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FDI, GROWTH AND THE ENVIRONMENT: EVIDENCE FROM INDIA ON CO_2 EMISSION DURING THE LAST TWO DECADES

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This paper examines two most important benefits and costs of foreign direct investment in the Indian context - GDP growth and the environment degradation. We find a statistically significant long run positive, but marginal, impact of FDI inflow on GDP growth in India during 1980-2003. On the other hand, the long run growth impact of FDI inflow on CO_2 emissions is quite large. The actual impact on the environment, however, may be larger because CO_2 emission is one of the many pollutants generated by economic activities. But CO_2 being a global air pollutant, our finding has some far reaching implications for the global environment as well, with India having emerged as the fourth highest in the global ranking of CO_2 emissions by turn of this century.

Keywords: Foreign Direct Investment, GDP Growth, Environment
JEL classification: F21, F43

1. INTRODUCTION

The inflow of Foreign Direct Investment (FDI) has increased rapidly during the late 1980s and 1990s in almost every region of the world revitalizing the long and contentious debate about the costs and benefits of FDI inflows. The positive benefits of FDI to the receiving host country include capital, skill and technology transfer, market access and export promotion. This paper examines the two and arguably the most important benefits and costs of foreign direct investment in the Indian context: GDP growth and the environmental degradation.

Economic theory provides us with many reasons why FDI may result in enhanced growth performance of the host country. However, there is no universal agreement

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among the empiricists about the positive association between FDI inflows and economic growth. While some studies observe a positive impact of FDI on economic growth, others detect a negative relationship between these two variables (Aitkin and Harrison (1999), Djankov and Hoekman (2000), Damijan *et al.* (2001), Konings (2001), Castellani and Zanfei (2002a, 2002b), and Zukowska-Gagemann (2002)). In a survey, Mello (1997) lists two main channels through which FDI may be growth enhancing: First, FDI can encourage the adoption of new technology in the production process through capital spillovers. Second, FDI may stimulate knowledge transfers, both in terms of labour training and skill acquisition and by introducing alternative management practices and better organizational arrangements. A survey by OECD (2002) underpins these observations and documents that 11 out of 14 studies have found FDI to contribute positively to income growth and factor productivity. Both Mello and OECD stress one key insight from all the studies reviewed: the way in which FDI affects growth is likely to depend on the economic and technological conditions in the host country. In particular it appears that the host countries have to reach a certain level of development in education and/or infrastructure, before they are able to capture potential benefits associated with FDI. Otherwise the potential benefits remain far from realized including a weak or insignificant impact on economic growth.

Four studies, relying on a variety of cross-country regressions, have looked into the conditions necessary for identifying FDI's positive impact on economic growth. Interestingly, they emphasize on different, though closely related, aspects of development. First, Blomstrom *et al.* (1994) argue that FDI has a positive growth effect when a country is sufficiently rich in terms of per capita income. Second, Balasubramanyam *et al.* (1996) observe trade openness as being crucial for realization of the potential growth impact of FDI. Third, Borensztein *et al.* (1998) find that FDI raises growth, but only in countries where the labour force has achieved a certain level of education. Finally, Alfaro *et al.* (2004) draw attention to financial markets as they find that FDI promotes economic growth in economies with sufficiently developed financial market.

More recent empirical studies make use of panel data to correct for continuously evolving country-specific differences in technology, production and socioeconomic factors, thus eliminating many of the difficulties encountered in cross-country estimations. Bengoa and Sanchez-Robles (2003) show that FDI is positively correlated with economic growth, but host countries require human capital, economic stability and liberalized markets in order to benefit from long-term FDI inflows. Using data on 80 countries for the period 1979-98, Durham (2004) fails to identify a positive relationship between FDI and economic growth but suggests instead that the effects of FDI are contingent on the 'absorptive capability' of host countries. Li and Liu (2005) examine a panel of data for 84 countries over the period 1970-99. A significant endogenous relationship between FDI and economic growth was identified from the mid-1980s

onwards.[1]

