RUNNING HEAD: FDI AND NATURAL RESOURCES

Foreign Direct Investment, Ecological Withdrawals and Natural Resource Dependent Economies

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Abstract

This article examines the relationships between foreign direct investment (FDI) and natural resource depletion and natural resource rents for a longitudinal (2005-2013: *N*=125 nations) sample of less developed countries (LDCs). Theoretically, we argue that FDI contributes to increased ecological withdrawals and dependence on the natural resource sector for economic growth within countries. We hypothesized that LDCs with higher levels of FDI would also have higher levels of natural resource depletion and income (i.e. rents). We assess whether this hypothesized relationship holds across nations in our sample for four different natural resource depletion and rents measures (energy, forest, mineral and total natural resource rents). We find strong support for our hypotheses regarding natural resource depletion and resource rents, with the exception of energy rents. The outcome lends support to the ecological withdrawal and ecostructural theory of foreign investment dependence perspectives.

Introduction

Natural resource extraction and the income dependence it generates has been the subject of significant sociological analysis over the past twenty years (Gelb 1988; Freudenburg 1992; Jorgenson 2010; Ross 2003). Recently, however, there has been interest in examining how these variables play out cross-nationally, where some less developed countries (or LDCs) serve as natural resource 'supply depots' and as a result subsequently develop unhealthy economies (e.g., Jorgenson 2007a, 2007b). We extend this particular line of sociological inquiry by asking two important questions. First, how does foreign investment (i.e. stocks of capital originating from foreign firms that are invested in a second country) appear to influence the level of natural resource extraction within LDCs? Second, how does foreign investment by firms in one country influence the composition of natural resource income (i.e., the income generated from the extraction and sale of natural resources) as a proportion of the gross domestic product in LDCs? Both questions are important for understanding the role of transnational capital investment in maintaining global economic inequality and the treadmill of production. In turn, economic inequality is also associated with ecological inequality or ecologically unequal exchange (Jorgenson 2009, 2010). Importantly, the production and consumption of goods in the world economy ties countries together suggesting that a global understanding of natural resource extraction and income is critical for scholars and policy makers trying to understand how cross-national environmental inequality is produced by these connections.

To understand how foreign investment may be related to extraction and natural resource income in LDCs, we organize the paper as follows. First, we briefly review sociological research on foreign investment (or foreign direct investment [FDI]), which is a measure of capital created in one country and subsequently invested in another country. Next, we examine the concept of FDI as it relates to ecological withdrawals, the transnational

organization of production and the ecostructural approach. In that discussion we highlight the importance of these theoretical concepts in explaining the potential relationship between FDI and natural resource extraction and natural resource income. That literature is then used to frame our hypotheses, methodology and results. The final section expands on the relationships between FDI, ecological withdrawals and natural resource dependent economies.

Foreign Direct Investment

Foreign direct investment (FDI) is capital from a firm originating in one country that is invested in a second country.[1] Research in comparative cross-national sociology has demonstrated the large impact that the penetration of foreign capital can have on countries (e.g. Bornschier and Chase-Dunn 1985; Dixon and Boswell 1996). The effect of FDI is widespread as, FDI "inflows have grown faster than world income since the 1960s, multinational enterprises now account for about 70 percent of world trade, and the sales of their foreign affiliates have exceeded total global exports" (Li and Resnick 2003).

Scholars have studied the impact of FDI on numerous social justice related outcomes including economic growth (Bornschier, Chase-Dunn and Rubinson 1978), international migration (Sanderson and Kentor 2008), human rights (Blanton and Blanton 2007), and the environment (Jorgenson 2007a, b, 2009; Jorgenson, Dick and Mahutga 2007; McKinney 2014). Here we focus attention on the environmental consequences of FDI. In particular, we suggest that FDI plays an important role in depleting nature resources and generating natural resource income in LDCs (FDI; Bunker and Ciccantell 2005). In particular, developed countries require large quantities of natural resources to fuel their consumption oriented lifestyles and obtain those resources from LDCs (Jorgenson, Austin and Dick 2009). This

[1] FDI is operationalized by the World Bank (2014) as ownership of a controlling number of shares of a business in one country by a business or other entity located in a second country. Thus, monetary amounts for FDI reflect those controlling shares.

allows companies located primarily in the developed world to invest in natural resource extraction in developing countries where the extraction is also cheaper and bolsters profit-making. To date, there is not much scholarly work examining the association between FDI and natural resource extraction. Asiedu (2006), for example, examined whether natural resource extraction and FDIs are related in sub-Saharan Africa. Asiedu found that in addition to several other factors, larger natural resource endowments provide "opportunities" for resource extraction that promote increases in FDI. While natural resource availability may attract FDI, the additional question is whether FDI continues to drive natural resource extraction upward, which in turn would increase the proportion of gross domestic product of natural resource exporting LDCs that can be linked to those exports.

