Environmental Economics, Law and Policy: Brazil vis-a-vis India (Part I: Theoretical Modelling)

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Sustainable Development: Comparative Analytics of Law and Economics: Brazil *vis-a-vis* India

(A Discourse)

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PAPER SUMMARY

On 17 July 2014 the Indian Prime Minister and South African President jointly announced about the upcoming summit of IBSA (India, Brazil and South Africa). The third member Brazil did not get any attention here. The task of the Indian academic fraternity here is to bring to the notice of the policy makers the issues and the connections between India and Brazil in light of welfare economics.

Almost 70 per cent of India's surface water resources and a growing percentage of its groundwater reserves are contaminated in absence of strong water pollution regulation thanks to the Supreme Court for active implementation and enforcement of air pollution regulation. In Brazil deforestation, acid rain, endangered species, air pollution and waste disposal are the issues of concern. Against this backdrop this study analyzed from the view point of welfare economics the impact of the environmental issues of deforestation in Brazil and water pollution in India on the national productive activities. The changes in the welfares of polluters and pollutees under alternative legal regimes with respect to taxes and subsidies are analyzed here.

This study sheds light on the fusion of legal and economic elements with regard to deforestation in Brazil and water pollution in India. The utility maximization framework is applied here (i) to both of polluter and pollutee in the context water pollution and to both of beneficiaries and antagonists of deforestation. In terms of findings, this study explored, among others, (i) the factor, that may motivate the victim of water pollution not to spend a single paise on filtration for setting up an effluent treatment plant under the generous legal regime which likes to pay subsidy equal to damage and (ii) the nature of preference of the victim of pollution for tax *vis-à-vis* compensation.

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ABSTRACT

Amidst the perils of industrialization in the forms of environmental impacts of mining and use of energy and destruction of urban biodiversity, it became imperative for the Latin American countries to design environmental policies in accordance with the respective historicity, demography, and polity of each nation. But in resolving a tussle between eco-environmental maintenance and vigorous industrialization while trying to find a choice between eco-friendly environment or prosperous economic growth, the Indian judiciary accepted that neither the eco-environment alone nor the industrial and economic growth by itself will meet the human needs in the global competition. It is necessary for the policy makers in framing any environmental policy or for legislators in enacting any environmental law to have an appropriate frame of environmental impact assessment. In this context, this study sheds light on the fusion of legal and economic elements with regard to deforestation in Brazil and water pollution in India.

Keywords: Externality, Pigovian Tax, Subsidy, Deforestation, Water Pollution, Social Cost

INTRODUCTION

The role of taxation as an instrument in fiscal policy to influence aggregate demand and consequently economic growth is in the extant economic literature. There are several works on the relationship between economic growth and taxation. Environmental taxes have bearings upon the productive activities which have environmental implications; for example, illegal logging and deforestation in Brazil and water pollution in India. Tax administration also has legal implications. Successful tax administration calls for *inter alia* a speedy process of delivering justice in course of the legal system. In view of the fact that scant literature is available with respect to impact of environmental tax on economic growth, particularly in the context of deforestation and pollution, this study investigates the implications imposing taxes on these activities from the view point of welfare economics and environmental law.

BACKGROUND

On 17 July 2014 the Indian Prime Minister and South African President jointly announced about the upcoming summit of IBSA (India, Brazil and South Africa). The news reported by the Times of India reflects the needs and connections of these two countries. Here the task of the Indian academic fraternity is to bring to the notice of the policy makers the needs or issues and the connections therein in light of welfare economics.

FORESTRY PROBLEMS

Markku Simula adequately described the sectoral contribution of forestry which can be measured in terms of such traditional indicators as Gross Domestic Product (GDP) share, balance-of payments impacts or export revenue, industrial output, employment, or income generation. He highlighted that the current accounting systems, particularly in developing countries, tend to dismiss a significant part of sectoral contribution to GNP (Gross National Product) and related indicators, while changes in physical

stocks are also excluded such that the developmental role of forestry in policy decisions on resource allocation is undermined.

As per the World Bank, forests are one of the most mismanaged resources in many countries partly because forests are seriously undervalued and many of their environmental benefits are not captured by market values; however, forests have a critical role to play in green growth. Forests can help meet the growing demands for food, fiber, biofuel, shelter, and other bio-products as the world population increases to nine billion people by 2050.

Production of tropical industrial roundwood ("logs") in ITTO (International Tropical Timber Organization) producer member countries increased in 2011 to 173.6 million cubic meters (m3), recovering from a continuing decline since the onset of the global economic crisis. Four countries, namely Indonesia, Brazil, India, and Malaysia accounted for two-thirds of total production in 2011 with the bulk (59 percent) of production in the Asia-Pacific region. Production in 2012 is estimated to have dropped to 172.5 million, with most of the decline attributed to a 10 percent decline in Malaysia's production. Tropical log production has become increasingly supply constrained in many producer countries, reflecting tightness in tropical log availability due to past over-exploitation of natural forests, tangible progress towards sustainable forest management in many producer countries, and gaps in achieving plantation targets to alleviate pressure on natural forests.

