Volume: 26, Issue: 1
Page: 177-186
2023

International Journal of Science and Business

Journal homepage: ijsab.com/ijsb

Impact of foreign direct investment on CO2 emissions: the case of Tajikistan

UMARALIEV ABDUKHUSEN & GUY MERLAIN DJAKOU

Abstract

Employing the cointegration procedure and time series data covering the years 1990–2020, this investigation investigates the effect of foreign direct investment inflows on carbon dioxide emissions in Tajikistan in order to test the veracity of the pollution paradise theory. Our conclusion that the variables are cointegrated is supported by the bivariate cointegration study. In addition, the outcomes of ordinary least squares (OLS) estimators demonstrate that foreign direct investment (FDI) has a favorable long-term association with carbon dioxide emissions. The Engle-Granger causality test results, on the other hand, show that both short- and long-term carbon dioxide emissions are increased by foreign direct investment inflows. So, it stands to reason that although filthy industries initially abide by environmental laws and norms, with time they too start to pollute. It is advised to keep luring these applicants while setting up systems and tools to lessen carbon dioxide emissions under the confines of strict environmental regulations.

IJSB
Accepted 10 August 2023
Published 17 August 2023
DOI: 10.58970/IJSB.2174

ISSN: 2520-4750 (Online) 2521-3040 (Print)

Keywords: *Foreign direct investment, Cointegration technique, Engle-Granger causality test, CO2 emissions, Pollution paradise hypothesis.*

About Author (s)

UMARALIEV ABDUKHUSEN (Corresponding Author), Ph.D. Student, School of Economics, Capital University of Economics and Business (CUEB), Beijing, China.

GUY MERLAIN DJAKOU, Ph.D., School of Economics, Capital University of Economics and Business (CUEB), Beijing, China.

Introduction

Both developed and developing nations benefit from foreign direct investment. It has grown in importance in emerging nations, especially since the 1980s. Given their catalytic effects on economic growth, attracting Foreign Direct Investment has become a major economic concern for developing countries. FDI makes it possible to convey factors (human capital, physical capital, public capital, and technology) considered by the theory of endogenous growth as determinants of long-term economic growth. By providing new know-how, improving the skills of workers (possibly through learning-by-doing), and providing new capital goods, FDI increases the stock of knowledge in the host country. Consequently, FDI rises the growth proportion of the host economy in the both short and long term (OECD, 2002). FDI, through the transmission of new knowledge, contributes to reducing the technological gaps between countries, which can be an important factor in economic convergence (Romer, 1993). In addition, FDI is likely to generate growth through technology transfer, human capital accumulation, and increased international trade (Borenstein et al., 1998). According to the Pollution Haven Hypothesis (PHH), some businesses with high levels of pollution and consumption may seem concealed from other countries via FDI and trade, resulting in a considerable rise in pollutant emissions (see, for instance, Savona and Ciarli 2019; Stef and Jabeur 2020). Research that links FDI flows to environmental deterioration in a favourable way often supports PHH (see, for instance, Sapkota and Bastola 2017; Hanif et al. 2019; Salehnia et al. 2020; among others). However, new research suggests that FDI flows may potentially lower CO2 emissions because of better management practises and technological advancements (for examples, see Zhu et al. 2016, Wang et al. 2019, and Huang et al. 2017).

Tajikistan had an increase in FDI inflows from 213 million USD in 2019 to 107 million USD in 2020, according to UNCTAD's World Investment Report 2021, mostly as a result of the worldwide health and economic crises brought on by the Covid-19 epidemic. In 2020, FDI stocks totaled USD 3.1 billion. FDI flows, however, might harm the environment in the host countries, which are often developing nations. Intense discussions on this issue have taken place between economists, academics, and political organisations, leading primarily to the development of two contentious ideas. According to the first, trade liberalisation would cause enterprises that manufacture polluting goods to migrate from wealthy countries with strong environmental constraints to developing nations with more light environmental standards. As a result, polluting companies in developed nations would find safe harbour in poor nations. The polluter haven hypothesis (HHP), which was initially put out in 1994 (Copeland and Taylor, 1994), is the name given to this theory. Contrarily, the Porter (HP) hypothesis contends that companies invest more in green and efficient technology because of strict environmental legislation in their home nations. These eco-friendly solutions boost productivity and lower marginal costs, improving business competitiveness (Porter and van der Linde, 1995).

