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GLOBALIZATION AND ENVIRONMENT IN INDIA

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Abstract

India embarked on a path of liberal economic reform in the 1990s after years of nurturing an intensively regulated and controlled economic environment that was loosened slightly in the mid-1980s. The most important and critical segments of this reform were trade and foreign investment. India has felt the impact of globalization through increased prosperity, partly triggered by increasing trade volumes, investment, and growth. The theme of this article is to make readers aware of the impact of international trade and foreign direct investment (FDI) on climate change with special reference to India's economy.

Scholarly work on trade, FDI, and the environment in India with rich theoretical insight and solid empirical evidence is scarce. However, there is a good amount of work on general environmental issues. Our hypothesis is that trade liberalization has not directly or substantially affected carbon dioxide (CO_2) emissions. However, it has probably had greater effects through its impact on gross domestic product (GDP). In other words, we impress upon readers that the direct impact of trade and FDI on environmental conditions is less of an issue compared with the indirect effects through the positive impact on GDP growth and resultant prosperity. We also emphasize that enforcing regulations is a complex task given corruption, informal markets, and the inability of citizens to cooperate and form effective lobbies.

Preliminary calculations using data from the World Bank show that GDP has a direct, proportional relationship with the extent of CO_2 emissions in India, and the relationship is even stronger after the introduction of the liberalization policy in the 1990s. However, trade seems to have an inversely proportional relationship, consistent with the view that Indian imports are mostly manufactured items that may involve polluting production process and are currently being produced outside India.

We believe more specific research is needed to assess the overall environmental impact of patterns of production and consumption. Recent scientific analysis focuses on better scientific measures of the damage and impact of climate change and its effect on inequality. Clearly, warmer regions around the globe, including India and many developing Asian countries, will be affected more than their northern counterparts due to global warming. In fact, recent estimates show that climate change has increased inequality in the United States between the north and the south. Patterns of production are generally induced by the conditions of global trade and investment and by physical infrastructural support and local resources. India and the People's Republic of China (PRC), the two largest countries in Asia, have very different GDP compositions. This poses the question of whether excessive industrialization coupled with the usual transboundary and climate concerns make the PRC more vulnerable than India, which thrives on service sector growth and in turn benefits from the low pollution content of growth. This also calls for serious exploration of green accounting and the preparation of databases with better environmental indicators.

It will be worthwhile to explore the effect of liberalization on other climatic aspects, such as water pollution and land salinity, with the help of large scientific databases. But the fact remains that only through trade can countries replace the local production of pollution intensive goods with imports and reduce CO_2 emissions. Countries that can replace the production of pollution intensive goods by imports will reduce CO_2 emissions on this count. The growth effect, however, will go the other way. Countries with different trade patterns may suffer on both counts. India is possibly a mixed case and more detailed analysis is needed to examine the hypothesis.

Keywords: international trade, FDI, environment, corruption, informal economy

JEL Classification: F18, F21, F64, D73, F26

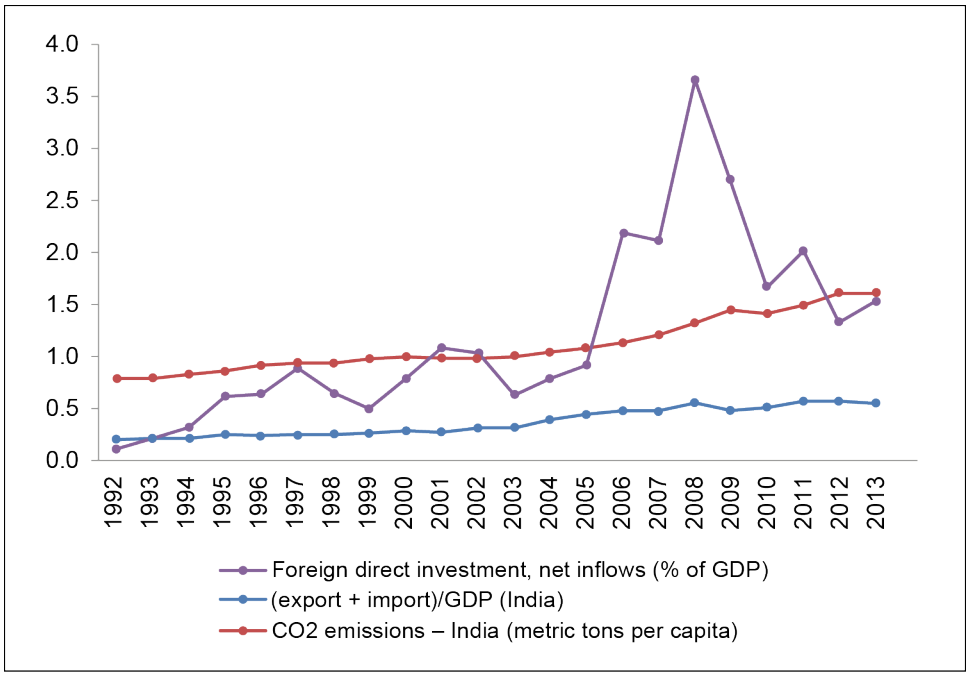
Contents

1. INTRODUCTION

India embarked on a path of liberal economic reform in the 1990s after years of nurturing an intensively regulated and controlled economic environment that was loosened a bit in the mid-1980s. Now it is well recognized that such a sea change in policy has led to impressive achievements in many sectors of the economy. The most important and critical segment of this reform has been trade and foreign investment, including deregulations in the well-known industrial licensing system. The theme of this chapter is to make readers aware of the relevant work on climate change and the impact of trade and environment on climate change with special reference to India's economy. The impact of globalization on India has been felt in terms of increasing prosperity, partly triggered by increasing volume of trade, investment, and growth.

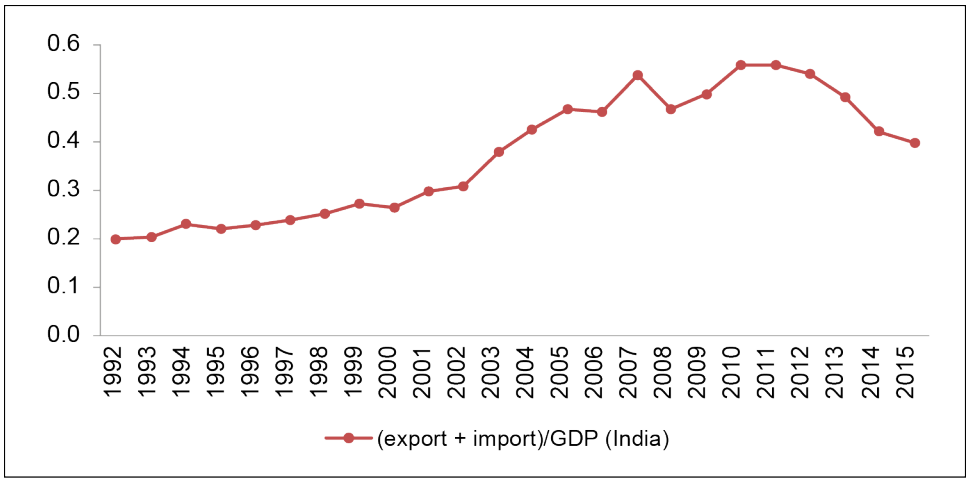
A cursory look at the evidence suggests that the conventional openness index, represented by the ratio of volume of trade to gross domestic product (GDP), increased substantially from a little over 10% in the 1990s to almost 50% in recent times. Average tariff rates came down drastically, leading to greater imports and exports. The foreign direct investment (FDI) flows also started recording impressive levels over the next two decades. Trade and FDI in the Indian context are depicted in Figures 1 and 2. Per capita energy consumption and carbon dioxide (CO_2) emissions have also increased in the post-reform period, as suggested in Figures 3 and 4; Figure 5 depicts India's GDP growth. However, as Figures 6 and 7 show, India's per capita consumption of energy and CO_2 emissions are both way below the People's Republic of China (PRC) and the United States (US).

