UNIVERSITY OF SOUTHAMPTON

POLITICAL ECONOMY MODELS OF TRADE AND THE ENVIRONMENT IN A FEDERAL SYSTEM

Surjinder Johal

Doctor of Philosophy

Department of Economics

Faculty of Social Sciences

September 2002

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF SOCIAL SCIENCES

ECONOMICS

Doctor of Philosophy

POLITICAL ECONOMY MODELS OF TRADE AND THE ENVIRONMENT IN A FEDERAL SYSTEM

By Surjinder Johal

This thesis extends existing literature by linking strategic competition and political economy analysis of global trade and environment issues when there are two levels of government. The economic setting is a strategic trade model in which two identical firms, located in different states and engaging in Cournot competition, produce a single good for export to a third market. Production generates pollution; this can be abated but at a cost. The only policy available to governments is an emission standard, which is set prior to firms' production decision. The level of damage costs is private information that becomes available only to national governments and only when elected. The institutional structure is that of a federation. The federal authority need not be an explicit government but can more generally be thought of as a supra-national or intergovernmental agency. The policy can then be set non-cooperatively at the level of the nation state or cooperatively by the supra-national agency. The political model is one where two ideologically motivated parties (industrialists and environmentalists) compete for office. They differ in the weight they place on the environment. The election outcome is influenced by donations made by lobby groups. A similar process takes place at the federal level. Chapter 1, by way of introduction, provides an overview of the literature on trade and environment. Chapters 2 (without lobbying) and 5 (with lobbying) address some constitutional issues. (i) Should policy be set at the national or supra-national level ? It is shown that it is always better to set policy at a supra-national level – that is, the benefits of cooperation outweigh the problems of asymmetric information. (ii) Should politicians be allowed to set discretionary policies ? The benefit is that they can use the true level of damages; the drawback is that they are subject to political influence. The alternative is social pooling: mandating a policy based on ex-ante expected damage costs. It is shown that political discretion is preferable as the difference in states' damage costs diverge and social pooling is appealing when the political parties diverge. (iii) Should policies be harmonised at a supra-national level to overcome incentives to engage in environmental dumping ? It is shown that harmonisation is never worthwhile at the supra-national level if it is not also better at the state level. Chapters 3 (with purely domestic pollution) and 4 (with transboundary pollution) address the concerns that setting policy at a supra-national level brings with it a further set of problems. These include a democratic deficit if policy making shifts from elected national MPs to un-elected bureaucrats and the asymmetric power wielded internationally by industrial lobby groups and Northern countries. It is shown that this greater influence may actually make these groups or nations worse off if it encourages them to engage in too much wasteful lobbying. It is also shown that whatever the problems associated with the global coordination of policies, they are still outweighed by the benefits, fundamentally the elimination of environmental dumping. Chapter six concludes.

LIST OF CONTENTS

List of Figures and Tables

PREFACE

Chapters 2-5 have been written have been written together with my supervisor Alistair Ulph. Chapter 2 has been submitted to the European Economic Review and is currently in the process of being revised. An earlier version of chapter has been released as a working paper for the University of Southampton, Department of Economics and also for Fondazione Eni Enrico Mattei. Chapter 3 has been published in volume 10, issue 3 of the Review of International Economics. Chapter 4 is to be included in the forthcoming volume "Global Environmental Governance, Political Lobbying and Transboundary Pollution", Recent Advances In Environmental Economics, Edited by John List and Aart de Zeeuw, Edward Elgar. Chapter 5 is to be included in the forthcoming volume "Limiting Political Discretion and International Environmental Policy Coordination with Active Lobbying" in M. Rauscher and C. Withagen (eds.) The International Dimension of Environmental Policy, Kluwer. The chapters have been presented at various conferences and seminars.

ACKNOWLEDGEMENTS

This thesis could not have been completed without the patience and wisdom of my supervisor Alistair Ulph. In addition, I have been fortunate to benefit from the many staff and students I have come across during my time at Southampton. However, there are some who deserve particular mention.

First I want to thank Grazia Rapisarda for her invaluable support and companionship both in good times and bad. Her own drive and perseverance have helped drag me to the finish line. Always made sure I never went too far off the rails – a function she still performs with relish. As yet, I have been unsuccessful in persuading her to support Liverpool.

Jan Podivinsky's reputation as a benevolent social planner is richly deserved. Many a philosophical discourse has been prolonged into the early hours and will no doubt continue to do so in the years ahead. However, a bit of a yo-yo performer in the annual fantasy football league.

Colin Jennings was generous enough to offer me asylum in his office whilst I sought refuge from the authorities. I feel as though we both taught each other quite a few things during those seminal years though maybe not all of it useful. Must also take credit for being the originator of the fantasy football league which is still going strong. Fine cricketer and clinical goalscorer. Likes to be referred to as a political theorist.

Roberta Piermartini always provided a very unusual slant on life in Southampton, indeed on most things. Particularly renowned for eccentric time-keeping. She has been a most generous host on a number of occasions and is always a huge source of entertainment. A fellow Ulph-ite.

Laura Valentini was an early office companion and as the most experienced Ulph-ite was a valuable source of information. Laura must also be commended on the quality of food that she provided during the parties at her flat.

Lucy O'Shea was another who could always be relied upon to keep me on the straight and narrow. She was certainly immune from most of the claptrap that I came out with although I like to think I wore her down a bit in the end. Lucy was the fourth member of the Clan Ulph.

As with Roberta, Gianluca Grimalda was a huge source of entertainment although in a very different way. Freedom of expression, whether it be musically, intellectually, or, above all, physically, is safe as long as he is around. An excellent pianist but a poor gambler. His football was very much from the Claudio Gentile school of Italian defending.

Alessandra Canepa provided me with a regular tennis partner and someone with whom I could regularly discuss sporting injuries. Alessandra has always been a very calming influence although her attempts to teach me basic statistics proved a challenge. An accomplished runner.

Despite his complete antipathy towards football, John Aldrich could always be relied upon to be the most affable of lunch companions. His complete disregard for the more solemn aspects of the departmental wine seminars was a consistent delight; irregular double acts with Roberta particularly entertaining.

Zheng Wang arrived towards the end of my time in Southampton but became a very good friend. She took over as my regular tennis partner and also introduced me to some unusual Chinese cuisine. Zheng had the grave misfortune of having me as her driving instructor; despite that she did pass.

Francesco Bravo was the departmental hard man. Hard talking and hard living he could have been a character from the 70s TV cop show The Sweeney. However, he did have a soft interior. Francesco had a unique no-nonsense approach to life. Why use twenty words when a two or three would suffice?

Giovanni Forchini was one of the first to demonstrate to me that econometric theorists are quite an unrepresentative sample of the population. Famous for his choice of transport and his Italian dialect (although this did not mean much to me).

Robin Mason quite often battered me on the tennis court but was always willing to listen and help with my work. Also the most enthusiastic sportsman amongst the staff: he well deserved his reputation as the football hard man. His chosen sport was Eton fives.

Dieter Balkenborg was kind enough to 'baby-sit' me during my early days in Southampton. He never failed to impress me when cycling home after a hard night's slog in the pub.

Chris Watts was probably the first PhD student I met in Southampton. Renowned for his huge tennis serve and had a memorable wedding reception on a boat. Let himself down by being the lone France supporter during the World Cup final. Did not make any friends that night.

Orietta Dessy was often around in the department to keep me company in the very late hours. A very passionate Neapolitan.

Duncan McVicar was another from the 'Early Years'. Noted for his Oliver Reed-esque wild man appearance and reputation although he had probably mellowed somewhat by the time I arrived.

Eleonora Patacchini and Emanuela Lotti were charming late additions who assured that the strength of the Italian influence was maintained throughout my Southampton years.

Finally, a special mention to Elisabeth Leeks who has been one of the friendliest people during my time in Southampton. Liz gets particular credit for the number of times she managed to dissuade Alistair from arranging meetings at eight in the morning. I was certainly not the only one who appreciated this.

In addition, I would like to acknowledge all the participants of the hugely popular five-a-side football, particularly those who helped get us to the semi-final one year. We were robbed! Also I'd like to mention everyone who attended the departmental wine seminars and made them such enjoyable events.

During the course of this thesis I have also worked at the Department of Trade and Industry in London, the World Trade Organisation in Geneva and the University of Portsmouth. I would like to thank friends and colleagues at all those institutions. In particular, I must mention the wonderful Andrea Villanueva who has given me constant support during the latter stages of the thesis and continues to do so.

I am also grateful to the ESRC who have provided invaluable funding over the years.

Finally, I would like to dedicate this thesis to my family who have (usually) shown great patience and without whom it would not have been possible.

Chapter 1

Trade and Environment: An Overview.

1.1 The Issues Involved in the Debate on Trade and the Environment.

Environmentalists have long argued that economic growth is bad for the environment because the production process lends itself to harmful effects such as the use of fossil fuels, the depletion of natural resources and air and water pollution. Economists too, have long been interested in the environment[1]. The early to mid 1970s saw a number of papers analysing the exact nature of the relationship, both theoretically and empirically. The latter part of the 1980s witnessed a rise in environmental activism and awareness linked to a growing concern about global environmental problems such as global warming. Simultaneously, this period saw rapid progress in negotiations geared towards trade expansion and liberalisation. These came into effect most prominently with the creation of the Single European Market in 1992, the conclusion of the Uruguay Round and the creation of the World Trade Organisation (WTO) in 1994 and the North American Free Trade Agreement (NAFTA), also in 1994[2].

Under these parallel developments, the debate surrounding trade and the environment evolved. Environmentalists argued that 'globalisation' was pursued without proper regard for its implications upon environmental quality. They felt that the pursuit of economic growth through the global expansion of production was being done without sufficient environmental safeguards. More specifically, the process of trade liberalisation – the reduction of trade barriers and international mobility of capital – lowered the incentives of companies and policymakers to implement rigorous environmental regulations. In a world devoid of alternatives, strategic agents would

[1] See the debate between Bhagwati and Daly (1993).
[2] Other regional agreements include, The Southern Common Market (MERCOSUR), The Association of South-East Asian Nations (ASEAN) and The Common Market of Eastern and Southern Africa

seek to gain a competitive advantage over foreign rivals by lowering environmental standards; a process often referred to as 'environmental dumping' (or eco-dumping). Similarly there is a concern that nations are encouraged to deliberately lower their environmental standards to attract companies to locate in their countries, creating so called 'pollution havens'. [3] These multinational companies (MNCs) often bring large amounts of jobs and revenue to some impoverished places but some fear that nation states are ceding too much control of their domestic policies to these global corporations. Protest groups have derided the whole process of globalisation as eroding democracy and the sovereignty of the nation state and increasing the influence of MNCs and intergovernmental agencies such as the EU, WTO and the International Monetary Fund (IMF). According to this line, trade issues carry a disproportionate weight in international negotiations relative to environmental issues and that the agenda is captured, or at least disproportionately influenced, by the powerful MNCs. Similarly, it is felt that intergovernmental agencies do not give environmental concerns sufficient balance in their regulations.

This polarisation of views during the 1990s contributed to the growth of the anti-globalisation movement, a loose coalition of protest groups whose many concerns include global environmental security. The WTO in particular has felt the wrath of protest groups who see it as the symbol of the move toward freer trade, at the expense of the environment. Shrybman (1990) wrote that "nowhere is the failure to integrate the environment and the economy clearer than in the GATT negotiations in which, with only limited exceptions, evaluating the environmental implications of trade

(COMESA). In addition, there have been a labyrinthine number of bilateral agreements and the opening up of huge economies such as India, China and Russia.

[3] The arguments surrounding the new trade and environment debate are often mirrored in the debate on trade and labour standards.

proposals is not even on the table. To make matters worse, the negotiations are veiled in secrecy, and virtually no opportunity exists for public comment or debate. Since environmental organizations, in particular, are excluded from the process, trade proposals are routinely put forward without any consideration whatsoever of their potential environmental effects. The most likely outcome of such a process is trade agreements which enshrine economic principles that are often at odds with environmental objectives." A decade later, the Turning-Point Project [4] repeated the accusations. According to them, the WTO is "secretive" and "undemocratic" and has "been granted unprecedented powers" over national laws "concerning public health" and "food safety" if these are seen as barriers to trade and that they can "demand their abrogation, or enforce very harsh sanctions" in response. Protests reached a zenith during the Ministerial meeting of the WTO in Seattle in 1999 and have been a familiar sideshow at international occasions since.

For its part, the WTO has certainly tried to take on board these issues. In 1996, the Committee on Trade and Environment (CTE) was set up to evaluate the trade-environment linkages and look at ways in which to proceed. Unsurprisingly, the WTO favours a multilateral approach and argues that trade restrictions may not be the most effective measure to enforce multilateral environmental agreements (MEAs) (WTO, 1996). They also point out that, as yet, there have been no conflicts between MEAs and WTO rules. Indeed, they cite increasing transparency and increasing cooperation with MEAs and environmentally based bodies such as the United Nations Environment Programme (UNEP) (WTO, 2002). As yet though, this has not extended

[4] The Turning Project is a Washington based non-governmental organisation. See http/www.turnpoint.org/.

to observer status for NGOs at the WTO.[5] The latest round of trade negotiations, implemented after the Doha ministerial meeting of 2001 placed trade and environment on the agenda and the EU in particular is pushing for more movement. Developing countries though, are wary of introducing any measures which they fear could be used for implicit protection and favour a multilateral approach.[6] Even within developed countries there have been a number of contentious cases. When the EU banned the sale of all hormone treated beef it cited the precautionary principle, alleging that consumers were potentially at risk. However, one of the effects of the ruling was to drastically reduce beef imports from the United States. There have been a number of other product standard cases where the 'side-effect' has been to increase domestic firms share in a particular industry.

This thesis looks into a number of these issues: the incentives to engage in strategic competition in environmental policies; the need for cooperation in international environmental policy-making; the capture of the policy-making process by special interest groups; the incentives for politically-motivated governments to deviate from first best environmental policies; the potential loss of national sovereignty and the possibility of creating a democratic deficit if ceding policy to a supra-national agency.

The focus of this chapter is on the evolution of the debate surrounding trade and the environment and where this thesis sits within the literature. In section 2, we briefly overview some of the directions the trade and environment literature has taken in recent years. In section 3, we look at models based upon traditional trade theory before tracing out how the literature has developed with the use of imperfect

[5] Esty (1997) argues the case for non-governmental organisation participation in the WTO.

competition models of trade. In section 4, we look at the role political economy models have played in the literature. Section 5 summarises the contributions within this thesis and concludes.

[6] The most often cited example of this is the well-known tuna-dolphin case involving the United States and Mexico. See developing countries' submissions to the CTE at http://www.wto.org.

1.2 Overview of the Literature.

One of the problems faced by economists was that the new trade-environment debate could not be rationalised under traditional theory. All of the issues we raise relate to the incentives for states, governments and firms to set environmental policies which differ from the first best level in terms of social welfare. The standard response in a neoclassical model is that, for a small country, operating under perfect competition, the most efficient policy is for the government to set the first best environmental policy along with the first best trade policy. That is, to implement the Pigouvian level of environmental regulation by setting marginal abatement cost equal to the marginal damage cost alongside free trade. This is true whether using emission taxes or standards. The only change for the large country analysis is that optimal trade policy (from the perspective of an individual country) now consists of imposing an optimal tariff. In neither case can a country be better off deviating from the optimal level of environmental regulation. Models based upon perfect competition do not allow governments or firms to make strategic decisions.

To make a rationale for concerns about environmental-dumping, economists moved towards the use of the imperfect competition models of trade developed in the 1980s. Brander and Spencer's (1985) model of strategic export policies was modified to take into account environmental pollution in the form of a production externality[7]. This allowed authors such as Barrett (1994) and Ulph (1992, 1996) to build models where governments had incentives to deviate from first best environmental standards in a second best world where trade policies were not available. These models were

straightforward variations of Brander and Spencer with two identical countries, each with one firm, selling to a third market under Cournot competition. They showed that the non-cooperative Nash equilibrium was for both countries to set environmental policies that were more lax than optimal. As with the strategic trade literature, these results are not particularly robust[8].

An interesting and influential counter-argument is the so-called 'Porter hypothesis' (Porter 1991)[9]. He claimed that rather than being detrimental, stricter environmental regulations can yield dynamic benefits by promoting innovative business and production solutions. These can more than offset the initial, static, cost of compliance and enhance competitiveness and profitability by giving innovators a first-mover advantage[10].

The introduction of capital mobility allowed scope for firms to relocate to gain maximum economic benefit. The fear of de-location to another country is another factor for policymakers to consider when setting environmental regulation. Hoel (1997) used a very simple two country model to show that governments would set lower than optimal environmental regulations to entice a single firm to locate in their country. This result is not at all robust though – if the damage cost were sufficiently high then the government would seek to deter location in its country by setting tougher standards. Markusen et al (1993) extend Hoel's model by adding transport costs. In this scenario, the firm must make its location decision based on the level of

[7] The Brander and Spencer model itself gave a rationale to supporters of export promotion whose beliefs prior to it could not be given theoretical credence. The authoritative survey of the strategic trade literature is Brander (1995). An earlier treatment of the theory is in Krugman and Helpman (1989).
[8] See Grossman (1986) and Eaton and Grossman (1986). Ulph (1997a) provides a critique with regard to strategic environmental policy.
[9] See also Porter and van der Linde (1995a, 1995b).

environmental regulation relative to the transport cost of supplying the second market. Markusen et al show that when environmental regulation is sufficiently lax, the firm has an incentive to locate a plant in both countries to avoid the relatively higher transport cost but that when regulation is sufficiently high, it is worthwhile locating only in one country and paying the relatively lower transport cost. In this model though, the direction of the incentive path is that firms react to government policy rather than governments set policies to accommodate MNCs. Both theoretically and empirically, the concerns over 'footloose' firms and the creation of pollution havens do not appear to be sustainable. A WTO (1999) study argues that there is little evidence to show that MNCs will relocate to countries with laxer environmental regulations[11]. This is perhaps not all that surprising since the proportion of total costs taken by environmental policies is usually small.

The literature on multilateral environmental agreements (MEAs) is principally concerned with the incentives of prospective MEA signatories and the ex-post incentive structure of the agreement using cooperative game theory. According to Finus (2000), the literature seeks to answer a number of questions: Under which conditions will a MEA be signed and ratified ? On which reduction target will the negotiators agree ? How many countries will sign ? Which countries will sign ? Will the agreement be stable ? What measures can be taken to ensure or increase stability ?[12]

[10] The Porter hypothesis has been challenged by, amongst others, Ulph and Ulph (1997).
[11] The results of Levinson (1996) and Mani Pargal and Huq (1997) are consistent with this finding.
[12] The literature on MEAs is beyond the scope of this thesis. Good starting points for those who are interested are the books by Finus (2001) and Ulph (2001).

There is a clear relationship between the directions the literature has taken. They are all are concerned, to some degree, with the structure of global environmental policies when individual states have incentives to deviate from the environmentally optimal strategy. A natural progression from this is to introduce the use of political economy into the models. In the past decade, a number of authors have attempted to integrate the various devices of political economy – voting, lobbying, constitutional design, the role of institutions and bargaining – into the trade and environment debate. Ulph (2000) pointed out that environmental policies might deviate from first best not only because of strategic competition but also for political economy reasons.

The work in this thesis differs from the traditional approach in three ways, each of which alters the incentive structure of the analysis in crucial ways. The first, the use of imperfect competition, allows the rationalisation of the concerns outlined in section 1 by providing players – most notably firms and politicians – the incentives to behave in a strategic manner and deviate from first best policies. It is natural to combine this with the second deviation, the use of asymmetric information, both between different countries and between firms and governments. The final deviation is in the use of political economy. Traditional neo-classical models simply assume the existence of some benign, benevolent policymaker who would set policy to maximise social welfare. Political economy models allow us to consider what happens when voters, firms, lobbies and politicians, all of whom have their own preferences, have a role to play in formulating policy.

1.3 Traditional Models of Trade and the Environment.

Early models in the area were based upon the Ricardo or Heckscher – Ohlin models of trade or their various extensions. The focus of these papers was not just on how or whether trade was harmful to the environment but, more generally, what the linkages between the two were. Consequently, the question of how environmental policy could harm to the gains from trade became equally valid. The models were based upon the restrictive assumption of competitive markets, which did not allow analysis of strategic action when firms have market power. These models allow market power only to the governments.

Consider a small country that, prior to trade, is capable of producing two goods, A and B, which both require capital and labour as inputs. Say that A is relatively more capital intensive and that the country is relatively capital abundant. Production of A causes pollution whilst the production of B is 'clean'. Assume that pollution is only from production (there is no pollution from consumption) and that it is purely domestic in nature. Pollution can be abated but abatement activity also involves the input of capital and labour, which have to be diverted from A and B. Abatement requires some level of government regulation. If the country moves from autarky to trade, we can immediately see that there will be a welfare trade off. The country will specialise in the production of A but this means that although there is a welfare gain from trade there is a welfare loss from additional pollution. Pethig (1976) and Siebert (1977) pointed out that when there are no environmental policies available then negative environmental externalities could reverse any gains from trade. However, if

an environmental policy was available then trade liberalisation must be welfare improving.

What if the country was labour abundant ? Then trade would be unambiguously beneficial. By switching resources to the clean product, B, the country's welfare would increase from not only the gains from trade but also reduced pollution. So, if we assume that we are in a second best world where environmental regulation is disallowed then the overall welfare change is ambiguous if trade results in the increased production of the pollution intensive good but unambiguously positive if it reduces production of the polluting good. [13]This type of analysis is particularly useful in identifying some of the linkages between environmental quality and the pattern of trade. Of course, if we assume that both goods are equally environmentally unfriendly then that will negate further some of the gains from trade. Similarly, the negative effects of trade will be more pronounced if we introduce consumption externalities and transboundary pollution.

If we begin from a position that trade is already taking place and the only instrument available to the government is environmental regulation then it is clear that the same dilemma is present. Any abatement activity will divert resources for A and B so that the welfare gain from an improved environment is tempered by welfare loss from reduced production.

We turn now to optimal policies. The analysis is straightforward in a first best world. Following on from Pigou (1920), Bhagwati (1971) and Grubel (1976), the first best

environmental policy is to set environmental regulation at the level of the marginal damage cost to the environment (e.g. Pigouvian tax) and the first best trade policy is free trade.