Natural Resources, the Transnational Organization of Production and FDI

In this section we review discussions concerning the relationship between economic production and ecological disorganization. We also link that discussion to ecostructural theory and research on the impact of FDI on LDCs.

In his classic work, *The Environment: From Surplus to Scarcity*, Schnaiberg (1980) noted that there are two main types of environmental degradation (or as he called it, ecological disorganization); ecological additions and withdrawals. In his theoretical approach, referred to as the treadmill of production, Schnaiberg suggested that the international capitalist economy necessitates ever-increasing levels of ecological additions and withdrawals to generate economic growth. Ecological additions are by-products of the production process added to the environment (i.e. pollution). Ecological withdrawals consist of the removal of natural resources to aid in production. The present study focuses on ecological withdrawals, specifically the extraction of energy (i.e. coal, natural gas and oil), forest and mineral resources. In the treadmill of production view, these non-renewable resources are being extracted at an increasing rate as the treadmill expands, which accelerates

resource reserve depletion and increases ecological disorganization. As Schnaiberg (1980) and others (Jorgenson 2008, 2010) have noted, the ecological withdrawal process is harmful to the environment and easily documented in relation to many major contemporary withdrawal technologies (e.g., mountain top removal mining; sand tar extraction; hydraulic fracturing).

The treadmill of production is a global process as production and consumption often do not take place in the same location. In fact, extraction of raw materials often occurs in one location, production in a second and consumption in a third (Gould, Pellow and Schnaiberg 2008). This suggests that consumers as well as producers in wealthy countries can maintain high levels of consumption while externalizing the costs of withdrawal (e.g. the extraction of already scarce resources and ecological disorganization from the extraction/production process) to LDCs. This process has been characterized as the transnational organization of production (e.g. Jorgenson 2008) to signify how economic production and its consequences have become increasingly globalized (see also Schnaiberg 1980).

Research has demonstrated how the transnational organization of production creates ecological disorganization through ecological withdrawals (e.g. Jorgenson 2008, 2010) that predominately takes place in LDCs. One mechanism through which the ecological withdrawal of natural resources for production in LDCs is initiated from the developed world is through increases in FDI. Firms directing FDI to LDC resource extraction also attempt to accelerate extraction to allow continued production (Bunker and Ciccantell 2005). In turn, LDC reliance on FDI can encourage LDCs to deplete their natural resources to facilitate domestic economic development because they are "foreign investment dependent" (or capital dependent, see Chase-Dunn 1975; Bornschier and Chase-Dunn 1985; Dixon and Boswell 1996; Firebaugh 1996). The theoretical tradition of foreign investment dependence suggests that increases in FDI stocks increases LDCs' vulnerability to the negative effects of global

capitalism (Jorgenson 2010: 459), including impaired economic growth (Dixon and Boswell 1996). Foreign investment dependence has also been linked to increasing levels of ecological disorganization (Jorgenson 2007a, b, 2008, 2010; Jorgenson, Dick and Muhutga 2007; Jorgenson and Kuykendall 2008;).

To help conceptualise this process, Jorgenson and colleagues have introduced an *ecostructural* theory of foreign investment dependence that focuses on how, "the transnational organization of extraction and production in the context of foreign investment dependence partially allows for more developed countries and the transnational firms headquartered within them to treat less developed countries as *supply depots* as well as sinks for waste" (Jorgenson 2010: 459-460, emphasis added). This perspective is particularly relevant for studying the effects of FDI on natural resource extraction because natural resource laden LDCs submit to economic restructuring to attract FDI which, in turn, stimulates LDC ecological disorganization through escalating resource extraction and ecological additions associated with those extraction processes. This process can be promoted by LDCs adopting lax environmental and labor regulations in order to enhance the likelihood of FDI (Jorgenson 2010). According to Jorgenson (2010), then, the ecostructural theory of foreign investment dependence suggests that increased FDI promotes growth in LDC natural resource extraction and is associated with the transnational organization of production and efforts to locate cheap supply depots of natural resources.