EU-27 imports of tropical plywood increased nine percent in 2010 to 980,000 m3, but this recovery was short-lived as imports slowed in 2011 and plunged in 2012 to 626,000 m3, the lowest level in ITTO's statistical records. European Union (EU) imports were mostly accounted for by the United Kingdom (UK), the Netherlands, Belgium, Germany, and France, with most imports originating from Malaysia, China, and Indonesia and Brazil. In 2013, imports from tropical supplying countries are expected to be impacted by a build-up of European hardwood plywood stocks prior to the coming into effect of the EUTR (EU Timber Regulation); the contraction of European consumption; supply constraints in tropical countries; and continuing delays in the implementation of VPAs (Voluntary Partnership Agreements) between the EU and some supplying countries.[i]

Brazil's tropical roundwood production is mainly concentrated in the northern states of Pará, Amazonas and Mato Grosso, while the plantation estates are located in the non-tropical south and southeast regions of the country. Production remained relatively stable at around 30.8 million m3 in 2011 and 2012. Although the vastness of the resource and the spread of colonization have made it difficult to control illegal activities in the forests, ITTO (2011) reports that significant advances have been made towards sustainable management in the Brazilian Amazon. For example, the area of certified natural forests has doubled since 2005 and despite continuing deforestation, clearance rates have declined dramatically in the last five years. However, illegal harvesting and unsustainable forest management practices have persisted in the Amazon region for several reasons including: poor infrastructure; the remoteness of many forests from centres of commerce and control; the weak competitiveness of SFM (sustainable forest management) as a land use; declining wood-processing capacity in the Amazon; and a lack of awareness about SFM and its potential benefits among timber operators. A preliminary assessment suggests that deforestation has again accelerated in the Amazon, increasing 26.5 percent in 2012 compared with 2011, with 78 percent of deforestation occurring in the state of Mato Grosso[ii]. The government of the state of Pará, which is predominantly covered by natural forests, launched a state plantation programme recently to stimulate the establishment of more wood-based industries[iii]. Similar to Indonesia, Brazil's log production estimates are likely to be considerably higher if unofficial/illegal harvests are taken into account.

The world's biggest rainforest is in Brazil (BBC, 2012). In Brazil the forest law of 1965 regulates the harvesting of timber resources. As per GEF (2011) Brazil's forests constituting 13% of global forest area and almost 30% of the tropical forest area may be a sustainable source of timber and non timber forest products and provide scope for services that are increasingly valued by society, such as tourism, recreation and conservation of water and soil. As per Bauch *et al*. (2009) the national forests in Brazil are created with time production as one of the key objectives and there are legislations towards providing incentives to private landowners for timer production.

Brazil's national forest policy dating back to the early 20th century from colonization to protectionism, during which extrasectoral policies largely served to marginalize

forest policy is followed in Banerjee, Macpherson and Alabalapati (2009). The original vegetation in the Atlantic rainforest was partially destroyed due to degradation processes caused by the removal of timber for building, firewood and charcoal, and expansion of coffee plantations and other crops (Barros and Melo, 2011).

GLOBAL LEGISLATIONS DESIGNED TO REMOVE ILLEGAL WOOD FROM TRADE

On 22 May 2008, the US Lacey Act was amended with the intent of extending its application to include illegally harvested timber. The amendment makes it illegal to import, export, transport, sell, receive, acquire, or purchase in interstate or foreign commerce, any plants or products made from plants with limited exceptions that were harvested or taken in violation of a domestic or foreign law. The Act gives the government the power to fine and jail individuals and companies that import timber products harvested, transported or sold in violation of the laws of the country in which the timber was originally harvested. The high profile and controversial raids by US Federal agents on the Gibson Guitar factory in Nashville Tennessee, for allegedly importing wood materials that violate the Lacey Act, has already instilled some caution for US importers of tropical wood products.[iv]

EUTR became operational on 3 March 2013. This legislation has been introduced to prohibit the sale within the EU market of illegally harvested timber or timber products derived from such timber. The Regulation puts a traceability obligation on traders throughout the supply chain to identify the operators or the traders who have supplied the timber and timber products; and where applicable, the traders to whom they have supplied timber and timber products; and requires companies to implement a "due diligence" system to minimise the risk that timber they sell was harvested illegally[v].

