The Impact of Foreign Direct Investment on the Ecological Footprint of Nations

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Introduction

FDI is a flow traditionally associated with transfer of knowledge, technology and management practices from home countries to host countries. FDI has become of very significant part of globalization activities. FDI is known to bring a composition effect, a technique effect and scale effect to firms' operations. The composition effect may cause a structural change with one sector shrinking and another one expanding, which can have various impacts on the existing ecosystems and biocapacity of a nation in general. The technique effect refers to a transfer of new technologies, which can potentially improve the state of the ecosystems.

As part of globalization, the existing environmental literature links FDI to environmental change because of several hypothesized processes: a "race to the bottom", also known as the "pollution heaven hypothesis" (Copeland and Taylor, 1994), an "FDI halo hypothesis" (Eskeland and Harrison, 2003; Doytch and Uctum, 2016), and an "Environmental Kuznets curve (EKC)" hypothesis (Shafik, 1994, Grossman and Krueger, 1995, Holtz-Eaking and Selden, 1995, Hilton and Levinson, 1998). The "pollution heaven hypothesis" states that FDI flows tend to go to countries where the environmental regulations are lax and therefore lead to a shift of enterprises from more developed to less developed nations[1]. The "FDI halo" hypothesis states that

[1] The original pollution haven hypothesis (Copeland and Taylor, 1994) states that as trade is liberalized, industries that pollute shift from rich countries with tight regulation to poor countries with weak regulation and conversely,

multinational firms that originate in more developed countries oftentimes have the ability and resources to disseminate superior knowledge and environmental practices to local firms that originate in less developed nations. As such, multinationals become a vehicle for dissemination of improved environmental standards and laws. The "Environmental Kuznets curve (EKC)" also plays a role in the processes of FDI impacting the environment, since it implicitly captures effects associated with the environment. The EKC is oftentimes described by an inverse U-shaped relation between pollution and income. It corresponds to the fact that countries tend to pollute more in the industrialization phase of their development and then- less as they become more developed and have smaller share of "dirty" sectors in their economies[2].

In this paper, we argue that the three environmental literature concepts, listed above, are implementable to the ecological concept of the Ecological Footprint (EF), which measures not only pollution, but also natural resources, including ecosystems' services, needed to support human demand and production activities. The *Global Footprint Network* defines four different kinds of ecological footprints: *Consumption EF, Production EF, Imports EF,* and *Exports EF*, computed based on the National Footprint Accounts of Global Footprint Network. They all represent exhaustion of biocapacity. i.e. ecosystems for the satisfaction of human-induced economic activities. The *Consumption EF* indicates the consumption of biocapacity embedded directly in human consumption of goods and services; the *Production EF* indicates the consumption of biocapacity resulting from production processes, and the *Imports EF* and

clean industries migrate towards rich countries. Although related to the halo effect, since our emphasis will not be on the impact of regulation on environment and investment decisions, we will not address this literature here. For a survey of the earlier literature see Jaffee et al. (1995) and more recent literature Dong et al. (2012) and Chung (2014).

[2] The initial research corroborated the EKC argument (Shafik, 1994, Grossman and Krueger, 1995, Holtz-Eaking and Selden, 1995, Hilton and Levinson, 1998). More recent research, however casts doubt on the existence of a neat inverse U-shaped relation (Stern, 1998, Harbaugh et al. 2002, Hettige et al. 2000).

Exports EF indicate consumption of biocapacity, associated with international trade activities. All ecological footprints are measured in global hectares areas (gha).

Disaggregation of the FDI flows in the analysis is becoming an increasingly common approach. To a large extent the impact of FDI on productivity is not intra-industry but rather inter-industry and inter-sectoral (Doytch and Uctum, 2011). Some the other recent studies that have applied this approach are Vu and Noy (2009), focused on productivity spillovers in six developed economies and Slimane et al. (2015). In addition, FDI can possesses and unfold a significant technique effect. c, who study the effect of sectoral FDI on renewable energy consumption find evidence of energy-saving technologies, associated with services FDI. In the environmental literature, services FDI to industrialized nations are also known to cause an "FDI halo" effect, i.e. an effect of reduction of environmental pollution (Doytch and Uctum, 2016).

Although there have been previous studies examining the direct impacts of FDI on the environment, including sectoral FDI, in the ecological economics literature, this subject is new. The goal of this study is to estimate a number of different effects- the sectoral FDI effects on all four ecological footprints and within country groups with different levels of the development according to countries' per-capita income distribution. In that way, we offer several innovations:

(1) This is the first study (to our knowledge so far) to estimate the FDI effects across four different kinds of ecological footprints.
(2) It is the first study to estimate the ecological effects of FDI within country groups that account for level of development. For this, we utilize an income distribution of countries, provided by the World Bank with a modification. First, we use 3 categories of countries, instead of four, combining the World Bank's two categories into one.

And second, we create a dynamic concept of income level, allowing countries to transition between categories and using the World Bank methodology for that.

(3) This is first study that takes into account the FDI sectoral distribution in the ecological analysis[3]. The sector-level and industry-level flows considered are: extractive industries FDI; manufacturing FDI; aggregate services FDI; and the differentiated services FDI flows, namely financial services FDI and non-financial services FDI.

(4) The study utilizes a model that accounts for EKC in the process of the estimations.

(5) The study merges two unique data sets- the (now open-source) ecological footprints data, compiled by the *Global Footprint Network* and the proprietary data on sectoral FDI, compiled by UNCTAD.

(6) We use a dynamic panel method of estimation- the Blundell- Bond system GMM, which allows us to control for endogenity problems in the data while exploring both the cross-section and the time-series variation in the data[4].

The main findings are:

(1) Overall, High Income countries tend to experience more of a consumption-related ecological impact of FDI, whereas Low and Middle Income countries tend to experience more of production-related ecological impact of FDI.

(2) The production-related impacts of FDI are distributed in the following way: while Middle Income countries tend to bear the *Exports EF* impact of FDI, Low Income countries bear the domestic *Production EF* -related impact of FDI.

[3] The sector of FDI matters for productivity and environmental spillovers (Doytch and Uctum, 2011; Liu, 2008, Doytch and Uctum, 2016)

[4] See Arellano and Bover (1995) and Blundell and Bond (1998).

(3) There is evidence in favor of validity of an "FDI ecological heaven" hypothesis when we examine the *Imports EF* and *Exports EF*. FDI has more of an impact on *Imports EF* of wealthier countries, High Income and Middle Income, and more of an impact on *Exports EF* of poorer countries- Middle Income and Low Income.

(4) The sectoral distribution of FDI is important when taken in conjunction with the income distribution of countries. In High Income countries services FDI flows- an effect attributed to financial services FDI, can produce a reduction impact of the *Production EF,* rather than contribute to its worsening- evidence for the FDI halo hypothesis. In Low Income countries, the same flow causes an opposite effect on the same footprint.

(5) Although the effects of FDI are fairly well-spread among different sectoral flows, one thing that emerges as a general finding is the detrimental role non-financial services FDI flows play for ecological footprints. Surprisingly, and this is different from some environmental studies on FDI[5], manufacturing FDI in not the most detrimental flow for the ecological ecosystems. Since the ecological footprints measure not only the pollution generated directly as a result of economic activity, but also resource exhaustion needed to support economic activities, the manufacturing sector activities need not to be the most detrimental ones. The footprints measures take into account consumption effects as well as direct production effects. As it turns out, non-financial services FDI produce more ecosystems' degradation than manufacturing FDI.

1. (Working) Literature Review.

[5] Doytch and Uctum, 2016.

The Global Footprint Network defines "ecological footprint" as human demand for consuming nature. The measure captures the biophysical burden imposed by populations and industrial processes on the supportive ecosystems (Rees, 2001; Kissinger and Rees, 2010). This biophysical burden is quantified by adding the energy, the material consumption, the waste generation, and the ecosystem productivity to estimate a total ecosystem area required to support economic activities (Rees, 1992; Rees and Wackernagel, 1994; Wackernagel and Rees, 1996; WWF, 2006; Kissinger and Rees, 2010).[6]

There is now research consensus that increasing human demand for biologically productive land and ocean area is starting to have a significant effect on nature's ability to recover its ecosystems (Winzettel et al., 2013; Butchart et al., 2010; Defries et al., 2010; Foley et al., 2005, 2011; Godfray et al., 2010; Lambin and Meyfroidt, 2011; Pauly et al., 2002; Tilman et al., 2009; Wirsenius et al., 2010). The question of whether the rates of use of ecosystem services decouple from economic development at certain stage of development has been the object of a number of recent studies (Myers and Kent, 2003; Tilman et al., 2011; Krausmann et al., 2009; Steinberger and Krausmann, 2011). One of the hypotheses is that globalized economic activities (international trade, international capital flows) distort the processes of ecosystems use for economic development. Countries use ecosystems located abroad to cover for consumption of food, minerals and energy at home. They also use foreign ecosystems to absorb home countries' waste.