A debate has emerged around whether LDC reliance on the natural resource sector for economic development is beneficial or deleterious (e.g. Sachs and Warner 1995, 2001; Bulte, Damania and Deacon 2005). One argument – the "resource curse" – states that nations with significant ecological resources are disadvantaged with respect to economic growth (e.g. Ross 1999). Explanations for the curse vary, but there is some suggestion that natural resource rich economies may crowd out the manufacturing sector of the economy by

concentrating on resource exportation, leading to diminished finished product exports, which harms economic growth (Sachs and Warner 2001). In turn, countries focused mainly on exporting natural resources as a strategy of economic growth experience deteriorating economic growth. Natural resource curse researchers also propose that an abundance of resources may diminish state institutions and make them economically and socially ineffective so they are unable to enact sound economic policies to grow the economy (Ross 2003; Mehlum, Moene and Torvik 2006). Because the curse has not been found to operate in all countries there is now an argument that some countries benefit and some are harmed by resources abundance. Moreover, scholars who reject the research curse hypothesis argue instead that natural resource extraction drives economic development and "institutional quality" (e.g. Brunnschweiler 2008; Brunnschweiler and Bulte 2008). In fact, numerous researchers have suggested that empirical analyses that support the resource curse hypothesis ignore flaws in the analyses and misinterpret the findings (Wright and Czelusta 2004; Ding and Field 2005; Stijns 2005; Brunnschweiler 2008; Saad-Filho and Weeks 2013:4). Given these conflicting findings related to the effect of natural resource income on LDC economic development, one can conclude that these unstable results indicate the need to abandon or revisit, refine and reevaluate this hypothesis to gain a better understanding of how foreign direct investments impact LDCs in the transnational global economy.

Despite contradictory evidence concerning the effects of FDI on LDCs, it can be argued that LDC reliance on natural resource income as an engine for economic growth has implications for the ecological disorganization and the transnational organization of production perspectives. Here we begin with the observation that nations dependent on natural resource income for growth will likely continue to expand resource extraction to attract foreign investment, thereby increasing levels of ecological withdrawals. This observation is consistent with the ecostructural argument that FDI increases natural resource

extraction to satisfy the needs of the transnational organization of production. Thus, it is reasonable to assume a similar pattern exists between FDI and natural resource income. Foreign firms invest capital in a country with natural resources in order to extract them to increase production. These firms hope that their invested capital provides inexpensive raw materials which should contribute to an increase in profits. Furthermore, firms that invest foreign capital into another country and receive increased profits from their investment should be more likely to increase their future levels of FDI in that country in hope of continuing the profit-making cycle from natural resource extraction. If this process unfolds in the above manner, FDI could contribute to countries becoming more dependent on the natural resource sector for economic growth. This situation could also, therefore, reinforce the current organization of the transnational economy and the treadmill of production.

Hypotheses

Based on the above, we forward two hypotheses. First, that increases in the level of FDI a country receives will be associated with increases in the extraction of that country's natural resources. Second, increases in the level of FDI a country receives will be associated with increases in the amount of income a country generates from the sale of natural resources relative to other income sources. These hypotheses have importance for the following reasons. With respect to hypothesis 1, if the FDI-resource extraction link is observed, this supports the idea that FDI drives ecological disorganization in receiving nations. Evidence of the second hypothesis would suggest that counties receiving FDI are becoming more dependent on that income, and as this process continues and the stock of natural resources in FDI receiving nations declines, so too might FDI, leading to declining economic conditions in FDI receiving nations. Below we elaborate on the measures of the variables we employ in our analyses to examine the relationship between FDI, natural resource extraction and natural resource income.

Method

To examine the relationships between natural resource extraction, rents and FDI we employ fixed-effects panel models based on longitudinal data from the period 2005-2013 for a sample of 125 Less Developed Countries (LDCs) (see Appendix A for list of countries). Countries were defined as LDCs using the United Nations country classification scheme (United Nations, 2014). The fixed-effects model can be specified as follows:

$$Y_{ct} = X_{ct}B + \alpha_c + e_{ct} \text{ for } t = 1,\ldots,T \text{ and } c = 1,\ldots N$$

Where Y_{ct} is the dependent variable for the country c at time t, X_{ct} is a 1 by k matrix of predictor variables, α_c is the unobserved time-variant country effect and e_{ct} is the error term. The nations were chosen due to the availability of data, meaning that all countries in the analysis were required to have values of the dependent variables and total FDI stocks over the time period, to be included in the sample. The analysis controls for several competing explanations depicting the relationship between FDI and natural resource depletion and rents. All of the variables in the analyses, except democracy, were skewed, and were transformed into natural logs to reduce the impact of the skewness. The variables used in the analysis are described below.

Dependent Variables

Natural resource depletion. The natural resource extraction variable for LDCs was operationalized as an indicator of the ratio of the volume of natural resources extracted to the quantity of remaining resource reserves. This measure of extraction can be conceptualized as measuring natural resource depletion and is obtained from the World Bank (2016). The World Bank collects depletion data on energy, forest, mineral resources and their sum. Depletion is defined as the ratio of the value of the stock of resources to the remaining reserve lifetime as a percent of the country's GDP. Energy resources include coal, crude oil

and natural gas, forest rents include the total roundwood harvest, and mineral depletion includes tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite and phosphate.