The FLEGT (Forest Law Enforcement Governance and Trade) Voluntary Partnership Agreement licensed timber and timber products covered by CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) certificates are effectively given a free pass under the legislation and are not required to be subject to any further scrutiny or risk mitigation by traders. MIS (Market Information

Service) reports that the EUTR has already been driving changes in the EU timber trade, with a trend towards consolidation of the trade around the larger companies that have the resources and networks required for effective due diligence of supply chains. There are indications that importers are already shifting from high to low risk sources, favoring timber from verified legal and sustainable sources. European importers, for example, are being more selective in plywood products imported from China[vi].

Australia introduced legislation in 2012 for promoting the trade in legally harvested timber. This was done by restricting imports of illegally logged timber into Australia. The Australian Timber Act[vii], places requirements on Australian businesses. Within two years of the Bill becoming law it is estimated that the regulations will outline the due diligence process for importers and processors of domestic timber for certain timber products.

The Convention on International Trade in Endangered Species (CITES) CoP (Conference of the Parties) 16 in March 2013 featured numerous agenda items relevant to tropical tree species, including reports on the Mahogany working group; work on Cedrela and Dalbergia species; treatment of plantations of agarwood producing species; Madagascar's precious wood species; and proposals for listing over 200 species of tropical trees in Appendix II of CITES. Appendix-II species are those that may become endangered if their trade is not regulated, requiring controls aimed at preventing unsustainable use, maintaining ecosystems and preventing species from entering Appendix I (which bans all trade). The meeting voted to include a number of tropical hardwood species in Appendix II of the Convention, including Malagasy ebony (*Diospyros spp*.), Thailand rosewood (*Dalbergia cochinchinensis*), Black rosewood *(Dalbergia retusa*), Granadillo rosewood (*Dalbergia granadillo*), Honduras rosewood (*Dalbergia stevensonii*), and Malagasy rosewood (*Dalbergia spp*.). [viii]

Interest in procurement of wood-based products from sustainable sources is growing. Concerned consumers, retailers, investors, communities, governments, and other groups increasingly want assurances that by buying and consuming these products they are making positive social and environmental contributions. A number of national governments worldwide have introduced some form of procurement policy

for timber, including Brazil, Japan, Mexico, China, New Zealand and several EU member states[ix].

In a review of Brazil's Environmental Policies and Challenges Ahead Minister Izabella Teixeira at the Wilson Center noted the strides that Brazil made toward protecting its environment including having set aside the equivalent of 70 percent of all protected areas in the world in 2009 and the establishment of the Amazon Fund (Hodges, 2010). Amazon Fund was established to preserve millions of acres of the Amazon in a strategic alliance with Amazonia Association, which has a 15 year old established eco-preserve of 450,000 acres (AF, 2013). Brazilian President Luiz Inácio Lula da Silva signed a decree establishing the Action Plan for Prevention and Control of Deforestation and Wildfires in Cerrado on Wednesday in September 2010 (SECOM, 2010). For conservation of the Amazon rainforest the Government of Brazil has taken the key measures including land regularization such as the Legal Land Program (i.e. Programa Terra Legal), the creation of new protected areas, increased efforts against illegal deforestation, and agreements to prevent the marketing of soy, timber, and beef produced in illegal areas (SECOM, 2013). There are legal measures against illegal deforestation and sale of timber and agreements between the Federal Government and the private sector regarding, *inter alia*, refraining from buying illegal timbers.

Barbier (2001) quoted ITTO's statement that sustainable forest management is essential for uninterrupted flow of, inter alia, timbers. In this context it is pertinent to mention the environmental issues in Brazil and India. In Brazil deforestation, acid rain, endangered species, air pollution and waste disposal are the issues of concern (www.brazil.org.za, 2011). From the perspective of sustainable development the issues highlighted by FBDS (2013) are combining environmental benefits with business opportunities in the carbon market, promoting the use of cleaner and more efficient energies, promoting productive activities Interconnected with the socio-environmental context as a part of land management, designing appropriate water resource management keeping in mind the role of water as a restraining factor in sustainable development, conservation of life for future generations in order to maintain biodiversity and raising awareness for corporate sustainability. Among all these, the dominant policy approach linking tropical forests to climate change seems

to be REDD (Reducing Emissions from Deforestation and forest Degradation), one which is related to selling carbon credits as a proof of lowering deforestation (EDF, 2013). Cattle problem and paper pulp problem are the other environmental issues highlighted by WWF (2013). As per the same source the problems in India are little different – deforestation, thirst for palm oil and pollution.