Figure 1: FDI, Trade, and CO_2 Emissions in India



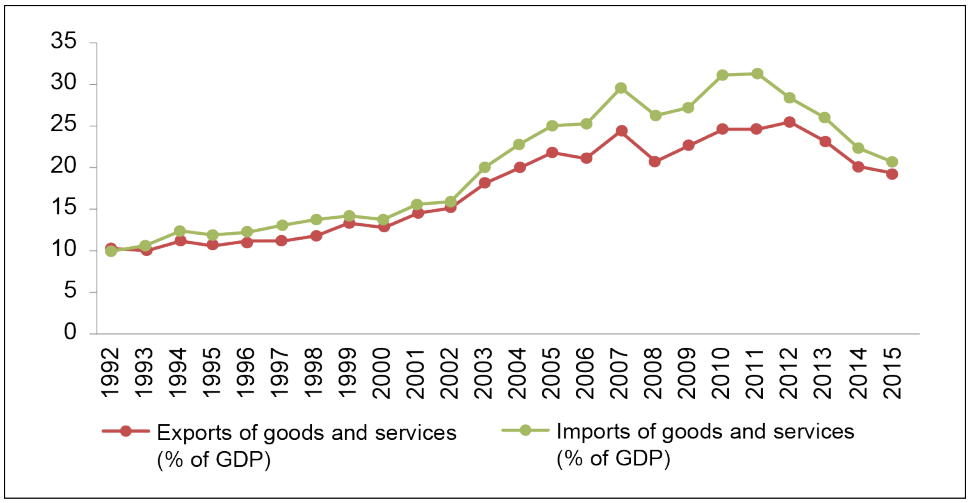
Source: World Bank Data (www.data.worldbank.org).

Figure 2.1: Trade Openness after Liberalization



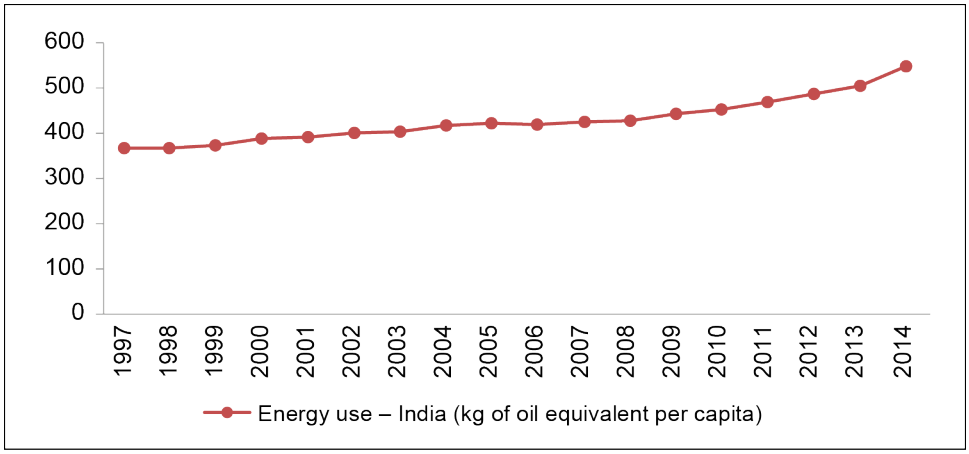
Source: World Bank Data (www.data.worldbank.org).

Figure 2.2: Exports and Imports



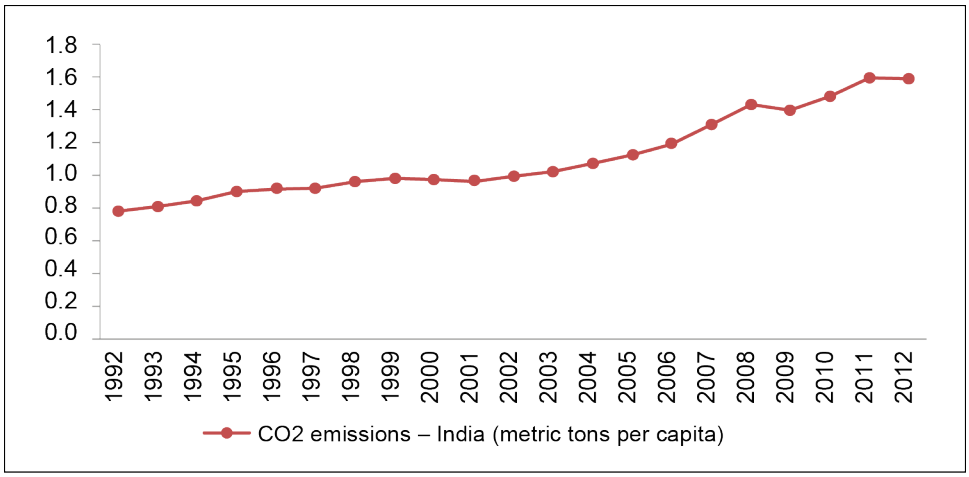
Source: World Bank Data (www.data.worldbank.org).

Figure 3: Energy Utilization in India



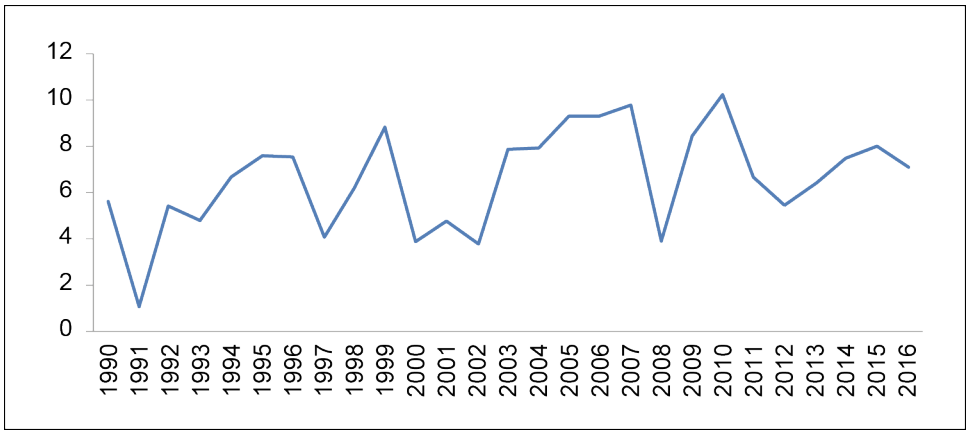
Source: World Bank Data (www.data.worldbank.org).

Figure 4: CO_2 Emissions in India after Liberalization



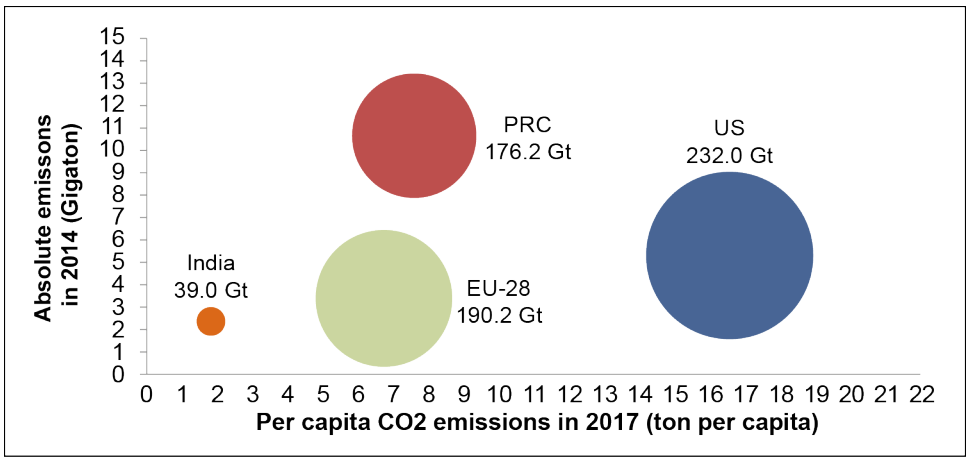
Source: World Bank Data (www.data.worldbank.org).

Figure 5: GDP Growth of Indian Economy, 1990–2016



Source: World Bank Data (www.data.worldbank.org).

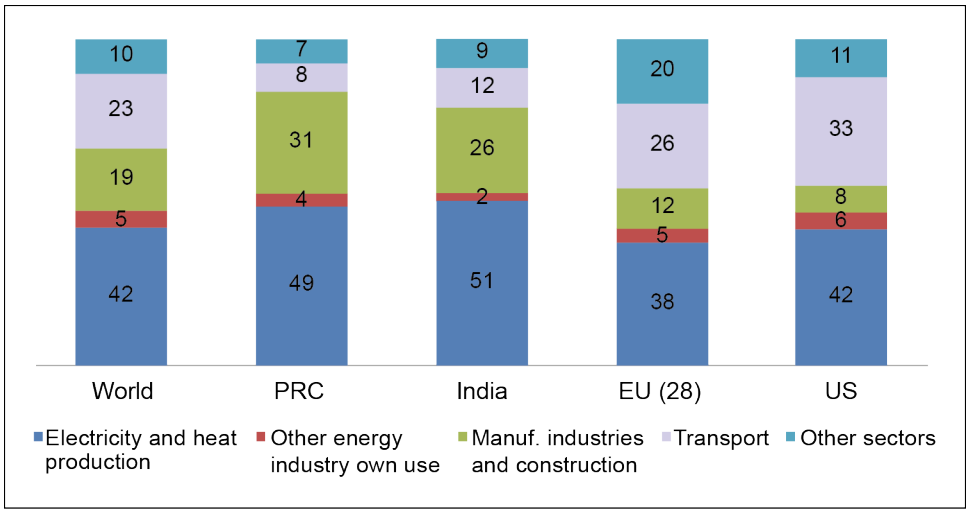
Figure 6: Per Capita CO_2 Emission in Selective Countries



Note: Bubble width indicates total emissions between 1970 and 2014 for the respective countries, indicated alongside the bubbles.