Natural resource rents. This variable measures the income generated from natural resources in the form of natural resource rents. In this context, rent is essentially the surplus value gained from the sale of the resources, or the difference between the cost of production and their price/value on the world market. In this study, natural resource rents are measured in two ways: (1) rents for forest, mineral, and energy[2] are examined separately, and (2) then summed to create the measure total natural resource rents (World Bank 2016). A "rent" value is the difference between the value of production at world prices and their total cost of production. This variable is measured as the percentage of the country's GDP that is due to natural resource rents.

Independent Variables[3]

Total FDI stocks, measured in millions of USD as percent of host country GDP, is the total value of capital provided by foreign firms to the host country in all sectors of the economy (UNCTAD 2016).

Control Variables

GDP per capita. Previous research has indicated that economic development and natural resource extraction are related (Sachs and Warner 1995; Ross 1999; Bulte, Damania and Deacon 2005). To control for a county's level of economic development we use Gross Domestic Product per capita (World Bank 2016).

[2] Energy rents equal the sum of coal, natural gas and oil rents. We collapsed these them into "energy" because the World Bank only reports energy depletion for our other dependent variable, resource depletion. Energy depletion is also equal to the sum of coal, natural gas and oil depletion. So, we collapsed the energy rent variable for consistency.

[3] We would like to recognize the importance of the work of Jorgenson and colleagues (e.g. Jorgenson 2007a, 2007b; Jorgenson, Dick and Mahutga, 2007; Jorgenson and Kuykendall, 2008;) on FDI and various environmental outcomes. These works have shaped the analytical approach of this paper, particularly the selection of independent and control variables.

Agriculture exports and *Fuel exports*. These two indicators control for the level of agricultural and fuel exports originating from the host country (World Bank 2016). These variables are measured as a percent of the host country's GDP.

Gross capital formation, (also referred to as gross domestic investment) is a measure of a county's net addition of capital stock. Capital stock contributes to a county's ability to provide goods and services to its population. Increases in capital stock are referred to as capital formation (World Bank 2016).

Agriculture value added and *Industry value added.* These two variables control for the extent to which the host country is agriculture or industry based respectively. We measure these controls as the percent of total country GDP (World Bank 2016).

Democracy. It is possible that the type of government affects the level of natural resource depletion and rents in a country. We control for this using the Freedom of the World Democracy Index created by Freedom House (2016), which scores a country's political freedom over time on a seven-point scale, "1" (most free) to "7" (least free). We reverse coded the democracy index so higher values indicated higher political freedom.

Exports of goods and services. In addition to the industry specific controls (i.e. agriculture and fuel) for the degree to which a country relies on exports for economic growth, we also control for the percent of a country's GDP that is generated from all exports of goods and services (World Bank 2016). This is a measure of trade dependency, the degree to which a country is dependent on trade for economic growth.

External debt service. The level of external debt that a country has may be linked to natural resource depletion and rents as the economic restructuring requirements that accompany loans from international financial institutions like the World Bank and the International Monetary Fund often require countries to reorient their economies to more export-oriented strategies (McMichael 2004). External debt service is the sum of principal

repayments and interest paid on short-term and long-term debt and repayments to the IMF. It is measured as a percent of the country's GDP (World Bank 2016).

Analytic Strategy

We first tested FDI stocks and natural resource depletion and rents for endogeneity using Granger causality tests to determine casual ordering of these variables. Next, to test our hypotheses we used longitudinal data for the years 2005-2013 for a sample of 125 LDCs. We estimated fixed-effects panel regression models to test the effects of the predictors on annual changes in natural resource depletion and rents during 2005-2013, while controlling for country characteristics not explicitly included in the models (i.e., omitted variable bias). Fixed-effects models the within country changes in the dependent variable that are due to the combination of predictors in the model. Between country effects are not estimated. In these models, due to a lack of adequate time-series data on primary sector FDI stocks, the main independent variable of interest is total FDI stocks.[4]

We estimated eight fixed-effects models of natural resource depletion and rents each to test our hypotheses.[5] We estimated two models for each of the eight dependent variables: total natural resource depletion, energy depletion, forest depletion, mineral depletion, total natural resource rents, energy rents, forest rents and mineral rents. The first models include only FDI stocks, while the second model adds in all of the controls.