In comparison to the year before, CO2 emissions grew by 3.37%, or 197,027 tonnes more than in 2015 when they were 5,852,730 tonnes. In this case, Tajikistan would not be excluded from the conversation. Despite the fact that its CO2 emissions rose by 3.37% from the year before, compared to 2015, when they were 5,852,730 tonnes (World Population Prospects: The 2019 Revision), this represents an increase of 197,027 tonnes. Therefore, it is essential to comprehend and analyse the association between FDI flows and CO2 emissions in order to forecast the country's ecological imminent and make the recommendations essential for its sustainable growth. In this article, we examine the association between FDI flows and CO2 emissions in order to assessment the viability of the pollution haven concept for the instance of Tajikistan. This is how the article will be structured: The literature on the connection

between the development of FDI and the verification of the aforementioned hypothesis is briefly reviewed in Section 1. The research's methodology is presented in Section 2. The results are outlined in Section 3 before being concluded and discussed in Section 4.

Literature review

Researchers and academics have been debating the possessions of economic growth and greater industrial activity on the environment for several decades, which has led to numerous contentious hypotheses. According to the environmental Kuznets curve (EKC), a country's effluence absorption rises as it develops and industrializes up to a point and then declines as it utilizes its greater resources to further lower pollution concentrations, is one of the most researched hypotheses (Jbara, 2007). There are several options for reducing the concentration of pollution; the first is the adoption of cleaner production technologies by developed nations, and the second is the specialization of developed nations in the manufacture of clean goods while polluting businesses are relocated to evolving nations via the IDE, where there are rarer ecological boundaries.

The pollution refuge effect, the scale effect, and the pollution halo are three processes through which FDI may affect the intensity of CO2 emissions. One the one hand, through pollution shielding and scale effects, FDI will boost CO2 emissions. IFDI (inward foreign direct investment) can drive economies of scale, boost regional economic growth, and raise energy use and CO2 emissions. Additionally, to draw in foreign investment, developing nations or areas might participate in "bottom-up competition" and decrease the FDI entry barrier. Due to this, industrialised nations transfer "high pollution, high energy consumption, and high emissions" (high three-tier companies) to developing nations and view them as "shelters against pollution," which raises the CO2 emissions of the host nations.

A "pollution halo effect" brought on by foreign direct investment, however, would lower the force of CO2 releases. According to the "pollution halo hypothesis" espoused by Letchumanan and Kodama (2000), IFDI may lead to a chain reaction of green technologies. Foreign company colonies may bring cutting-edge management and production techniques that can be used as models by domestic firms. The "lagging advantage" of host country firms may be fully used through learning by imitation in order to improve industrial structure and production methods, lower national CO2 emissions, and keep up with advancements in green technology and environmental management.

Research on polluter havens frequently uses a variety of estimating techniques, various data samples, shifting trends, and other variables that have an influence on the findings. This results in competing arguments, which either support or refute the validity of the premise and, consequently, the presence of FDI's environmental impact in the host nations. Starting from a business standpoint, a research using panel data of manufacturing sectors for the instance of Turkey between 1994 and 1997 revealed that exports expanded at the same rate as polluting industries, supporting the presence of the hypothesis (Akbostanci et al., 2007). The Granger causality test performed using the model at error correction (ECM) also revealed the existence of a causal relationship between the variables when looking at associations between FDI invasions, CO2 releases, and economic growth over the period 1987Q1–2009Q4; this finding supports the polluter haven hypothesis for the same country (Mutafoglu, 2012).

Managi (2005) examines the association between FDI levels and CO2 emissions using facts from 63 industrialized and developing nations from 1960 to 1999. The likelihood of an

endogenous link between trade openness, FDI, and income has been taken into consideration in the estimation, similar to the work of Frankel and Rose (2005). The study demonstrates that rising FDI inflows cause rising emissions, with an estimated elasticity (a measure of CO2 emissions' responsiveness to FDI) of 0.579.