India has sought to increase inflows of FDI with a liberal trade and investment policies since 1991 after four decades of caution, if not restrictive attitude to it. The timing of policy liberalization by India has coincided with the dramatic upsurge in the global FDI outflow from US $50 billion a year in mid-1980s to cross a peak of US $350 billion in 1996. The 1990s and henceforth have witnessed a sustained rise in annual inflows to India as well. Although they would appear quite small relative to the kinds of magnitudes that some of India's counterparts in Southeast or East Asia attract, the rise would appear to be impressive. In an analysis of changing patterns of global FDI inflows, Dunning (1998) has found the rate of growth of investment directed to India to be well above average although absolute magnitudes remained very small. It is not clear, however, whether this rise has been provoked by the policy of liberalization alone or has resulted from expansion of scale of global FDI activity. Since 1990s, the inflows have also changed from the past patterns in terms of sources, sectoral composition and organizational form. The period 1991-2004 has also experienced significant increase in the GDP growth rates in India at an average annual rate of 7%. It is natural then to ask whether and to what extent the upsurge in FDI inflows during the same period may have caused or contributed to such increased growth rates. This is one of the two major concerns of this paper.[2]

The other concern of this paper is the impact of FDI inflow in India on its environment. The relationship between FDI inflow and the environment is not simple either. On the one hand, the much-debated capital flight and pollution heaven hypotheses (PHH) talk about FDI being attracted into the countries that have relatively lax environmental regulations or lower environmental taxes. Survey papers by Beghin (1996) and Jaffe (1995) have dealt with the industrial flight and the pollution heaven hypotheses. In this case, regarding the relocation of industries, the popular argument is that the relatively low environmental standards in developed countries compared to the industrialized nations leads to "dirty industries" shifting their operations to these countries. In addition, the general apprehension is that the developing countries may purposely undervalue the environment in order to attract new investment.

These capital flight and PHH, if true, imply that pollution level of a country will increase due to FDI-led expansion of economic activities in the dirty industries. Even if we reject these hypotheses, there can still be significant environmental damages that can be caused by FDI. Environmental damages, in the long run arise through the growth

[1] On the whole there seems to be a strong relationship between FDI and growth, though the relationship is highly heterogeneous across countries.

[2] The causation can, of course, run in the opposite direction as well: Fast-growing economies attracting more FDI, as larger market raises profitability of investment. As in the past, improved economic growth helped many countries attract more FDI (WIR, 2003). Most of the countries and regions with high economic growth rates recorded a sharp increase in FDI inflows in 2004.

impact of FDI. At the heart of this relationship lies the observed inverted-U relationship between output growth and the level of pollution known as the Environment Kuznet Curve (EKC).[3]

In the short run, FDI inflows generate both scale and composition effects. The scale effect refers to an increase in the pollution emission and resource depletion cropping up from FDI-led greater economic activity. On the other hand, the composition effect is the change in the share of dirty goods in GDP, which may come about because of a price change favouring their production. Income growth may also have a favourable effect in long run on the environment by changing the demand towards relatively cleaner goods [Dean (1999)]. This causes the share of pollution-intensive goods in output to fall, reducing the pollution emission. With a constant scale of the economy and no change in the emission intensities per industry, this effect would decrease total pollution. At low output and income levels, the adverse scale effect seems to be more prominent resulting in overall degradation of the environment due to FDI inflow as indicated by the upward rising part of the EKC.

However, empirical testing of these composition and scale effects are not easy as there are many methodological and conceptual issues that are involved in measuring the environmental damages. First of all, some dirty industries cause air pollution (such as cement, fuel, wood, transportation), some cause water pollution (such as chemicals, paper and pulp) and a few cause both air and water pollution (such as metals). Conceptually it is not very meaningful to combine air and water pollution emissions, and thus arrive at some aggregate measure of pollution emission or degradation of the environmental quality of a country and thus relate that measure to FDI inflow. Second, even in case of air pollution, there are local pollutants and global pollutants. SO_2, CO and NO_X are three major local air pollutants whereas CO_2 is the major global pollutant. Thus, to estimate relationship among FDI, growth and environmental degradation, one has to properly define the focus and scope of the study. Though we make some cursory look at composition effect of FDI in India during the 1990s in terms of the share of dirty industries in total FDI inflow, non-availability of data on local as well as global air pollutants emitted by different industries for sufficiently long time period constrains us to examine only the growth-effect of FDI on the CO_2 emission by India.[4] In the global economy context, however, examining the impact on global air pollutant like CO_2 emission may be more relevant, particularly given the fact that during the late 1990s India emerged as the fourth highest in the global ranking of CO_2 emissions.

