory emerged as a reaction to the failed promises of modernization theory and the more mainstream neoclassical economic approaches that became popular among those in the developed world in the 1960s (Sheppard 2008; Timmons and Grimes 2002). Modernization theory is exemplified by the writings of Rostow (1960) who wrote that all countries could embark on a path from a traditional society toward a modern capitalist consumption based economy. A typical country would need some sort of external shock or assistance to spur them on the path toward development (Rostow 1960).

Missing from modernization theory, especially the version developed and propagated in the United States, is the fact that the current members of the developed world could not have undertaken this development without the exploitation of the third world with its roots in colonization (Roberts and Grimes 2002; Wallerstein 1974). Specifically, it was imperative to have weaker countries that could be exploited either through direct colonial relationships, as in the case of European countries, or through indirect hegemonic pressures, as in the case of the United States (McMichael 2012; Wallerstein 1974). Thus, the modernization approach to development is ahistorical in nature as it does not consider how these exploitative relationships propelled Western development. In addition, the modernization perspective is consistent with earlier ideas about comparative advantage, which describes that countries best opportunity to develop economically would be to find what they have a natural comparative advantage in, and then build the economy around this specialization (e.g., Ricardo 1817; Smith 1776). While there is some merit to the idea that specialization can lead to efficiencies in production and global trade, and that these can help to stimulate economic growth in a country, it is not a sustainable approach for all countries. Some newly industrialized countries (e.g., South Korea, Taiwan) were able to parlay this strategy into economic growth, but specialization in low-value, low-wage commodities, including agricultural items leaves many lesser-developed countries behind (e.g. McMichael 2012).

World-systems theory was advanced simultaneously by Samir Amin, an Egyptian-French economist, and by Immanuel Wallerstein, an American sociologist (Sheppard et al. 2009). One of the main insights of world-systems theory is that the focus of action or unit of analysis in not an individual state, but rather the world-system and the interactions therein (e.g., Chase-Dunn 1998; Wallerstein 1974). Thus, if seeking to explain events that take place in once country, such as a small-holding cocoa farmer moving deeper into protected national forests in Côte d'Ivoire to find more suitable lands for cultivating cocoa trees, it would be insufficient to look for explanations for these actions solely by focusing attention on the direct relationship between the farmer and the local market. Instead, because the world operates as a system, the driving force leading to the farmer's actions would have its roots elsewhere in the world-system (e.g., Wallerstein 1974).

Wallerstein (1974) conceptualized that relations between countries in a capitalist world economic system have a relational aspect and that world is divided into three strata of economic processes: the core, semi-periphery, and periphery. Core economic processes are those that focus on heavy industrial production and high-value production processes, while peripheral economic processes are those that focus on the export of minerals and primary agricultural products (as well as some light manufacturing) (Sheppard et al. 2009). Wallerstein (1974) posits that core and peripheral processes tend to be spatially clumped together in modern nation-states, the main political unit within a capitalist world system. Counties higher up on this relational continuum actively exploit those below it, thus leaving the semi-peripheral counties in a rather unique position to be both exploited by some and the exploiter of others as they engage in a mix of core-like and periphery economic processes (Chase-Dunn 1998; Wallerstein 1974). One mechanism by which peripheral countries are exploited by those closer to the core is through the underlying process of unfair trade patterns, or unequal exchange.

Unequal Exchange

The concept of unequal exchange, originally conceptualized by Emmanuel (1972), posits that countries in the core and periphery exchange commodities that are inherently unequal in value. The exchange value of primary of commodities produced in the periphery (with the exception of some mineral commodities such as diamonds and oil) is typically lower than manufactured or finished goods produced in the core (Sheppard et al. 2009; Wallerstein 1974). When core and periphery countries trade with each other, those countries exporting higher-valued goods typically receive better terms of trade and increased profits relative to those countries who export low-value primary goods. Thus, trade is unequal and the related power imbalance allows core countries to distort the terms of trade to their own economic benefit (McMichael 2012; Wallerstein 1974). Specialization in primary commodities, natural resources, and low-valued manufactured goods in which peripheral countries have a "natural" comparative advantage does not provide an avenue for all countries to spur substantial and lasting economic development (McMichael 2012). While there are several mechanisms that drive unequal exchanges, it is beneficial to delineate a few of these to demonstrate how this works in practice.

First, neoclassical approaches to development encourage countries in the periphery to specialize and place efforts in agricultural items, as poor nations have a natural comparative advantage of being located in tropical areas conducive to growing crops (e.g. World Bank 2008). This leaves these peripheral countries heavily dependent on a relatively few number of products or commodities. While at times this can be beneficial and may lead to big gains if the product is highly sought-after, diversification, not concentration, provides more protections against worldwide economic fluctuations (Emmanuel 1972). Furthermore, the agricultural products that periphery nations are pressured to produce are very competitive in that they are alike one another. Competition between producing nations for the same product (like cocoa) drives down prices and bargaining power.

Additionally, primary commodities do not possess the flexibility of production that high valued manufactured goods have to respond to market fluctuations. For instance, in a manufacturing plant in times of high demand, shifts can be extended, new shifts can be added, and workers can be brought on the payroll all to take advantage of this increase of demand. In the opposite situation when demand is low, the steps described above can be reversed. However, for those that grow cocoa and other similar items, it takes years for a cocoa tree to mature to the point where it produces pods and there are a limited number of growing seasons in a year. Thus, production of primary products is rather inflexible and too much of a product on the market drives the prices down restricting economic gains.

