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Public Versus Personal Welfare: An Aspect of Environmental Policymaking in Developing Countries[1]

by

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Abstract

In this paper, we shed light on the nature of the interaction between an environmental authority (EA) and the polluting sector in a developing country (DC) when there is *uncertainty* about the relative weight that this EA places on *public* versus its *own* welfare. Within the context of this general issue, we answer three specific questions for any arbitrary time period t. First, we determine the expected level of pollution as well as the actual pollution in the polluting sector. Second, we compute the mean social loss arising in part from the uncertainty about the relative weight that the EA places on public versus its own welfare. Finally, we solve for the optimal value of the parameter which measures the relative weight the EA places on public versus its own welfare.

Keywords: Developing Country, Environmental Authority, Game, Policy, Uncertainty

JEL Codes: O130, Q580

1. Introduction

Since the publication of the now prominent Brundtland Report (Brundtland, (1987)), the environment has loomed large in virtually every discussion of what it means for the process of economic development to be sustainable. Although this notion of "sustainable development" now quite often means different things to different individuals, there is little debate on the basic point that the process of making economic development in the world's low income countries sustainable is fundamentally all about environmental protection.[3]

As Dwivedi and Khator (1995), Jan (1995), and Stoett (1995) have pointed out, in recent times, many developing countries have adopted a number of measures to protect their environmental resources. However, because stringent environmental measures often inflict "pain" on certain sectors of a developing country's (hereafter DC's) economy, there is some concern among researchers and observers about the ability of DC governments to carry through with meaningful environmental policies. Put a little differently, because environmental protection and employment creation are often competing objectives, the worry is that although DCs may initiate the process of instituting and implementing environmental policies, over time, their faithfulness to such policies is likely to diminish.[4]

Recently, Batabyal and Beladi (2002b) have studied some of these issues concerning the conduct of environmental policy in DCs. Specifically, they pose and answer the following two questions. First, when faced with a self-financing constraint, should an environmental authority (EA)

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[3] There is now a vast literature on the topic of sustainable development. For more on this literature, the reader should consult Atkinson *et al.* (1997), Dwivedi (1997), Farmer and Randall (1997), Pezzey (1997), Heal (1998), Munasinghe (2007), and Stern (2007).

[4] See Batabyal (1998), Batabyal and Beladi (2002a), and Lee and Batabyal (2002) for a more detailed discussion of this point.

raise/lower pollution taxes over time or should it run a deficit/surplus? Second, should an EA make its preferences about the relative benefits of environmental protection versus production public, or should it keep its preferences private? Batabyal and Beladi (2002b) show that when faced with a self-financing constraint, it is optimal for the EA to run a deficit/surplus. Second, social losses are lower when this EA keeps its preferences private.

Despite the presence of these useful findings in the extant literature, a question that has not received adequate theoretical attention in the literature concerns the nature of the interaction between an EA and the polluting sector in a DC when there is *uncertainty* about the relative weight that this EA places on *public* versus its *own* welfare. Therefore, in this paper, we shed light on this general issue. Further, within the context of this general issue, we answer three specific questions for any arbitrary time period t. First, we determine the expected and the actual levels of pollution in the DC's polluting sector. Second, we compute the mean social loss arising in part from the uncertainty about the relative weight that the EA places on public versus its own welfare. Finally, we solve for the optimal value of the parameter which measures the relative weight the EA places on public versus its own welfare.

Why is it important to analyze the general issue stated at the beginning of the previous paragraph? This is because the actual practices associated with environmental policymaking in many DCs suggest that this "public versus personal welfare" issue is salient. We now corroborate this claim with some discussion of actual practices of environmental policymaking in two large and important DCs, namely, China and India.