The question of the international transfers of biocapacity burden recently gave rise to the topic of ecological inequality between countries Moran et al. (2013). Classical trade theory posits

[6] The index actually estimates several different kinds of land areas: cropland, forests, grazing land, and fishing grounds (Global Footprint Network). However, the specific cartelistic of these different ecosystems are left out this study. We are concerned with the impact of FDI on all them take as an aggregate.

that countries rich in certain resources tend to specialize in production that uses intensively these resources. In this way, ecologically unequal exchanges are a "natural" outcome. Proponents of the classical view would say that globalization tends to increase factor productivity and wealth (Das, 2004; Bhagwati, 2004; Stiglitz, 2006). Therefore, in the long run international trade would lead to better standards of living, including environmental standards of living (Easterbrook, 1995; Simon, 1996; Das, 2004; Bhagwati, 2004). In that way, globalization and trade generates the necessary income to pay for potential environmental improvements (Beckerman, 1995; Bhagwati, 2004). Newer studies, however, criticize these postulates raising the existence of market failures (Daly and Townsend, 1993; Norgaard, 1990; Rees and Wackernagel, 1999). These authors point out the inadequate valuation of ecosystem services, which turns certain ecosystems into pollution sinks and leads to overexploitation of natural resources.

Moran et al., (2013) point out that the current patterns of international biomass use and their drivers are not fully understood. Some of the unresolved question include: is there a transition to a new levels and rates of biomass consumption with development or is there decoupling of the two processes (Myers and Kent, 2003; Tilman et al., 2011, Krausmann et al., 2009); does the EKC hold, since it appears to be mostly a time series phenomenon and cross-sectional studies struggle to find it (Steinberger and Krausmann, 2011; Al-Mulali et al., 2015); what is the role of globalization- importing food, energy, fiber etc. and exporting waste, into the coupling/decoupling of ecological change and economic development. (Erb et al., 2009; Lambin and Meyfroidt, 2011; Mayer et al., 2005; Rudel et al., 2009).

With respect to trade, Moran et al., (2013) find that ecological trade deficit shows some co-variation with financial trade deficit; exports from developing nations tend to be relatively ecologically intensive; and fail to confirm that high income countries tend to exert

disproportionate ecological effects on low income countries. Although the specific focus of our study is slightly different- the impact of FDI on the ecological footprints and in part deficit, our broad scope is also the internationalization of ecological biomass consumption. Our findings give a different perspective to the results of Moran et al., (2013). For example, we find that mining FDI (associated with relatively ecologically-intensive activity) increase the Exports EF of Low income nations. However, conversely to Moran et al. et al., (2013), we find that High Income nations do experience a significant *Imports EF* increase due to some kinds of FDI (non-financial services FDI), whereas the same countries do not experience a significant FDI impact on their *Exports EF.*

Although the pollution effects of FDI have been studied to some extent, the ecological effects of FDI in terms of biomass loss have not been examined. In the environmental literature FDI is the object of firm-level studies that generally examine the effects of manufacturing FDI. Among the studies that find mixed evidence about the role of FDI are: Pargal and Wheeler, (1996); Hartman et al., (1997); Dasgupta et al. (2000). However, more recently, a few studies find stronger support for the FDI halo hypothesis. For example, Eskeland and Harrison (2003), who analyze outbound US FDI, find that foreign plants are significantly more energy efficient and cleaner in their energy uses than their domestic partners and Cole et al. (2008) find that foreign training of firm's managers does reduce fuel use especially in foreign owned firms.

Some of the strongest support for the FDI halo hypothesis is found in Albornoz et al. (2009), who study Argentinian firms. They find that: (i) foreign-owned firms are more likely to implement environmental management systems compared to domestic firms; (ii) firms that supply sectors with high multinationals more likely adopt environmental management systems;

(iii) firms' absorptive capacity, ownership and export status also influence the extent to which they benefit from environmental spillovers.

The goal of this study is to cast light over the ecological effects of FDI.

2. Stylized facts about the ecological footprints.

3. Methodology.

Equation (1) describes the empirical model used, which is consistent with the existing literature (Doytch and Uctum, 2016).

$$(1) ln\left(EF_{it}^{k}\right) = \beta_0 + \beta_1 ln\left(EF_{it}^{k}\right) + \beta_2 \log(y_{it}) + \beta_3\left[\log\left(y_{i,t}\right)\right]^2 + \beta_4 f_{it}^{j} + \beta_5 anticor_{it} + \beta_6 D^t + \mu_i + \varepsilon_{it}$$

with $\mu_i \sim i.i.d(0,\sigma_{\mu_i})$, $\varepsilon_{it} \sim$ i.i.d.$(0,\sigma_{\varepsilon})$, $E[\mu_i \varepsilon_{it}] = 0$ and where where *i* is the country sub-subscript and the subscript *j* stands for an index for total, mining, manufacturing, total services, financial services, non-financial services FDI. The variable EF_{it}^{k} is the index of the ecological footprint with the super-script *k* denoting respectively Consumption EF; Production EF; Imports EF; and exports EF; y_{it} is measure of per-capita GDP in const. 2005 USD, and ${f_{it}}^{j}$ is the respective net FDI inflow share of GDP. The EKC effect is captured by the terms $\beta_2 \log(y_{it}) + \beta_3\left[\log\left(y_{i,t}\right)\right]^2$. If $\beta_2 > 0$ *and* $\beta_3 < 0$, then there is an inverse U shaped relation between EF_{it}^{k} and y_{it}. The $anticor_{it}$ is an index of control of corruption, which is used as a proxy for institutional quality. It ranged from 0 to 6, 6 being the highest control of corruption. D^t is a time dummy and μ_i is an idiosyncratic country specific effect.

If $\beta_2 > 0 \; and \;\; \beta_3 < 0$, then there is an inverse U-shaped relation between EF_{it}^{k} and y_{it}. If $\beta_4 < 0$, then the impact of FDI on EF is one of reduction, whereas $\beta_4 > 0$ indicates a contribution of FDI to the accumulation of EF. Although we expect $\beta_5 < 0$, meaning a positive effect of control of corruption on reducing EF, this effect can also go in reverse- stronger control of corruption- more ecological degradation, because of a positive effect on production activity and income.

We choose a dynamic-effects methodology in order to capture the long memory in the process of accumulation of the ecological footprint. In that respect, the system GMM method allows us to capture both the cross-sectional and the time-series characteristics of the data (Alonso-Borrego and Arellano, 1996; Blundell and Bond, 1998). At the same time, it allows us to control for the endogeneity and possible reverse causality between FDI and the four ecological footprints. We also control for the correlation between lagged dependent, which part of the process by design, and the unobserved residual. This method is an improvement upon the static method of fixed effects, which suffers a bias, caused by the correlation between $EF_{i,t-1}^{k}$ and μ_i - a bias that does not disappear with time-averaging. If such a correlation exists, the true underlying structure of the data is a dynamic one and time-averaging introduces a bias that cannot be removed by applying the method of fixed effects[7].

The system GMM method, developed by Alonso-Borrego and Arellano (1996) and Blundell and Bond (1998) is also an improvement upon the difference GMM method, developed by Arellano and Bond (1991). Under the following conditions, the variance of Arellano-Bond estimates may increase asymptotically and create considerable bias: (i) the dependent variable follows a random walk, which makes the first lag a poor instrument for its difference, (ii) the

[7] See Doytch and Uctum (2011).

explanatory variables are persistent over time, which makes the lagged levels weak instruments for their differences, (iii) the time dimension of the sample is small (Alonso-Borrego and Arellano, 1996; Blundell and Bond, 1998).