We assessed multicollinearity in the models with Variance Inflation Factor (VIF) values. We reran the fixed-effects models using ordinary least squares equations and then calculated VIF values based on those equations. The mean VIF for all predictors of resource

[4] We used total FDI stocks, rather than primary sector FDI stocks, in the longitudinal models because longitudinal data on primary sector FDI stocks was not available for the study time period. We recognize that previous studies that examine the link between FDI and environmental outcomes have employed primary sector FDI data (e.g. Jorgenson 2007; Jorgenson and Kuykendall 2008), however those studies utilized data primarily from the 1990s and early 2000s, to our knowledge primary sector FDI data is not available for the time period of the current study (2005-2013). See Appendix B for models using 2010 primary sector FDI stocks for a small sample of countries in which data were available.

[5] The sample sizes vary from model to model due to missing data.

depletion was 1.99 (range = 1.11-3.66), while resource rents was 1.96 (range = 1.11-3.65). These values indicate that multicollinearity does not appear to substantively affect the results, as VIF values under four typically mean low multicollinearity (Madalla 1992).

Results

Table 1 provides the descriptive statistics for the untransformed versions of the variables in the analysis. We first tested for endogeneity of FDI and the two dependent variables, natural resource depletion and rents as some previous research suggests that the causal ordering of these concepts is reversed (see Asiedu 2006). To do this, we gathered data on FDI stocks, natural resource depletion and rents for the time-period 1970-2013. Using these data, we conducted Granger Causality Wald tests for FDI and natural resource depletion and FDI and natural resource rents. In both cases, the null hypothesis that FDI does not "Granger-cause"[6] natural resource depletion (Wald $\chi^2 = 7.56$, $p = 0.023$) and rents (Wald $\chi^2 = 8.49$, $p = 0.014$) was rejected. The reverse tests with the natural resource variables (depletion Wald $\chi^2 = 2.23$, $p = 0.328$; rents Wald $\chi^2 = 2.51$, $p = 0.285$) as the Granger-cause of FDI were not rejected indicating that the resource variables are not a cause of FDI. Therefore, these results suggest that FDI should be used as a predictor of natural resource depletion and rents, not the reverse.

[INSERT TABLE 1 ABOUT HERE]

Table 2 contains fixed-effects regression equations modelling the natural resource depletion variables. Based on the models in Table 2, it is clear that annual increases in FDI stocks are associated with annual increases in all of the natural resource depletion variables in this study. In other words, as the amount of FDI stocks increase, so too does total natural resource (Total NR 2 – $p<0.01$), energy (Energy 2 – $p<0.001$), forest (Forest 2 – $p<0.05$) and mineral (Mineral 2 – $p<0.05$) depletion, controlling for the other explanations of natural

[6] The Granger causality test is a hypothesis test designed for determining whether one time-series variable is useful for predicting a second time-series variable. (see Granger 1969, 2004).

resource depletion included in the models. These findings strongly support hypothesis 1 due to the consistent effect of FDI across the dependent variables.

GDP per capita significantly predicts each of the natural resource depletion variables; however the direction of the relationship is inconsistent. Annual increases in GDP per capita are positively related to total natural resource, forest and mineral depletion, while it is negatively related to energy depletion. Another important predictor of natural resource depletion, according to the results in Table 2, is exports of goods and services. With the exception of forest depletion, annual increases in exports and goods and services significantly predicts the resource depletion variables ($p<0.001$), suggesting that in most cases as countries increase exports, natural resources will be withdrawn from the environment in larger amounts. The remaining control variables are sporadically significant; however, no meaningful patterns emerge in the prediction of the resource depletion variables.

[INSERT TABLE 2 ABOUT HERE]

Table 3 reports the results of fixed-effects regression models of total natural resource, energy, forest and mineral rents. FDI stocks positively predict annual changes in all of the natural resource rents variables except energy. Annual increases in FDI stocks are associated with significantly higher total natural resource, forest and mineral rents, while there is no relationship between FDI stocks and energy rents. Therefore, hypothesis 2 has been supported for all natural resource rents variables with the exception of energy rents.

[INSERT TABLE 3 ABOUT HERE]

Unlike the natural resource depletion models, GDP per capita does not appear to be as important a predictor of the resource rents variables. It positively predicts mineral rents ($p<0.001$), but does not significantly predict any of the other rents variables. Similar to the resource depletion models, exports of goods and service is a significant predictor of natural resource rents in all of the models.

Earlier we noted that primary sector FDI stock data are not available for the time period of this study and historical cross-national time-series primary sector FDI data are sporadic at best. However, we have included a brief analysis of total natural resource depletion and rents using primary sector FDI stocks and the control variables using least squares regression equations in Appendix B. The models are based on a sample of 2010 data for 52 countries, both developed and less developed (due to availability of data). The results support our findings above since increases in primary sector FDI stocks is associated with increases in total natural resource depletion and rents.

