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LAUDATO SI' AND THE PAPAL VIEW OF ECOLOGICAL DEBT AN EMPIRICAL EXPLORATION¹

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Abstract. In 2015, Pope Francis released his second papal encyclical, *Laudato Si': On Care for Our Common Home* (Francis, 2015), the central idea of which is the Holy Father's concern for the future of our planet, our common home, and to seek sustainable and integral development. The purpose of this article is to examine critically and empirically the specific notion of ecological debt as described in the encyclical (Francis, 2015: 51 and 52), beginning with a historical background on the origins and use of the term. We then touch upon the Pope's discussion of ecological debt and his indictment of multinational corporations (MNCs) in *Laudato Si'*, which resonate with the so-called pollution haven hypothesis (PHH) which states that pollution-intensive industries in developed countries relocate their "dirty" industries to developing countries with relatively lax environmental regulations. In a similar vein, we propose that a rise in total greenhouse gases is associated with the resource extraction and commodity export-based activities of MNCs in developing countries where such activities and their resultant pollution are subject to less stringent regulations due to imperatives for economic growth. This creates an ecological debt when commodity exports from developing countries to more developed ones come at the cost of the environment in the former. Our article thus connects *Laudato Si'* with PHH, enabling us to examine empirically the Pope's statement that the "export of raw materials to satisfy markets in the industrialized North has caused harm locally" (Francis, 2015: 51).

Keywords: ecological debt; developing country commodity exports; pollution havens

1. INTRODUCTION

The central idea in *Laudato Si'* is Pope Francis's concern for the future of our planet and his moral appeal to "every person living on [it]" to engage in an inclusive dialog on sustainable and integral development. In paragraph 51, Francis introduces the idea of ecological debt and states that "a true ecological debt" exists between the global North and South. In his view, over-consumption on the part of the global North has led to a disproportionate use of natural resources extracted from the global South, resulting in local environmental damage for the latter. The debt thus arises when raw materials are exported from poor nations (South) to rich nations (North) to satisfy the latter's appetites.

Francis also draws attention to the operations of multinational corporations (MNCs) in poor countries, asserting that such companies

operate in ways that “they would never do at home” (Francis, 2015: 51). He notes that the pollution produced by MNCs in less developed countries (LDCs) results in great human and environmental liabilities such as unemployment, abandoned towns, the depletion of natural reserves, deforestation, and the impoverishment of agriculture and local stock breeding, among others (Francis, 2015: 51). These indictments of the nature of globalization form the foundation of what the Pope defines as “ecological debt”—a phenomenon where the global South continues to fuel the development of the global North at its own peril (Francis, 2015: 52).

In this article, we examine the arguments inherent in paragraph 51 of *Laudato Si'* in an empirical framework. First, we provide a historical perspective on the notion of ecological debt as enunciated in the encyclical. Second, we explore the Pope’s indictment of MNCs via an examination of the pollution haven hypothesis (PHH), which suggests that pollution-intensive industries in developed countries relocate their “dirty” operations to developing countries with relatively lax environmental regulations (Dinda, 2004). For our empirical analysis, we will emend the standard arguments of the PHH.

We propose that MNC activities related to natural resource extraction and commodity export production in developing countries are positively associated with pollution as measured by greenhouse gas levels. Furthermore, such activities and resultant pollution are subject to less stringent regulations due to the imperatives of economic growth in these LDCs. In other words, an ecological debt is created when commodity exports from developing countries to more developed ones come at the cost of the environment in the former. Our article thus connects *Laudato Si'* with the PHH, thereby enabling us to examine empirically Francis’s statement that the “export of raw materials to satisfy markets in the industrialized North has caused harm locally” (Francis, 2015: 51).

In the second section that follows, we trace the evolution and usage of the term “ecological debt” from the mid-1980s to Francis’s references in *Laudato Si'*. Section 3 outlines some issues in the estimation of ecological debt and motivates our empirical analysis. Section 4 discusses the pollution haven hypothesis (PHH) and derives two testable hypotheses that link the export production activities of MNCs to pollution in developing economies. Section 5 details our methodology and Section 6 presents our econometric results. Finally, Section 7 concludes with a discussion of the results, limitations of the study, and future research directions.

