International Environmental Agreements (2006) 6:29–38
DOI 10.1007/s10784-004-7861-2

Distributional Conflicts and the Timing of Environmental Policy

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Accepted 20 December 2004

Abstract. This paper examines the timing of adopting a policy for tackling an environmental issue such as climate change from a viewpoint of distributional conflicts. A dynamic game of providing public goods (Alesina and Drazen, *American Economic Review* **81**(5), 1170–1118 (1991)) is applied to the argument, modified by including abatement costs as well as the loss in the environment. In this framework, even if the immediate adoption of environmental policy is socially optimal, a disproportionate burden of pollution reduction leads to a delay in policy adoption. This is because the disproportionate burden increases the gain from waiting for each individual hoping that the other will agree to bear the heavier burden. The impact of income distribution on the timing is also examined. The level of averting behavior is assumed to depend on the level of income. If the distribution of income is more dispersed, the regional disparities in environmental degradation become larger because the poor tend to avert less and get more loss than the rich due to their tighter budget constraints. Under asymmetric information on damages, as the disparities in income become more dispersed, each individual expects that his/her opponent's damage becomes severe; then, he/she gives in first. Thus, each individual holds out longer so that the timing of policy implementation is delayed further. Finally, the theoretical result is empirically tested by both probit and discriminant analyses to examine whether income distribution has an impact on the timing of ratifying the Kyoto Protocol in practice.

Key words: environmental policy, political economics

1. Introduction

This paper examines the timing of adopting environmental policy from a viewpoint of distributional conflicts. A model of delay as "a war of attrition" (Alesina and Drazen 1991; Drazen and Grilli 1993) is applied to the argument, expanded by including abatement costs as well as utility loss resulted from pollution. In this framework, a disproportionate burden of pollution abatement results in a delay in policy adoption. Moreover, the more dispersed distribution of income leads to the longer time of waiting for the policy adoption.

The adoption of environmental policy reducing such pollutants as particulate matters and greenhouse gases is occasionally delayed probably as a result of political conflicts, even if the policy itself is socially desirable. Everyone can benefit from pollution reduction; however, the agreement on the distribution of abatement costs is difficult because different emitters have different emission intensities; hence, the burden of pollution abatement tends to be unevenly shared. For instance, although the Kyoto Protocol[1] for mitigating climate change was reached in 1997 within the framework of the U.N. Convention on Climate Change, it took a longer time to be implemented than expected. A report prepared by the U.S. Congressional Budget Office (2003) states that distributional concerns are difficult questions for nations to answer and that, even within a specific country, developing plans to mitigate climate change are difficult. Consumer attitudes vary regarding environmental issues including those involving carbon emissions. Different firms have different energy intensities. Thus, the costs for pollution abatement are likely to be disproportionate, which impedes chances for negotiation. From developing countries' viewpoint, Pan (2003) emphasizes equity concerns on disparities in mitigation costs between regions within countries.

In addition to the problem above, the difference in "benefits" of pollution reduction may influence negotiation. An environmental problem such as climate change differently influences each region. Regions in which poor people live may be more vulnerable to potential damages than the rich partly because their tighter budget constraints may prevent them from carrying out averting activities. Such a problem of distributional conflicts will be dominant if the issues are negotiated among nations.

Several economic analyses exist for investigating the timing of adopting environmental policy, many of which deal with scientific uncertainty and learning of the issues that are causing the delay. Pindyck (2000, 2002) analyzes how scientific uncertainty and learning in the future can affect the timing of adopting environmental policy where not only the irreversibility in environmental degradation but also that in abatement investment exists. Fisher and Narain (2002) investigate it in which the risk of damage in the future is dependent on the current level of emission reduction. Specifically in the case of climate policy, many articles such as Tol (2000) have investigated the timing of the policy adoption by employing simulation models.