Discussion and Conclusion

It has long been assumed that LDCs are exploited for their natural resources and may build their economies on unsustainable natural resource income. Moreover, the impact of FDI on many social and environmental outcomes has been studied in detail by social scientists. We contribute to this area of study by examining the impact of FDI on natural resource depletion and rents for LDCs. We hypothesized that annual increases in FDI will lead to annual increases in natural resource depletion within countries (hypothesis 1), and that annual increases in FDI will lead to annual increases in natural resource rents within countries (hypothesis 2). Our findings lend substantial support to both hypotheses. Increases in FDI stocks were associated with increases in all forms of natural resource depletion and all forms of natural resource rents, except energy rents. These finding suggest that among LDCs, FDI increases natural resource depletion. Moreover, since resource rents also increase as a result of FDI, it appears that the transnational organization of production contributes to many LDCs becoming more and more dependent on the natural resource sector of their economies. We will now expand on the implication of both of these findings.

First, FDI increases natural resource depletion in LDCs pushing them toward environmentally unsustainable behaviour. This relationship between FDI and resource

depletion also means that FDI is likely to increase ecological disorganization in LDCs. Importantly, it is likely the case that the ecological disorganization resulting from resource depletion includes the actual depletion that occurs, but also the environmental externalities generated from the extraction and production of natural resources. This process unfolds as the ecostructural theory of foreign investment dependence asserts it will (Jorgenson 2010). That is, our results suggest that the transnational organization of production uses foreign capital to obtain the raw materials necessary for production, while turning LDCs with large natural resource endowments into supply depots for other countries.

Second, we find that FDI increases natural resource rents within LDCs. This suggests that foreign investment may also contribute to making the economies of LDCs more dependent on their natural resource sector for economic growth. While evidence is mixed regarding the impact of natural resource rents on future economic growth there is still reason for concern because several studies have suggested that such conditions foster "resource addition" or a "natural resource curse" (e.g. Freudenberg 1992; Ross 1999; Sachs and Warner 1995, 2001). Given that there is a substantial theoretical and empirical literature documenting these adverse conditions we suggest that policy makers in these countries should be weary of becoming too dependent on resource extraction and sales for economic development. Additionally, as foreign capital is contributing to this resource dependency, these countries are also losing some control over their own economic policy decisions. For example, a government of a LDC that is heavily reliant on natural resource rents may be unable to move away from economic policies that focus primarily on natural resources to pursue a more profitable part of the transnational organization of production without considerable consequences. Such a situation may place countries in a state of perpetual subordination to more developed countries in a way that supports the global treadmill of production as is suggested by ecostructural theory.

Future research is needed to address this issue further. Using historical data, research could, for example, locate nations where FDI investment has driven available natural resource stocks in LDCs to low levels. Once these nations are identified, researchers can then examine how the economies of those nations are affected. Future researchers should also focus more closely on understanding the mechanisms linking FDI to the specific resource depletion and rents that are the subject of the paper.

We need to acknowledge several limitations to this study. First, the dataset was limited to countries with available data; the number of countries available for use in any specific estimate was also affected by the availability of control variables. Second, because reliable time-series primary sector FDI stock data is not available we use total FDI stocks as the main independent variable. This was not ideal because specific stock data would have provided a more accurate measure of our primary independent variable. As a result, we believe the relationships in our study may be attenuated by measurement error. Moreover, we supplemented these findings with cross-sectional results using primary sector FDI stock as the main independent variable for a sample of LDCs where data were available. These additional cross-sectional analyses found strong relationships between primary sector FDI stocks and natural resource depletion and rents suggesting that the relationship is correctly estimated in our longitudinal analysis.

In the end our findings suggest that FDI increases natural resource depletion and the income generated from that depletion (i.e. rents). Consequently, it appears that foreign capital increases ecological disorganization in LDCs, while also making these countries more dependent on natural resources for economic growth, which may harm the health of their economies over the long term. The transnational organization of production has generated economic growth for many countries, however it appears that it also increases and displaces

ecological disorganization, while giving foreign firms influence over LDCs' approach to economic growth.

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Table 1. Descriptive Statistics of Untransformed Variables in the Analysis

	Mean	Standard Deviation	Skewness	*n*
Natural resource depletion	7.86	11.68	2.64	1512
Energy depletion	4.60	10.70	3.56	1718
Forest depletion	1.64	4.25	4.07	1522
Mineral depletion	0.97	2.73	4.47	1737
Natural resource rents	9.83	15.72	2.15	1926
Energy rents	6.74	15.10	2.66	1780
Forest rents	2.45	5.06	3.74	1608
Mineral rents	1.65	4.91	5.57	1747
FDI stocks	0.54	0.75	4.53	1654
GDP per capita	14085.7	21875.1	2.89	1747
Agriculture exports	3.65	7.94	5.28	1364
Agriculture value added	13.10	12.84	1.36	1523
Fuel exports	16.78	26.57	1.89	1325
Gross capital formation	24.54	8.68	1.50	1538
Industry value added	29.38	14.52	1.38	1523
Democracy	4.64	2.07	-0.38	1314
Exports of goods and services	43.84	29.22	2.75	1646
External debt service	4.00	6.87	11.20	1047