Along with the issue of deforestation in Brazil, in light of welfare economics, this study likes to analyze the issue of water pollution in India. A major coverage on water pollution in India is provided by Murty and Kumar (2011) in a situation where almost 70 per cent of its surface water resources and a growing percentage of its groundwater reserves are contaminated by biological, toxic, organic, and inorganic pollutants. Performance audit of water pollution is conducted in order to examine whether (i) quality of water in rivers, lakes and groundwater had been adequately assessed, (ii) risks to environment and health as a result of river, lake and ground water pollution had been recognized and evaluated, (iii) policies, legislations or programmes had been formulated to address water pollution and were effective institutions put into place for pollution prevention, treatment and restoration of polluted water in rivers, lakes and ground water, (iv) current programmes to address river, lake and ground water pollution had been planned, implemented and monitored effectively, (v) measures to address water pollution were sustainable in the long run and (vi) measures to address water pollution have had the desired impact in terms of improvement in water quality (GOI, 2012a). The latest version of the National Water Policy first approved in 2002 was released in 2012 (GOI, 2012b).

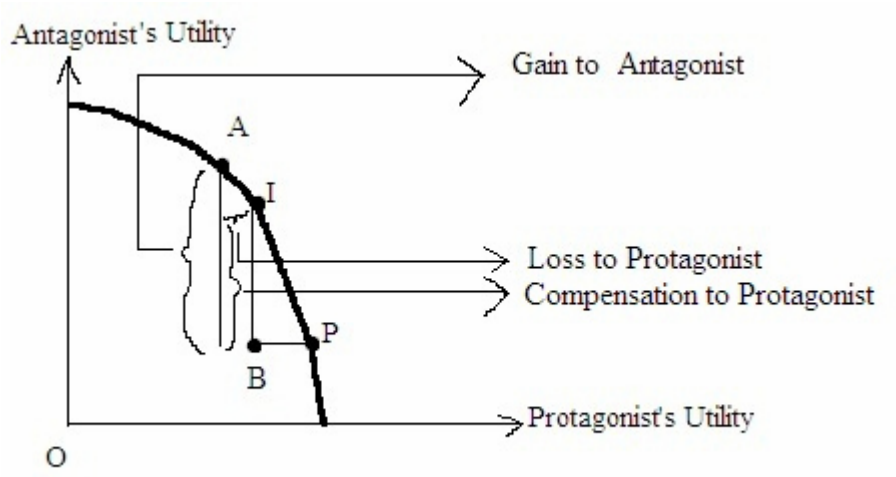
ECONOMIC ANALYSIS OF DEFORESTATION IN BRAZIL

Referring to the problem of non-achievement of Pareto optimality in page 36 of Kolstad (2000), it may be discerned that not all individuals vote against deforestation in Brazil and pollution in India. The utility function of an individual is $U = U(x, e)$. Where x = composite material good, e = composite environmental good. If there are two consumptions bundles - (x', e') and (x'', e''). While 'x' varies in quantity, let 'e' vary in quality. Let e' denote environmental good with deforestation and e'' denote environmental good without deforestation in Brazil.

The lists of environmental goods are available at Eurostat portal of European Commission. For Brazil they are available in online library of OECD. Depending on the nature of production, the goods pertaining to the category titled 'Agriculture, Forestry, Fishery, Mining and Quarrying' in Economic Survey (Ministry of Finance, 2014, pp. 5-7) may be termed 'environmental good without deforestation', the measure of which is '*x*'. Similarly goods pertaining to the category titled 'Manufacturing, Construction, Gas, Electricity and Water Supply' may be termed 'environmental good with deforestation', the measure of which is '*e*'. The prices are available in World timber Price Quarterly.

For India, the word 'deforestation' may be replaced by 'pollution'. All individuals do not prefer *(x'', e'')* over *(x', e')* as long as market exists for illegal timbers in Brazil and polluting commodities in India. On the aforesaid page Kolstad proposed transfer of resources from those who are against, i.e. the antagonists of deforestation to the beneficiaries, who may be called here as the protagonists of deforestation. In Brazil and many other emerging economies including India, illegal logging in many ways is responsible for deforestation and act as a deterrent factor to timber investment. In line with Kolstad, if there is transfer of resources from those in legal business of forest-products including timber etc to the marginalized forest-dependent communities, there may be unanimous voting for the bundle *(x'', e'')*. The transfer of resources may take place in the form of compensation. If the gains to the antagonists of deforestation exceed the losses of the protagonists, the former may compensate the latter so that the losers become at least well-off as with deforestation. This is depicted in Figure 1.

Figure 1: Compensation to the Protagonist of Deforestation from the Antagonist



The initial combination of utilities of both the parties is the point 'B'. It is Pareto-inefficient and below the social utility possibility frontier. The antagonist prefers to vote for the position 'A' because the movement from the position 'B' to the position 'A' yields him a gain in utility delineated by the length of perpendicular hanging from the point 'A' on the social utility possibility frontier. But the movement from the position 'B' to the position 'A' causes loss to the protagonist to the extent to the horizontal distance between the perpendicular hanging from the point 'A' and the line segment 'BI'. The antagonist's gain is surely bigger than the protagonist's loss. In this circumstance, the former may compensate the latter to an extent of the length of the line segment 'BI' such that the protagonist can move to the point 'I' on the social utility possibility frontier. Here the point 'I' may be called weakly Pareto-efficient combination. When not all but majority of the individuals vote for the position 'A', it is a weakly Pareto-efficient allocation.