1.1. China

In the case of China, the work of Sinkule and Ortolano (1995) tells us clearly that conflict of interest issues abound in the implementation of environmental policy. Consider the case of Chinese environmental protection bureaus (EPBs). Sinkule and Ortolano (1995, p. 79) note that the increased influence of EPBs may well "be offset by potential conflicts of interest that limit the EPB's ability to regulate." Citing Qu Geping, a former administrator of the national environmental protection agency (NEPA), Sinkule and Ortolano (1995, p. 178) emphasize "the importance of preventing corruption and misuse of fees collected by environmental protection units..." These authors also point out that very few EPBs are actually interested in seeing pollution discharge fees being set equal to the cost of treating wastewater. This is because if these fees are set as they ought to be set then factories will "respond by building more wastewater treatment plants, and then the EPBs [will] lose fees as a source of revenue" (Sinkule and Ortolano, 1995, p. 180).

More recently, Michael Palmer (2000) has commented on environmental policymaking in contemporary China. According to the revised Criminal Law, which came into effect on 1 October 1997, "officials responsible for supervising and managing the protection of the environment may be liable for criminal punishment...for deviant acts committed in the course of duty" (Palmer, 2000, p. 73). In addition, "[a]rticles 187 and 188 stipulate liability for maladministration and abuse of power in relation, *inter alia*, to environmentally polluting conduct" (Palmer, 2000, p. 77).

1.2. India

In India, environmental policymaking in general and the enforcement of environmental regulations in particular leave a lot of room for improvement. For instance, in his detailed analysis of environmental policies and regulations in India, Dwivedi (1997, p 99) points out that "the administrative machinery set up to implement the [environmental] legislation interprets its own duties from time to time, and such interpretations often do not conform to the...intent and purpose of the law." In addition, although several meaningful environmental laws exist on the books, the fact of the matter is that environmental degradation continues to quicken. This is because government "bureaucrats and industry managers have a basically mistrustful relationship" (Dwivedi, 1997, p. 215). To make matters worse, this mistrustful relationship has "resulted in the inability of government regulatory agencies to communicate candidly and freely with industry, and in industry's reluctance to seek joint industry-government solutions to industrial pollution-control problems" (Dwivedi, 1997, p. 215).

At the level of environmental inspections, there is a considerable amount of corruption to contend with. We learn that "environmental inspectors succumb to bribes partly because they are poorly paid, partly because of the political culture prevailing in the nation and partly because the punishment is not severe enough to deter them or the polluter. In other words, both inspectors and polluters have an incentive to cheat" (Dwivedi, 1997, p. 127). This saturnine state of affairs has the unfortunate effect of making bribery rampant in society. Indeed, bribery "is the best known means of evading law enforcement, and when it is subtly employed it can be a useful delaying tactic for the polluter" (Dwivedi, 1997, p. 204). Because of the reasons given in this and the preceding paragraph, it is not unreasonable to contend, as Dwivedi and Vajpeyi (1995, p. 65) have, that environmental regulators in India suffer "from the lack of political support and public credibility..."[5]

1.3. Discussion

This discussion of environmental policymaking in both China and India and our intuition together tell us that there is really no reason to believe that an EA in a DC will *only* be interested in

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For more on the importance of credibility in environmental policy in DCs, see Batabyal (1998), Batabyal and Beladi (2002a, 2002b), and Lee and Batabyal (2002).

the welfare of the public. In fact, given the discussion in sections 1.1 and 1.2, what is more likely is that as far as the implementation of environmental regulations is concerned, an EA will be interested in *both* public and its own welfare. However, what relative weight an arbitrary EA will place on public versus private welfare is typically not something that is known with certainty. Therefore, in this paper, we suppose that this relative weight is a *random* variable. We now proceed to study the nature of the interaction between an EA and the polluting sector in a DC when there is *uncertainty* about the relative weight that this EA places on *public* versus its *own* welfare.

