POLITICAL ECONOMY OF ENVIRONMENTAL PROTECTION: DYNAMICS OF COLLECTIVE ACTION IN THE MONTREAL PROTOCOL

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Abstract

This paper analyzes the collective action problems observed in environmental protection policies at international level, particularly focusing on the issue of ozone depletion. Within the framework developed by Mancur Olson, it emphasizes the significance of a privileged actor(s) that is capable of punishing the defectors. In case of the Montreal Protocol, the U.S. was the privileged actor, for which the benefits of unilateral regulations against ozone depletion far exceeded its costs. As the hegemonic power of the new unipolar international order, the U.S. was capable of implementing various punishment mechanisms, making it significantly costly for other countries to avoid the protocol. On the other hand, in the case of global warming, American government was persuaded that the measures proposed in Kyoto protocol were not economically beneficial for the country. Hence despite the catastrophic nature of the threat-as perceived by the public opinion-the U.S did not back the Kyoto protocol, which in the absence of a hegemonic power lacked a credible threat mechanism and remained largely ineffective.

Key Words: *Collective Action, Environmental Economics, International Environmental Treaties, Kyoto Protocol, Montreal Protocol, Provision of Public Goods.*

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Özet

ÇEVRE KORUMACILIĞININ EKONOMİ POLİTİĞİ: MONTREAL PROTOKOLÜ'NDE KOLEKTİF FAALİYET'İN DİNAMİKLERİ

Bu çalışmada Mancur Olson tarafından geliştirilen çerçeveden hareketle uluslararası düzeyde çevreyi korumaya yönelik düzenlemelerde yaşanan kolektif faaliyet problemleri Montreal Protokolü sürecinden çıkarılan dersler üzerinden yeniden gözden geçirilmektedir. Bu perspektiften bakıldığında yasal düzenlemeleri tanımaktan kaçınan ülkeleri cezalandırma kapasitesine sahip "ayrıcalıklı aktörlerin" varlığının uluslararası anlaşmaların etkinliği üzerinde belirleyici bir rol oynadığı görülmektedir. Ozon tabakasını korumaya yönelik düzenlemeler ABD'de diğer dünya ülkelerinden daha önceleri gündeme gelmiş ve kimya endüstrisi alternatif teknolojiler geliştirmiştir. Ozon tabakasındaki deliğin yol açtığı cilt kanseri gibi hastalıklarla mücadelenin yüksek maliyetleri de göz önüne alındığında ABD'nin ekonomik çıkarları Montreal Protokolünün getirdiği düzenlemelerle denk düşmüştür. İmtiyazlı aktör konumundaki ABD'nin hegemonik gücü Montreal Protokolünü hatırı sayılır bir yaptırım gücüne sahip kılarken, aynı ülke küresel ısınmaya yönelik düzenlemelerden ekonomik kaygılarla geri durmuş ve Kyoto Protokolü'nün yaptırım gücünün dolayısıyla da etki alanının sınırlı kalmasına neden olmuştur.

Anahtar Kelimeler: *Çevre ekonomisi, Kamu mallarının üretimi, Kolektif faaliyet, Kyoto Protokolü, Montreal Protokolü, Uluslararası Çevre Anlaşmaları.*

1. Introduction

Protection of the stratospheric ozone layer has been an environmental concern since the mid-1970s, when it was discovered that chlorine could potentially deplete the ozone layer. However, ozone depletion emerged as a vital international problem only after significant losses of ozone were reported in 1985. Since then, the principal international policy instrument for the protection of the stratospheric ozone layer has been the Montreal Protocol, which now includes 193 signatory nations worldwide.[1] Due to its widespread adoption and implementation, the protocol has been hailed as an example of exceptional international cooperation with Kofi Annan quoted as saying it is "Perhaps the single most successful international agreement to date..." (UNEP, 2006). The protocol proved that prisoner's dilemma is not a destiny for all environmental problems requiring collective action at the international level.

[1] As of 25 June 2008, those who have not signed the protocol are Andorra, San Marino and Timor-Leste (UNEP, 2008).

This paper examines the distinguishing features of the Montreal protocol, which rendered its success. This analysis will also enable us to identify the reasons for the shortcomings of the Kyoto Protocol.

2. Environmental Protection as a Public Good

In the last three decades economics literature witnessed a surge in environmental studies, which led to the emergence of a field called environmental economics. At the very heart of environmental economics lies the concept of "market failure", i.e. market fails to allocate the scarce resources in the manner that generates the greatest social welfare. One major reason for market failures are the externalities that occur when an agent makes a choice (such as deciding the level production) given the market prices, which in turn imposes costs or yield benefits on other people that are not accounted for in the market prices. For instance, in the absence of environmental regulations a firm emitting pollution will not take into account the costs its production imposes on other people. In such cases, government intervention is needed to issue and enforce new regulations in order to reach a socially efficient outcome.

Another concept heavily utilized in environmental economics is "public goods". The distinct feature of public goods is that their consumption is non-rivaled and non-excludable. This means that consumption of a public good does not reduce the availability of the same good for others and people cannot be excluded from consuming it.[2] Because of these features, the production of public goods results in positive externalities, which are not remunerated. Since people can take advantage of these externalities without sharing the burden of provision, there remains little or no incentive for private agents to provide public goods. Hence, even though it is in everyone's interest that public goods should be provided, it might be in no one's individual interest to provide them since everyone might do better by trying to "free ride" on the actions of others.

[2] Goods have varying degrees of publicness. Some goods are pure public goods that are absolutely non-rivaled and non-excludable such as air. There are also goods that are non-rivaled but excludable such as internet and cable television. These are called club goods. Some goods on the other hand are non-excludable yet rivaled. These are common pool resources such as the fish stock. Everyone has access to these resources, but since they are finite "over-consumption" of some actors might cause others to be deprived from these resources. This problem is often cited as the tragedy of the commons. A loaf of bread on the other hand is a private good, whose consumption renders it unavailable for others and the owner of the bread has the exclusive right to its consumption.

Thus, when left to market forces public goods would remain underprovided or not provided at all (Coase, 1974).

The geographical range, over which goods exhibit features of publicness, is called the spill-over range of the public good. Public goods are grouped under four categories based on their spillover ranges: local, national, regional and global (Binger, 2003:6). A lighthouse is a local good, which only benefits the vessels within its radius of influence (Binger, 2003:6). National health or education systems are typical national public goods. Regional public goods benefit a group of nations with contiguous borders such as pest control, curbing acid rain or geoclimatic-specific agricultural research. Global public goods, on the other hand, benefit all humanity, such as protection of the ozone layer or curbing global warming.