In this case one needs to insert a tradable resource like money in the utility function. Then only the loser can have a position on the social utility frontier but nevertheless by voting for the same commodity bundle for which the antagonists of deforestation are voting, the loser is dispensing with her original position. The idea of compensation descends from Kaldor and Hicks reported by Kolstad and implies that any social action which redistributes resources among people appears good if the beneficiaries are ready to compensate the losers but need not do the same except what is needed by law. This idea did not get uniform support from all the three groups of welfare economists – Benthamite, Egalitarian and Rawlsian. Their social welfare functions are different. In page 39, Kolstad (2000) distinguished between three kinds

of social welfare functions. The Benthamite function is the weighted sum of individual utilities. The Egalitarian function is the difference between aggregate of individual utilities and a fraction of the sum of the differences between the individual utilities and the minimum of the individual utilities. The Rawlsian function is the minimum of all individual utilities. Hence if a society is bifurcated into two categories (i) haves, i.e. the antagonists of deforestation and (ii) have-nots, i.e. the protagonists of deforestation; when the former are ready to compensate the latter in the case of illegalizing deforestation, in the preference map of the latter $(x'', e'') \geq (x', e')$ in terms of the definition of Pareto Efficiency enunciated by Varian (1992) in page 323. But unanimous votes for (x'', e'') motivated by the promise for compensation by the haves may not necessarily lead to Pareto efficiency in the sense that the utility of the have-nots in either case does not remain unchanged hence the social welfare remains unoptimized. It is a well known result that a Pareto-inefficient bundle of goods does not maximize welfare. if $(\tilde{x}, \tilde{e})$ is the bundle that maximizes Bergson-Samuelson social welfare function $W = W(U(x_1, e_1), U(x_2, e_2), \cdots U(x_n, e_n))$, for '$n$' individuals having identical form of utility function but the different bundles of choice, $W(U(x_1, e_1), U(x_2, e_2), \cdots \cdots U(x_n, e_n)) < W(U(\tilde{x}, \tilde{e}), U(\tilde{x}, \tilde{e}), \cdots \cdots U(\tilde{x}, \tilde{e}))$. This is because $(\tilde{x}, \tilde{e}) > (x'', e'')$ since (x'', e'') is not a Pareto-efficient bundle.

The economic impact of the business of felling timbers and selling lumbers by the protagonists on the antagonists and the recourse may also be explained in terms of production externality line with the page 433 of Varian (1992). Let the output of the above business be denoted by 'Q' that imposes a social cost in terms of the loss function $L(Q)$ facing the antagonists.

Let timber be the output of the business of felling and selling woods, the measure of which is 'Q'. The time series data on prices are available at the portal of the Office of the Economic Advisor to the Government of India. For Brazil, they are available in the ITTO statistics.

The loss function may be the formula of impact of water pollution in Guang (2011).

The production function in the business of the protagonists is such that production of 'Q' units of output generates so much of hazardous wastes that kill 'Q' number of trees. If 'P' is the competitive price of the output, the profits of the protagonists is $\Pi_1 = PQ - C(Q)$, where $C(Q)$ is the private cost of production of the protagonists.

Following Daniels (2010) the cost function may be of translog form or following Eswaran, Lewis and Heaps (1983) the cost function may take cubic form.

The profits of the antagonists is $\Pi_2 = - L(Q)$. Let both the cost functions are increasing in output and convex. The profit maximizing output Q^* of the protagonists is given from the equality $P = C'(Q^*)$. The protagonists are concerned only with their private cost. They ignore the social cost. At this juncture Q^* is not the efficient output from the social point of view. Determination of the socially efficient output may need merger of both the parties. In that case the profit function is $\Pi_1 = PQ - C(Q) - L(Q)$ and the socially efficient output is determined by the equality $P = C(Q^*) + L(Q^*)$, where price equals private as well as social marginal costs.