Relational aspects of trade, such as differentials in political power, also affect trade. In bilateral trade agreements and multilateral trade mechanisms, such as the World Trade Organization (WTO), those with more political power have more leverage to determine the terms of trade in these agreements (McMichael 2012). Countries in the periphery with relatively less political power are not able to negotiate the most favorable terms of trade.

The mechanisms discussed above demonstrate numerous problems for economic development strategies that rely on primary sector specialization. Peripheral countries also face environmental costs and related adverse consequences that arise out of specialization in the primary sector and the unequal relations between core and peripheral countries in the world-system. These relations are best understood in terms of ecologically unequal exchange.

Ecologically Unequal Exchange

A growing body of research examines how the structure of the world-system, especially how the organization of international trade leads to negative environmental outcomes for some countries and not others (e.g. Bunker and Ciccantell 2005). This research originated with Bunker's (1985) *Underdeveloping the Amazon: Extraction, Unequal Exchange, and the Failure of the Modern State*. Bunker argued that insufficient attention was placed on the environmental inequalities inherent in the capitalist world-system created and maintained through unequal exchange relationships. Unequal exchanges do not just focus on environmental degradation such as deforestation, but also encompass the unequal use of natural resources, over-utilization of environmental space, and the displacement of environmental risks to poor nations (Frey 2003; Jorgensen 2016; Rice 2008).

Unequal trade relations and the specialization on commodity production in poorer nations allows the environmental consequences of consumption in affluent nations to be shifted or externalized to the poorer countries where primary commodities are produced (e.g. Bunker and Ciccantell 2005; Frey 2003; Rice 2008). Countries closer to the core are able to shift a majority of the environmental costs of consumption and waste generation to more peripheral countries, leading to increased environmental degradation in poor nations relative to the core (e.g., Jorgenson 2016; Rice 2008). Higher levels of environmental destruction lead to an increasing inability of these peripheral counties to consume their own resources and protect their natural assets, fostering underdevelopment (e.g., Bunker and Ciccantell 2005).

Previous cross-national research using the world-systems frame and applying the concept of ecologically unequal exchange yields insight on the impact that specializing in export of primary commodities has on a variety of ecological outcomes, such as biodiversity loss of mammals and birds (Shandra et al. 2009b), the environmental footprints of nations (Jorgenson and Burns 2007), climate change (Roberts and Parks 2007), organic water pollution (Shandra et al. 2009c), the use of environmental space (Frey 2003; Rice 2007), and deforestation (Austin 2010a, 2010b; Jorgenson 2004, 2006; Jorgenson et al. 2010).

Several quantitative studies using the concept of ecologically unequal exchange attempt to assess the environmental impacts of the vertical flow of exports from less developed countries to more developed countries. This has been carried out in a variety of ways, using weighted export flow indicators for various products or product categories (e.g. Jogenson 2006; Jorgenson et al. 2010), the concentration of certain export types to core countries (e.g. Shandra et al. 2009a, 2009b), or simply export concentration in certain commodities that are exclusively produced in poorer nations, such as coffee (e.g., Austin 2012). Regardless of how ecologically unequal exchange is operationalized,[2] there is overwhelming empirical support for negative impacts across a variety of environmental outcomes, including deforestation.

[2] Jorgenson (2012) found a correlation of .9 between both measures (weighted indicators or concentrations of exports) of ecologically unequal exchange in this study of carbon dioxide emissions.

Table 1. Top 10 Cocoa Bean Exporting Countries in 2009 by Export Value

Rank	Country	Export Value (1000 US$)
1	Cote d'Ivoire	2595897
2	Ghana	1090910
3	Indonesia	1087485
4	Nigeria	599000
5	Cameroon	540281
6	Ecuador	334925
7	Togo	285480
8	Dominican Republic	154716
9	Malaysia	37026
10	Uganda	27829

Table 2. Top 20 Chocolate Consuming Countries in 2014

Rank	Country	Lbs. / per capita
1	Switzerland	19.8
2	Germany	17.4
3	Austria	17.2
4	Ireland	16.5
5	UK	16.5
6	Norway	14.6
7	Estonia	13.2
8	Slovakia	11.9
9	Sweden	11.9
10	Kazakhstan	11.7
11	Russia	11.7
12	Finland	11.7
13	Belgium	11.5
14	Australia	10.8
15	Netherlands	10.4
16	New Zealand	9.9
17	USA	9.5
18	France	9.3
19	Denmark	9.3
20	Lithuania	9.3

Source: Confectionery News 2014

I extend this line of research by examining the impact of cocoa export concentration on deforestation. This measure is appropriate as cocoa is almost exclusively grown in less-developed countries and consumed in highly developed countries. Indeed, Table 1 indicates that the major countries growing and exporting cocoa beans are located in peripheral areas of West Africa and Central, South America, and South-East Asia. In comparison, Table 2 depicts where chocolate is consumed, and indicates that the largest consumers are those mainly located in the countries of Western Europe such as Switzerland, Germany, Austria, Ireland, and the United Kingdom.

