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Testing for Granger causality between energy use and foreign direct investment Inflows in developing countries

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ABSTRACT

Foreign direct investment inflows (FDI) and emissions exhibit a two way relationship. In particular, this research studies the relationship between FDI inflows and emissions from energy use in developing countries. This is done through conducting a Granger causality test on the direction of the relationship between FDI inflows and energy use. For that, a fixed effect panel data model with heterogeneous slopes is used. Heterogeneous slopes specification is selected to account for individual differences within countries. Error correction model is the chosen estimation approach. The empirical results highlight the presence of a two way relationship between FDI inflows and emissions from energy use when testing for short and long run effects jointly. However, this result varies when testing for no long run effect within individual countries. Policy implications for developing countries are also given.

Contents

1. Introduction

Nowadays, environmental concerns are spreading everywhere in both developed and developing countries. The climate is changing, scarce species are diminishing, many resources are depleting and above all humans' lives are threatened. In general, this is usually attributed to our consumption and production patterns. However, in particular, foreign direct investment (FDI), trade and energy use are usually accused of increasing pollution and environmental degradation.

FDI can increase pollution and environmental degradation when it is concentrated in polluting industries. The pollution havens hypothesis, for example, assumes that stringent environmental laws in developed countries will push polluting industries away from developed countries in the form of FDI outflows [1]. At the same time, lax environmental laws in developing countries will attract polluting industries via FDI inflows. This is magnified with trade liberalization and free movement of capital. Also, trade

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can harm the environment. This may happen, for example, if the traded good damages the environment such as trading in illicit drugs, radioactive wastes, scarce species and prohibited goods.

Furthermore, energy use may result in increasing polluting emissions. According to the World development indicators, energy use is defined as using primary energy before changing to other end-use fuels [2]. This is calculated by adding local production to imports and stock changes and subtracting from them exports and fuels used in international transportation. Accordingly, energy consumption is considered in this definition. Primary energy can be classified into renewable and non renewable sources. Renewable energy sources include solar energy, wind energy, falling and tidal energy, biomass sources and geothermal energy. On the other hand, non renewable energy sources are oil, coal, natural gas and natural uranium. Environmentalists are more concerned with the use of non renewable energy sources. This is because of polluting emissions such as carbon dioxide, nitrogen oxide, or sulfur oxides associated with this process. In contrast, renewable energy sources are environmental friendly and are often labeled as 'clean energy' sources due to releasing less emissions. For instance, to generate electricity from fossil fuels, natural gas releases between 0.6–2 pounds of carbon dioxide equivalent per kilowatt-hour (CO_2E/kWh), while coal releases between 1.4 and 3.6 pounds of CO_2E/kWh [3]. In contrast to this, renewable energy sources produce lower levels of carbon dioxide emissions so that the corresponding figures for wind, solar, geothermal and hydroelectric are between 0.02–0.04, 0.07–0.2, 0.1–0.2 and 0.1–0.5 pounds of CO_2E/kWh respectively [3]. However, emissions from biomass can be higher if compared to other renewable energy sources depending on the resource and the applied technique.

It is true that the use of clean energy is increasing over time but still fossil fuels remain the major source of energy worldwide [4]. For that, energy use can be used as a proxy measure for pollution emissions. However, if patterns of energy consumption change in the future, this argument will no longer be true.

There is a two way relationship between FDI inflows and emissions from energy use. This is because high emissions from energy use, which are a result of lax environmental laws in a country, attract polluting FDI inflows. On the other hand, FDI inflows can affect emissions from energy use. This may happen when FDI inflows increase energy consumption in a country and hence, may lead to more polluting emissions. It would be interesting also to consider the effect of FDI inflows on pollution emissions from energy use when these FDI inflows use environmental friendly techniques in production.

For that, this paper focuses on studying the relationship between FDI inflows and emissions from energy use. This is done through conducting a Granger causality test on the direction of the relationship between FDI inflows and energy use in developing countries. In general, Granger causality test measures the direction of the relationship between two or more variables. Granger measures causality between two variables X and Y through testing how much of the current values of Y are explained by preceding values of Y and whether the insertion of lagged values of X improves the explanation [5].

