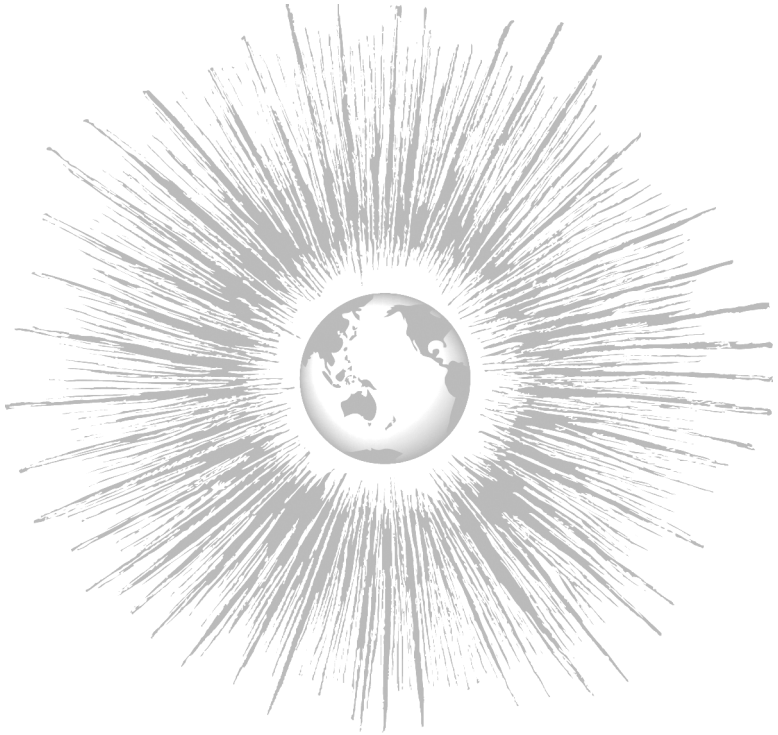

ABSTRACT:

Many social scientists argue that more-developed countries externalize their environmental costs through the tapping of resources of less-developed countries, which reduces levels of consumption in the latter while increasing forms of environmental degradation within their borders. However, these assertions lack systematic empirical support. This study offers a new conceptualization of the structure of international trade that may help to partly resolve this issue: weighted export flows, which quantifies the relative extent to which exports are sent to higher-consuming, more-developed countries. Our hypothesis is that less-developed countries with higher levels of exports sent to more-developed countries exhibit lower domestic levels of resource consumption, measured as ecological footprints. In a series of regression models of per capita ecological footprints for less-developed countries in 2000, evidence is found supporting the hypothesis. The negative effect of weighted export flows on the per capita footprints of nations is robust, net of the often cited impacts of capital intensity, urbanization, domestic inequality, human capital, and other export-related characteristics. Results of this study provide empirical evidence of the environmental impacts of the structure of international trade and outline a new methodological approach to studying uneven ecological exchange.

Structural Dynamics of International Trade and Material Consumption: A Cross-National Study of the Ecological Footprints of Less-Developed Countries*

Andrew K. Jorgenson
James Rice

INTRODUCTION

Natural resource consumption and resulting environmental degradation are among the most pressing issues confronting us today. Paradoxically, nations with larger ecological footprints generally experience lower domestic levels of particular forms of environmental degradation, including deforestation, organic water pollution intensity, and increasing greenhouse gas emissions intensity (e.g. Jorgenson 2003, 2004a, 2005). Moreover, these forms of degradation negatively impact the quality of life and general well-being of domestic human populations. For example, organic water pollution resulting from monoagricultural export-oriented production in less-developed countries increases infant mortality rates, net of health expenditures, forms of human capital, and other social factors (e.g. Burns, Kentor, and Jorgenson 2003; Jorgenson 2004c; Jorgenson and Burns 2004).

The ecological footprint / environmental degradation paradox is not necessarily the consequence of increased problem-solving capacity due to greater affluence and development. Rather, many social scientists posit that these relationships are illustrative of structural conditions and asymmetrical processes in which more-developed countries externalize their consumption-based environmental

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impacts through the tapping of natural resources and produced commodities of less-developed countries, reducing material consumption for the latter while increasing particular types of environmental destruction within their borders. The general argument concerns the structure of international trade, particularly the flows of exports from less-developed countries to more-developed countries. Yet, these interrelated assertions lack appropriate empirical evaluation.