The CEK hypothesis, which predicts a bright future for the environment in the long term (thanks to the entry of FDI), clashes with the pessimistic polluter haven hypothesis. According to the latter, developing countries have comparative advantages in polluting sectors because their low level of income does not allow them to impose strict environmental protection rules as rich countries do, which results in the displacement of polluting industries from developed countries to developing countries. In other words, the quality of environmental regulation in developing countries makes them potential pollution havens that could host FDI in polluting technologies. FDI flows directed towards sub-Saharan Africa (SSA) seem to confirm this hypothesis.

Khalil and Inam (2006) utilised Pakistan's time-series data from 1972 to 2002 and a cointegration test to find that FDI had a beneficial influence on CO2 emissions. Using panel data from China for the years 1999 to 2004, Sha and Shi (2006) assessed the environmental impact of FDI. China's natural environment apparently suffered serious harm as a result of FDI. In 44 developing nations between 1987 and 1995, Talukdar and Meisner (2001) looked at the private sector's carbon emissions. They discovered that FDI encouraged a drop in carbon dioxide emissions. The host country's environmental quality may be significantly enhanced by FDI, according to the Organisation for Economic Cooperation and Development (OECD, 1999). The host country's environmental requirements will be simpler for FDI enterprises to comply with than they will be for local businesses (Shehzad et al., 2020; Sarfraz et al., 2019; Sarfraz et al., 2019b). This is due to green and environmentally friendly technology as well as effective management technologies.

The polluted paradise idea was supported by an examination of long-term cointegration using data for West African nations from 1970 to 2017 (Halliru et al., 2021). (Omri et al., 2014) used global panel data made up of 54 nations for the years 1990–2011 and grouped several areas to construct a dynamic model of a system of conjoint cubic equations. In all categories (Latin America and the Caribbean, Middle East, North Africa, and Sub-Saharan Africa), empirical studies demonstrate a bidirectional causal relationship between FDI inflows and economic growth. However, all panels, with the exception of those for Europe and North Asia, only indicate a causal relationship between FDI and CO2. A separate study that used dynamic panel data for 188 countries found that FDI significantly had a negative impact on carbon intensity in both high- and low-income nations (Shao, 2018). (Shahbaz et al., 2015) examined the heterogeneity of the relationship between FDI and environmental degradation in 99 high-, middle-, and low-income countries. In the global and middle-income panels, the FMOLS estimate shows an inverted U-shaped link between FDI and CO2 emissions. However, FDI raises the environmental standards in high-income nations. They also highlight the potential damage that FDI rules in low-end manufacturing and industrial sectors in low-income nations might do to the environment. The results of the weighted and unweighted meta-averages imply that the environmental impact of FDI is negligible. Increasing FDI causes a decrease in emissions after accounting for publication bias and individual variation. This discovery, which offers empirical test data, supports the pollution halo theory from the meta-analysis (Demena and Afesorgbor, 2020). Increased economic openness, according to Li et al., will only result in a rise in carbon emissions from the lower-middle income group (Li and others, 2021).

According to Manage et al. (2008), the effect of foreign direct investment (FDI) on CO2 emissions varies depending on whether it affects developed or developing nations. The authors evaluate how FDI affects the levels of emissions of CO2, SO2, and biochemical oxygen demand (BOD), which are regarded as markers of pollution levels. They make use of panel data on emissions of CO2, SO2, and BOD from 88 nations between 1973 and 2000 as well as 83 countries between 1980 and 2000. With the help of their econometric research, they can both account for the endogenous character of income and FDI and discriminate between the short- and long-term correlations between FDI and CO2 emissions. According to these writers, growing FDI inflows causes industrialized nations' CO2 emissions to decline. But when FDI rises domestically, CO2 emissions rise in emerging nations. This shows that FDI will worsen the socioeconomic and environmental conditions in SSA, making the area a possible shelter for pollution.