The rest of the paper is organized as follows: Section 2 describes recent trends of FDI and energy use. Section 3 provides a quick theoretical background with empirical evidences. Section 4 includes the empirical analysis. Section 5 presents the empirical results. Finally, Section 6 concludes and suggests policy implications for developing countries.

2. Recent trends of FDI and energy use

The scale of FDI has amplified quickly during the period 1980–2000. As reported by Fredriksson, nominal FDI inflows worldwide enlarged by 18% per year during 1987–1997 [6]. This result is confirmed by the figures of the Organization for Economic Co-operation and Development (OECD) of both FDI inflows and outflows for OECD countries [7]. Fig. 1 shows the increase in FDI inflows from 1995–2009 by region [8].

Nevertheless, FDI composition and the relative importance of its determinants varied across time [9]. For example, FDI was mostly in the primary sector and natural resources were the most effective determinant of FDI in the 50s [10,11]. Since the 60s, FDI was more going to the industrial sector with a shrinkage in natural resource importance. Escaping trade barriers is a likely explanation for variations in FDI flows. Also, there are other sources of attraction to FDI investors such as market size and economic growth [11].

Since the 80s FDI inflows were more towards the services and technology based manufacturing. For example, FDI inflows in the services sector accounted for 60% of FDI inflows in 1990 [12]. The increase in importance of the services sector is evident in the case of FDI inflows in developing countries. However, still the petroleum sector, construction, chemicals production and transportation are the main receivers of FDI inflows in developing countries [13]. Accordingly, polluting industries are still concentrated in developing countries through FDI. Table 1 illustrates FDI inflows to developing countries by sector [14].

The share of FDI inflows to developing countries has increased from 25% of world FDI inflows in 1980–84 to 40% in 1994–96 [9]. Among developing countries, China has been the chief beneficiary of FDI inflows since 1992. Not only this, but also China is the second largest receiver in the world after US. China accounts for 35% of FDI flows to developing countries with a $33 billion of FDI yearly from 1993–96. Second after China are South, East and Southeast Asia (excluding China) and Latin America and the Caribbean each constituting 30% of FDI flows to developing countries. FDI inflows to Latin America and the Caribbean peaked at $39 billion annually in 1994–96. Nevertheless, since then their share has been declining opposite to its comparable South, East and Southeast Asia whose share is increasing. Lastly, in absolute terms FDI inflows to Africa enlarged from an annual average of $800 million in 1975–80 to $4.5

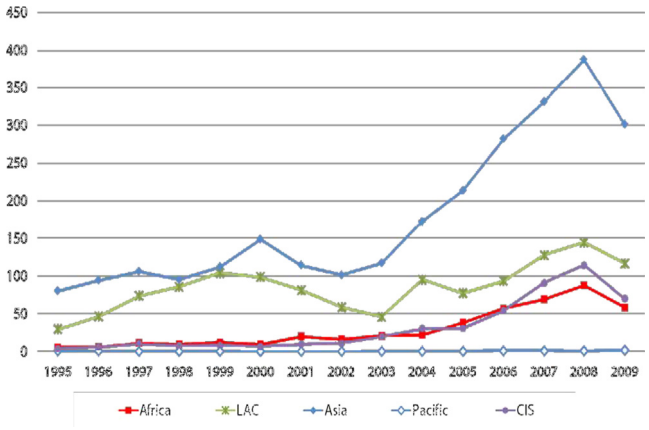

Fig. 1. FDI Inflows by Region (1995–2009) US$ Billions.
Source: Calculated using data from UNCTAD World Investment Report [8].

Table 1
FDI inflows to developing countries by sector (US$ Billions).
Source: Calculated using data from UNCTAD, World investment report [14].

Period	Primary	Manufacturing	Services
1989–1991	3.9	16.1	9.3
2005–2007	46.8	121.0	161.4