The present study begins to resolve the issues discussed above. Specifically, we test the following hypothesis: less-developed countries with greater levels of exports sent to higher-consuming, more-economically developed countries exhibit lower domestic levels of per capita consumption, measured as ecological footprints. This hypothesis is sensitive to the potential uneven ecological exchange dynamics promoting disproportionate utilization of natural resources by developed countries at the expense of less-developed countries. The ecological footprint demand exhibited by less-developed countries, therefore, is not simply the consequence of domestic driving forces, including relative affluence and population pressures, but also the structural relations forged through international trade.

To test this hypothesis, we create an index of weighted export flows that quantifies the relative extent to which exports of countries are sent to receiving nations with higher levels of economic development. Creation of this index allows for a more explicit examination of potential asymmetrical processes of international trade between countries. Using ordinary least squares regression, we incorporate this new index into a series of quantitative cross-national analyses of the structural causes of per capita ecological footprints of less-developed countries, 2000. We include controls identified by previous studies to be robust predictors of footprints, including level of economic development, urbanization, domestic income inequality, and human capital. We also consider the effects of other export-related factors and the extent to which domestic economies are service-based. Results of this study provide robust support for the tested hypothesis, and underscore the importance of addressing the structural dynamics of international trade when analyzing material consumption and other environmental outcomes, particularly the relative flow of exports and relevant attributes of receiving countries.

Material Consumption and the Externalization of Environmental Costs

A growing body of empirical work in the social sciences addresses the structural factors that explain variation in cross-national levels of total and per capita consumption of natural resources in the contemporary world-economy. This comprehensive approach to material consumption and its environmental impacts

focuses on the ecological footprints of nations (e.g. Jorgenson 2003, 2004a, 2005, forthcoming [b]; Jorgenson and Burns 2004; Jorgenson, Rice, Crowe, and Rice forthcoming; Rice 2005; Rosa, York, and Dietz 2004; York, Rosa, and Dietz 2003). The ecological footprint measures the amount of biologically productive land required to support the consumption of renewable natural resources and assimilation of carbon dioxide waste products of a given population (e.g. Chambers, Simmons, and Wackernagel 2002). More specifically, national footprints consist of the area of cropland required to produce the crops consumed, the area of grazing land required to produce the animal products, the area of forest required to produce the wood and paper, the area of sea required to produce the marine fish and seafood, the area of land required to accommodate housing and infrastructure, and the area of forest required to absorb the carbon dioxide emissions resulting from energy consumption (Wackernagel et al. 2002).

Footprints are measured in area units where one footprint equals one hectare. This natural capital accounting framework captures indirect effects of consumption that are difficult to measure, and the approach does not require knowing specifically what each consumed resource is used for. However, footprints do not identify the locations where the consumed resources originate.

Jorgenson (2003, 2004a, 2005) analyzes the structural causes of per capita ecological footprints, and finds that a country's level of per capita consumption is largely a function of its relative position in the international stratification system, level of urbanization, domestic income inequality, and human capital. Through the unpacking of relative international power into its relevant geopolitical-economic components, Jorgenson (2005) empirically illustrates that economic power in the form of capital intensity, military technological power, and overall export dependence are the structural driving forces of per capita resource consumption.

Social scientists pay considerable theoretical and empirical attention to the environmental impacts of economic development (e.g. Burns, Kick, and Davis 2003; Burns, Kentor, and Jorgenson 2003; Chase-Dunn and Jorgenson 2003; Foster 1999, 2002; Jorgenson forthcoming [a]; Jorgenson and Kick 2003; Moore 2003; O'Connor 1998; Schnaiberg 1980; Schnaiberg and Gould 1994; Wallerstein 1999). Relative economic power generally takes the form of capital intensity (i.e. GDP per capita), which often refers to the ability of a country to be more competitive in the global marketplace (Kentor 2000). Countries with higher capital intensity generally contain articulated consumer markets that consume greater levels of material resources (Jorgenson 2003, 2004a; York, Rosa, and Dietz 2003).