At the national level the government can either step up and provide the public good itself or enforce laws that induce its citizens to contribute to the provision of the public goods. The basic problem with the provision of international public goods (regional and global goods) is the absence of an international body, which is capable of providing these goods or enforcing the regulations worldwide. In some cases, countries acting in their own interest contribute to the provision of the IPGs. They build safer financial systems, better health systems for their own interest, which in turn contribute to the stability of world finance or eradication of a regionally or globally threatening disease. But, in the absence of a superior enforcement mechanism, which most international treaties lack, countries choose to free-ride on others' efforts unless they receive net benefits from contribution.

3. Collective Action Failures and the Provision of Global Public Goods

3.1. The Logic of Collective Action

In his seminal work "The Logic of Collective Action: Public Goods and the Theory of Groups", Mancur Olson (1965) investigated the dynamics involved in formation of groups aimed at provision of public goods. Olson pointed out that "rational, self-interested individuals will not act [voluntarily] to achieve their common or group interests" due to the non-excludability of the public good, which compels the rational individual to restrict his own contribution in order to maximize his individual welfare (Olson, 1965:2). Since

Olson’s work, the so called “free-rider problem” has been identified as the major source of collective action failures.[3]

According to Olson, provision of a public good would require the presence of a “privileged actor(s)” within the group, who would derive net benefit from his contribution regardless of the contribution levels of the other actors. Olson also suggested that group size is inversely related to the success of the collective action. In large groups each actor’s gain from his own contribution to the public good would be so small that privileged actors were less likely to emerge. For instance, it is a proven fact that smoking causes pollution. But knowing that his cigarette is only one among millions of others, environmental concerns (leaving aside personal health concerns) would not suffice for an individual to stop smoking. The same is true for littering the sea, in which an individual’s contribution might be limited to a can of soda, but when summed up with the littering of millions of others they lead to substantial water pollution.

Olson asserted that “privileged groups” that are small enough to contain at least one privileged member would provide its members with a certain level of collective good, even if not at optimal level (Olson, 1965:48-50). Even in small groups, when left to market forces, the large privileged actor would provide the public good, and the small actor would choose to free-ride on his contribution. According to Olson, there was a “systematic tendency for exploitation of the great by the small”(Olson, 1965:35).

“Intermediate groups” are distinguished by the absence of the privileged actors, but the group size is still sufficiently small that defection is noticeable (Olson, 1965:48-50). Coercion or inducement is needed for a large group to provide a collective good because the individual contribution of a group member would be insignificant to the overall provision. In the absence of selective incentives there would be no motivation for participation within a large group. However, larger the group, the more difficult and costly is the detection of free riders. Hence, as the group size becomes larger than

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3 Although the term free-rider was never used within Olson’s text, the term has almost been identified with the book itself. The closest Olson comes to using the terminology is the following paragraph: “Once a smaller member has the amount of the collective good he gets free from the largest [privileged] member, he has more than he would have purchased for himself, and has no incentive to obtain any of the collective good at his own expense (Olson, 1965: 35).

intermediate then it is latent and is unlikely to provide its members with any level of collective good (Olson, 1965:48-50).

Since the publication of the “Logic of Collective Action” the universal validity of the Olsonian propositions has been challenged by a wide range of scholars in the field. Nevertheless, despite its limitations Olson’s work became widely popular in the literature due to the insights it offered to everyday collective action problems. One major issue of criticism has been the universality of the assumption of summation technology in the supply of public goods, which led to prisoner’s dilemma type of collective action failures. More recent contributions in the field pointed out the presence of numerous other technologies of public supply that helped to explain many instances where collective action problems did not necessarily arise even in large groups (Hirshleifer, 1983; Sandler, 1992).

3.2. Provision of Global Public Goods under Alternative Aggregation Technologies

Provision of a global pure public good benefits every country regardless of their contribution. But only the countries that provide the public good pay for its provision. So each country may rather choose to free ride on other's provision. This incentive to free ride causes the total provision of the public good to remain in very low levels. Hence, Nash equilibrium occurs at a point inferior to the Pareto efficient outcome. The collective action problem outlined is Olsonian type of international collective action problem, which is usually described by the well-known prisoner's dilemma game in a 2x2 matrix. In this game, summation technology of public supply aggregation applies. With summation technology, every agent's contribution is a perfect substitute for that of another, so each unit contributed adds the same at the margin regardless of who gives.

This technology is represented by,

$$Q = \sum_{i=1}^{n} q^{i} , \qquad (1)$$

where the total amount of the public good (Q), equals to the sum of the n agents' individual contribution (Sandler, 1998:224).

In the game matrix, each player has two strategies: to cooperate by contributing to the provision of public good or to defect by not contributing. The assumption behind this game is that individual cost of provision exceeds the individual benefit. Let us assume that each contribution gives both players a benefit of 5, at a cost of 6 only to the provider. If both players contribute they both receive a net benefit of 4 (10-6). But, if only one of them contributes and the other one chooses to free ride on other's provision then the contributor gets -1 (5-6) and the non-contributor gets 5 as a net benefit. When neither of them contributes their pay offs are zero and no public good is provided. Here defection is the dominant strategy for both players. Even though the players make rational decisions, the game ends up with collective failure where neither of them contributes.

Figure 1: Strategic behavior under summation technology

		Country A	
		Cooperate	***Defect***
Country B	***Cooperate***	***4,4***	***-1,5***
	Defect	***5,-1***	***0,0***

Source: Sandler,1992:43.

Under the assumption of the summation technology, identity or the location of the provider of the public good makes no difference. Hence, there is perfect substitutability between the individuals' contributions. Elimination of air pollution where total emission is the sum of pollution emitted by all actors is a typical example.