Now let us return to the second best world where environmental policy, in the form of an emission tax, is fixed and where the only available policy instrument is a trade tax. If pollution is still caused solely by production and if the environmental damage from this is excessive then there may be a case to deviate from free trade. In other words, trade policy can be used to partly internalise the production externality (see Panagariya et al, 1993). The optimal policy in our example would be a subsidy to imports. However, if environmental policy is not fixed at the first best level then it is unlikely that trade policies are even second best policies for dealing with failures in environmental policies. If the environmental policy is in the form of an emission standard, then the optimal trade policy remains free trade since there is no direct link between trade policy and environmental policy. Now consider the case where there is a fixed, non optimal, trade policy and the only instrument available to the government is environmental policy. Once again, it is possible that welfare may be enhanced by deviating environmental policy from the level that is optimal in a first best world. In the case where there is a positive tariff on imports, for example, tougher than first best regulation on domestic production may be justified if, as well as less environmental damage, it encourages a closer to first best level of imports. If the country is large and able to influence world prices, the second best analysis is along the optimal tariff lines. If trade policy is fixed, then a country can use emission taxes to exert market power. Krutilla (1991) showed that the equilibrium tax rate would be higher than the

[13] If we had considered a consumption externality, it is straightforward to make the analogous argument

Pigouvian level when the country is an exporter, because of the desire to favourably influence the terms of trade. If the country is an importer then optimal regulation will be set below the marginal damage cost.

that trade is unambiguously welfare improving if it induces less consumption of a polluting good but ambiguous otherwise.

1.4 Strategic Environmental Policy.

The traditional analysis gave no real justification for the fears outlined in the opening section. To try to rationalise these arguments, economists turned to the advances in trade theory that took place in the 1980s. The crucial difference in these models compared to the Heckscher – Ohlin and Ricardo models is that they were based on imperfect competition. This meant that gains from trade could come about not only from the exploitation of comparative advantage but also from the profit maximising behaviour of firms attempting to benefit from increasing returns to scale.

The Brander and Spencer (1985) model of strategic trade policy, or more specifically strategic export promotion, showed how, under certain conditions, a government subsidy to exporters could take market share from a rival, foreign, producer and increase national welfare. Brander and Spencer used a partial equilibrium model of Cournot competition between two firms, located in different but symmetric countries and selling to a third market and without any domestic consumption. This meant that profits minus the cost of the subsidy were the only measure of national welfare. The government is aware that it can manipulate market conditions because of its ability to pre-empt the firms' production decision. By acting strategically, the government can offer a subsidy that effectively lowers the costs of the home firm's production relative to the foreign firm. This advantage enables the home firm to 'snatch' profits from its rival and in so doing so boost national welfare by shifting its reaction function and establishing an equilibrium closer to that of a Stackleberg leader. It is well known that these results are far from robust. Grossman (1986) and Eaton and Grossman (1986), for instance, pointed out a number of problems. The optimal policy under Bertrand

competition becomes an export tax. This prevents excessive competition but is detrimental to consumers in the third country. By not considering general equilibrium effects, there is no analysis of the effects of diverting resources to one industry at the expense of others. The model assumes perfect information, which means that the government not only knows the form of market competition but also the shapes of the firms' reaction curves. Horstman and Markusen (1986) extended the model by allowing for entry of firms. They showed that the rents available in the industry would attract new firms; the increased competition would dissipate the rents. Finally, there is assumed to be no foreign retaliation. If there were then, assuming that the countries are identical, the Nash equilibrium outcome would leave both countries worse off.

Despite these weaknesses, the theory provided a rationale for government intervention that naturally appealed to industrial lobby groups. Some economists, whilst acknowledging the weaknesses of the model, argued that there was some justification for the targeting of certain, strategically important industries.[14]

1.4.1 A Rationale Behind the Fears of a 'Race to the Bottom'.

Another of the weaknesses of export subsidisation was its illegality under WTO rules or in the rules of other regional free trade agreements. The debate began to centre on how implicit subsidisation took place. Amongst others, the setting of lax environmental standards became an issue. Objections to this came from both environmentalists and industrialists. Environmentalists feared a 'race to the bottom' in environmental standards in a bid to gain competitive advantage; industrialists wanted

[14] See, for example, Tyson's (1992) discourse on high-technology industries.

to be able to compete on a level playing field with their foreign rivals. A production externality was added to the Brander and Spencer model, although only in the producing country. The key references are Barrett (1994), Conrad (1993, 1996), Kennedy (1994) and Ulph (1992, 1996).[15] Trade policies are disallowed but environmental policies aimed at pollution abatement are available. National welfare is now measured by the firm's profits minus environmental damage. The early literature on strategic environmental policy was concerned mostly with establishing equilibrium results and showing how they differed from the first best outcome.

For the general case, consider the model as a three-stage game. In stage 1, the government chooses the type of environmental policy it wishes to employ. In stage 2, the government chooses the level of the policy and in so doing it influences the firms' output decisions, which take place in stage 3. The government seeks to maximise national welfare whilst the firms' maximise profits as normal. The game is solved backwards as normal to establish the subgame perfect Nash equilibrium.

If we take stage 1 as exogenous, then solving the model is reduced to a two stage process. If governments do not act strategically then we can establish that the first best equilibrium for emission standards is where the marginal abatement cost is equal to the marginal damage cost. The first best level of emission taxes is also equal to the marginal damage cost. However, governments are aware that the output of the foreign firm depends upon their actions at the prior stage. A government will take the policy of the other government as given and choose the level of its own policy to maximise national welfare. For emission standards, the Nash equilibrium will involve setting

[15] Rauscher (1994) looked at environmental dumping in a general equilibrium setting.

emission standards that are higher than the first best level whilst for emission taxes the equilibrium level will be below first best. In other words, in a situation where trade policies are fixed, then governments actively pursue laxer than optimal environmental policies to try and grant domestic firms a competitive advantage over its foreign rival – in short, environmental dumping. Bigano (1999) extends Ulph's model to include consumers and finds that the results are not greatly affected. Of course, there remains the caveats concerning the lack of robustness of the model identified in the previous section. [16] For example, under Bertrand competition, the incentive for the governments will be to set tougher than first best policies to reduce output and increase profits by moving closer to the monopoly (collusion) equilibrium. In effect, a 'race to the top'.

Barrett (1994) pointed out that if other policies are available to the policymaker then the incentive to relax environmental policy can be removed. When export subsidies are also available then it becomes optimal to use those to support the domestic firm and set the first best environmental policy. An argument against this, of course, may be that export subsidies may break WTO rules. Walz and Wellisch (1997) look at a scenario where trade liberalisation is taking place in a world where eco-dumping is already taking place. They showed that it is possible to increase welfare via a negotiated reduction of export subsidies from the non-cooperative level. This is because the extent of implicit subsidisation, through environmental policy, is less than the level of direct export subsidisation. The reason is that there is a real social cost to

[16] Ulph (1996) analysed the case where producers also acted strategically. This involved a fourth stage, prior to setting output but after the government had set its policy, where producers choose strategies concerning their investment in R & D. In the second stage, the government must assess not only the effects of its policy on the rival firm's output in stage 4 but also its R & D decision in stage 3. In equilibrium, this does not reverse the incentive for governments to relax their environmental policies but it does reduce the incentive somewhat.

increasing production (pollution) while it is often assumed that there is no social cost to financing export subsidies. Sturm (2001) shows that this result is not particularly robust – for example if Bertrand rather than Cournot competition is used – and indeed that the reverse result is possible. The author speculates whether this provides some justification for the view that trade liberalisation may not be welfare enhancing if not accompanied by environmental rules designed to prevent strategic manipulation of environmental policies.

1.4.2 Some Policy Choices.

The next stage in the literature was to try to find improvements on the non-cooperative outcome and ask how policymakers should deal with eco-dumping and the incentives to deviate towards laxer environmental standards. One way in which the incentive can be internalised is if states acted cooperatively. This involves the maximisation of a joint welfare function in stage 2 and it is straightforward to show that the cooperative equilibrium is an improvement in welfare terms on the non-cooperative equilibrium. Whatever policy instrument is chosen, the cooperative equilibrium involves environmental policies that are tougher than in the non-cooperative case, meaning not only lower pollution but also higher levels of profits. When setting policy cooperatively governments have an incentive to behave in a collusive manner. The strategic incentives that exist in the non-cooperative case result in not only too much output from a pollution point of view but also from a profit point of view. A lower level of output, in a Cournot setting, will increase total industry profits. Acting cooperatively then, governments will use environmental policy to restrict output by setting tougher standards. For this reason, whilst the non-

cooperative equilibrium involves laxer than simple first best environmental regulation, the cooperative equilibrium involves tougher than first best regulation. Higher profits and lower pollution means that welfare is unambiguously higher.

Many commentators, both environmentalists and industrialists, have put forward the notion of harmonised policies across states, which, it was argued, would both remove the commercial incentives to reduce standards and also allow rival firms to compete on a 'level playing field'.[17] Harmonisation in this model requires the two governments to set identical policies, which can be either taxes or standards. For now, assume that the level of the policy is chosen exogenously.

It is straightforward to show that a policy of harmonisation may not bring about a welfare improvement over the cooperative outcome. It is well established that if countries are different then their optimal environmental policies should also be different. However, if cooperative outcomes are not available, for whatever reason, then could a policy of harmonisation improve on the non-cooperative equilibrium? Kanbur et al (1995) and Ulph (1997b) showed that if the two states are sufficiently different in their damage costs then no harmonised policy could improve on the non-cooperative equilibrium, regardless of which policy instrument is used. Assume that one country has a low damage cost and that the other has a high damage cost. The low damage cost country can gain a Pareto improvement by moving from the harmonisation equilibrium to the non-cooperative equilibrium. This is because harmonisation requires the low damage country to reduce its output and pollution by imposing tougher standards than under the non-cooperative equilibrium. This allows

the high cost country to increase output and pollution and gain market share at the expense of the low cost country.

The use of minimum standards has been proposed as an alternative to harmonisation.[18] The reasoning behind this is that it would be possible to toughen the policies of the countries with the weakest policies whilst countries whose polices were already tougher than the minimum standard would, at worst, leave them unchanged, and at best, would be motivated to stiffen their own policies. In this way the use of minimum standards was seen as a way to 'ratchet-up' environmental standards.

In our two country model, the minimum standard can be set in three ranges. If it is set at a point higher than either country's emission standard under the non-cooperative equilibrium, then the original level would remain as the equilibrium. If the minimum standard is set below the emission standard of both countries under the non-cooperative equilibrium, then both countries would emit up to that level and the result would be equivalent to the harmonisation equilibrium. So, it is only if the minimum standard is set below the high emitting country's level and above the low emitting country's level that it is distinct from the non-cooperative or harmonisation equilibria. In this intermediate range, the policy will only be binding on the high emitting country, the low emitting country will set its policy as a best response.

As with harmonisation, the key question is whether minimum standards can yield a Pareto welfare improvement over the non-cooperative equilibrium. The papers by Kanbur et al (1995) and Ulph (1997b) suggest that it depends upon the slope of the

[17] Harmonisation has been proposed at times by both the European Commission and the OECD (see

reaction functions. Ulph (1997b) uses emission standards to point out that the low emitting country will respond to the tougher policy of their rival country not by maintaining its current policy, or ratcheting up, but rather, by relaxing policy to gain market share. The high emitting country would lose profits from the reduced output but this will be offset by reduced pollution. The additional increase in output by the rival country though will leave it worse off.

However, when emission taxes are used in Ulph's paper, it is possible that minimum standards can improve upon the non-cooperative equilibrium. This mirrors the finding of Kanbur et al. Although they use emission standards, the shape of their reaction functions is similar to the emission taxes case of Ulph. Again, there are three ranges in which the minimum standard (tax) can be set; once more, it is the intermediate range, where only the low tax country is affected, which is interesting. In this range, the minimum standard will be binding for the low tax country and the high tax country will set its policy as a best response. The rise in the tax level of the low tax country, up to a critical limit, will reduce output and profits but this will be offset by reduced pollution. The best response for the high tax country will be to follow suit since, with upward sloping reaction functions, the reduced level of output will move the firms closer to the collusion equilibrium, making both firms better off. Ulph suggests though that the gap between the low country's Nash tax level and the critical limit is not particularly wide, so that although a Pareto improvement is possible, informational requirements would make it problematic.

---

their contributions to House of Commons (1996)).

1.4.3 Asymmetric Information and Institutional Structure.

Since non-cooperative behaviour, harmonisation and minimum standards are all inferior to a cooperative policy then why isn't the cooperative equilibrium not just imposed ? The first, obvious, answer is the lack of an appropriate incentive scheme. Cooperative behaviour would require some sort of constitutional or institutional arrangement. As we mentioned earlier, this could be in the form of a multilateral environmental agreement such as the Montreal Protocol on ozone depleting substances or the Convention on International Trade in Endangered Species (CITES). In these, countries sign up to a treaty and agree to act in a cooperative manner. Unfortunately, there are clear incentives to cheat. To avoid some of these problems, an alternative is to assume that there is a more formal devolution of power to a separate body in the way that the WTO implements trade law. In Europe, the various bodies of the EU could carry out this role. On a global level UNEP or a World Environmental Organisation (WEO) along the lines suggested by Esty (1994) could do this. Implicitly, it is assumed that the stability of any coalition is maintained – no insiders are better off not being in the group and no outsiders are better off being members. In addition, we need to assume that conditions for internal and external stability are met. This supra-national authority or, in the language of the literature on fiscal federalism, federal government, chooses the appropriate policy for individual countries and so removes strategic competition from the policy process.[19]

---

[18] See, for example, the contribution of Oxfam to House of Commons (1996).

[19] Throughout this thesis, we shall be using the terms supra-national authority and federal government interspersed. It should be pointed out that this need not be a government in the true sense but can be interpreted more loosely. Similarly, for individual countries we use the terms national authority and state government.

This brings us to the second reason why the cooperative equilibrium is not simply imposed – asymmetric information[20]. It is not unreasonable to assume that individual countries are better informed about their own damage costs than rival countries. It is also reasonable to assume some level of asymmetry between state and federal governments although the direction of this asymmetry is debatable. There is a sensible argument that there are large international institutions, such as the United Nations, which have access to large pools of information and expertise, enabling them to be better informed than individual states about their level of environmental damages. This may be especially true in the presence of transboundary pollution or a global pollutant. The counter argument is that state governments are more aware of the importance given to environmental damage by the local population and have a better understanding of how much weight to place on environmental issues than overseas agencies. In this thesis, we assume that it is state governments that have private information although we accept that both points of view are defendable. Once this is established, the choice of cooperative policy levels becomes a problem of mechanism design. The federal government sets the appropriate policy by eliciting truthful declarations of damage costs from individual states.[21] This is also more in tune with the literature on regulation where it is the regulator who is uninformed. However, now that we have introduced the information asymmetry, it raises the separate question of whether policy should be ceded to a federal authority in the first place – the subsidiarity question. If individual states are better informed, the argument goes, should they not set their own policies ? This adds a fourth stage to the model. Prior to

[20] Lewis (1995) presents an excellent survey of the literature on incentive regulation to make suggestions about how to deal with environmental when there is asymmetric information.
[21] It is implicitly assumed that there is no informational asymmetry between state governments and individual firms.

the three-stage game outlined earlier, there will be a constitutional decision whether to set policy at a state level or whether it should be devolved to a federal level.

How does the introduction of asymmetric information affect the policy regimes we looked at in the previous section ? In the models of Ulph (1997b, 2000) the damage costs of the two countries can take high or low values with a given probability. In the non-cooperative game, state governments choose their emission policy knowing their type but not those of the other state. However, they are aware of the probabilities. Essentially, then, the solution concept of this game is that of a Bayesian-Nash equilibrium. The key result is that under asymmetric information, the equilibrium policy for a low damage country is tougher than under full information; for the high damage country the equilibrium policy is laxer than under full information. This is true for both emission taxes and standards. In other words, the two policies are closer together.

Now, returning to the cooperative game under asymmetric information, Ulph (1997b) models the federal agency's problem as the maximisation of a joint welfare function subject to both incentive compatibility constraints (that states are at least as well off telling the truth as they would be when lying) and individual rationality constraints (that states are at least as well off as in the non-cooperative game). He finds that when the two states declare themselves as high damage cost then the agency can simply implement the full information cooperative equilibrium. This is because neither state has an incentive to lie about being high damage cost. When both declare themselves low damage cost then the federal agency will impose laxer policies than under full information. This is to punish high damage cost countries for lying – the extra

pollution will be particularly damaging for them. In the asymmetric case, if there are large differences in the damage costs then, once again, the full information equilibrium can be imposed. If the difference is less pronounced, then the policies for the two states will be much closer than under full information although this does not imply harmonisation. The intuition why, with asymmetric information, environmental policies for high and low damage cost countries are closer together than with full information is that now the high damage cost country has an incentive to pretend to be low damage cost to help its domestic firm gain market share. This incentive is reduced by narrowing the gap between the two policies that are set. In terms of welfare, both states are better off in the cooperative over the non-cooperative equilibria.

1.5 Political Economy Models.

In this section, we remove the assumption that policymakers are benevolent social welfare maximisers and instead ask how the dialectic changes as we introduce various interest groups into the model. There exists a large volume of literature on the political economy of trade policy and it is not the intention to go through this in detail but only to refer to those models that have been adopted in the environmental policy arena.[22] The volume by Dijkstra (1999) provides a comprehensive treatment of the political economy of environmental policy in a non-trade setting.

The chapter by Rauscher (1997) is a useful starting point. He analysed how various environmentally motivated policies would be received by industrial and environmental lobby groups and showed that there is much room for ambiguity. The setting is a partial equilibrium analysis of a small domestic economy producing a single good under constant returns to scale. This good is not traded. A second good is imported from a foreign country. Pollution arises from both production and consumption of both goods but is not transboundary. An industrial lobby is concerned with maximising its income whilst an environmental lobby is concerned with environmental quality. Lobbying only takes place domestically. The environmentalists are split according to whether they care about domestic pollution or about global pollution. In the language of Hillman and Ursprung (1992, 1994) these are 'greens' and 'supergreens' respectively. There are numerous policies available: an emissions tax on the domestic good, a consumption tax on either the domestic or foreign good and a quality standard on either good. We will only consider these being

used in isolation. The welfare function consists of social welfare plus lobbies' interests.

For environmentalists it turns out that all of the policies lead to ambiguous effects. This is mainly because any policy that reduces either production or consumption of one good simply shifts it to the other good. For example, an emission tax on the domestic good raises production costs and prices that result in demand shifting to the foreign good. Although environmentalists gain from the reduced emissions, it is possible that there will be additional pollution from the consumption of the foreign good (this will depend on the parameters of the model). For supergreens, there is the additional burden of increased production emissions in the foreign country. For industrialists it is slightly more clear-cut. A foreign (domestic) consumption tax is unambiguously good (bad) whilst a quality standard for the foreign good is also unambiguously good. However, there remains ambiguity over the domestic emissions tax and the quality standard on the domestic good. The reasoning is that although there is the obvious downside of higher production costs and the feeding through of these to final demand, there is also a substitution effect. This will be in the form of an increase in demand for factors that are environmentally-friendly or can be used for abatement purposes. This leads to the interesting implication that industrialists may find it worthwhile lobbying for a tougher emissions policy.

[22] Important contributions to the political economy of trade policy include the collections by Magee,

1.5.1 Small Country Analysis.

The papers by Fredriksson (1997), Fredriksson and Gaston (2000), Aidt (1998), (2000), Schleich (1999), Schleich and Orden (2000) and Conconi (2003) all employ the Grossman and Helpman (1994) model of lobbying which itself is based upon the common agency auction model of Bernheim and Whinston (1986). The idea behind the model is that policies are available for 'sale' in a menu-auction and that lobby groups offer the policymaker a list of contributions or 'gifts' they would be willing to make for each possible policy outcome. These 'gifts' can be thought of as political contributions to finance future election campaigns or alternatively simply as bribes. The policymaker takes these into consideration before making his policy decision. Formally, this is a two stage non-cooperative game with full information. In stage 1, lobbies simultaneously choose an optimal schedule of contributions for every possible policy outcome, taking the contribution schedules of other lobbies and the government's actions in stage 2 as given. Lobbies choose their contribution schedules to maximise the joint welfare of its members. Individuals and unorganised groups make no political contributions. In stage 2, the government takes the political contributions as given and sets its policy. The government chooses its policy to maximise its objective function, which is increasing in both the total levels of contributions but also aggregate social welfare.[23] There are multiple equilibria in the model but, following Bernheim and Whinston, Grossman and Helpman focused on those involving only truthful strategies.

Brock and Young (1989), Hillman (1989), Rodrik (1995) and Grossman and Helpman (2002).

[23] Throughout, it is assumed that the free rider problem in lobby formation, as alluded to by Olsen (1965), can be overcome.

Fredriksson (1997) considers a small open economy with two industries, one polluting and one clean, where pollution is entirely domestic. Both industries are perfectly competitive. He looks at how the introduction of two lobby groups affects the rate at which the government sets an emission tax. There is an industrial lobby which is made up of owners of an industry-specific factor used in the production of the polluting good, and who accrue all of the profits within the industry. Naturally, this group lobbies for a lower level of tax. The second group is made up of environmentalists representing those damaged by the polluting industry; they lobby for a tougher tax regime. The emission tax is the government's only policy instrument. Fredriksson shows that the equilibrium level of the tax will depend upon: the proportion of the population that has joined either group[24], the weight the government attaches to social welfare and the absolute value of the inverse elasticity of pollution with respect to the emission tax. Most importantly, if the elasticity value is above (below) the value of one, then the equilibrium tax rate will be lower (higher) than the first best Pigouvian level. Fredriksson then introduces a government abatement subsidy into his model and shows how its introduction may lead to higher levels of pollution. The subsidy, which is not subject to lobbying, allows the industry to increase production without increasing pollution. This in turn may allow a greater opportunity for the industrialists to expend greater lobbying effort; this may offset any benefit of the subsidy.