Hypotheses

My study builds on previous empirical analyses and examines whether specialization in the export of cocoa leads to heightened deforestation in cocoa-producing nations. Two hypotheses are tested. The first hypothesis follows:

> *H1: Current specialization in cocoa exports leads to deforestation in developing nations, net of other relevant factors.*

As emphasized previously, many reports highlight the increased demand for chocolate over time and that demand is now at historically elevated levels (World Resources Institute 2015). Additionally, new production patterns, where farmers are increasingly mono-cropping cocoa trees as compared to traditional semi-shade cultivation, may be leading to additional demands on forests and appear to be a relatively recent phenomenon. Thus, I examine the intensity of the relationship between cocoa exports and deforestation in the period, 2009 to 2014, compared to the period, 1999 to 2004. Therefore, my second hypothesis is:

> *H2: Increased pressure on famers in recent years because of demand and altered cultivation patterns leads to more intense deforestation in the most recent period (from 2009 to 2014) as compared to an earlier time period (from 1999 to 2004), net of other relevant factors.*

Methods

This study examines the impact of cocoa exports on forest loss over two time periods: 1999 to 2004 and 2009 to 2014. The dependent variable, deforestation, is the change in forest cover during the specified five-year period, and the independent and control variables are measured at the beginning of each time period (i.e., 1999 or 2009). While there is a temporal aspect to cthe two analyses, each is technically cross-sectional.[3] These specific time periods are chosen for two reasons. First, by using the contemporary time period, I incorporate the most recently available data on forest stocks from 2014 and recent levels of cocoa exports. The examination of cocoa exports on deforestation from 1999 to 2004 allows for a time gap between the two analyses, facilitating a richer comparison. To ensure that my results were not driven by the time periods chosen, I investigated other time periods and found similar results.[4]

Samples

This study is based on two samples of less developed countries across the two different time frames. Two different (though highly overlapping) samples were used to maximize the number of cases in each sample.[5] Both samples include all countries for which there are available data on cocoa bean exports for the years 1999 and 2009. Results are based on a sample of 51 countries for 1999 to 2014 and 52 countries for 2009 to 2014. Samples of countries are displayed in Tables 3 and 4 below, along with the value of the key independent variable, export concentration in cocoa.

The source for all variables used in the analysis is the World Bank's *World Development Indicators* (WDI), unless otherwise noted. Table 5 displays the correlation matrix for the five-year deforestation period ending in 2004 and Table 6 displays the correlation matrix for the five-year deforestation period ending in 2014.

Dependent Variable: Deforestation

To capture the process of deforestation I used a change score calculated from FAO estimates of forest area from 1999 to 2004 and from 2009 to 2014. The forest stock variable is reported in square kilometers. To qualify as forest area, the land must be larger than .5 hectares and have trees at least 5 meters high and producing a canopy area of more than 10 percent of this area or at least have trees that can reach these standards. In addition, it is does not include land that is currently used for agriculture or urban use. Following Shandra (2007) the change scores were subsequently multiplied by -1 to reflect deforestation and aid in the interpretation of the regression results.

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[3] Longitudinal analyses are not preferable or possible for a few reasons. First, the quality of data on forest stocks have improved greatly over time, so researchers should be cautious in comparing across wide time frames using multiple measures of forest stock. Data on deforestation before 1990 should not be compared with more recent data (Shandra 2007). Thus, my analyses focus only on the most recent comparable data. Also, the sample size is inherently very small, as relatively few nations produce cocoa. In creating a longitudinal dataset, missing data on key controls would have further limited the sample size to unacceptable levels. Creating two analyses across two different time periods of a narrower time window lessens these limitations, but still adds the time dimension needed to examine if the pressures on forests from cocoa production are more applicable in recent years, as current reports suggests (e.g. Wessel and Quist-Wessel 2015).

[4] These are available from the author upon request.

[5] However, I also ran the analyses with one consistent sample that contained the same members and achieved consistent substantive results involving cocoa exports and deforestation. However, the sample size was greatly reduced; thus, I chose to retain the two samples in the final results presented here.

Previous studies of deforestation have examined change over 5-year (e.g. Austin 2010b) and 15-year periods (e.g. Jorgenson et al. 2010).

Table 3. Countries in the 200

Country	Export Concentration in Cocoa	Country	Export Concentration in Cocoa
Belize	0.04	Lebanon	0.01
Benin	0.03	Madagascar	1.53
Bolivia	0.07	Malaysia	0.41
Brazil	0.03	Mexico	0.09
Bulgaria	0.02	Moldova	0.01
Cameroon	27.03	Nicaragua	0.06
Colombia	0.01	Nigeria	58.05
Congo (Dem. Rep.)	6.70	Panama	0.16
Congo (Rep.)	1.47	Peru	0.10
Costa Rica	0.01	Philippines	0.01
Cote d'Ivoire	52.64	Russia	0.31
Cuba	0.07	Solomon Islands	12.89
Dominica	0.02	South Africa	0.00
Dominican Republic	3.78	St. Lucia	0.07
Ecuador	4.00	Swaziland	0.00
Egypt	0.01	Tanzania	0.98
El Salvador	0.00	Thailand	0.00
Fiji	0.06	Togo	6.00
Ghana	77.89	Tunisia	0.00
Grenada	5.87	Turkey	0.00
Guinea	6.79	Uganda	0.35
Honduras	0.07	Ukraine	0.00
India	0.00	Vanuatu	6.78
Indonesia	5.77	Venezuela	1.94
Jamaica	0.40	Zimbabwe	0.00
Kenya	0.00		