2. ECOLOGICAL DEBT: A HISTORICAL PERSPECTIVE

Prior to its reference in *Laudato Si'*, the notion of “ecological debt” was understood and used by grassroots and non-governmental organizations (NGOs) as an activist term that focused on the lack of political power of poor regions and countries. Literature documents the first use of the term at a 1985 World Conference on Women held in Nairobi. As reported by Warlenius et al. (2015), an eco-feminist named Eva Quiristop articulated the concept of ecological debt in the following manner:

The debts we are paying are numerous: ecological debts, caused by the plundering, pollution, and irreversible destruction of our natural resources and making it ever more difficult for women to secure the existential basis for their lives and those of their children. (Warlenius et al., 2015: 8)

The term was subsequently discussed at a 1992 United Nations Conference on Environment and Development held in Rio de Janeiro. Conference participants formulated a so-called Debt Treaty that acknowledged the existence of a planetary ecological debt owing to the actions of the global North in exploiting the resources of the global South. The treaty maintained that developed countries owed a debt to the less developed ones in light of resource over-utilization and resultant environmental damage, and demanded the establishment of a system to quantify the cumulative debt of the developed countries over the course of the last five hundred years.

In 1999, the term “ecological debt” grew in prominence through the activities of an Ecuadorian NGO, Acción Ecológica (AE), which defined ecological debt as “the responsibility that the industrialized countries have for the gradual destruction of the planet caused by their production and consumption patterns” (Paredis, Goeminne, Vanhove, Maes, & Lambrecht, 2008: 6). The following year, AE partnered with Friends of the Earth International (FoEI) to launch a campaign to understand ecological debt. AE and FOEI organized a network of NGOs and founded the Southern People’s Ecological Debt Creditors Alliance (SPEDCA), the aim of which was to push for an international recognition of ecological debt.

By 2005, several NGO networks in Latin America and Europe began to adopt the language of ecological debt as their main campaign theme. In 2008, five Latin American countries—Argentina, Bolivia, Ecuador, El Salvador, and Nicaragua—mentioned ecological debt in their public address to the U.N. Commission on Sustainable Development and raised calls for its valuation. In the same year, the Centre for Sustainable

Development (CSD) at Ghent University proposed a working definition of ecological debt, defining it as

1. the ecological damage caused over time by a country, through its production and consumption patterns, in other countries;
2. the ecological damage caused over time by a country, through its production and consumption patterns, in ecosystems beyond its natural jurisdiction; and
3. the exploitation or use of ecosystems (and their goods and services) over time by a country at the expense of the equitable rights of other countries to these ecosystems (Paredis et al., 2008: 145).

Francis's direct reference to ecological debt in *Laudato Si'* has since reinvigorated discussion of the term. In paragraph 51, Francis acknowledges a "true ecological debt" between the global North and South that stems from harmful environmental impacts of global trade and the disproportionate use of renewable and non-renewable natural resources by developed countries over long periods of time. The Pope's call for a recognition of ecological debt was also echoed at the Paris climate talks in December 2015, where many developing countries asked for an acknowledgement of ecological debt as well as a climate finance plan to deal with it.²

3. ESTIMATING ECOLOGICAL DEBT

It has always been easier to define rather than operationalize ecological debt. This section summarizes some studies that attempt to estimate it. Paredis et al. (2008) identifies two main methods: the first is an *ecological damage*-based approach that looks at specific indicators of ecological damage such as deforestation and overfishing, and the second is based on an *ecological deficit* approach that employs an ecological footprint framework. This latter estimates the over-usage of a

²French Prime Minister Francois Hollande explicitly acknowledged that "there is an ecological debt that the world needs to pay back to Africa" as he convened a special session focusing on climate finance on the continent. At the talks, Hollande promised to provide €2 billion in sustainable energy investment for the African continent as a move toward debt repayment (<https://europeansting.com/2015/12/02/there-is-an-ecological-debt-that-the-world-needs-to-pay-back-to-africa-french-president-francois-hollande-promises-2-bn-euros-from-cop21-in-paris/>).

resource relative to locally available capacity. Both approaches have been employed by environmental economists.

Srinivasan et al. (2008) employ an ecological damage lens to estimate ecological debt. Their analysis is based on a Net Present Value (NPV) methodology as they estimate the environmental costs of human activities from 1961 to 2000 across six major categories (climate change, stratospheric ozone depletion, agricultural intensification and expansion, deforestation, overfishing, and mangrove conservation) for poor, middle income, and rich countries. The researchers found that climate change and ozone depletion impacts upon developing countries are significantly driven by middle income and rich countries.