Aidt (1998) looks at how competition between lobby groups can internalise environmental externalities. Once again, he extends the Grossman-Helpman model to include a production externality although this time with numerous sectors, each with

[24] A general result from Grossman and Helpman (1994) is that if the entire population were members of

constant returns to scale. A numeraire good is produced without pollution and with labour as its only input. The remaining sectors use two inputs – labour and an industry-specific capital that is in fixed supply - and production in each of these sectors generates pollution. The only policy available to the government is an emissions tax. All individuals own some capital but in only one sector. The return to capital is one of three forms of income; the others are the wage rate and a government transfer financed by the emissions tax. Consumers derive utility from the consumption of all goods, but disutility from the aggregate level of pollution. In some, but not all, of the sectors, the capital owners form lobby groups and offer the government a schedule of contributions as before. The remaining industries do not organise. Lobbies reflect their members' interests so that they have multiple goals; they care not only about industry profit but also about environmental damage and government transfers. Consequently, they face a trade off between protecting their profits (by lobbying for a low tax) and protecting the environment (by lobbying for higher taxes). It is this diversity that drives Aidt's main result that, in equilibrium, competition between lobby groups fully internalises the environmental externality despite the fact that not all individuals are members of lobby groups and that each lobby is only concerned with the damage suffered by its own members. Moreover, this result is independent of the weight the government places on social welfare.[25] However, this equilibrium is unlikely to be a social optimum because the organised sectors will tend to receive a tax discount at the expense of unorganised sectors. As with Fredriksson (1997), the equilibrium tax rate for the organised sectors will tend to be lower than the first best whilst that for the unorganised sectors will tend to be higher. This is because the

lobby groups, then the effect of the lobbying would cancel out. This is because the weighted sum of the lobbies' utilities would be essentially the same as the social welfare function.

organised sectors lobby also for taxes to rise in the unorganised sectors; they gain from the reduction in emissions and the increase in government revenue that can be used for redistribution.

The paper by Schleich (1999) allows for a richer set of policy alternatives. He considers environmental quality when the government is able to use both environmental and trade policies. The domestic environmental policies available are production taxes, consumption taxes and consumption subsidies; trade policies are taxes or subsidies to imports and exports. The economy is very similar to that of Aidt. The only tangible difference is that only production of one of the goods generates pollution. Individuals' utility is again increasing in goods and decreasing in environmental damage. All lobbies are industry specific and they aim to induce policies that raise the domestic price in their industries but also take into account that environmental damages harm their members who are also consumers.

Schleich's first result confirms the findings of Fredriksson and Aidt – that lobbying by an organised polluting industry can result in a lower than socially optimal level of environmental quality - in a more general setting whereby a sufficient condition is non-decreasing marginal disutility from environmental damages. However, decreasing marginal damage costs could lead to higher environmental quality than the Pigouvian tax. The second result is that when the government is restricted to either production policies or trade policies then it is possible that trade policies can yield a higher environmental quality than environmental polices. The rationale behind this is that there are two distortions at work here - the externality and the lobbying behaviour -

[25] The reason is that the distortionary effect on domestic prices and the environmental damage are

and the effect of a production policy can be ambiguous. Whilst a production tax is more efficient than trade policy for addressing the externality, a production subsidy is more efficient than trade policy for addressing the demands of lobbying. For linear functions, it is shown that this result occurs either when the political strength of the polluting industry is large or when the marginal damage cost is low.

1.5.2 Large Country Analysis.

Schleich and Orden (2000) extend Schleich (1999) to allow for two large and similar countries with transboundary pollution. This enables the government to exert some market power when setting policy and means that it needs to take into account the actions of the other government. The economic structure is similar to the previous paper but now, when setting policy, the governments can either act cooperatively or non-cooperatively.

In a first best world, with all policies available and governments behaving non-cooperatively, it is shown that equilibrium production taxes are lower than the Pigouvian level. The reason is that there are conflicting demands on the production policy – it is used not only to address the pollution externality, but also to pacify the lobby groups with output subsidies. In a second best world, where only production policies are available, then for an exporting country it is shown that the equilibrium tax rate can again be lower than the Pigouvian level. As in the previous paper, when only one policy option is available, trade policy can lead to higher environmental quality than environmental policy. This is because the political support effect offsets

---

proportional to the share of the population in each lobby group so that the two concerns have equal

the terms of trade effect so that inefficient trade policies can lead to higher environmental quality than efficient domestic policies when there is an externality. A final result is that cooperation between governments means that some lobbies can be satisfied at a lower cost to others; this gain may be used to buy additional political favours and this may result in lower environmental quality than non-cooperation.

Conconi (2003) presents a very similar scenario and asks the question whether environmental lobbying strengthens or weakens the need for global environmental policy coordination. She focuses on emission leakage; this is the effect of domestic policy on foreign emissions. Making domestic policy tougher and reducing domestic pollution may result in shifting production and pollution to the foreign country. Unilateral tightening of environmental regulation may result in higher global pollution if the spillovers are large enough; with transboundary pollution, welfare maximising governments will set laxer than efficient policies. With emission leakages, the equilibrium policies will be even lower (Barrett 1998). The author shows that when governments behave non-cooperatively, then the impact of lobbying by environmentalists leads to a tougher policy. When free trade is in place and governments choose to unilaterally use environmental policy then the presence of emission leakages reduces and may reverse environmental lobbies' support for higher pollution taxes. The results tend to suggest that the effect of environmental lobbying on the need for coordination of policies depends to some extent on the degree of trade policy coordination – non-cooperative policies are more likely to be desirable when trade policies are also non-cooperative. From an institutional point of view, this suggests that with trade rules already in place, there may be an argument for the

---

weight from society's point of view.

creation of a World Environmental Organisation (WEO) or at least more coordinated global environmental policy. However, if WTO rules do not bind then there may be a case for a non-cooperative environmental policy.

1.5.3 Imperfect Competition.

In the model of Hillman and Ursprung (1994) there are two sectors, one of which is polluting, the other is clean. The polluting industry is characterised by imperfect competition between two firms in different countries. The pollution is entirely domestic and can be the result of either a production or consumption externality. An import tariff is the only available policy instrument. There are three lobby groups. The first represents the owners of an industry-specific factor in the domestic country and the second represents a similar group in the foreign country. The third lobby group is made up of environmentalists. The authors further make a distinction between environmentalists who are solely concerned with domestic pollution ('greens'), and those who are concerned with global pollution ('supergreens'). Lobbying takes place in both countries. The approach to political economy in this model is something of a hybrid between the traditional rent seeking literature[26] and the work on electoral competition[27]. It is similar to the approach of Magee et al (1989), which is concerned with trade policy. In stage 1 of the game, two political parties (or candidates) choose policy platforms to maximise their probability of electoral success. Parties are assumed to have some degree of ideological motivation and they are labelled as 'protectionist' and 'liberal'. In stage 2, the lobbies observe this policy stance and choose their campaign contributions to maximise expected utility taking other groups

[26] See, for example, the collection by Buchanan et al (1980) or Mueller (1997).

contributions as given. There is no formal role for voters (or consumers) in this model. Instead, the electoral outcome is decided by the relative levels of contributions to each party that is expressed in a contest success function.[28] Once a party is elected it implements its platform policy. The political equilibrium is that the parties will take polarised positions – one a protectionist stance and the other a free trade stance.[29]

The focus of this paper is not so much on the level of the tariff policy but rather the behaviour of the environmental groups. Industrial lobby groups in both countries will tend to favour protectionist parties but the behaviour of the environmentalists is not so straightforward. If pollution is caused by consumption then both greens and supergreens will support the protectionist party. The protectionist party will introduce higher domestic tariffs which will reduce consumption and with it pollution. If pollution is caused by domestic production, greens in both countries would find that supporting the liberal party is a dominant strategy. A lower domestic tariff encourages foreign production at the expense of domestic production that lowers domestic pollution. Supergreens though, remain in favour of autarky. Indeed, on the whole, the model predicts that in most cases, environmentalists and domestic industry groups are aligned in their anti-free trade stance.

---

[27] This began with Downs (1957) and Black (1948). For a review, see Hinich and Munger (1997) or Persson and Tabellini (2000).

[28] Austen-Smith (1991) has been very critical of this type of model since the structure lacks any microfoundation. It is true that voters play no active role, their views are simply aligned with those of the interest groups. However, Mayer and Li (1994) have extended this type of model to include these microfoundations. Austen-Smith (1987) presents a model in which campaign contributions are used in a probabilistic voting model by candidates to help clarify voters' uncertainties about their political positions.

[29] The basic Downsian model predicts a convergence of candidates toward the centre of the voter distribution and also assumes that election winners implement their winning platform. From the literature on elections with ideologically motivated candidates (without lobbying but with voters), Alesina (1988), building on the work of Wittman (1983) and Calvert (1985), argued that, regardless of their policy stance, the only rational action for the winning candidate was to implement their preferred policy once elected. Osborne and Slivinski (1996) and Besley and Coate (1997) build on this to provide a full rational choice explanation of the election process by endogenising the emergence of candidates and allowing for strategic voting.

Aidt (2000) extends the two country, intra-industry trade model of Brander (1981). The economies of the two countries produce two goods. One of the goods is tradable and is polluting. Pollution is transboundary and can take three forms – reciprocal, unidirectional and global. The markets are treated as segmented. The populations are divided into capitalists, consumers and environmentalists. The utility function is increasing in the consumption of the two goods and decreasing in environmental damage. Environmentalists though, suffer more from the damage because they internalise the environmental damage suffered by those in the other country (supergreens). All three groups receive a wage and a government transfer from pollution tax revenue whilst capitalists also get profits from their share in the domestic firm. The political model is Grossman-Helpman with all lobbying being domestic although, as already stated, environmentalists do take the level of global pollution into account. Government policy consists of an emissions tax and there is no cooperation in policies.

The main result is that there are circumstances in which the introduction of environmental lobbying can reduce global environmental quality and induce a race to the bottom. The scenario is that pollution is reciprocal but relatively immobile across states. The domestic government cannot directly affect what the other firm does but tries to appease environmentalists who are concerned about pollution in the other country. The policy response is then to lower its own tax to encourage the domestic firm to produce more and shift production away from the other country and its lower pollution. However, domestic pollution is higher as is total global pollution. This result will disappear when pollution becomes more mobile.

1.5.4 Constitutional and Institutional Setting.

The work of Boyer and Laffont (1999) comes from a different perspective to those we have been considering. Firstly, it does not consider trade; secondly, it concentrates on a single industry characterised by a natural monopoly; thirdly, it introduces asymmetric information between the firm and government. Boyer and Laffont use an incomplete contract approach to consider the constitutional design of policies where the choice is constrained by various imperfections. In particular, they assess why it may be desirable to limit the discretion allowed to an incumbent government when the setting of environmental policy is subject to political influence. The natural monopoly undertakes a public project that creates pollution. The government aims to regulate the firm but is unaware of the firm's costs of abatement.

When implementing optimal environmental regulation under asymmetric information the firm retains an information rent that is increasing in the toughness of the imposed policy. This information rent has a social cost that can take two values and becomes known to the government only when in power. The population consists of shareholders in the firm and non-shareholders and the government aims to represent the interests of the majority. Both groups are harmed by environmental damage. If the shareholders are the majority then the government will reflect this by acting as if the social cost is below its true cost. If the non-shareholders are the majority then the government acts as if the social cost is above its true level. At some prior constitutional stage, there is a choice of political institution, between allowing the government to set policy according to its discretion or by a process of social pooling.

A "sophisticated environmental policy is dependent on non verifiable variables which cannot be contracted upon in the constitution. Consequently it must be delegated to politicians, creating an incentive problem when politicians motivations are to stay in power by pleasing a majority of voters and not to maximise social welfare". If political discretion is chosen, the government can use its knowledge of the true value of the social cost when setting the policy but there is the potential drawback that it will be subject to political bias. If social pooling is chosen, then the policy will be set by maximising a social welfare function using the expected value of the true social cost to funds. The choice is made based on ex ante expected welfare, taken across both values of the social cost and both possible government types. The authors show that social pooling is more likely to be preferred when there is a higher variance in government types and that political discretion is more likely to be preferred when there is a higher variance in the social cost. As the two potential political platforms become polarised, then limiting the government's ability to set policy becomes more attractive. By contrast, as the two possible values of the social cost become polarised it becomes more appealing to allow the government to use its knowledge of the true value when setting policy.

Fredriksson and Gaston (2000) adopt a political economy approach in a federal structure. The distinction they make between the state and the federal level is the presence of capital competition when there is de-centralised policy setting. They look at capital movements and environmental regulation and the standard argument that de-centralised policymaking leads to laxer standards as states compete for capital. There are three distinct interest groups in their model. A lobby group representing labour seeks to increase the capital base in its own state by obtaining laxer regulation. There

is an environmental lobby group, which derives disutility from laxer standards and prefers tougher standards. The third type of group is made up of capital owners, although these may not be present in every state.

In their model, there are many states that produce goods in a perfectly competitive market. There are three inputs – capital, labour and a polluting emission. Labour is immobile, capital is perfectly mobile and the pollution is purely domestic. State policymakers are concerned with effect of standards on investment and capital flows whilst federal policymakers are not concerned with capital flight. Members of all groups gain utility from the production of the good but environmentalists gain disutility from pollution. Lobbying and the government's welfare function are a la Grossman-Helpman so that the political equilibrium is a two stage non-cooperative game with a sub-game perfect Nash equilibrium.

The authors find that when policies are set de-centrally the environmental policy is efficient although capital competition may influence policymakers to reduce the standard of regulation. A second result is that if the capital stock is immobile, and when policy is set at the federal level then the outcome reduces to the decentralised outcome. This means that it is essentially independent of institutional design. The reason is that the lobbying of capital owners affects environmental regulation in a similar way that capital competition affects policy when it is set at the state level. The result suggests that state level policymaking may be preferable if states are more heterogeneous.

1.6 Contribution of this Thesis.

In this thesis we build upon a number of the models we have reviewed in this chapter and try and analyse some of the issues that have been raised. Fundamentally, we take a political economy approach to strategic environmental policy in a federal structure. This provides the two possible routes identified by Krugman (1997) by which environmentalists' concerns about a 'race to the bottom' could be rationalised. The underlying economic model is that of Ulph (1997b), which is built upon a Brander-Spencer model of trade and generates wasteful strategic competition between two national governments. Policy can be coordinated by a supra-national agency or set individually by nation states. Each state holds private information about its damage costs although governments only learn the true value when they come into power. The information is not available to either voters or the supra-national agency.

In chapter 2, we adapt the model of Boyer and Laffont (1999) to a two country setting. The main aim of the chapter is to consider some constitutional issues. Firstly, the Subsidiarity question – is it welfare enhancing to cede environmental policy to a supra-national agency ? We find that it is overwhelmingly better to do so. The second, the decision is whether to grant policymakers the discretion to implement their favoured policies or whether to limit their discretion. Politicians are captured by special interest groups so that they give too high or low a weight to environmental damages relative to the weight in social welfare. Limiting discretion is done via social pooling – setting policies by maximising welfare based on the ex ante expected value of damage costs. In this model social pooling implies harmonisation. The enables us to ask a related question – is harmonisation of environmental policies justified on

political economy grounds ? We find that social pooling is more appealing as the political types diverge and that allowing discretion is more appealing as the differences in damage costs diverge. Social pooling or harmonisation is never worthwhile at the federal level if it is not also better at the state level.

In chapter 3 we try and assess some of the concerns raised by environmentalists and anti-globalisation groups. Although there may be an acceptance that policies need to be coordinated at a supra-national level to overcome strategic competition this raises further concerns. In particular is claimed that a 'democratic deficit' is created where policies are set by un-elected and unaccountable 'technocrats'. Another issue is the concern that the policymaking process is captured by certain groups – developed countries and industrial groups (MNCs) – whilst other groups are excluded or ignored – developing countries and environmental groups. To capture these asymmetries in influence, we build on the model in chapter 2 to include lobbying. Lobbying is similar to Magee et al (1989) and Hillman and Ursprung (1992, 1994) in that a contest success function is determined by relative political contributions and that voters play no active role. Lobbying expenditure can be thought of as pure waste. By varying the costs of lobbying for different groups, we can address any asymmetries in influence. It is shown that having influence may lead to unexpected effects. For example, industrialists may be worse off having greater access to policymakers because they undertake too much costly lobbying. In addition, the major effects of asymmetries occur when policy is set at the national level. This is due to the effect on strategic competition between the two state governments.

In chapter 4 we introduce a further distortion into the model by including transboundary pollution. Now there are two motivations behind coordinating environmental policy at a supra-national level – to prevent damaging strategic competition and also to overcome transboundary pollution. It is shown that transboundary pollution increases the amount of lobbying that takes place and that the various asymmetries in lobbying we analyse have bigger effects in terms of groups' utility and national welfare. Despite all the distortions that take place, we show in both chapters that it is still overwhelmingly desirable to set policy at a supra-national level.

In chapter 5 we extend the analysis in both chapters 2 and 3. The aim is to address the constitutional issues we looked at in the model of chapter 2 and test whether the results remain robust when active lobbying is included. Broadly we show that they are. Chapter 6 concludes.

Chapter 2

International Coordination of Environmental Policies, Harmonisation, and Limiting Political Discretion.

Abstract.

We consider a federal system where states face local environmental problems, but where, due to imperfect competition, if states set environmental policies non-cooperatively they set laxer environmental policies than if a federal government set policies to maximise the joint welfare of states. It is often argued that the federal government should "harmonise upwards" states' environmental policies, but, in general, harmonisation would not be optimal if states differ with respect to environmental damage costs. This remains true even if, as we assume, each state has private information about its damage costs.

However this presumes welfare maximising governments. In this chapter we assume that governments at state and federal level can be influenced by pressure groups, resulting in governments giving too high or low a weight to environmental damages relative to their weight in social welfare. There are two constitutional choices: (i) whether environmental policies should be set at the state or federal level; (ii) whether to allow governments to set environmental policy using the information they acquire about damage costs, but giving these costs too high or low a weight (political discretion), or to tie governments' hands by prescribing policies which maximise welfare, but based on the expected value of damage costs (social pooling). In our model social pooling implies harmonisation. We show that within our model expected welfare is higher when policy is set at the federal level. Social pooling is desirable when the difference in the weight given to environmental damage costs by different government types is large, relative to the potential difference in damage costs.

However social pooling is less desirable when policy is set at the federal level than when policy is set at the state level. Indeed we show that it is never the case that one would want social pooling at the federal level but not at the state level. Thus the argument for harmonisation cannot be justified on the grounds that environmental policy needs to be coordinated at a supra-national level.

2.1 Introduction.

It is widely accepted that there is a need for international co-ordination of environmental policies of nation states to tackle transboundary or global pollution problems. But in recent debates on trade liberalisation, some environmentalists and business interests have called for co-ordination and even harmonisation of the environmental policies of nation states to deal with purely domestic environmental problems. One rationale given by environmentalists for harmonisation is the fear that in a more competitive trade regime, governments of nation states acting independently will compete by setting weak environmental regulations ('environmental dumping'), triggering a 'race-to-the bottom'[1]. The rationale given by industrialists for harmonisation is a wish to preserve a 'level playing field' for international trade. There are many definitions of harmonisation of environmental policies[2], but in this chapter we shall take the strictest definition, namely that nation states should set identical environmental standards (e.g. the same emission tax or the same emission standard).

Conventional economic analysis provides little support for harmonisation or even co-ordination of purely domestic environmental policies. Globally efficient allocations of resources are supported by free trade with national governments setting the usual first-best environmental policies[3]. If countries differ in terms of endowments of environmental resources, tastes for a clean environment or abatement technology, then

[1] Bhagwati (1996) gives an elegant survey of a number of philosophical, political and economic arguments advanced to support calls for harmonisation of environmental, labour and other policies.
[2] See Leebron (1996) for an excellent discussion.
[3] By first-best environmental policies we mean policies which ensure that marginal abatement costs are equalised for all polluters and are equal to marginal environmental damage costs.

in general, efficient allocations will have countries setting different environmental standards. If markets are competitive, and there are no other distortions, then in a small country a welfare maximising government would wish to pursue free trade and first-best environmental policies, no matter what policies were pursued in other countries. So there would be no incentive for 'environmental dumping'. A welfare maximising government in a large country prevented from setting trade taxes might wish to set environmental policies which differed from the first-best, but, for pollution related to production, this would involve net exporters setting environmental policies tougher than first-best, net importers setting policies weaker than first-best, so again there is no presumption of environmental dumping by all states[4].

As Krugman(1997) notes there are two possible routes by which one might try to make sense of concerns about environmental dumping and the call for harmonisation[5] - strategic trade considerations and political economy models.

It is straightforward to construct models of imperfectly competitive trade where welfare maximising governments who cannot use trade instruments engage in environmental dumping[6]. As is well known from the literature on strategic trade, these

[4] See Bhagwati and Srinivasan (1996) and Ulph (1997a) for surveys of the literature on trade and environment where these standard results are presented. Verbruggen and Kuik (1997) also summarise the main welfare economic principles linking trade and environment in their report on the failure of the first Ministerial WTO Conference in Singapore in December 1996 to tackle trade and environment issues, in part because of the tension between calls for harmonisation of environmental policies as opposed to preserving environmental diversity.

[5] Karp, Zhao and Sacheti (1997) use a second-best argument to provide a justification for harmonisation of purely domestic environmental policies; but this does not explain why distortions arise in the first place, and, as with most second-best arguments, it requires a rather special model to justify harmonisation, rather than just co-ordination, of domestic environmental policies.

[6] Note that the literature employs two distinct definitions of environmental dumping: (a) national governments set environmental policies which are weaker than the first-best environmental policies described earlier; (b) national governments acting non-cooperatively set environmental policies which are weaker than they would set if they acted cooperatively.

results are not at all robust[7], and it is also difficult to find any empirical support that differences in environmental policies between countries have significant effects on trade or FDI[8]. However even if there was a significant problem of national governments setting weak environmental policies, what would the policy implications be? By the second definition of environmental dumping, it is possible to choose a set of cooperative policies that make all the states which engage in environmental dumping better off than when they act non-cooperatively. But, if countries differ with respect to the environment in the ways noted above, then both harmonisation of environmental policies and the imposition of minimum environmental standards may fail to deliver even a Pareto improvement over the non-cooperative equilibrium[9].

This raises the question of how a cooperative set of policies might be implemented. In the context of regulatory competition it seems natural to consider a federal/state structure in which the setting of environmental policies at the state level corresponds to a non-cooperative equilibrium, while if environmental policies are set at the federal level this implies the choice of a cooperative policy[10]. Then, if imperfectly competitive trade leads to significant environmental dumping when domestic environmental policies are set at the state level, the solution is to have such policies set at the federal level. This raises the natural question of whether the federal government may be less well informed about domestic environmental problems than

[7] Thus it is also possible to produce models in which there is a 'race-to the-top', e.g. NIMBYISM. Results depend upon the form of market competition (e.g. Bertrand or Cournot), whether producers are also able to make strategic investments in capital, R&D or location, the level of environmental damage costs, general equilibrium effects amongst others. See Wilson (1996) Rauscher (1997) Chapter 6 and Ulph (1997a) for surveys of the available results.