An additional necessary condition for the efficiency of the Blundell-Bond system GMM estimator is that, even if the unobserved country-specific effect is correlated with the regressors' levels, it is not correlated with their differences. This condition also means that the deviations of the initial values of the independent variables from their long-run values are not systematically related to the country-specific effects.[8] FDI is instrumented with GMM style 2-lag instruments, which will account for reverse causality between FDI and the four EF indexes.[9] We perform robustness checks with the method of fixed effects.

4. Data

We use annual data for 117 countries, spanning 1984 to 2011. We disaggregate the sample of countries based on level of development: 1-Low Income Countries; 2- Middle Income; and 3-High Income[10]. The groups are based on the World Bank country classification, combining categories "Low Income" and "Lower Middle Income" from the World Bank classification into our "1-Low Income Countries" and renaming the "Upper Middle Income" World Bank

[8] These sets of conditions are:
(i) No second order autocorrelation in the error term: $E[EF^{k}_{i,t-s}\ (\varepsilon_{it} - \varepsilon_{i,t-1})] = 0$ for s≥2 and t=3,….T ; $E[y_{i,t-s}(\varepsilon_{it} - \varepsilon_{i,t-1})] = 0$ for s≥2 and t=3,….T; $E[f^{j}_{i,t-s}(\varepsilon_{it} - \varepsilon_{i,t-1})] = 0$ for s≥2 and t=3,….T, where y_{it} , f^{j}_{it} are the level of income and FDI, respectively and where for instruments we use their past levels and differences.
(ii) No correlation of the unobserved country-specific effect with their difference requires: $E[(EF^{k}_{i,t-1} - EF^{k}_{i,t-2})(\mu_i + \varepsilon_{it})] = 0$; $E[(y_{i,t-1} - y_{i,t-2})(\mu_i + \varepsilon_{it})] = 0$; $E[(f^{j}_{i,t-1} - f^{j}_{i,t-2})(\mu_i + \varepsilon_{it})] = 0$. This condition allows using lagged first differences as instruments for levels.

[9] We present here a set of results based on the minimum optimum lags, an approach that we selected to preserve the degrees of freedom (Roodman, 2006).

[10] Table 1 displays the list of countries in the sample under four categories.

classification into our “2- Middle Income Countries”. The “High Income Countries” in the World Bank and our classifications overlap.

In addition, we define our income level classification as a dynamic one: we allow for countries to transition from one income group to another as they develop. The per-capita gross national product (GNI) ranges for each category are as follows: "Low Income"- GNI<= $4,125; "Middle Income"- $4,125<GNI<= $12,736; and "High Income”- GNI >$12,736, where GNI is computed based on the "World Bank Atlas" method. For all country groups, please see Table 1.

<Insert Table 1>

The dependent variables, the four Ecological Footprint indicators, *Consumption EF, Production EF, Imports EF,* and *Exports EF*, are computed based on the National Footprint Accounts of Global Footprint Network. The National Footprint Accounts (NFAs) measure the ecological resource use and resource capacies of countries over time. In this study, we use the four measures of ecological resource exhaustion in order to estimate how presence of foreign ownership affects them. These four measures reflect societies’ demand side for natural resources.

The supply side of natural resources is determined by the biocapacity. The biocapacity is measured by calculating the amount of biologically productive land and sea area (cropland, forest, grazing land and fisheries) available to provide the resources a population consumes and to absorb its wastes, given current technology and management practices (Global Footprint Network). It could be thought of as the productivity of a country’s ecosystems. A country is said to have an ecological reserve if its Footprint is smaller than its biocapacity; otherwise it is operating with an ecological deficit. The former are often referred to as ecological creditors, and

the latter ecological debtors (Global Footprint Network). We treat this ecosystem productivity as provided by solely by nature and therefore leave it out of our model. In other words, we estimate the FDI effect directly on the footprints, not the ecological deficits or surpluses.

The calculations in the National Footprint Accounts, provided by the Global Footprint Network are based on United Nations data sets, including the Food and Agriculture Organization, the United Nations Commodity Trade Statistics Database, and the UN Statistics Division, as well as the International Energy Agency. Supplementary data sources include studies in peer-reviewed science journals and thematic collections (Global Footprint Network).

The Ecological Footprint is derived by tracking how much biologically productive area it takes to absorb a population's carbon dioxide emissions and to generate all the resources it consumes by four economic activities: consumption, production, importing and exporting (Global Footprint Network). All commodities carry with them an embedded amount of bioproductive land and sea area necessary to produce them and absorb the associated waste. Therefore, international trade flows can also be seen as flows embodying Ecological Footprint. The four different EF measures are related in the following way:

(2) Consumption EF_{it} = Production EF_{it} + (Imports EF_{it} – Exports EF_{it})

The *Consumption EF* indicates the consumption of biocapacity by the inhabitants of a country. It is most amenable to change through changes in individuals' consumption behavior. In order to assess the total domestic demand for resources and ecological services of population, the *Consumption EF* accounts for both, the export of natural resources and ecological services for

use in other countries, and the import of resources and ecological services for domestic consumption (Global Footprint Network).

The *Production EF* indicates the consumption of biocapacity resulting from production processes with a given geographical area, such as a country. It represents the sum of all bioproductive areas within a country necessary for supporting the actual harvest of primary products (cropland, grazing land, forestland, and fisheries), the country's build-up area (rods, factories, cities), and the area needed to absorb all fossil fuel carbon emissions generated within the country. From a certain perspective, this measure mirrors GDP (Global Footprint Network).

The *Imports EF* and *Exports EF* indicate the use of biocapacity within international trade activities. If *Exports EF > Imports EF,* the country is a net exporter of natural resources and ecological services. If *Imports EF > Exports EF,* then the country is a net importer of natural resources and ecological services (Global Footprint Network).

The calculation methodology for the National Footprint Accounts 2011 edition has been published in the *Ecological Indicators* Journal (Vol. 24: pages 518-533). The actual implementation of the National Footprint Accounts through database-supported templates is described in the Guidebook to the National Footprint Accounts 2016. The Ecological Footprint Standards 2009 are the current operational standards that we use with all of our partners and businesses, including our 2016 Edition of the National Footprint Accounts[11] (Global Footprint Network).

[11] The 2009 Standards build on the first set of internationally recognized Ecological Footprint Standards, released in 2006, and include key updates—such as, for the first time, providing standards and guidelines for product and organizational Footprint assessments. The Ecological Footprint Standards 2009 are designed to ensure that Footprint assessments are produced consistently and according to community-proposed best practices. They aim to ensure that

The key independent variables are disaggregated FDI flows share of GDP denominated in current USD. All *FDI* series are *net flows*, accounting for the purchases and sales of domestic assets by foreigners in the corresponding year. FDI is defined as investment that "reflects the objective of obtaining a lasting interest by a resident entity in one economy (''direct investor") in an entity resident in an economy other than that of the investor (''direct investment enterprise")" (OECD, *International direct investment database,* Metadata). This lasting interest implies a long-term relationship between the direct investor and the enterprise and a significant influence on the management of the enterprise. The data on sectoral FDI inflows to mining, manufacturing, financial services and nonfinancial services FDI are compiled from *United Nations Conference on Trade and Development* (UNCTAD), *Organization for Economic Cooperation and Development* (OECD), *The Association of Southeast Asian Nations* (ASEAN), and individual national statistical agencies web sites.

Institutional variables are from the *International Country Risk Group* (ICRG). Following the environmental effects of FDI literature, we adopted the control of corruption as an independent variable. It is measured from 0 to 6, 0 representing the countries with worst corruption and 6 representing countries with the best practices. The index refers to actual or potential corruption in the form of excessive patronage, nepotism, job reservations, 'favor-for-favors', secret party funding, and suspiciously close ties between politics and business. These sorts of corruption are potentially corrosive to growth performance and of great risk to foreign business in that they can lead to popular discontent, unrealistic and inefficient controls on the

assessments are conducted and communicated in a way that is accurate and transparent, by providing standards and guidelines on such issues as use of source data, derivation of conversion factors, establishment of study boundaries, and communication of findings. The Standards are applicable to all Footprint studies, including sub-national populations, products, and organizations (Global Footprint Network).

state economy, and encourage the development of the black market (*International Country Risk Guide)*.