In some cases, the location or the identity of the provider might affect the level of provision of the public good. Under these circumstances, when summation still applies but contributions do not have the same weight on total provision of the public good, the technology of supply is called the weighted-sum technology (Sandler, 1998: 226).

$$Q^i = \sum_{j=1}^{n} \alpha_{ij} q^j \ , \ i = 1,2,...,n \qquad (2)$$

where Q^i denotes the total amount of public good received by nation i, q^j denotes the provision level of country j and α_{ij} is the share country i receives from country j's provision. Considering that this equation applies to all n countries, the overall technology can be represented by

$$Q = Aq \quad (3)$$

where Q is the $n \times 1$ vector $(Q^{i}, \ldots, Q^{n})$, A *is* the $n \times n$ matrix of the α_{ij} s and q is the $n \times 1$ vector $(q^{i},\ldots,q^{n})$. In the matrix A, if all the diagonal α_{ij} s are 1, then the model turns into a typical pure public good model where summation technology applies. On the other hand, if all the α_{ii} s are 1, but the off-diagonal α_{ij} s are 0, then it means that country i's provision benefits no one but country i, hence it a pure private good model follows (Sandler, 1998:226-227). The matrix A is symmetric when the distance from the provider determines the share one country receives from another country's provision. A typical example is national parks, in which distance determines the benefit derived. However, when direction matters the matrix becomes asymmetric. In case of sulfur emissions, emission in one region is carried to another by the wind. Hence, direction of the wind determines the share of pollution the neighboring countries get from a country's emission.

Weighted summation does not necessarily imply a prisoner's dilemma. If α_{ii} s are large enough that a country derives net benefit from its own contribution, then contribution becomes the dominant strategy. In other words, the greater the country specific benefits from a public good, the greater the inducement to contribute. Also, several studies have shown that weighted sum technology might host various other game forms including coordination and assurance games (Runge, 1984; Sandler and Sargent, 1995).

In cases where perfect substitutability does not work and the supply technology cannot be simplified under the weighted sum assumption, other functional forms might be required to express the relationship between the individual contributions and the supply of the public good. Another important supply technology is the weakest link where the smallest provision determines the total level of provision (Sandler, 1998:227).

$$Q = \min \{ q^{1}, q^{2}, \ldots, q^{n} \} \quad (4)$$

One well known example of the weakest link technology is the erection of dikes in a circular island where the level of flood protection is determined by the height of the lowest barrier (Hirsheliffer, 1983:371). The weakest link technology applies to global or regional efforts to prevent the advancement of contagious diseases. The failure of such protective measures in one region causes the disease to gain a stronghold and spread faster than before.

Environmentalists argue that despite improving environmental regulations in various developed countries, many environmentally harmful industries choose to relocate their production to the third world countries where environmental regulations (if exist at all) are not enforced. Hence, most governments in the developing countries are reluctant to pass environmental legislations or enforce the existing ones, in order to remain competitive, avoid capital outflow, and attract foreign capital that seeks to relocate its production facilities due to increasing costs imposed by environmental regulations in developed countries. To sum up the argument, cost driven competition in the global markets creates an incentive for relocation, which leads to a race to the bottom in environmental standards. Weakest link technology applies to the "race to the bottom" argument (in terms of environmental standards) since the country most "flexible" in terms of environmental regulations sets the standard for the other developing countries. This is one of the major reasons why environmental problems cannot be solved at the national level and international organizations are required for the enforcement of environmental regulations.

The following 2x2 matrix illustrates a case where weakest link applies. Each agent chooses whether to contribute or not to the provision of the public good at a cost of 4. If they both contribute they receive a benefit of 5. Hence mutual cooperation yields a net benefit of 1. When one of them defects, the public good is not provided at all, since lowest contribution determines the provision level of the public good under weakest-link technology. Hence, non-contributor receives nothing while the contributor ends up with the cost of his contribution without reaping any benefit in return. The game has the structure of an "assurance game" with two pure-strategy Nash equilibria at mutual cooperation (1,1) and mutual defection (0,0). The strategic point is that if agents trust each other they opt for contribution since mutual cooperation outcome is more efficient than mutual defection. Otherwise, it is most likely that both parties would choose to defect, since single-handed contribution is a very costly move.

Figure 2: Strategic behavior under weakest-link technology

		Country A	
		Cooperate	***Defect***
Country B	***Cooperate***	***1,1 ****	***-4,0***
	Defect	***0,-4***	***0,0****

Source: Sandler,1992:43.

In "assurance games" such as the one above, agents make their decisions by assigning a probability to the other agent's strategies and then assess their expected benefits from alternative strategies. In our case, country B assumes that country A would choose to cooperate with a probability of p and defect with a probability of 1-p. Then, country B would receive p-4(1-p) if chose to contribute and 0 if it chose to defect. Hence, the p value required for country A to be indifferent between two strategies is p- 4(1-p) = 0; it would choose to cooperate if p>0.80 and defect if p<0.80.

As shown in this example mutual cooperation might require high level of trust in cases where weakest-link technology applies. In such cases, reputation of the players also plays a crucial role in forming the probability assignment of other players regarding their strategy choices. We should also note that by imposing penalties for status quo, we could eliminate mutual defection as a pure strategy equilibrium and turn the game into a privileged game where both agents' dominant strategy is to cooperate. In this example a penalty of -5 on defection would suffice to do the trick.

Another technology in the provision of public goods is called the best-shot technology where the largest individualized effort determines the level of public provision (Sandler, 1998: 231)

$$Q = \max\{q^1, q^2, ..., q^n\} \tag{5}$$

The following 2x2 matrix illustrates a case where best shot technology applies. In this case, first unit of contribution yields 5 unit of benefit to each party regardless of the contributor, but additional contribution does not increase the benefit. Hence, for the provision of the public good it is sufficient if only one agent contributes.

This game is a typical "coordination" game with no dominant strategy but two pure strategy equilibria (CD) and (DC). Mutual cooperation (CC) is Pareto inferior to the equlibria since contribution of the second agent only increases the cost but does not add up to the benefit. Aside from the pure strategy equlibria the game has a unique mixed strategy equilibrium which can be found the same way as in the weakest link example.

Figure 3: Strategic behavior under best-shot technology

		Country A	
		Cooperate	***Defect***
Country B	***Cooperate***	***1,1***	***1,5****
	Defect	***5,1****	***0,0***

Source: Sandler,1992: 39.

This technology applies to most breakthroughs in science that require large amount of funding for research and development. Researching a cure for AIDS or cancer is a typical example of this technology. It also applies to the development of environment-friendly substitutes for hazardous or health/environment affecting substances.

Best shot and weakest link technologies have contrasting policy implications. In weakest link technology it is important to fund the weakest partner. On the other hand, in best shot technology funds should be channelized to a single source i.e. the most technologically advanced actor. One problematic aspect of this proposition is that some public goods that are crucial for poor nations might be undersupplied (or not supplied at all) if rich donors do not have interest in is provision, such as in case of malaria to which rich countries remained indifferent because it did not pose any threat to their population (Binger, 2003:13).