Source: Economic Survey 2015–2016 (Government of India).

Figure 7: CO_2 Emission from Different Sectors



Source: Economic Survey 2015–2016 (Government of India).

The effects of trade and FDI, though mixed and different, are felt on growth in GDP. India has jumped ahead of nations, breaking the taboo of the so-called historic "Hindu" rate of growth of 3% per annum, averaging around 8% per annum (India's GDP growth rate in the post-reform period is shown in Figure 5).

In spite of the major financial crises and crashes of 1997 and 2008, India has remained a close second to the PRC and is currently growing at a commendable rate. After the historic demonetization episode in November 2016, when about 86% of currency was withdrawn from circulation to control black market transactions and illegal liquidity, the growth rate has faltered a little. The recent work on global fiscal policy and inequality by the International Monetary Fund (IMF) (Clements et al. 2015) confirms the claim that millions of people have been lifted above the poverty line thanks to the historic switch to a regime of liberal economic policies. Interestingly, while the degree of inequality in the 2000s shows a moderately increased level relative to the 1980s, the increment is far lower than in the PRC and the increase itself is definitely on the lower side if compared with the world average during the relevant period.

Against this backdrop, it is hard to be too concerned about the direct environmental consequences of more open trade and investment regimes. It is also extremely difficult to isolate effects that are exclusively due to liberal trade policies and quite independent of the growth effect. The real need is to analyze the problems at various levels by focusing on the effects of a significant change in the growth regime, reflecting the increasing level of prosperity, which has definitely been impacted by liberal trade policies. The pattern of trade should itself have some effect on environmental elements such as fossil fuels, renewable energy, carbon emissions, etc. Further to this effect, one should worry about overall climate change, food supply, and food security. It is also important to understand the pattern of India's trade and investment that has characterized its growth path over the last few decades. On the one hand, trade and investment policies may directly regulate environmental damage and affect optimal utilization of natural resources. On the other hand, any kind of regulatory policy or its emergence will be guided by several critical factors involving awareness, political lobbies, strategic reactions, and the massive size of the informal sector. Coupled with this, India's participation in global policy making to control transboundary pollution, climate change, and CO_2 emission-related factors will be also important. We reflect on all of these as much as possible given the limited length of the chapter. The main point of this chapter

is to argue that, by global standards, India's performance has not been particularly worrisome. Liberal trade policies and market integration have contributed to growth, resulting in pressure on the use of natural resources. However, poor regulatory control has created sporadic natural and national disasters in tandem with factors that are affected by global warming. It is this problem of implementing regulations that requires special attention.

There are certain global issues which involve transboundary concerns and India cannot be insulated from those concerns. Globalization and the environment in India are dependent in part on global climatic conditions and the policies of the other countries, as one cannot ignore global negative externalities. These will be related to the policies with which the Indian government has been engaged. In this introductory section, we highlight research on climate change at the global level and emerging problems that require attention. We reflect upon some of these issues in the policy section.

In the second section of the chapter, we discuss the theoretical implications, drawing from various contributions in the sphere of environmental regulations. In the third section, we provide a panoramic view of the available academic literature on the impact of trade on the environment in general and on India specifically, mainly from an empirical perspective. The fourth section highlights the global research on climate change and the Indian counterpart. The fifth section briefly addresses the policy strategies of the Indian government. The concluding section will highlight issues that require further attention and link India's concerns with the greater Asian perspective before providing some concluding remarks.

2. THEORETICAL PERSPECTIVE

Trade and FDI-impacted prosperity may potentially have severe, but sporadic, environmental consequences, along with silent erosion of ecological surroundings. However, a look at the destination of trade and FDI in various sectors shows a relatively benign picture (Kar and Majumdar 2016). It is very difficult to suggest that trade and FDI were singularly important in terms of environmental damage.

The expansion of tourism, an appetite for real estate investments, and prosperity-led demand for the construction sector can lead to excessive use of land-based resources, giving rise to catastrophic events. Agriculture, with increasing use of chemical fertilizers and pesticides, has long affected the soil condition; however, it is very difficult to identify and isolate the role of trade in such a malady. India has suffered, and will continue to suffer, since the regulatory framework may not function properly for institutional reasons. It is generally the case that if we give up industries that generate pollution in the process of production and import the underlying products as trade opens up, we reduce the extent of environmental damage. On the other hand, if our export good has significant pollution content, the result is exactly reversed; given that India's trade pattern is not manufacturing intensive, it may not have suffered from this aspect of the problem. However, the pressure of growth and prosperity on the informal sector, weak and corrupt institutional structure, and social neglect may have severely impacted the ability to regulate or control environmental damage. Theoretical and empirical research on the problem of such regulatory control in the context of the informal sector has been amply demonstrated in Biswas, Farzanegan, and Thum (2012) and Biswas and Thum (2017). The problem of regulation with a huge informal sector has been discussed in detail in Marjit, Ghosh, and Biswas (2007), Marjit and Kar (2011, 2012), etc. The basic idea is as follows.

Consider $Y(T)$ as the level of GDP. It is favorably affected by the volume of trade T, with

$$Y'(T) > 0 \quad (1)$$

However, with environmental damage, the social value is $eY(T)$ with $0 < e < 1$, as $(1 - e)$ fraction of $Y(T)$ is lost in the process as a cost. If one could do effective green accounting, the true national income would be $e.Y(T)$. The regulator can regulate by forcing the producers to invest in abatement technology $C(e)$

$$C = C(e),\ C' > 0,\ C'' > 0 \quad (2)$$

A better environment—i.e., higher e—requires a higher cost of abatement. The socially optimal abatement level is determined by maximizing:

$$V(e) = eY(T) - C(e) \quad (3)$$

F.O.C.$V'(e) = 0$, [with $V''(e) < 0$and$C'' > 0$]

$$C'(e) = Y(T) \quad (4)$$

Thus optimal

$$e^* = f[Y(T)],\ f' > 0 \quad (5)$$

Note that as T and Y increase, the social marginal benefit from abatement increases. With every increase in$e$, the saving is more; therefore, optimal environmental quality actually increases.

Producers do not internalize e. Hence, to them, the cost is $C(e^*)$ and profit is given by:

$$\pi(e^*) = Y(T) - C(e^*)$$

$$= Y(T) - C[e^*(T)] \quad (6)$$

They may try to bribe the agent of the regulator. Also, enforcing e^* for the informal segment can be very difficult because of unrecorded and unregistered activities. Producers will try to maximize the following:

$$\pi(\tilde{e}) - \pi(e^*) = \left[C\left(e^*(T)\right) - C(\tilde{e})\right] - B(e^* - \tilde{e}) \quad (7)$$

$\tilde{e}$ is the maximum abatement that will be engaged in after paying a bribe determined by the bribe function B. In the simplest application of a Nash bargaining problem, the bribe amount will be:

$$B = \frac{1}{2}[C(e^*) - C(\tilde{e})] \quad (8)$$

Typically, if there is no other cost, then $\tilde{e} = 0$, but there may be other costs depending on further monitoring, auditing, etc. This may happen when eventually, due to a national level disaster or calamity and media attention, punishment cannot be avoided. In that case, let that cost be $Z(e^* - \tilde{e})$, with $Z' > 0$, $Z'' > 0$. The maximum abatement level is then finally guided by:

$$\max_{\{\tilde{e}\}} \frac{1}{2}[C(e^*) - C(\tilde{e})] - qZ(e^* - \tilde{e}) \quad (9)$$

$$\Rightarrow qZ'(e^* - \tilde{e}) = \frac{1}{2}C'(\tilde{e}) \quad (10)$$

where q is the probability that the evader is further audited after paying the bribe. For very low q or $\text{very low } Z'$, $\tilde{e}$ will be close to zero. With rising T, e* will increase and that will increase $\tilde{e}$. One must appreciate the fact that an environmental disorder is a natural consequence of prosperity, however big or small, and for a country like India, implementing regulatory policy is really a huge task due to corruption in the governance process.