The transfer of resources to the protagonists from the antagonists may be analyzed in terms of Pigovian Tax in line with the page 434 of Varian (1992). Domingues (2012) described that the environmental tax system in Brazil is largely influenced by Spanish Law. Protection of environmental is a fundamental right there. There are taxes on pollution. The way Domingues (2012) the tax legality principle in relation to the Brazilian Constitution, imposition of tax on polluting firms is quite tenable. In the Indian context Srivastava and Rao (2010) maintain that the pollution tax can induce appropriate environmental decisions by raising the relative costs of polluting inputs and outputs and thereby correcting the negative externalities of a polluting activity. They subscribe to the view that pollution levies are an efficient instrument for achieving environmental objectives. A Pigovian tax is the recourse to divergence between private benefit is more than private cost because of presence of some social cost (Pigou, 1932). In the opposite case subsidy is the recourse. Let an environmental tax of 'T' be imposed on the protagonists to the extent of $L(Q^*)$ in a way such as to motivate the protagonists to produce the socially optimal level of output Q^*. Here the taxation authority need to know the exact form of the function $L(Q)$. In absence of any legal obstacle in buying illegal timbers as is there in Brazil, but not in India, let there be a

market where such product sells at a price 'I' to *inter alia* the antagonists. In this case Y_1 is the volume of illegal timbers the protagonists intend to sell, $\Pi_1 = PY_1 + IY_1 - C(Y_1)$. On the other hand if Y_2 is the volume of illegal timbers the antagonists intend to buy, $\Pi_2 = - L(Y_2) - IY_2$. First order conditions for profit maximization call for the equalities $P + I = C'(Y_1)$ and $- I = L'(Y_2)$. If the demand for illegal timber equals the supply thereof, i.e. $Y_1 = Y_2$, the first order conditions for profit maximization boil down to the case of the merged firm.

The difficulties of the taxation authorities in knowing the exact form the loss function $L(Q)$ facing the antagonists give birth to the question how to design the tax-administration system that drives the preferences of both the protagonists and the antagonists for a socially efficient output. In line with the page 436 of Varian (1992) let the protagonist announce that for any level of output Q, it would pay tax $\tau_1 Q$, out of which the antagonists would receive $\tau_2 Q$ and each party need to pay a tax based on the difference between τ_1 and τ_2. The profits are here

$\Pi_1 = PQ - C(Q) - \tau_2 Q - (\tau_1 - \tau_2)^2$

$\Pi_2 = \tau_1 Q - L(Q) - (\tau_2 - \tau_1)^2$

The profit function of the antagonist may be modified by inserting the assumption that the protagonist's choice of 'τ_2' influences the antagonist's profit such that $Q = Q(\tau_2)$ for the antagonist. The profit maximization conditions are now

$P = C'(Q) + \tau_2$ for the protagonist, (1)

$\Pi'_2(Q) = (\tau_1 - L'(Q))Q'(\tau_2) - 2(\tau_2 - \tau_1)$ for the antagonist. (2)

If the protagonist chooses the tax rate equal to what the antagonist chooses, then

$\tau_2 - \tau_1 = 0$ (3)

Combination of (1), (2) and (3) yields $P = C'(Q) + L'(Q)$.

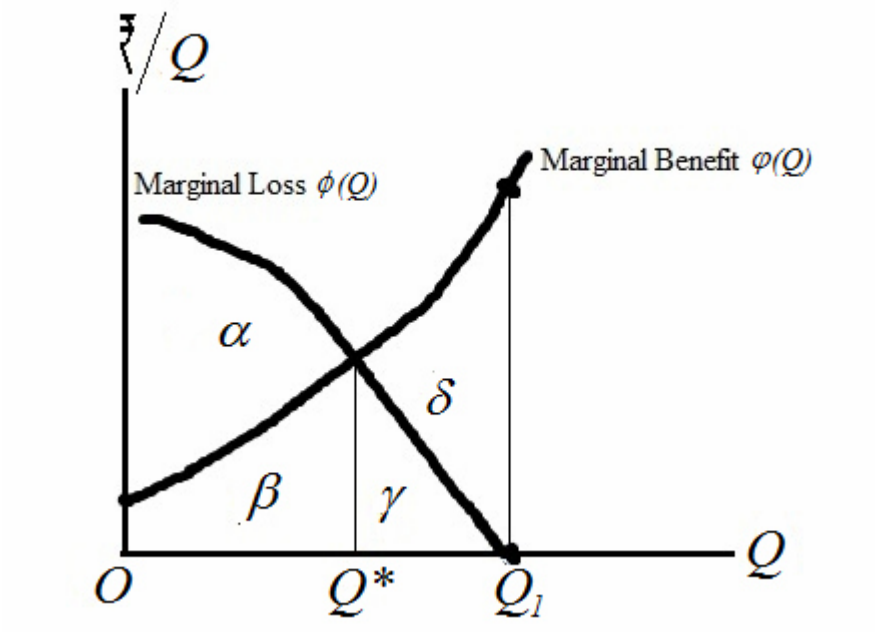
Here the incentives of the protagonists and the antagonists are compatible with each other. If the antagonist thinks that the protagonist likes to compensate the antagonist in a bigger way, the latter would prefer less tax for the former and vice versa.

