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The impact of FDI on CO2 emission in a small island developing state: A cointegration approach

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Abstract

This paper examines the long run and short run impact of FDI (disaggregated into manufacturing and non- manufacturing sector), on CO2 emission in Mauritius. In this study the bounds testing approach to cointegration is used. For instance, the Autoregressive Distributed Lag (ARDL) model is used on time series data over the period 1980 to 2012. The main findings of this study show that foreign investment in the manufacturing sector is harmful for the environment whereas FDI in non-manufacturing sectors does not really affect the environment. Moreover, an increase in growth is as well seen to increase the level of CO2 emission. Energy use in the country also proved to result in an increase in CO2 emission. The findings further confirm the stability of the model for the small island economy of Mauritius.

Keywords: FDI; CO2 emission; ARDL cointegration; causality
JEL Classification Codes: F23, Q50, C22

1. Introduction

FDI inflow in Mauritius has been experiencing constant growth over the last years. Indeed in 2014, FDI inflows to Mauritius reached an amount of USD 418 million (Mauritius Trade Easy, 2016). The Mauritian government has been providing various incentives to boost FDI in the country. For instance, these include tax incentives and more so, the country provides the appropriate investment climate attracting foreign investors. For example, there is a stable economic and political environment which prevails in the economy. In addition to that, there is modern infrastructure, a robust judicial system, a stable financial system and as well as a highly skilled and trained workforce. Referring to the ratings of Doing Business 2016, issued by the World Bank, Mauritius is the 32nd (out of 189) most favorable country for doing business in the world.

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Hence, with consistent inflow of FDI, the economy has been experiencing economic growth. For instance, referring to papers like Blin et al (2009) and Fauzel et al, (2016), investigating the impact of FDI on economic growth in Mauritius, a positive and significant result has been obtained. Regarding economic growth and energy use, studies like Rögnvaldur (2009) found a significant and positive relationship between energy use and growth in GDP for all 171 countries considered. However, the main question that is being asked by policy makers and researchers is about the extent to which FDI leads to sustainable growth. For instance, while FDI can benefit the economy by promoting economic growth, it can as well harm the economy by increasing the level of pollution.

For example, the study by Beladi et al, (2005) shows that foreign investment adversely impacts on the environment in the South. Analysing the literature on a sectoral basis or industry wise basis, the study of Blanco et al (2013) come up with some interesting results. Their research uses a panel Granger causality tests to investigate the relationship between sector specific FDI and CO2 emissions. Using a sample of 18 Latin American countries for the 1980-2007 period, they found causality running from FDI in polluting intensive industries to CO2 emissions per capita. For other sectors, they found no robust evidence of FDI causing CO2 emissions.

Hence this paper focuses on the relationship between FDI and CO2 emission in Mauritius. The objective of the study is to investigate whether FDI in the manufacturing sector (FDI_M) and non-manufacturing sector (FDI_NM) flowing in the small island economy of Mauritius increases the level of CO2 emission. Using time series data from 1980 to 2012, the rather complex relationship between FDI_M and FDI_NM and CO2 emission is being modeled. The ARDL model has been used mainly because it corrects the endogeneity bias. The stability of the link among the variables included in the study is also assessed. Lastly, this study outlines several policy implications that are drawn from the investigation.

The structure of the paper is as follows; section 2 describes the methodology while section 3 presents the results. Finally concluding remarks are presented in section 4.

2. Research design and methodology

The aim of this study is to investigate the extent to which FDI (M & NM) influence carbon emissions in Mauritius for the period 1980 to 2012. The basic specification of the model is based on the principles of some earlier studies like Peter Grimes and Jeffrey Kentor (2003), Yanchun (2010) and Shaari, Abdullah, and Kamil (2014). Hence, the econometric model takes the following form.

$$\begin{aligned} Ln\ CO_{2t} = \beta_0 + \beta_1\ lnFDI\_M_t + \beta_2 lnFDI\_NM_t + \beta_3 ln\ GDP_t + \beta_4\ ln\ ENER_t \\ + \beta_5\ lnK_t + \beta_6\ \ln POP_t + \beta_7 lnTO_t + \mu_t \end{aligned} \tag{1}$$

Where:

- FDI_M =FDI in flow in the manufacturing sector
- FDI_NM= FDI in flow in the non-manufacturing sector
- GDP = real gross domestic product
- ENER = per capita energy consumption measured in million Btu per person
- K= domestic investment measured by GDFCF
- POP = level of population
- TO = trade openness measured as the sum of imports and exports to GDP
- Co2 emission= per capita CO2 emissions measured in metric tons per capita

The data have been extracted from the World Development Indicators and the Bank of Mauritius website. The natural logarithm of the variables is employed for ease of interpretation (that is in percentage terms).