One point that has been critically avoided in the above framework is a direct impact of e on T. It is possible that the process of abatement involves a cutback in the production of the export good or certain specific imports, adversely affecting T. In general, such a problem has a serious political impact and thus tends to restrict regulatory control. The problem then looks like:

$$V(e) = eY\big(T(e)\big) - C(e) \quad (11)$$

$$V'(e) = 0 \Rightarrow Y\big(T(e)\big) + eY'T'(e) = C'(e) \quad (12)$$

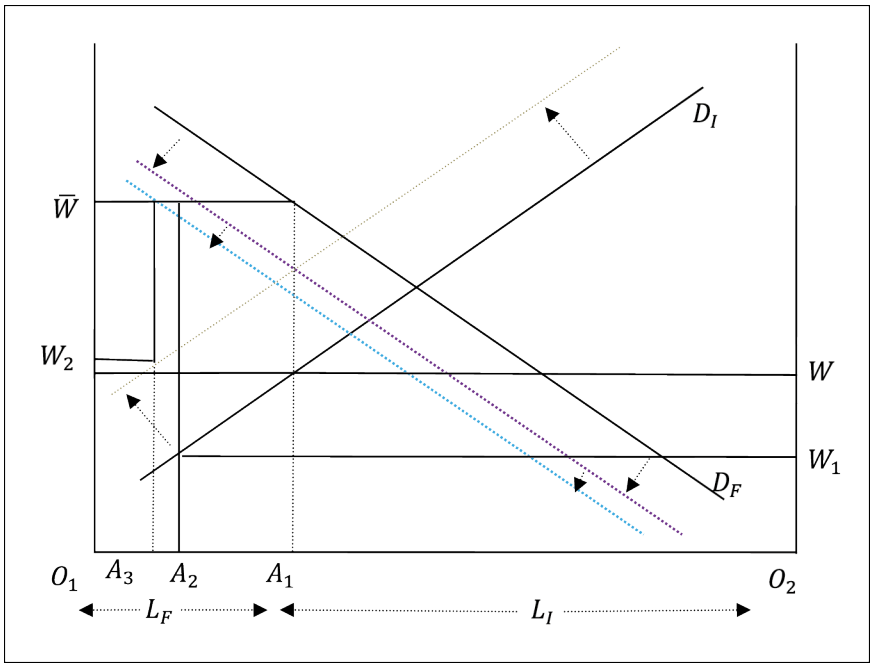
with $T'(e) < 0$; Left hand side (LHS) in (12) is less than the right-hand side (RHS) in (4) as the social marginal benefit for a higher e is lower, pushing e^* down.

Another interesting feature of environmental regulation concerns the impact of such regulation on employment and wages. This constitutes a major problem for the government, as the majority of the workforce is engaged in the informal sector, with no exception across the entire developing world. As has been elaborated in Marjit and Kar (2011), this is the stark reality for India. Critical policies have been discussed in the context of the labor market by Marjit (2003); Marjit, Kar, and Acharyya (2007); Marjit and Kar (2012); Acharyya and Kar (2014), etc. focusing on interaction between the formal and informal sectors. However, such a general equilibrium exercise is rare in the context of environmental regulations.

Typically, the political concern seems to be that environmental regulations tend to depress employment and wages and so are difficult to implement in democracies. However, movement of capital between formal and informal sectors, coupled with the inability of the government to push through regulations in the informal sector, may actually prove to be helpful to the informal workers by raising wages. We provide a theoretical example drawn primarily from Marjit (2003) and Marjit and Kar (2011).

Figure 8 describes a situation where $L_F = O_1A_1$ is hired in the formal sector with a fixed unionized wage $\overline{W}$. The rest, $A_1O_2 = L_I$, are hired in the informal sector at wage W, where $\overline{W} > W$. (D_F,D_I) are demand for labor in the formal and informal sectors respectively. Regulatory tax will shift D_F to the left, reducing L_F to O_1A_2 and informal wage to $W_1 < W$, the standard contractionary effect. However, if we allow capital (hidden in the level and the slope of D_F) to move from formal to informal, shifting D_F down further but shifting D_I up, L_F still falls to O_1A_3 but W rises to $W_2 > W > W_1$. Environment regulation in this case has actually helped the informal workers. The intuition is that lack of regulation leads to excessive allocation of capital in the formal sector. Also, an upward shift of D_I can occur even when regulations affect that sector. It is the relative shift that will determine the result.

Figure 8: Environmental Regulation and Informal Wage



This has serious political economic implications. If there is a decline in W, vote bank politics will not allow such a regulatory move. The above example is based on the assumption that the informal sector produces a final good: the result will change when the informal sector produces an intermediate good for the formal sector. A pollution tax on the formal sector will affect the informal sector directly, even if the government cannot directly enforce an environmental stand on the informal sector. As long as the price of the intermediate good is pegged by trade by a standard small economy assumption, the result will not vary much, as the informal sector can find other buyers in the international market. Return to capital will fall and w will rise. If the price of the intermediate good is endogenously determined and/or there is a direct environmental tax on the informal sector, w may fall. The environmental regulations imposed on the formal and informal sectors may exhibit complex policy reactions.

Let us move from production-related environmental concern to the problem of regulation in the domain of public goods. Economic growth fueled by trade or FDI-related prosperity often leads to excessive use of natural resources. Examples in India are abundant where the expanding real estate and construction business often encroach upon water bodies on the one hand and lead to excessive local demand for water on the other, pushing the water level further down. Lack of cooperative effort on the part of citizen users for the renovation of water bodies, cleaning, dredging, etc. leads to suboptimal public investment in critical areas of consumption, as lobbying is inadequate. A few years ago, in Northern India, a massive landslide caused by torrential rain feeding a mountain river led to a huge loss of prosperity and human lives (Kala 2014; Singh et al. 2016). Everyone could see the problem of construction of cheap hotels across river banks that crippled the soil base and made it vulnerable to natural disaster. Excessive use of groundwater in India has led to serious arsenic-related diseases. This has been documented time and again (Das et al. 1994). These point to an inevitable fallout of excessive demand on natural resources, a hallmark of a fast-growing economy. It is well known that energy-intensive consumption activities during winter perennially affect the PRC and its overuse of coal-based resources. (The National Development and Reform Commission of the PRC said in its annual report that it would implement policies

aimed at reducing coal consumption and controlling the number of energy-intensive projects in polluted regions, Aizhu et al. 2015).

The problem arises at three levels.

First, the regulation priorities of the government can be lopsided, being dependent on the electoral policies and economic performance of the political regime. For example, if trade and FDI stimulate growth and growth relates to ecological problems at the local, regional, or national level, governments may not stir unless natural and national disasters occur through floods, droughts, landslides, etc.

Second, people may not consider environmental degradation as a quality of life issue in a poor country. While growth and affluence slowly make an impact, public consciousness in this regard may turn out to be too shallow and non-existent. The recent policy drive by the Indian government, known as the Clear India (Swatch Bharat) mission, is an endeavor that has created millions of toilets. This speaks loudly of a chronic problem of defecation-induced health hazards and a lack of awareness among people. International trade, FDI, and other growth-augmenting avenues have very little to deliver in that respect, as prosperity and social awareness may not go hand in hand.

Third, lack of cooperation in public good-related initiatives among affluent citizens to resolve local problems of excessive exploitation of natural resources makes the problem even more complex.

The latter problem can be related to a simple theoretical structure. Cooperation may fail to emerge in a trigger strategy-led repeated game-theoretic setting with increasing prosperity.

Consider a community of n persons with expenditures x_i, $i = 1,2, \ldots \ldots, n$. While higher x_i delivers higher utility, $\sum_i^n x_i$ may affect a natural resource commonly used by all but without any property right assigned. Symmetry assumption implies $x_i = x \; \forall \; i$.

$$\text{Let } U_0 = \alpha x_0 - \beta(nx_0).nx_0 \text{ (with } x_0 \text{ as initial level of expenditure)} \tag{13}$$

We assume $U_0 > 0$, with $U_0(0) = 0, \beta' > 0$, $\alpha > 0$. β represents cost to the environment—for example, a decline in the water level due to excessive use.

With enough curvature restrictions on $\beta(.)$, we can show that with excessive expenditure U_0 goes down. However, people usually do not care about the negative component or β. If a cooperative arrangement could be enforced, we could decide on some $\bar{x}$ that is optimal and also some corresponding $\overline{U}$. This can be derived by treating U_0 as a social welfare function. However, people can cheat within a cooperative agreement and if one of them does it, cooperation breaks down. The cheating pay-off is $\widetilde{U} > \overline{U} > U_0$, since the deviant will presume that, given all others stick to $\bar{x}$, she can increase her own x. Once cooperation breaks down, they get U_0, which is the punishment pay-off. Therefore, such an agreement will break down if:

$$\frac{\overline{U}}{1-\delta} < \widetilde{U} + \frac{\delta U_0}{1-\delta} \tag{14}$$

$$\text{Or, } \overline{U} < (1-\delta)\widetilde{U} + \delta U_0 \tag{15}$$

(where δ is the rate of discount $0 < \delta < 1$). Since $\widetilde{U} > U_0$, higher δ will reduce the RHS (right-hand side) in (15) and therefore the higher δ is, the better the chance of cooperation is. As greater prosperity sets in, if $\overline{U}$ is not renegotiated appropriately, perceived pay-off from cheating $\widetilde{U}$ is likely to increase more than U_0 even if $d\tilde{x} = dx_0$,

thwarting cooperation. Hence cooperation may be more difficult to sustain under growth and prosperity. The result will change if people become more environment-conscious, with appropriate changes in $\beta(.)$ function, or if one could design property rights in this context through properly pricing the natural damage. Related issues have been discussed rigorously by Chander and Tulkens (2006), Chander and Muthukrishnan (2015), and Quah (2015).