[8] See, for example, Levinson (1996), van Beers and van der Bergh (1997).

[9] See Kanbur, Keen and van Wijnbergen (1995), Ulph (1997b, c).

[10] i.e. a policy which maximises a federal welfare function, which is a non-decreasing function of the welfares of each state, subject to the condition that no state is worse off than in the non-cooperative equilibrium.

state governments, and some authors simply assume that such an asymmetry of information implies that when policy is set at the federal level it must be uniform across states[11]. A more sophisticated analysis would analyse how the asymmetry of information affected the design of federal policy. Ulph (2000) showed that when each state has private information about its own environmental damage costs, then environmental policies for states with different damage costs will be more similar than would be the case if there was full information, but this falls far short of harmonisation of environmental policies[12].

In summary, strategic trade considerations can imply that governments may impose weak environmental policies, though this argument is neither theoretically nor empirically compelling, and while this could justify a need to co-ordinate domestic environmental policies of states, it cannot justify harmonisation of these policies.

We now turn to the second route for rationalising environmentalists' concerns - political economy models. There is now a small literature applying political economy models of electoral competition or political influence to trade and environment[13]. As with strategic trade arguments, these models can explain why, even in a small country, a government may not implement first-best environmental policies, or pursue free

[11] See for example Emeny, Frederikson and Gaston (1997) who analyse the impact of political lobbying at state and federal level. Although there is no explicit analysis of asymmetric information, they explicitly assume that the federal government must set a uniform policy (rather than this being the equilibrium outcome when states are identical), and it is this inefficiency in federal policy which drives the difference between state and federal outcomes in their model.

[12] The rationale is that in a full information cooperative equilibrium where states have different damage costs, it is efficient to have a lot of production take place in states with lower damage costs. To provide states with high damage costs with an incentive to truthfully reveal this information, they must be given a larger market share, and hence their environmental policies must move closer to those in states with lower damage costs.

[13] See Hillman and Ursprung (1992, 1994), Frederikson (1997a, 1997b), Rauscher (1997); Ulph (1997d) provides an overview.

trade, but deviations from first-best could involve either too lax or too tough environmental policies depending on relative strengths of lobby groups. This literature also explains why environmentalists may support protectionist groups. However, this literature does not provide any support for a policy of harmonisation, for two reasons. First, even if it is true that environmental policies in some states are not first-best, that does not provide a reason to co-ordinate reforms of environmental policies; there have to be other reasons, such as those provided by strategic trade literature, for co-ordinating environmental policies. Second, the literature is entirely positive, and does not address the issue of whether or how to limit political influence on environmental policies.

Boyer and Laffont (1999) address the second concern by analysing whether it might be desirable to limit political influence over the setting of environmental policy. They consider a single government regulating a single polluter whose abatement costs are private information. Environmental policy must be designed to take account of this asymmetry of information, and this leaves the polluter with an information rent. Because there is a social cost to raising funds, leaving this rent with the firm is costly. The social cost of funds is unknown to voters, and becomes known only to a government when it comes into power. The rationale behind this is that only the government in power will have full access to confidential data or reports regarding the state of the national economy. Also because it is only the government in power which has use of the vast resources within the civil service. The government may be elected either by a party which represents the interests of shareholders in the regulated firm, and who attach too little weight to the social cost of the information rent (relative to its weight in a social welfare function), or by non-shareholders who attach too much

weight to the social cost of the information rent[14]. At a prior constitutional stage, society can choose two ways to organise government. Society can opt for *political discretion*, i.e. the government in power can implement an environmental policy based on the true social cost of funds, but applying a weight to the information rent which may be too high or too low. Or society can select *social pooling*, in which the voters 'tie the government's hands' to implement an environmental policy which maximises welfare, but based only on the expected value of the social cost of funds. The choice between these two regimes is based on expected welfare, and Boyer and Laffont show that social pooling will be preferred when there is a relatively low variance of true social cost of funds, and a relatively high variance on the weight different parties attach to the social cost of funds.

In this chapter we address both the limitations of the existing literature identified above, by combining the strategic trade analysis of Ulph (2000) with the Boyer and Laffont (1999) analysis of whether to tie governments hands. As in Ulph (2000) environmental damage costs in each state are unknown *a priori*, and are learned only by the state government once it gets into power. However, each government (at the state and federal level) is no longer assumed to maximise welfare, but to maximise a utility function which puts too high or too low a weight on environmental damage costs depending on whether they are a 'green' or an 'industrial' government. As in Boyer and Laffont, there is a constitutional choice between *political discretion* (allowing a government to set environmental policy knowing the true environmental damage cost, but attaching too high or too low a weight to environmental damages) or

[14] Paradoxically this will mean the 'shareholder government' will impose a tougher environmental policy than the 'non-shareholder government'.

social pooling, where a government is constrained to act to maximise welfare, but based on the expected value of environmental damages. In the simple model presented here, countries are *ex ante* identical, so that pursuing social pooling implies harmonisation of environmental policies across countries which, *ex post*, may have very different damage costs.

There is a fourfold constitutional choice to be made: for each level at which environmental policy may be set, there is a choice between political discretion and social pooling; for each choice of social pooling or political discretion there is a choice between policy being set at the state or federal level. We show that it is always better to have policy set at the federal level. Whether policy is set at the state or federal level, social pooling will be preferred to political discrimination when the difference in weights attached to environmental damages by governments of different types is high relative to the potential difference in damage costs.

The key question we ask is whether social pooling is more likely when policy is set at the federal level – i.e. does the need to coordinate environmental policies at the federal level, to overcome strategic policy competition, make it more likely that one will want to limit political discretion through social pooling and hence, in our context, harmonise policies? Our answer is unambiguously no. We show that social pooling is always more preferred when policy is set at the state level than at the federal level, in the sense that it is never the case that social pooling would be preferred to political discretion when policy is set at the federal level while political discretion would be preferred to social pooling if policy is set at the state level. In this sense, the need to have policy set at the federal level to counteract wasteful environmental policy

competition if policy was set at the state level, cannot justify harmonisation of environmental policies if those policies would not already have been harmonised at the state level.

2.2 The Model.

We consider a partial equilibrium model of an industry with two identical firms each located in a different state. These two states form a federation. The two firms produce a good which is sold entirely outside the federation. The production of the good causes emissions of a pollutant, although these emissions can be abated, at a cost. The only instrument available to control pollution in each state is an emission limit. Each firm takes as given its emission limit and the output of the other firm and chooses its own output level and abatement to maximise profits (net of abatement costs). The equilibrium profit function for firm i is $\Pi(e_i, e_j)$ where e_i is the emission limit set by state i.

Unabated pollution causes environmental damage, but only in the state in which the firm is located. The damage cost function in state i is denoted $\delta_i D(e_i)$ where δ_i is a parameter and D is a strictly convex function. Welfare in state i is thus given by $W(e_i, e_j, \delta_i) \equiv \Pi(e_i, e_j) - \delta_i D(e_i)$.

To capture asymmetric information, we suppose that the damage cost parameter, δ_i, in each state is known only to the state government in power. To keep things simple, we suppose that in state i =1, 2, δ_i can take one of only two values, δ_L and δ_H, $\delta_L < \delta_H$, with probabilities p and 1- p respectively. Note that this implies that, *ex ante*, both states are identical. We denote the expected value of damage costs by $\bar{\delta} = p\delta_L + (1-p)\delta_H$.

To allow for governments which do not maximise welfare, we assume that there are three elections for governments in state 1, state 2 and the federal government. In each election there are two possible types of government that can be elected: an industrial government or an environmental government. Governments have utility functions, which differ from welfare functions by the weight they attach to environmental damages. Environmental governments attach a weight $\gamma_H > 1$ to environmental damages; industrial governments attach a weight $\gamma_L < 1$ to environmental damages. Thus, in state $i = 1, 2$, the state government maximises a utility function: $U(e_i, e_j, \delta_i, \gamma_i) \equiv \Pi(e_i, e_j) - \gamma_i \delta_i D(e_i)$; the federal government will maximise a utility function: $U(e_i, e_j, \delta_i, \delta_j, \gamma_F) \equiv \Pi(e_i, e_j) + \Pi(e_j, e_i) - \gamma_F [\delta_i D(e_i) + \delta_j D(e_j)]$. We assume that in each of the three elections there is a probability q that the government elected will be an environmental government, and that this probability is independent of the probability of electing an environmental government in any other election. We assume that the expected value of the political weight attached to environmental damage costs is: $\bar{\gamma} = q\gamma_H + (1-q)\gamma_L = 1$, so that, on average, governments are welfare maximisers.

Finally, we assume that there is a constitutional choice about how environmental policies in each state should be set. There are two aspects. The first is the standard question in a federal system of which level of government should be allowed to set environmental policy. Whatever level is chosen, there is a second choice, which is how to deal with the problem of governments being captured by interest groups, and for this choice we follow Boyer and Laffont (1999). To prevent governments being captured by special interest groups, society could decide to tie governments hands

through *social pooling*, by which we mean that governments are mandated to maximise expected welfare. Since this choice is made before state governments have been elected, and before those governments learn the true value of damage costs, social pooling requires that governments set their policies to maximise expected welfare, using the expected value of damage costs, $\bar{\delta}$, which is public knowledge. Since we assume that both states have the same value of expected damage costs, social pooling implies harmonisation of environmental policies. However, social pooling means that governments will not be able to use the information they get to learn about the true value of damage costs. The alternative then is for society to choose *political discretion*, in which environmental policies are not set by governments until after the state governments learn their true damage costs. But at that stage it is no longer possible to tie governments hands, and so governments will set policies to maximise utility, but need to take account of the fact that the true value of damage costs in state i is private information to the government of state i. Which choice is made at the constitutional stage depends on the expected welfare of each state, taking expectations across the type of government that might be elected in each of the three elections and the level of damage costs that each state might turn out to have. At this constitutional stage, each state is *a priori* identical, so both states will agree on the best constitutional choice.

The timing of events is as follows. At the first stage society chooses the level of government at which environmental policy should be set and whether to use social pooling or political discretion. There is then a random process which determines which type of government will be elected in each state and at the federal level. Next, there is a random process which determines what level of damage costs each state has.

Governments then come into power and each state government learns the true value of damage costs in its state. Governments then set policies according to the choice made by society at the first stage.

We now describe the outcome in each of the four possible constitutional choices.

2.2.1 Social Pooling - Policy Set at the State Level.

Governments in each state are mandated to maximise expected welfare based on the expected value of damage costs. Thus the government in state i = 1, 2 takes as given the emission limit set the other state, $\breve{e}_j$, and sets its own emission limit $\breve{e}_i$ to maximise $U(\breve{e}_i, \breve{e}_j, \bar{\delta}, 1)$, for which the first-order condition is $W_1(\breve{e}_i, \breve{e}_j, \bar{\delta}) = 0$. In the resulting Nash equilibrium it is clear that since the two states are *ex ante* identical, the equilibrium emission limits will be equal, $\breve{e}_i = \breve{e}_j = \breve{e}$. Expected social welfare for each state from this stage one choice is simply $\breve{W} = W(\breve{e}, \breve{e}, \bar{\delta})$.

2.2.2 Social Pooling - Policy Set at the Federal Level.

The federal government is required to maximise total expected welfare based on the expected value of damage costs. Thus the federal government chooses e^*_1, e^*_2 to maximise $U(e^*_1, e^*_2, \bar{\delta}, 1) + U(e^*_2, e^*_1, \bar{\delta}, 1)$, for which the first-order condition is $W_1(e^*_1, e^*_2, \delta) + W_2(e^*_2, e^*_1, \bar{\delta}) = 0$. Again it is clear that since the two states are identical

ex ante, the solution must require $e^*_1 = e^*_2 = e^*$. Expected social welfare for each state from this stage one choice is simply $W^* \equiv U(e^*, e^*, \bar{\delta}, 1)$.

If we compare the two social choices involving social pooling, it is clear from the properties of the welfare function that $e^* < \bar{e}$, $W^* > \overline{W}$, so that if social pooling is chosen at the constitutional stage, then it always be better to have environmental policy set at the federal level. Note the important point that social pooling implies that environmental policies will be *harmonised* across the two states, no matter what the *ex post* level of damage costs turns out to be in the two states.

2.2.3 Political Discretion - Policy Set at the State Level.

There are four possible configurations of government types in the two states. For any configuration (γ_1, γ_2) the emission limits in the two states are set as the Nash equilibrium of a game in which each state government knows its own damage costs but not those of its rival. Thus there are four equilibrium emission limits to be determined: $\tilde{e}_1(\gamma_1, \gamma_2, \delta_L), \tilde{e}_1(\gamma_1, \gamma_2, \delta_H), \tilde{e}_2(\gamma_1, \gamma_2, \delta_L), \tilde{e}_2(\gamma_1, \gamma_2, \delta_H)$, and four first-order conditions to determine them. For example, if state 1 has low damage costs, it will take as given the low damage cost and high damage cost emission limits of state 2 and choose $\tilde{e}_1(\gamma_1, \gamma_2, \delta_L)$ to maximise expected utility:

$$pU[\tilde{e}_1(\gamma_1, \gamma_2, \delta_L), \tilde{e}_2(\gamma_1, \gamma_2, \delta_L), \delta_L, \gamma_1] + (1-p)U[\tilde{e}_1(\gamma_1, \gamma_2, \delta_L), , \tilde{e}_2(\gamma_1, \gamma_2, \delta_H), \delta_L, \gamma_1]$$

From the equilibrium emission limits we can define the equilibrium expected utilities for each state for each configuration of government types and each level of damage costs: $\tilde{U}_1(\gamma_1,\gamma_2,\delta_L),\tilde{U}_1(\gamma_1,\gamma_2,\delta_H),\tilde{U}_2(\gamma_1,\gamma_2,\delta_L),\tilde{U}_2(\gamma_1,\gamma_2,\delta_H)$.. We then compute expected utility for each state i with configuration of government types (γ_1,γ_2): $\tilde{U}_i(\gamma_1,\gamma_2)=p\tilde{U}_i(\gamma_1,\gamma_2,\delta_L)+(1-p)\tilde{U}_i(\gamma_1,\gamma_2,\delta_H)$. Similarly we can evaluate expected welfare for state i : $\tilde{W}_i(\gamma_1,\gamma_2)$.

Finally, we can evaluate expected utility and welfare for each state over the four possible configurations of government types in the two states:

$$\tilde{U}=q^2\tilde{U}(\gamma_L,\gamma_L)+q(1-q)[\tilde{U}(\gamma_L,\gamma_H)+\tilde{U}(\gamma_H,\gamma_L)]+(1-q)^2\tilde{U}(\gamma_H,\gamma_H)$$

$$\tilde{W}=q^2\tilde{W}(\gamma_L,\gamma_L)+q(1-q)[\tilde{W}(\gamma_L,\gamma_H)+\tilde{W}(\gamma_H,\gamma_L)]+(1-q)^2\tilde{W}(\gamma_H,\gamma_H)$$

Note that since the two states are identical *ex ante* expected utility and welfare must be the same for the two states, so we drop the subscript identifying the state.

2.2.4 Political Discretion - Policy Set at the Federal Level.

There are eight possible configurations of government types at the state and federal levels, $(\gamma_1,\gamma_2,\gamma_F)$. For any given configuration, the federal government has to solve a mechanism design problem in which it sets emission limits for each state contingent on the announced damage costs of both states so as to maximise expected utility of the federal government subject to incentive-compatibility constraints. The mechanism design problem is a reduced form version of that used in later chapters where we also

allow the government to use financial transfers to help induce truthful revelation and also include individual rationality constraints.[15] However, those later chapters rely more on numerical simulations and since in this chapter we are seeking to explore some analytical results, for simplicity, it was decided to only adopt the incentive compatibility constraints. Note also that in the federal government's utility function it is the federal government's political weight for environmental damage costs that will be used, but that in the incentive - compatibility constraints the federal government must take account of the political weights in the individual states' utility functions.

Formally, the federal government must choose the set of policy instruments[16]:

$\hat{e}^1_{LL}, \hat{e}^1_{LH}, \hat{e}^1_{HL}, \hat{e}^1_{HH}, \hat{e}^2_{LL}, \hat{e}^2_{LH}, \hat{e}^2_{HL}, \hat{e}^2_{HH}$, to maximise:

$$
\begin{aligned}
&p^2\{[U(\hat{e}^1_{LL}, \hat{e}^2_{LL}, \delta_L, \gamma_F) + M^1_L] + [U(\hat{e}^2_{LL}, \hat{e}^1_{LL}, \delta_L, \gamma_F)]\} \\
&+ p(1-p)\{[U(\hat{e}^1_{LH}, \hat{e}^2_{HL}, \delta_L, \gamma_F) + M^1_L] + [U(\hat{e}^2_{HL}, \hat{e}^1_{LH}, \delta_H, \gamma_F)]\} \\
&+ p(1-p)\{[U(\hat{e}^1_{HL}, \hat{e}^2_{LH}, \delta_H, \gamma_F) + M^1_H] + [U(\hat{e}^2_{LH}, \hat{e}^1_{HL}, \delta_L, \gamma_F)]\} \\
&+ (1-p)^2\{[U(\hat{e}^1_{HH}, \hat{e}^2_{HH}, \delta_H, \gamma_F) + M^1_H] + [U(\hat{e}^2_{HH}, \hat{e}^1_{HH}, \delta_H, \gamma_F)]\}
\end{aligned}
$$

subject to the incentive-compatibility constraints:

$$
\begin{aligned}
&pU(\hat{e}^1_{HL}, \hat{e}^2_{LH}, \delta_H, \gamma_1) + (1-p)U(\hat{e}^1_{HH}, \hat{e}^2_{HH}, \delta_H, \gamma_1) \geq \\
&pU(\hat{e}^1_{LL}, \hat{e}^2_{LL}, \delta_H, \gamma_1) + (1-p)U(\hat{e}^1_{LH}, \hat{e}^2_{HL}, \delta_H, \gamma_1)
\end{aligned}
$$

$$
\begin{aligned}
&pU(\hat{e}^2_{HL}, e^1_{LH}, \delta_H, \gamma_2) + (1-p)U(\hat{e}^2_{HH}, \hat{e}^1_{HH}, \delta_H, \gamma_2) \geq \\
&pU(\hat{e}^2_{LL}, e^1_{LL}, \delta_H, \gamma_2) + (1-p)U(\hat{e}^2_{LH}, \hat{e}^1_{HL}, \delta_H, \gamma_2)
\end{aligned}
$$

[15] In chapter 5 we also allow for there to be a social cost of raising public funds to make the transfers. One interpretation would be to think of the case in this chapter as one where the social cost of raising funds is sufficiently high that no transfers are made.

[16] To save notation we omit the dependence of these policy instruments on the configuration of government types.

The incentive compatibility constraints require that states with high damage costs have no incentive to pretend to have low damage costs in order to be allocated a higher emission limit and hence get a larger share of industry output. The mechanism design problem is solved for any configuration of government types above. Having obtained the optimal values of the policy instruments we can then calculate the expected utilities and welfares for the two state governments and the federal government: $\hat{U}_i(\gamma_1,\gamma_2,\gamma_F), \hat{W}_i(\gamma_1,\gamma_2,\gamma_F)\ i=1,2,F$.

Finally we take expectations over the eight possible configurations of government to calculate expected utility and expected welfare for each state and the federal government. By the *ex ante* identity of the two states expected utility is the same for both states, and so too is expected welfare, so we drop the state identifiers:

$$\hat{U} = q^3\hat{U}(\gamma_L,\gamma_L,\gamma_L) + q^2(1-q)[\hat{U}(\gamma_L,\gamma_L,\gamma_H) + \hat{U}(\gamma_L,\gamma_H,\gamma_L) + \hat{U}(\gamma_H,\gamma_L,\gamma_L)]$$
$$+ q(1-q)^2[\hat{U}(\gamma_H,\gamma_H,\gamma_L) + \hat{U}(\gamma_H,\gamma_L,\gamma_H) + \hat{U}(\gamma_L,\gamma_H,\gamma_H)] + (1-q)^3\hat{U}(\gamma_H,\gamma_H,\gamma_H)$$

$$\hat{W} = q^3\hat{W}(\gamma_L,\gamma_L,\gamma_L) + q^2(1-q)[\hat{W}(\gamma_L,\gamma_L,\gamma_H) + \hat{W}(\gamma_L,\gamma_H,\gamma_L) + \hat{W}(\gamma_H,\gamma_L,\gamma_L)]$$
$$+ q(1-q)^2[\hat{W}(\gamma_H,\gamma_H,\gamma_L) + \hat{W}(\gamma_H,\gamma_L,\gamma_H) + \hat{W}(\gamma_L,\gamma_H,\gamma_H)] + (1-q)^3\hat{W}(\gamma_H,\gamma_H,\gamma_H)$$

2.2.5 Analysis of Constitutional Choice.

We have now defined the expected welfare for each state for each of the four possible constitutional choices that can be made at stage one: $\bar{W}, W^*, \tilde{W}, \hat{W}$. All we have been able to establish so far is that $\bar{W} < W^*$, so that if social pooling is selected, then it is

better to have policy set at the federal level, for the obvious reason that, since there is no information asymmetry between federal and state governments, having policy set at the federal level overcomes the mutually damaging policy competition between the states. To make further progress we will need to use particular functional forms, and we turn to this in the next section.

2.3 A Special Case.

In this section we set out a special case of the model in the previous section, drawing on the special case used in Ulph (1997b). In that model, the two firms produce a homogenous good and face a simple linear inverse demand function with intercept A and unit slope. There are no costs of production but there are quadratic abatement costs, $0.5a^2$ and the damage cost function is also quadratic: $D(e) = 0.5e^2$. It is then straightforward to show that the utility function for state i is:

$$U(e_i, e_j, \delta_i, \gamma_i) = 3(2A - e_j)^2 + 18e_i(2A - e_j) - (37 + 64\delta_i\gamma_i)e_i^2 \qquad (1)$$

We also assume that $p = 0.5$, $\delta_H = (1+\lambda)\bar{\delta}$ and $\delta_L = (1-\lambda)\bar{\delta}$ where $0 < \lambda < 1$, and λ is a measure of the dispersion of damage costs around expected value, $q = 0.5$, $\gamma_H = 1+\upsilon$ and $\gamma_L = 1-\upsilon$ where $0 < \upsilon < 1$ and υ is a measure of the dispersion of political weights for environmental damage costs. The three key parameters of the model are: expected damage costs, $\bar{\delta}$; dispersion of damage costs, λ; and dispersion of political weights attached to damage costs, υ.