4. CFCs and Stratospheric Ozone Depletion

Chlorofluorocarbons (CFCs) are a group of inert, nontoxic, and nonflammable synthetic chemical compounds used as aerosol propellants in refrigerators, air conditions, and in plastic foams for insulation and packaging. Until 1970s it was believed to be environmentally safe to use these compounds. Since then successive independent studies raised a question about a serious problem relating the use of CFCs with the depletion of the stratospheric ozone layer, which protects the earth from the harmful UV-B radiation. Studies have shown that when cooled in polar winter nacreous and nitric acid trihydrate (NAT) clouds trigger a reaction that causes the stable chlorine reservoirs to release molecular chlorine. The resulting chlorine along with ozone is broken down by sunlight and in the process they combine to form chlorine monoxide and oxygen. Ozone layer is depleted during this chemical process. Once in the atmosphere, CFCs have a long life time, about 100 years (UNEP, 2006). Hence, the depletion of the ozone layer is irreversible in the short run.

Studies have also shown that an increase in the amount of UV-B radiation reaching the earth surface can have serious negative effects on human health, plants and aquatic ecosystems. Health effects include skin cancers, suppression of the immune system leading to a higher incidence of infectious diseases, and eye disorders such as cataracts or retinal damage. Besides its health effects, researches also suggest that increased UV-B radiation cause a decrease in crop production and a change in the composition of the species in natural aquatic ecosystems, which may also reduce fishery productivity.

The most significant health effect of increasing UV-B radiation is the increasing incidences of skin cancer. In the U.S. Environmental Agency (EPA) reports, it is estimated that one percent decrease in ozone would cause a two percent increase in UV-B and one percent increase in UV-B could result in a two to five percent increase in the rate of non-melanoma skin cancers. Scientific evidence also shows that increase in UV-B might also cause an increase in the rate of melanoma skin cancer, which is rarer but more deadly. EPA estimations illustrate the magnitude of the potential danger; if CFC use continued to grow at 2.5% a year, an additional 150 million skin cancer incidences could occur, causing more than 3 million death in the U.S. population born before 2075 (Morisette, 1989). In addition, it is proved that CFC is also an efficient greenhouse gas in the lower atmosphere, which means that any action taken to curb ozone depletion would also contribute to the global warming problem.

The evolution of the stratospheric ozone depletion policy can be understood as a two stage process. First stage is the emergence of ozone depletion as a domestic issue in the United States, and some other countries particularly in Canada and Sweden in the 1970s. This stage includes development of domestic regulations controlling CFC use in these countries.

Second stage is the development of an international policy response to the problem in 1980s.

5. Domestic Regulations to Curb Ozone Depletion

Ozone depletion, as an issue of public concern, first emerged in 1970s in the United States over the development of a commercial fleet of supersonic transports. In 1978 the use of CFCs as aerosol cans have been banned in the country. During this time most European countries showed little or no response.

There were several reasons for the different responses of the U.S. and European countries (Downing and Kates, 1982).

1- The threat of ozone depletion from the proposed fleet of U.S. commercial supersonic transports (SST) was one of the arguments that had been used by the environmentalists to stop the project. So, ozone depletion was already a political issue in the U.S. even before the discovery of the role of CFCs as ozone depleters.

2- Growing public interest in the U.S. on the issue of ozone depletion was the result of both growing importance of environmental problems as political issues in the country and growing public concern about cancer and its causes.

3- Above all, Europeans were not convinced that a problem existed. They argued that the U.S. was being motivated by economic rather than environmental concerns. Especially the British and French who were involved in developing a commercial SST were skeptical to Americans' motivations, believing that the real concern of the U.S. authorities was the prospects for European dominance in commercial supersonic flights.

6. Ozone Depletion as an Issue of International Concern

Before the signing of the Montreal protocol, some countries had already regulated the production of CFCs especially by restricting their use in certain products like aerosol spray cans. But by 1980s, the use of CFCs in some other industries increased progressively. Between 1975 and 1982, the use of CFCs in the manufacture of computer chips more than doubled. In mid 1980s, with the end of the global economic recession, the demand for CFCs started to grow more rapidly. Demand for CFCs had been growing at five percent annually since 1983, and by 1986 it had reached the levels that existed in mid 1970s before CFC regulations. Increasing demand for refrigerators from all over the world played an important role in this process (Morisette, 1989).

It was during this period when ozone depletion emerged as a global problem in the international political arena. Vienna Convention in 1985 was an important step in legitimizing ozone depletion as an international political issue and providing the framework for the Montreal protocol. After Vienna Convention, the key question was no longer whether there would be a protocol, but rather how strong it would be.

Two weeks after the Vienna Convention, the British Antarctic Survey, reported that between 1977 and 1985 the ozone layer over the Antarctic had been depleted by 40%. This so called "hole" in the ozone layer was shifting northward during the summer and mixing with other air masses, thus depletion was being shared worldwide on a more or less equal basis (Sandler, 1992:169). This scientific evidence, showing the real dimensions of the problem played a crucial role in the success of Montreal protocol.

6.1. Montreal Protocol

In September 1987, representatives from 24 nations signed the "Montreal Protocol on Substances that Deplete the Ozone Layer". The Montreal Protocol required phasing out of the production and consumption of compounds that deplete ozone in the stratosphere— chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform- by 2000 (2005 for methyl chloroform) (UNEP, 2008).

The protocol entered into force on January 1, 1989, with 30 signatories including the European Community. These participants were together counted for 83% of the global consumption of the ozone depleting substances that were listed in the Montreal Protocol. The Montreal Protocol included following features: By July 1993, the ratifiers were supposed to reduce their annual consumption and production of CFC's to 1986 levels. For subsequent years until 1 July 1998, annual consumption and production could not exceed 80% of 1986 levels. After this date it would be kept below 50% of 1986 levels. In 1990 they banned the import of ozone depleting substances from non-ratifiers; and starting in 1993, a similar ban was applied to the export of these substances (UNEP, 2000).

The treaty was substantially amended in 1990 and 1992. By year 2000, 175 countries had committed to a precise schedule for reducing and eventually phasing out their use of ozone depleting substances under the Montreal Protocol. The agreement had different requirements for so-called Article 5 countries (developing countries). The first important step for developing countries was the freeze of Annex A CFCs (CFC-11, -12,-113,-114.-115) at the 1995-1997 average levels, which came in to effect on July 1999. After this date Article 5 countries would reduce the use of these substances 50% by 2005, 85% by 2007 and 100% by 2010 (UNEP, 2000). So, Article 5 countries had great inducement to sign this protocol, because they could delay compliance by ten years and in this time period they could gain technical and financial assistance while remaining exempted from trade sanctions.