2.1 Research on Trade and Environment

Several papers have discussed the environmental implications of international trade or a more open trade regime. A representative introductory sample is Copeland and Taylor (2004, 2013) and Chao and Yu (2004). While these works have provided rich insights toward an understanding of the problem, there have been other recent papers. Later, we will try to focus on the aspects that are particularly relevant for India. We now briefly summarize some works that have examined the relationship between trade and environment from a general perspective. This is very selective, but the papers themselves have a plethora of references to draw from that readers can use. Later, we reflect on the Indian scenario.

Neumayer (2000) critically assesses three ways in which trade might harm the environment. First, trade liberalization might exacerbate existing levels of resource depletion and environmental pollution; second, open borders might allow companies to migrate to "pollution havens," thus undermining high environmental standards in host countries; and third, the dispute settlement system of the World Trade Organization (WTO) might favor trade over environmental interests in case of conflict. It is shown that while trade liberalization can lead to an increase in environmental degradation, pollution havens are not a statistically significant phenomenon.

Copeland and Taylor (2001) draw quite heavily from trade theory but develop a simple pollution demand and supply system featuring marginal abatement cost and marginal damage schedules familiar to environmental economists. They use a simple model to facilitate extensions examining the environmental consequences of growth, the impact of trade liberalization, and strategic interaction between countries. One could also refer to Antweiler et al. (2001) in this context.

Chen and Woodland (2013) analyze non-cooperative environmental policies and investigate whether trade undermines the effectiveness of unilateral environmental policies, in which carbon leakage and international competitiveness are of particular importance. They review the interactions between trade and environmental policies, border tax adjustment policies, and the role of the World Trade Organization in combating climate change arising from economic activities.

Dellink, Hwang, Lanzi, and Chateau (2017), by building on the analysis in the OECD's 2015 report, The Economic Consequences of Climate Change, present a plausible scenario of future socioeconomic developments and climate damage to shed light on the mechanisms at work in explaining how climate change will affect trade.

Sauvage and Timiliotis (2017) discuss international trade in environmental-related services. By lowering the costs of these services and improving access to suppliers, trade policy can contribute, alongside energy and environmental policy, to the prevention and abatement of greenhouse gas emissions and pollution in all its forms.

Readers can also consult Beghin et al. (1994), Sturm (2003), and Dupuy (2012) for additional references in this area.

2.2 Research on Trade and Environment on India

India's trade is typically dominated by the service sector, agriculture, oil, industrial components, gems and jewelry, etc. The fact that wage inequality has been on the rise in the country for quite some time indicates an ever-growing premium for human capital, in particular in the information technology-led sectors (Marjit and Acharyya 2003, 2009). India's weak link seems to be manufacturing. While the service sector commands about 60% of GDP, manufacturing contributes only around 25%. Historically, over the last few decades since reform, India's tradition is exactly the opposite to the PRC's if we look at the composition of GDP. A simple exercise to trace the impact of trade, FDI, and GDP on CO_2 emissions has been attempted in terms of econometric analysis.

Scholarly work on trade, FDI, and the environment in India that offers rich theoretical insights and solid empirical evidence is scarce, although there is a good body of work on general environmental issues, some of which we summarize in the next section, along with the general literature on climate change from science, technology, and economic perspectives. We first consider an empirical exercise on the relationship between overall CO_2 emissions, growth, trade, and FDI in India, specifically to show that it is more GDP-led prosperity than trade and FDI that has led to a growth in emissions.

To understand the effect of liberalization on the extent of carbon emission in India in forms of a very simple rudimentary framework, we regress CO_2 emissions on three variables: GDP per capita, trade per capita, and FDI per capita. However, our explanatory variables might not have an immediate effect on the level of CO_2 emissions; therefore, lagged explanatory variables might be appropriate. Here we have taken a two-period lag. Our equation is as follows.

$$CO_2\ Emission_t = \alpha + \beta_1\ GDP\ Per\ Capita_{t-2} + \beta_2 Trade\ Per\ Capita_{t-2} + \beta_3 FDI\ Per\ Capita_{t-2} + \varepsilon_t \quad (16)$$

Here t denotes time point. We run the regression for the period 1978 to 2013.

Table 1: Regression Results

Explained Variable: LOG [CO2 emissions (tons per capita)]	
Explanatory Variables	**Estimated Coefficient**
LOG [GDP per capita (-2)]	1.44*
LOG [TRADE per capita (-2)]	–0.33*
LOG [FDI per capita (-2)]	0.04*
Constant	–5.40
R-squared	0.97

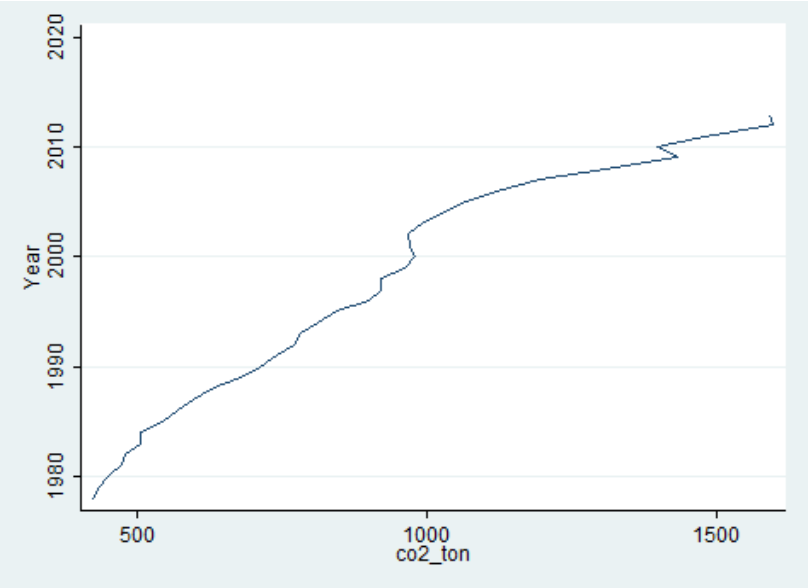
Note: * denotes significance at 1% level; ** denotes significance at 5% level.
Source: Author's own calculation based on World Bank Data.

As we see from the result, GDP per capita has a direct and statistically significant impact on the extent of CO_2emission in India. This implies that the Indian economy has grown at the cost of environmental degradation. The relationship between trade and CO_2emissions seems to be inversely proportional, implying that, holding other factors constant, with increased trade CO_2emission has gone down. As an educated guess, we

may propose that Indian imports are mostly manufactured items, which may involve a polluting production process, and are being produced outside India. On the other hand, due to the import of these manufacturing items, the polluting import substitution manufacturing is being closed down, possibly resulting in lower pollution in India due to imports. Furthermore, Indian exports, though they have manufacturing content, also comprise growing IT service-oriented activities, which are almost without pollution. Hence trade helps India to reduce pollution, as reflected in the negative relationship in our estimated equation. Like GDP, FDI is found to positively, though rather insignificantly, influence CO_2emission in India. The FDI result echoes the work of Acharyya (2009), which we discuss later.

Now, we all know the Indian economy was opened to the rest of world in 1991 through the process of liberalization. This is expected to have had some impact on pollution. After liberalization, GDP, trade, and FDI all rose for the Indian economy. We need to ascertain whether pollution in India has increased due to liberalization. In Figure 9, we plot the level of CO_2emissions across the years and try to see if there is any structural shift.

Figure 9: CO_2 Consumption in India



Source: World Bank Data (www.data.workbank.org).

It seems from the diagram that there is no structural shift but there is a change in slope after liberalization. To capture this aspect, we use an interaction dummy with the break point being 1992. So, our equation becomes:

$$CO_2\ Emission_t = \alpha + \beta_1\ GDP\ Per\ Capita_{t-2} + \beta_2 Trade\ Per\ Capita_{t-2} + \beta_3 FDI\ Per\ Capita_{t-2} + (d_i \times GDP\ Per\ Capita_{t-2}) + \varepsilon_t \quad (17)$$

where d stands for dummy = 0 if year < 1992, 1 if year ≥ 1992.