We now analyse each of the four possible constitutional choices for this special case.

2.3.1 Social Pooling - Policy set at the State Level.

Setting $\delta_i\gamma_i = \bar{\delta}$ in (1) and maximising with respect to state i's emission limit yields the first-order condition:

$$18(2A - e_j) - 2(37 + 64\bar{\delta})e_i = 0.$$

In equilibrium, $e_i = e_j = \breve{e}$, so

$$\breve{e} = \frac{9A}{23 + 32\bar{\delta}}.$$

Clearly $d\breve{e}/d\bar{\delta} < 0$, as one would expect. Substituting $\bar{e}$ into the welfare function yields:

$$\breve{W}(\bar{\delta}) = \frac{192A^2(37 + 64\bar{\delta})(1 + \bar{\delta})}{(23 + 32\bar{\delta})^2},$$

and it is readily shown that $d\breve{W}/d\bar{\delta} < 0$, again as one would expect. Note also that, by construction, both $\breve{e}$ and $\breve{W}$ depend only on expected damage cost parameter, $\bar{\delta}$, and not on the dispersion of either damage costs or the political weight on damage costs, λ and υ.

2.3.2 Social Pooling - Policy Set at the Federal Level.

Again substituting $\delta_i \gamma_i = \bar{\delta}$ in (1) and maximising the sum of the welfare functions for states i and j yields the first-order condition for e_i:

$$18(2A - e_j) - 2(37 + 64\bar{\delta})e_i - 6(2A - e_i) - 18e_j = 0.$$

In equilibrium $e_i = e_j = e^*$; so

$$e^* = \frac{6A}{26+32\bar{\delta}} < \bar{e}.$$

Again it is clear that e^* is a decreasing function of $\bar{\delta}$. Substituting e^* into the welfare function yields:

$$W^*(\bar{\delta}) = \frac{192A^2(1+\bar{\delta})}{(13+16\bar{\delta})} > \breve{W}(\bar{\delta}).$$

It is straightforward to see that W^* is a decreasing function of $\bar{\delta}$. Again, note that both e^* and W^* depend only on expected damage cost parameter, $\bar{\delta}$, and not on the dispersion of either damage costs or the political weight on damage costs, λ and υ.

2.3.3 Political Discretion - Policy Set at the State Level.

For any values of γ_1, γ_2 we wish to find for state i = 1, 2 the emission limits it will set if it has high and low damage costs, defined by $\tilde{e}_{iH}, \tilde{e}_{iL}$ respectively. With high damage costs, $\tilde{e}_{iH}$ will maximise $pU(\tilde{e}_{iH}, \tilde{e}_{jL}, \gamma_i, \delta_H) + (1-p)U(\tilde{e}_{iH}, \tilde{e}_{jH}, \gamma_i, \delta_H)$. Define $\beta_{iL} = 37 + 64\gamma_i\delta_L$, $\beta_{iH} = 37 + 64\gamma_i\delta_H$, $\bar{\beta}_i = 37 + 64\gamma_i\bar{\delta}$. Then for the particular functional forms of our special case given in (1), the set of first-order conditions for state i, i = 1,2 are given by:

$$18A - 9[p\tilde{e}_{jL} + (1-p)\tilde{e}_{jH}] - \beta_{iH}\tilde{e}_{iH} = 0,$$

$$18A - 9[p\tilde{e}_{jL} + (1-p)\tilde{e}_{jH}] - \beta_{iL}\tilde{e}_{iL} = 0.$$

These first-order conditions can be solved to yield:

$$\tilde{e}_{iH} = \frac{18A\beta_{iL}[\beta_{jL}\beta_{jH} - 9\bar{\beta}_j]}{\beta_{iL}\beta_{iH}\beta_{jL}\beta_{jH} - 81\bar{\beta}_i\bar{\beta}_j}$$

$$\tilde{e}_{iL} = \frac{18A\beta_{iH}[\beta_{jL}\beta_{jH} - 9\bar{\beta}_j]}{\beta_{iL}\beta_{iH}\beta_{jL}\beta_{jH} - 81\bar{\beta}_i\bar{\beta}_j} \qquad i, j = 1, 2 \quad i \neq j \qquad (2)$$

It is easy to see that $\tilde{e}_{iH} < \tilde{e}_{iL}$, so, for any configuration of government types, each state sets a lower emission limit if it learns it has high damage costs than if it has low damage costs. It can also be shown that $\partial\tilde{e}_i/\partial\gamma_i < 0, \quad \partial\tilde{e}_i/\partial\gamma_j > 0$; whatever damage costs a state has, high or low, its emission limit is decreasing in the political weight its state government attaches to damage costs, and increasing in the political weight the other state government attaches to damage costs.

We now want to calculate expected welfare with political discretion when policy is set at the state level: $\tilde{W}(\bar{\delta}, \lambda, \upsilon)$. For any configuration of government types, (2) shows that equilibrium emission limits are quite non-linear functions of the key parameters, $\bar{\delta}$, λ and υ, so expected welfare is going to be a more complicated non-linear function of these parameters. However, it is possible to derive some results for two limiting cases.

(i) No Political Distortion: $\upsilon = 0$.

Suppose that both state governments are welfare maximising. Then, from (2) there are only two emission limits of interest:

$$\tilde{e}_L = \frac{18A\beta_H}{\beta_L\beta_H + 9\bar{\beta}}; \qquad \tilde{e}_H = \frac{18A\beta_L}{\beta_L\beta_H + 9\bar{\beta}}$$

where $\bar{\beta} = 37 + 64\bar{\delta}$; $\beta_L = (1-z)\bar{\beta}$; $\beta_H = (1+z)\bar{\beta}$; $z = \lambda.\phi$ and $\phi \equiv \frac{64\bar{\delta}}{37+64\bar{\delta}}$.

Note that if $z = \lambda = 0$, then $\tilde{e}_L = \tilde{e}_H = \tilde{e} = \frac{18A}{\bar{\beta}+9} = \breve{e}$, where $\breve{e}$ is the equilibrium emission limit with social pooling when policy is set at the state level. Thus, not surprisingly, if both state governments are welfare maximisers, and both states have expected damage costs, then social pooling and political discretion at the state level are equivalent. Now if we ignore terms in z^2, then, to an approximation, we have: $\tilde{e}_L \cong (1+z)\breve{e}$; $\tilde{e}_H \cong (1-z)\breve{e}$. Then, using these approximations, we have the following result[17]

Result 1 *If* $v = 0$, *then* $\frac{\partial \tilde{W}(\bar{\delta},\lambda,0)}{\partial\lambda} = \frac{324A^2\lambda\phi^2(20+32\bar{\delta})}{(23+32\bar{\delta})^2} > 0$.

In words, increasing the dispersion of damage costs increases expected welfare from political discretion. The intuition behind this result is as follows. Increasing λ has two effects. First, it increases the dispersion of emissions. For a *given* welfare function, this effect unambiguously reduces welfare. But second, it changes the welfare function itself – reducing damage costs in low damage states, increasing damage costs in high

[17] Proofs of all results which are not obvious from the text are in an appendix.

damage states. But since emissions are higher in low damage states, the benefit of the reduction in damage costs in the low damage state outweigh the increase in damage costs in the high damage state, causing welfare to rise. This second, direct effect outweighs the first, indirect effect, so that expected welfare is increasing in λ.

(ii) No Difference in Damage Costs $\lambda = 0$.

Then from (2) there are only two emission limits of interest:

$$\tilde{e}_I = \frac{18A(\beta_E - 9)}{\beta_I \beta_E - 81}; \qquad \tilde{e}_E = \frac{18A(\beta_I - 9)}{\beta_I \beta_E - 81} \tag{3}$$

where $\beta_E = (1+\upsilon\phi)\bar{\beta}$; $\beta_I = (1-\upsilon\phi)\bar{\beta}$. Note that if $\upsilon = 0$, then $\tilde{e}_I = \tilde{e}_E = \breve{e}$. Ignoring terms in $(\upsilon\phi)^2$, (3) can be written as: $\tilde{e}_I \cong (1+y)\breve{e}$; $\tilde{e}_E \cong (1-y)\breve{e}$; where $y = \upsilon\eta$ and $\eta = \frac{64\bar{\delta}}{28+64\bar{\delta}}$. So an industrial government will set an emission limit which is higher than the emission limit with social pooling, and an environmental government will set an emission limit lower than social pooling. Then using these approximations, we can derive the following result:

Result 2 *If $\lambda = 0$ then* $\frac{\partial \tilde{W}(\bar{\delta},0,\upsilon)}{\partial \upsilon} = \frac{-324A^2\upsilon\eta^2(17+32\bar{\delta})}{(23+32\bar{\delta})^2} < 0.$

Increasing the dispersion of political weights attached to environmental damage costs, reduces expected welfare. The reason is that, as with the increase in λ, an increase in υ

increases the dispersion of emissions, moving them further from the welfare maximising level of emissions, and this unambiguously reduces expected welfare. But, since υ does not affect the welfare function itself, this is the only effect that an increase in υ has, and so expected welfare is decreasing in υ.

Finally, for any given $\bar{\delta}$, we will be interested in the slope of iso-welfare contours defined by points in (λ,υ) space s.t. $\tilde{W}(\bar{\delta},\lambda,\upsilon)$ is constant. Define the slope of such an iso-welfare contour by:

$$\tilde{V}(\lambda,\upsilon) \equiv -\frac{\partial \tilde{W}}{\partial \lambda} \Big/ \frac{\partial \tilde{W}}{\partial \upsilon}.$$

Then from Results 1 and 2 it is straightforward to calculate that, close to the origin:

$$\tilde{V}(\lambda,\upsilon) = \frac{\lambda[(40+64\bar{\delta})(28+64\bar{\delta})^2]}{\upsilon[(37+64\bar{\delta})^2(34+64\bar{\delta})]}. \qquad (4)$$

It is straightforward to show that $\frac{\partial \tilde{V}}{\partial \bar{\delta}} > 0$, $\lim_{\bar{\delta}\to\infty} \tilde{V} = \frac{\lambda}{\upsilon}$ and so $\tilde{V}(\lambda,\upsilon) \le \frac{\lambda}{\upsilon}$.

2.3.4 Political Discretion – Policy Set at the Federal Level.

It is worthwhile beginning with a special case of the general problem: the full information case, where the federal government knows the true damage costs of both states, and does not have to solve a mechanism design problem.

(i) Full Information Case.

The federal government has a political weight on environmental damage costs γ_F, and knows the true damage costs of states 1 and 2, δ_1, δ_2. The federal government will choose e_1, e_2 to maximise: $U(e_1, e_2, \delta_1, \gamma_F) + U(e_2, e_1, \delta_2, \gamma_F)$. Using the particular functional form for the utility function (1), it is straightforward to show that the equilibrium emission limits are:

$$\hat{\hat{e}}_i = \frac{48A(1+4\delta_j\gamma_F)}{[(17+32\delta_1\gamma_F)(17+32\delta_2\gamma_F)-81]} \qquad i,j=1,2 \quad i \neq j \qquad (5)$$

If we now consider the possible combinations of damage costs in the two states, there are three possibilities: both states could have low damage costs, which we denote by *LL*; both could have high damage costs, which we denote by *HH*; or one state could have high damage costs and the other low, which we denote by the pair (*HL,LH*). Then, from (5) the corresponding emission limits would be:

$$\hat{\hat{e}}_{LL} = \frac{3A}{(13+16\delta_L\gamma_F)}; \qquad (6a)$$

$$\hat{\hat{e}}_{HH} = \frac{3A}{(13+16\delta_H\gamma_F)}; \qquad (6b)$$

$$\hat{\hat{e}}_{HL} = \frac{48A(1+4\delta_L\gamma_F)}{[(17+32\delta_L\gamma_F)(17+32\delta_H\gamma_F)-81]}; \tag{6c}$$

$$\hat{\hat{e}}_{LH} = \frac{48A(1+4\delta_H\gamma_F)}{[(17+32\delta_L\gamma_F)(17+32\delta_H\gamma_F)-81]}. \tag{6d}$$

It is readily shown that $\hat{\hat{e}}_{HL} \leq \hat{\hat{e}}_{HH} \leq \hat{\hat{e}}_{LL} \leq \hat{\hat{e}}_{LH}$, so that, in terms of market share, the worst outcome is to be a high-damage cost state competing with a low-damage cost state. It is useful to consider some special cases. Note first that if $\lambda = 0$, so that $\delta_L = \delta_H = \bar{\delta}$, then (6) simplifies to yield a single emission limit which will be set in each state:

$$\hat{\hat{e}} = \frac{3A}{13+16\bar{\delta}\gamma_F}. \tag{7}$$

If, in addition, $\upsilon = 0$ so $\gamma_F = 1$, then (7) simplifies to yield: $\hat{\hat{e}} = \frac{3A}{13+16\bar{\delta}} = e^*$. So again, not surprisingly, if there is no uncertainty about damage costs, and the federal government is welfare maximising, then the emission limit the federal government sets with political discretion will be the same as with social pooling.

(ii) Asymmetric Information.

Now assume that the level of damage costs in each state is private information to the government of that state. The federal government has to set for each state a set of emission limits for each of the possible combinations of damage costs set out above, which will induce each state government to reveal its true damage costs, and in particular will induce a state with high damage costs not to pretend it has low damage

costs. Assuming that the incentive compatibility constraints bite, then the solutions for the various emission limits are as follows.

Both States Have High Damage Costs.

There will be a pair of first-order conditions for state $i = 1, 2$ of the form:

$$\begin{aligned}&(1+2\mu_i)[18(2A-\hat{e}^j_{HH})]-2\hat{e}^i_{HH}[(37+64\gamma_F\delta_H)+2\mu_i(37+64\gamma_i\delta_H)]\\&-(1+2\mu_j)[6(2A-\hat{e}^j_{HH})+18\hat{e}^j_{HH}]=0,\end{aligned} \qquad (8)$$

where μ_i is the Lagrange multiplier on state i's incentive compatibility constraint.

These first-order conditions can be solved to yield the optimal emission levels for each state when both have high damage costs, as (non-linear) functions of the political weights each of the three governments attaches to environmental damages and as functions of the Lagrange multipliers on the incentive compatibility constraints. Now suppose we consider the case where $\gamma_1 = \gamma_2 = \gamma_F$, so that all the governments have the same preferences. Then, by symmetry, $\hat{e}^i_{HH} = \hat{e}^j_{HH} = \hat{e}_{HH}$, and $\mu_i = \mu_j = \mu$, and (8) simplifies to:

$$\hat{e}_{HH} = \frac{3A}{13+16\gamma_F\delta_H} = \tilde{\tilde{e}}_{HH} \qquad (9)$$

(9) is similar to the result in Ulph (2000) (which assumed welfare maximising governments) that if both states are claiming to have high damage costs, then the federal government knows they cannot be lying, and so sets the efficient level of emissions, i.e. the same as with full information.

Both States Have Low Damage Costs.

There will be a pair of first-order conditions for state i =1,2 of the form:

$$6A(1-3\mu_i+\mu_j)-9\hat{e}^j_{LL}(1-\mu_i-\mu_j)-\hat{e}^i_{LL}[(17+32\gamma_F\delta_L)-\mu_i(37+64\gamma_i\delta_H)+3\mu_j]=0 \qquad (10)$$

Again this pair of first-order conditions can be solved to yield optimal emission limits for each state when both have low damage costs. Again, it is useful to consider the special case where all governments have the same political weight. Then (10) simplifies to yield:

$$\hat{e}_{LL}=\frac{3A}{[13+16\gamma_F\delta_L]-\frac{2\mu}{1-2\mu}[16\gamma_F(\delta_H-\delta_L)]}>\hat{\hat{e}}_{LL}. \qquad (11)$$

So with asymmetric information, if both states declare they have low damage costs, then the federal government will set them a higher emission limit than with full information. The reason is that if states were only pretending to have low damage costs, then being asked to produce more emissions than would be efficient would be particularly damaging to them, and this encourages truthful revelation of damage costs.

One State Has Low Damage Costs, the Other High.

Suppose state i has low damage costs and state j has high damage costs, then there will be the following pair of first-order conditions to determine their emission limits:

$$\begin{aligned} &12A(2-3\mu_i-\mu_j)-18\hat{e}^j_{HL}(2-\mu_i+\mu_j)= \\ &\qquad 2\hat{e}^i_{LH}[(34+64\gamma_F\delta_L)-\mu_i(37+64\gamma_i\delta_H)-3\mu_j] \\ &12A(2+\mu_i+3\mu_j)-18\hat{e}^i_{LH}(2-\mu_i+\mu_j)= \\ &\qquad 2\hat{e}^j_{HL}[(34+64\gamma_F\delta_H)+\mu_j(37+64\gamma_j\delta_H)+3\mu_i] \end{aligned} \tag{12}$$

Again we consider the special case where $\gamma_1=\gamma_2=\gamma_F$. Then (12) becomes:

$$\begin{aligned} &6A(1-2\mu)-9\hat{e}_{HL}-\hat{e}_{LH}[\omega_L-\mu(\omega_H+3)]=0 \\ &6A(1+2\mu)-9\hat{e}_{LH}-\hat{e}_{HL}[\omega_H+\mu(\omega_L+3)]=0 \end{aligned} \tag{13}$$

where $\omega_L=17+32\gamma_F\delta_L$ and $\omega_H=17+32\gamma_F\delta_H$. (13) can be solved for e_{LH}, $\tilde{e}_{HL}$ to yield:

$$\begin{aligned} \hat{e}_{LH} &= \frac{6A[(\omega_H-9)-\mu(15+2\omega_H-\omega_L)+2\mu^2(\omega_L+3)]}{\{(\omega_L\omega_H-81)-\mu[\omega_H(\omega_H+3)-\omega_L(\omega_L+3)]-\mu^2(\omega_L+3)(\omega_H+3)\}} \\ \hat{e}_{HL} &= \frac{6A[(\omega_L-9)+\mu(15+2\omega_L-\omega_H)-2\mu^2(\omega_H+3)]}{\{(\omega_L\omega_H-81)-\mu[\omega_H(\omega_H+3)-\omega_L(\omega_L+3)]-\mu^2(\omega_L+3)(\omega_H+3)\}} \end{aligned} \tag{14}$$

To make comparisons with $\hat{\hat{e}}_{LH}, \hat{\hat{e}}_{HL}$, it is helpful to simplify (14). Note that the Lagrange multiplier μ, which is a measure of the welfare cost of the information asymmetry, will be small, and it will be particularly small when the difference in damage costs is small (so there is not much of an information asymmetry) and when the difference in damage costs is large, because for large differences in damage costs it is possible to implement the full information outcome (see Ulph (2000)), simply

because the cost to a high damage cost state of pretending to be low damage, and hence produce a lot of pollution, is too great. So in (14) we ignore terms in μ^2 and $\mu(\omega_H - \omega_L)$, *i.e.* $\mu(\delta_H - \delta_L)$, and we get the following expressions:

$$\hat{e}_{LH} \cong \frac{6A[(\omega_H - 9) - 32\mu(1+\gamma_F\delta_H)]}{(\omega_L\omega_H - 81)} < \frac{6A(\omega_H - 9)}{(\omega_L\omega_H - 81)} = \hat{\hat{e}}_{LH}$$

$$\hat{e}_{HL} \cong \frac{6A[(\omega_L - 9) + 32\mu(1+\gamma_F\delta_L)]}{(\omega_L\omega_H - 81)} > \frac{6A(\omega_L - 9)}{(\omega_L\omega_H - 81)} = \hat{\hat{e}}_{HL}. \qquad (15)$$

So (15) tells us that to a first approximation, the difference in emission limits for low and high damage cost states will be smaller with asymmetric information than in the full information case, because it is this difference which provides the incentive for high damage cost states to want to pretend to be low damage cost, and to reduce this incentive it is necessary to narrow the gap in emission limits.

Putting these results together shows that, for the case where all governments have the same political weight attached to damage costs, the relationship between emission limits in the asymmetric information case and the full information case is as follows:

$$\hat{\hat{e}}_{HL} \le \hat{e}_{HL} \le \hat{\hat{e}}_{HH} = \hat{\hat{e}}_{HH} \le \hat{\hat{e}}_{LL} \le \hat{e}_{LL} \le \hat{e}_{LH} \le \hat{\hat{e}}_{LH} \qquad (16)$$

Welfare

In principle we can solve the above expressions for emission limits as functions of the key parameters $\bar{\delta}, \lambda$ and υ. It is clear that these are going to be complex non-linear functions of these parameters, more so than in the case of political discretion at the state level, because we also have to solve for the endogenously determined Lagrange multipliers. We then need to substitute these emission limits into the expressions for expected welfare, to compute $\hat{W}(\bar{\delta}, \lambda, \upsilon)$. Deriving closed formed solutions is going to be impossible, but we can derive analytical results for the same special cases we considered with political discretion at the state level.

(iii) No Difference in Damage Costs: λ =0.

In this case there is no information problem to solve since the federal government knows that both states have damage cost parameter $\bar{\delta}$, so the federal government sets the same emission limit for each state. This emission limit will depend on whether the federal government is an environmental or industrial government, and from (5) the emission limit which each of these federal government types will set is given by:

$$\hat{e}_E = \frac{3A}{13+16\bar{\delta}(1+\upsilon)} \qquad \hat{e}_I = \frac{3A}{13+16\bar{\delta}(1-\upsilon)} \tag{17}$$

Note that $\hat{e}_E < e^* < \hat{e}_I$, so that environmental governments set emission standards lower than with social pooling at the federal level, while industrial governments set emission standards tougher than with social pooling. Then we have the following result:

Result 3 *If $\lambda = 0$, then:*

$$\frac{\partial \hat{W}(\bar{\delta},0,\upsilon)}{\partial \upsilon} = -64\bar{\delta}(13+16\bar{\delta})[\frac{(e^* - \hat{e}_E)\hat{e}_E}{13+16\bar{\delta}(1+\upsilon)} + \frac{(\hat{e}_I - e^*)\hat{e}_I}{13+16\bar{\delta}(1-\upsilon)}] < 0.$$

So, if there is no information problem, increasing the dispersion of the political weight that federal governments of different type attach to environmental damage costs reduces welfare. The reason is exactly the same as when policy was set at the state level: increasing υ increases the dispersion in emission limits, creating a greater gap between the environmental policies which federal governments serving different special interest groups would set and the policy a welfare-maximising federal government would set.