In this analysis, as a possible reason for the delay in the adoption, the distributional aspects of environmental policy are discussed. The regional differences in benefits and costs of environmental policy as well as income disparities are examined to determine how they affect the timing of the adoption of environmental policy. A dynamic game of "a war of attrition" is modified by including abatement costs as well as the loss in the environment. "A war of attrition" is a type of game for providing public goods, in which each individual plays a waiting game in the hope that the other individual will give in fast and be the one who provides the public goods (Drazen 2000). In this paper, environmental taxation is considered as a public good and each individual, who obtains benefits and costs of the policy, plays the game hoping that the other individual accepts the larger costs incurred for conserving the environment first.

An agreement is assumed to be essential on the allocation of abatement costs among individuals in a jurisdiction for the government to implement environmental taxation for pollution reduction. Only if a certain individual agrees to take on a higher portion of taxation, that is, to "concede" earlier, the other individual agrees on accepting the rest of it. It is also assumed that the degree of environmental degradation depends not only on the total level of pollution but also on the place where people live. Thus, an individual living in a region which has more loss from environmental degradation may agree to accept a heavier burden on policy implementation first. However, the information on regional disparities in damages is "asymmetric," in that an individual knows the degree of damage of his/her own. Hence, he/she does not exactly know the degree of damage the other undergoes but only knows the probability distribution of it. Hence, every individual expects that the damage of the other individual is more severe, and wants to wait until the other accepts the heavier burden. In this framework, even if the immediate adoption of environmental policy is socially optimal, a disproportionate burden of pollution reduction leads to a delay in policy adoption. The disproportionate burden of pollution reduction increases the gain from waiting for each individual in the hope that the other, expected to have more severe damage, will agree to bear this burden.

The impact of income distribution on the timing is also examined. The degree of damage is assumed to be negatively dependent on the level of income because the level of "averting behavior," that is, the level of activities for avoiding the damage by building such as offshore breakwaters, tends to be dependent on the level of income possibly because the tighter budget constraint of the poor may inhibit them from carrying out such averting activities. If the distribution of income is more dispersed, the regional disparities in environmental degradation become larger. Under the asymmetric information mentioned above, as the disparities in income becomes more dispersed, each individual expects that his/her opponent's damage becomes more severe and he/she gives in first. Thus, each individual holds out longer so that the timing of the policy implementation is delayed further.

In the last section, the theoretical result is empirically tested by both probit and discriminant analysis to examine whether income distribution has an impact on the ratification of the Kyoto Protocol in practice. If the reality of the climate change issue is carefully considered, the income distribution between developed and developing countries should be investigated. However, there is no binding commitment for developing countries; thus, distributional conflicts within developing nations may not significantly influence the status of their ratification at this moment. Therefore, the analysis below only examines the case of developed countries, i.e., Annex B countries. In this sense, the empirical test will provide a preliminary result.

Concerning the political aspects of environmental policy, Jones and Manuelli (2001) analyze endogenous choices of environmental policy. Ericksson and Persson (2003) extend it by including heterogeneity in income as well as environmental quality. However, neither of them explicitly analyzes the timing of the policy adoption. This paper investigates the extent to which heterogeneity in costs and benefits of environmental policy as well as income distribution have an impact on the timing of adopting environmental policy. Xepapadeas and Amri (1998) empirically examines an inverted-U relationship between economic growth and pollution by utilizing the probit model; however, neither the distribution aspect nor the timing issue is investigated in their analysis.

In the following sections, a basic model is introduced first. Next, the relationship between income distribution and policy adoption is analyzed. After the relationship is empirically tested, a tentative conclusion is provided.