Table 2: Regression Results

Explained Variable: LOG [CO2 emissions (tons per capita)]	
Explanatory Variables	**Estimated Coefficient**
LOG [GDP per capita (-2)]	1.51*
LOG [Dummy ×GDP per capita (-2)]	0.10*
LOG [TRADE per capita (-2)]	–0.37*
LOG [FDI per capita (-2)]	0.01
Constant	–5.83*
R-squared	0.97

Note: * denotes significance at 1% level; ** denotes significance at 5% level.
Source: Author's own calculation based on World Bank Data.

It seems from our estimated equation (equation 17) that, holding other factors constant, there is a positive change of slope. This means that the rate of increment of CO_2 emissions in India has increased due to the rise in GDP after liberalization. Hence it can be inferred that the liberalization-backed GDP growth has had an adverse environmental impact on the Indian economy.

If we wish to see whether there is any shift due to trade after liberalization, we modify our equation as follows:

$$CO_2\ Emission_t = \alpha + \beta_1\ GDP\ Per\ Capita_{t-2} + \beta_2 Trade\ Per\ Capita_{t-2} + \beta_3 FDI\ Per\ Capita_{t-2} + (d_i \times Trade\ Per\ Capita_{t-2}) + \varepsilon_t \quad (18)$$

where d stands for dummy = 0 if year < 1992, 1 if year ≥ 1992.

Table 3: Regression Results

Explained Variable: LOG [CO_2 emissions (tons per capita)]	
Explanatory Variables	**Estimated Coefficient**
LOG [GDP per capita (-2)]	1.51*
LOG [TRADE per capita (-2)]	–0.37*
LOG [Dummy ×Trade per capita (-2)]	0.01
LOG [FDI per capita (-2)]	0.02
Constant	–5.80*
R-squared	0.97

Note: * denotes significance at 1% level; ** denotes significance at 5% level.
Source: Author's own calculation based on World Bank Data.

Keeping other things constant, trade seems to have a negative impact on the extent of CO_2emissions in India. However, there is no statistically significant shift in the slope or rate of increase/decrease of pollution due to trade after the liberalization policy came into force in India.

Acharyya (2009) provides an early analysis of the impact of FDI on the environment, where it is demonstrated that FDI inflow in the 1990s had a quite large positive impact on CO_2 emissions through output growth, and FDI had a positive but marginal impact on growth. The two together imply that growth must have a very high emission

elasticity. This, in a way, may contradict the observations of Wei and Smarzynska (1999) and Hassaballa (2013) regarding the developing world and pollution havens, as reported in Kar and Majumdar (2016).

Papers by Kar and Majumdar (2016) have made a serious attempt to reflect on trade and technology policies with reference to the developing world and with a special emphasis on India. Before we discuss these papers, it is important to note that the better environmental standards are usually dependent on internal policies rather than on trade and FDI-related policies. However, the impact of market integration on the environment may require trade-specific policies. Coupled with such policies, one needs to seriously focus on abatement technology. Continuous upgrading of technology through diffusion and interlinkage across the value chain can have a profound, albeit invisible, impact on emission standards.

Kar and Majumdar (2016) show that for a group of low-middle-income countries and sorted on the basis of manufacturing to trade ratios, of which India is a prominent member, a rise in MFN (most favored nation) tariff rates reduces CO_2 emissions, and that effect is further reinforced if FDI flows to non-polluting sectors such as agriculture. A rise in MFN tariff rates takes care of the trade diversion problem. The paper rigorously demonstrates that further protection may actually help lower emission standards. For agriculture, substitution of imports by FDI has a better effect on emissions.

Majumdar and Kar (2017) study the emission intensity of fifteen organized manufacturing and agricultural sectors in India and find the relationship between technology adoption and emission intensity at the industry level over 1996–2009. They show that when better technologies are adopted for the production of export goods as opposed to non-traded goods, emissions fall in a significant way. Typically, international trade and FDI facilitate the adoption of technology. The direct effect of globalization might therefore have helped in this regard.

3. PROBLEM OF CLIMATE CHANGE AT THE GLOBAL LEVEL: ENDURING AND CONTEMPORARY POLICY ISSUES

Climate change is a complex problem which, though environmental in nature, has consequences for all spheres of existence on our planet. It either impacts, or is impacted by, global issues, including poverty, economic development, population growth, sustainable development, and resource management. Climate change is a global challenge and requires a global solution. Greenhouse gas emissions have the same impact on the atmosphere whether they originate in Washington, London, or Beijing. Consequently, action by one country to reduce emissions will do little to reduce global warming unless other countries act as well. Ultimately, an effective strategy will require commitment and action from all the major emitting countries. Climate change poses the serious challenge of carbon dioxide emission reduction. Emission control by developing countries is becoming key for the effective mitigation of climate change, as those countries now account for more than a half of global emissions and are still expanding their energy infrastructure.

At the very heart of the response to climate change, however, lies the need to reduce emissions. In 2010, governments agreed that emissions need to be reduced so that global temperature increases are limited to below two degrees Celsius.

In 1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change (UNFCCC), to consider what they could do to limit global temperature increases and the resulting climate change, and to cope with its impacts. By 1995, countries realized that emission reduction provisions in the Convention were inadequate. As a result, they launched negotiations to strengthen the global response to climate change and, in 1997, adopted the Kyoto Protocol.

In short, the Kyoto Protocol is what "operationalizes" the Convention. It commits industrialized countries to stabilizing greenhouse gas emissions based on the principles of the Convention. The Convention itself only encourages countries to do so. The Protocol sets binding emission reduction targets for 37 industrialized countries and the European community in its first commitment period. Overall, these targets add up to an average 5% emissions reduction compared to 1990 levels over the five-year period 2008 to 2012 (the first commitment period). The Protocol is structured on the principles of the Convention. It only binds developed countries because it recognizes that they are largely responsible for the current high levels of GHG emissions in the atmosphere, which are the result of more than 150 years of industrial activity. The Kyoto Protocol places a heavier burden on developed nations under its central principle, that of common but differentiated responsibility. The Kyoto Protocol legally binds developed countries to emission reduction targets. The Protocol's first commitment period started in 2008 and ended in 2012. The second commitment period began on 1 January 2013 and will end in 2020.

3.1 Selective Global Research on Climate Change

A change in climatic conditions has a diversified impact on an economy. A good climate helps a country to grow by way of good production and thereby helps in eradicating inequality and poverty. To begin with, we consider the paper by Blicharska et al. (2017), which gathers scientists from around the world and deals with researches on climate change across the globe in recent years. The authors look carefully at the global North-South divide in research on climate change and its negative consequences. They postulate that the northern domination of science in relation to climate change policy and practice, and the limited research led by southern researchers in southern countries may hinder the further development and implementation of global climate change agreements and nationally appropriate actions. The authors illustrate the extent of the divide, review underlying issues, and analyze the consequences for climate change policy development and implementation. The paper proposes a set of practical steps that a wide range of actors in both northern and southern countries should take at global, regional, and national levels to span the North-South divide.

A recent article by Burke, Hsiang, and Miguel (2015) presented an analysis of the relationship between historic temperature fluctuations and macroeconomic growth. Their findings can be summarized as follows. First, in contrast to past studies, they argue that twenty-first century warming could lead to huge global-scale macroeconomic impacts. The best estimate from Burke and colleagues is that business-as-usual emissions throughout the 21st century will decrease per capita GDP by 23% below what it would otherwise be, with the possibility of a much larger impact. Second, they conclude that both the size and the direction of the temperature effect depend on the starting temperature: countries with an average yearly temperature greater than 13°C (55°F) will see decreased economic growth as temperatures rise. For cooler countries, warming will be an economic boon. This non-linear response creates a massive redistribution of future growth, away from hot regions and toward cool regions. Based on

the analysis, rich and poor countries respond similarly at any temperature, but the impact of warming is nonetheless much greater on poor countries because they are mostly in regions that are already warm.

Hsiang et al. (2017) developed a flexible architecture for computing damage that integrates climate science, econometric analyses, and process models. The authors used this approach to construct spatially explicit, probabilistic, and empirically derived estimates of economic damage in the United States from climate change. The combined value of market and non-market damage across analyzed sectors—agriculture, crime, coastal storms, energy, human mortality, and labor—increases quadratically with global mean temperature, costing on average roughly 1.2% of gross domestic product per +1°C. Importantly, risk is distributed unequally across locations, generating a large transfer of value northward and westward that increases economic inequality. By the late 21st century, the poorest third of countries is projected to experience damage of between 2% and 20% of income (90% chance) under business-as-usual emissions.