To maintain profits, producers must constantly expand production, which requires additional ecological material inputs (O'Connor 1998). Schnaiberg

(1980) and Schnaiberg and Gould (1994) characterize these processes as the heart of the treadmill of production. Producers are usually headquartered in developed countries, and outsource production and resource extraction to export-dependent countries. The expansion of production and consumption usually takes the form of global commodity chains in which resources are added or modified at every chain (Gereffi and Korzeniewicz 1994; Jorgenson forthcoming [b]; Princen, Maniates, and Conca 2002). Produced commodities are usually transported to and consumed by developed countries with high capital intensity, and the majority of profits derived from these goods further increase the economic development of market economies that house the headquarters of producers (e.g. Bornschier and Chase-Dunn 1985; Kentor and Boswell 2003).

Many social scientists argue that less-developed countries generally have lower domestic levels of material consumption and ecological footprints because they tend to export produced commodities and raw materials to higher-consuming, more-developed countries (e.g. Clapp 2002; Conca 2002; Jorgenson 2003; Jorgenson, Rice, and Crowe forthcoming; Princen 2002; Rice 2005). The latter contain productive economies and articulated markets while less-developed countries generally consist of more extractive oriented economies and disarticulated markets (Boswell and Chase-Dunn 2000; Bunker 1985).[1] Moreover, less-developed countries with extractive economies are often highly dependent on a small number of primary exports, most notably agricultural products and other natural resources (e.g. Burns, Kentor, and Jorgenson 2003; Jorgenson 2004c; Tucker 2002). Dependence on agricultural exports lessens the well-being of human populations in many less-developed countries (e.g. Jorgenson and Burns 2004).

Less-developed countries with higher levels of domestic income inequality exhibit relatively lower ecological footprints (Jorgenson 2004a). This type of outcome is often explained by two interrelated factors. First, the majority of the population has substantially lower income levels, and second, the domestic market focuses on the exportation of raw materials and commodities produced by means of dependent industrialization (e.g. Beer and Boswell 2002; Evans 1979; Jorgenson 2003).

Overall, countries with higher levels of urbanization consume greater amounts of material resources (Jorgenson 2003; York, Rosa, and Dietz 2003). These areas require more resources to maintain the overall built infrastructure,

[1.] Disarticulated economies depend on external markets while articulated economies are more able to focus on domestic markets (Jorgenson 2004a; Bunker 1985).

and urbanized regions contain intensified articulated consumer markets relative to more agrarian areas. However, urban processes in less-developed countries vary substantially from more-developed nations. Many urbanized regions in less-developed countries are characterized by outdated manufacturing sectors that are exported from more-developed countries coupled with a shift towards export-oriented development (Grimes and Kentor 2003; Portes et al. 1997; Smith 1996). Furthermore, many less-developed countries have experienced increased roles as nodes in the exportation of natural resources from regional extractive economies (Bunker 1985; Smith 1996).

Thus, the complicated processes of underdevelopment, emerging dependent industrialization, and economic stagnation limit the domestic levels of natural resource consumption in less-developed countries. Moreover, this is further exacerbated by their classically dependent, extractive-oriented domestic characteristics and export-oriented production of goods for articulated consumer markets in higher-consuming, more-developed countries (e.g. Bunker 1985; Hornborg 2001; Jorgenson 2003, 2004a, 2004b).

Neoclassical economic perspectives suggest that the overall structure of domestic economies greatly determines their overall environmental impacts. More specifically, it is assumed that nations with more service-based economies consume less material resources and emit less waste into regional ecological systems and the biosphere (e.g. Ehrhardt-Martinez, Crenshaw, and Jenkins 2002; Grossman and Krueger 1995; OECD 1998). However, York, Rosa, and Dietz (2003) find no evidence indicating that nations with relatively greater service-based economies consume fewer resources, and likewise, Jorgenson (2004d, forthcoming [a]) and Burns and Jorgenson (2004) find no evidence suggesting that less-developed nations with relatively more service-based economies experience lower rates of deforestation and methane emissions intensity, net of other factors.