2. The Model

In this analysis, a model of delay as a war of attrition (Alesina and Drazen 1991) is applied, modified by including abatement costs as well as utility loss as a result of pollution. A decentralized economy consists of consumers enjoying positive utility from consumption, and negative utility from pollution. The substance polluting the environment in this economy are "uniformly mixed" pollutants such as greenhouse gases so that the spatial location of emissions does not matter for damages. However, the severity of damage varies regionally; hence, consumers assumed to be heterogeneous with regard to damages. The individual-specific damage indicator $\phi_i(> 0)$ describes this aspect. It is assumed that the individuals only know their own indicator, while the others only know the distribution of damage indicator $F(\phi)$ with lower and upper bounds $\underline{\phi}$ and $\overline{\phi}$.

The level of utility of individual i is given as

$$u_i = c_i - \phi_i P, \tag{1}$$

where c_i is the level of i's consumption and P is the total level of pollution in this economy. The social planner would immediately stabilize this pollution to an optimal level, which is normalized as zero pollution in this analysis. However, this economy is decentralized, so there is the government which requires the agreement on the allocation of abatement costs among individuals before implementing environmental taxation. Thus, the pollution beyond the optimal level is resulted from an inability to agree on the distribution of the burden. Moreover, as it was mentioned, only if certain individuals agree to take on a higher portion of taxation, the others agree to accept the rest of it.

The individuals consume their current income y which is supposed to be the same for all consumers in this section. Later, this assumption is relaxed to allow a difference in income. The amount of emission is assumed to be equal to the level of income,[2] i.e., $y = P$ because, as people become richer, they are likely to consume more and produce more emissions. Before the adoption of an environmental policy, the consumption for each individual is given as

$$c^{SQ} = y, \tag{2}$$

where SQ denotes the "status-quo" prior to the agreement. The government imposes an emission tax to eliminate pollution, and its revenue is assumed to be paid back as a lump-sum transfer T equally to all individuals. Provided that there are two groups of individuals; a group which concedes first L and the rest of them H. Then, consumption after the adoption for individuals in a group which concedes first, c^L, and the one for those in the other group, c^H, are described as

$$c^L = y - \alpha m + T/2, \tag{3}$$

$$c^H = y - (1 - \alpha)m + T/2, \tag{4}$$

where m is the total amount of pollution abatement to reduce to (normalized as) zero pollution, i.e., $m = P$, and $\alpha(\geq 1/2)$ is group L's share of total abatement. The government budget is balanced; thus, the transfer is equal to the tax revenue, i.e., $T = m$. The marginal cost of abatement is set to be unity. As it is shown in Alesina and Drazen (1991),[3] the first-order condition for this problem is derived with (1)–(4) as follows:

$$\left[-\frac{f(\phi)}{F(\phi)}\frac{1}{T'(\phi)}\right](2\alpha - 1)m/\rho = \phi P - (\alpha - 1/2)m, \tag{5}$$

where $T'(\phi) \leq 0$, indicating that a group with more environmental damage agrees to accept a heavier burden on policy implementation first. The left-hand side displays the expected benefit from waiting another period to concede. The term in brackets is the probability that, under the condition that a group in question has not yet conceded, the other group concedes at time $T(\phi)$. The other term in the left-hand side is the present discounted value of lower taxes if the other group concedes over the infinite horizon. The right-hand side indicates the cost of waiting another period to concede, in which the loss resulted from pollution without policy implementation, minus the cost for implementing the policy which can be saved over the period. Therefore, the optimal timing is determined if the expected benefit from waiting is equal to the cost of waiting. Because $P = m$, this condition can be rewritten as

$$T'(\phi) = -\frac{f(\phi)}{F(\phi)}\frac{(2\alpha - 1)/\rho}{\phi - (\alpha - 1/2)}. \tag{6}$$

Therefore (6) implies that, as the group L has the higher portion of pollution abatement α, the longer is the time of waiting.[4] The increase in α raises the expected benefit from waiting hoping that its opponent will bear this disproportionate burden and decreases the cost of waiting because the cost of policy provision which can be saved over the period is increased by it. Hence, each group holds out longer.[5]

3. Income Distribution and Environmental Policy

Having discussed the relationship between the disproportionate burden of abatement and the timing of policy implementation, the relationship between income distribution and the timing of policy adoption is displays in this section. To be more specific, whether the more dispersed level of income leads to the longer time of waiting is examined.