5. Results Overview

The empirical results are summarized in Tables 2 and 3, where we post the extracted coefficients of FDI effects on EF and the estimates about the EKC. Since we run a large number of models (four different EF indexes time four country groups times six different sectoral FDI), the full regression results are listed as a Supplement. Both, Table 2 and Table 3, consist of four panels. Table 2 describes the estimates of FDI and the four panels respectively present: upper left- "Panel 1- Impact of FDI on the Consumption EF"; lower left- "Panel 2- Impact of FDI on the Production EF"; upper right- "Panel 3- Impact of FDI on Imports EF"; and lower right- "Panel 4- Impact of FDI on Exports EF". The structure of Table 3 is the same as Table 2. However, the panels of results present estimates of coefficients $\beta_2 \; and \; \beta_3$, which indicate presence or absence of an EKC. The four panels of Table 3 respectively represent: upper left- "Panel 1- EKC with Consumption EF"; lower left- "Panel 2- EKC with Production EF"; upper right- "Panel 3- EKC with Imports EF"; and lower right- "Panel 4- EKC with Exports EF".

If we view the panels of Table 2 and Table 3 as vertical blocks of panels, the *Left Block*, consisting of Panels 1 & 2 represents impacts related to domestic economy EF- *Consumption EF* and *Production EF*. At the same time, the *Right Block*, consisting of Panels 3 & 4 represents impacts related to economy's external trade linkages- *Imports EF* and *Exports EF*. Likewise, if we view Tables 2 and 3 as horizontal blocks, the *Top Block*, consisting of Panels 1 & 3 represents impact from activities related to consumption - *Consumption EF* and *Imports EF* and

the *Bottom Block,* consisting of Panels 2 & 4 - activities related to production, *Production EF* and *Exports EF*.

The role of the different idiosyncratic shocks to different sectors is reflects in estimates of different sectoral FDI, presented in columns of each of the four panels of Tables 2 and 3. The six columns present respectively estimates of: (1) total (aggregate) FDI; (2) mining (extractive sectors) FDI; (3) manufacturing (secondary sector) FDI; (4) total services (an aggregate of financial and non-financial services) FDI; (5) financial services FDI; and (6) non-financial services FDI.

To control for heterogeneity of countries caused by different levels of development, we run the models within country groups with similar income distributions. These effects are displayed in rows of each of the four EF panels in the following fashion: row (1)- "All Countries"; row (2)- "Low Income Countries"; row (3) – "Middle Income Countries"; row (4)- "High Income Countries". In Table 2, next to the FDI estimates, we also report the number of observations, of countries and AR(2) p-values from each model. The full results of models in rows (1), corresponding to the full country sample- all 117 countries are listed in Tables 4-8.

A brief overview of the results of the impact of sectoral FDI on the *Consumption EF* in Table 2, Panel 1, show that non-financial services FDI, which comprise of[12] the value added in wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional, and personal services such as education, health care, as well as real estate services, play is significant role in the accumulation of the *Consumption EF* in both Low and High Income countries (Table 2, Panel 1, rows 1, 2 & 4, column 6). At the same time

[12] Services correspond to ISIC divisions 50–99.

manufacturing FDI play a role in the *Consumption EF* of High Income countries (Table 2, Panel 1, row 4, column 4).

The non-financial services FDI and the manufacturing FDI flows appear to be among the most important flows, when we look at the accumulation of EF from a production perspective as well. Examining Panel 2 of Table 2, we uncover positive and significant effects by these flows in Low Income Countries (Table 2, Panel 2, row 2, columns 4 & 6). They also translate to an overall positive effect of total FDI on the *Production EF* of these countries (Table 2, Panel 2, row 2, columns 1). These positive effects are, of course no good ecological news for Low Income countries as they represent ecological degradation due to production activities by foreign owners in these countries. This is in fact consistent with the "pollution haven" hypothesis known from the environmental pollution literature (Copeland and Taylor, 1994). Mining FDI plays a similar environmental degrading role in Middle and High Income countries when we estimate the effects on the *Production EF* (Table 2, Panel 2, rows 3&4, column 2).

The impact of services FDI in High Income countries, which could be attributed to financial services FDI, however, goes in the opposite direction; it produces a negative significant impact on the *Production EF* (Table 2, Panel 2, rows 4, column 4&5). A negative impact means reduction of the EF by these flows in High Income Countries. This is in fact consistent with what previous studies have found regarding the CO2 pollution effects of FDI (Doytch and Uctum, 2016). This effect is known as a "FDI halo effect" in the pollution literature. Although it sounds counter-intuitive at first, what the effect represents is actually the development of non-polluting and therefore less *Production EF*-contributing, sectors of the economy. This effect is typical for High Income economies as they have a large share of services FDI in FDI and large shares of the services sectors in the economies in general (Doytch and Uctum, 2011). Services FDI in this case

plays a diverting role of resources from more ecologically exhaustive to less ecologically exhaustive sectors.

This "ecological halo" effect appears to be most pronounced through an impact on *Production EF.* The *Consumption EF* of these countries reflects more of the income effect of FDI. As we see in Table 2, Panel 1, the *c* effect of non-financial services FDI specifically is positive (Table 2, Panel 1, row 4, column 6), reflecting a FDI contribution to rising incomes and therefore, ecological degradation, due to increased consumption of goods and services.

Continuing with the analysis of the consumption effect of FDI, we can move in to Panel 3 of Table 2. Panel 3 represents a different effect on consumption- one that estimates the EF embedded in imported goods. We hypothesize that FDI flows that have strong income effects may have similar impact on the *Consumption EF* and the *Imports EF*. In fact, the *Imports EF* can be thought of as a part of the *c* according to equation 2. It represents the ecological degradation embedded in imported goods and services consumed. We hypothesize that this effect should be more pronounced for more developed countries, as they run larger trade deficits and allegedly prefer to import goods with "dirty" production processes.

In that respect, non-financial services FDI appear to be the flow that causes enough of an income effect to change significantly the accumulation of *Imports EF* in Middle and High Income economies (Table 2, Panel 3, rows 3&4, column 6). Whereas the effect on High Income countries is consistent with the effect on *Consumption EF,* the effect of these flows within Middle Income countries is new. Regarding Low Income countries FDI, only mining (extractive industries) FDI appears to be causing a significant enough income effect to have an effect on the *Imports EF* (Table 2, Panel 3, row 2, column 2). This effect is visible when "All Countries" are examined together (Table 2, Panel 3, row 1, column 2).

Finally, when considering the *Exports EF* in Panel 4 of Table 2, we hypothesize that the *Exports EF* effects should be stronger for poorer countries, Low and possibly Middle Income countries, if an "FDI ecological haven" hypothesis is correct. These are the countries, where allegedly firms from wealthier countries with stricter environmental regulations go to pollute and exploit the natural resources of and then export large shares of that production. In other word, the "ecological haven" could be captured by analyzing the *Imports EF* of rich countries or by analyzing the *c* of poorer nations.

A quick overview of the FDI effects in Panel 4 of Table 2 show that indeed, consistent with the "FDI ecological haven" hypothesis, High Income countries do not suffer ecological degradation from FDI, whereas there are positive significant effects from several FDI flows observed in Low Income and Middle Income countries. More specifically, foreign firms in the extractives sector, as well as the sectors of financial and non-financial services in Middle Income countries appear to contribute significantly their *Exports EF* (Table 2, Panel 4, row 3, columns 2, 4, 5&6). The effect of these activities should be thought of as a production effect, since the *Exports EF* enters the *Consumption EF* equation 2 with a negative sign.

One interpretation of this negative production effect is a direct environmental degradation and depletion of the natural resources due to the presence of foreign firms in the economy. This is a plausible explanation for the mining FDI effect and the non-financial services FDI effect, as non-financial services comprise some heavily polluting sectors, for example transportation. Another interpretation of the Exports EF-augmenting effect of FDI in Middle Income countries could be an indirect effect on the economy. For example, the presence of foreign banks (financial FDI) boosts up economic activity through increased lending and crediting of business, which in turn, engage in ecologically degradable economic activities. Whether direct or indirect, the effect

of foreign ownership of firms appear to be ecologically detrimental for Low Income and Middle Income countries. For Low Income countries, this effect is attributable to mining FDI (Table 2, Panel 4, row 2, columns 2). This is consistent with the large fraction of extractives in the export sectors of these countries.