The rest of this paper is organized as follows. Section 2.1 delineates our stylized model of the interaction between an EA of the sort described in the previous paragraph and the polluting sector in an arbitrary DC and for an arbitrary time period t. Section 2.2 ascertains the expected pollution level and the actual pollution level in the DC's polluting sector. Section 2.3 computes the mean social loss arising in part from the uncertainty about the relative weight that our EA places on public versus its own welfare. Section 2.4 calculates the optimal value of the parameter—portraying the relative weight the EA places on public versus its own welfare—that minimizes the expected social loss computed in section 2.3 above. Finally, section 3 concludes and offers suggestions for future research on the subject of this paper.

2. Public Versus Personal Welfare

2.1. Preliminaries

As in Batabyal and Beladi (2002b), consider a trading DC whose economy is dualistic. One sector is the traditional sector in which there is no pollution. The second sector is the modern or the industrial sector in which production causes pollution. In the remainder of this paper, our attention will be on this polluting sector. Further, the subscript t on a variable will refer to the time period under consideration. Because we want to work with pollution in a time period, x_t, directly as the EA's control variable, as in Batabyal and Beladi (2002b), we shall assume that the functional relationship between the production of the polluting sector in time period t, q_t, and the pollution generated in this same time period, x_t, is strictly monotonic. As in Batabyal and Beladi (2002b), we would, once again, like to work with a loss function. Therefore, it will be helpful to think of the EA as an entity that sets pollution levels (the bad) directly.

To reiterate, x_t is the period t pollution level that is set by the EA in our DC. Let x_t^e denote the polluting sector's period $t-1$ expectation of what pollution will be in period t. Assuming that all agents in the polluting sector of our DC have rational expectations, we get $x_t^e \equiv E_{t-1}x_t$, where $E[\cdot]$ is the expectation operator. There will generally be some discrepancy between the EA's targeted output level of the polluting good[6] and the actual output level. To account for this, let $w>0$ denote the positive wedge between these two output levels. In addition, the production of the polluting good may be subject to output supply shocks. To model this possibility, we let z_t be a conditional mean-zero, independently and identically distributed (i.i.d) output supply shock. Finally, we suppose that the EA's preferences over pollution and the production of the polluting good can be described by a loss function with the following form[7]

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[6] As discussed in the previous paragraph, x_t and q_t are functionally related in a specific manner. Consequently, targeting pollution directly has the effect of targeting output indirectly.

[7] This kind of loss function has been used in the monetary economics literature by Barro and Gordon (1983), Backus and Driffil (1985), and others. For a good account of dynamic consistency issues in monetary economics, see Obstfeld and Rogoff (1996, pp. 634-658).

$$\mathcal{L}_t = (x_t - x_t^e - z_t - w)^2 + \chi x_t^2 + 2\lambda_t \delta x_t. \quad (1)$$

The loss function in equation (1) is clearly the sum of three terms. The first term $(x_t - x_t^e - z_t - w)^2$ represents the EA's concern for the output of the polluting good. The second term χx_t^2 represents the EA's concern for pollution. Finally, the third term $2\lambda_t \delta x_t$ represents the EA's concern for its own welfare. The reader may find it useful to think of this third term $2\lambda_t \delta x_t$ as a monetary payment to the EA that is reduced when pollution increases. The parameter χ in the second term χx_t^2 measures the cost of pollution relative to that of suboptimal output. In the third term $2\lambda_t \delta x_t$, $\lambda_t > 0$ is a *random* variable that captures the relative weight our EA places on public versus its own welfare (monetary payment). To keep the subsequent mathematics straightforward, we assume that $E_{t-1}[\lambda_t] = 1$ and that the variance $Var_{t-1}[\lambda_t] = \sigma_\lambda^2$. In sum, equation (1) tells us that our EA wishes to minimize the weighted sum of three terms that reflect its concern for the output of the polluting good, pollution itself, and its own monetary payment or welfare. The outstanding task before us now is to determine the expected and the actual pollution levels in the polluting sector of the DC under consideration.