In the second scenario, the dynamic relationship between FDI and energy use is investigated. In order to conduct an empirical inquiry on the dynamic relationship between the intensity of energy consumption and the scope of FDI, Su and Wang (2011) created a vector panel autoregression model and an econometric panel model based on the panel data of Chinese provinces from 1995 to 2008. The empirical results show that their relationship is a typical inverted U-shaped one. In other words, when FDI grows in size, energy demand increases first before decreasing. Furthermore, the intensity of energy consumption, which is held at 4.3%, is considerably increased by FDI. The impact of energy consumption intensity on the FDI scale is still 5.4%. Sun (2009) employed impulse response functions to dynamically model the impact of FDI on the efficiency of technological progress and the structural efficiency of China's energy consumption in order to investigate the causal relationship between the IDE and the two spillover channels. The results show that FDI may reduce the intensity of energy use. Granger causation over a long length of time, however, cannot be shown between FDI and structural and efficiency characteristics.

To delve into the influence of environmental regulations on FDI patterns and evaluate the polluter haven hypothesis, a study conducted by Chung (2014) scrutinized the dynamics of South Korean FDI during the 2000-2007 timeframe. Notably, this period witnessed Korean businesses persisting with outdated production technologies despite the rapid tightening of environmental standards. Analysis of the collected data clearly reveals a preference among polluting companies for directing more investments toward countries with more lenient environmental regulations. This preference is evident in both the intensity of investment (intense margin) and the proliferation of new foreign subsidiaries (extensive margin). Similar trends emerge when examining import patterns.

Another research effort (Sun et al., 2014) evaluates the legitimacy of the pollution refuge hypothesis through an investigation spanning from 1980 to 2012, utilizing annual time series data. The analysis encompasses primary contributors to CO2 emissions, encompassing variables like GDP, GDP squared, energy consumption, foreign direct investment (FDI), economic freedom, urbanization, financial development, and trade openness, all approached through the ARDL method. The outcomes of the limits tests affirm a stable, enduring relationship among the selected variables in each model. Particularly noteworthy is the finding that a 1% increase in incoming FDI flows (relative to GDP) in China results in a 0.058% rise in CO2 emissions, bolstering the pollution haven theory (Sun et al., 2017). The subsequent

sections of this article will maintain a similar approach, outlining the methodology, scrutinizing findings, and ultimately arriving at a conclusive assessment of the research's implications.

Methodology, data, and empirical model

Given the aforementioned considerations, the question of whether foreign direct investment (FDI) flows exert influence on CO2 emissions remains a topic of ongoing discourse. Empirical investigations yield divergent outcomes, at times corroborating this relationship while at others presenting contradictions. It is worth noting that this field of inquiry is still in its developmental stages, and the environmental dimension remains relatively underexplored in Tajikistan. Hence, there is a compelling need to initiate research efforts in this domain. To substantiate the presence of the pollution haven hypothesis within the context of Tajikistan, the initial stride involves addressing the trajectory of FDI inflows—a pivotal driver of Moroccan economic advancement—from an environmental vantage point. A comprehensive assessment of the immediate and enduring repercussions of these inflows on CO2 emissions (EC) emerges as a central pursuit. In this vein, a pivotal inquiry arises: what extent of influence does incoming FDI wield over CO2 emissions in Morocco, and is this impact subject to temporal fluctuations or does it exhibit constancy across short- and long-term horizons? To address this quandary, we employ a meticulously curated assemblage of pertinent variables, complemented by judiciously chosen empirical methodologies. The discourse necessitates explicit articulation concerning the methodological approach, the designated model for analysis, the procedural sequence entailed in the empirical estimation, and a comprehensive depiction of the underlying dataset.

The methodology adopted

In the host country, economic growth, industrialization, urbanization, opening rates, and other variables that effect carbon emissions are also discussed in the literature study. Nevertheless, rather than identifying the precise role of the transmission channels between FDI and carbon emissions, our objective would be to capture the overall impact without taking the auxiliary factors into account. The cointegration strategy, which also eliminates estimation problems like serial correlation, heteroscedasticity, and multi-collinearity, greatly supports the bivariate technique. The aforementioned approach also allows us to use the Engle-Granger causality test technique to assess the impact of FDI on Tajikistan's short- and long-term carbon emissions.