Torras (2003) calculates ecological debt using the ecological deficit approach discussed above. His estimates and assumptions are based on the Living Planet Report (Loh, 2000) and work done by Costanza et al. (1998). He calculates ecological deficits for developed countries and ecological surpluses for less developed countries and assigns monetary values to his estimates (in dollars). He also focuses on total exports from developing countries (LDCs) as these exports represent an ever-increasing transfer of bio-capacity from LDCs to support consumption in developed countries (Torras, 2003).

Paredis et al. (2008) propose an alternate and simpler methodology to estimate carbon (ecological) debt that relies on calculating a country's cumulative carbon emissions over and above a sustainable emission level relative to the country's population. Warlenius et al. (2015) propose an estimate based on the gross accumulated greenhouse gas emissions of a country as compared to a globally sustainable level of total emissions (adjusted for population).

While the above methodologies do provide a helpful framework in which to monetize ecological debt, major data deficiencies hinder them as adequate measures of such. Indeed, several academics have critiqued efforts and related methodologies for quantifying ecological debt. Rice (2009), for instance, notes that there is no consensus or a universal method for calculating ecological debt.

One deficiency of the studies on ecological debt mentioned above is that they ignore the linkages between exports, FDI by MNCs, and total greenhouse gas emissions. Our analysis attempts to address this deficiency by empirically examining ecological debt from the perspective of an (emended) PHH. In resonance with the arguments made in *Laudato Si'*, we propose that the commodity export production undertaken by MNCs in developing countries to satisfy demand in developed countries is

positively associated with pollution. In the sections that follow, our analysis will be motivated by reviews of literature relevant to the PHH. We will also rely on the working definition of ecological debt provided by the Centre for Sustainable Development, particularly on the point that ecological debt is the amount of ecological damage caused over time by a country, through its production and consumption patterns, in ecosystems beyond its natural jurisdiction.

4. MNCS AND THE POLLUTION HAVEN HYPOTHESIS (PHH)

A rich vein of empirical literature supports the operations of the PHH (Dinda, 2004), which posits that companies, when faced with stricter environmental regulations or higher costs associated with pollution control at home, simply relocate manufacturing to locations with less stringent regulations or lower costs associated with pollution control. For instance, Eskeland and Harrison (2003) examined the pattern of U.S. foreign investment in Mexico, Venezuela, Morocco, and Côte d'Ivoire and found some evidence to indicate that such investments are skewed toward sectors with high pollution abatement costs. Cole, Elliott, and Okubo (2010) examined industry-level data for Japan and observed, after accounting for geographic immobility of an industry, that pollution haven effects are stronger and more discernible when trade in industries with the greatest environmental costs occurs with developing countries.

Foreign direct investment (FDI) undertaken by MNCs is an important variable related to the PHH. Weak environmental regulation in less developed host countries may attract FDI inflow from profit driven companies that want to avoid costly regulations in their home countries (Jensen, 1996). But while FDI inflows can promote economic growth, they might also have a negative impact on the environment (Xing & Kolstad, 2002; He, 2006), and can also contribute significantly to the host country's industrial output which in turn increases overall pollution (Zarsky, 1999).

That FDI inflows contribute to increased pollution and CO₂ emissions, especially in countries in middle and low stages of development, have been demonstrated by empirical studies (Grimes & Kentor, 2003; Hoffmann, Lee, Ramasamy, & Yeung, 2005). Such findings resonate with the Pope's statement on ecological debt as well as his indictment of MNCs in developing economies, and deserve further attention. In this regard, we propose two testable linkages—one that links FDI by MNCs to commodity exports from developing countries to high income countries, and another that links such commodity exports to greenhouse gas pollution.

4.1. FDI and commodity exports

Clausing (2000) investigates the operations of U.S. MNCs in 29 host (developing) countries from 1977 to 1994 and finds a strong positive influence of FDI on exports. Tang (2015) observes that export-oriented FDI is more sensitive to local environmental regulations than local market-oriented FDI. Liu, Burrridge, and Sinclair (2002) and Pacheco-López (2005) provide evidence suggestive of a bi-causality between exports and FDI. However, Dritsaki et al. (2004) document a unidirectional causality from FDI by MNCs to export growth. Similarly, Bhatt (2013) provides empirical evidence supporting a positive association between FDI and export growth for Vietnam. Xuan and Xing (2008) also provide empirical evidence linking FDI as one of the major factors driving the rapid export growth of Vietnam. Liu, Wang, and Wei (2001) studied China's aggregate trade and FDI relationships with individual partner countries. Causality tests reveal that inward FDI undertaken by MNCs was associated with a significant rise in exports to the investing country. Makki and Somwaru (2004) and Mehrara et al. (2010) find a causality in the reverse direction and note that export growth attracts FDI to developing countries.