Many social scientists argue that more-affluent nations reduce their impacts on the environment within their own borders through the importation of resources and the exportation of wastes, a process commonly referred to as the "Netherlands Fallacy" (e.g. Ehrlich and Ehrlich 1990; Ehrlich and Holdren 1971; Frey 1998; Jorgenson forthcoming [b]). Developed countries possess the international political-economic power and institutional infrastructure to achieve improvements in domestic environmental conditions while continuing to impose negative externalities globally (e.g. Andersson and Lindroth, 2001; Chase-Dunn 1998; Chew 2001; Foster 1999; Jorgenson, Rice, and Crowe forthcoming). The Netherlands fallacy suggests that domestic environmental conditions are not necessarily an accurate reflection of the aggregate environmental burdens engendered by domestic standards of living and rates of material consumption. It is

argued that any particular country's environmental impact, positive or negative, is not simply the consequence of domestic factors but also its structured relations with other countries. To more fully conceptualize the complexity of consumption related dynamics in a globalizing world, it is increasingly important to examine zero-sum relations among countries and the socio-economic and environmental costs that are differentially incurred as a result (Hornborg 2001, 2003; Jorgenson 2005; Rice 2005).

The broadening and deepening of international trade provides a means by which intra-national patterns of production and consumption become domestically disassociated, particularly in regards to concomitant environmental impacts (Anderrson and Lindroth 2001; Chew 2001; Jorgenson 2004d, forthcoming [b]; Rothman 1998:185; Ekins 1997). Most social scientific studies of different forms of environmental degradation analyze the effects of overall levels of exports (e.g. Burns et al. 1994; Jorgenson 2005; Kick et al. 1996; Rudel 1998), while other studies address the possible environmental and economic impacts of dependence on exports to a limited number of trading partners (e.g. Galtung 1971; Kentor 2000; Kentor and Boswell 2003). However, the structural processes and outcomes theorized by political-economic scholars and environmental sociologists focus upon the environmental impacts of the structure of exports, particularly the flow of raw materials and produced commodities from less-developed countries to higher-consuming, more-developed countries.[2]

A related perspective deals with material flows analysis. This orientation is quite popular in ecological economics. Researchers working in this area have created meticulous natural capital accounting frameworks for measuring various international flows of bioproductive mass and other resources, but their analyses are almost exclusively descriptive by design (e.g. Fischer-Kowalski 1998; Fischer-Kowalski and Amann 2001; Muradian and Martinez-Alier 2001). Many ecological economists derive assumptions about uneven ecological exchange without directly testing and empirically identifying the actual connections between high resource consumption in developed countries and low consumption (and concomitant environmental degradation) in less-developed countries (e.g. Fischer-Kowalski and Amann 2001; Muradian and Martinez-Alier 2001; Muradian, Eisenmenger, and Giljum 2003; Proops et al. 1999). Moreover, other relevant political-economic and social factors are not considered.

[2] For relatively similar arguments concerning the structure of international trade and other outcomes, such as economic development and domestic income inequality, see Kentor and Boswell 2003; Rubinson and Holtzman 1981; Smith and White 1992; and Snyder and Kick 1979.

Summary of Recent Findings, Theoretical Arguments, and Present Hypothesis

A growing body of social scientific research indicates that the amount of material resources a country consumes is largely a function of its level of economic development, urbanization, and other domestic social factors. Many of these studies identify a paradoxical series of relationships: countries with higher material consumption measured as ecological footprints experience lower domestic levels of environmental degradation. Researchers and theorists argue that these relationships are illustrative of macro-structural conditions in which more-developed countries externalize their consumption-based environmental costs through the inflows of material resources in the form of produced commodities and raw materials from lower-consuming, less-developed countries. These international dynamics of environmental externalization result in the reduction of resource consumption within the borders of less-developed countries. Put differently, less-developed countries often have lower ecological footprints because they largely focus on the export of produced goods and raw materials to higher-consuming, more-developed countries. Suppressed environmental consumption, therefore, is partly a consequence of asymmetrical processes enacted through international trade relations, shaping inequitable access to and utilization of global natural resources. However, these arguments lack systematic empirical evaluation.

In the subsequent analyses, we begin to address these disconnects between theories of uneven ecological exchange and prior quantitative cross-national research. Specifically, we test the following hypothesis: less-developed countries with higher levels of exports sent to more-developed (i.e. higher-consuming) nations exhibit lower domestic levels of resource consumption, measured as per capita ecological footprints. Prior to the analyses, we create an index of weighted export flows, which allows for the direct testing of the hypothesis.