Given these concerns we derive the following results. First, a cointegration analysis shows that during 1980-2003, FDI inflow did have some positive though marginal, long run impact on growth of aggregate output. Second, the declining share of dirty industries in total FDI inflow does not provide any first-hand evidence on PHH in India after the

[3] See Dinda (2004) for a survey of EKC.

[4] Sectoral decomposition of FDI in India is also available only after the mid 1990s.

mid 1990s. This does not rule out though the adverse environmental impact of FDI flows since the share of dirty industries in aggregate output may have increased. Third, FDI seems to have a quite large long run positive impact on the CO_2 emission through GDP growth. Thus, our estimates provide some empirical support that FDI inflow has caused degradation of air quality as measured by CO_2 emission. Since CO_2 emission is a global pollutant in nature, this result has some far reaching implications for the global environment as well. This may, however, be an underestimation of the adverse impact of FDI inflow on the environment because the changes in water pollution and local air pollutants are not estimated.

The rest of the paper is organized as follows. In section 2, we examine the impact of FDI inflow on GDP growth in India. Section 3 discusses the relationship between FDI inflow and the environment. Finally, we conclude the paper in section 4.

2. FDI AND ECONOMIC GROWTH IN INDIA

2.1. The Data

The data used in this study consists of total FDI expressed in Million US $ observed for the period 1980-2003. The data is primarily taken from World Development Indicator (2007). Another variable in this study is GDP growth, also converted in Million US $ for the period 1980-2003. Here the focus is on examination of the causal relationship between FDI and GDP growth. A first look at the data reveals that there has been a steady annual increase in the total amount of FDI approved over the last decade. It has risen from a modest US $79.2 million in 1980 to US $4,334 million in 2001. There had been, however, some sharp declines in FDI inflow during 1997-99 and after the year 2001[5] when the highest inflow of FDI was recorded. But overall, there has been a quite sharp and statistically significant upward trend in FDI inflow during 1980-2003 [see Figure 1]. The GDP growth, on the other hand, had a dip down during 1991-93, but thereafter had steadily increased.

2.2. Time Series Properties

Before going into any rigorous econometric exercise, we first investigate the time series properties of the FDI and GDP series. We take all the variables in log form and a comparison of FDI and GDP growth in log form is shown in Figure 2. This log conversion will capture, in a simple OLS, by what percentage point the GDP grows following a 1% growth in FDI inflow. The Augmented Dickey-Fuller (henceforth, ADF) test for the unit root reveals that the log GDP series is non-stationary both at the level

[5] There has been upsurge of FDI inflow again during the past three years.

and at the first difference but stationary at the second difference.[6] Similar unit root test confirms that log FDI series is non-stationary at the level but stationary at the first difference. This makes it difficult to carry out any meaningful econometric exercise since the log GDP series is I(2) whereas log FDI is I(1).