Rice (2007) tries to measure the impact of resource exports from low and middle income countries to eleven countries in the global North. The study notes that the export of resources from LDCs fuels an overconsumption in developed countries at the expense of the LDCs' ability to utilize their own biocapacity. Such research supports the proposition that FDI promotes exports that fuel the global North's overconsumption, thereby shifting the externality to less developed nations. In fact, an UNCTAD (2011) report states that FDI undertaken by MNCs in developing and less developed countries has resulted mainly in export-oriented primary production which actually has had limited impact on local employment. The report also states that FDI inflows largely target countries rich in natural resources.

This review of the literature leads us to our first hypothesis (H1): *FDI to commodity exporting developing countries is positively associated with commodity exports from such countries to high income countries.*

4.2. Commodity exports and total greenhouse gas emissions

There is empirical evidence that indicates a positive association between exports and the emission of greenhouse gases (GHGs). Grether and Mathys (2013) studied the effect of exports and imports on carbon emissions using data covering 62 countries. Their findings reveal that poor and emerging countries such as Indonesia, China, and Chile exhibit high emission intensities for exports relative to imports while large,

rich countries such as the U.S., Germany, and Japan are characterized by lower emission intensities for exports compared to their imports. Anatasia (2015) provides empirical evidence of a unidirectional Granger causality running from exports to CO₂ emissions in the case of Thailand and Malaysia for the period covering 1978–2008.

Weber et al. (2008) studied the impact of exports on Chinese CO₂ emissions during the period covering 1987–2005. They observed that almost 60% of Chinese exports go to the developed world for their consumption and that almost one-third of Chinese CO₂ emissions were generated by the production of such goods for export. Li et al. (2014) calculated the CO₂ emissions embodied in the bilateral trade between China and 112 other countries/regions. Their results show that the flows of embodied CO₂ emissions in export trade are highly concentrated, with the United States and Japan accounting for 1/4th and 1/7th of the total CO₂ emissions in export trade, respectively. Shui and Harriss (2006) examined the U.S.-China trade during the period covering 1997–2003 to understand the impact of exports to the U.S. on the CO₂ emissions in China. The results reveal that if the U.S. had produced the same quantity of products domestically rather than importing them from China, the CO₂ emissions in the U.S. would have increased by 3% (1997 and 1998) to 6% (2003) higher than the reported levels. Meanwhile, the CO₂ emissions in China due to the production of exports to the U.S. accounted for 7% (1997) to 14% (2002 and 2003) of China's annual CO₂ emissions.

This leads us to our second hypothesis (H2): *exports by commodity exporting developing countries to high-income countries are positively associated with total GHG emissions.*

In the next section, we discuss our methodology before subjecting our hypotheses to econometric testing.

5. METHODOLOGY

We obtained a list of 52 commodity exporting emerging market and developing economies³ from the International Monetary Fund (IMF) World Economic Outlook report (2015) (see Table 1). To test *H1*, we utilized data from the World Development Indicators Database (World Bank Group, 2015) and examined the association between FDI inflows

³Commodity exporters are emerging market and developing economies for which gross exports of commodities constitute at least 35% of total exports and net exports of commodities constitute at least 5% of exports-plus imports on average, based on the available data for 1960–2014.

and exports for our panel of commodity exporting countries over the period covering 1991–2011.⁴ Missing data, however, restricted our sample to 45 countries.

There is evidence in the literature of endogeneity between FDI and exports. Singh and Jun (1995) suggest that the relationship between exports and FDI may be simultaneous. A Hausman test also indicated endogeneity⁵ between FDI and exports in our sample. To address this issue, we constructed an instrumental variable estimate of FDI⁶ (FDINST) that we used in our test of *H1*.

$$\text{HEXP} = C(1) + C(2)*\text{FDINST} + C(3)*\text{LAG FDINST} + C(4)*\text{GFCF_GDP} + C(5) \text{ LABFRC} + \text{error}$$

Where,

HEXP = Exports to high-income countries as a percentage of GDP.⁷

FDINST = Instrumental variable estimate of FDI

⁴The year 2011 was the last period for which data was available. Seven countries from our original sample of 52 commodity exporting emerging market and developing economies had to be excluded due to missing data.