Construction of Weighted Export Flows

We create a comprehensive index weighted by attributes of receiving countries: export flows weighted by per capita GDP. The index is calculated for 1990, and quantifies the relative extent to which exports are sent to more-developed countries. Data required for the construction of the weighted index include relational measures in the form of export flows and attributional data that quantify characteristics of receiving countries. Export flows data are taken from the International Monetary Fund's *2003 Direction of Trade Statistics* CD ROM database. All figures are reported in current US dollars. Attributional data required for the construction of the indices include GDP per capita, which quantifies a

country's level of economic development. These data are taken from Maddison (2001), and are in constant 1995 international dollars.

The weighted export flows index is calculated as:

$$D_i = \sum_{j=1}^{N} p_{ij} a_j$$

Where:

D_i = weighted export flows for country i
p_{ij} = proportion of country i's total exports sent to receiving country j
a_j = attribute of receiving country j (e.g. GDP per capita)

The first step is to convert the flows of exports to receiving countries into proportional scores. More specifically, exports to each receiving country are transformed into the proportion of the sending country's total exports. The transformation into proportions allows for cross-national comparisons of per capita levels of resource tapping that are not partly attributable to overall population differences between nation-states, sometimes referred to as "the China effect" in the international economic inequality literature (e.g. Babones 2002; Firebaugh 1999) or cross-national differences in the scale and intensity of environmental outcomes (e.g. Redclift and Sage 1998; Roberts 2001). The second step involves multiplying each proportion by the corresponding receiving country's attribute of interest (per capita GDP). The third step is to sum the products of the calculations in step two. The sums of these products quantify the relative level of exports sent to more-developed countries that generally exhibit larger ecological footprints.

METHODS

Our primary goal is to test a hypothesis derived from fundamental arguments of environmental sociologists and political-economic scholars concerning uneven ecological exchange between nations. This involves the development of an empirical indicator that quantifies the relative extent to which less-developed countries send their exports to nations with greater economic development. We incorporate this new index into a series of cross-national analyses of per capita ecological footprints for less-developed countries. Like other studies that restrict their analyses to less-developed countries, we argue that the domestic social infrastructure and relative position of less-developed countries in the world-economy create conditions in which the social and environmental impacts of political-economic characteristics vary substantially between developed and less-developed countries. For example, a developed country might send a high proportion of exports to other developed countries, but its relatively powerful position in the world-economy enables the developed country to import natural

resources and produced commodities from less-developed countries.[3] Moreover, developed countries generally possess domestic infrastructures and technologies that enable them to reduce some forms of environmental degradation within their borders (e.g. Burns, Kick, and Davis 2003; Kick et al. 1996).

We employ OLS regression and listwise deletion in all reported analyses. For comparison, the models we use here are similar to those tested in other recent studies of national-level footprints. They include measures of economic development, urbanization, domestic inequality, human capital, domestic economy structure, and other export-related characteristics.

Dependent Variable

Combined ecological footprint per capita, 2000, is the comprehensive measure of the total area required to produce the commodities consumed and assimilate the wastes generated for a given nation. These data are taken from Venetoulis, Chazen, and Gaudet (2004).

Independent Variables[4]

Weighted Export Flows, 1990 (natural log). These data quantify the relative extent to which a nation's exports are sent to more economically developed countries. We log this variable to correct for skewness.

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3. Indeed, the value of the constructed weighted export flows index for Canada (as well as many other developed nations) is relatively high compared to many less-developed countries. This is similar to other political-economic characteristics, including foreign capital penetration and foreign investment concentration (Grimes and Kentor 2003; Jorgenson forthcoming[a]; Kentor and Boswell 2003)

4. An anonymous reviewer posed a concern about our use of independent variables mostly for the year 1990, which creates a 10 year time lag between these predictors and the dependent variable. The reasoning for this lag is primarily pragmatic and to ease interpretation of the findings for readers. Measures for some of the independent variables are not available for more recent years, particularly export partner concentration and domestic income inequality. However, in a series of unreported analyses, we employ more recent measures of the remaining independent variables. Results for those analyses differ very little from those reported in the current study. Thus, we choose to report findings for the analyses that involve the consistent 10 year time lag. Moreover, the dependent variable of the current study, per capita ecological footprints for 2000, is correlated .937 with per capita footprints for 1996. The 1996 measures have been used as dependent variables in most relevant published studies (e.g. Jorgenson 2003, 2004a, 2005; Jorgenson and Burns 2004; York, Rosa, and Dietz 2003).