Alagidede, Adu, and Frimpong(2016) contribute to the empirics of climate change and its effect on sustainable economic growth in sub-Saharan Africa. Using data on two climate variables, temperature and precipitation, and employing panel cointegration techniques, the authors estimate the short- and long-run effects of climate change on growth. The paper finds that an increase in temperature significantly reduces economic performance in sub-Saharan Africa. Furthermore, it is shown that the relationship between real gross domestic product per capita on the one hand and climate factors on the other is intrinsically non-linear.

Dell, Jones, and Olken (2008) examine the impact of climatic change on economic activity throughout the world. The authors find three primary results. First, higher temperatures substantially reduce economic growth in poor countries but have little effect in rich countries. Second, higher temperatures appear to reduce growth rates in poor countries rather than just the level of output. Third, higher temperatures have wide-ranging effects in poor nations, reducing agricultural output, industrial output, and aggregate investment, and increasing political instability. Analysis of decade-long or longer climate shifts also shows substantial negative effects on growth in poor countries.

Costinot, Donaldson, and Smith (2016) seek to quantify the macro-level consequences of some micro-level shocks. Using an extremely rich micro-level dataset that contains information about the productivity—both before and after climate change—of 10 crops for 1.7 million fields covering the surface of the earth, the authors find that the impact of climate change on these agricultural markets amounts to a 0.26% reduction in global GDP when trade and production patterns are allowed to adjust. Since the value of output in our ten crops is equal to 1.8% of world GDP, this corresponds to about one-sixth of the total crop value.

Zhang, Zhang, and Chen(2017) explore the importance of some additional climatic variables other than temperature and precipitation. Using county-level agricultural data from 1980 to 2010 in the PRC, we find that those additional climatic variables, especially humidity and wind speed, are critical for crop growth. Therefore, omitting those variables is likely to bias the predicted impacts of climate change on crop yields. In particular, omitting humidity tends to over predict the cost of climate change on crop yields, while ignoring wind speed is likely to underpredict the effect. The paper finds that climate change is likely to decrease the yields of rice, wheat, and corn in the PRC by 36.25%, 18.26%, and 45.10% respectively by the end of this century.

Zewdie (2014) reviews literature on the impacts of climate change and food security specifically in sub-Saharan Africa to characterize and synthesize our current understanding of the problem and identify priorities for future research.

In sub-Saharan African countries, fast GDP growth has created a great opportunity to improve developmental indicators, including food security, but has shown only limited improvements. There is scientific consensus on climate change and it is expected to have substantial impact on food security. Therefore, new advocacy and a public health movement are recommended to reduce the effect of climate change on food security and malnutrition. Zewdie seeks to assess the impacts of climate change on food security in sub-Saharan Africa.

Documents related to the impacts of climate change on food security are reviewed. Literature indicates that climate components like temperature, precipitation, CO_2 concentration, and extreme climate events have an effect on food security components. Sub-Saharan Africa is one of the most severely affected regions in terms of climate change, where most of the population is dependent on climate-sensitive economic activities. The most direct effect and well-researched component of climate change in relation to food security is food availability by reducing net crop production. It is also found that climate change has an impact on food accessibility and utilization, but this is not well studied due to its complexity. Projections indicate that this problem will be more severe in the future than it is currently unless climate change mitigation and adaptation strategies are undertaken.

The review concludes that climatic conditions are changing in sub-Sahara African countries and this is affecting food availability, food accessibility, and utilization. The problem will be severe in the future unless the current adaptation and mitigation efforts do not improve. Therefore, to reduce the problem, the region should use its potential to counter climate change.

The United Nations System Standing Committee on Nutrition (UNSCN) (2010) highlights how climate change further exacerbates the already unacceptably high levels of hunger and under-nutrition, and proposes policy directions to address the nutrition impact of climate change for consideration by the 16th Conference of the Parties (COP) to the UNFCCC. The current negotiation process offers opportunities to identify and address some of the actions needed. However, great efforts will be required beyond COP16, and nutrition should be part of future negotiations. One could also refer to publication of World Health Organization (2008) who identified major health consequences of climate change and devised research agenda to obtain strategies to cope these challenges.

3.2 Indian Literature on Climate Change

Panda (2009) discusses the consensus on the definition of vulnerability to climate change and the regionally-nuanced mapping of the variable impact of climate change. The author opines that despite considerable advances in the methodologies for assessing vulnerability to climate change, ambiguities and uncertainties nevertheless remain. According to the author, vulnerability research is facing challenges in three areas. First, climate change is not the only stress that society faces: multiple stressors operate in all the human environment systems. It is therefore a challenging task for researchers to identify and evaluate those stressors most relevant for assessing climate change vulnerability. Second, vulnerability assessment requires characterization of the future in terms of socioeconomic and biophysical variables; however, uncertainties about the future make vulnerability assessment that much more difficult and challenging. Third, the apparent lack of consistency in the use and meaning of the variety of concepts employed in vulnerability research contributes to

increasing confusion in this area. The author feels that the research in India on vulnerability to climate change is still underdeveloped. Further research is urgently required in several areas. This research has to be based on an understanding of the regional and micro-level aspects of climate change to properly address the vulnerability of people with more accuracy.

In a commentary, Kumar (2007) has discussed the existing literature on the effect of climate change on Indian agriculture, covering three strands of assessment: impact, vulnerability, and adaptation. The author finds that the economic impact of climate change on agriculture has been studied extensively the world over and it remains a hotly debated research problem. Papers based on the two approaches to assessing the economic impact—namely, the agronomic- economic and the Ricardian approach—are discussed by the author. Using these approaches, it is observed that the GDP for the Indian economy is expected to decline due to climate change in the latter half of the twenty-first century.

Kapur, Khosla, and Mehta (2009) summarize extracts from the papers presented at a conference on climate change held in New Delhi in March 2009 focused on the different bargains India might have to strike, both domestically and internationally. The conference was meant to address the options that India will have to exercise to maintain its growth and emerge as a global superpower. The authors summarize the papers presented at the conference and conclude that climate change poses particularly difficult challenges for India. On the one hand, India does not want any constraints on its development prospects; on the other, it wants to be seen as an emerging global power. While the former may be best served by its current position, the latter will require it to take a leadership role on key global issues, climate change being a critical one. It can either approach climate change as a stand-alone global negotiation, or weave these negotiations into a "grand bargain" involving linkages with other international negotiations that also involve key Indian interests, whether reforms of the Security Council, World Trade Organization negotiations, the financial architecture, etc.

Hanif et al. (2010) tried quantifying the impacts of changes in normal climate parameters for the variable and sustainable development of the agricultural sector at both regional and country level. The study confirms the premise that climate change impinges considerably upon agricultural production and the price of agricultural land.

The authors find that all the climate variables except maximum temperature have a highly significant relationship with land prices. Climate change is imposing a cost at the same that it brings the benefit of an increase in land prices in Rabi season due to the increase in maximum temperature. Benefits show farmers' adaptation in the changing climate, which leads to an increase in long-run net revenues.

The increase in precipitation in Kharif season tends to increase land value. The increase in precipitation in Rabi season results in a loss due to the decreased production. The increase in mean minimum Rabi temperature, being negatively significant, imposes a cost on the agricultural sector with increase an in temperature in this season.

The authors conclude that the aggregate global effects on agricultural productivity are expected to be negative by late this century, and developing countries are expected to suffer sooner and worse.

Kumar, Shyamsundar, and Nambi (2010) provide a summary of the discussions held during a 2010 workshop on the economics of climate change adaptation and draw some conclusions for future policy analyses. Given the possibility of moderate or catastrophic climate change in developing countries and the failure of the climate summit in Copenhagen in December 2009 to achieve any consensus on greenhouse gas mitigation plans, adaptation as a policy option requires careful attention. This is a report on the said workshop that examined India's need to adapt to climate change.

The article by Sharma (2012) reviewed literature on the impacts on human health of climate change and land use transition in the Hindu Kush Himalayan (HKH) region, specifically dealing with topics such as the relationship between climate change and health; health sensitivity, vulnerability, and adaptation; health determinants related to climate change; temperature extremes and health issues; air pollution, black carbon, and health; food security, nutrition, and health; land use change and infectious diseases; and population migration and livelihood transition. The article outlines an agenda for future research on climate change and human health for the HKH region. The author suggests three main agendas: first, developing methods to quantify the current impacts of climate and weather on a range of health outcomes for people living both in the mountains and downstream; second, improving health impact models for projecting the health impacts of climate and land use change under different ecological and socioeconomic conditions; and third, evaluating the costs of the projected health impacts of climate change and the effectiveness of adaptation for policy inputs.