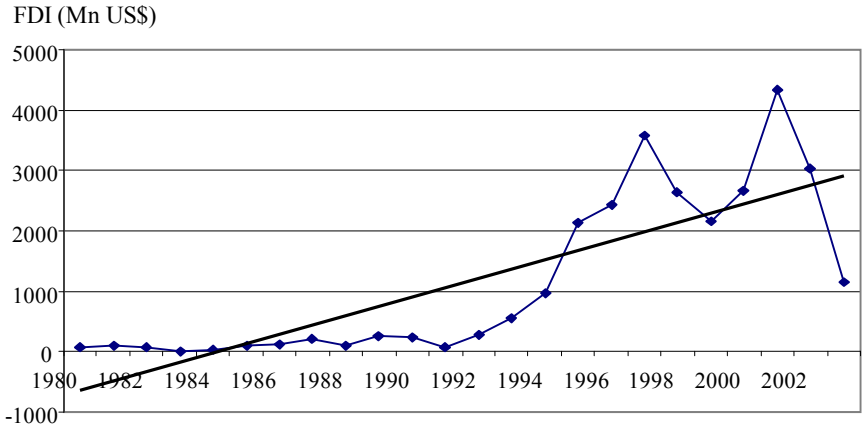


Figure 1. FDI Inflow in India

However, a closer look at the GDP series indicates a structural break in 1992. This is not unexpected because major structural reforms of the Indian economy along with significant liberalization of the international trade and exchange rate policies were introduced during 1990-1991, which had some far reaching implications for GDP growth. Also a look at the FDI series reveal a structural break in the year 1996, which is quite natural as India has experienced a shift of regime in its trade reforms during that period. Both these structural breaks are confirmed by relevant CUSUMSQ tests.[7]

To account for the structural break in log GDP we introduce a dummy variable for the intercept and a time-dummy variable for the trend. A re-test for unit root confirms log GDP series as a stationary one at the first difference. Thus, both the LGDP (taking into account the structural break) and LFDI are I(1), rendering a co-integration regression meaningful *at the level* where these two series are non-stationary.

[6] The original GDP series is also non-stationary at the level.

[7] See Brown, Durbin and Evans for application of recursive residuals test and CUSUMSQ test for structural change over time.

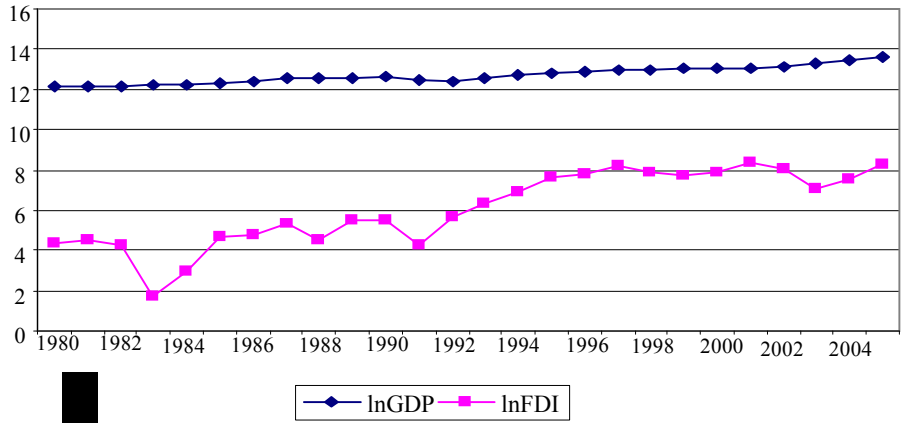


Figure 2. GDP and FDI Growth in India

For the cointegration regression, we estimate the following relationship taking both the intercept and trend dummies for the year 1992:[8]

$$\ln GDP = \beta_0 + \beta_1 t + \beta_2 \ln FDI + \beta_3 D_1 + \beta_4 D_2 t + u_t, \quad (2)$$

where t is the trend variable measured chronologically and D_1, D_2 are the intercept and time dummies such that

$D_j = 0$ for 1980-1991,

$D_j = 1$ for 1992-2003; $j = 1, 2$

Table 1 reports the cointegration regression result and the ADF test statistic for unit root of the estimated residuals. Since the computed value of ADF test statistic is much more negative than the critical value at 1% level, our conclusion is that the residuals from the above regression are I(0), that is they are stationary at the level. Hence the above regression is not a spurious one, even though individually lnGDP and lnFDI are non-stationary at the level. Thus lnGDP and lnFDI are cointegrated, i.e., there is a stable long-run relationship between GDP growth and growth in FDI inflow during 1980-2003.[9] Also note that all the estimated coefficients are significant.