Table 4. Countries in the 2014 Sample

Country	Export Concentration in Cocoa	Country	Export Concentration in Cocoa
Belarus	0.00	Indonesia	5.12
Belize	0.03	Iran	0.00
Brazil	0.00	Kazakhstan	0.00
Bulgaria	0.00	Kenya	0.00
Cameroon	55.67	Lebanon	0.00
Central African Rep.	0.10	Madagascar	7.90
China	0.00	Malawi	0.00
Colombia	0.11	Malaysia	0.20
Congo (Dem. Rep.)	4.03	Mexico	0.00
Congo (Rep.)	0.22	Niger	0.00
Costa Rica	0.03	Nigeria	60.44
Cote d'Ivoire	50.89	Pakistan	0.00
Cuba	0.07	Panama	0.48
Dominica	0.03	Peru	0.83
Dominican Republic	15.18	Philippines	0.02
Ecuador	8.76	Sao Tome & Principe	91.05
Egypt	0.00	South Africa	0.00
El Salvador	0.00	Tanzania	2.44
Equatorial Guinea	94.83	Thailand	0.00
Fiji	0.00	Timor-Leste	0.19
Ghana	77.14	Togo	76.47
Grenada	37.42	Tunisia	0.17
Guatemala	0.00	Turkey	0.03
Guinea	4.38	Uganda	3.59
Honduras	0.02	Ukraine	0.00
India	0.01	Venezuela	12.48

I examined change over a shorter period of time due to the increase in reports in the most recent time frame indicating increases in cocoa demand and changes in cultivation practices to more mono-cropping techniques rather than semi-shade cultivation especially in the first decade of the 21st century (e.g. Wessel and Quist-Wessel 2015).

Table 5. Correlation Matrix, Means, and Standard Deviations for 5-Year Deforestation Ending 2004

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	Deforestation (1999-2004)	1								
(2)	Export Concentration Cocoa in 1999	0.162	1							
(3)	Percent of Land Area Forests in 1999	0.263	-0.035	1						
(4)	GDP per capita in 1999	-0.209	-0.289	0.092	1					
(5)	Primary Schooling in 1999	0.066	-0.304	-0.082	0.448	1				
(6)	Liberal Democracy in 1999	0.052	-0.161	0.129	0.316	0.341	1			
(7)	Agriculture (% of GDP in 1999)	0.282	0.428	-0.013	-0.712	-0.403	-0.192	1		
(8)	Rural Population Change 1999-2004	0.266	0.141	-0.068	-0.326	-0.285	-0.155	0.548	1	
(9)	Population Change 1999-2004	0.308	0.239	0.078	-0.164	-0.192	-0.206	0.469	0.798	1
	Mean	0.801	5.54	38.285	1883.811	102.355	68.639	18.171	3.776	0.085
	S.D.	6.298	15.375	20.722	1509.189	20.279	28.223	11.218	6.323	0.059

Table 6. Correlation Matrix, Means, and Standard Deviations for 5-Year Deforestation Ending 2014

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	Deforestation (2009-2014)	1							
(2)	Export Concentration Cocoa in 2009	0.334	1						
(3)	Percent of Land Area Forests in 2009	-0.141	0.089	1					
(4)	GDP per capita in 2009	-0.244	0.111	0.248	1				
(5)	Primary Schooling in 2009	0.07	-0.125	0.14	-0.133	1			
(6)	Liberal Democracy in 2009	-0.016	-0.066	0.398	0.093	0.302	1		
(7)	Agriculture (% of GDP in 2009)	0.431	0.171	-0.229	-0.669	-0.152	-0.189	1	
(8)	Rural Population Change 2009-2014	0.333	0.159	-0.168	-0.201	-0.133	-0.13	0.464	1
(9)	Population Change 2009-2014	0.324	0.22	-0.122	-0.193	-0.122	-0.124	0.446	0.808
	Mean	1.825	11.737	34.66	4027.674	106.681	63.608	15.375	3.352
	S.D.	7.61	25.54	20.992	3764.6	14.969	23.503	11.547	8.246

Key Independent Variable: Export Concentration in Cocoa

To capture the extent to which a country is dependent on the export of cocoa beans, I calculated the export concentration by using data for two variables. The first is the value of cocoa bean exports obtained from the FAOSTAT database. While the FAOSTAT database contains data on several cocoa products such as beans, butter, powder, and paste, this paper focuses on the export of cocoa beans as they are the primary source of chocolate, and as the values for export of cocoa butter, powder, and paste were very low, if a nation exported these at all.[6] The export value of cocoa beans were then divided by the total export value for all agricultural products in a country in the given year and multiplied by 100 to calculate the percent of total agricultural export dollars that are from cocoa beans or the export concentration in cocoa. The total agricultural export value was obtained from the World Bank's *WDI* databank and both of these variables were measured in thousands of current U.S. dollars. This variable was created for 1999 to predict deforestation from 1999 to 2004 and created for 2009 to predict deforestation from 2009 to 2014. [7]

Control Variables

Forest Stock. It is important to control for forest stock when undertaking analyses of deforestation. It is possible that the rate of deforestation could be influenced by whether a nation has a relative high amount or low amount of forest available to be deforested (e.g., Austin 2010b; Jorgenson 2008; Rudel 1989). Thus, the amount of forest area in a country as a percent of all land was included as a measure of forest stock.

Control Variable: GDP per capita. According to the ecologically unequal exchange perspective, countries with higher levels of GDP per capita are likely to experience lower levels of resource degradation within their borders, as they are able to export the negative environmental consequences of their consumption to poorer countries. Thus, GDP per capita was expected to have a negative effect on deforestation.[8]

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[6] To illustrate that my results were not influenced by analyzing data only on cocoa beans are the re-analyzed the final models for both time periods creating a new variable export concentration in all cocoa products and the results were consistent with my original models with export concentration in cocoa beans.