The basic structure of the model is the same as that of Alesina and Drazen (1991). Now the assumption of the equality in consumer's income is relaxed to allow a difference in individual income y_i. Their assumption is modified so that, when a certain level of pollution is given, the lower level of income leads to the more severe environmental degradation, i.e., $\phi = \phi(y)$, $\phi' < 0$, because tighter budget constraints of the poor may prevent them from carrying out averting activities. In this case, if the distribution of income is more dispersed, the regional disparities in environmental degradation become larger. Under these conditions, as it is also shown in Alesina and Drazen (1991), the more dispersed income distribution results in the longer time of waiting, i.e. $dT^E(\sigma)/d\sigma \geq 0$[6].

3.1. Empirical Test

Now, the above theoretical finding is empirically tested to examine whether income distribution has an impact on the ratification of the Kyoto Protocol in practice. The status of ratification of the Kyoto Protocol for Annex B party at the present time of writing is displayed in Table I. The dispersion of income distribution is represented by the Gini coefficient, GN_i, which is obtained from World Bank (2002). The status of ratification is obtained from the UNFCCC's web site in April, 2003 at the present time of writing. The dependent variable, T_i, indicates the status of ratification. Iceland, Liechtenstein, Luxembourg, and Monaco are excluded because the Gini coefficients for those countries cannot be found. "Timing," implying the timing of ratification, is defined to be 0 if a country has already ratified the Protocol and 1 if it has not ratified yet.

Table I shows that the mean of Gini coefficients for ratified countries is 30.000, and that for not-ratified is 36.1833. When the hypothesis test for a paired-mean difference is performed, the difference between the sample mean Gini coefficients of ratified and not-ratified countries is 6.1833, the Wilks' lambda is 0.846 with (1,32) degrees of freedom and an associated P value is $P = 0.022$. The mean difference of those pairs are statistically significant; thus, comparing these two groups are meaningful.

Second, the binomial probit model as well as discriminant analysis is employed to test whether or not the more dispersed income distribution delays the ratification of the Kyoto Protocol.[7]

First, maximum likelihood probit estimation is performed for the test by using the NLOGIT computer package. The following result is obtained:

Table I. The status of ratification of Kyoto Protocol: Annex B party in April, 2003.

Country	Timing	Gini coefficient
Australia	1	35.2
Austria	0	23.1
Belgium	0	25.0
Bulgaria	0	28.3
Canada	0	31.5
Croatia	1	26.8
Czech Republic	0	25.4
Denmark	0	24.7
Estonia	0	35.4
Finland	0	25.6
France	0	35.7
Germany	0	30.0
Greece	0	32.7
Hungary	0	30.8
Ireland	0	35.9
Italy	0	27.3
Japan	0	24.9
Latvia	0	32.4
Lithuania	0	32.4
Netherlands	0	32.6
New Zealand	0	43.9
Norway	0	25.8
Poland	0	32.9
Portugal	0	35.6
Romania	0	28.2
Russia	1	48.7
Slovakia	0	19.5
Slovenia	0	26.8
Spain	0	32.5
Sweden	0	25.0
Switzerland	1	33.1
Ukraine	1	32.5
UnK	0	36.1
UnS	1	40.8

$$\begin{aligned} T = {} & \underset{(-2.573)^{**}}{-4.1559} \quad + \underset{(2.064)^{**}}{0.0993GN}, \end{aligned}$$

in which $n = 34$, $\ln L = -15.8440$ and McFadden's ρ^2 is 0.1593. The analysis above indicates that there is a tendency that the more dispersed income distribution leads to the longer time of policy adoption; thus, it leads to the longer time of waiting. However, due to the nature of the maximum likelihood analysis, there is not sufficient number of observations. Thus, only the sigh of these coefficients may be relevant.