Gross Domestic Product per capita (natural log), 1990 is included in nearly all cross-national studies of ecological footprints, and measures a country's level of economic development. These data are obtained from Maddison (2001), and are measured in 1990 international dollars. Consistent with most studies, we log these data to correct for skewness.

Gross Domestic Product per capita Change, 1980–1990 controls for the extent of a country's average annual rate of economic development. We calculate average annual percent change scores using Maddison's (2001) data.

Urban population, 1990 (residualized) controls for the percentage of a country's population residing in urban areas. These data are taken from the World Bank (2000). To correct for its high collinearity with GDP per capita, we regress this variable on per capita GDP and use the residuals as measures of urbanization, which allows for analyses of its effects, independent of level of economic development.

Exports of goods and services as percentage of total GDP, 1990 (natural log) measures overall levels of exports and controls for the extent of a country's integration into the world-economy. These data are obtained from the World Bank (2000). We log this variable to correct for skewness.

Domestic income inequality, measured as gini coefficients, controls for the distribution of income within countries. The year of measurement for gini coefficients vary slightly across countries, but range in the early 1990s. These data are taken from the World Bank (2001).

Secondary school enrollment, 1990 (residualized) is an indicator of human capital, and is defined as the ratio of total secondary school enrollment, regardless of age, to the population of the age group corresponding to this level of education. These data are obtained from the World Bank (2000). Like urban population, we residualize these data to correct for its high collinearity with GDP per capita.

Services as percentage of total GDP, 1990 controls for the extent to which a domestic economy is services based. These data are taken from the World Bank (2000).

Export partner concentration, 1990 quantifies the percentage or proportion of total exports to the single largest importing country. These data are obtained from the World Bank (1996). Other studies model this indicator as a form of trade dependence in which high levels of export partner concentration make the host country more vulnerable to international market forces and allow the country receiving the largest proportion of their exports to obtain more favorable economic and environmental outcomes (e.g. Hirschman [1945] 1971; Jorgenson 2004d; Kentor and Boswell 2003). Hence, the implementation of this statistical control reduces the likelihood of invalid inferences concerning the tested hypothesis.

Table 1 – Descriptive Statistics for all Variables Included in the Analyses

	N	Mean	Std Dev	Skewness	Kurtosis	Min	Max
Ecological Footprint per capita, 2000	69	1.586	.799	.967	.343	.500	3.970
Weighted Export Flows, 1990	69	9.548	.261	-1.140	1.759	8.630	10.000
Gross Domestic Product per capita, 1990 (log)	69	7.640	.800	.105	-1.018	6.070	9.470
Gross Domestic Product per capita change, 1980-1990	69	.231	2.197	1.086	1.713	-4.080	7.440
Urban Population, 1990 (residualized)	69	.000	12.754	-.130	1.904	-40.575	42.232
Exports / GDP, 1990 (log)	69	3.089	.581	-.427	-.074	1.730	4.340
Domestic Inequality	57	43.614	9.982	.184	-.867	24.400	62.900
Secondary Education, 1990 (residualized)	63	.000	14.771	.513	.584	-35.320	40.730
Services / GDP, 1990	67	46.251	9.485	-.052	.312	24.260	73.300
Export Partner Concentration, 1990	55	31.577	18.127	.651	-.058	2.560	80.160

Countries Included in the Analyses

We focus the analyses on less-developed countries categorized by the World Bank (2000). Specifically, we include countries not categorized as high income by the World Bank's income quartile classification. To maximize the use of available data, we allow sample sizes to vary among tested models.[5] Table 1 provides descriptive statistics and Table 2 presents correlations for all variables included in the analyses.

Findings and Discussion

Results of the analyses are provided in Table 3. Our most noteworthy finding is that weighted export flows has a significant negative effect on per capita

[5] Saudi Arabia and South Korea were found to be outliers and excluded from the reported analyses.