[8] The year 1992 also appears to be the year of structural break of the residuals for the estimation of the relationship $\ln GDP = \alpha_0 + \alpha_1 t + \alpha_2 \ln FDI + u_t$.

[9] This is also confirmed by the computed value of cointegrating regression Durbin Watson (CRDW) statistic of 1.52 which is above the critical value of 0.511 at 1% level of significance as provided in Sargan & Bhargava (1983).

Thus, cointegration analysis does indicate a positive long run impact of FDI inflow on GDP growth though the value of the growth-elasticity of FDI inflow is rather low as indicated by the estimated coefficient of FDI.

Table 1. Long Run Growth Impact of FDI Inflow in India During 1980-2003
Dependent Variable: lnGDP

Variables	**Coefficients**
Constant	5.185065*
	(180.1971)
Time	0.019782*
	(8.395252)
Constant Dummy (1992)	-0.211046*
	(-4.711340)
Time Dummy (1992)	0.008262**
	(2.679719)
lnFDI	0.032383***
	(2.067999)
R^2	0.974671
DW test statistic	1.516018
Unit root test for residuals (First Difference)	
ADF test statistic	-3.365851*
R^2	0.623424

Notes: *t*-values are shown in parentheses and *, **, and *** denote significance at 0.01, 0.05 and 0.10 levels respectively. For ADF test, the MacKinnon critical value for rejection of hypothesis of a unit root is -2.6819 for the significance at 0.01.

3. FDI INFLOW AND THE ENVIRONMENT

During the past few decades many poor countries have experienced rapid economic development after adopting liberal economic policies. More recently, attention has been turned to the possible impact of differences in environmental regulations.

Regulation of industrial pollution increases with economic development for two main reasons. First, the demand for environmental quality rises with income, both for aesthetic reasons and because the valuation of pollution damage increases. Second, more developed economies have more highly developed public institutions and are more capable of enforcing desirable environmental norms. If the income elasticity of regulation is greater than one, the developing countries will not retain a comparative advantage in dirty production.

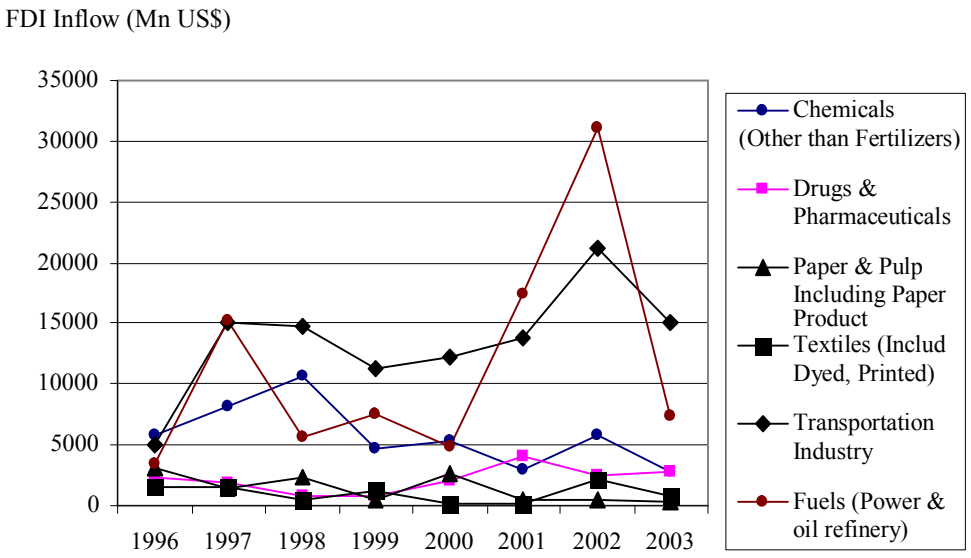
As mentioned earlier, the capital flight and pollution heaven hypotheses constitute two major popular perceptions regarding the link between FDI and the environment.