Table 2. Fixed-Effects Regression Coefficients (*b*) and Standard Errors (SE) of Determinants of Natural Resource Depletion Variables
for Less Developed Countries, 2005-2013

	Total NR 1 *b* (SE)	Total NR 2 *b* (SE)	Energy 1 *b* (SE)	Energy 2 *b* (SE)	Forest 1 *b* (SE)	Forest 2 *b* (SE)	Mineral 1 *b* (SE)	Mineral 2 *b* (SE)
FDI stocks (ln)	0.21***	0.15**	0.29***	0.44***	0.15***	0.14*	0.88***	0.33*
	(0.04)	(0.06)	(0.07)	(0.08)	(0.03)	(0.06)	(0.12)	(0.13)
GDP per capita (ln)		0.15#		-0.35**		0.24*		1.61***
		(0.09)		(0.12)		(0.10)		(0.21)
Agriculture exports (ln)		-0.15**		-0.11		-0.01		-0.21#
		(0.04)		(0.07)		(0.05)		(0.11)
Agriculture value added (ln)		0.18		0.12		0.41#		-0.01
		(0.20)		(0.27)		(0.23)		(0.48)
Fuel exports (ln)		0.01		0.09**		-0.01		0.03
		(0.01)		(0.03)		(0.01)		(0.04)
Gross capital formation (ln)		-0.01		0.40**		-0.01		-0.33
		(0.10)		(0.12)		(0.15)		(0.22)
Industry value added (ln)		0.73**		1.26***		0.03		-0.24
		(0.23)		(0.33)		(0.28)		(0.53)
Democracy		0.02		-0.03		-0.06		0.28**
		(0.04)		(0.05)		(0.04)		(0.08)
Exports of goods and services (ln)		0.64***		0.93***		0.09		1.28***
		(0.15)		(0.23)		(0.17)		(0.36)
External debt service (ln)		-0.02		-0.08		0.12*		-0.18*
		(0.04)		(0.05)		(0.05)		(0.09)
Constant	4.40***	-2.81	4.92***	0.57	2.00***	-1.29	12.15***	-12.03**
	(0.55)	(1.91)	(1.07)	(2.78)	(0.50)	(2.18)	(1.74)	(4.48)
N	1029	572	646	389	710	387	773	490
F	34.76***	8.66***	17.16***	14.95***	21.86***	2.27**	58.20***	17.99***
R^2 *within*	0.04	0.15	0.03	0.31	0.03	0.07	0.08	0.30

Note: ***p<0.001, **p<0.01, *p<0.05, #p<0.10 significance (two-tailed).

Table 3. Fixed-Effects Regression Coefficients (*b*) and Standard Errors (SE) of Determinants of Natural Resource Rents Variables
for Less Developed Countries, 2005-2013

	Total NR 3 *b* (SE)	Total NR 4 *b* (SE)	Energy 3 *b* (SE)	Energy 4 *b* (SE)	Forest 3 *b* (SE)	Forest 4 *b* (SE)	Mineral 3 *b* (SE)	Mineral 4 *b* (SE)
FDI stocks (ln)	0.23***	0.08#	-0.15	-0.46	0.16***	0.19***	0.69***	0.23#
	(0.05)	(0.04)	(0.38)	(0.58)	(0.02)	(0.04)	(0.11)	(0.13)
GDP per capita (ln)		0.01		0.59		0.02		1.37***
		(0.06)		(0.51)		(0.06)		(0.20)
Agriculture exports (ln)		-0.03		0.27		-0.04		-0.21*
		(0.03)		(0.40)		(0.03)		(0.10)
Agriculture value added (ln)		-0.09		0.92		0.37**		0.39
		(0.13)		(1.09)		(0.13)		(0.45)
Fuel exports (ln)		0.03**		1.09*		0.0002		0.05
		(0.01)		(0.47)		(0.009)		(0.04)
Gross capital formation (ln)		-0.05		1.12		-0.07		-0.24
		(0.07)		(0.86)		(0.07)		(0.21)
Industry value added (ln)		0.62***		2.54		-0.56**		-0.05
		(0.16)		(1.66)		(0.16)		(0.50)
Democracy		0.04#		0.22		0.001		0.25**
		(0.03)		(0.20)		(0.03)		(0.08)
Exports of goods and services (ln)		0.57***		3.54**		0.18#		1.19**
		(0.11)		(1.07)		(0.11)		(0.35)
External debt service (ln)		0.02		-0.08		0.06*		-0.18*
		(0.03)		(0.35)		(0.03)		(0.08)
Constant	4.98***	-1.19	-5.45	-44.93***	2.22***	3.15*	9.79***	-12.62***
	(0.76)	(1.32)	(5.78)	(13.77)	(0.35)	(1.33)	(1.67)	(4.25)
N	1116	598	277	191	1107	593	777	491
F	20.90***	11.02***	0.15	3.16***	50.88***	6.62***	39.13***	14.58
R^2 *within*	0.02	0.18	0.001	0.17	0.05	0.12	0.05	0.26