Table 2 – Correlations for all Variables Included in the Analyses

		1.	2.	3.	4.	5.	6.	7.	8.	9.
Ecological Footprint per capita, 2000	**1.**									
Weighted Export Flows, 1990	**2.**	.020								
Gross Domestic Product per capita, 1990 (log)	**3.**	.762	.201							
Gross Domestic Product per capita change, 1980-1990	**4.**	-.034	.041	.107						
Urban Population, 1990 (residualized)	**5.**	.237	.016	.000	-.620					
Exports / GDP, 1990 (log)	**6.**	.369	.302	.420	.047	-.016				
Domestic Inequality	**7.**	-.002	.183	.003	-.280	.370	.168			
Secondary Education, 1990 (residualized)	**8.**	.034	-.096	.000	-.006	.041	-.046	-.361		
Services / GDP, 1990	**9.**	.229	.315	.399	-.048	.117	.226	.257	-.210	
Export Partner Concentration, 1990	**10.**	-.145	.526	-.027	-.154	-.043	.001	.216	-.431	.218

ecological footprints of less-developed countries. The effect is almost identical in magnitude and statistically significant across all models, which provides strong support for the tested hypothesis. This finding, coupled with the often identified paradoxical relationships between the footprints of nations and levels of domestic environmental degradation, provides evidence of the externalization of consumption-based environmental costs by more-affluent nations (Frey 1998; Hornborg 2001; Jorgenson 2003, 2004a; 2005; Jorgenson and Burns 2004; Princen, Maniates, and Conca 2002; Rice 2005).

Turning to the other predictor variables, we find that level of economic development positively affects per capita footprints, while the effect of rate of development is non-significant across all tested models. The former finding is consistent with recent cross-national studies of footprints (e.g. Jorgenson 2003, 2004a, 2005; Rice 2005; York, Dietz, and Rosa 2003). Level of urbanization positively affects per capita footprints in Models 1 through 3, but becomes non-

Table 3 – Standardized Coefficients for Analyses of Ecological Footprints Per Capita, 2000 in LDCs

	Model 1	Model 2	Model 3	Model 4	Model 5
Weighted Export Flows, 1990	-.171* (-2.314) [1.111]	-.176* (-2.150) [1.167]	-.177* (-2.100) [1.149]	-.182* (-2.147) [1.203]	-.214* (-2.131) [1.400]
Gross Domestic Product per capita, 1990 (log)	.739*** (9.447) [1.243]	.751*** (8.482) [1.358]	.761*** (8.153) [1.410]	.883*** (8.955) [1.621]	.889*** (8.538) [1.507]
Gross Domestic Product per capita change, 1980-1990	.099 (1.092) [1.657]	-.060 (-.615) [1.644]	-.074 (-.708) [1.782]	-.178 (-1.689) [1.861]	-.218 (-1.741) [2.179]
Urban Population, 1990 (residualized)	.338*** (3.764) [1.639]	.254* (2.547) [1.728]	.237* (2.136) [1.994]	.086 (.743) [2.231]	.039 (.292) [2.437]
Exports / GDP, 1990 (log)	.110 (1.381) [1.293]	.138 (1.583) [1.322]	.133 (1.471) [1.316]	.082 (.898) [1.376]	.093 (.946) [1.332]
Domestic Inequality		-.106 (-1.265) [1.226]	-.108 (-1.139) [1.466]	.020 (.201) [1.662]	.097 (.870) [1.721]
Secondary Education, 1990 (residualized)			-.027 (-.312) [1.192]	.002 (.024) [1.262]	-.011 (-.110) [1.479]
Services / GDP, 1990				-.163 (-1.777) [1.403]	-.127 (-1.313) [1.296]
Export Partner Concentration, 1990					-.045 (-.401) [1.720]
Constant	.475 (.225)	.635 (.292)	.787 (.338)	.100 (.047)	1.614 (.564)
Sample Size	69	57	54	52	44
Adjusted R^2	.665	.677	.672	.694	.690

Note: T-Ratios are in parentheses; VIFs appear in brackets; ***p<.001; **p<.01; *p<.05

significant and close to null when including services and export partner concentration as additional controls. We speculate that the non-significant effect in the two most fully-controlled models is partly an artifact of the reduced sample size and the use of traditional linear regression techniques, rather than indirect effects models that treat urbanization as a mediating variable, partly a function of economic development and other social factors (e.g. Jorgenson 2003; Jorgenson and Burns 2004; Kentor 2001). However, the effect of urbanization is not the central focus of the current study.

Domestic income inequality proves to be a non-significant predictor of footprints of less-developed countries when controlling for the structure of export flows, which contradicts the findings of other recent studies (e.g. Jorgenson 2003, 2004a). Like York, Dietz and Rosa (2003), we find no evidence indicating that nations with more service-based economies consume lower levels of material resources. The effect of level of exports is non-significant across all tested models, and export partner concentration also proves to be a non-significant predictor of ecological footprints. Thus, the cumulative structure of export flows and the attributes of receiving countries are of more relevance than the overall level of exports or diversity of trading partners.