Capital flows into the country (and sectors) where the environmental standards are less stringent and the developing countries keep such standards deliberately low to attract FDI. In the Indian context, to test for such explanations, we first of all need a clearly defined set of dirty industries. A conventional approach in the literature has been to identify pollution-intensive sectors as those that incur high levels of abatement expenditure per unit of output in the US and other OECD economies (Low (1991)). Another more direct approach is to select sectors that rank high on actual emission intensity (emission per unit of output). We here adopt the former approach to select our group of dirty industries which include pulp and paper products, organic chemicals, inorganic chemicals, radioactive materials, mineral tars and petroleum chemicals, manufactured fertilizers, paper and board, paper articles, plywood and improved wood, wood manufactures, refined petroleum, agricultural chemicals and cement.

Given this set of dirty industries, one simple way to look at the environmental impact of FDI and to study whether pollution heaven hypothesis can at all be a plausible explanation of FDI inflow is to examine the composition of FDI inflow and the share of these sectors in total FDI inflow. However, sectoral decomposition of FDI inflow in India is available only after mid 1990s with cumulative FDI inflow figures during 1991-95. Thus, no rigorous econometric or statistical time series analysis is possible. However, from Figure 3, it is evident that among the highly polluting industries except for Fuels, Transportation and Chemicals, the FDI inflow has been rather small during 1996-2003. FDI inflow has been even smaller in cement and gypsum industry which contributes almost 7 percent of world's air pollution through CO_2 emission.[10]

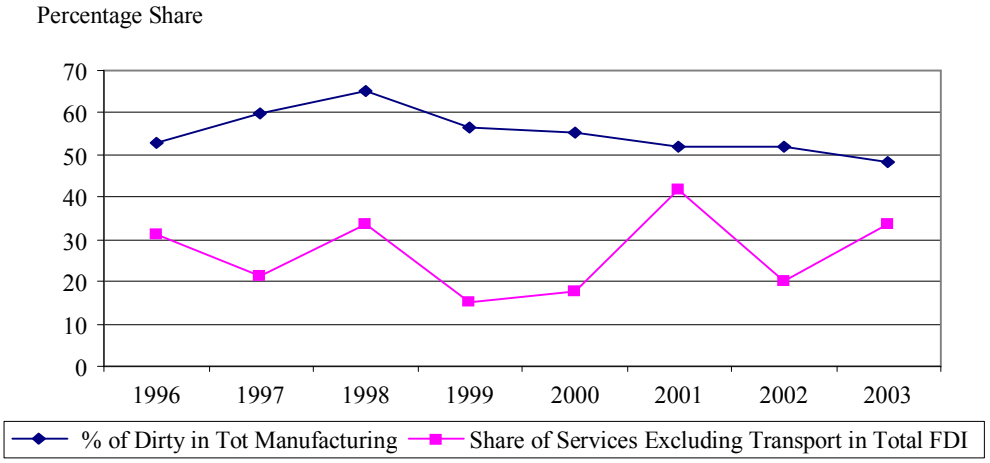
Figure 4, on the other hand, illustrates the changing composition of the FDI inflow across manufacturing and (relatively less or non-polluting) services and within the manufacturing industries. Almost one-third of FDI inflow is being attracted in the service sectors with a significant proportion of it going to the telecommunication and software services. On the other hand, there has been a declining trend in the percentage share of dirty industry in total FDI inflow attracted by the manufacturing sector in India since 1998. The overall trend shows a gradual fall in percentage of this sector. More recent data indicates that this fall is even larger after 2005.

[10] The CO_2 emission per capita by cement and gypsum industry in India has increased from 0.14 metric ton in 1980 to 0.32 metric ton in 2003 according to estimates of Carbon Dioxide Information Analysis Centre, Oak Ridge National Laboratory.



Source: Own Calculation based on data reported at www.Indiastat.com.

Figure 3. FDI Inflow in Some Selected Dirty Industries



Source: Own Calculation based on data reported at www.Indiastat.com.

Note: Share of service sector in total FDI inflow is calculated excluding FDI inflow in transportation service.