ECONOMIC ANALYSIS OF WATER POLLUTION IN INDIA

In India pollution of the Ganga River is a major issue (Mitra, 2013). Disposal of hazardous waste of leather-tanning factory into the river causes damages or losses to a food manufacturing firm that uses the water of the river as an input (GOI, 2013). In

the context of river pollution Gravelle and Rees (2004) explained the transfer of resources from the polluter to the pollutee in terms of the Coase Theorem that bargaining can achieve an efficient allocation of resources whatever the initial assignment of property rights. They assumed a concave marginal benefit function $\phi(Q)$ for the polluter and a convex marginal cost function $\varphi(Q)$ for the pollutee. Their analysis is portrayed in Figure 2. If the law of the land is extremely permissive, the polluter won't care for the social cost of pollution. The polluter's benefit is $\alpha + \beta + \gamma = \int_0^{Q^*} \varphi(Q)dQ$ and the pollutee's cost $\beta + \gamma + \delta = \int_0^{Q_1} \phi(Q)dQ$. On the other hand under an extremely restrictive law regime the polluter is not allowed to continue production. Thus, on the one hand the polluter's output would be more than socially optimal and on the hand it would be zero which is also not socially desirable. So they propose payment by the pollutee to the polluter in exchange for reduction in the polluter's output or pollution.

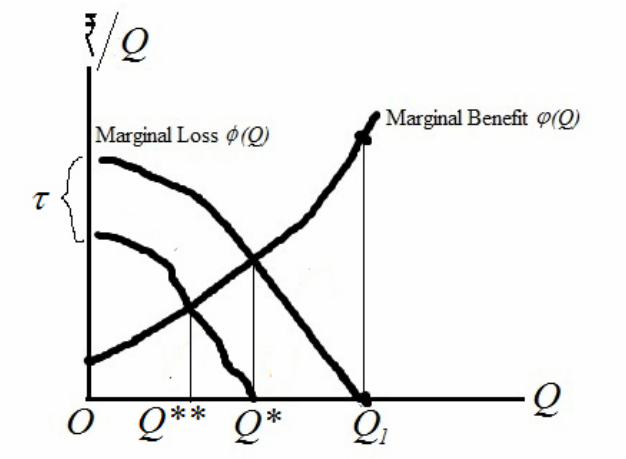
Figure 2: Ganga Pollution Analysis



In Figure 2, 'O' is the polluter's output level under an extremely restrictive legal system and 'Q_1' is the polluter's output level under an extremely permissive legal system. Both these levels are not efficient. Efficiency requires the legal system to allow production of the level 'Q*' where the benefit of the chemical factory reduces by the area $\gamma = \int_{Q^*}^{Q_1} \varphi(Q)dQ$ and the loss of the beverage factory reduces by the area γ

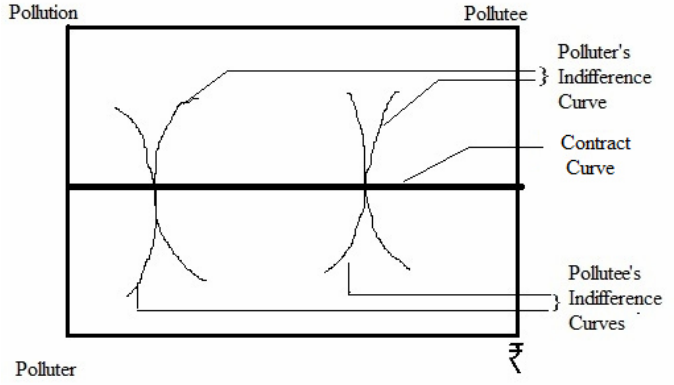
$+ \delta = \int_{Q^*}^{Q_1} \phi(Q)dQ$. If the legal system is extremely restrictive, the chemical factory as per Coase Theorem would be ready to pay an amount equal to the area 'β', i.e. the loss to beverage factory owing to production of 'Q*' level of output plus a portion of the area 'α' as an incentive to the beverage factory such that the latter tolerates the loss area 'α'. So an efficient bargain here increases the polluter's profit from nil to a portion of the area 'α' and increases the pollutee's income from nil to the rest of the area of 'α'. On the other hand if the legal system is extremely permissive, the beverage factory as per Coase Theorem would be ready to pay an amount equal to the area 'γ', i.e. the loss to the chemical factory owing to the reduction in the level of output from 'Q*' to 'Q_1' plus a portion of the area 'δ' such as to motivate the chemical factory for the above reduction in production. So an efficient bargain here increases the polluter's profit from by a portion of 'δ' and reduces the pollutee's loss by the rest of the area of 'δ'. The Coase Theorem may not apply to a situation where one factory is polluting several entities and if some contract between the polluter and one of the pollutees leads to reduction in pollution, other pollutees reap the benefit despite not becoming party to the contract. Hence they do not show interest in such contract nor do they prefer to litigate owing to the time-consuming procedure in India (Prakash, 2013). In these circumstances a Pigovian tax, say, an 'τ' per unit output, would drive the polluter towards reducing output level to Q* in Figure 3 in an extremely permissive legal system because maximization of the polluter's objective function 'total revenue - τQ' and simultaneous minimization of the pollutee's objective function 'τQ – total loss' leads to an inefficient allocation in the form of $\varphi'(Q) = \tau = \phi'(Q)$. But nevertheless, if the two parties still bargain, the efficient allocation would drive the polluter towards further reduction of output level to Q**.