The Joint Global Change Research Institute and Battelle Memorial Institute, Pacific Northwest Division (2009) identifies and summarizes the latest peer-reviewed research related to the impact of climate change on India, drawing on both the literature summarized in the latest Intergovernmental Panel on Climate Change (IPCC) assessment reports and on other peer-reviewed research literature and relevant reporting. It includes such impacts as sea-level rise, water availability, agricultural shifts, ecological disruptions and species extinctions, infrastructure at risk from extreme weather events (severity and frequency), and disease patterns. This paper addresses the extent to which regions within India are vulnerable to climate change impact.

Menon et al. (2016) studied fishermen’s perceptions of climate change from two coastal districts of Andhra Pradesh during 2011. Fishermen were interviewed to ascertain their perception of climate change over the last 20 years, the impact of the change in climatic parameters on their lives and on marine fisheries, and the adaptation measures required. All fishermen contacted believed that the climate had changed in the last two decades. Wind was ranked as the parameter that had changed the most in the last two decades, while sea status was ranked as the most problematic to fishermen. Avenues for a safe exit from villages and coastal protection structures in case of natural calamities were the highest scoring adaptation measures. Wind was considered the most critical parameter affecting marine fishery and overfishing was identified as the biggest problem facing fisheries.

Ruchita and Rohit (2017) estimate the impact of climate change on food grain yields in India, namely rice and millet. The authors estimate a crop-specific agricultural production function with exogenous climate variables, namely precipitation and temperature, and control for key inputs such as irrigation, fertilizer, and labor. The analysis is at the district level using a panel dataset for physical yield (output per hectare gross cropped area) for the period 1966–1999. The paper finds significant impacts of climate change (temperature and precipitation) on Indian agriculture. For rice, the evidence is overwhelmingly that both rainfall and temperature matter, but so do other inputs—labor, fertilizer, and irrigation. For millet, rainfall is the sole determinant.

Kumar, Jawale, and Tandon (2008) look at the impacts of climate change on the financial capital of India, Mumbai. These include the impact of temperature rise on rains and floods, and their consequent effects on health. Other consequences, such as a rise in deaths from vector-borne diseases, dislocation due to floods, and sea-level rise, are shown as projected economic losses for the years 2025 and 2050. The economic costs of sea-level rise in terms of loss of property along the coastline are also projected for a 25- and 50-year timescale. The costs arising due to increases in malaria, diarrhea, and leptospirosis outbreaks are projected up to 2050. The conservative estimate of the total cost of all these impacts, including the impact of climate change on tourism, is found to be enormous.

Sinha and Swaminathan (1991) and Kalra et al. (2008) argue that crop production in India is dependent on temperature. Temperature vs. crop production shows a funnel shape for all seasons. For the lower temperature, the properties are almost linearly correlated. In Rabi, production initially shows a negative trend with temperature which slowly converts to a positive trend. In Kharif, that negative trend is not visible. At higher temperatures, production increases for both the seasons but with large variations. These findings may be helpful for studying the effect of climate change on crop production.

4. GOVERNMENT OF INDIA POLICIES

4.1 Indian Initiatives for Climate Protection

Various programs have been adopted across the globe to protect the environment. One such program is the Global Environment Facility (GEF), established as a pilot program for environmental protection. The current project cycle is GEF-6, covering the years 2014–2018. In 1992 at Rio de Janeiro it was decided that the GEF would be adopted as a financial mechanism to help developing countries meet their financing needs to achieve their climate change goals. As of November 2015, the GEF has directly invested a total of $14.5 billion in 3,946 projects in 167 countries, of which $4.2 billion is in 1,010 projects for climate change mitigation. To date, India has received $516.6 million of GEF grant, of which $324.69 million is for climate change mitigation projects while $10 million is for climate change adaptation projects.

In addition, the Clean Development Mechanism (CDM) was adopted as a mitigation instrument under the Kyoto Protocol. At present, the CDM is facing its most severe crisis, having witnessed a steady decline in the number of projects being registered since 2013 owing to the crash in the price of certified emissions reduction (CER) after 2012. As of January 2016, 1,593 of a total of 7,685 projects registered by the CDM executive board are from India, the second highest in the world, the PRC taking the lead with 3,764 registered projects. Indian projects have been issued with 191 million CERs, 13.27% of the total number of CERs issued. These projects are in energy efficiency, fuel switching, industrial processes, and the municipal solid waste, renewable energy, and forestry sectors, and are spread across the country. Around 90%–95% of the CDM projects are being developed by the private sector, facilitating investments of about 583,751 crores ($ 87.77 billion) in the country, which is more than the total of multilateral grants available for climate change-related activities.

Apart from these international measures, the Government of India has also taken some initiatives domestically. The National Action Plan on Climate Change (NAPCC) is known to be the major component of India’s domestic action against climate change. The NAPCC has proposed a waste-to-energy mission which will incentivize efforts toward

harnessing energy from waste and is aimed at lowering India's dependence on coal, oil, and gas for power production. The National Mission on Coastal Areas (NMCA) will prepare an integrated coastal resource management plan and map vulnerabilities along the entire (nearly 7,000 km long) shoreline.

The State Action Plan on Climate Change (SAPCC) has also been introduced to create institutional capacity and implement sectoral activities to address climate change. These plans are focused on adaptation with mitigation as a co-benefit in sectors such as water, agriculture, tourism, forestry, transport, habitat, and energy.

A National Adaptation Fund for Climate Change (NAFCC) has been established with a budget provision of 1,350 crore for the year 2015–2016 and 2016–2017. It is meant to assist in meeting the cost of national and state level adaptation measures in areas that are particularly vulnerable to the adverse effects of climate change.

To reduce the consumption of coal, India has introduced carbon tax in the form of a cess on coal. The National Clean Energy Fund (NCEF) is supported by the cess on coal. The NCEF was created for the purposes of financing and promoting clean energy initiatives, funding research in the area of clean energy and any other related activities.

The Perform, Achieve, and Trade (PAT) scheme under the National Mission on Enhanced Energy Efficiency was introduced by the Indian government as an instrument for reducing specific energy consumption in energy-intensive industries with a market-based mechanism that allows trading of the energy saving certificate. The first PAT cycle, which ended on 31 March 2015, included 478 industrial units in eight sectors.

India has also started progressing on the renewable energy front. Renewable energy has become a major focus area of the government, with the ambitious target of achieving 40% cumulative electricity capacity from non-fossil fuel-based energy resources by 2030. India is currently undertaking the largest renewable energy capacity expansion program in the world.

The Prime Minister of India launched the ISA at COP 21 in Paris on 30 November 2015. The ISA will provide a special platform for mutual cooperation among 121 solar resource-rich countries lying fully or partially between the Tropic of Cancer and Tropic of Capricorn. The Secretariat of the ISA will be hosted by India.

Another major renewable energy policy initiative is the National Offshore Wind Energy Policy 2015 to help offshore wind energy development, including the setting up of offshore wind power projects and research and development activities in waters in or adjacent to the country up to the seaward distance of 200 nautical miles' exclusive economic zone (EEZ) of the country from the base line. (Mainly drawn from Economic Survey 2017).

5. CONCLUDING REMARKS

This chapter attempts to provide an analytical description of how forces of globalization—primarily trade and FDI—have impacted the environment in India. Unfortunately, as stated earlier, specific literature on the topic does not contain a significant number of worthwhile research initiatives from an analytical and holistic perspective. We have tried to impress upon the readers that the direct impact of trade and FDI on environmental conditions is less of an issue compared to its indirect effect through its positive impact on GDP growth and resultant prosperity. We also emphasize that enforcing regulations is presently a hugely complex task given

corruption, informal markets, and the inability of citizens to cooperate and form effective lobbies. We have tried to give simple, readable theoretical inputs and examples. We have provided original time series estimates of the impact of trade and FDI on the environment over the last three and a half decades. We have then elaborated briefly on global climate change research and its Indian counterpart to provide a perspective for our work, followed by a brief summary of recent policy initiatives from the Indian government.

We believe that more specific research is needed to assess the environmental impact of patterns of production and consumption. Recent scientific analysis focuses on better scientific measuring of the damage and focuses on the impact of climate change on inequality (Hsiang et al. 2017; Pizer 2017). Clearly, warmer regions in the globe, including India and many developing and Asian countries, are affected more than their northern counterparts by global warming. In fact, recent US estimates show that climate change has increased inequality between the north and the south of the US; the pattern of production specialization is generally induced by the conditions of global trade and investment, and by the physical infrastructural support. India and the PRC, the two largest countries in Asia, have very different GDP composition. This poses the question of whether excessive industrialization, coupled with the usual transboundary and climate concerns, makes the PRC more vulnerable than India, which thrives excessively on service sector growth and, in turn, gets the benefit of low pollution growth. This also calls for serious exploration of green accounting and preparation of a database with better environmental indicators, as extensively discussed in Sengupta (2013).

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