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The contribution of foreign direct investment to clean energy use, carbon emissions and economic growth

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HIGHLIGHTS

- ▶ FDI inflows strongly lead to economic growth in the G20.
- ▶ FDI inflows lead to an increase in energy use in the G20.
- ▶ FDI inflows are in no relation to CO₂ emissions in the G20.
- ▶ FDI inflows are in no relation to clean energy use in the G20.
- ▶ Economic growth is in negative relation to CO₂ emissions in the G20.

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ABSTRACT

The paper investigates the contributions of foreign direct investment (FDI) net inflows to clean energy use, carbon emissions, and economic growth. The paper employs cointegration tests to examine a long-run equilibrium relationship among the variables and fixed effects models to examine the magnitude of FDI contributions to the other variables. The paper analyzes panel data of 19 nations of the G20 from 1971 to 2009. The test results indicate that FDI has played an important role in economic growth for the G20 whereas it limits its impact on an increase in CO₂ emissions in the economies. The research finds no compelling evidence of FDI link with clean energy use. Given the results, the paper discusses FDI's potential role in achieving green growth goals.

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1. Introduction

Within policy circles, there is a widespread belief that foreign direct investment (FDI) enhances the productivity of host countries and promotes economic growth. The notion supports FDI may not only provide direct capital financing but may also create positive externalities via the adoption of foreign technology and know-how. [Batten and Vo \(2009\)](#) have shown that FDI stimulates economic growth through technology transfer, spillover effects, productivity gains, and the introduction of new processes and managerial skills. [Fernandes and Paunov \(2012\)](#) have recently shown that FDI has positive effects on innovation activities and manufacturing productivity. [Hermes and Lensink \(2003\)](#) reported that FDI plays an important role in modernizing the economy and promoting economic growth.

The historical data released by the World Bank indicate that FDI may have played an important role in addressing the growth challenges, in particular, in the group of twenty (G20) countries.

The G20 is a group of heads of government or state from 20 leading economies, 19 countries plus the European Union, including Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, South Korea, Mexico, Russia, Saudi Arabia, South Africa, Turkey, the United Kingdom, and the United States. Collectively, the G20 economies account for more than 80 percent of the gross world product, 80 percent of the world trade, and 62 percent of the world population, according to data from the World Growth Indicators. Most of the G20 economies are growing rapidly and as economic growth increases so too does the demand for energy. According to the [International Energy Agency \(2007\)](#), between 2005 and 2030 the world energy demand is expected to grow at an average annual rate of 1.8%. The G20 economies will contribute to 84% of the increase in the world energy demand.

[Table 1](#) displays the summary statistics of 19 countries of the G20 during 1971–2010. There is a great deal of variation in mean per capita income with the highest mean per capita income levels 50,746 US dollars in Australia and the lowest 1375 US dollars in India with exhibiting an average of 23,078 US dollars in the G20, which is 252 percent higher than that of the world, an average of 9157 US dollars per capita in 2010. FDI net inflows per capita indicate a great deal

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Table 1
Summary statistics, the G20 countries.

Country Name	GDP (1)	CO ₂ (2)	Energy (3)	Clean energy (4)	FDI (5)
Argentina	9123	4.84	1853	6.78	3339
Australia	50,746	18.56	5642	1.31	15,032
Brazil	10,992	2.05	1242	15.61	2170
Canada	46,212	16.32	7481	21.26	17,896
China	4433	5.30	1695	3.65	1057
France	39,170	5.85	4060	44.72	13,821
Germany	39,851	9.58	4053	13.09	8917
India	1375	1.46	559	2.34	163
Indonesia	2952	1.72	851	8.39	281
Italy	33,788	7.43	2813	5.95	4238
Japan	43,063	9.46	3883	17.16	934
Korea	20,540	10.40	4989	15.93	1524
Mexico	9133	4.30	1497	6.26	3258
Russia	10,481	12.03	4558	9.01	2138
Saudi Arabia	16,423	16.56	5888	0	6589
South Africa	7272	8.93	2920	2.44	988
Turkey	10,049	4.00	1440	6.51	1515
United Kingdom	36,186	8.51	3282	8.53	24,678
United States	46,701	17.95	7225	11.59	10,862
<i>Consolidated</i>					
Mean	23,078	8.70	3470	10.55	6284
St. Deviation.	17,437	5.48	2107	10.12	7045
Minimum	1375	1.46	559	0	163
Maximum	50,746	18.56	7481	44.72	24,678
World average	9157	4.76	1790	9.22	2853

(1) GDP per capita in 2010 (current US\$).

(2) CO₂ emissions per capita in 2009 (metric tons).

(3) Energy use per capita in 2010 (kilogram of oil equivalent).