For later purposes, we use the kind of approximation analysis we developed for the case of political discretion at the state level. Thus we can approximate the emission levels in (17) by:

$$\hat{e}_E \cong (1-\upsilon\psi)e^*; \qquad \hat{e}_I \cong (1+\upsilon\psi)e^* \quad \text{where} \quad \psi \equiv \frac{16\bar{\delta}}{13+16\bar{\delta}}.$$

Then we have:

Result 3' *If $\lambda = 0$, then:*

$$\frac{\partial \hat{W}(\bar{\delta},0,\upsilon)}{\partial \upsilon} \cong -128\bar{\delta}\upsilon\psi e^{*2} = -\frac{4608A^2\upsilon\bar{\delta}\psi}{(26+32\bar{\delta})^2} < 0.$$

(iv) No Political Distortion: $\upsilon = 0$.

We now suppose that all three governments are welfare maximisers, i.e. $\gamma_1 = \gamma_2 = \gamma_F = 1$. It is useful to begin with the full information case.

Full Information.

We can approximate the full-information emission levels as follows:

$$\hat{e}_{HL} \cong (1-\lambda\rho)e^*; \quad \hat{e}_{HH} \cong (1-\lambda\psi)e^*; \quad \hat{e}_{LL} \cong (1+\lambda\psi)e^*; \quad \hat{e}_{LH} \cong (1+\lambda\rho)e^*,$$

where $1 > \rho \equiv \frac{16\bar{\delta}}{4+16\bar{\delta}} > \frac{16\bar{\delta}}{13+16\bar{\delta}} = \psi.$

Result 4 *With $v = 0$ and full information:*

$$\frac{\partial \hat{W}(\bar{\delta},\lambda,0)}{\partial\lambda} = 64\lambda e^{*2}\bar{\delta}(\rho+\psi) = \frac{2304A^2\lambda\bar{\delta}(\rho+\psi)}{(26+32\bar{\delta})^2} > 0.$$

So increasing the dispersion of damage costs around expected damages, increases expected welfare from political discretion at the federal level. Again the intuition is the same as when policy was set at the state level. The increase in λ has the indirect effect of increasing the dispersion of emission limits, which reduces welfare. But it also has the direct effect of reducing damage costs in low damage states, a benefit, and increasing damage costs in high damage states, a cost; since emissions are higher in low damage states, the benefit outweighs the cost. This direct effect out weighs the indirect effect.

Asymmetric Information.

From our earlier analysis, we can approximate the asymmetric information emission levels as follows:

$\hat{e}_{HL} \cong (1-\lambda\hat{\rho})e^*$; $\hat{e}_{HH} \cong (1-\lambda\hat{\psi})e^*$; $\hat{e}_{LL} \cong (1+\lambda\hat{\psi})e^*$; $\hat{e}_{LH} \cong (1+\lambda\hat{\rho})e^*$;

where $\rho > \hat{\rho} > \hat{\psi} > \psi$. Note that $\hat{\rho}$ and $\hat{\psi}$ depend on the endogenously determined Lagrange multiplier, μ. In principle, as λ varies so will μ, but in our welfare analysis we shall ignore this effect, since it is likely to be small. The dependence of $\hat{\rho}$ and $\hat{\psi}$ on μ also means that we have not been able to derive closed-form solutions for $\hat{\rho}$ and $\hat{\psi}$ in terms of the key parameters $\bar{\delta}$, λ and υ.

Then we have:

Result 5 *With $\upsilon = 0$ and asymmetric information:*

$$\frac{\partial \hat{W}(\bar{\delta},\lambda,0)}{\partial\lambda} \cong 64\lambda e^{*2}\bar{\delta}(\hat{\rho}+\hat{\psi}) \cong \frac{2304A^2\lambda\bar{\delta}(\rho+\psi)}{(26+32\bar{\delta})^2} > 0.$$

As with political discretion at the state level, for any given $\bar{\delta}$, we shall be interested in the slope of iso-welfare contours for political discretion at the federal level defined by points (λ,υ) s.t. $\hat{W}(\bar{\delta},\lambda,\upsilon)$ is constant. Denote this slope by $\hat{V}(\lambda,\upsilon)$, from Results 3' and 4 it is straightforward to calculate that, with full information, close to the origin:

$$\hat{V}(\lambda,\upsilon) = \frac{\lambda(\psi+\rho)}{2\upsilon\psi} = \frac{\lambda(34+64\bar{\delta})}{\upsilon(16+64\bar{\delta})} \qquad (18)$$

Similarly, with asymmetric information we have:

$$\hat{V}(\lambda,\upsilon)=\frac{\lambda(\hat{\psi}+\hat{\rho})}{2\upsilon\psi} \qquad 19)$$

As noted above, it has not proved possible to derive closed form solutions for $\hat{\psi}$ and $\hat{\rho}$ in terms of $\bar{\delta}, \lambda$ and υ. However, we know that $\rho > \hat{\rho} > \hat{\psi} > \psi$, so we shall assume that, to a reasonable approximation, $\hat{\rho}+\hat{\psi} \cong \rho+\psi$, so that (18) and (19) are approximately equal, and hence the slope of an iso-welfare contour close to the origin with asymmetric information is also given by (18).

It is straightforward to show that

$$\partial\hat{V}/\partial\bar{\delta} < 0, \quad \lim_{\bar{\delta}\to\infty}\hat{V}=\frac{\lambda}{\upsilon}, \text{ and so } \hat{V}(\lambda,\upsilon) \geq \frac{\lambda}{\upsilon}.$$

Finally, we wish to compare the effects of variations in λ and υ on welfare when policy is set at the state and federal levels. We have the following result:

Result 6 *For all* $\bar{\delta} \geq 0, \frac{\partial\tilde{W}}{\partial\lambda} > \frac{\partial\hat{W}}{\partial\lambda} > 0; \frac{\partial\tilde{W}}{\partial\upsilon} < \frac{\partial\hat{W}}{\partial\upsilon} < 0; \quad \hat{V}(\lambda,\upsilon) > \hat{V}(\lambda,\upsilon).$

In words, an increase in either λ or υ has a bigger absolute effect on welfare when policy is set at the state level than when it is set at the federal level. This increased effect at the state level is relatively greater for an increase in υ than for an increase in λ and so the slope of the iso-welfare contour in λ–υ space is greater at the federal level than at the state level. The intuition for why the welfare effects are greater at the state level than at the federal level, is that when the increase in λ or υ causes the increased dispersion in emission limits, a form of distortion, this is in addition to

distortions that are already in place: at the federal level it is the welfare loss caused by asymmetric information, at the state level it is the welfare loss caused by strategic competition. This latter distortion is greater than the former, so the marginal welfare loss caused by the increased dispersion of emission limits is greater at the state than at the federal level. The fact that the distortion is relatively greater for an increase in υ than for an increase in λ is because in the latter case there is the offsetting welfare gain of reducing damage costs in low states and increasing damage costs in high damage states; since emissions are greater when policy is set at the state than federal.

2.4 Constitutional Choice.

In the previous section we derived expected welfare for social pooling at the state and federal level, $\breve{W}(\bar{\delta})$, $W^*(\bar{\delta})$ respectively and for political discretion at the state and federal level, $\tilde{W}(\bar{\delta},\lambda,\upsilon)$, $\hat{W}(\bar{\delta},\lambda,\upsilon)$ respectively. We now assess which constitutional choice society should make.

2.4.1 Social Pooling or Political Discretion.

(i) Policy Set at the State Level.

For any given value of $\bar{\delta}$, we want to compare $\breve{W}(\bar{\delta})$ and $\tilde{W}(\bar{\delta},\lambda,\upsilon)$. So consider the iso-welfare contour for political discretion at the state level such that: $\tilde{W}(\bar{\delta},\lambda,\upsilon)=\breve{W}(\bar{\delta})$. We call this society's *indifference curve* between social pooling and political discretion when policy is set at the state level, or for brevity, the state indifference curve. Now we know that $\tilde{W}(\bar{\delta},0,0)=\breve{W}(\bar{\delta})$, so that when there is no dispersion in damage costs or political weight attached to damage costs, then social pooling and political discretion are equivalent and yield the same expected welfare. We also know that $\tilde{V}(\lambda,\upsilon) > 0$, so the slope of the state indifference curve is upward-sloping and passes through the origin (see Figure 2.1). Since

$$\frac{\partial\tilde{W}(\bar{\delta},\lambda,0)}{\partial\lambda}>0, \quad \frac{\partial\tilde{W}(\bar{\delta},0,\upsilon)}{\partial\upsilon}<0,$$

in the region of (λ , υ) space lying below the state indifference curve (when λ is high and υ is low), expected welfare from political discretion will be higher than expected

welfare with social pooling, while in the region above the state indifference curve expected welfare from political discretion will be lower than expected welfare with social pooling. So society will prefer political discretion when there are significant benefits from learning the true value of damage costs before setting policy and political influence does not move governments too far from welfare maximisation. Society will prefer social pooling when there is not much to be learned about damage costs and political influence takes governments quite far from welfare maximisation. This is consistent with the findings of Boyer and Laffont (1999) for a single state.

(ii) Policy Set at the Federal Level.

A similar analysis can be done when policy is set at the federal level. For any given value of $\bar{\delta}$, we want to compare $W^*(\bar{\delta})$ and $\hat{W}(\bar{\delta},\lambda,\upsilon)$. Again define the particular iso-welfare contour with political discretion at the federal level such that: $\hat{W}(\bar{\delta},\lambda,\upsilon)=W^*(\bar{\delta})$. We call society's indifference curve between social pooling and political discretion when policy is set at the federal level, or for brevity, the federal indifference curve. We know that $W^*(\bar{\delta})=\hat{W}(\bar{\delta},0,0)$, i.e. social pooling and political discretion are equivalent when there is no dispersion in either damage costs or the political weights special interest groups attach to damage costs. We also know that $\hat{V}(\lambda,\upsilon)>0$, so the federal indifference curve is upward-sloping and passes through the origin (see Figure 2.1). At points (λ,υ) lying below the federal indifference curve political discretion is preferred to social pooling, while at points above the federal indifference curve social pooling is preferred to political discretion.

(iii) Comparison of State and Federal Level.

How do the preferences between social pooling and political discretion compare between having policy set at the state and federal levels? From Result 6 we know that $\hat{V}(\lambda,\upsilon) > \tilde{V}(\lambda,\upsilon) \quad \forall \bar{\delta} \geq 0$, so that the federal indifference curve is steeper than the state indifference curve. The situation is shown in Figure 2.1. Thus there are only three possible regimes: Regime I: for high values of υ and low values of λ, social pooling is preferred to political discretion at both state and federal level; Regime II: for high values of λ and low values of υ political discretion is preferred to social pooling at both state and federal level; Regime III: for an intermediate range of values of λ and υ political discretion is preferred at the federal level but social pooling is preferred at the state level. We can summarise this conclusion in the following result:

Result 7 *It is never the case that social pooling is preferred at the federal level but political discretion is preferred at the state level.*

Now recalling that social pooling implies harmonisation of environmental policies, what Result 7 implies is that if, say, globalisation called for environmental policy to be set the federal level to overcome the environmental dumping that would occur if policy was set at the state level, that could not justify harmonisation of environmental policies between states unless harmonisation had already occurred when policy was set at the state level. Indeed there would be cases where policies had been harmonised at the state level where it would be desirable not to have harmonisation if policy-making was switched to the federal level.

2.4.2 Policy Set at State or Federal Level?

(i) Social Pooling.

From sections 2.3.1 and 2.3.2 we know that $\forall \bar{\delta} \geq 0, W^*(\bar{\delta}) > \breve{W}(\bar{\delta})$, so with social pooling it is always preferable to have policy set at the federal level, to overcome environmental dumping.

(ii) Political Discretion.

We want to compare $\tilde{W}(\bar{\delta},\lambda,\upsilon)$ and $\hat{W}(\bar{\delta},\lambda,\upsilon)$. We argue that with political discretion, it will always be desirable to set policy at the federal level. To see the argument, consider all the points (λ,υ) lying on the welfare contour $\hat{W}(\bar{\delta},\lambda,\upsilon) = W^*(\bar{\delta})$. For all such points it must the case that $\tilde{W}(\bar{\delta},\lambda,\upsilon) \leq \breve{W}(\bar{\delta}) < W^*(\bar{\delta}) = \hat{W}(\bar{\delta},\lambda,\upsilon)$ (see Figure 2.1). A similar argument would apply to any other pair of iso-welfare contours for political discretion at federal and state level passing through the same point on either axis. Thus we have:

Result 8 *For all* $(\bar{\delta},\lambda,\upsilon)$, $\tilde{W}(\bar{\delta},\lambda,\upsilon) < \hat{W}(\bar{\delta},\lambda,\upsilon)$.

Thus, the welfare gains from policy coordination at the federal level outweigh any losses due to asymmetric information between state and federal level, or welfare loses due to governments being captured by special interest groups.

2.4.3 Some Numerical Results.

The analytical results derived so far have depended on a number of approximations, and in particular the arguments in sections 2.4.1 and 2.4.2 depended on comparisons of the slopes of iso-welfare contours with political discretion at the federal and state levels which strictly only applies to points close to the origin. So it may be useful to check whether our conclusions hold outside such approximations. To do this we have taken a range of values for the three key parameters $(\bar{\delta},\lambda,\upsilon)$, and for each set of values we have calculated exact values for emission limits for political discretion at the state and federal levels (solving exactly the full mechanism design problem for the federal government), and hence calculated exactly the expected welfare levels for the four constitutional choices: $\breve{W}(\bar{\delta}),W^{*}(\bar{\delta}),\tilde{W}(\bar{\delta},\lambda,\upsilon),\hat{W}(\bar{\delta},\lambda,\upsilon)$. We chose $\bar{\delta}$ = 0.1, 0.3, 0.5, 0.7, 0.9; as noted in Ulph (1997b), if $\bar{\delta} = 0.3$ then environmental damages in the absence of any government policy would constitute about 40% of profits. We chose $\lambda = 0.025, 0.05, \ldots, 0.975$, and similarly for υ.

For all these values, we confirm Results 5, 6, 7 and 8: i.e. the state and federal indifference curves are always upward sloping; the federal indifference curve always lies above the state indifference curve; and with political discretion expected welfare is always higher when policy is set at the federal than at the state level. Figure 1 shows the computed indifference curves for the value of $\bar{\delta} = 0.5$, and similar pairs of indifference curves were computed for the other values of $\bar{\delta}$. Table 1 shows the proportion of (λ,υ) space that lies in each of the three Regimes I, II, III defined earlier for values of $\bar{\delta}$ from 0.1 to 0.9. As $\bar{\delta}$ increases, Regime II (social pooling preferred

at state and federal level) becomes bigger while the other two Regimes decline. This is not quite what we would have expected from the approximation results. Since, close to the origin, $\partial\hat{V}/\partial\bar{\delta} < 0, \partial\tilde{V}/\partial\bar{\delta} > 0$, it would have been expected that as $\bar{\delta}$ increases Regimes I and II both increased while Regime III got smaller.

In summary, the numerical results show that all the key results of the chapter proved using approximations go through more generally.

2.5 Conclusions.

In this chapter we have taken seriously the frequently expressed concern that globalisation may lead states acting independently to set too weak environmental policies, which provides a rationale for a federal government (supra-national agency) to co-ordinate the environmental policies of individual states. We have been concerned with the means by which such co-ordination might take place, and specifically the suggestion that environmental policies might be harmonised. It is well known that such a proposal is inefficient if countries differ in significant ways in their environmental characteristics, raising the question why such an obviously inefficient policy is proposed. Ulph (2000) showed that appealing to asymmetric information between federal and state governments did not provide an answer, because a federal government could use more sophisticated policies to induce state governments to reveal their information.

In this chapter we have considered an alternative explanation: governments at state and federal level may be captured by special interest groups, and a simple way of limiting the influence of such groups is to require governments to implement policies which would maximise welfare based on the expected value of the damage costs states might face. There is then a simple trade-off between the benefit of allowing governments to use their better information about the true level of damage costs in different states and the costs of governments pursuing policies which are in the interests of only a subset of society rather than the whole of society. Not surprisingly it is better to constrain governments in this way when the variance in government types is large relative to the variance in potential damage costs.

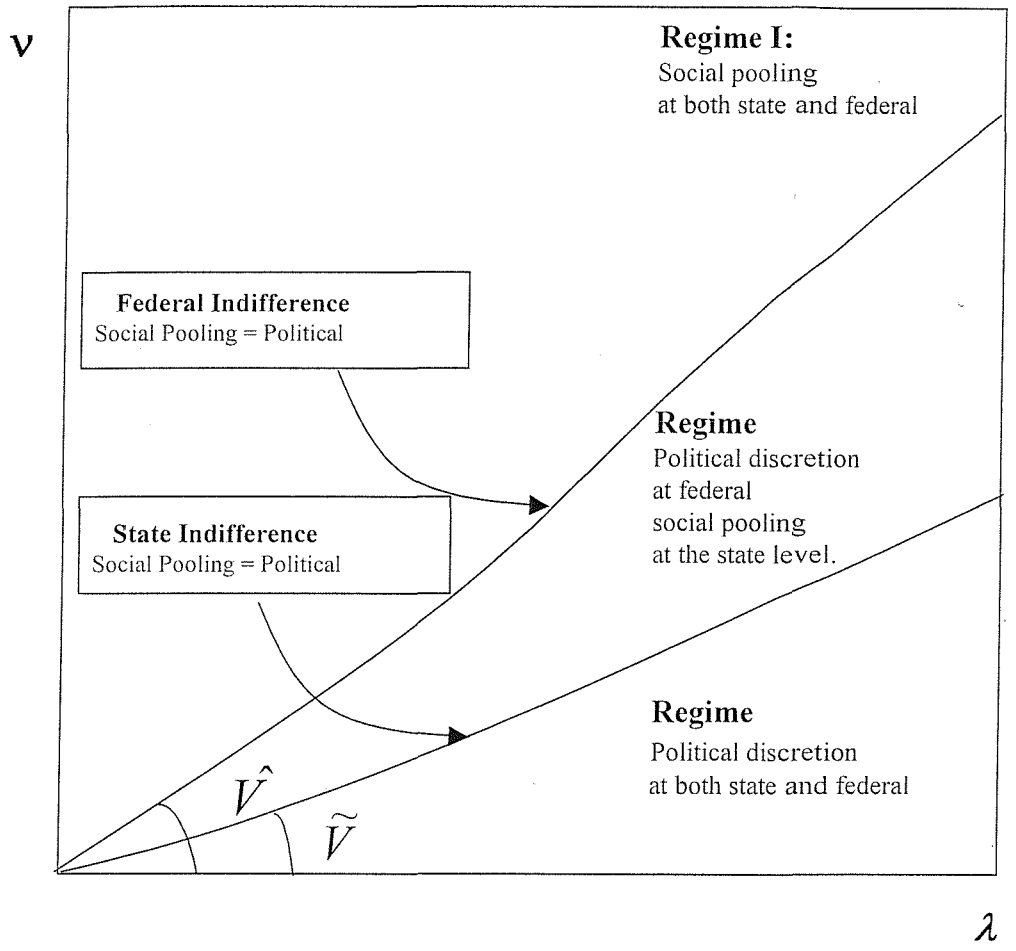
However, the case for constraining governments applies whether policies are set at state or federal level, and what we have shown is that while it is always desirable to set environmental policies at federal level rather than state level to overcome policy competition between states, it is never the case that it would be desirable to constrain governments when policy is set at the federal level, but not to constrain governments if policy is set at the state level. So having policy move from state to federal level to overcome policy competition cannot justify harmonisation of environmental policies if they had not already been harmonised at the state level.

Of course our model of political behaviour is very simple. For example we have no explicit welfare costs of lobbying behaviour by special interest groups, nor have we captured many of the allegations made about the behaviour of supra-national agencies like WTO, that they are less democratic than nation states, that they are biased towards the interests of multi-national companies or the developed world. In the following chapters we extend the analysis by incorporating richer political behaviour with better micro-foundations.

Table 2.1. Relative Incidence of Different Regimes

Parameter $\overline{\delta}$	Regime I	Regime II	Regime III
0.1	0.637	0.135	0.227
0.3	0.598	0.174	0.227
0.5	0.586	0.197	0.216
0.7	0.581	0.214	0.205
0.9	0.571	0.224	0.204

Figure 2.1. Constitutional Choice: Social Pooling or Political Discretion ($\overline{\delta} = 0.5$).



Appendix

Proof of Result 1

$\widetilde{W}(\delta,\lambda,0)=\widetilde{W}=\widetilde{\pi}-\widetilde{D}$ where:

$\widetilde{\pi}=0.25[\pi(\widetilde{e}_L,\widetilde{e}_L)+\pi(\widetilde{e}_L,\widetilde{e}_H)+\pi(\widetilde{e}_H,\widetilde{e}_L)+\pi(\widetilde{e}_H,\widetilde{e}_H)]; \quad \widetilde{D}=32(\delta_L\widetilde{e}_L^2+\delta_H\widetilde{e}_H^2)$

$$\pi(\widetilde{e}_L,\widetilde{e}_L)=\frac{12A^2}{(9+\overline{\beta})^2}\{(\overline{\beta}-9z)^2+54(1+z)(\overline{\beta}-9z)-999(1+z)^2\}$$

with similar expressions for $\pi(\widetilde{e}_L,\widetilde{e}_H)$ etc.