With respect to the EKC results, Table 3 uncovers several cases when the EKC holds- with *Consumption EF* and *Production EF* and the sub-samples of "All Countries" and "Low Income Countries" (Table 3, Panels 1&2, rows 1&2). We observe presence of EKC with the *Exports EF* in isolated cases- with non-financial services FDI and Low Income countries and financial FDI within all countries (Table 3, Panel 4, row 1, columns 1&5; row 2, column 6). In this way, the hypothesis that pollution worsens during the initial growth process and improves as income rises is verified for the sample of all countries, where the heterogeneity in development is large, and also for the cases of the *Consumption EF* and *Production EF.* In these cases, EKC hold irrespective of the sector of FDI inflow.

An interesting finding that is consistent with previous pollution EKC findings, is that EKC is mostly inexistent in high-income countries[13]. This suggests that traditional EKC results hold only at the early stages of development.

Finally, we briefly review the results about the impact of corruption control (anticorruption) on the four ecological footprints[14]. Control of corruption worsens the *Consumption EF* for High Income Countries absorbing mining and non-financial services FDI; improves (reduces) the *Production EF* in Middle Income countries, receiving mining and services flows and High Income Countries receiving manufacturing FDI flows; improves (reduces) the *Exports EF* in Low Income countries, receiving services FDI flows; and worsens

[13] See Doytch and Uctum (2016).
[14] Many of these results are displayed in the Supplementary tables due to lack of space to show all in the paper.

(expands) the *Exports EF* in High Income countries receiving mining FDI flows. Like the EKC results, we find no cases of impact of anticorruption on the *Imports EF*.

6. Discussion.

When domestic EF are considered, the *Consumption EF* and the *Production EF* in the *Left Block* of Table 2, the most detrimental international flows for the economies are mining and non-financial services FDI flows (Table 2, Panel 1: rows 2&4, columns 4&6; Panel 2: rows 1,2,3, columns 1,2, 4&6). The only flow appearing to cause an opposite- negative effect on ecological degradation, in fact contributing to enhancing biosystems services, is financial FDI. This is believed to be an indirect effect. However, it is present only in High Income Economies.

When we consider the ecological degradation embedded in traded goods and services (*Right Block* of Table 2), we find some evidence for the existence of FDI "ecological heavens". More developed countries (High and Middle Income countries) experience FDI contribution to ecological deterioration embedded in imported goods (this is true for non-financial services FDI to those countries- Table 2, Panel 3: rows 3&4, column 6) and less developed countries (Low and Middle Income economies) experience FDI contribution to ecological deterioration embedded in exported goods and services (this is true for mining and services flows- Table 2, Panel 4: rows 2&3, columns 2, 4,5, 6).

When we analyze the EF effects of FDI in terms of consumption vs. production effects (*Top Block* vs. *Bottom Block* of Table 2), we find consumption effects largely due to non-financial services FDI (Table 2, Panel 1&3: columns 6) and production effects spread out among almost all flows (Table 2, Panel 2&4).

In terms of level of development, countries are affect in different ways- High Income countries show some evidence of presence of "FDI halo" effects of financial services FDI on their *Production EF.* This is the little bit of evidence that FDI does not need to be necessarily ecologically detrimental. However, all effects we see in Low and Middle Income countries are of a "FDI ecological heaven" type. Low Income countries suffer Consumption EF, Production EF, Imports EF, and Exports EF worsening due to the presence of foreign firms in their extractive and services sectors (Table 2, all Panels: rows 2). At the same time, Middle Income countries suffer EF worsening due only to production activities and due to all kinds of FDI (Table 2, Panels 2&4, rows 3).

Conclusion

In this study, we obtain a rich set of results pertaining to the impact of sectoral FDI on four types of ecological footprints: *Consumption EF, Production EF, Imports EF*, and *Exports EF*. We control income and the squared term of income, the well-known environmental Kuznets curve (EKC) for the environmental literature. We also control for quality of institutions, proxied by control of corruption. Our findings can be interpreted in several different: (1) by impact on different types of footprints, taking into account that they pair up into footprints related to domestic economic activities (*Consumption EF and Production EF)* vs. external linkages (*Imports EF* and *Exports EF)* and footprints related to consumption (*Consumption EF and Imports EF)* and footprints related to production activities (*Consumption EF and Exports EF);* (2) by income distribution of countries (Low vs. Middle vs. High Income, in addition to the sample of "All Countries"); and (3) by sectoral FDI flow.

The main findings of the study include:

(1) Overall, High Income countries tend to experience more of a consumption-related ecological impact of FDI, whereas Low and Middle Income countries tend to experience more of production-related ecological impact of FDI.

(2) The production-related impacts of FDI are distributed in the following way: while Middle Income countries tend to bear the *Exports EF* impact of FDI, Low Income countries bear the domestic *Production EF* -related impact of FDI.

(3) There is evidence in favor of validity of an "FDI ecological heaven" hypothesis when we examine the *Imports EF* and *Exports EF*. FDI has more of an impact on *Imports EF* of wealthier countries, High Income and Middle Income, and more of an impact on *Exports EF* of poorer countries- Middle Income and Low Income.

(4) The sectoral distribution of FDI is important when taken in conjunction with the income distribution of countries. In High Income countries services FDI flows- an effect attributed to financial services FDI, can produce a reduction impact of the *Production EF,* rather than contribute to its worsening- evidence for the FDI halo hypothesis. In Low Income countries, the same flow causes an opposite effect on the same footprint.

(5) Although the effects of FDI are fairly well-spread among different sectoral flows, one thing that emerges as a general finding is the detrimental role non-financial services FDI flows play for ecological footprints. Surprisingly, and this is different from some environmental studies on FDI[15], manufacturing FDI in not the most detrimental flow for the ecological ecosytems. Since the ecological footprints measure not only the pollution generated directly as a result of economic activity, but also resource

[15] Doytch and Uctum, 2016.

exhaustion needed to support economic activities, the manufacturing sector activities need not to be the most detrimental ones. The footprints measures take into account consumption effects as well as direct production effects. As it turns out, non-financial services FDI produce more ecosystems' degradation than manufacturing FDI.

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Table 1: Country Income Group Classification

1 Low Income Countries; 2 Middle Income Countries; 3 High Income Countries.

Country	Data Coverage	Income Group	Country	Data Coverage	Income Group	Country	Data Coverage	Income Group
Albania	1971-2007	1	Greece	1971-2011	3	Pakistan	1971-2008	1
Albania	2008-2011	2	Guatemala	1971-2001	1	Pakistan	2009-2011	1
Argentina	1971-2012	2	Honduras	1971-2001	1	Panama	1971-2011	2
Armenia	1991-2011	1	Honduras	2002-2011	1	Paraguay	1971-2011	1
Austria	1971-2012	3	Hong Kong	1971-2011	3	Peru	1971-2009	1
Australia	1971-2012	3	Hungary	1971-2007	2	Peru	2010-2011	2
Azerbaijan	1991-2008	1	Hungary	2008-2011	3	Philippines	1971-2011	1
Azerbaijan	2009-2011	2	Iceland	1971-2011	3	Poland	1971-2011	2
Cambodia	1995-2011	1	India	1971-2008	1	Portugal	1971-2011	3
Bangladesh	1971-2011	1	India	2009-2011	1	Romania	1971-2011	2
Belgium	1971-2011	3	Indonesia	1971-2011	1	Russian Fed.	1991-2011	2
Bolivia	1971-2011	1	Ireland	1971-2011	3	Saudi Arabia	1971-2011	3
Bosnia & Herzegovina	1991-2007	1	Israel	1971-2011	3	Serbia	1991-2011	2
Bosnia & Herzegovina	2008-2011	2	Italy	1971-2011	3	Singapore	1971-2011	3
Brazil	1971-2011	2	Jamaica	1971-2004	1	Slovak Rep	1971-2005	2
Brunei	1971-2011	3	Jamaica	2005-2011	2	Slovak Rep	2006-2011	3
Bulgaria	1971-2012	2	Japan	1971-2011	3	Slovenia	1991-2011	3
Canada	1971-2011	3	Kazakhstan	1991-2011	2	Sri Lanka	1971-2011	1
Chile	1971-2011	2	Korea, Rep.	1971-2011	3	Spain	1971-2011	3
China	1971-2009	1	Kyrgyz Rep	1991-2011	1	Sweden	1971-2011	3
China	2010-2011	2	Latvia	1991-2011	2	Switzerland	1993-2012	3
Colombia	1971-2006	1	Lithuania	1991-2007	2	Syrian Arab Rep.	1971-2011	1
Colombia	2007-2011	2	Lithuania	2008-2011	3	Tanzania	1971-2011	1
Costa Rica	1971-2011	2	Luxembourg	1971-2011	3	Thailand	1971-2009	1
Croatia	1991-2007	2	Macedonia, FYR	1991-2007	1	Thailand	2010-2011	2
Croatia	2008-2011	3	Macedonia, FYR	2008-2011	2	Tunisia	1971-2008	1
Cyprus	1971-2011	3	Malaysia	1971-2011	2	Tunisia	2009-2011	2
Czech Rep.	1971-2011	3	Mexico	1971-2011	2	Turkey	1971-2011	2
Denmark	1971-2011	3	Moldova	1971-2008	1	UA Emirates	1971-2011	3
Dominican Rep.	1971-2007	1	Morocco	1971-2011	1	United Kingdom	1971-2011	3
Dominican Rep.	2008-2011	2	Mozambique	1971-2011	1	United States	1971-2011	3
Ecuador	1971-2009	1	Myanmar	1971-2011	1	Uruguay	1971-2011	2
Ecuador	2010-2011	2	Netherlands	1971-2011	3	Venezuela	1971-2011	2
El Salvador	1971-2011	1	New Zealand	1971-2011	3	Vietnam	1971-2008	1
Estonia	1991-2011	3	Nicaragua	1971-2011	1	Vietnam	2009-2011	1
Finland	1971-2011	3	Norway	1971-2011	3			
France	1971-2011	3	Oman	1971-2006	2			
Germany	1971-2011	3	Oman	2007-2011	3			