6.2. Key Factors Underlying the Montreal Protocol

There were some key factors underlying the evolution of ozone depletion into an international policy concern:

6.2.1. Evolving Scientific Understanding of the Problem

Uncertainty in the causes of ozone depletion was the major argument of the CFC producers against those of the environmentalists. CFC producers in US, Europe and Japan had engaged in a long battle against the regulation of CFCs arguing that there was no clear scientific proof that CFCs were harmful to the ozone layer (Morisette, 1989).

The evolving scientific understanding of the stratospheric ozone depletion problem showed the magnitude of the potential disaster and influenced the policymakers. Gaining knowledge of the problem is one of the most effective motivators for cooperation. It also needs to be available and taken seriously when there is still to time to avert a disaster. In 1985, when nations were provided with indisputable evidence that ozone layer was thinning at a higher rate than it was previously predicted they were convinced to curb CFC emissions (Sandler, 1997:8). The British Antarctic survey was the turning point in the evolution of ozone depletion problem (Sandler, 1992:169).

6.2.2. Catastrophic Nature of the Risks and Increasing Public Interest

Public perception of the risks from an environmental problem can have a significant effect on policymakers' decisions. In ozone depletion case, the perception of the potential for a global disaster and increasing public concern on the problem was particularly based on the threat of skin cancer associated with the discovery of the Antarctic ozone hole.

There are several factors determining the extent of the public perception. Slovic identifies a shared set of characteristics called “dread” that help to explain how the public perceives risks from certain technologies and hazards. These risks are perceived to be high in dread if they are globally catastrophic, threatening the future generations, increasing, hard to prevent, not easily reduced, involuntary, and personally threatening (Morisette, 1989).

In addition to the dread factor, Morisette (1989) defines two other factors, determining the level of public perception. One of them is familiarity with the threat, depending on the observability of the risks and whether the effects are immediate or delayed. Ozone depletion problem shares many of these characteristics to a great extent. Last factor is the extent of exposure. As mentioned before, uniform mixing of the stratosphere occurs within a few years, thus the ozone depletion problem creates a worldwide threat. Another notion to be noted is the irreversibility of depletion. Considering the long period of time it has taken for the ozone shield to develop, depletion cannot be reversed quickly, but can be stopped, which still provides large benefits even in the short run.

Distribution of the intra-national costs of banning CFCs was an important factor increasing the effectiveness of public perception. Earnings derived from CFCs affect only a small proportion of the industries. Hence, once people comprehended the health risks associated with ozone depletion, the majority of the population in the CFC producing countries supported phasing out of CFCs, thereby exerting pressure on the policy makers. It is a known fact that pressure groups, especially the environmentalists in developed countries played a significant role on the decision making process for curbing the ozone depletion (Andersen and Sarma, 2002:340).

6.2.3. Industry's Position and Availability of Substitutes for Ozone Depleting Substances

As mentioned earlier, producers of CFCs were strictly opposed to any kind of regulation on these compounds. The basic argument of the industry lobbies was that there was no clear scientific proof that CFCs were depleting the ozone shield. In the mid 1980s increasing demand for CFCs were accompanied by the growing scientific evidences on the role of CFC as a serious threat to the ozone shield. Growing public concern on the problem following these scientific advancements forced the industry to reevaluate its position.

In the meanwhile, chemistry industry had already been working on developing new chemicals such as CFC-123 and -134, which decomposed in the troposphere and could be used as substitutes for CFC-11 and -12. During the transition period, availability of new acceptable substitutes for CFCs could even provide a monopoly power to larger producers in the industry. DuPont, the largest producer of CFCs with 25% of the global market, had already announced that suitable alternatives would be available within a few years. Knowing that it would obtain even a more advantageous position in the industry, DuPont strongly supported an international agreement on curbing the ozone depletion (Morisette, 1989).

7. Economic Analysis of Ozone Depletion Problem

For a better understanding of the U.S. government’s approach to the ozone depletion case, it is crucial to have a closer look at the cost-benefit assessments made by governmental agencies prior to the ratification of the protocol. The USEPA’s (United States Environmental Protection Agency) projections illustrated three different scenarios for curbing ozone depletion. In the first scenario, no controls are adopted by any country. In the second scenario only the US adopts the requirements of the Montreal Protocol. The last scenario is the one that gives the most likely outcome where the protocol is adopted by 94% of the industrial countries and 65% of developed countries.

Table 1: Cost-Benefit analysis of ozone depletion for the u.s. under three scenarios

Ozone Depletion (%) by	**No controls**	**Montreal Protocol**	**Unilateral Implementation of the Protocol by the US**
2000	1.0	0.8	0.9
2050	15.7	1.9	10.3
2100	50.0	1.2	49.0
Benefits and Costs to the U.S (billions of U.S. dollars)			
Benefits	–	3,575	1,373
Costs	–	21	21
Net Benefits	–	3,554	1,352

Source: Barrett, 1999:201.

Estimations illustrated that by 2001 ozone depletion could be reduced from 50% - with no controls adopted- to 1.2% with the existing requirements and participants of the protocol. Another fact drawn from the above figures was the need for collective action. According to the estimations, unilateral actions by the United States would have a significant effect on ozone depletion in the short run, but in the long run ozone layer would be depleted by 49% (based on the estimations for year 2100).

Largest part of the benefits from curbing the ozone depletion would be the avoidance of cancer related illnesses and death. Based on the estimations of the USEPA, present value of net benefits from avoiding cancer death was counted in trillions of dollars for the United States. This amount included the costs of treatment and costs of cancer deaths, which were taken to be the value of a statistical life (Barret, 1999:200).

On the other hand, costs of abatement were based on the replacement of ozone depleting substances and products using these substances with ozone-friendly substitutes. Costs of abatement also included the research and development expenditures for the development of acceptable substitutes and costs of implementing the policies of Montreal Protocol (Barret, 1999:201).

The most important result of this analysis was that the benefits of adopting the requirements of Montreal Protocol exceeded the costs by a wide margin, irrespective of the behavior of the other countries. Although this cost benefit analysis was only conducted for the U.S., the results could be generalized for most other industrialized countries.