⁵The Hausman Test (also called the Hausman specification test) detects endogenous regressors (predictor variables) in a regression model. There is also evidence of Granger bi-causality between FDI and exports as discussed in section 4.

⁶We used the following equation:

$$\text{FDIN} = C(1) + C(2)*\text{GDPGR} + C(3)*\text{TRADEINT} + C(4)*\text{INFLCPI} + C(5)*\text{GOVTEXPGDP} + \varepsilon$$

where FDIN represents the inward flow of foreign direct investment to an economy and GDPGR represents the real GDP growth rate. Here we posited that FDI is attracted to economies with higher growth rates. The variable TRADEINT represents trade intensity and is a proxy for trade openness; it has been used in the literature as a proxy for the openness of an economy. We used this as a proxy for trade intensity measured by exports as a percentage of GDP plus imports as a percentage of GDP, and posited that a more “open” economy attracts more FDI. The variable INFLCPI measures the level of inflation in an economy and serves as a proxy for risk. We posited that high inflation reduces the attractiveness of an economy to FDI inflows. Finally, GOVTEXPGDP represents the proportion of government expenditure as a percentage of GDP.

⁷To estimate HEXP, we obtained data on total merchandise exports (MEX) and merchandise exports to high-income countries as a percentage of MEX (MEXPCNT) from the World Development Indicators database. We then obtained GDP data for each economy and calculated HEXP as follows: $\text{HEXP} = (\text{MEX} * \text{MEXPCNT}) / \text{GDP}$.

GFCF_GDP = Gross Fixed Capital Formation as a percentage of GDP. We expected this variable to be positively associated with exports to high-income countries, thereby reflecting a higher investment in fixed capacity building and infrastructure.

LABFRC = the logged value of the labor force in a country. LABFRC was expected to be positively associated with exports to high-income countries, thereby reflecting a larger labor pool.

We estimated a fixed-effects regression and used robust standard errors to account for heteroscedasticity and cross-sectional dependence. Consistent with *H1*, we expected the coefficients C(2) and C(3) to be positive and significant, indicating that exports to high-income countries were impelled by FDI to commodity exporting developing economies.

To test our second hypothesis, *H2*, we obtained data for an initial list of 214 countries over the period covering 1991–2011 which was available from the World Development Indicators Database (World Bank Group, 2015). However, due to missing data, our final sample consisted of 94 countries of which 27 are commodity exporting emerging market and developing economies (see Table 3). We estimated the following fixed-effects regression:

$$\begin{aligned} \text{TOTALGRNGSEMPCAP} = & C(1) + C(2)*\text{GDPPCAP} + \\ & C(3)*\text{GDPPCAP}* \text{COMEX} + C(4)*\text{POPDENSE} + C(5)*\text{HEXPPCAP} + \\ & C(6)*(\text{HEXPPCAP})*\text{COMEX} + C(7)*\text{CRISIS} \\ & + C(8)*\text{ELECTOILGASCOAL} + C(9)*\text{ELECTRENEWNOHYDRO} + \\ & C(10)*\text{EMPINDUSTRY} + C(11)*\text{ENRGYUSEPCAP} + C(12)*\text{AGRIVALADD} \\ & + C(13)*\text{FOREST} + \text{error} \end{aligned}$$

Where,

TOTALGRNGSEMPCAP = total greenhouse gas emissions per capita.

GDPPCAP = GDP per capita. Research on the environmental Kuznets curve (EKC) suggests a positive association between GDP per capita and greenhouse emissions per capita. We expected this relationship to be significantly more positive for commodity exporting countries (Panayotou, 1993).

COMEX = an indicator variable for a commodity exporting country, equal to “1” for each commodity exporter, “0” otherwise.

POPDENSE = Population density. There is evidence which indicates that greenhouse emissions increase/decrease with population density. Selden and Song (1994) and Patel et al. (1995) claim that an increase in population density might cause increased awareness of environmental impacts, resulting in more pressure to adopt stringent environmental standards and clean technologies. However, emissions may increase with population density if changes in settlement patterns necessitated by population growth result in requiring more transport, resources, goods, and services. Moreover, a higher population density might create demand for energy-intensive services that would not be required in areas with a low population density (Holdren, 1991).