Model Specification

Two empirical models are provided that are inspired by investigations using the dynamic bivariate cointegration approach.

Model (1) illustrates how FDI affects the long-term EC.:

$$CE_t = \alpha + \beta FDI_t + \varepsilon_t \quad \text{..... (1)}$$

With CE_t the carbon emissions in Tajikistan in the year t (in metric tons per capita) and FDI_t the net foreign direct investment inflows in Tajikistan in the same year t (in current US Dollar).

Model (2) presents the dynamic impact of FDI on short- and long-term CE by estimating the Engle-Granger causality test model as follows:

$$\Delta CE_t = \alpha + \lambda \varepsilon_{t-1} + \sum_q \theta_q \Delta CE_{t-q} + \sum_q \beta_q \Delta FDI_{t-q} + \mu_t \quad \text{..... (2)}$$

In this equation, q is the optimal lag, θ is the speed of adjustment to the long-term equilibrium path, λ is the long-term effect of the FDI on the β CE, is the short-term effect of the FDI on the ECs and μ is the white noise error term.

Description of data

The empirical study confirms the influence of FDI inflows on carbon emissions in Tajikistan using unbalanced data over a 30-year period, from 1990 to 2020. The dataset for the two variables was sourced from the World Bank database, wherein foreign direct investment is categorized as encompassing earnings that fulfill the prerequisites for constituting a net investment. This classification further encompasses the authorization for acquiring a lasting stake in an enterprise situated beyond the originating country, notably the United States. The sum of equity, reinvested profits, other long-term capital, and short-term capital is recorded in the balance of payments. The World Bank also specifies that carbon emissions originate from both the manufacture of cement and the combustion of fossil fuels. They include carbon dioxide emissions from flaring as well as emissions from burning fuels that are solid, liquid, or gaseous.

Results and discussion

Unit root tests

Prior to examining cointegration and determining how FDI affects long-term CEs, it is necessary to check the significance of the variables and whether these variables are integrated in the first order I.

Table 1: ADF and PP test

Variables	ADF test		PP test	
	Test statistic	Critical value	Test statistic	Critical value
CE	-2.255	-2.986	-2.215	-2.986
FDI	-2.443	-2.986	-2.342	-2.986
dCE	-3.524***	-2.986	-3.257**	-2.986
dFDI	-9.984***	-2.986	-7.597***	-2.986

*Note: The significance levels are denoted as follows: ***, **, and * represent significance at the 1%, 5%, and 10% thresholds, respectively.*

The initial assessments employ the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests. The outcomes of the quartet of unit root tests converge to the consensus that both variables lack level stationarity. This conclusion is substantiated by the non-rejection of the null hypothesis indicating the presence of two-unit roots that exhibit stationarity in both the ADF and PP tests. Furthermore, upon undertaking the initial differencing, a discernible shift is observed. This shift renders both variables stationary at the first order. This deduction is substantiated by the rejection of the null hypothesis for the two-unit roots, as ascertained by the ADF and PP tests, conducted at a significance level of 1%. Consequently, we deduce that both variables exhibit first-order integration, denoted as I(1).

Cointegration test

It is customary to evaluate the cointegration between the two variables using Fisher's tests after confirming that they are integrated in the same I(1) order:

Rank deterministic lag T-statistic 5%Critical value

Table 2: Johansen Cointegration test

Rank	deterministic	lag	T-statistic 5%	Critical value
0	Trend-constant	1	17.3983	15.41
1	Trend-constant	1	3.1266*	3.76
2	Trend-constant	1		

Source: Author's computation using the data

The preceding table's conclusion demonstrates that the variables have a long-term relationship such that the independent variables (foreign direct investment) significantly affect Tadjikistan's carbon emission. This indicates that the explanatory factors adequately describe

the dependent variable. Additionally, neither test can rule out the null hypothesis, which states that there is only one cointegrating link. According to the table, one may draw the conclusion that the variables are cointegrated, i.e., that a long-term link exists.