2.2. Expected and actual pollution

The reader should think of the interaction between the EA and the polluting sector in our DC as a one-shot game. We now want to determine the equilibrium of this game. In symbols, we want to determine the optimal values of x_t^e and x_t. We begin by solving the EA's optimization problem.

This EA solves

$$\min_{\{x_t\}} \mathcal{L}_t = (x_t - x_t^e - z_t - w)^2 + \chi x_t^2 + 2\lambda_t \delta x_t. \qquad (2)$$

The first order necessary condition for an optimum to this problem is

$$x_t - x_t^e - z_t - w + \chi x_t + \lambda_t \delta = 0. \qquad (3)$$

Now, taking time period $t-1$ expectations, setting $E_{t-1}[x_t] = x_t^e$, and then simplifying the resulting expressions, we get

$$x_t^e = \frac{w - E_{t-1}[\lambda_t]\delta}{\chi} = \frac{w-\delta}{\chi}. \qquad (4)$$

Equation (4) gives us the equilibrium expected level of pollution. Now, to obtain the equilibrium actual level of pollution, x_t, let us substitute the above value of x_t^e from equation (4) into equation (3) and then solve the resulting expression for x_t, keeping in mind that $w - \delta = \chi x_t^e$. This gives us

$$x_t = x_t^e - \frac{(\lambda_t - E_{t-1}[\lambda_t])\delta}{1+\chi} + \frac{z_t}{1+\chi} = x_t^e - \frac{(\lambda_t - 1)\delta}{1+\chi} + \frac{z_t}{1+\chi}. \qquad (5)$$

Recall that the random variable $\lambda > 0$ captures the weight that our EA places on public welfare versus its own welfare. Given this interpretation, equations (4) and (5) together describe the equilibrium of the one-shot game that we are analyzing. In addition, these two equations also tell us that when there is uncertainty about an EA's intentions as far as public versus private welfare is concerned, the expected or mean amount of pollution is the *same* as when λ is known to equal unity. This conclusion follows because $E_{t-1}[\lambda_t]=1$. However, the reader should note that the *ex post* uncertainty about the type of EA that our polluting sector is confronted with creates *additional variability* in the actual amount of pollution that arises. We now proceed to compute the mean social loss arising in our DC in part from the uncertainty about the relative weight that our EA places on public versus its own welfare.

2.3. Mean social loss

To calculate the mean social loss in a straightforward manner, we shall make two assumptions. In particular, we suppose that the relevant *social* loss function is of the form

$$\mathfrak{L}_t=(x_t-x_t^e-z_t-w)^2+\chi x_t^2, \tag{6}$$

and that the covariance between the random variables λ and z is zero or $Cov(\lambda,z)=0$. Now, making the appropriate substitutions from equations (4) and (5) into equation (6), we get

$$E_{t-1}\mathfrak{L}_t=E_{t-1}[\{-\frac{(\lambda_t-1)\delta}{1+\chi}+\frac{z_t}{1+\chi}-z_t-w\}^2+\chi\{\frac{w-\delta}{\chi}-\frac{(\lambda_t-1)\delta}{1+\chi}+\frac{z_t}{1+\chi}\}^2]. \tag{7}$$

After several steps of algebra, the right hand side (RHS) of equation (7) can be simplified to

$$E_{t-1}\mathcal{L}_t = w^2 + \frac{(w-\delta)^2}{\chi} + \frac{\sigma_\lambda^2\delta^2}{1+\chi} + \frac{\chi\sigma_z^2}{1+\chi}, \tag{8}$$

where σ_λ^2 and σ_z^2 are the variances of the random variables λ and z respectively. Inspection of equation (8) leads to three salient conclusions. First, as the parameter χ which measures the cost of pollution relative to that of suboptimal output increases, the expected loss to society decreases. Second, as the uncertainty associated with the output supply shock (σ_z^2) goes up, the mean loss to society also goes up. Finally, when the uncertainty associated with the EA's weight over public versus its own welfare (σ_λ^2) increases, once again, the expected loss to society also increases. This last result clearly tells us that from the standpoint of environmental policymaking, DCs need to ensure, to the extent possible, that individuals who are placed in positions of authority are in fact public spirited in the discharge of their official duties. The final task before us now is the calculation of the optimal value of the parameter δ which measures the relative weight the EA places on public versus its own welfare (also see equation (1)).