8. A Game Theoretical Approach to Montreal Protocol

Ozone depletion is a global pure public bad. In other terms, reduction in the production and consumption of ozone depleting chemicals is a global pure public good. The release of CFCs and other ozone depleting substances thins the ozone shield that protects plants and animals from harmful ultraviolet radiation. The depletion of the ozone shield has worldwide consequences, thus it is non-excludable. One nation's increased exposure to enhanced ultraviolet radiation does not lessen the risks for other nations; so it is also non-rival (Murdoch and Sandler, 1997).

Although Prisoner's Dilemma has become almost synonymous with international treaties, the Montreal Protocol proved that it's not necessarily their destiny. Even with the summation technology it is possible to end up at a cooperative equilibrium. In the case of Montreal Protocol, the key point is the existence of a privileged actor who receives a net benefit from individual contribution regardless of the actions taken by the others.

As mentioned before, in ozone depletion case, the primary producers and users of CFCs are a relatively small number of industrial countries that also spend billions of dollars to cope with illnesses related with the depletion of the ozone layer. So we may assume that the game is being played by a small number of countries that gain net benefit from their contribution even if they act unilaterally.

Figure 4: Fully Privileged Game with n Players

Number of cooperators besides i					
i's strategy	*0*	*1*	*2*	*...*	*n-1*
Cooperate	*3*	*9*	*15*	*...*	*6n-3**
Defect	*0*	*6*	*12*	*...*	*6(n-l)*

Source: Modified from n-person games developed by Sandler (1992).

When individual benefits exceed the individual costs and summation applies, the group is fully privileged. Here we have a game matrix for n players, where n is the group size including the individual i. The rows indicate the strategy of individual i and the columns refer to the actions of the other contributors. The pay offs listed are those of individual i. For this game, suppose that each unit of public good brings a benefit of 6 to all parties at a cost of 3 to the provider. Now, even if the other players defect, i still gains a net benefit of 3 from contributing. So contribution to the provision of the public good is beneficial for individual i irrespective of the others' behavior. Given that the benefit of contribution exceeds the provision cost for every individual, dominant strategy is to contribute for all players and we reach the cooperative equilibrium, where n players including i, contribute to the provision of the public good.

One may argue that under the existing full privileged model, the protocol seems useless. Even without the protocol we can reach the cooperative equilibrium with unilateral actions because benefits exceed the costs even, if the actors act unilaterally. For a better understanding of the protocol, we must extend our analysis. Until this point we considered a public good provided by a small fully privileged group of countries that place higher value on environmental protection. But, tastes may differ among countries thereby creating a considerable asymmetry in their payoffs. As often pointed out, environmental concerns are closely related with the level of income and the effectiveness of democratic institutions (Murdoch and Sandler, 1997). Some countries may place lower value on environmental issues and their effects. This situation may result with a leakage, which in this case means the relocation of the production of the ozone-depleting substances to these countries. Nevertheless, Montreal protocol has credible threat mechanisms to prevent this leakage.

First, banning the importation of ozone-depleting substances and goods incorporating them, it reduces the incentives for relocation of production. Second, the agreement also discourages the exportation of technology for the production and utilization of these substances to any non-signatory countries. The credibility of sanctions is another important feature of Montreal Protocol. If the sanctions deter the relocation of production or emissions, then the countries imposing the sanctions gain by imposing them. This, in turn reinforces the credibility of sanctions (Barret, 1999:215).

In order to illustrate the importance of trade sanctions we will add another game with n players, with a threshold j. This threshold shows the minimum number of participants that are required for the protocol to take place. The row player i is a less developed country placing lower value on environmental issues. For this game, suppose that each unit of public good brings a benefit of 2 to country i at a provision cost of 3 and after the threshold is achieved a punishment of-2 is practiced on the non participants. Thus, until the threshold j, country i's costs of participating exceed the benefits. After this threshold is achieved, now there are sufficient participants to create a credible threat and effective trade sanctions are practiced on the non-participants. Hence, if there are less than j participants other than i, then defection is the dominant strategy for country i. On the other hand, if the participants exceed j, then the protocol enters into force and trade sanctions make contribution the dominant strategy. Thus, we end up with two equilibriums: First is the one where none of them contributes and the second one where all parties contribute.

Figure 5: Cooperative equilibrium under trade sanctions

Number of cooperators besides i

i' s strategy	*0*	*...*	*j-1*	*J*	*j+1*	*...*	*n-1*
Cooperate	*-1*		*2j-3*	*2j-1*	*2j+1*		*2n-3**
Defect	**0*		*2(j-1)*	*2j-2*	*2j*		*2n-4*

The key point is the minimum amount of participants that are required for the protocol to enter into force. In Montreal Protocol this amount was very small, because in ozone depletion case, a small number of developed countries produced a large proportion of ozone-depleting substances. Montreal protocol would enter into force after being ratified by 11 countries, which accounted for at least two thirds of the worldwide consumption of the ozone depleting substances. Since this threshold was already reached by developing countries, whose benefits from participation exceeded their costs, country i chooses to contribute and we reach the cooperative outcome. Hence, the effectiveness and the credibility of the trade sanctions in Montreal Protocol changed the dominant strategy for all countries and ensured the cooperative equilibrium.

9. Curbing Global Warming: Why did Kyoto Protocol Remain Ineffective?

When the sunlight passes through the atmosphere, it warms the Earth's surface, which reradiates it back into the atmosphere. Greenhouse gases absorb some of the radiation and trap it in the lower atmosphere, while the remainder is emitted to space. Since the industrial revolution, the emission of these gases has risen dramatically. Fossil fuel_combustion, increasingly intensive agriculture, and an expanding global human population have been the primary causes. While some greenhouse gases such as water vapor, carbon dioxide, methane, nitrous oxide and ozone also occur naturally, human activities contribute to their production in growing amounts. Others such as hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride result exclusively from industrial activities (IEA, 2002). As the industry grows human activities cause more emission of greenhouse gases through driving cars, using electricity from coal-fired power plants, or heating with oil or natural gas. Deforestation also contributes to global warming, since fewer trees means conversion of less carbon dioxide to oxygen. The Kyoto Protocol, signed in 1997, aims to reduce the use of greenhouse gases in an effort to prevent climate change.