[7] When examining the data, it was clear that there were some countries that had missing values for these specific years, but reported cocoa exports for neighboring years, suggesting issues of data availability. In these cases, I averaged the three preceding and three subsequent years to fill in these idiosyncratic missing values. In practice, it was a very small handful of countries in which this was an issue (~5). I also tested the analyses only with the data available for the specific years used in the analyses, and achieved consistent results.

[8] I also examined whether or not the concentration of wealth as measured by the Gini had an impact on deforestation. The variable was non-significant and also did not change the substantive conclusions of the analysis. In addition, due to missing data on the Gini variable, the sample size was further reduced to 45 nations and thus was omitted from the final analysis.

Education. To measure the extent to which education may impact deforestation I used gross enrollment ratios of primary schooling. Schooling can impact deforestation in two ways. As education expands, so does knowledge of the environment as well as the harmful effects of deforestation. In addition, it is likely that with increased schooling there are fewer people working the land and adding to the pressure to deforest the land.[9]

Liberal Democracy. Previous studies have suggested that counties with higher levels of liberal democracy are more likely to have increased environmental protection due to higher levels of environmental activism and the increased accountability of leaders (Shandra 2007; Shandra et al. 2009b). The measure of liberal democracy used here is Bollen's recently updated Liberal Democracy Series I Indicator. This is a continuous variable that ranges from 0 to 100 and has been shown to be superior to alternative indicators such as the Polity or Freedom House's combined political rights and civil liberties index because it controls for measurement error (Noble 2016).[10]

Agriculture as a Percent of GDP. It is also important to control for other forms of agricultural production in order to demonstrate that concentration in cocoa exports has a unique effect on deforestation, even when considering the impact of all other agricultural products. If there is evidence that concentration in cocoa exports impacts deforestation while controlling for all types of agricultural production (domestic production as well as export production), then this would demonstrate the exceptional effect of cocoa on deforestation, even when taking into account the cultivation of other agricultural commodities.[11]

Rural Population Growth. Rural encroachment has been theorized to lead to greater environmental degradation (e.g., Rudel 1989). Migrants from urban areas typically are typically poor, unskilled, and lack the education of their urban counterparts. Thus, they are more likely to depend on the land for survival and this may increase prospects for environmental degradation. Rural population growth is included as an additional control variable. Growing rural populations within a country often place additional pressures on forests that can lead to deforestation (e.g., Austin 2010b; Jorgenson and Burns 2007; Rudel 1989). Rural population growth was calculated from 1994-1999 in the first set of analyses, and from 2004-2009 in the second set of analyses.

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[9] Analyses were based on primary education because data for gross enrollment in secondary education were limited and would have led fewer cases. However, the main findings regarding cocoa exports on deforestation did not change when additional tests using the secondary schooling enrollment data were used. I prefer to use primary education in the final models to maximize the sample size.

[10] The analyses were also tested using a democracy measure from Freedom House and achieved consistent results with those presented here.

[11] Another control for agricultural exports was created which subtracted cocoa exports from total agricultural exports, then divided this by GDP. This measure therefore controlled for specialization in non-cocoa agricultural exports. This measure was not significant and did not impact the substantive findings reported here. I chose to use the agriculture as percent of GDP in the final models displayed here to also capture the potential influence of domestic production of food items.

Total Population Growth. Total population change was included as a control for each of the five-year periods under investigation. Previous studies have shown that population change overall can cause environmental degradation, including deforestation (e.g., Burns et al. 2003; Jorgenson 2008; Jorgenson and Burns 2007; Rudel and Roper 1997). Those nations with more rapid population growth were expected to have higher levels of deforestation. Total population growth was calculated from 1994-1999 in the first set of analyses, and from 2004-2009 in the second set of analyses.

Results

Four models were estimated using OLS regression techniques in Stata.[12] These models consisted of a baseline model (Model 1) that included the key independent variable, export concentration in cocoa, and two important control variables, the percent of forested land area and GDP per capita. Model 2 is based on the introduction of social variables, specifically educational enrollment and the level of liberal democracy. Model 3 included the variable agriculture as a percent of GDP to account for other forms of agricultural production. Model 4 included the previously mentioned variables and variables accounting for population dynamics.[13] I built the models in this step-wise fashion to help alleviate concerns of multicollinearity. The VIFs indicated that multicollinearity is not a major limitation in the present analyses.

Cocoa Exports and Deforestation from 1999 to 2004

The results of the regressions predicting deforestation from 1999 to 2004 are displayed in Table 7 and demonstrate that few variables included in the analyses appear to have a significant impact on the deforestation during this period. Models 1-4 show that the percent of land area that is forested has a positive and statistically significant influence on deforestation across all four models in this analysis at the 0.05 level. The positive effect can be interpreted as countries with higher levels of forested land area had higher levels of deforestation from 1999 to 2004. The size of the effect is relatively consistent across all four models.