It is straightforward to show that: $\frac{\partial\widetilde{\pi}}{\partial x}=-1836z.\frac{12A^2}{(9+\overline{\beta})^2}$ and hence:

$$\frac{\partial\widetilde{\pi}}{\partial\lambda}=-1836\lambda\phi^2\frac{12A^2}{(9+\overline{\beta})^2}$$

$$\widetilde{D}=32\overline{\delta}\widetilde{e}^2\{(1-\lambda)(1+z)^2+(1+\lambda)(1-z)^2\}$$

$$\frac{\partial\widetilde{D}}{\partial\lambda}=-128\overline{\delta}\widetilde{e}^2\lambda\phi(2-\phi)$$

$$\frac{\partial\widetilde{W}}{\partial\lambda}=-1836\lambda\phi^2\frac{12A^2}{(9+\overline{\beta})^2}+128\overline{\delta}\widetilde{e}^2\lambda\phi(2-\phi)=\frac{1296A^2\lambda\phi}{(9+\overline{\beta})^2}\{32\overline{\delta}(2-\phi)-17\phi\}$$

$$=\frac{1296A^2\lambda\phi^2(20+32\overline{\delta})}{(9+\overline{\beta})^2}=\frac{324A^2\lambda\phi^2(20+32\overline{\delta})}{(23+32\overline{\delta})^2} \qquad \text{Q.E.D.}$$

Proof of Result 2

Following similar lines to Result 1 it is straightforward to see that:

$$\frac{\partial \tilde{\pi}}{\partial \upsilon} = -1836\upsilon\eta^2 \frac{12A^2}{(9+\bar{\beta})^2}$$

$$\tilde{D} = 32\bar{\delta}\tilde{e}^2\{(1-y)^2 + (1+y)^2\} \quad \text{so} \quad \frac{\partial \tilde{D}}{\partial \upsilon} = 128\bar{\delta}\tilde{e}^2\upsilon\varphi^2$$

$$\frac{\partial \tilde{W}}{\partial \upsilon} = -\frac{324A^2\upsilon\eta^2(17+32\bar{\delta})}{(23+32\bar{\delta})^2} \qquad \text{Q.E.D.}$$

Proof of Result 3

$$\hat{W}(\bar{\delta},0,\upsilon) = \hat{W} = 0.5[W(\hat{e}_E) + W(\hat{e}_I)] \quad \text{so} \quad \frac{\partial \hat{W}}{\partial \upsilon} = 0.5[\frac{\partial W}{\partial \hat{e}_E}.\frac{\partial \hat{e}_E}{\partial \upsilon} + \frac{\partial W}{\partial \tilde{e}_I}.\frac{\partial \hat{e}_I}{\partial \upsilon}]$$

$$\frac{\partial \hat{W}}{\partial e} = 8(13+16\bar{\delta})(e^*-e); \quad \frac{\partial \hat{e}_E}{\partial \upsilon} = -\frac{16\bar{\delta}\hat{e}_E}{13+16\bar{\delta}(1+\upsilon)}; \quad \frac{\partial \hat{e}_I}{\partial \upsilon} = \frac{16\bar{\delta}\hat{e}_I}{13+16\bar{\delta}(1-\upsilon)}$$

$$\frac{\partial \hat{W}}{\partial \upsilon} = -64\bar{\delta}(13+16\bar{\delta})[\frac{(e^*-\hat{e}_E)\hat{e}_E}{13+16\bar{\delta}(1+\upsilon)} + \frac{(\hat{e}_I-e^*)\hat{e}_I}{13+16\bar{\delta}(1-\upsilon)}] \qquad \text{Q.E.D.}$$

Proof of Result 3'

Using the approximations for $\hat{e}_E, \hat{e}_I$ yields:

$$\frac{\partial \hat{e}_E}{\partial \upsilon} = -\psi e^*; \qquad \frac{\partial \hat{e}_I}{\partial \upsilon} = \psi e^*; \quad \frac{\partial \hat{W}}{\partial \hat{e}_E} = 8(13+16\bar{\delta})\upsilon\psi e^*; \quad \frac{\partial \hat{W}}{\partial \hat{e}_I} = -\frac{\partial \hat{W}}{\partial \hat{e}_E};$$

$$\therefore \frac{\partial \hat{W}}{\partial \upsilon} = -8\upsilon\psi^2(13+16\bar{\delta})e^{*2} = -128\upsilon\psi\bar{\delta}e^{*2} \qquad \text{Q.E.D.}$$

Proof of Result 4

$\hat{W}(\bar{\delta},\lambda,0) = \hat{W} = 0.25\{\hat{\pi} - \hat{D})$ where

$\hat{\pi} = \pi(\hat{\hat{e}}_{HH},\hat{\hat{e}}_{HH}) + \pi(\hat{\hat{e}}_{HL},\hat{\hat{e}}_{LH}) + \pi(\hat{\hat{e}}_{LH},\hat{\hat{e}}_{HL}) + \pi(\hat{\hat{e}}_{LL},\hat{\hat{e}}_{LL})$

$\hat{D} = 64[\delta_H \hat{\hat{e}}^2_{HH} + \delta_H \hat{\hat{e}}^2_{HL} + \delta_L \hat{\hat{e}}^2_{LH} + \delta_L \hat{\hat{e}}^2_{LL}]$

and $\pi(e_1,e_2) = 3(2A - e_2)^2 + 18e_1(2A - e_2) - 37e_1^2$

$\frac{\partial \hat{\pi}}{\partial \hat{\hat{e}}_{HH}} = 24A - 104\hat{\hat{e}}_{HH}$; $\frac{\partial \hat{\pi}}{\partial \hat{\hat{e}}_{LLL}} = 24A - 104\hat{\hat{e}}_{LL}$;

$\frac{\partial \hat{\pi}}{\partial \hat{\hat{e}}_{HL}} = 24A - 36\hat{\hat{e}}_{LH} - 68\hat{\hat{e}}_{HL}$; $\frac{\partial \hat{\pi}}{\partial \hat{\hat{e}}_{LH}} = 24A - 36\hat{\hat{e}}_{HL} - 68\hat{\hat{e}}_{LH}$;

$\frac{\partial \hat{\hat{e}}_{HH}}{\partial \lambda} = -\psi e^*$; $\frac{\partial \hat{\hat{e}}_{LL}}{\partial \lambda} = \psi e^*$; $\frac{\partial \hat{\hat{e}}_{HL}}{\partial \lambda} = -\rho e^*$; $\frac{\partial \hat{\hat{e}}_{LH}}{\partial \lambda} = \rho e^*$;

$\therefore \frac{\partial \hat{\pi}}{\partial \lambda} = \psi e^*[24A - 104\hat{\hat{e}}_{LL} - 24A + 104\hat{\hat{e}}_{HH}]$

$+ \rho e^*[24A - 36\hat{\hat{e}}_{HL} - 68\hat{\hat{e}}_{LH} - 24A + 36\hat{\hat{e}}_{LH} + 68\hat{\hat{e}}_{HL}]$

$= -208\lambda(\psi e^*)^2 - 64\lambda(\rho e^*)^2$

$\hat{D} = 64\bar{\delta}e^{*2}\{(1+\lambda)[(1-\lambda\psi)^2 + (1-\lambda\rho)^2] + (1-\lambda)[(1+\lambda\psi)^2 + (1+\lambda\rho)^2]\}$

$\frac{\partial \hat{D}}{\partial \lambda} = -256\bar{\delta}e^{*2}\lambda[2(\psi+\rho) - (\psi^2 + \rho^2)]$

$\frac{\partial \hat{\pi}}{\partial \lambda} - \frac{\partial \hat{D}}{\partial \lambda} = 256\lambda\bar{\delta}e^{*2}(\psi + \rho)$

$\therefore \frac{\partial \hat{W}}{\partial \lambda} = 64\lambda\bar{\delta}e^{*2}(\psi + \rho)$ Q.E.D.

Proof of Result 5

Follows from proof of Result 4 substituting $\hat{\psi}$, $\hat{\rho}$ for ψ, ρ.

Proof of Result 6

Working with absolute values we can write:

$$\frac{\partial \widetilde{W}}{\partial \lambda} = \frac{1327104A^2\lambda\bar{\delta}^2(20+32\bar{\delta})}{(23+32\bar{\delta})^2(28+64\bar{\delta})^2}; \quad \frac{\partial \widetilde{W}}{\partial \upsilon} = \frac{1327104A^2\upsilon\bar{\delta}^2(17+32\bar{\delta})}{(23+32\bar{\delta})^2(28+64\bar{\delta})^2}$$

$$\frac{\partial \hat{W}}{\partial \lambda} = \frac{36864A^2\lambda\bar{\delta}^2(17+32\bar{\delta})}{(26+32\bar{\delta})^2(4+16\bar{\delta})(13+16\bar{\delta})}; \quad \frac{\partial \widetilde{W}}{\partial \upsilon} = \frac{73728A^2\upsilon\bar{\delta}^2}{(13+16\bar{\delta})(26+32\bar{\delta})^2}$$

$$(i)\ \frac{\partial \hat{W}}{\partial \upsilon} > \frac{\partial \widetilde{W}}{\partial \upsilon} \Leftrightarrow \frac{9(17+32\dot{\delta})}{2(23+32\bar{\delta})^2(14+32\bar{\delta})^2} > \frac{2}{(26+32\bar{\delta})^3}$$

$\Leftrightarrow 9(17+\chi)(26+\chi)^3 > 4(14+\chi)^2(23+\chi)^2$ where $\chi = 32\bar{\delta}$

Inequality true since: $9(17+\chi) > 4(14+\chi)$; $(26+\chi)^3 > (14+\chi)(23+\chi)^2$

$$(ii)\ \frac{\partial \widetilde{W}}{\partial \lambda} > \frac{\partial \hat{W}}{\partial \lambda} \Leftrightarrow \frac{36(20+32\bar{\delta})}{(23+32\bar{\delta})^2(37+64\bar{\delta})^2} > \frac{(17+32\bar{\delta})}{(26+32\bar{\delta})^2(4+16\bar{\delta})(13+16\bar{\delta})}$$

$\Leftrightarrow 9(40+y)(16+y)(52+y)^3 > 4(34+y)(46+y)^2(37+y)^2$ where $y = 64\bar{\delta}$

Inequality holds since $(52+y)^2 > (46+y)^2$, $(40+y) > (37+y)$ and

$9(52+y)(16+y) > 4(37+y)(34+y) \Leftarrow 2(52+y)(16+y) > (37+y)(34+y)$

$\Leftrightarrow 1664+136y+2y^2 > 1268+71y+y^2$

$(iii)\ \hat{V}(\lambda,\upsilon) \geq \frac{\lambda}{\upsilon} \geq \widetilde{V}(\lambda,\upsilon)$ QED

Chapter 3

Globalisation, Political Lobbying and the Design of International Environmental Governance.

Abstract.

Recent anti-globalisation protests have focussed on a perceived failure of international bodies to mitigate its harmful effects such as the impact on the environment. One of the concerns is that nation states may engage in a 'race-to-the-bottom' in setting environmental policies to gain a strategic trade advantage, in particular to prevent transnational companies from delocating. To counter this it is argued that environmental policies need to be co-ordinated at a supra-national level, perhaps in a body such as the WTO. This in turn raises concerns about the way such agencies operate, with fears of a 'democratic deficit' and that certain groups, such as developing countries and environmental lobbies are excluded. We develop a model in which environmental policy can be set at a national or supra-national level. Governments (or agencies) at each level act in the interests of the group they represent, and interest groups can use lobbying to influence the probability of getting their type of government elected. By varying the costs of this lobbying we can address some key questions. If there is indeed a democratic deficit or if developing nations and environmentalists do exert less influence then what are the effects in terms of national welfare ? Our main conclusions are: (i) these asymmetries may not always have the expected effect (e.g. industrialists may be worse off having greater influence); (ii) the major effects of these asymmetries occur when policy is set at the national rather than supra-national level; (iii) any negatives in the political process are far outweighed by the benefits of international coordination of environmental policies.

3.1 Introduction.

Recent anti-globalisation protests have highlighted perceived concerns that supranational bodies, primarily WTO, have failed to address some of the negative effects of globalisation such as its impact on the environment[1]. In particular there is a concern that globalisation may lead nation states acting independently to engage in 'environmental dumping' in order to compete for market share or FDI. To counter this alleged 'race-to-the-bottom' in environmental standards it is argued that there is a need for policy intervention at the supra-national level. One proposal is that the WTO should allow trade measures to be taken against countries with lower environmental standards. Another proposal is setting up a World Environment Organisation (WEO) to co-ordinate or even harmonise environmental policies to prevent policy competition. Such co-ordination though, raises two further concerns.

Constructing imperfect competition models of environmental dumping is straightforward[2] but, as noted in the fiscal federalism literature, there may be an information asymmetry in that a supra-national body may be less well informed about a nation's domestic environmental problems than its own government. (For convenience, we will adopt the fiscal federalism language and refer to the supra-national agency as a 'federal government' and nations as 'state governments'). Ulph

[1] Deardorf (2000) discusses concerns about globalisation and the operation of the WTO, and Ulph (1997a) surveys the literature on trade and environment. In this chapter we ignore transboundary environmental problems, so the need for international environmental governance arises solely through strategic trade considerations. Transboundary pollution reinforces the strategic incentives to weaken environmental policies (see Ulph (1997a)), so we believe that our conclusions would carry over to a more general setting.

[2] These results, as is well known in the strategic trade literature are not at all robust For example, it is possible to produce models in which there is a 'race-to the-top' if we introduce Bertrand competition. See Wilson (1996 Rauscher (1997) Chapter 6 and Ulph (1997a) for surveys of the available results.

(1997b, 2000) showed that when each state government has private information about its environmental damages, then environmental policies set at a federal level for states with different damage costs will be more similar than if the federal government had full information, but this falls far short of harmonisation.[3] A second concern is that agencies like WTO may lack democratic accountability and are prey to powerful lobby groups. Moreover it is argues there are significant asymmetries in the ability of different groups (e.g. environmental groups and developing countries) to influence policy making.

In this chapter we develop a model to address these concerns and ask whether it is appropriate to vest responsibility for environmental policy-making at the federal level when, as well as asymmetric information, policy-makers are influenced by special interest groups. The model adds lobbying behaviour to the model in chapter 2.

Our main conclusions are: (i) the effects of asymmetries can be counter intuitive: industrialists may lose out despite a producer bias, the North may be worse having more political influence; (ii) the major effects of the asymmetries occur when policy is set at the state rather than federal level; and (iii) the benefits of international co-ordination far outweigh any asymmetries in the political process. Thus, while there may well be arguments for reforming supra-national agencies to make them less susceptible to asymmetric influence, these would appear to be less important than ensuring that appropriate international coordination takes place.

[3] Harmonisation or a minimum environmental standards is optimal if nation states differ in endowments of environmental resources, tastes for a clean environment or abatement technologies. See Kanbur,

3.2 The Model.

We start from the basic Brander-Spencer (1985) framework with a partial equilibrium model of an industry with two identical firms located in different states, denoted $i = 1, 2$. The two firms produce a good, which is sold outside the two states. Firm i has total revenue and cost functions: $R(x_i, x_j)$, $C(x_i)$ respectively, with standard properties. The production of the good causes emissions of a pollutant, although these emissions can be abated, at a cost. By appropriate choice of units, emissions by firm i are: $x_i - b_i$ where b_i is its abatement level; total abatement costs are the strictly convex function $B(b_i)$. The only instrument available to control pollution by each firm is an emission limit, denoted e_i[4]. Firm i takes as given its emission limit and the output of the other firm and chooses its own output (Cournot competition) and abatement to maximise profits, net of abatement costs: $\pi(x_i, x_j, e_i) \equiv R(x_i, x_j) - C(x_i) - B(x_i - e_i)$. Assuming that both emission limits bite, the resulting equilibrium profit function for firm i is denoted $\Pi(e_i, e_j)$.

Unabated pollution causes environmental damage, but only in the state in which the firm is located. The damage cost function in state i is denoted $\delta_i D(e_i)$ where δ_i is a parameter and D is a strictly convex function. Welfare in state i is given by

$$W(e_i, e_j, \delta_i) \equiv \Pi(e_i, e_j) - \delta_i D(e_i).$$

Keen and van Wijnbergen (1995), Ulph (1997b, 2000).

[4] While the use of different environmental policy instruments can produce somewhat different results in models of strategic policy competition (see Ulph (1997a for a discussion) these differences are not

To capture asymmetries of information between state and federal level, we suppose that the damage cost parameter, δ_i, in each state is known only to the state government in power. To keep things simple, we suppose that in state i =1, 2, δ_i can take one of only two values, δ_L and δ_H, $\delta_L < \delta_H$, with probabilities p and 1- p respectively, independent of what happens to damages in the other state. Note that this implies that, *ex ante*, both states are identical[5]. We denote the expected value of damage costs by $\overline{\delta} \equiv p\delta_L + (1-p)\delta_H$.

We now introduce special interest groups. There are four special interest groups, indexed g = 1,...,4; groups 1 and 2 are *environmental* special interest groups in states 1 and 2 respectively; groups 3 and 4 are *industrial* special interest groups in states 1 and 2 respectively. The *utility* of group g in state i is given by:

$$U(e_i, e_j, \delta_i, \gamma_g) \equiv \Pi(e_i, e_j) - \gamma_g \delta_i D(e_i),$$

where γ_g is the weight which the special interest group g attaches to environmental damage. γ_g can take two values: $\gamma_g = \gamma_H > 1$ if $g = 1,2$; while $\gamma_g = \gamma_L < 1$ if $g = 3,4$. In other words, environmentalists attach more weight to environmental damage than the weight it has in the welfare function, while industrialists attach less weight to environmental damage than in the welfare function.

---

relevant for the issues being discussed here. So we do not believe that our results would be significantly different with different instruments.

[5] We assume underlying symmetry of states simply for analytical convenience so that we can focus on the main asymmetries in this chapter, namely lobbying asymmetries; note that we allow environmental

Finally, we describe the political process. We assume that there are elections[6] for three governments, the two state governments and a federal government. There is competition between the two types of special interest groups to have governments elected which represent their interests. Since there are only two types of interest groups, only two types of governments can be elected. State government i will set its policy to maximise its "utility function":

$$U(e_i, e_j, \delta_i, \gamma_i) \equiv \Pi(e_i, e_j) - \gamma_i \delta_i D(e_i) \ ,$$

where again the parameter γ_i can take the values γ_H or γ_L depending on whether the state government represents the interests of environmentalists or industrialists. Similarly, a federal government will set policy using its utility function:

$$U^F(e_1, e_2, \delta_1, \delta_2, \gamma_F) = \Pi(e_1, e_2) + \Pi(e_2, e_1) - \gamma_F(\delta_1 D(e_1) + \delta_2 D(e_2)) \ .$$

Whether the outcome of an election produces an environmental or industrial government is a random process, but the probability of electing, say, an environmental government is influenced by the amount of lobbying done in each election by each special interest group. We assume that each group can lobby in each election[7], but the environmental special interest groups lobby only for an environmental government

---

policies to be state specific, so if there were underlying asymmetries between countries these would be reflected in differences in policies even if there was symmetric lobbying.

[6] Given our general interpretation of governments, especially at the federal level, we interpret elections as some process by which special interest groups attempt to capture governments.

and similarly for industrial special interest groups. We denote by l_{gi} the amount of lobbying done by group g in election i = 1, 2, F, and assume that the probability of electing an environmental government in election i is given by:

$$q_i = \frac{1 + l_{1i} + l_{2i}}{2 + L_i} \quad \text{where } L_i = \sum_{g=1}^{g=4} l_{gi} \,. \tag{1}$$

Note that in the absence of lobbying the probability of electing an environmental government is 0.5. It is straightforward to show that that $0 < q_i < 1$ and that q_i is an increasing, concave function of lobbying efforts by environmental groups and a decreasing convex function of lobbying efforts by industrial groups. Finally we assume that if group g expends lobbying effort l_{gi} in election i then it incurs a cost $0.5k_{gi}.(l_{gi})^2$ where k_{gi} is a parameter which, as we shall see, can be varied to allow for the three asymmetries referred to in the introduction. Special groups choose their lobbying effort to maximise their expected utility net of the costs of lobbying. We shall need to distinguish between *gross* and *net* utilities of special interest groups, where net utilities are gross utilities minus the costs of lobbying. In a similar way we shall distinguish between gross and net welfares of states.

To complete our broad description of the model, we assume that prior to any of the above activity taking place there will be a *constitutional* decision about whether environmental policy should be set at the state level, in which case policy will be set by the state governments acting independently to maximise utility, so we will have a

[7] This assumption reflects the fact that lobby groups sometimes work outside their own national boundaries; however we assume they act non-cooperatively and an interesting extension of this chapter

non-cooperative equilibrium and environmental dumping; or whether it is to be set at the federal level, in which case the federal government acts to maximise its utility, but there will be no environmental dumping. This constitutional decision will be based on the expected *welfare* which each state expects to derive from the subsequent political process. We assume that policy will only be set at the federal level if both states derive higher expected net welfare from this constitutional choice. [8]

Formally we have a six stage game: in stage 1 there is a constitutional choice whether to set policy at state or federal level; in stage 2, lobby groups decide how much lobbying effort to undertake in each election; in stage 3 elections are held; in stage 4 state governments learn their true damage costs; in stage 5 either state or federal governments set emission limits; finally in stage 6 firms set their levels of output and abatement.

3.2.1 Stage 6: Firms Choose Outputs and Abatement.

---

would be to explore what happens if lobby groups co-operate, perhaps especially at the federal level.

[8] Note that if policy is set at the state level, then we need to track the types of governments elected in the two states. There are four configurations of state government types which we denote by $\tilde{\Gamma}_s = (\gamma_1, \gamma_2)$, s=1,..,4, where: $\tilde{\Gamma}_1 = (\gamma_H, \gamma_H)$; $\tilde{\Gamma}_2 = (\gamma_H, \gamma_L)$; $\tilde{\Gamma}_3 = (\gamma_L, \gamma_H)$; $\tilde{\Gamma}_4 = (\gamma_L, \gamma_L)$ with probabilities: $\tilde{Q}_s$, s = 1,...,4, where $\tilde{Q}_1 = q_1 q_2$; $\tilde{Q}_2 = q_1(1-q_2)$; $\tilde{Q}_3 = (1-q_1)q_2$; $\tilde{Q}_4 = (1-q_1)(1-q_2)$. If policy is set at the federal level then we need to know the configuration of government types elected in the two states and the federal government. There are eight configurations denoted: $\hat{\Gamma}_f = (\gamma_1, \gamma_2, \gamma_F), f = 1,...,8$, where $\hat{\Gamma}_1 = (\gamma_H, \gamma_H, \gamma_H), \hat{\Gamma}_2 = (\gamma_H, \gamma_H, \gamma_L)$, etc. with probabilities: $\hat{Q}_f, f = 1,...,8$ where $\hat{Q}_1 = q_1 q_2 q_F, \hat{Q}_2 = q_1 q_2 (1-q_F)$, etc.