Estimation of the effect coefficient throughout the long and short periods.
We compute the enduring and immediate coefficients of model (1) through the application of Ordinary Least Squares (OLS) cointegration regression methodologies, building upon the findings outlined earlier. In order to mitigate potential challenges arising from autocorrelation, heteroscedasticity, and multicollinearity, we resort to employing OLS regression techniques.

Table 3. Estimation of the long and short-term coefficient

Variables		**Variables**	
Long run estimates		Short run estimates	
		Constant	-0.0147005
			(-0.54)
FDI	0.3233704	FDI	0.002099
	(6.44)***		(0.948)
Observation			29

Source: Computed by the author using the provided data
*Footnotes: The variable CE serves as the dependent factor. Statistical significance at levels of 1%, 5%, and 10% is represented by ***, **, and *, respectively. Standard errors are enclosed within parentheses.*

According to the cointegration regression techniques, net FDI inflows into Tajikistan have a positive influence on carbon emissions with a significant level of 1% over the long run and a positive but minor impact over the short term. 0.3233704 metric tonnes of CO2 per person, using the OLS approach, may lead to an increase in FDI of $1 million.

Autocorrelation
The Lagrange multiplier assessment is used to determine if residuals are serially connected to one another or whether there is autocorrelation. The results table below indicates that there is no serial correlation issue with the model because the p-value at lag 2 is larger than 5%.

Table 4: Lagrange-multiply test

lag	Chi2	df	Prob chi2
1	1.0513	4	0.90192
2	0.5141	4	0.97211

Specification and stability Table

Table 5: Eigenvalue stability condition

Eigenvalue	**modulus**
1	1
0.4752171 + 0.3260689i	0.576326
0.4752171 - .3260689i	0.576326
-.2208511	0.220851

We can observe from the table above that the remaining eigenvalues' moduli are strictly smaller than one. And vecstable plotted the corresponding matrix's eigenvalues as we indicated the graphics option in the image below. Therefore, the stability check shows that our model is stable and well-specified.

Conclusion

In this study, our focus centered on examining the correlation between inflows of foreign direct investment and carbon dioxide emissions spanning the years 1990 to 2020. The core objective was to scrutinize the applicability of the pollution paradise hypothesis to the context of Tajikistan. By deploying a comprehensive cointegration analysis, we successfully established the presence of a sustained causal relationship between foreign direct investments and carbon dioxide emissions. This validation was predicated on the confirmation of first-order integration, as established through unit root testing. Our exploration extended to the assessment of the Ordinary Least Squares (OLS) cointegration regression technique, which was employed utilizing the aforementioned dataset as the underpinning. The outcome of this analysis unveiled a significant and positive impact. Specifically, foreign direct investment inflows were found to exert a noteworthy beneficial effect of 1% on carbon dioxide emissions per capita.The Engle-Granger causality test, which was used to evaluate the short- and long-term causation between variables, however, shows a favorable short- and long-term causal connection between FDI flows and carbon dioxide emissions. To put it another way, FDI flows help to raise carbon dioxide emissions. Long-term, these findings support those of a study that examined the validity of the polluter's paradise theory for African nations during the same time period (Gharnit et al., 2019). In reality, the fact that foreign investors adhere to environmental laws and norms when entering Tajikistan explains how FDI contributed to the rise in emissions. These businesses can, however, start to disregard these rules more and more, continuing to harm the environment with their activities. Due to these factors, it is advised that Tajikistan strengthen its environmental policy, enhance CO2 emission-reduction mechanisms and tools like environmental taxes and carbon capture and storage, and keep an eye on the operation of polluting industries, especially after they have relocated to Tajikistan. Further restrictions on this article include: To evaluate how FDI flows affect CO2 emissions, our empirical research exclusively considers FDI flows from Tajikistan. In other words, just a few countries are covered by the empirical study in this article. Future research might broaden its scope to include more nations and investigate the effects of FDI from other nations on environmental deterioration in recipient nations.

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Cite this article:

UMARALIEV ABDUKHUSEN & GUY MERLAIN DJAKOU (2023). Impact of foreign direct investment on CO2 emissions: the case of Tajikistan. *International Journal of Science and Business, 26*(1), 177-186. doi: https://doi.org/10.58970/IJSB.2174

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