[12] In addition to the standard OLS regression, I also examined the STIRPAT (Stochastic Impacts by Regression on Population, Affluence, and Technology) formulation of my model in which the logged version of all variables is used. STIRPAT is a reformulation of IPAT and posits that the effects of predictors are multiplicative and has been recommended by previous researchers. See York, Rosa, and Dietz (2003) for more information. In the present analysis, I found that the logged version of all predictors did not change the substantive results in a significant manner. It did, however, introduce multicollinearity into the model as evidenced by inflated VIFs for several of the predictors. Thus, I retained use of more traditional OLS regression analyses in the final models presented here.

[13] In addition to the control variables noted, I also tested for the influence of a number of other measures, including urban population growth, debt and debt service, GDP growth, regional dummy variables for Latin America, Sub-Sharan Africa, and SE Asia, as well as interactions between these regions and cocoa exports. None of these were significant in predicting deforestation, and none of these impacted the results surrounding cocoa exports and deforestation. For the sake of parsimony, results of these alternative models are not presented here, and I only focus on the measured featured most prominently in prior unequal exchange and deforestation research (e.g. Austin 2010a, 2010b).

There is some evidence that GDP per capita in 2009 has a negative and significant effect on deforestation from 1999-2004, however this effect was not consistent across all models. Somewhat surprisingly, the results in Table 7 also reveal that primary schooling has a positive impact on deforestation. This suggests that countries with higher levels of pupils enrolled in primary school experienced higher levels of deforestation from 1999 to 2004. These latter results run counter to what was expected.

Most importantly, the results displayed in Table 7 suggest that specialization in cocoa exports did not have a negative impact on forests during 1999-2004. In other words, no significant association between cocoa exports and deforestation is evidenced from 1999-2004, net of other factors.

Cocoa Exports and Deforestation from 2009 to 2014

The second set of OLS regression estimates are for the period 2009 to 2014 and displayed in Table 8. A key finding of these analyses is that export concentration in cocoa has a positive and statistically significant effect on deforestation across all models. Overall, the relationship between cocoa exports and deforestation from 2009 to 2014 is quite robust, although slightly attenuated with the inclusion of control variables in Models 3 and 4. These findings indicate that export concentration in cocoa has a unique and significant positive effect on deforestation, even after controlling for other factors, including other forms of agricultural production. The size of the effect of cocoa export specialization on deforestation is 0.084 in the final model, Model 4, meaning that for each additional percent increase in agricultural exports accounted for by cocoa, there is on average a 0.084 percent increase in the deforestation rate.

In addition to the robust impacts of specialization in cocoa exports, the results in Table 8 also demonstrate that agriculture as a percent of GDP also has a positive and statistically significant effect on deforestation (as displayed in Models 3 and 4). These findings are consistent with world-systems theory and specifically the concept of ecologically unequal exchange. Somewhat surprising is the result that the percent of land area forested is no longer a significant predictor of deforestation in the most recent time period as it was in the earlier period. One could speculate that the size of the forested area in a country no longer matters in terms of whether it uses these forests for economic development. The pressure to reap forest resources may be intensified, regardless of the size of forest stocks.

Table 7. OLS Regression Predicting Deforestation (1999-2004)

	Model 1	Model 2	Model 3	Model 4
Export Concentration Cocoa in 1999	0.047	0.070	0.047	0.054
	(0.058)	(0.058)	(0.061)	(0.063)
	[0.114]	[0.170]	[0.115]	[0.131]
Percent of Land Area Forests in 1999	0.087*	0.096*	0.093*	0.092*
	(0.041)	(0.042)	(0.041)	(0.043)
	[0.285]	[0.315]	[0.305]	[0.304]
GDP per capita in 1999	-0.001	-0.001*	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
	[-0.203]	[-0.327]	[-0.177]	[-0.273]
Primary Schooling in 1999		0.085^{+}	0.089^{+}	0.095^{+}
		(0.049)	(0.049)	(0.050)
		[0.273]	[0.288]	[0.307]
Liberal Democracy in 1999		0.011	0.008	0.017
		(0.033)	(0.033)	(0.034)
		[0.050]	[0.035]	[0.076]
Agriculture (% of GDP in 1999)			0.131	0.013
			(0.114)	(0.131)
			[0.234]	[0.023]
Rural Population Change 1999-2004				0.133
				(0.251)
				[0.134]
Population Change 1999-2004				17.688
				(26.546)
				[0.165]
Constant	-1.184	-10.113	-13.680*	-14.034*
	(2.119)	(5.174)	(6.011)	(5.944)
N	51	51	51	51
R^2	0.136	0.199	0.223	0.275

Notes: Coefficients flagged as follows *** $p < .001$, ** $p < .01$, * $p < .05$, $^{+}$ $p < .10$ (two-tailed tests); Standard errors in Parentheses; Standardized Coefficients in Brackets

The results in Table 8 also illustrate that GDP per capita has a negative and statistically significant effect on deforestation from 2009 to 2014 in some of the models, similar to the findings from the earlier time period in Table 7.

When it comes to evaluating the two hypotheses stated above, I find partial evidence for Hypothesis 1 stating that specialization in cocoa production leads to deforestation in poor nations.