The methodology used is the autoregressive distributed lag (ARDL) approach to cointegration proposed by Pesaran et al. (2001). The ARDL bounds cointegration technique has been selected to determine the long run and short run relationships between FDI and CO2 emission. This method has been chosen based on several deliberations. First, as discussed by Pesaran et al. (2001), the ARDL models yield consistent estimates of the long run coefficients that are asymptotically normal irrespective of whether the underlying regressors are I(1) or I(0). Second, this technique generally provides unbiased estimates of the long run model and valid t-statistics even when some of the regressors are endogenous (Harris and Sollis, 2003). Inder (1993) and Pesaran (1997) have shown that the inclusion of the dynamics may help correct the endogeneity bias. Third, given the size of the sample and the number parameters to be estimated the bound approach appears more appealing than the Johansen cointegration technique, which would have required the estimation of a system of equations and thus a considerable loss in degree of freedom. The procedures to carry out the ARDL approach to cointegration technique includes the determination of the long run relationships among the variables used in the models; and the estimation of the coefficients of the long and short run relationships. To estimate the ARDL model is to test for the presence of long run relationships among the variables by using the Bounds F-Test. To implement the bound test procedure, equation (1) is modeled as a conditional ARDL error correction model (ECM) as follows:

$$\begin{aligned}\Delta lnCO2_t = {} & \propto_0 + \sum_{i=1}^{n} \propto_i \Delta lnFDI_{M_{t-1}} + \sum_{i=1}^{n} \partial_i \Delta lnFDI_{NM_{t-1}} + \sum_{i=1}^{n} \delta_i \Delta lnGDP_{t-1} \\ & + \sum_{i=1}^{n} \beta_i \Delta lnENER_{t-1} + \sum_{i=1}^{n} \sigma_i \Delta lnK_{t-1} + \sum_{i=1}^{n} \gamma_i \Delta lnPOP_{t-1} \\ & + \sum_{i=1}^{n} \rho_i \Delta lnTO_{t-1} + \eta_1 lnCO2_{t-1} + \eta_2 lnFDI_{M_{t-1}} \\ & + \eta_3 lnFDI_{NM_{t-1}} + \eta_4 lnGDP_{t-1} + \eta_5 lnENER_{t-1} + \eta_6 lnK_{t-1} \\ & + \eta_7 lnPOP_{t-1} + \eta_8 lnTO_{t-1} + \varepsilon_t \end{aligned} \tag{2}$$

Where α_0 is a drift component and εt is the white noise error. The long run multipliers are signified by the coefficients of the lagged level variables while αi, δi, βi, σi and γi represent the short run impacts on CO2 emission. OLS is used to estimate the equation. The next step is to test the presence of cointegration by restricting all estimated coefficients of lagged level variables equal to zero. That is the null hypothesis of no cointegration; $(H_0: \eta_1 = \eta_2 = \eta_3 = \eta_4 = \eta_5 = \eta_6 = \eta_7 = \eta_8 = 0)$ is tested against the alternative hypothesis $(H_0: \eta_1 \neq 0, \eta_2 \neq 0, \eta_3 \neq 0, \eta_4 \neq 0, \eta_5 \neq 0, \eta_6 \neq 0, \eta_7 \neq \eta_8)$ by using the F test with an asymptotic non-standard distribution. Two asymptotic critical value bounds provide a test for cointegration when the independent variables are I(d) with 0≤d≤1. The lower bound assumes that all the regressors are I (0), and the upper bound assumes that they are I (1). Hence, if the computed F-statistic lies above the upper level of the band, the null is rejected, indicating cointegration (Pesaran and Pesaran, 1997). If the computed F-statistic lies below the lower level band, the null cannot be rejected, supporting the absence of cointegration. If the statistics fall within the band, inference would be inconclusive. Therefore, once the long run relationship has been recognized, the concluding step of the ARDL framework would include the estimation of the coefficients of the long run relations and making inferences about their values (Pesaran and

Pesaran, 1997). This stage involves two further steps. The first stage involves selecting the orders of the lags based on Schwarz Bayesian Information Criteria (SBIC) or the Akaike Information Criteria (AIC). In the second step, the selected optimal ARDL model restricted to the lag structure defined in the first stage of the final ARDL process is then estimated including the short run and error correction model. A lagged error correction term is constructed to substitute the whole set of lagged level variables. It is therefore possible to estimate the short run coefficients as an error correcting model while allowing for the long run estimates as follows:

$$\begin{aligned}\Delta lnCO2_t = \propto_0 + \propto_0 + \sum_{i=1}^{n} \propto_i \Delta lnFDI\_M_{t-1} + \sum_{i=1}^{n} \partial_i \Delta lnFDI\_NM_{t-1} \\ + \sum_{i=1}^{n} \delta_i \Delta lnGDP_{t-1} + \sum_{i=1}^{n} \beta_i \Delta lnENER_{t-1} + \sum_{i=1}^{n} \sigma_i \Delta lnK_{t-1} \\ + \sum_{i=1}^{n} \gamma_i \Delta lnPOP_{t-1} + \sum_{i=1}^{n} \rho_i \Delta lnTO_{t-1} + \Psi_t\, ECM_{t-1} + \gamma_t\end{aligned} \tag{3}$$

ECM_{t-1} is the error correction term and its coefficient ψ_t is the speed of adjustment. Other coefficients in the model are the short run dynamics that cause the model to converge to equilibrium. These methodologies will be applied to avoid spurious results.