Figure 3: Impact of Pigovian Tax



This means the contract curve of their indifference curves in the Edgeworth Box would be a straight line in Figure 4 with a fixed amount of pollution but with varying distributions of money in line with page 649 of Varian (2010).

Figure 4: Straight Line Contract Curve



In the context of pollution in India page 4 of Mankiw (2006) is quite relevant. He mentioned the choice between high (real) income and low pollution. Low pollution increases cost of production and hence the profits go down. So the firms pay lower wages to labour and often pass on the burden of extra cost to the consumer so that there is reduction in consumer surplus. In an emerging economy like India with a substantial fraction of the population below poverty line, it is unlikely that the rural and forest-dependent populace would vote against deforestation. Secondly the compensation by way of transfer from the antagonist to the protagonist may be viewed as recourse to externality mentioned in page 10 of Mankiw (2006). Now the question is that if the Pigovian tax collected from the polluter is paid to the pollutee as compensation, what should be the exact amount of compensation? Following page 323 of Gravel and Rees (2004), if the pollutee is a food manufacturer it has to make

expenditure (E) on repair of damage, i.e. it has to use the water after proper filtration under a legal regime which does not have a subsidy policy. Let $\Theta(Q, E)$ be the damage function with the nature with increasing expenditure on filtration, the damage reduces by one rupee so that $\Theta_E < 0$. Under an alternative legal regime which has a subsidy policy, let the subsidy be based on the damage such that the subsidy function is $\Psi = \Psi(\Theta)$. The pollutee likes to maximize the margin $\Psi - \Theta - E$ with respect to 'E'. The first order condition is $\Psi' \Theta_E - \Theta_E - 1 = \Theta_E (\Psi' - 1) - 1 = 0$. But from the society's point of view the difference between the aggregate benefit and the aggregate cost should be maximized with respect to E. The aggregate benefit is the integration of the polluter's marginal benefit function $\phi(Q)$ which does not depend on E. So the maximizable objective is $- \Theta(Q, E) - E$. The first order condition is $- \Theta_E - 1 = 0$ $\Rightarrow - \Theta_E = 1$. This means the damage will reduce exactly by one rupee with each additional one rupee spent on filtration. This means additional compensation should be exactly equal the additional damage. This may motivate the pollutee not to spend a single paise on filtration for setting up an effluent treatment plant under the generous legal regime which likes to pay subsidy equal to damage. In that case the damage function would be $\Theta(Q, 0)$. If any the subsidy function is designed like $\Psi = \Psi(\Theta) - F$, where 'F' is the fee charged on the application for subsidy in the case of those who does have filtration plant, this fee may neutralize the above motivation.

CONCLUSION

Both the members of IBSA – India and Brazil have environmental issues of concern. Almost 70 per cent of India's surface water resources and a growing percentage of its groundwater reserves are contaminated, whereas in Brazil deforestation, acid rain, endangered species, air pollution and waste disposal are the issues of concern. In this context, this study sheds light on the fusion of legal and economic elements with regard to deforestation in Brazil and water pollution in India. The utility maximization framework is applied here (i) to both of polluter and pollutee in the context water pollution and to both of beneficiaries and antagonists of deforestation. In terms of theoretical modeling this study explored the shapes of private benefit function, social benefit function, private loss or damage function and social loss function. The most important findings, relevant to policy makers are (i) the factor, that may motivate the

victim of water pollution not to spend a single paise on filtration for setting up an effluent treatment plant under the generous legal regime which likes to pay subsidy equal to damage and (ii) the nature of preference of the victim of pollution for tax *vis-à-vis* compensation.

IMPORTANT ACRONYMS

AF: Amazon Fund

EDF: Environmental Defense Fund

FBDS: FUNDAÇÃO BRASILEIRA PARA O DESENVOLVIMENTO

GEF: Global Environment Facility

GOI: Government of India

FBDS: FUNDAÇÃO BRASILEIRA PARA O DESENVOLVIMENTO SUSTENTÁVEL (Brazilian Foundation for Sustainable Development)
REDD: Reducing Emissions from Deforestation and Forest Degradation

SECOM: The Secretariat for Social Communication

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