In addition to the above test, discriminant analysis is performed by using the statistical software SPSS on the same data. The following canonical correlation is derived

$$T = -5.466 + 0.176GN$$

in which the Wilks' lambda is 0.846, and χ^2 is 5.280. Hence, the Wilks' lambda statistic is significant at 5% for the Gini coefficients. As a result of these two analyzes, it can be tentatively concluded that the more dispersed income distribution has a negative impact on the timing of adopting the Kyoto Protocol; thus, it leads to the longer time of waiting.

4. Conclusion

From the above discussion, the timing of adopting an environmental policy has been examined. While existing analyses deal with scientific uncertainty and learning of the issues that are causing the delay, in this paper a dynamic game as a war of attrition (Alesina and Drazen 1991) has been applied and the timing has been examined from a viewpoint of distributional conflicts. The above argument implies that even if the immediate adoption of environmental policy is socially optimal, a disproportionate burden of pollution reduction leads to a delay in policy adoption. This is because the disproportionate burden increases the gain from waiting for each group hoping that the other group will agree to bear the heavier burden. The impact of income distribution on the timing has also been analyzed. As the disparities in income become more dispersed, each group expects that its opponent's damage becomes more severe and it gives in earlier. Thus, each group holds out longer so that the timing of the policy implementation is delayed further. In the last section, whether income distribution influences the ratification of the Kyoto Protocol has been empirically tested to find that the more dispersed income distribution has a negative impact on the timing of adopting the Kyoto Protocol.

There are obvious limits to the above argument. With regard to the empirical analysis, only preliminary results have been shown. The income distribution between developed and developing countries have not been examined. For the probit analysis, the number of observations is not sufficient. Other political, economic and ecological factors should also be examined. Possibly, the degree of damage relies not only on income but also on some ecological factors, for instance, how vulnerable the place is to sea level rise. These points should be further investigated.

Acknowledgements

The author would like to thank for suggestions by anonymous referees, which substantially improved the analysis. He is grateful to Akihisa Shibata and Kazuhiro Ueta for their informative advice and also thanks to Masayuki Sato for his helpful comments. This work is supported by the Japan Society for the Promotion of Science and partially by the Suntory Foundation. Nonetheless, remaining errors are the sole responsibility of the author.

Notes

1. The Kyoto Protocol may not be a good example of the free rider argument since the Protocol would not have come into force unless 55 countries with 55% of 1990 emissions have signed. However, in fact, the U.S. can be said a free rider because other nations, including Russia, signed the protocol.
2. The assumption, the amount of emission is equal to the level of income, seems too simplified. However, a more complex setting, for instance, the emission also depends on an environmental technology parameter β, i.e., $y = \beta P$, would not change the qualitative nature of the result.
3. Please see Alesina and Drazen (1991) for the derivation process.
4. As following Alesina and Drazen (1991), it is assumed that $\underline{\phi} > \alpha - 1/2$. If it were not the case, people would always wait and never concede, which is not the focus of this analysis. This assumption indicates $T'(\phi) \leq 0$.
5. The increase in α has a negative impact on $T'(\phi)$

$$\frac{d^2T(\phi)}{d\alpha d\phi} = -\frac{f(\phi)}{F(\phi)} \frac{8\phi}{\rho(2\phi - 2\alpha + 1)^2} < 0.$$

   Since $T(\bar{\phi}) = 0$ should be satisfied, $\tilde{T}(\phi) > T(\phi)$ for $\phi < \bar{\phi}$, which implies $\tilde{T}^E > T^E$. Here, $\tilde{T}$ implies expected time of adoption after α indicates the timing of adoption after ϕ is increased.

6. Please also see Alesina and Drazen (1991) for its derivation.
7. Those who are interested in probit analysis and discriminant analysis should consult Train (2003) and Morrison (1976), respectively.

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