3. Findings

3.1. Results for Unit Root test.

Before choosing to use the ARDL method, stationarity test were applied on all the variables. Indeed, the use of non-stationary variables in time series will leads to spurious results. The unit root test has been applied to verify the order of integration. The Augmented Dicker Fuller (ADF) test was used and it was concluded that the variables have a mixture of I (0) and I (1).

3.2 Results for Bounds F test

The Bounds F test is shown in the table below. The table below compares the computed F-statistic of the model with the bounds. The findings approves that the computed F-statistic is greater than the upper bound critical value at 1% significance level. The null hypothesis of no cointegration is, therefore, rejected. Hence, the results confirm stable long run cointegration relationship between FDI and CO2 emission.

Table 1. Cointegration Test.

Dependent Variable	*F Statistics*	*1% critical F Values*	
		Lower Bound	*Upper Bound*
LnCO2	17.98	1.92	2.89

Secondly in the ARDL framework, the long run and short run ECM coefficients are determined. Once, cointegration relationship was detected in the model, equation 3was estimated using ARDL (1, 1, 0, 1, 0, 0, 1, 1) specification. As per the results, the coefficient of the lagged of the error correction mechanism, ecm(–1), is -0.90 and is statistically significant. The Breusch-Godfrey serial correlation LM test has been used. The result shows no problem of serial correlation.

Table 2. Long Run and Short Run Results.

	Regressor	Ln CO2 Coefficient
Long Run	LFDI_M	0.021176*
	LFDINM	0.002292
	LGDP	0.040458*
	LENER	2.282935***
	LK	-0.074143
	LTO	0.288150
	LPOP	-1.275078
	Constant	-15.434584
Short Run	D(LFDI_M)	0.012307**
	D(LFDINM)	0.001241
	D(LGDP)	0.014957**
	D(LENER)	1.810472***
	D(LK)	-0.074537
	D(LTO)	0.086260
	D(LPOP)	10.124532
	ecm(-1)	-0.905304
MODEL SUMMARY ARDL (1, 1, 0, 1, 0, 0, 1, 1) $R^2 = 0.99$		*DIAGNOSTIC TEST* Serial correlation: 1.0133

Notes: *, **, *** represent significance at 10%, 5% and 1% respectively.

The estimated coefficients of the long-run relationship between CO emission and FDI in the manufacturing sector are positive and significant. It therefore means that an increase in foreign investment in the manufacturing sector in Mauritius leads to an increase in CO2 emission in the country. More precisely, a 10% increase in FDI in the manufacturing sector leads to 0.21% increase in CO2 emission. This result is consistent with that of Peter Grimes and Jeffrey Kentor (2003) who examined the impact of foreign investment dependence on carbon dioxide emissions between 1980 and 1996. There results shows that an increase in FDI has a significant positive effect on the growth of CO2 emissions in China. Relating this result to the Mauritian economy, it is noted that there has been massive inflow of foreign investment in the manufacturing sector which was seen to be crucial in the early stages of export development, contributing much to the take-off of the EPZ sector. These foreign inflows led to export growth, technological transfer and job creation.

Further, referring to the results, it is observed that FDI in non-manufacturing sector does not have a significant impact on CO2 emission in the country. This result can be explained by the fact that FDI in non-manufacturing in Mauritius is basically based in the tertiary sector such as the financial sector and the Tourism sector and these are not really polluting sectors. Moreover, an increase in GDP is seen to increase CO2 emission in the country. In fact, in the long run, a 10% increase in GDP leads to 0.40% increase in CO2 emission. Similar results were obtained by Seetanah et al, (2011). Other studies revealing results alike to the present study are Ferda (2008) and Dinda and Coondoo (2006) for the case of Africa and Asia.

Zooming further on the results, it is noted that energy use and CO2 emission are as well closely linked. For instance, energy consumption causes substantial pollutant emissions. In fact as depicted in the above table, the results clearly illustrate that for every 10% increase in per capita energy use, CO2 emission increases by 22.8%. This result is well predictable, since in Mauritius, the majority of energy used is fossil fuels and the burning of the latter unavoidably leads to environmental degradation. As a matter of fact, Amin et al. (2012) reported that it is a regular economic phenomenon to see a rise in CO2 emissions as energy consumption increases.