Figure 4. Share of Services and Dirty Manufacturing Industries in Total FDI

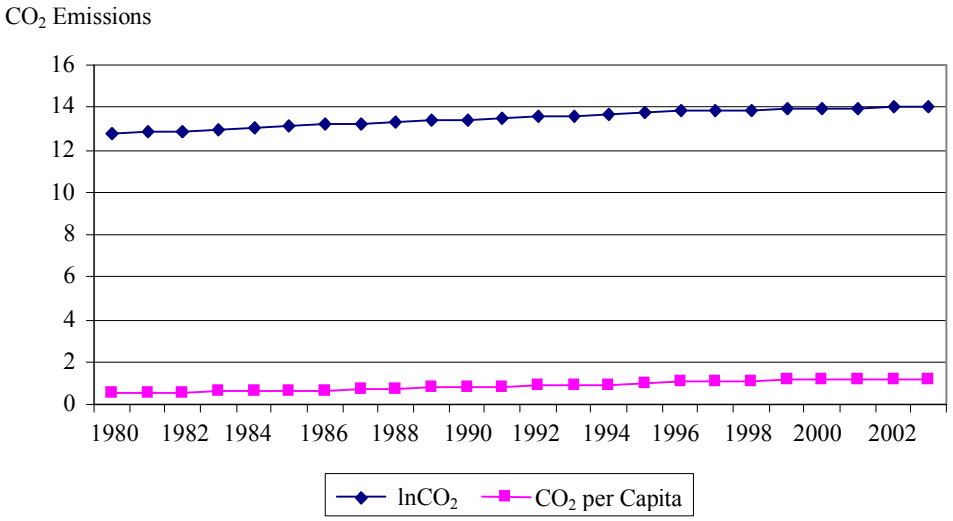
Many factors may explain this relative decline of FDI flow into the pollution-intensive industries in India since 1998. One plausible explanation may be the lower income elasticity for dirty goods which means less demand in the developed nations. Another possible explanation may be that regulation probably led to both significant abatement by pollution-intensive industries in India and displacement of some pollution-intensive production to India's trading partner. On the other hand, reasons for change in the sectoral diversification of FDI inflows towards service sector in India is an outcome of increased outsourcing activities by the MNCs particularly in telecommunications and software service sectors. On the whole the PHH does not appear to be an acceptable argument behind FDI inflow in India, at least since mid-1990s. This does not mean, however, that FDI inflow did not cause any environmental damages. Without having proper empirical estimates on the relationship between sectoral composition of FDI inflow and sectoral contribution of environmental damages it is premature to conclude either way. This is because the pollution intensities and emission rates differ across the sectors. Moreover FDI inflows may have multiplier effects on sectoral growth which may also differ significantly across the sectors due to asymmetries in the production and labour market conditions. Thus even a small FDI inflow may have a large long run growth impact on environmental damages caused by different industries. However, as we have already noted, there is not much of data available on the contribution of different industries to the environmental degradation as well as on the distribution of FDI inflow for a reasonably longer period of time to carry out any meaningful empirical tests. On the other hand, there is no uniform indicator of pollution emission as well. Some industries cause water pollution, some cause air pollution and a few contribute to both. There are the issues of local and global pollutants being emitted as well.

In general the environmental damage can be categorized in two different types, e.g., pollutants with more short term and local impacts, rather than those with more global indirect and long term impacts (Arrow *et al.* (1995), Cole *et al.* (1997), John *et al.* (1995)). One of the most important local pollutants is water and among other local pollutants we have SO_2, SPM, NO_x and CO (Cole *et al.* (1997)). In contrast the global environmental indicators having indirect impact of FDI are like CO_2, municipal wastes, energy consumption (Horvath (1997)) and traffic noise and the like.

Though CO_2 emission are not available at the industry level except for a few industries like cement and gypsum and fuel, the national CO_2 emission - both the gross level and per capita rates - are available for our period of study. This enables us to examine the long run growth impact of FDI inflow in India on its air quality in terms of the effect on CO_2 emission. In what follows we examine and quantify this long run growth effect of FDI. Of course, since air pollution is only one component of environmental degradation, the analysis capturing the growth impact on CO_2 emissions will only be an underestimate of the actual environmental damage that may have been caused by the FDI inflow in India.