HEXPPCAP = Merchandise exports to high-income countries on a per capita basis. We expected a significantly positive association between total greenhouse gas emissions and merchandise exports to high-income countries. This variable is our proxy for the “Global North” as discussed in *Laudato Si’*.

CRISIS = is a dummy variable for the financial crisis in 2008–2009. We expected a decrease in this variable to be associated with a decrease in the level of economic activity.

ELECTOILGASCOAL = percentage of electricity generated by fossil fuels. We expected total greenhouse gas emissions to increase with the increased use of fossil fuels.

ELECTRENEWNOHYDRO = percentage of electricity generated by renewable sources other than hydro-electricity. We expected a decrease in total greenhouse gas emissions associated with this variable.

EMPINDUSTRY = Percentage employed in industry. We expected an increase in total greenhouse gas emissions to be associated with higher levels of industrialization in an economy.

AGRIVALADD = Value-added from agriculture as a percent of GDP. Agricultural activities are relatively less pollution intensive compared to manufacturing, although in keeping with the literature, the coefficient could be positive or negative. However, rising GHGs are also associated with agricultural activities such as livestock rearing, maintaining nitrogenous agricultural soils, and specifically rice production (Russell, 2014).

ENRGYUSEPCAP = Energy used per capita. We expected higher greenhouse gas emissions from economies where the energy use per capita is higher.

FOREST = Percentage of forest land to land area. We expected lower levels of greenhouse gas emissions to be associated with economies with a greater proportion of forested land. This could be for two reasons. First, it is possible that less industrially developed economies emit lower levels of greenhouse gas. Second, forests may serve as sponges that absorb carbon emissions.

Initial descriptive statistics of the variables used in our model to test *H2* are presented in Table 4. We compared the key variables for our commodity exporting countries with the rest of the countries in our sample and provided basic univariate statistics. Consistent with *H2*, we expected the interaction coefficient C(6) to be significantly positive, indicating that exports to high-income countries are incrementally and positively associated with greenhouse gas emissions.

6. RESULTS

Our econometric results for *H1* are displayed in Table 2. Consistent with our expectations and *H1*, we observed that contemporaneous FDI inflows to commodity exporting countries are significantly associated with an increase in exports to high-income countries. Indeed, such resource-seeking FDI inflows seem to impel said exports.

Contrary to our expectations, however, the variable GFCF_GDP was significantly but negatively associated with HEXP. This could be because GFCF_GDP stimulated the domestic economy and “crowded-out” any impact on export-based activities. None of the other variables achieved statistical significance.

Our results for *H2* are displayed in Table 5. We found that the GDPPCAP, ELECTOILGASCOAL, EMPINDUSTRY, ENERGYUSEPCAP, and AGRIVALADD are positively and significantly associated with total greenhouse gas emissions. Thus, economies with higher levels of GDP per capita, fossil fuel consumption, employment in the industry, and energy use per capita emit higher levels of greenhouse gases per capita. Contrary to our expectations, however, FOREST is significantly and positively associated with GHGs. It is possible that this variable is in effect a proxy for the level of activities such as exploration for and discovery of minerals, oil, and natural gas deposits. Greenhouse gas emissions were reduced significantly during the crisis in 2008 and 2009 that saw lowered levels of economic activity.

We observed that coefficient C(5) of the variable HEXPPCAP (per capita exports to high-income countries) is negative and significant, indicating that these exports reduce total greenhouse gas emissions. However, consistent with our expectations and *H2*, we observed that the coefficient C(6) for the interaction term HEXPPCAP*COMEX that measures the incremental impact of such exports to high-income countries is significantly positive. Unlike the rest of the sample, such exports to high income countries are associated with a significant and positive increase in total greenhouse gas emissions. To test the robustness of our results, we re-ran the regression without the interaction term on just the 27 COMEX countries in this sample.⁸ We observed that the coefficient on the variable HEXPPCAP is significantly positive. In other words, exports from commodity exporting countries to high-income countries are associated with an increase in greenhouse gas emissions. This finding is consistent with the statements made by the Pope in *Laudato Si'*, paragraph 51.

Taken together, our hypotheses validate several points raised in paragraph 51 of *Laudato Si'*, especially when viewed from the perspective of the PHH and the activities of MNCs. Our econometrics establishes a significant association between FDI undertaken by MNCs in developing countries and commodity exports from these countries. Results also indicate that such exports to the global North (high income countries) are significantly associated with higher greenhouse gas emissions. In sum, the Pope's claim that the "export of raw materials to satisfy markets in the industrialized North has caused harm locally" (Francis, 2015: 51) appears to be empirically valid with regard to our sample.