Source: Authors' calculations based on the income level methodology of the World Bank

Table 2: Effect of FDI on The Four Ecological Footprints*

		(1)	(2)	(3)	(4)	(5)	(6)			(1)	(2)	(3)	(4)	(5)	(6)
	Panel 1: *Consumption EF*	**Total FDI/GDP**	**Mining FDI/GDP**	**Manufact. FDI/GDP**	**Services FDI/GDP**	**Finance FDI/GDP**	**Nonfinanc FDI/GDP**		**Panel 3: *Imports EF***	**Total FDI/GDP**	**Mining FDI/GDP**	**Manufact. FDI/GDP**	**Services FDI/GDP**	**Finance FDI/GDP**	**Nonfinanc FDI/GDP**
(1)	**All countries**	-0.000362	0.0944	0.110	0.00317	0.00292	**0.168****		**All countries**	-0.00428	**0.405*****	0.0325	0.000511	0.00185	**0.229****
		(0.00356)	(0.0720)	(0.0853)	(0.00281)	(0.00516)	**(0.0685)**			(0.00445)	**(0.139)**	(0.0761)	(0.00547)	(0.00706)	**(0.113)**
	Observations	3,007	1,285	1,488	1,294	1,224	1,032		**Observations**	3,007	1,285	1,488	1,294	1,224	1,032
	Countries	117	83	87	86	76	76		**Countries**	117	83	87	86	76	76
	AR(2)	0.377	0.470	0.488	0.327	0.0866	0.135		**AR(2)**	0.743	0.311	0.648	0.842	0.323	0.305
(2)	**Low Income**	0.0433	0.0934	-1.097	0.880	2.932	**1.176***			0.0588	**0.398*****	1.998	1.330	0.964	0.300
	Countries	(0.0376)	(0.0594)	(1.317)	(0.558)	(1.931)	**(0.661)**		**Low Income Countries**	(0.0906)	**(0.0823)**	(1.832)	(0.895)	(1.803)	(1.193)
	Observations	1,610	441	462	465	336	311		**Observations**	1,610	441	462	465	336	311
	Countries	63	34	36	36	29	29		**Countries**	63	34	36	36	29	29
	AR(2)	0.233	0.907	0.544	0.725	0.230	0.329		**AR(2)**	0.480	0.689	0.543	0.530	0.295	0.359
(3)	**Middle Income**	0.151	0.333	0.0175	0.146	-0.291	0.353		**Middle Income Countries**	0.360	-0.398	-0.568	0.502	1.201	**1.205****
	Countries	(0.306)	(0.646)	(0.603)	(0.189)	(0.423)	(0.369)			(0.343)	(1.377)	(1.346)	(0.507)	(0.963)	**(0.550)**
	Observations	587	305	348	314	308	272		**Observations**	587	305	348	314	308	272
	Countries	41	28	29	29	27	26		**Countries**	41	28	29	29	27	26
	AR(2)	0.786	0.388	0.197	0.378	0.190	0.328		**AR(2)**	0.478	0.408	0.292	0.412	0.345	0.612
(4)	**High Income**	0.00600	0.428	0.0967	**0.00849***	0.00275	**0.184****		**High Income Countries**	0.00596	-0.542	0.0709	0.00949	-0.00835	**0.212****
	Countries	(0.00723)	(0.343)	(0.0765)	**(0.00439)**	(0.00692)	**(0.0820)**			(0.00786)	(0.401)	(0.0487)	(0.00765)	(0.0114)	**(0.0893)**
	Observations	810	539	678	515	580	449		**Observations**	810	539	678	515	580	449
	Countries	39	38	39	38	35	35		**Countries**	39	38	39	38	35	35
	AR(2)	0.450	0.926	0.635	0.620	0.460	0.398		**AR(2)**	0.403	0.754	0.596	0.583	0.374	0.974
(1)	**Panel 2: Production EF**	**Total FDI/GDP**	**Mining FDI/GDP**	**Manufact. FDI/GDP**	**Services FDI/GDP**	**Finance FDI/GDP**	**Nonfinanc FDI/GDP**		**Panel 4: Exports EF**	**Total FDI/GDP**	**Mining FDI/GDP**	**Manufact. FDI/GDP**	**Services FDI/GDP**	**Finance FDI/GDP**	**Nonfinanc FDI/GDP**
	All countries	-0.000340#	0.0290	0.0361	**-0.00544*****	**-0.00575****	0.00902		**All countries**	0.00298	0.125	-0.0938	0.000497	0.00418	0.219
		(0.00314)	(0.0672)	(0.0311)	**(0.00186)**	**(0.00280)**	(0.0579)			(0.00782)	(0.0798)	(0.158)	(0.00460)	(0.00612)	(0.194)
	Observations	3,007	1,285	1,488	1,294	1,224	1,032		**Observations**	3,007	1,285	1,488	1,294	1,224	1,032
	Countries	117	83	87	86	76	76		**Countries**	117	83	87	86	76	76
	AR(2)	0.0318	0.456	0.632	0.361	0.536	0.310		**AR(2)**	0.743	0.311	0.648	0.842	0.323	0.305
(2)	**Low Income**	**0.0411***#**	-0.00864	-2.140	**1.497*****	2.419	**1.666*****		**Low Income Countries**	0.0328	**0.171***	0.0456	1.788	0.0988	1.089
	Countries	**(0.0139)**	(0.0311)	(1.418)	**(0.530)**	(1.961)	**(0.622)**			(0.0996)	**(0.0878)**	(1.632)	(1.429)	(2.554)	(1.355)
	Observations	1,610	441	462	465	336	311		**Observations**	1,610	441	462	465	336	311
	Countries	63	34	36	36	29	29		**Countries**	63	34	36	36	29	29
	AR(2)	0.0204	0.242	0.547	0.209	0.448	0.283		**AR(2)**	0.651	0.395	0.314	0.277	0.824	0.765
(3)	**Middle Income**	0.119	**1.128*****	0.403	0.238	0.188	0.164		**Middle Income Countries**	0.969	**1.809****	0.623	**0.648**#**	**3.337*****	**0.701***
	Countries	(0.211)	**(0.333)**	(0.426)	(0.146)	(0.385)	(0.309)			(0.773)	**(0.760)**	(0.654)	**(0.325)**	**(0.898)**	**(0.360)**
	Observations	587	305	348	314	308	272		**Observations**	587	305	348	314	308	272
	Countries	41	28	0.0816	29	27	26		**Countries**	41	28	0.0816	29	27	26
	AR(2)	0.621	0.848	0.618	0.398	0.285	0.394		**AR(2)**	0.889	0.140	32.62	0.0746	0.0927	0.171
(4)	**High Income**	0.000386	**0.369****	0.0490	**-0.00527****	**-0.00744***	-0.0672		**High Income Countries**	-0.000629	-0.0298	0.0439	-0.00164	-0.00104	-0.0221
	Countries	(0.00338)	**(0.167)**	(0.0446)	**(0.00267)**	**(0.00446)**	(0.0466)			(0.00477)	(0.312)	(0.0622)	(0.00503)	(0.00465)	(0.0730)
	Observations	810	539	678	515	580	449		**Observations**	810	539	678	515	580	449
	Countries	39	38	39	38	35	35		**Countries**	39	38	39	38	35	35
	AR(2)	0.725	0.883	0.985	0.671	0.744	0.635		**AR(2)**	0.644	0.688	0.698	0.271	0.432	0.553

* The first entry in each cell is the estimate of the effect of FDI flows on the respective Ecological Footprint, estimated by the System GMM method. Figures in parentheses are standard errors; * and ** denote significance at the 10 % and 5 % respectively. Results are robust to heteroscedasticity. # Presence of AR(2).