Both the growth in total CO_2 emissions (in Kiloton) and metric tons per capita show increasing trend during 1980-2003. To make the units of CO_2 emission comparable with

our GDP and FDI series, we consider log of total CO_2 emissions which is shown in Figure 5. A CUSUMSQ test indicates a structural break in the time trend of $\ln CO_2$ in the year 1990. Thus, we test stationarity of $\ln CO_2$ series considering both constant and trend dummies for the year 1990 and find that it is non-stationary at the level but stationary at the first difference. Thus once again, though no causality test can be meaningful, the co-integration regression can be carried out to reflect the long run (stable) relationship between the GDP growth and CO_2 emission (per capita).



Source: World Development Indicator (2007)

Figure 5. Growth in CO2 Emissions in India

However, since we are concerned here to quantify the indirect effect of FDI on environment through GDP growth we proceed as follows. Referring back to the cointegration regression result suggesting a long run stable impact of FDI inflow on GDP growth in India, the estimated $\hat{\beta}_2$ lnFDI in (2) quantifies the growth impact of FDI inflow during 1980-2003. Thus this estimated value can be considered as the component of GDP growth that is explained by the growth in FDI inflow. Hence, for our purpose, instead of lnGDP we consider $\hat{\beta}_2$ lnFDI, redefined as BLFDI, as one of the explanatory variable for growth in (total) CO_2 emission during the same period. The value of $\hat{\beta}_2$ is taken to be the estimated value of 0.0323 as reported in Table 1. Thus we estimate the following relationship:

$$LCO_2 = \alpha_0 + \alpha_1 t + \alpha_2 D_1 + \alpha_3 D_2 t + \alpha_4 BLFDI + v_t , \quad (3)$$

where, $BLFDI = 0.0323$ (lnFDI) and D_1 and D_2 are the intercept and trend dummies respectively,

$D_j = 0$ for 1980-1990,

$D_j = 1$ for 1991-2003; $j = 1, 2$.

The co-integration regression is reported in Table 2 along with the unit root test for residual. The estimated value of ADF statistic suggests that CO_2 and BLFDI are cointegrated and the regression is not a spurious one.[11] Thus, there has been a stable long run positive growth impact of FDI inflow in India on CO_2 emission during 1980-2003, and the magnitude of the FDI-led growth elasticity of CO_2 emission is quite high at 0.864. That is, the FDI inflow raises 0.86% of CO_2 emission for every 1% growth in GDP that such inflow contributes to.

Table 2. Long Run Growth Impact of FDI Inflow on CO_2 Emission

Dependent Variable: lnCO_2

Variables	**Coefficients**
Constant	12.64555*
	(533.0632)
Time	0.066675*
	(25.59163)
Constant Dummy (1990)	0.253220*
	(8.259657)
Time Dummy (1990)	-0.021208*
	(-7.343123)
BLFDI	0.864319**
	(2.261010)
R^2	0.997588
DW test statistic	1.567489
Unit root test for residuals (First Difference)	
ADF test statistic	-7.553724
R^2	0.730970

Notes: t-values are shown in the parentheses and * and ** denote significance at 0.01, 0.05 levels respectively. For ADF test MacKinnon critical values for rejection of hypothesis of a unit root is -2.6819 for significance at 0.01.

[11] Once again, the computed value of DW test statistic for the cointegration regression rejects the null hypothesis of cointegration at the 1% level of significance and thus reconfirms that the regression is not spurious.

4. CONCLUSION

Using the data on GDP growth, FDI inflow and CO_2 emissions in India during 1980-2003, we have examined, first, the growth impact of FDI, and second FDI-induced growth impact on the CO_2 emission. Our cointegration analysis shows that FDI inflow in India did have a positive, but marginal, long run impact on GDP growth. On the other hand, though the pollution heaven hypothesis may not be a plausible argument for the upsurge in FDI inflow in the 1990s, such inflows did have a quite large positive impact on the CO_2 emissions through output growth. This, however, may be an underestimate since the effect of FDI on water pollution and on the local air pollutants are not estimated.

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