Table 8. OLS Regression Predicting Deforestation (2009-2014)

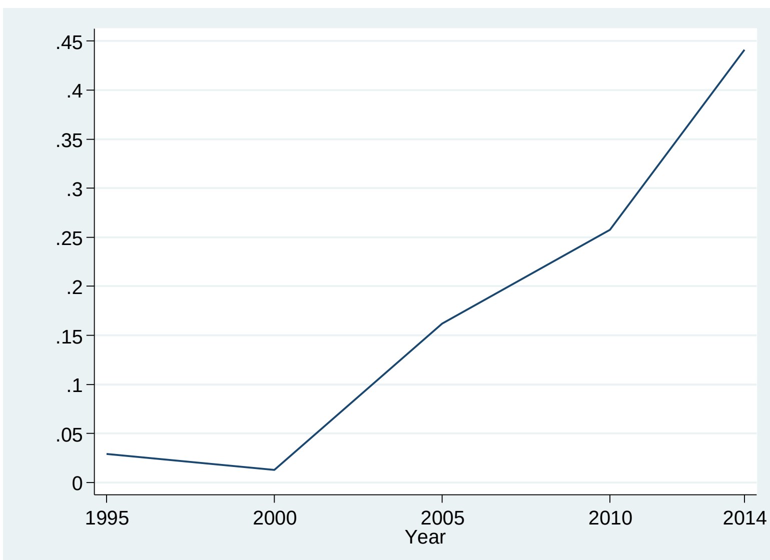
	Model 1	Model 2	Model 3	Model 4
Export Concentration Cocoa in 2009	0.111**	0.116**	0.087*	0.084*
	(0.039)	(0.040)	(0.040)	(0.041)
	[0.372]	[0.390]	[0.292]	[0.282]
Percent of Land Area Forests in 2009	-0.040	-0.056	-0.051	-0.047
	(0.048)	(0.053)	(0.051)	(0.052)
	[-0.110]	[-0.154]	[-0.141]	[-0.129]
GDP per capita in 2009	-0.001+	-0.000+	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
	[-0.258]	[-0.243]	[0.066]	[0.038]
Primary Schooling in 2009		0.045	0.090	0.090
		(0.071)	(0.071)	(0.071)
		[0.088]	[0.176]	[0.176]
Liberal Democracy in 2009		0.022	0.027	0.027
		(0.048)	(0.046)	(0.047)
		[0.067]	[0.082]	[0.083]
Agriculture (% of GDP in 2009)			0.287*	0.232+
			(0.124)	(0.137)
			[0.435]	[0.352]
Rural Population Change 2009-2014				0.108
				(0.203)
				[0.117]
Population Change 2009-2014				4.018
				(25.391)
				[0.035]
Constant	4.006	-1.757	-13.609	-13.428
	(2.019)	(7.527)	(8.823)	(9.076)
N	52	52	52	52
R^2	0.202	0.216	0.300	0.316

Notes: Coefficients flagged as follows *** p < .001, ** p < .01, * p < .05, + p < .10 (two-tailed tests); Standard errors in Parentheses; Standardized Coefficients in Brackets

This hypothesis was validated in the models for the contemporary time period, but not in the earlier one. This evidence suggests that there is nothing inherent in the specialization of cocoa production that leads to deforestation. Rather, the confirmation of Hypothesis 2, that the impacts of cocoa exports on deforestation have become more robust in recent time periods, likely illustrates that increased pressures on farmers to expand cultivation sites and engage in unsustainable growing practices contributes the most to deforestation.

To further examine how the impacts of cocoa production on deforestation have changed over time, I calculated the bivariate correlation for cocoa export concentration and deforestation for the intervening years of the analyses. These results are displayed in Figure 1 below. The results presented in Figure 1 provide compelling evidence that the effects of cocoa exports on deforestation have greatly changed over time, with a large upswing in the correlation between cocoa exports and deforestation in the 2000s. In particular, the correlation between cocoa export concentration and deforestation prior to 2000 is near 0, but by 2014, the correlation has increased to nearly .45. This provides further evidence of the recent detrimental impact of cocoa exports on deforestation that was not present in earlier time periods.[14] This finding is consistent with evidence presented in Wessel and Quist-Wessel (2015) as well as policy and media reports (allAfrica 2016; Bloomberg 2014; World Resources Institute 2015) indicating large increases in cocoa production in West African countries as well as other nations in the first decade of the 21st century and that the increase in production is generated by felling new forests.

Figure 1. Deforestation and Cocoa Export Dependency Correlation 1995-2014



[14] My argument may be furthered strengthened if I could demonstrate that the size of the average cocoa farm has increased over time. Yet, I also argue that the current pressures and challenges on small and large farmers alike may not be dependent on farm size. However, specific data on the average size of cocoa farms by country does not exist and thus cannot be incorporated into this analysis.

Conclusion

Taken together, the results of this study point to an important and newly emerging relationship between cocoa export concentration and deforestation. In particular, I find that cocoa export concentration is not important in predicting deforestation in earlier time periods. However, regression results predicting deforestation from 2009 to 2014, as well as the correlational results in Figure 1, demonstrate that cocoa exports are a significant cause of deforestation in most recent years, net of other factors. Thus, specialization in cocoa is a form of ecologically unequal exchange, where the environmental costs of chocolate consumption are placed on more peripheral nations where cocoa is produced and exported. Overall, the higher the concentration of cocoa exports in 2009, the more elevated the rates of deforestation from 2009 to 2014 across producing nations.

The findings in Table 8 show that the impact of cocoa specialization on deforestation is robust, even when taking into account the production of other agricultural commodities. This analysis did not set out to explain all causes of deforestation in cocoa exporting countries, nor is it making the claim that cocoa is the only driver of deforestation in these countries. Rather, the results from this study demonstrate that cocoa has unique and detrimental impacts on forests in developing nations, net of other forms of agricultural cultivation, in recent years. While the main finding surrounding cocoa export concentration and deforestation from 2009-2014 confirms the propositions of world-systems theory and ecologically unequal exchange, specifically, some of the other findings reflect this perspective as well. For example, the positive association between agriculture as a percent of GDP and deforestation for 2009-2014 also confirms the basic tenants of ecologically unequal exchange more generally. Additionally, some of the models across Tables 7 and 8 show a negative association between GDP per capita and deforestation, where nations with higher levels of economic development tended to have lower levels of forest loss.