Moreover, various studies confirmed the existence of this positive relationship. For instance, Hossain (2012) found that in the long term higher energy consumption in Japan would give rise to more CO2 emissions.

It can be noted however that domestic investment, population growth as well as trade openness does not significantly influence carbon emission in the country. Hence, an increase in local investment does not really pose a problem on the environment as well as population growth. This result is in contradiction with those found by Shi (2001), who concluded that population growth is one of the main driving forces behind growing CO2 emissions worldwide.

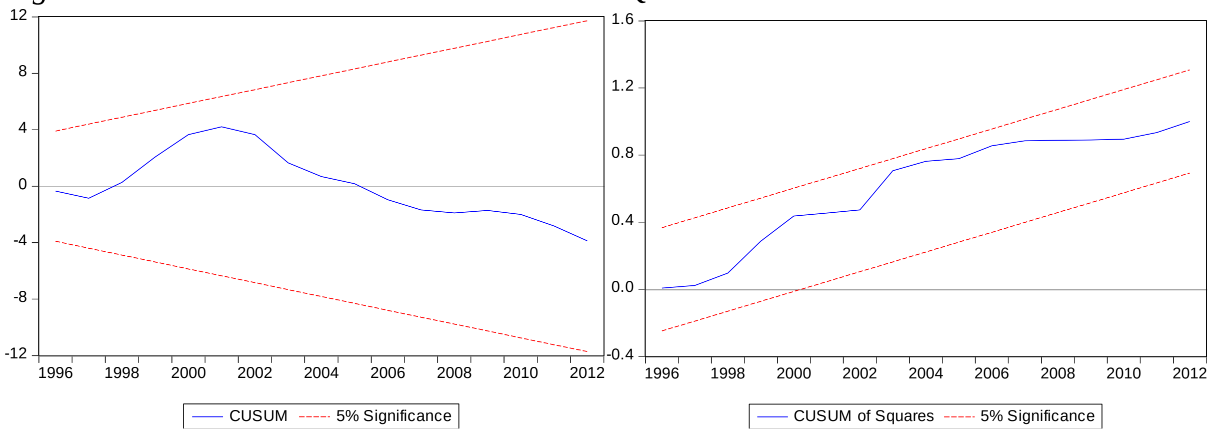
In addition to the ARDL results, the next step is to report the short run estimates. Given that the variables in the model are cointegrated provides support for the use of an ECM representation so as to investigate the short run dynamics and are presented in the Table 2 above. Referring to the short run relationships it is observed that there is a positive and significant impact of FDI in the manufacturing sector on CO2 emissions. Moreover, the signs of the short run dynamics are preserved to the long run.

3.3 Stability of the Model

Finally, the stability of the long-run coefficients together with the short run dynamics is investigated. Following Pesaran and Pesaran (1997), the CUSUM and CUSUMSQ (Brown, Durbin, and Evans, 1975) tests were applied. In fact, the tests are done to the residuals of the model. Precisely, the CUSUM test makes use of the cumulative sum of recursive residuals based on the first set of n observations and is updated recursively and plotted against break points. The null hypothesis that all coefficients in the error correction model are stable will not be rejected if the plot of CUSUM statistics stays within the critical bounds of 5% significance level. However, if either of the lines is crossed, the null hypothesis of coefficient constancy can be rejected at the 5% level of significance. Same applies to CUSUMSQ tests. The results are shown below.

Both plots show no evidence of any significant structural instability.

Figure 1. Results of the CUSUM and CUSUMSQ tests.



4. Conclusion

The paper investigated the dynamic relationship between FDI in the manufacturing and non-manufacturing sector and CO2 emission for Mauritius by using annual time series data from 1980-2012 and applied the bounds testing (ARDL) approach to co integration. The results of the long run and short run links between the variables are reported. The main findings of this study show that foreign investment in the manufacturing sector has proved to be harmful for the environment whereas FDI in non-manufacturing sectors does not really affect the environment. Moreover, an increase in growth is as well seen to increase the level of CO2 emission in both the long run and short run. Energy use in the country also proved to result in an increase in CO2 emission. Furthermore, the empirical result shows that there is no association between domestic investment, population growth and trade openness and CO2 emission.

FDI is crucial for the country in terms of economic growth and development and employment creation. FDI cannot be discouraged but certainly the Mauritian government can introduce Carbon tax which can be used as an efficient mechanism to reduce pollution level. More so, by adopting clean and renewable energy sources, pollution level will fall, and it will as well contribute towards a sustainable economy in the future. The government can thus endeavor to make these policies, a reasonable tool for the country.

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