Table 3: Environmental Kuznets Curve (EKC)with the Four Ecological Footprints*

		(1)	(2)	(3)	(4)	(5)	(6)			(1)	(2)	(3)	(4)	(5)	(6)
(1)	*Consumption E*	Total FDI/GDP	Mining FDI/GDP	Manufact. FDI/GDP	Services FDI/GDP	Finance FDI/GDP	Nonfinanc FDI/GDP		*Imports EF*	Total FDI/GDP	Mining FDI/GDP	Manufact. FDI/GDP	Services FDI/GDP	Finance FDI/GDP	Nonfinanc FDI/GDP
	$log\ (Real\ GDP\ p$	**0.0339*** (0.00757)**	**0.0382 (0.0275)**	**0.0698*** (0.0238)**	**0.0542*** (0.0190)**	**0.0762** (0.0380)**	**0.0733* (0.0397)**		$log\ (Real\ GDP\ per\ capita)$	0.0330 (0.0208)	0.0734 (0.0571)	0.0479 (0.0317)	0.00724 (0.0545)	0.0773 (0.0530)	0.00394 (0.0590)
	$[log\ (Real\ GDP$	**-0.00196* (0.00115)**	**-0.00188* (0.00111)**	**-0.00344*** (0.00126)**	**-0.00248** (0.000973)**	**-0.00342** (0.00146)**	**-0.00350** (0.00165)**		$[log\ (Real\ GDP\ per\ capita)$	**-0.00205** (0.00100)**	**-0.00400* (0.00241)**	**-0.00339** (0.00160)**	-0.000792 (0.00222)	-0.00359 (0.00236)	-0.00108 (0.00255)
(2)	$log\ (Real\ GDP\ p$	0.0213 (0.0213)	**0.117* (0.0703)**	**0.129*** (0.0466)**	**0.119*** (0.0445)**	**0.328** (0.135)**	**0.213* (0.127)**		$log\ (Real\ GDP\ per\ capita)$	-0.0144 (0.0445)	0.185 (0.162)	0.0799 (0.157)	0.0102 (0.142)	0.241 (0.167)	0.00252 (0.233)
	$[log\ (Real\ GDP$	-0.00105 (0.00180)	**-0.00771* (0.00456)**	**-0.00898*** (0.00348)**	**-0.00810*** (0.00299)**	**-0.0211** (0.00926)**	**-0.0142* (0.00836)**		$[log\ (Real\ GDP\ per\ capita)$	0.00210 (0.00334)	-0.0114 (0.0102)	-0.00362 (0.00908)	0.00117 (0.00860)	-0.0154 (0.0112)	-0.000738 (0.0154)
(3)	$log\ (Real\ GDP\ p$	-0.308 (0.419)	-0.232 (0.480)	-0.188 (0.409)	-0.0633 (0.367)	-0.284 (0.505)	0.107 (0.473)		$log\ (Real\ GDP\ per\ capita)$	-0.427 (0.629)	0.245 (1.523)	0.247 (1.205)	0.503 (0.979)	0.836 (1.278)	1.255 (1.491)
	$[log\ (Real\ GDP$	0.0208 (0.0237)	0.0147 (0.0280)	0.0118 (0.0240)	0.00439 (0.0214)	0.0173 (0.0295)	-0.00491 (0.0276)		$[log\ (Real\ GDP\ per\ capita)$	0.0289 (0.0368)	-0.0106 (0.0897)	-0.0110 (0.0712)	-0.0264 (0.0566)	-0.0427 (0.0738)	-0.0682 (0.0853)
(4)	$log\ (Real\ GDP\ p$	0.0800 (0.172)	0.187 (0.228)	0.0532 (0.129)	0.113 (0.197)	-0.111 (0.288)	-0.123 (0.167)		$log\ (Real\ GDP\ per\ capita)$	0.276 (0.246)	-0.0522 (0.397)	0.00579 (0.262)	0.354 (0.232)	-0.0614 (0.236)	0.104 (0.144)
	$[log\ (Real\ GDP$	-0.00379 (0.00854)	-0.0108 (0.0117)	-0.00348 (0.00661)	-0.00548 (0.00995)	0.00643 (0.0141)	0.00561 (0.00855)		$[log\ (Real\ GDP\ per\ capita)$	-0.0157 (0.0126)	0.000315 (0.0201)	-0.000893 (0.0132)	-0.0186 (0.0117)	0.00208 (0.0118)	-0.00654 (0.00714)
	Production EF	**Total FDI/GDP**	**Mining FDI/GDP**	**Manufact. FDI/GDP**	**Services FDI/GDP**	**Finance FDI/GDP**	**Nonfinanc FDI/GDP**		**Exports EF**	**Total FDI/GDP**	**Mining FDI/GDP**	**Manufact. FDI/GDP**	**Services FDI/GDP**	**Finance FDI/GDP**	**Nonfinanc FDI/GDP**
(1)	$log\ (Real\ GDP\ p$	**0.0376*** (0.00703)**	**0.0377* (0.0205)**	**0.0577*** (0.0216)**	**0.0391* (0.0206)**	**0.0407* (0.0233)**	**0.0914*** (0.0273)**		$log\ (Real\ GDP\ per\ capita)$	**0.0934*** (0.0205)**	0.120 (0.0862)	0.0364 (0.0421)	0.0620 (0.0606)	**0.147* (0.0826)**	0.0746 (0.0697)
	$[log\ (Real\ GDP$	**-0.00227*** (0.000679)**	**-0.00244** (0.00101)**	**-0.00306** (0.00124)**	**-0.00264** (0.00107)**	**-0.00282** (0.00118)**	**-0.00506*** (0.00140)**		$[log\ (Real\ GDP\ per\ capita)$	**-0.0046*** (0.00141)**	**-0.00659* (0.00383)**	-0.00229 (0.00241)	-0.00344 (0.00310)	**-0.00775* (0.00415)**	-0.00475 (0.00376)
(2)	$log\ (Real\ GDP\ p$	0.0370 (0.0276)	0.127 (0.0777)	**0.130*** (0.0477)**	**0.123** (0.0555)**	**0.270* (0.158)**	**0.308** (0.132)**		$log\ (Real\ GDP\ per\ capita)$	0.0952 (0.0682)	0.0212 (0.248)	-0.0310 (0.175)	0.101 (0.223)	0.0535 (0.238)	**0.823*** (0.253)**
	$[log\ (Real\ GDP$	-0.00227 (0.00198)	**-0.00879* (0.00527)**	**-0.00950*** (0.00350)**	**-0.00827** (0.00390)**	**-0.0180* (0.0107)**	**-0.0211** (0.00891)**		$[log\ (Real\ GDP\ per\ capita)$	-0.00362 (0.00538)	0.000908 (0.0165)	0.00348 (0.0122)	-0.00478 (0.0148)	-0.00374 (0.0162)	**-0.0547*** (0.0176)**
(3)	$log\ (Real\ GDP\ p$	**-0.727* (0.382)**	**-0.779** (0.308)**	-0.562 (0.424)	**-0.585* (0.309)**	-0.542 (0.406)	-0.430 (0.338)		$log\ (Real\ GDP\ per\ capita)$	-0.871 (0.598)	**-1.212* (0.659)**	-0.821 (0.588)	-0.467 (0.519)	0.431 (0.864)	-0.661 (0.504)
	$[log\ (Real\ GDP$	**0.0434** (0.0220)**	**0.0450** (0.0178)**	0.0325 (0.0246)	**0.0340* (0.0178)**	0.0312 (0.0234)	0.0252 (0.0197)		$[log\ (Real\ GDP\ per\ capita)$	0.0519 (0.0355)	**0.0685* (0.0379)**	0.0477 (0.0347)	0.0263 (0.0297)	-0.0254 (0.0494)	0.0384 (0.0289)
(4)	$log\ (Real\ GDP\ p$	-0.175 (0.154)	-0.0250 (0.146)	-0.123 (0.140)	-0.0925 (0.124)	-0.194 (0.171)	-0.0894 (0.121)		$log\ (Real\ GDP\ per\ capita)$	-0.151 (0.243)	0.149 (0.237)	-0.326 (0.223)	0.104 (0.194)	-0.129 (0.217)	-0.0156 (0.227)
	$[log\ (Real\ GDP$	0.00832 (0.00786)	-8.42e-05 (0.00755)	0.00593 (0.00718)	0.00368 (0.00638)	0.00905 (0.00867)	0.00327 (0.00603)		$[log\ (Real\ GDP\ per\ capita)$	0.00555 (0.0122)	-0.00931 (0.0120)	0.0153 (0.0112)	-0.00639 (0.00933)	0.00462 (0.0107)	-0.000562 (0.0111)