The Montreal Protocol and the Kyoto Protocol resemble each other in several aspects. Just as the depletion of the ozone layer once was, today global warming is widely believed to be the world's most threatening environmental problem. Both environmental problems received public attention on the basis of relatively recent scientific work. The risks of ozone depletion were first explored in a paper published in 1974. The risks of climate change have even a longer history (as they were identified as early as in 1896), but the current academic consensus is considered to be a product of the research in 1990s (Sunstein, 2006:2). Both CFCs and greenhouse gasses stay in the atmosphere for a long time, hence the damage is irreversible in the short run. Both problems are international and intergenerational in the sense that all nations and future generations are affected by the damages inflicted on the environment. It is also true that the elimination of both problems requires international cooperation and cannot be delimited by a unilateral action of any nation. Finally, the U.S. appears to be the key actor in both problems not only as a major emitter of the ozone depleting chemicals and the greenhouse gases but also the hegemonic power of the modern capitalism (Sunstein, 2006).

One crucial difference between the protocols is that while the Montreal protocol has been a smashing success in eliminating ozone depleting substances, Kyoto protocol still lacks the full support of the international community despite the fact that it proposes taking modest steps toward the stabilization of greenhouse gas emissions. Kyoto protocol, signed in 1997, went into force in 2005 after Russia's ratification and as of January it has been ratified by 184 nations including major emitters such as the EU, China, Brazil and India (UNFCCC, 2009). Nevertheless, under the current protocol, developing nations have no obligations besides monitoring and reporting their emissions. As a result, emissions of greenhouse gasses in these countries continue to climb steadily despite their ratification of the treaty. In 2007, China overtook U.S. in the carbon dioxide emissions to become the largest emitter in the world (NEAA, 2008). The U.S. is the only developed country that did not ratify the protocol. It backed the Kyoto treaty in the early phases of the negotiations, however powerful industrial lobbies who felt threatened by the treaty convinced the senate in 1998 to vote 95-0 to prohibit further U.S. involvement in the negotiations (White House, 2001).

Several academic and governmental studies shaped the perceptions of the U.S. senate and fueled the economic concerns behind the bipartisan opposition to the treaty. An early report during the Clinton administration had projected that the treaty would cause merely a $.04 to $.06 increase in the gasoline prices and an up to $110 increase in an average family's energy bill by 2010 (Pring: 2007:194). However, this report was disputed even by the administration itself. A later report by the department of energy had revised the projected increase in gasoline prices as $1.39 to $1.91 and added that electricity prices could rise up to 86 percent (Pring: 2007:196). Another study portrayed even a darker picture as it projected the doubling of the price of energy and electricity causing the loss of 2.4 millions of jobs and $300 billon in the nation's GDP with an average annual cost of $2700 per household (Sunstein, 2006:25). Hence prior to the vote, the general perception of the senate was that the Kyoto protocol would "cause serious harm to the U.S. economy" and impose drastic increases in the cost of living.[4]

[4] U.S. president George W. Bush had expressed the administration's views on the Kyoto Protocol in the following words: "I oppose the Kyoto protocol because it … would cause serious harm to the U.S. economy. The senate's vote, 95-0, shows that there is a clear consensus that the Kyoto Protocol is an unfair and ineffective means of addressing global climate change concerns" (White House, 2001).

While perceived costs of the Kyoto treaty as portrayed by these reports were almost catastrophic, there was a great deal of uncertainty about the potential benefits of the treaty. A good example is the report issued by the Intergovernmental Panel on Climate in 2001, which projected an increase of between 1.4 and 5.8C by 2100 Sunstein, 2006:26). While 5.8C increase might yield catastrophic results, 1.4C increase would be considerably tolerable in the short run. In the midst of disagreement among academicians regarding the consequences on climate change, the industrial lobbies led the public opinion in the country and argued that it was more reasonable to postpone the problem to future generations who would “hopefully” have a large set of alternative technologies in their disposal to wipe out the use of greenhouse gasses. Hence, while there was a clear consensus on the net economic benefits of curbing the ozone depletion, the case against global warming lacked such a consensus.

Adding to the controversy were the deficiencies of the Kyoto protocol and its anticipated affects on climate change. Nordhaus and Boyer argued that the Kyoto protocol would have little effect on global warming, reducing the temperature by a mere 0.03C by 2100 (Nordhaus and Boyer, 2000:152). Another study estimated that the treaty would bring only a 1.2C decrease in global warming by 2300 (Cline, 2004:29).

The shortcomings of the treaty were caused by the following reasons. First, the emissions of the developing countries were not regulated. These countries included China, India and Brazil whose contributions to global warming are rapidly increasing. Moreover, the treaty did not require substantial cuts in emissions but merely a return to emission levels that are slightly below the levels in 1990. Hence, the continuing emission of greenhouse gasses worldwide would severely restrict the contribution of the treaty. The “shortcomings of the treaty” is hardly a reasonable argument for the official negligence of the U.S. towards global warming. Had it been the reason, the U.S. could easily revise the treaty, propose larger cuts on emissions and harsh sanctions for the violators. As in the case of ozone depletion, the U.S. government (under the influence of the powerful industrial lobbies) was mostly concerned about net monetized benefits of the treaty, which, as illustrated in Table 2., were in great contrast with those of the Montreal protocol.

The economic concerns of the U.S. are crucial to understand the failure of the Kyoto protocol despite the existence of a successful predecessor, the

Montreal protocol. The fates of both agreements were largely determined by the self interest judgments (cost-benefit assignments) of the U.S government. In ozone depletion case, the U.S. had already developed technological substitutes. Therefore, the restrictions imposed by the Montreal protocol not only made the U.S. more competitive but also enabled it to sell technology to other countries. In case of restrictions on greenhouse gasses, American industry was as vulnerable as those in other countries.

Table 2: Potential Costs and Benefits of the Kyoto Protocol for the U.S. (in billions of dollars by 2000)

	No Controls	**Kyoto Treaty**	**Unilateral action to comply with Kyoto**
Benefits	–	12	0[5]
Costs	–	325	325
Net Benefits	–	-313	-325

Source: Sunstein, 2006:29

Hence despite the catastrophic nature of the threat, the U.S. government did not back the Kyoto protocol, which in the absence of a hegemonic power lacked a credible threat mechanism and caused the treaty to remain ineffective. As the hegemonic power of the international system and having the most powerful economy the U.S. was capable of implementing various subsidies as well as punishment mechanisms to the industries emitting greenhouse gasses including trade sanctions, which would make it more costly for other countries to avoid the protocol. For China and India exclusion from the American market would have destructive consequences.

10. Conclusion

Mancur Olson had pointed out that as the group size gets larger, the provision of the public good becomes more of a problem. The Montreal

5 A rough estimate based on the assumption that unilateral action would have significant effect on climate change. For instance, industrial activities that produce greenhouse gasses would shift to developing countries keeping total emissions at the same level.