Although the direct causal mechanisms cannot be accounted for in cross-national analyses, the findings presented here regarding the increased role of cocoa exports in damaging forests in more recent years fit with current reports that document heightened demand for cocoa globally by any means necessary, as well as increased use of more harmful mono-cropping techniques (e.g. Bloomberg 2014; Wessel and Quist-Wessel 2015; World Resources Institute 2015). Certainly, more case study and qualitative research is needed to fully parcel out these mechanisms and how strategies in cultivating or establishing cocoa plantations have changed in recent years, which present a potential avenue for future research.

Based on current consumption patterns that point to increasing demand in rapidly developing nations like China and India, this situation is likely to worsen over time. Indeed, as mentioned previously, many chocolate company executives are looking to rising Asian nations as untapped markets for chocolate and places of enormous future growth (Reuters 2015). As demand in the two most populous countries in the world increases, this will no doubt place significant additional strains on cocoa farmers to expand cultivation sites. The problems associated with deforestation are well documented and include a loss of biodiversity, climate change, increased soil erosion, and rifts in the water cycle. In these ways, deforestation resulting from cocoa production is likely to have further negative impacts on other aspects of the environment and local ecology.

This research focuses on one environmental problem associated with the concentration of cocoa exports, deforestation. While deforestation is a significant environmental threat, other externalities are associated with cocoa production. In recent years, social issues such as the use of child labor and even child slaves on cocoa plantations have been uncovered and highly publicized in world media reports, including a documentary film, *Slavery: A Global Investigation* (BBC 2000). These reports have led governments to act; in the U.S. there was a congressional action in the form of the Harkin-Engle Protocol which demands that companies comply with International Labor Organization's Convention 182. This was only a voluntary agreement, but it was signed by most of the largest chocolate companies. While the industry is working to guarantee that child labor and child slaves are not used in the cultivation or harvest of cocoa beans, there is still evidence of this practice. Another documentary film, *The Dark Side of Chocolate*, released in March 2010, claimed the practice was still taking place almost 10 years later. A recent report published in 2015 documented an increase over the prior five years in the use of child labor in Côte d'Ivoire and Ghana (Tulane University 2015).

While there has been an increase in fair trade cocoa production, which ensures safer environmental and social practices and better economic returns to growers, the International Cocoa Organization (ICCO), reports that in 2015 only 0.5% of chocolate on the market is designated as fair trade (ICCO 2016). Considering the detrimental environmental and social consequences in poor nations involved in the cocoa industry, this statistic is staggering and indicates that more work is needed to ensure safer and more sustainable forms of production. In addition, in response to deforestation trends related to cocoa production, in some nations, such as Côte d'Ivoire, governments have chosen to eject small farmers from areas around protected forests in attempts to stem forest loss (allAfrica 2016). While this could bring some immediate relief to forests, the basic rights of indigenous people to the land are overlooked with these types of policies. In general, victimizing poor, smallholding farmers who are influenced by larger structural trends inherent in the capitalist world economy to undertake unsustainable growing practices, does nothing to address the roots of these environmental problems.

The main limitation of this study, and much of the other cross-national research using an unequal exchange framework, is that only restricted aspects of these processes can be examined here. While increased demand coming from Western Europe, North America, and the rapidly growing middle-class in Asian countries such as China and India that put the pressure on farmers to engage in unsustainable and environmentally deleterious practices, including deforestation, this demand is not captured in the empirical model. I make a compelling case that chocolate trade is an example of ecologically unequal exchange as it has grown almost exclusively in low-income countries and consumed mainly in high-income countries, and the unequal exchange framework is based on the exchange of low-value, environmentally damaging products for high-value products and services. However, both sides of this dynamic are not included in the empirical model in this study, nor in much of the research in this tradition. Measuring demand as well as both parts of the exchange inherent in unequal exchanges is important and future work on unequal exchange should aspire to do this.

An additional limitation of this study is that the social or additional environmental consequences of cocoa production are left unexamined. While this analysis is limited to deforestation, there are other important adverse social and environmental consequences of cocoa cultivation and monocropping, as discussed previously. Future research could also build on the work presented here to empirically examine the other potential harmful impacts of specialization in cocoa production across developing nations engaged in cocoa cultivation.

To adequately make real headway on deforestation and likely other environmental and social problems associated with cocoa production, we must propose solutions that address the underlying inequalities within the world-system. Although nations may be encouraged to cultivate cocoa due to increased demand in global markets for chocolate, it is clear that this form of specialization has had important costs on forests in recent years. As export concentration in cocoa is leading to heightened rates of forest loss in poor nations, it is not likely that this will spur successful development, but in fact, environmental decline of a nation's most vital resource may only lead to longer-term trends of underdevelopment. In these ways, ecologically unequal exchange in cocoa is not a viable development strategy. Mechanisms of unequal exchange continue to underpin inequalities between the Global North and the Global South, and chocolate represents a key luxury product in affluent nations that contributes to patterns of underdevelopment in poor nations.

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