CONCLUSION

This study provides a new approach to the analysis of international trade, material consumption, and concomitant environmental degradation. Foremost, we created an index that measures the relative extent to which exports of less-developed countries are sent to higher-consuming, more developed countries. Using this new index, we tested and confirmed the hypothesis that less-developed countries with higher levels of exports sent to more-developed countries exhibit lower domestic levels of resource consumption, measured as per capita ecological footprints. This finding is illustrative of the theorized structural conditions in which higher-consuming countries externalize their consumption-based environmental costs through the tapping of raw materials and produced commodities from less-developed countries, which tempers material consumption levels, thereby restricting the ecological footprints of the latter countries (e.g. Jorgenson 2005; Rice 2005).

Consistent with other recent studies of national footprints, level of economic development and urbanization positively affect per capita footprints of less-developed countries while the effect of size of service sector is non-significant (e.g. Jorgenson 2003, 2004a; York, Rosa, and Dietz 2003). The latter finding critically challenges neoclassical economic arguments concerning the environmental impacts of domestic economic conditions (e.g. Grossman and Krueger 1995). The overall level of exports and relative diversity in trading partners prove to be non-significant predictors of per capita footprints. Coupled with our most noteworthy finding concerning the effect of weighted export flows, these results suggest that the overall structure of exports is of more relevance to understanding variation in the ecological footprints of nations and perhaps the attendant forms of environmental degradation. More specifically, export flows and the attributes of receiving countries are central considerations when analyzing the variety of consumption-based environmental impacts of international trade.

Proponents of comparative advantage theory and other neoliberal perspectives (e.g. Magee 1980; Ricardo [1821] 1951) might argue that the findings of this study, particularly the negative effect of weighted export flows on the per capita footprints of less-developed countries, illustrate the overall environmental "benefits" of trade (i.e. "trade specialization"). However, cross-national studies provide evidence that nations with lower footprints experience higher domestic levels of particular forms of environmental degradation and serious health problems, including elevated infant mortality rates (e.g. Jorgenson 2003; Jorgenson and Burns 2004; see also Lofdahl 2002). Undoubtedly, the health and well-being of populations are largely a function of access to adequate shelter and consumption of minimal levels of food (Jenkins and Scanlan 2001; Jorgenson 2005), both of which are included in the composite footprints analyzed in the present study.

Thus, the per capita footprints of nations could be treated as a partial indicator of human quality of life (Rice 2005; see also Prescott-Allen 2001). Moreover, a large proportion of the less-developed countries included in the current study exhibit footprints below their bio-capacity per capita[6] (Venetoulis et al. 2004; Wackernagel et al. 2002). Indeed, their relatively low levels of globally sustainable consumption and high levels of domestic environmental degradation are characteristics of underdevelopment stemming from asymmetrical exchanges between developed and less-developed countries (e.g. Chase-Dunn 1998; Emmanuel 1972; Hornborg 2001; Jorgenson 2005; McMichael 2004).

For less-developed countries to share in the development outcomes exhibited by richer, more powerful countries they first must secure access to greater levels of material consumption within the confines of the biologically productive limits of the global environment. Asymmetrical processes of ecological exchange, however, highlight the challenges in doing so when the structure of export flows increases the material consumption opportunities of more economically devel-

6. Global bio-capacity per capita is calculated by dividing all the biologically productive land and sea on earth by the total world population, which provides a general global estimate of human sustainable levels of consumption.

oped trading partners at the expense of less-developed countries. Arguably, such uneven consumption dynamics are not only complicit in promoting increasing global environmental demand but also linked to the diminishing opportunities of less-developed countries to achieve socio-economic stability and domestic ecological protection.

The next steps in this research agenda involve studying the effects of the structure of export flows on particular forms of environmental degradation, including deforestation, organic water pollution, and greenhouse gas emissions. These future analyses coupled with the findings of the present study will provide more comprehensive evidence of the uneven interrelationships between the divergent levels of resource consumption among nations and high levels of particular forms of environmental degradation within the borders of lower-consuming, less-developed countries.

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