Protocol stands out as an important exception to this argument, including over 191 nations, committing its ratifiers to significant cutbacks in consumption and production of the CFCs. Furthermore, all significant CFC producer and consumer nations are included in this agreement.

One of the major problems of the international environmental treaties that make them less effective —such as in the case of Kyoto Protocol— is that the nations, which harm the environment the most do not participate. This was not true in the ozone depletion case. The primary producers and users of CFCs are the industrial countries that also place more value on environmental protection and reducing the health risks. Each year an increasing portion of their GNP is being spent to cope with illnesses related with the depletion of the ozone layer such as skin cancer. Hence, the Montreal Protocol offered net monetized benefits to these countries. In case of the global warming, however, there was a lack of consensus on the net monetized benefits of the Kyoto protocol. Another important feature of Montreal protocol was the credibility of threat against non-participants. This mechanism was crucial to prevent a leakage that could partially offset the gains from the agreement.

The crucial actor in the both Montreal and Kyoto protocols was undoubtedly the U.S. whose cost-benefit assessments determined the effectiveness of these treaties. In the ozone depletion case, American industry had developed substitutes to the use of CFCs before the protocol, which placed them at a more advantageous position compared to their European rivals. Hence, the key American producers such as DuPont not only consented, but even lobbied for the treaty, while European industry remained reluctant. In the case of global warming, American industry was caught unprepared and hence strongly lobbied against the ratification of the Kyoto Protocol. In the absence of the U.S., as the hegemonic power of the capitalist world system and the largest economy, the Kyoto Protocol lacked credible enforcement mechanisms and remained largely ineffective. The Montreal Protocol on the other hand, was instrumental for the American producers to strengthen their lead in the market and thus it was fully supported by the U.S. government.

REFERENCES

Andersen, Stephen O. and K. Madhava Sarma. 2002. *Protecting the Ozone Layer: The United Nations History*. Earthscan: London.

Barret, Scott. 1994. "Self Enforcing International Environmental Agreements", *Oxford Economic Papers* 46: 878-894.

Barret, Scott. 1999. "Montreal versus Kyoto: International Cooperation and Global Environment", in I. Kaul, I. Grunberg and M. Stern (eds.), *Global Public Goods: International Cooperation in the 21st Century*. New York: Oxford University Press, 192-219.

Binger, Albert. 2003. "Global Public Goods and Potential Mechanisms for Financing Availability", Background Paper Prepared for the Fifth Session of the Committee for Development Policy Meeting, April 7-11.

Cline, William R. 2004. "Climate Change", in B. Lomborg (ed.), *Global Crises, Global Solutions*. Cambridge: Cambridge University Press, 13-44.

Coase, Ronald H. 1974. "The Lighthouse in Economics". *Journal of Law and Economics* 17 (2): 357–376.

Downing, Thomas E, and Robert W. Kates. 1982. "The International Response to the Threat of Chlorofluorocarbons to Atmospheric Ozone". *American Economic Review* 72: 267-272.

Hirshleifer, Jack. 1983. "From Weakest Link to Best Shot: The Voluntary Provision of Public Goods". *Public Choice* 41: 371-386.

IEA. 2002. Beyond Kyoto: Energy Dynamics and Climate Stabilization, OECD/IEA, Paris.

Morisette, Peter M. 1989. "The Evolution of Policy Responses to Stratospheric Ozone Depletion", *Natural Resources Journal* 29: 793-820. Reproduced by the Columbia University Center for International Earth Science Information Network at, http://www.ciesin.columbia.edu/docs/003-006/003-006.html

Murdoch, James C. and Todd Sandler. 1997. "The Voluntary Provision of a Pure Public Good: The Case of Reduced CFC Emissions and the Montreal Protocol". *Journal of Public Economics* 63: 331-49.

NEAA (Netherlands Environmental Assessment Agency),2008. Global CO2 Emissions Increase Continued in 2007, at <http://www.pbl.nl/en/publications/2008/GlobalCO2emissionsthrough2007.html> (last accessed on 16 May 2009).

Nordhaus, William D. and Joseph Boyer. 2000. *Warming the World: Economic Models of Global Warming*. Cambridge: The Massachusetts Institute of Technology Press.

Olson, Mancur. 1965. *The Logic of Collective Action: Public Goods and the Theory of Groups*. Cambridge: Harvard University Press.

Runge, Carlisle F. 1984. "Institutions and the Free Rider: The Assurance Problem in Collective Action". *Journal of Politics* 46: 152–81.

Sandler, Todd. 1992. *Collective Action: Theory and Applications*. Ann Arbor: University of Michigan Press.

Sandler, Todd. 1997. *Global Challenges: An Approach to Environmental, Political and Economic Problems*. Cambridge: Cambridge University Press.

Sandler, Todd. 1998. "Global and Regional Public Goods: A Prognosis for Collective Action". *Fiscal Studies* 19: 221-247.

Sandler, Todd. 1999. “Intergenerational Public Goods: Strategies, Efficiency and Institutions”, in I. Kaul, I. Grunberg and M. Stern (eds.), *Global Public Goods: International Cooperation in the 21st Century*. New York: Oxford University Press.

Sandler, Todd and Keith Sargent. 1995. “Management of Transnational Commons: Coordination, Publicness and Treaty Formation”. *Land Economics* 71: 145–62.

Sunstein, Cass R. 2006. “Montreal vs. Kyoto: A Tale of Two Protocols”. AEI-Brookings Joint Center Working Paper, 06-17.

UNEP (United Nations Environment Programme). 2000. Released Latest Analysis of Trends in Developing Country Compliance Under Montreal Protocol, 00/39.

UNEP. 2006. Key Achievements of the Montreal Protocol, at <http://ozone.unep.org/Publications/MP_Key_Achievements-E.pdf> (accessed on 6 August 2008).

UNEP. 2008. Ratification Status of the Montreal Protocol, at <http://ozone.unep.org/Ratification_status/> (accessed on 17 September 2008).

UNFCCC (United NationsFramework Convetion on Climate Change) 2009. Kyoto Protocol: Status of Ratification, at<http://unfccc.int/files/kyoto_protocol/status_of_ratification/application/pdf/kp_ratification.pdf> (accessed on 16 May 2009).

White House. 2001. Press Release on March 13 2001, at <http://www.whitehouse.gov/news/releases/2001/03/20010314.html> (accessed on 10 November, 2007)