2.4. The optimal value of the relative weight parameter

Inspecting equation (8) it is clear that if there is no uncertainty about the relative weight the EA places on public versus its own welfare, i.e., if $\sigma_\lambda^2 = 0$, then the expected social loss is minimized by choosing $\delta = w$. In words, in this case of certainty about the EA's type, the relative weight parameter δ is chosen so that it is equal to the positive wedge between the targeted output level of the polluting good and the actual output level of this same good.

However, when $\sigma_\lambda^2 \neq 0$ and hence λ is unpredictable, the previous paragraph's solution is not optimal and we have to contend with the fact that there is a tradeoff between reducing *mean* pollution by choosing a positive δ and raising the *variance* of pollution because the EA's preferences are stochastic. Now, to determine the optimal $\delta,$ we solve

$$\min_{\{\delta\}}[E_{t-1}\mathcal{L}_t = w^2 + \frac{(w-\delta)^2}{\chi} + \frac{\sigma_\lambda^2 \delta^2}{1+\chi} + \frac{\chi \sigma_z^2}{1+\chi}]. \tag{9}$$

Differentiating equation (9) with respect to δ and then setting the resulting expression equal to zero gives us the first order necessary condition for an optimum to this problem. Algebraically manipulating this first order condition gives us an expression for the optimal value of δ and that expression is

$$\delta = \frac{(1+\chi)w}{1+\chi(1+\sigma_\lambda^2)}. \tag{10}$$

Equation (10) tells us that when there is additional uncertainty about the EA's relative weight $\lambda,$ i.e., when $\sigma_\lambda^2 \neq 0,$ the optimal value of δ is less than $w,$ the positive wedge between the targeted output level of the polluting good and the actual output level of this same good. Consistent with the discussion in the first paragraph of this section, the reader can inspect equation (10) and thereby easily verify that when $\sigma_{\lambda}^{2}=0$ the optimal value of δ equals the positive wedge w. This completes our discussion of the computation of the optimal value of the parameter δ.

3. Conclusions

In this paper we shed light on a hitherto unstudied question about the nature of the interaction between an EA and the polluting sector in a DC when there is *uncertainty* about the relative weight that this EA places on *public* versus its *own* welfare. First, in section 2.2 we determined the mean and the actual pollution levels in the DC's polluting sector. Next, in section 2.3 we computed the mean social loss arising in part from the uncertainty about the relative weight that our EA places on public versus its own welfare. Finally, in section 2.4 we calculated the optimal value of the parameter—portraying the relative weight the EA places on public versus its own welfare—that minimizes the expected social loss computed in section 2.3.

Recently, in the context of India, Dwivedi (1997) has noted that environmental policymaking can be improved by, *inter alia*, increasing the public awareness of environmental problems and by taking steps to mitigate the venality of officials responsible for environmental management. In addition to having other benefits, these sorts of actions are also likely to diminish uncertainty about an EA's type. The analysis in this paper tells us that as far as the reduction of expected social losses is concerned, taking the above sorts of actions would clearly be a good thing.

The analysis in this paper can be extended in a number of different directions. In what follows, we propose two possible extensions. First, one can generalize the analysis conducted here by modeling and analyzing the interaction between an EA and the polluting sector of a DC as a repeated game. Second, with regard to the use of loss functions, it would be useful to study the nature of the interaction between an EA and a DC's polluting sector when the EA's focus is not on the minimization of social losses but instead on the maximization of the net benefit from the implementation of sound environmental policy. Studies of the conduct of environmental policy in DCs which incorporate these aspects of the problem into the analysis will provide richer accounts of environmental policymaking in DCs and this is a subject of considerable contemporary significance.