7. DISCUSSION, LIMITATIONS, AND FUTURE RESEARCH DIRECTIONS

In response to evidence of the role of human activities in accelerating climate change through increased carbon emissions, the Pope's encyclical calls for recognition of a global "ecological debt." Francis asserts that exports from poor countries to the industrialized North are associated with significant harm to the local environments of the former. Our results demonstrate that this assertion is empirically valid for our sample of commodity exporting developing countries.

The Pope argues that rich countries should help pay this debt by reducing their emissions and by actively helping poor countries put into

⁸Since the results were qualitatively similar, we did not tabulate them.

place policies and programs that support sustainable development. An alternative policy recommendation stemming from our analysis would also suggest carbon taxation as a viable option for commodity exporters looking to reduce carbon emissions. This might incentivize MNCs to consider carbon mitigation strategies as they engage in commodity extraction from developing countries. Finally, stricter regulation of the environment and enforcement of environmental laws in these developing countries are also called for.

In the end, our empirical analysis does in no way imply that commodity exporting developing countries should cut GHGs at the expense of their economic growth. Rather, we suggest that these countries look at sustainable development models that enable them to meet the needs of the present without compromising the needs of future generations. The U.N.'s 17 Sustainable Development Goals (SDGs) offer a blueprint for action in this regard (United Nations, 2015); these goals prioritize areas such as climate change, sustainable production and consumption, and social justice, among others.

It should be noted, however, that the concept of ecological debt is complex, and that this article is an initial attempt to examine one aspect of its manifestation, namely in the form of commodity exports from the global South. But the ecological debt that the North owes to the South cannot be estimated simply by a panel data set covering a certain period; any comprehensive study of this issue must include recognition of such debt as having accumulated over a historical range. Moreover, such a study may be complicated by the fact that it would have to consider colonial histories of exploitation and weak institutions in commodity exporting countries that ignore environmental damage, institutions that may have chosen to emphasize growth over environmental regulation. Also, any estimation of ecological debt should normalize carbon emissions in commodity exporting economies to their level of development and the level of pollution emitted by domestic producers.

Our study is also limited by insufficient data on commodity exporters. We also would have liked to disaggregate FDI flows by industry and by country to get a clearer picture, but such data are simply not available. Furthermore, we are unable to discern whether GHGs in our sample of commodity exporters would have persisted even if there was no FDI by MNCs. Are domestic producers cleaner than foreign MNCs? This question and others like it are beyond the scope of the present study, though they can represent an area of future research.

Issues inherent in the financing of green growth imperatives are also suggesting other areas of future research. For instance, can developing

economies sustain their economic growth to alleviate poverty while maintaining a low carbon intensity economy? How can business, government, and the civil sector work collaboratively to address these global issues? In this context, many economists have pushed government efforts to put a price on carbon pollution, either with a tax or a cap-and-trade program in which governments charge a fee to carbon polluters and where industry and market players can buy and sell carbon credits among themselves. Future research can focus on these policies and their impact on economic growth.

Country	Country
Algeria	Kazakhstan
Angola	Kuwait
Argentina	Libya
Azerbaijan	Malaysia
Bahrain	Mauritania
Bolivia	Mongolia
Brazil	Mozambique
Brunei Darussalam	Myanmar
Cameroon	Nicaragua
Chad	Niger
Chile	Nigeria
Colombia	Oman
Congo, Rep.	Papua New Guinea
Costa Rica	Paraguay
Cote d'Ivoire	Peru
Ecuador	Qatar
Gabon	Russian Federation
Ghana	South Sudan
Guatemala	Syrian Arab Republic
Guinea	Tajikistan
Guyana	Trinidad and Tobago
Honduras	Turkmenistan
Indonesia	United Arab Emirates
Iran, Islamic Rep.	Uruguay
Saudi Arabia	Venezuela, RB
	Yemen, Rep.
	Zambia

Table 1: List of Commodity Exporting Emerging Market and Developing Economies (IMF, 2015)

Dependent Variable: HEXP		
Sample: 1991–2011		
Cross-sections included: 45		
Total panel (unbalanced) observations: 717		
Variable	Coefficient	Signif.
C	2.101176	
FDINST	2.249685	***
LAGGED FDINST	0.455195	
GFCF_GDP	-0.195415	**
LABFRC	1.1284	
R-squared	0.868109	
F-statistic	89.59636	***
Total panel (unbalanced) observations	717	