* The first entry in each cell is the estimate of the effect of FDI flows on the respective Ecological Footprint, estimated by the System GMM method. Figures in parentheses are standard errors; * and ** denote significance at the 10 % and 5 % respectively. Results are robust to heteroscedasticity.

Table4: FDI Impact on Consumption EF per capita	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Total fdi	Mining fdi	Manufacturing fdi	Total Services fdi	Financial fdi	Non-Financial fdi
L.lnefconspercap_total	0.998***	0.984***	0.958***	0.966***	0.945***	0.957***
	(0.0362)	(0.0347)	(0.0266)	(0.0265)	(0.0406)	(0.0380)
lngdp05cap	**0.0339*** **	**0.0382**	**0.0698*** **	**0.0542*** **	**0.0762** **	**0.0733***
	(0.00757)	**(0.0275)**	**(0.0238)**	**(0.0190)**	**(0.0380)**	**(0.0397)**
sqlngdp05cap	**-0.00196***	**-0.00188***	**-0.00344*** **	**-0.00248** **	**-0.00342** **	**-0.00350** **
	(0.00115)	**(0.00111)**	**(0.00126)**	**(0.000973)**	**(0.00146)**	**(0.00165)**
anticor	-0.00150	-0.00103	0.00578	-0.000731	0.000548	0.00110
	(0.00352)	(0.00375)	(0.00513)	(0.00412)	(0.00383)	(0.00346)
fditotgdp5	-0.000362	0.0944	0.110	0.00317	0.00292	**0.168** **
	(0.00356)	(0.0720)	(0.0853)	(0.00281)	(0.00516)	**(0.0685)**
Observations	3,007	1,285	1,488	1,294	1,224	1,032
Number of count	117	83	87	86	76	76
AR(2) pval	0.377	0.470	0.488	0.327	0.0866	0.135
Sargan test chi2	69	66.25	40.72	33.61	37.41	25.80
Sargan test pval	2.57e-05	6.11e-05	0.0570	0.214	0.110	0.584

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table5: FDI Impact on Production EF per capita	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Total fdi	Mining fdi	Manufacturing fdi	Total Services fdi	Financial fdi	Non-Financial fdi
L.lnefprodpercap_total	1.002***	1.005***	0.981***	1.010***	1.006***	0.974***
	(0.0267)	(0.0155)	(0.0129)	(0.0150)	(0.0143)	(0.0169)
lngdp05cap	**0.0376*** **	**0.0377* **	**0.0577*** **	**0.0391* **	**0.0407* **	**0.0914*** **
	(0.00703)	**(0.0205)**	**(0.0216)**	**(0.0206)**	**(0.0233)**	**(0.0273)**
sqlngdp05cap	**-0.00227*** **	**-0.00244** **	**-0.00306** **	**-0.00264** **	**-0.00282** **	**-0.00506*** **
	(0.000679)	**(0.00101)**	**(0.00124)**	**(0.00107)**	**(0.00118)**	**(0.00140)**
anticor	-0.00147	-0.00139	-0.000814	-0.00246	0.000373	0.00257
	(0.00233)	(0.00344)	(0.00534)	(0.00366)	(0.00285)	(0.00315)
fditotgdp5	-0.000340	0.0290	0.0361	**-0.00544*** **	**-0.00575** **	0.00902
	(0.00314)	(0.0672)	(0.0311)	**(0.00186)**	**(0.00280)**	(0.0579)
Observations	3,007	1,285	1,488	1,294	1,224	1,032
Number of count	117	83	87	86	76	76
AR(2) pval	0.0318	0.456	0.632	0.361	0.536	0.310
Sargan test chi2	86.61	63.64	40.81	27.25	24.24	27.66
Sargan test pval	6.66e-08	0.000137	0.0559	0.505	0.669	0.483

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table6: FDI Impact on Imports EF per capita	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Total fdi	Mining fdi	Manufacturing fdi	Total Services fdi	Financial fdi	Non-Financial fdi
L.lnefimportspercap_total	1.003***	0.991***	1.000***	1.000***	0.968***	1.007***
	(0.0189)	(0.0352)	(0.0145)	(0.0269)	(0.0277)	(0.0317)
lngdp05cap	0.0330	0.0734	0.0479	0.00724	0.0773	0.00394
	(0.0208)	(0.0571)	(0.0317)	(0.0545)	(0.0530)	(0.0590)
sqlngdp05cap	**-0.00205****	**-0.00400***	**-0.00339****	-0.000792	-0.00359	-0.00108
	(0.00100)	**(0.00241)**	**(0.00160)**	(0.00222)	(0.00236)	(0.00255)
anticor	-0.00441	-0.00496	0.00404	-0.00488	-0.00119	-0.00624
	(0.00375)	(0.00848)	(0.00592)	(0.00561)	(0.00596)	(0.00648)
fditotgdp5	-0.00428	**0.405*****	0.0325	0.000511	0.00185	**0.229****
	(0.00445)	**(0.139)**	(0.0761)	(0.00547)	(0.00706)	**(0.113)**
Observations	3,007	1,285	1,488	1,294	1,224	1,032
Number of count	117	83	87	86	76	76
AR(2) pval	0.351	0.483	0.704	0.735	0.288	0.439
Sargan test chi2	30.51	49.48	36.08	27.22	27.91	17.51
Sargan test pval	0.339	0.00739	0.141	0.506	0.469	0.938

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table7: FDI Impact on Exports EF per capita	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Total fdi	Mining fdi	Manufacturing fdi	Total Services fdi	Financial fdi	Non-Financial fdi
L.lnefexportspercap_total	0.985***	0.984***	1.001***	0.992***	0.977***	1.005***
	(0.0105)	(0.0278)	(0.00773)	(0.0156)	(0.0220)	(0.0144)
lngdp05cap	**0.0934*** **	0.120	0.0364	0.0620	**0.147***	0.0746
	(0.0205)	(0.0862)	(0.0421)	(0.0606)	**(0.0826)**	(0.0697)
sqlngdp05cap	**-0.00466*** **	**-0.00659***	-0.00229	-0.00344	**-0.00775***	-0.00475
	(0.00141)	**(0.00383)**	(0.00241)	(0.00310)	**(0.00415)**	(0.00376)
anticor	-0.00357	-0.000389	-0.00865	-0.00724	-9.98e-05	-0.00760
	(0.00824)	(0.00878)	(0.00756)	(0.00793)	(0.00957)	(0.00892)
fditotgdp5	0.00298	0.125	-0.0938	0.000497	0.00418	0.219
	(0.00782)	(0.0798)	(0.158)	(0.00460)	(0.00612)	(0.194)
Observations	3,007	1,285	1,488	1,294	1,224	1,032
Number of count	117	83	87	86	76	76
AR(2) pval	0.743	0.311	0.648	0.842	0.323	0.305
Sargan test chi2	72.52	104.3	26.23	23.82	29.09	33.63
Sargan test pval	8.21e-06	1.03e-10	0.561	0.691	0.408	0.213

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1