Foreign direct investment, income, and environmental pollution in developing countries: Panel data analysis of Latin America

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ABSTRACT

Effects of foreign direct investment (FDI) and income on pollution emissions are examined using time series data from 1980 to 2010 for 14 Latin American countries. Specifically, we test the validity of Pollution Haven Hypothesis (PHH) and Environmental Kuznets Curve (EKC) hypothesis for this region. Results from panel fixed and random effects models that controlled the effects of physical capital, energy, human capital, population density, and unemployment rate indicate the validity of both the PHH and EKC hypothesis. Estimating two separate models for high and low-income countries does not alter the findings for the PHH, however, the impacts of human capital on pollution emission are found to be different for the two groups of countries. Policies that focus on attracting clean and energy efficient industries through FDI have potential to improve environmental health while enhancing economic growth in Latin America.

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1. Introduction

Foreign direct investment (FDI) inflows to Latin America and the Caribbean have reached to $217 billion in 2011, a 16% increase from 2010. This high growth in FDI is mainly attributed to expanding consumer markets, natural resource endowments, and relatively higher rate of return on investments in this region (UNCTAD, 2012). The top five FDI attracting countries in Latin America in 2011 include Brazil (43%), Chile (14%), Mexico (13%), Colombia (8%), and Argentina (6%).

Developing countries, emerging economies, and countries in transition have perceived FDI as a source of economic development and modernization, income growth, and employment (OECD, 2002). Envisaging the potential role of FDI inflows on economic growth and employment opportunities, such inflows are welcomed and encouraged by the recipient countries (Blanco et al., 2011). However, as FDI inflow has shown an increasing trend in this region, so does the pollution emission. Carbon Dioxide Information Analysis Center (CDIAC) reports that Mexico and Brazil belong to the list of top 20 highest fossil-fuel CO_2 emitting countries and they together accounted for about 53% of the 2008

regional total emissions (Boden et al., 2011). As developing countries continue to grow, their CO_2 emissions have become an important issue in international agreements related to trade and environment.

Polluting activities in high-income economies have higher regulatory costs than in developing countries (Jaffe and Peterson, 1995; Mani and Wheeler, 1998). Relatively weak environmental policies in the host countries may give the high-income economies a comparative advantage in pollution intensive goods, and hence the foreign direct investment (FDI) might harm the host country's environment through pollution, which is commonly known as Pollution Haven Hypothesis (PHH). With the increasing trend of FDI and pollution in Latin America, examining the validity of the PHH in this region seems to be quite interesting and worth pursuing.

Literature on relationship between FDI and environmental pollution in Latin American countries are sparse and inconclusive. Waldkirch and Gopinath (2008) examine if FDI flows into Mexico are affected by pollution intensity of production and find evidence of pollution haven effects in case of sulphur dioxide. On the other hand, Eskeland and Harrison (2003) find foreign firms to be significantly more energy efficient and use cleaner energy and hence do not support the PHH for Mexico and Venezuela, along with two African countries – Cote d'Ivoire and Morocco. Blanco et al. (2011) examine the relationship between sector specific FDI and CO_2 emissions using panel Granger causality test for 18

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Latin American countries. The result suggests that there is a causality running from FDI in pollution intensive industries to CO_2 emissions per capita.

Numerous studies (e.g., Shafik and Bandyopadhyay, 1992; Panayotou, 1993; Selden and Song, 1994; Grossman and Krueger, 1995) have examined the relationship between income and pollution after Grossman and Krueger's (1991) path breaking study of the environmental impacts of North American Free Trade Agreement which gave rise to environmental Kuznets curve (EKC) hypothesis. According to the EKC hypothesis, environmental quality at first tends to worsen as per-capita GDP rises but then improves as per-capita GDP increases further, giving rise to an inverse U-shaped relationship between environment pollution and economic growth.

Despite rich literature on test for validity of EKC hypothesis for different countries, those either at an individual country or at a panel level for Latin America are sparse. Mart and Bengochea-Morancho (2003) examined the relationship between the economic growth and CO_2 emissions using time series analysis for a panel of 19 Latin American and Caribbean countries over the period 1975–1998. The result suggests that there is no clear pattern related to the carbon dioxide emissions path. Bhattarai and Hammig (2001) used data from 1972 to 1991 to estimate panel fixed and random effects models and found strong evidence for EKC relationship between income and deforestation for 20 Latin American countries. However, a recent study that examines the effects of FDI and income on environmental pollution for a panel of Latin American countries using appropriate econometric methodology is completely lacking.

The primary objective of this study is to examine the relationships between income and pollution as well as between FDI and pollution in Latin America. Specifically, we test for the validity of PHH and EKC hypothesis for this region using data from a panel of 14 countries.[1] Apart from FDI and income, we include other variables such as unemployment rate, physical and human capital, energy use, and population density in the model to control for their potential effects on pollution emissions.