References

Atkinson, G., Dubourg, R., Hamilton, K., Munasinghe, M., Pearce, D., and Young, C. 1997. *Measuring Sustainable Development*. Edward Elgar, Cheltenham, UK.

Backus, D., and Driffil, J. 1985. Rational Expectations and Policy Credibility Following a Change in Regime, *Review of Economic Studies*, 52, 211-221.

Barro, R.J., and Gordon, D.B. 1983. Rules, Discretion, and Reputation in a Model of Monetary Policy, *Journal of Monetary Economics*, 12, 101-121.

Batabyal, A.A. 1998. Environmental Policy in Developing Countries: A Dynamic Analysis, *Review of Development Economics*, 2, 293-304.

Batabyal, A.A., and Beladi, H. 2002a. A Dynamic Analysis of Protection and Environmental Policy in a Small Trading Developing Country, *European Journal of Operational Research*, 143, 197-209.

Batabyal, A.A., and Beladi, H. 2002b. Aspects of the Theory of Environmental Policy in Developing Countries, *Discrete Dynamics in Nature and Society*, 7, 53-58.

Brundtland, G.H. 1987. *Our Common Future*. Oxford University Press, Oxford, UK.

Dwivedi, O.P., and Vajpeyi, K. Eds. 1995. *Environmental Policies in the Third World*. Greenwood Press, Westport, Connecticut.

Dwivedi, O.P., and Khator, R. 1995. India's Environmental Policy, Programs, and Politics, in O.P. Dwivedi and K. Vajpeyi, (Eds.), *Environmental Policies in the Third World*. Greenwood Press, Westport, Connecticut.

Dwivedi, O.P. 1997. *India's Environmental Policies, Programmes, and Stewardship*. St. Martin's Press, New York, NY, USA.

Farmer, M.C., and Randall, A. 1997. Policies for Sustainability: Lessons from an Overlapping Generations Model, *Land Economics*, 73, 608-622.

Heal, G. 1998. *Valuing the Future: Economic Theory and Sustainability*. Columbia University Press, New York, NY, USA.

Jan, G.P. 1995. Environmental Protection in China, in O.P. Dwivedi and K. Vajpeyi, (Eds.), *Environmental Policies in the Third World*. Greenwood Press, Westport, Connecticut.

Lee, D.M., and Batabyal, A.A. 2002. Dynamic Environmental Policy in Developing Countries With a Dual Economy, *International Review of Economics and Finance*, 11, 191-206.

Munasinghe, M. 2007. *Sustainable Development in Practice*. Edward Elgar, Cheltenham, UK.

Obstfeld, M., and Rogoff, K. 1996. *Foundations of International Macroeconomics*. MIT Press, Cambridge, MA, USA.

Palmer, M. 2000. Environmental Regulation in the People's Republic of China: The Face of Domestic Law, in R.L. Edmonds, (Ed.), *Managing the Chinese Environment*. Oxford University Press, Oxford, UK.

Pezzey, J. C.V. 1997. Sustainability Constraints versus "Optimality" versus Intertemporal Concern, and Axioms versus Data, *Land Economics*, 73, 448-466.

Sinkule, B.J., and Ortolano, L. 1995. *Implementing Environmental Policy in China*. Praeger, Westport, CT, USA.

Stern, N. 2007. *The Economics of Climate Change*. Cambridge University Press, Cambridge, UK.

Stoett, P.J. 1995. Environmental Problems, Policies, and Prospects in Africa: A Continental

Overview, in O.P. Dwivedi and K. Vajpeyi, (Eds.), *Environmental Policies in the Third World*. Greenwood Press, Westport, Connecticut.