*** = Significant at $p < 0.01$ level

**= Significant at $p < 0.05$ level

* = Significant at $p < 0.10$ level

Table 2: Association between Exports to High-Income Countries and FDI to Commodity Exporting Countries

Commodity Exporting (27)	Other Countries	Other Countries
Algeria	Albania	Cambodia
Argentina	Armenia	Korea, Rep.
Azerbaijan	Australia	Sri Lanka
Bolivia	Austria	Lithuania
Brazil	Belgium	Luxembourg
Chile	Bulgaria	Latvia
Colombia	Bosnia and Herzegovina	Moldova
Costa Rica	Belarus	Mexico
Ecuador	Canada	Macedonia, FYR

Commodity Exporting (27)	Other Countries	Other Countries
Guatemala	Switzerland	Malta
Honduras	China	Netherlands
Indonesia	Cuba	Norway
Iran, Islamic Rep.	Cyprus	New Zealand
Kazakhstan	Czech Republic	Pakistan
Malaysia	Germany	Panama
Mongolia	Denmark	Philippines
Nicaragua	Dominican Republic	Poland
Paraguay	Egypt, Arab Rep.	Portugal
Peru	Spain	Romania
Russian Federation	Estonia	Singapore
Saudi Arabia	Ethiopia	El Salvador
Syrian Arab Republic	Finland	Slovak Republic
Trinidad and Tobago	France	Slovenia
United Arab Emirates	United Kingdom	Sweden
Uruguay	Georgia	Thailand
Venezuela, RB	Greece	Tunisia
Yemen, Rep.	Croatia	Turkey
	Hungary	Ukraine
	Ireland	United States
	Iceland	Uzbekistan
	Italy	Vietnam
	Jordan	South Africa
	Japan	Morocco
	Kyrgyz Republic	

Table 3: List of 94 Sample Countries Used to Test H2

	Other (67 Countries)	Comex (27 Countries)	Country- Years	Signif.
Variables	Mean	Mean		
Value Added from Agriculture (% of GDP)	10.92	11.99	2457	**
Labor Force	24141499	15370395	2139	***
Electricity Generated from Fossil Fuels (% of Total)	58.99	57.99	2597	
Employment in Industry (% of Total)	25.95	22.95	2070	***
Exports (% of GDP)	42.12	33.45	2632	***
Exports to High Income Countries (% of GDP)	21.69	18.12	2598	***
FDI Inflows (% of GDP)	3.53	3.03	2516	**
Forest Area (% of Total Area)	28.5	31.46	2005	***
Real GDP Growth Rate	3.12	3.51	2715	*
GDP Per Capita (\$)	15807	5096	2728	***
Exports to High Income Countries per capita	390693	108786	2650	***
Total Greenhouse Gas Emissions (kt of CO ₂ equivalent per capita)	10.25	10.12	2790	
Ores and Metals Exports (% of merchandise exports)	5.24	9.41	2385	***
Agricultural Raw Materials Exports (% of merchandise exports)	3.25	5.05	2383	***

*** = Significant at $p < 0.01$ level

** = Significant at $p < 0.05$ level

* = Significant at $p < 0.10$ level

Table 4: Descriptive Statistics for Key Variables

Dependent Variable: TOTALGRNGSEMPCAP		
Sample: 1991–2011		
Cross-sections included: 94		
Total panel (unbalanced) observations: 1428		
Variable	Coefficient	Prob.
C	-7.304456	***
GDPPCAP	0.000147	**
GDPPCAP*COMEX	-0.000399	
POPDENSE	-0.000182	
HEXPPCAP	-1.41E-06	***
(HEXPPCAP)*COMEX	7.84E-06	***
CRISIS	-0.40442	**
ELECTOILGASCOAL	0.03078	***
ELECTRENEWNOHYDRO	-0.032003	
EMPINDUSTRY	0.0793	**
ENRGYUSEPCAP	0.002135	***
AGRIVALADD	0.062751	**
FOREST	0.184068	***
R-squared	0.937359	
F-statistic	186.4837	***

*** = Significant at p < 0.01 level
** = Significant at p < 0.05 level
* = Significant at p < 0.10 level

Table 5: Association between Exports and Total Greenhouse Gas Emissions per Capita for Sample Countries

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