Note: ***p<0.001, **p<0.01, *p<0.05, #p<0.10 significance (two-tailed).

Appendix A. List of Countries in the Analysis.

Afghanistan	Djibouti	Lebanon	Sao Tome and Principe
Albania	Dominica	Lesotho	Senegal
Algeria	Dominican Republic	Liberia	Serbia
Angola	Ecuador	Libya	Seychelles
Argentina	Egypt	Macedonia	Sierra Leone
Armenia	El Salvador	Madagascar	Solomon Islands
Azerbaijan	Eritrea	Malawi	South Africa
Bangladesh	Ethiopia	Malaysia	Sri Lanka
Belarus	Fiji	Maldives	St. Lucia
Belize	Gabon	Mali	St. Vincent
Benin	Gambia, The	Mauritania	Sudan
Bhutan	Georgia	Mexico	Suriname
Bolivia	Ghana	Moldova	Swaziland
Bosnia and Herz.	Guatemala	Mongolia	Syria
Botswana	Guinea	Montenegro	Tajikistan
Brazil	Guinea-Bissau	Morocco	Tanzania
Bulgaria	Guyana	Mozambique	Thailand
Burkina Faso	Haiti	Namibia	Timor-Leste
Burundi	Honduras	Nepal	Togo
Cabo Verde	Hungary	Nicaragua	Tonga
Cambodia	India	Niger	Tunisia
Cameroon	Indonesia	Nigeria	Turkey
Cen. African Rep.	Iran	Pakistan	Turkmenistan
Chad	Iraq	Panama	Uganda
China	Jamaica	Papua New Guinea	Ukraine
Colombia	Jordan	Paraguay	Uzbekistan
Comoros	Kazakhstan	Peru	Vanuatu
Congo, Dem. Rep.	Kenya	Philippines	Venezuela
Congo, Rep.	Kiribati	Romania	Vietnam
Costa Rica	Kyrgyz Republic	Rwanda	Yemen
Cote d'Ivoire	Lao PDR	Samoa	Zambia
			Zimbabwe

Appendix B. Least Squares Regression Coefficients (*b*) and Standard Errors (SE) for Determinants of Natural Resource Depletion and Rents, 2010[a]

	Total NR Depletion *b* (SE)	Total NR Depletion *b* (SE)	Total NR Rents *b* (SE)	Total NR Rents *b* (SE)
Primary sector FDI stocks (ln)[b]	0.64*** (0.10)	0.50*** (0.08)	0.58*** (0.08)	0.45*** (0.07)
GDP per capita (ln)		-0.49# (0.28)		-0.42# (0.22)
Agriculture exports (ln)		0.09 (0.20)		0.13 (0.16)
Agriculture value added (ln)		0.13 (0.39)		0.007 (0.32)
Fuel exports (ln)		0.16# (0.08)		0.15* (0.07)
Gross capital formation (ln)		-1.59# (0.84)		-0.77 (0.68)
Industry value added (ln)		2.99** (0.80)		2.28** (0.65)
Democracy		0.12 (0.15)		0.14 (0.12)
Exports of goods and services (ln)		-0.11 (0.32)		-0.05 (0.26)
LDC[c]	0.37 (0.36)	-0.52 (0.51)	0.29 (0.31)	-0.42 (0.41)
Constant	11.70*** (1.85)	8.59# (4.30)	11.26*** (1.57)	7.40* (3.47)
N	52	47	52	47
F	25.87***	12.14***	29.16***	14.36***
Adjusted R^2	0.49	0.71	0.52	0.74

Notes: ***p<0.001, **p<0.01, *p<0.05, #p<0.10 significance (two-tailed). [a]External debt service is not included in the models due to the volume of missing values. [b] Primary sector FDI stocks is the value of capital provided by foreign firms to the host county in the primary sector of the economy (i.e. agriculture and mining), measured by percent of host country GDP (ITC 2015). [c]Due to the small number of countries with primary sector FDI stocks data, we included both LDC and developed countries, the LDC indicator controls for this.