This study would find its significance from policy formulation perspective, particularly with respect to FDI. Given the role FDI plays in country's economic growth, delineating its effect on the environment would guide policy makers frame critical decisions on FDI inflow. For instance, if FDI is found to have negative impact on the environment, then the government may want to focus on FDI on service sector or clean technology. On the contrary, if FDI is found to exert positive effect on the environment, then the current policy on FDI would be appropriate.

This paper contributes to the literature in the following ways. Firstly, to our knowledge, no study has analyzed the effect of FDI and income on environmental pollution in Latin America in a panel framework. Examination of such a relationship utilizing panel econometric methodology would not only allow for obtaining consistent estimates with increased number of observations, but also control for differences in environmental regulations and other unobserved factors by including country-specific effects in the model. Moreover, this study provides systematic information on the relationship between FDI, pollution, and income in Latin American countries using recent data. Secondly, we incorporate additional control variables in the model, which would minimize omitted variable bias together with delineating the effects of those variables in environmental pollution in the region. Thirdly, extending the Lan et al. (2012) study that considered the endogeneity issue related with unemployment rate in studying the relationship between FDI and pollution in China, we deal with the endogeneity of both unemployment rate and FDI variables in the models. Importantly, the endogeneity test results suggested use of alternative estimation techniques (e.g., use of instrumental variables) to take care of the potential simultaneity bias and obtain consistent estimates.

The remainder of the paper is organized as follows. Next section provides an overview of literature on the relationships between FDI and pollution and between income and pollution. Section 3 describes data and variables where potential econometric issues are also discussed. Section 4 provides results and discussion. Section 5 concludes.

2. A brief review of literature on PHH and EKC hypothesis

2.1. Foreign direct investment and pollution

Impact of FDI inflow on host country's environment in developing nations is inconclusive. Some studies suggest that FDI is related to energy efficiency gains and increased environmental welfare through the transfer of eco-friendly technology and production process (Liang, 2008; Hubler and Keller, 2010; Letchumanan and Kodama, 2000; Eskeland and Harrison, 2003). For example, Liang (2008) examines the relationship between FDI and local air pollution in China and finds a negative correlation between the variables. The study suggests that trade and FDI could have beneficial effect on a developing country's environment as it improves productivity and energy efficiency through new and improved technology. In an examination of the relationship between FDI, growth, and environment for India using cointegration analysis, Acharyya (2009) concludes that the upsurge in FDI inflow in the 1990s did have a quite large positive impact on the CO_2 emissions through output growth. He (2006), examining the FDI-pollution relationship for China in a simultaneous equation framework, finds that a one percent increase in FDI capital stock increases industrial SO_2 emission by 0.098%.

Levels of human capital and economic growth are found to play important roles for the validity of PHH. The Lan et al. (2012) study reports that the impact of FDI on pollution emission is highly dependent on the level of human capital. The PHH is found to hold only in those Chinese provinces that have low human capital. The argument is that the higher (lower) level of human capital is more likely to absorb advanced (less) green technology and experience less (more) environmental pollution. Hoffmann et al. (2005), in their tests for Granger causality between FDI and pollution in a panel of 112 countries, find that the PHH is valid only for the low income countries and not for the middle and high income countries. They suggest that in the absence of FDI attracting factors like infrastructure and skilled labor, low income countries may use lax environmental regulations.

Few studies have examined the impact of environment regulations on FDI. Spatareanu (2007) suggests that more stringent environmental regulations in the investor's country relative to those in the potential host country are positively correlated with the probability of investment as well as with the volume of FDI. List and Co (2000) report that foreign firms are more sensitive to pollution regulations than their domestic counterparts.

2.2. Income and pollution

Studies that look at the relationship between income and pollution abound. The methods used are time series models (cointegration and vector error correction) as well as panel models (fixed and random effects) and the findings are mixed. For example, Narayan and Narayan (2010) test EKC hypothesis for 43 developing countries using panel cointegration and panel long-run estimation techniques and find that CO_2 emission has fallen with a rise in income in Middle Eastern and South Asian countries. Existence of a long-run and an inverted-U shape relationships between CO_2 emissions and GDP are reported for Malaysia (Saboori et al., 2012), India (Kanjilal and Ghosh, 2013), Pakistan (Nasir and Rehman, 2011), Tunisia (Fodha and Zaghdoud, 2010), France (Iwata et al., 2010), South Korea (Baek and Kim, 2013; Onafowora and Owoye, 2014), and Japan (Onafowora and Owoye, 2014), among others. However, some studies find monotonically increasing (Holtz-Eakin and Selden, 1995; Shafik, 1994)) and some find

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[1] The countries included are Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, and Venezuela and are selected based on data availability.