(4) Clean energy use (% of energy use).

(5) FDI net inflows per capita during 1971–2010 (current US\$).

of variation with the highest mean per capita FDI levels 24,678 US dollars in the United Kingdom and the lowest 163 US dollars in India, with exhibiting an average of 6284 US dollars in the G20. It is 220 percent higher than that of the world, an average of 2853 US dollars per capita during the period from 1971 to 2010. The mean energy use per capita ranges from 7481 kg of oil equivalent in Canada to 559 kg in India with exhibiting an average of 3470 kg per capita in the G20, which is 194 percent larger than that of the world, an average of 1790 kg per capita in 2010.

According to a report by the International Energy Agency (2011), the CO₂ emission levels are relatively high in most of the G20 countries. Table 1 displays that the mean CO₂ emission per capita ranges from 1.46 metric tons in India to 18.56 metric tons in Australia with exhibiting an average of 8.70 metric tons in the G20, which is 183 percent larger than that of the world, an average of 4.76 metric tons per capita in 2009. Along with the rapid economic growth in the G20 countries, the emission levels have been growing fast. Although a wide gap exists among the G20 countries, FDI and the growth of specific business sectors such as manufacturing and infrastructure may be putting tremendous pressure on energy resources and the environment in the countries. However, environmental problems know no economic boundaries since they are complex in nature and transcend national boundaries.

In the 2008 G20 Summit, the G20 discussed clean energy, economic growth, and the fiscal elements of growth. Since the meeting, understanding the determinants of energy demand and the use of clean energy is essential for making better energy policies in the future. A better understanding of how to manage global emissions of greenhouse gases is critical because energy related emissions make up mainly the bulk of CO₂ emissions. In this regard, the challenge facing the G20 is how to develop policy responses to counter the effects of the current environmental problems and climate change and lay the foundations for sustainable growth that achieves economic growth and at the same time

reduces the CO₂ emissions from the results of their economic growth. In addition, the increased economic importance of FDI raises new questions for the governments regarding the best policy frameworks to encourage continued economic growth, the reduction of CO₂ emissions, the efficient use of energy resources, and the increased use of clean energy resources.

In sum, this paper assumes that FDI contributes to economic growth whereas it may also lead to an increase in energy consumption, and thus result in high CO₂ emissions. Following the assumption above, FDI leads to an increase in CO₂ emissions while it may also lead to the increased use of clean energy.

2. Literature review and hypotheses

2.1. FDI and economic growth

Hypothesis 1. FDI leads to economic growth.

The role of capital investment in economic growth has been considered one of the basic principles in economics. Many researchers conclude that the rate of capital formation determines the rate of economic growth (Blomstrom et al., 1996; Ekanayake and Vogel, 2003; Tsang and Yip, 2007). For example, De Long et al. (1992) found a strong causal relationship between equipment investment and economic growth. Blomstrom et al. (1996) also reported that the growth rate is more closely related to the capital formation rates in succeeding periods than to the contemporary or preceding rates. Alfaro et al. (2010) have shown that FDI leads to higher additional growth in developed economies. Lee and Chang (2009) reported that FDI has a large direct effect on economic growth and extends the potential gains associated with FDI.

FDI is of special interest due to its supposed positive effects on growth. There is a widely accepted view that FDI promotes growth not only directly by augmenting capital formation in the recipient economy, but also indirectly by inducing human capital growth, helping technology transfers, and strengthening competition (Aitken et al., 1997; Kneller and Pisu, 2007). Thanks to these potential merits of FDI, both developing and developed countries have become more receptive to FDI inflows, and the global FDI flows have continued to increase except for short declines during 1982–1983, 1991–1992, 2001–2003, and 2008–2010.

Aitken et al. (1997) have shown evidence of beneficial spillovers from multinational enterprises to the host economy, whereas Hsiao and Shen (2003) reported that economic growth is one of the important factors in attracting FDI, in particular in developing countries. Some studies indicate that the direction of causality between economic growth and FDI is subject to country-specific factors (Zhang, 2001). Kim and Seo (2003) reported that FDI has a positive but insignificant effect on GDP growth, while GDP growth has a significant and highly persistent effect on the future level of FDI in South Korea. Qi (2007) reported that the countries that are heavily dependent on petroleum exports have more difficulties than other countries in benefiting from FDI, and the role of total investment in impelling growth is also weakened in oil-exporting countries. The findings in the literature indicate that a country's capacity to take advantage of FDI externalities might be limited by local conditions.

2.2. Economic growth, energy consumption and CO₂ emissions

Hypothesis 2. Economic growth is in positive relation to CO₂ emissions.

A fairly large amount of literature finds a causal relationship between energy consumption and economic growth, especially in

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