Firm i takes as given its emission limit, e_i, and the output of the other firm, x_j, and chooses its own output, x_i, and hence abatement, $b_i = x_i - e_i$, to maximise profits, net of abatement costs: $\pi(x_i, x_j, e_i) \equiv R(x_i, x_j) - C(x_i) - B(x_i - e_i)$. The first-order condition is: $R_1 - C' - B = 0$, i.e. marginal revenue equals marginal cost plus marginal abatement cost. Solving the pair of first-order conditions for the two firms yields the equilibrium outputs $X(e_i, e_j)$, $j = 1,2, i \neq j$, and substituting back into the profit function yields the equilibrium profit function: $\Pi(e_i, e_j)$. From the equilibrium profit function we derive the equilibrium (gross) welfare function for each state $W(e_i, e_j, \delta_i) \equiv \Pi(e_i, e_j) - \delta_i D_i(e_i)$. Similarly, it is possible to define the equilibrium (gross) utility functions for each interest group: $U(e_i, e_j, \delta_i, \gamma_g) \equiv \Pi(e_i, e_j) - \gamma_g \delta_i D(e_i)$ and for each government; these have similar properties to the equilibrium welfare function.

3.2.2. Stages 4 and 5: State Governments Learn Their Damage Costs And Set Emission Limits.

We take these stages together since at the end of stage 4 each state government knows only its own damage cost parameter δ_i and this affects how governments set their emission limits. We consider separately the cases where policy is set at the state and federal levels.

(i) Policy Set at the State Level.

For any given configuration of government types $\tilde{\Gamma}_s$, $s = 1,\ldots,4$ the emission limits in the two states are set as the equilibrium of a Nash game in which each state government knows its own damage costs but not those of its rival. So each state has to take as given the emission limits set by the other state depending on whether it has high or low damage costs. This means there are four equilibrium emission limits to be determined: $\tilde{e}_1(\tilde{\Gamma}_s, \delta_L)$, $\tilde{e}_1(\tilde{\Gamma}_s, \delta_H)$, $\tilde{e}_2(\tilde{\Gamma}_s, \delta_L)$, $\tilde{e}_2(\tilde{\Gamma}_s, \delta_H)$, and correspondingly four first-order conditions to determine them. For example, if state 1 has low damage costs, it will take as given the low damage cost and high damage cost emission limits of state 2 and choose $\tilde{e}_1(\tilde{\Gamma}_s, \delta_L)$ to maximise expected utility:

$$pU[\tilde{e}_1(\tilde{\Gamma}_s, \delta_L), \tilde{e}_2(\tilde{\Gamma}_s, \delta_L), \delta_L, \gamma_1] + (1-p)U[\tilde{e}_1(\tilde{\Gamma}_s, \delta_L), \tilde{e}_2(\tilde{\Gamma}_s, \delta_H), \delta_L, \gamma_1].$$

There will be three other similar first-order conditions: for state 1 with high damage costs, state 2 with low damage costs and state 2 with high damage costs.

Knowing the four equilibrium emission limits we can now calculate for configuration s expected (gross) welfare of each state i, $\tilde{W}_{is}$, and expected utility for each group g, $\tilde{U}_{gs}$. For example, for environmentalists in state 1, we have [9]:

$$\tilde{U}_{1s} = p\tilde{U}_{1s}(\delta_L) + (1-p)\tilde{U}_{1s}(\delta_H).$$

[9] Where $\tilde{U}_{1s}(\delta_L) = pU\left(\tilde{e}_1(\tilde{\Gamma}_s, \delta_L), \tilde{e}_2(\tilde{\Gamma}_s.\delta_L), \delta_L, \gamma_H\right) + (1-p)U\left(\tilde{e}_1(\tilde{\Gamma}_s, \delta_L), \tilde{e}_2(\tilde{\Gamma}_s, \delta_H), \delta_L, \gamma_H\right)$ and

(ii) Policy Set at the Federal Level.

For any configuration of three government types, $\hat{\Gamma}_f$, f =1,...,8, the federal government needs to provide incentives for the state governments to reveal their private information. These incentives consist of both the choice of emission limits and the use of financial transfers, M. Thus the federal government solves a standard mechanism design problem in which it asks state governments to announce their damage cost parameters, and depending on their announcements it will set each state an emission limit and a financial transfer. These are chosen to maximise the expected utility of the federal government, subject to both a set of incentive compatibility constraints, to ensure the state governments reveal their true damage costs, and a set of individual rationality constraints, that no state government with its given political weight and damage cost parameter would be worse off than in the case where environmental policy was set at the state level. It is because these incentive compatibility constraints and individual rationality constraints are expressed in terms of the utilities of the state governments, and hence depend on the type of state governments elected, that the choice of emission limits depends on the types of all governments rather than just the type at the federal level.

Formally, the federal government must choose the set of policy instruments[10]: $\hat{e}^1_{LL}, \hat{e}^1_{LH}$, $\hat{e}^1_{HL}, \hat{e}^1_{HH}$, $\hat{e}^2_{LL}, \hat{e}^2_{LH}$, $\hat{e}^2_{HL}, \hat{e}^2_{HH}$, $M^1_L, M^1_H, M^2_L, M^2_H$ to maximise:

$\tilde{U}_{1s}(\delta_H) = pU\left(\tilde{e}_1(\tilde{\Gamma}_s, \delta_H), \tilde{e}_2(\tilde{\Gamma}_s, \delta_L), \delta_H, \gamma_H\right) + (1-p)U\left(\tilde{e}_1(\tilde{\Gamma}_s, \delta_H), \tilde{e}_2(\tilde{\Gamma}_s, \delta_H), \delta_H, \gamma_H\right)$.

[10] To save notation we omit the dependence of these instruments on the configuration of government types

$$
\begin{aligned}
&p^2\left\{U(\hat{e}^1_{LL},\hat{e}^2_{LL},\delta_L,\gamma_F)+M^1_L+U(\hat{e}^2_{LL},\hat{e}^1_{LL},\delta_L,\gamma_F)+M^2_L\right\}\\
&+p(1-p)\left\{U(\hat{e}^1_{LH},\hat{e}^2_{HL},\delta_L,\gamma_F)+M^1_L+U(\hat{e}^2_{HL},\hat{e}^1_{LH},\delta_H,\gamma_F)+M^2_H\right\}\\
&+p(1-p)\left\{U(\hat{e}^1_{HL},\hat{e}^2_{LH},\delta_H,\gamma_F)+M^1_H+U(\hat{e}^2_{LH},\hat{e}^1_{HL},\delta_L,\gamma_F)+M^2_L\right\}\\
&+(1-p)^2\left\{U(\hat{e}^1_{HH},\hat{e}^2_{HH},\delta_H,\gamma_F)+M^1_H+U(\hat{e}^2_{HH},\hat{e}^1_{HH},\delta_H,\gamma_F)+M^2_H\right\}\\
&-\{pM^1_L+(1-p)M^1_H+pM^2_L+(1-p)M^2_H\},
\end{aligned}
$$

subject to the incentive compatibility constraints:

$$
\begin{aligned}
&pU(\hat{e}^1_{LL},\hat{e}^2_{LL},\delta_L,\gamma_1)+(1-p)U(\hat{e}^1_{LH},\hat{e}^2_{HL},\delta_L,\gamma_1)+M^1_L\geq\\
&pU(\hat{e}^1_{HL},\hat{e}^2_{LH},\delta_L,\gamma_1)+(1-p)U(\hat{e}^1_{HH},\hat{e}^2_{HH},\delta_L,\gamma_1)+M^1_H
\end{aligned}
\tag{2}
$$

$$
\begin{aligned}
&pU(\hat{e}^1_{HL},\hat{e}^2_{LH},\delta_H,\gamma_1)+(1-p)U(\hat{e}^1_{HH},\hat{e}^2_{HH},\delta_H,\gamma_1)+M^1_H\geq\\
&pU(\hat{e}^1_{LL},\hat{e}^2_{LL},\delta_H,\gamma_1)+(1-p)U(\hat{e}^1_{LH},\hat{e}^2_{HL},\delta_H,\gamma_1)+M^1_L
\end{aligned}
\tag{3}
$$

$$
\begin{aligned}
&pU(\hat{e}^2_{LL},\hat{e}^1_{LL},\delta_L,\gamma_2)+(1-p)U(\hat{e}^2_{LH},\hat{e}^1_{HL},\delta_L,\gamma_2)+M^2_L\geq\\
&pU(\hat{e}^2_{HL},\hat{e}^1_{LH},\delta_L,\gamma_2)+(1-p)U(\hat{e}^2_{HH},\hat{e}^1_{HH},\delta_L,\gamma_2)+M^2_H
\end{aligned}
\tag{4}
$$

$$
\begin{aligned}
&pU(\hat{e}^2_{HL},\hat{e}^1_{LH},\delta_H,\gamma_2)+(1-p)U(\hat{e}^2_{HH},\hat{e}^1_{HH},\delta_H,\gamma_2)+M^2_H\geq\\
&pU(\hat{e}^2_{LL},\hat{e}^1_{LL},\delta_H,\gamma_2)+(1-p)U(\hat{e}^2_{LH},\hat{e}^1_{HL},\delta_H,\gamma_2)+M^2_L
\end{aligned}
\tag{5}
$$

and the individual rationality constraints:[11]

$$
pU(\hat{e}^1_{LL},\hat{e}^2_{LL},\delta_L,\gamma_1)+(1-p)U(\hat{e}^1_{LH},\hat{e}^2_{HL},\delta_L,\gamma_1)+M^1_L\geq\widetilde{U}_{1s}(\delta_L)
\tag{6}
$$

$$
pU(\hat{e}^1_{LH},\hat{e}^2_{HL},\delta_H,\gamma_1)+(1-p)U(\hat{e}^1_{HH},\hat{e}^2_{HH},\delta_H,\gamma_1)+M^1_H\geq\widetilde{U}_{1s}(\delta_H)
\tag{7}
$$

$$
pU(\hat{e}^2_{LL},\hat{e}^1_{LL},\delta_L,\gamma_2)+(1-p)U(\hat{e}^2_{LH},\hat{e}^1_{HL},\delta_L,\gamma_2)+M^2_L\geq\widetilde{U}_{2s}(\delta_L)
\tag{8}
$$

[11] Our justification for imposing these constraints even though a prior constitutional stage has decided that policy should be set at the federal level is that it may represent less formal structures such as the EU. Here, even at the implementation stage, state governments may have an incentive to defect from the constitutionally agreed decision.

$$pU(\hat{e}^2_{HL}, \hat{e}^1_{LH}, \delta_H, \gamma_2) + (1-p)U(\hat{e}^2_{HH}, \hat{e}^1_{HH}, \delta_H, \gamma_2) + M^2_H \geq \tilde{U}_{2s}(\delta_H) \qquad (9)$$

The utilities on the right-hand side of the individual rationality constraints are derived from the solution to the model when policy is set at the state level; the configuration $\tilde{\Gamma}_s$ of types of state governments whose utilities are used on the RHS of (6) – (9) is the same as the configuration of state government types found in configuration $\hat{\Gamma}_f$ for which the mechanism design problem is being solved.

Incentive compatibility constraints (2) and (3) are for state 1 with low and high damage costs respectively, while (4) and (5) are for state 2 with low and high damage costs respectively. Similarly individual rationality constraints (6) and (7) are for state 1 with low and high damage costs, while (8) and (9) are for state 2 with low and high damage costs respectively.

So for any configuration of government types, *f*, we solve the mechanism design problem above. We can then calculate expected welfare for each state i =1,2, $\hat{W}_{if}$, and expected utility for each group g =1,...,4, $\hat{U}_{gf}$. The calculation of the expressions is straightforward, but we omit the details because they are cumbersome to write out.

3.2.3 Stage 3: Elections.

If policy is set at the state level, then, from the earlier stages of the game there will be given probabilities $\tilde{Q}_s$, s= 1,...,4 for each possible configuration of state government

types, $\tilde{\Gamma}_s$. For each such configuration, the previous section allows us to calculate expected (gross) welfares and utilities $\tilde{W}_{is}, \tilde{U}_{gs}$. So we can now take expectations over all possible configurations $\tilde{\Gamma}_s$ to derive the expected gross welfare and utility for each state and group as follows:

$$\tilde{W}_i = \sum_{s=1}^{s=4} \tilde{Q}_s \tilde{W}_{is}; \qquad \tilde{U}_g = \sum_{s=1}^{s=4} \tilde{Q}_s \tilde{U}_{gs}.$$

Similarly, if policy is set at the federal level we can calculate expected (gross) welfares and utilities across all configurations $\hat{\Gamma}_f$, $f = 1,\ldots, 8$:

$$\hat{W}_i = \sum_{f=1}^{f=8} \hat{Q}_f \hat{W}_{if}; \qquad \hat{U}_g = \sum_{f=1}^{f=8} \hat{Q}_f \hat{U}_{gf}$$

3.2.4 Stage 2: Lobbying.

We now determine the levels of lobbying effort by each special interest group in each election, and hence the probabilities of different types of government being elected.

(i) Policy Set at the State Level.

It is clear that since the type of federal government has no influence on utilities or welfare, and since lobbying is costly, each interest group g will not lobby at the

federal level. Denote by $\tilde{l} = (\tilde{l}_{11}, \tilde{l}_{12}, ..., \tilde{l}_{41}, \tilde{l}_{42})$ the vector of eight lobbying efforts $\tilde{l}_{gi}$ by interest group g =1,...,4 in the election in state i = 1,2. Denote by $Q_s(\tilde{l})$ the probability of electing configuration $\tilde{\Gamma}_s$ of state governments, given $\tilde{l}$. Then each special interest group will take as given the lobbying efforts by all other groups and choose $\tilde{l}_{g1}$ and $\tilde{l}_{g2}$ to maximise

$$\sum_{s=1}^{s=4} \tilde{Q}_s(\tilde{l})\tilde{U}_{gs} - \sum_{i=1}^{i=2}[0.5k_{gi}(\tilde{l}_{gi}^2)].$$

There will be a set of eight first-order conditions, where for example, the first-order condition for $\tilde{l}_{g1}$ is:

$$[\tilde{q}_2(\tilde{U}_{g1} - \tilde{U}_{g3}) + (1-\tilde{q}_2)(\tilde{U}_{g2} - \tilde{U}_{g4})]\frac{\partial \tilde{q}_1}{\partial \tilde{l}_{g1}} = k_{g1}\tilde{l}_{g1}. \qquad (10)$$

(10) has a standard interpretation. The RHS is the marginal cost of lobbying by group g in state i and the LHS is the marginal benefit, where the term in square brackets is the difference in expected utility to group g from having an environmental rather than industrial government in state i, and the remaining term is just the marginal effect on the probability of having an environmental government elected in state 1 from a bit more lobbying by group g. $\tilde{l}$ is the solution to the eight first-order conditions (10). We can now define the equilibrium lobbying costs of special interest group g as: $\tilde{K}_g(\tilde{l}) \equiv \sum_{i=1}^{i=2} 0.5k_{gi}(\tilde{l}_{gi})^2$. The outcome from this stage of the game, then, is that we

can define the equilibrium levels of *gross* welfare for each state and *gross* utility for each interest group by:

$$\tilde{W}_i^G = \sum_{s=1}^{s=4} \tilde{Q}_s(\tilde{l})\tilde{W}_{is}\,;\, i = 1,2; \quad \tilde{U}_g^G = \sum_{s=1}^{s=4} \tilde{Q}_s(\tilde{l})\tilde{U}_{gs}\,;\, g = 1,\ldots,4,$$

and the equilibrium levels of *net* utility for each interest group and *net* welfare for each state:

$$\tilde{U}_g^N = \tilde{U}_g^G - \tilde{K}_g(\tilde{l}),\, g = 1,\ldots,4; \quad \tilde{W}_1^N = \tilde{W}_1^G - \tilde{K}_1(\tilde{l}) - \tilde{K}_3(\tilde{l}); \quad \tilde{W}_2^N = \tilde{W}_2^G - \tilde{K}_2(\tilde{l}) - \tilde{K}_4(\tilde{l})$$

(ii) Policy Set at the Federal Level.

We proceed in a similar way when policy is set at the federal level. $\hat{l} = (\hat{l}_{gi})$ is the vector of lobbying efforts by groups $g = 1,\ldots,4$ in elections $i = 1, 2, F$. $\hat{Q}_f(\hat{l})$ is the probability of electing configuration $\hat{\Gamma}_f$, $f = 1,\ldots,8$ of governments types given lobbying efforts $\hat{l}$. Interest group g takes as given the lobbying efforts by all other groups and chooses $\hat{l}_{gF}$, $\hat{l}_{g1}$ and $\hat{l}_{g2}$ to maximise

$$\sum_{f=1}^{f=8} \hat{Q}_f(\hat{l})\hat{U}_{gf} - \sum_{i=F}^{i=2} [0.5k_{gi}(\hat{l}_{gi}^2)]\,.$$

There will be 12 first-order conditions to determine $\hat{l}$ where, for example, the first-order condition for $\hat{l}_{gF}$ is:

$$\left[q_1 q_2(\hat{U}_{g1} - \hat{U}_{g5}) + q_1(1-q_2)(\hat{U}_{g2} - \hat{U}_{g6}) + (1-q_1)q_2(\hat{U}_{g3} - \hat{U}_{g7})\right.$$

$$+(1-q_1)(1-q_2)(\hat{U}_{g4}-\hat{U}_{g8})\Big]\frac{\partial q_F}{\partial l_{gF}}=\mu_{gF}l_{gF}. \qquad (11)$$

Equation (11) has exactly the same interpretation as equation (10). We solve these 12 first-order conditions simultaneously to determine the equilibrium vector of lobbying effort $\hat{l}$. From this we can define the equilibrium level of lobbying costs for each group by

$$\hat{K}_g(\hat{l})\equiv\sum_{i=1}^{i=F}0.5k_{gi}(\hat{l}_{gi})^2.$$

Finally we can define the equilibrium levels of *gross* welfare for each state and *gross* utility for each interest group by:

$$\hat{W}_i^G=\sum_{f=1}^{f=8}\hat{Q}_f(\hat{l})\hat{W}_{if};\ i=1,2;\quad \hat{U}_g^G=\sum_{f=1}^{f=8}\hat{Q}_f(\hat{l})\hat{U}_{gf}$$

and the equilibrium levels of *net* utility for each group and *net* welfare for each state by:

$$\hat{U}_g^N=\hat{U}_g^G-\hat{K}_g(\hat{l}),\ g=1,...,4;\quad \hat{W}_1^N=\hat{W}_1^G-\hat{K}_1(\hat{l})-\hat{K}_3(\hat{l});\quad \hat{W}_2^N=\hat{W}_2^G-\hat{K}_2(\hat{l})-\hat{K}_4(\hat{l})$$

3.2.5 Stage 1: Constitutional Choice.

States will decide to vest responsibility at the federal level iff $\hat{W}_i^N \geq \tilde{W}_i^N$ for both states $i = 1,2$, with a strict inequality for at least one state; i.e. they will only agree to give up responsibility for environmental policy if no state expects to be made worse off, and at least one state expects to be made better off. Note that the *ex post* individual rationality constraints defined in (6) – (9) do not guarantee that these *ex ante* individual rationality constraints will be satisfied, because the *ex post* constraints are expressed in terms of government utility, while the *ex ante* constraints are expressed in terms of expected welfare.

Given the complexity of this six-stage game it has not been possible to determine closed form solutions to the full model; in the next section we set out a special case of this model, for which we then report numerical results.

3.3 A Special Case.

In this section we follow our earlier chapter and set out a special case of the model in the previous section, drawing on the special case used in Ulph (1997b). In that model, the two firms produce a homogenous good and face a linear inverse demand function with intercept A and unit slope. There are no costs of production but there are quadratic abatement costs, $0.5b^2$ and the damage cost function is also quadratic: $D(e) = 0.5e^2$. It is then straightforward to show that the utility function for state i is:

$$U(e_i, e_j, \delta_i, \gamma_i) = 3(2A - e_j)^2 + 18e_i(2A - e_j) - (37 + 64\delta_i\gamma_i)e_i^2 \qquad (12)$$

3.3.1 Choice of Parameter Values.

There are four key parameters in our model, $\bar{\delta}, \lambda, \nu,$ and k. We use three values of expected damage costs, $\bar{\delta} = 0.1, 0.3$ and 0.5, implying that in a completely unregulated economy, expected pollution damage costs would lie between 7.5% and 37.5% of GNP. For the measure of dispersion in damage costs, υ, and the dispersion in political weights, λ, we use the values 0.25, 0.5 and 0.75. The final figure, say in the case of υ, implies that damage costs in the high cost country are seven times greater than in the low cost country.[12] The main qualitative results reported are not sensitive to variations in parameter values, so we report detailed results only for the mid-point case where $\bar{\delta} = 0.3,\ \upsilon = 0.5,$ and $\lambda = 0.5$ and indicate which results do not carry over to other

[12] $\bar{\delta}, \lambda$ and ν can then be used to calculate $\delta_L = (1-\upsilon)\bar{\delta}$, $\delta_H = (1+\upsilon)\bar{\delta}$, $\gamma_L = (1-\lambda)$ and $\gamma_H = (1+\lambda)$.

parameter values[13]. For the cost of lobbying parameter we have chosen the two values $k = 1$ and $k = 10$. By varying these we can capture the asymmetries of influence which are the focus of the chapter. [14]

3.3.2 Results of the Numerical Experiments.

In Table 3.1 we present results for a number of 'experiments' using different assumptions about lobbying costs for the central case set of parameters: $\bar{\delta} = 0.3$; $\nu = \lambda = 0.5$. For each experiment, whether policy is set at the state or federal level, we present the following results: the equilibrium lobbying efforts by the four interest groups, *l*11,...,*l*4F; the equilibrium probabilities of electing a green government in each election: q1,...,qF; the gross and net expected utilities for each group, GU1,...,GU4, NU1,...,NU4; and the gross and net welfares for each state, GW1, GW2, NW1, NW2.

The effects of variations in lobbying costs on net utilities and welfare can briefly be described as follows. Changes in lobbying costs will affect lobbying effort. This in turn will affect the probabilities of different configurations of government types, and consequently, expected gross utility and welfare. Combining these various effects enables us to calculate the changes on expected net utilities and welfare.

[13] These produce welfare losses when policy is set at the federal level between 0.8% and 1.3% of GNP, which is within the range found by Katz and Rosenberg (1994) who calculated the costs of rent seeking as a percentage of GNP for a number of countries, and showed that this varied from 0.19% to 5.43%.
[14] Probability, *p*, is simply set as 0.5. *A* simply denotes the level of demand for the product and is just set equal to 10.

When changes in lobbying costs affect only some groups, the changes in lobbying behaviour will have a *direct effect* on the behaviour of groups whose costs have changed, and an *indirect strategic effect* on the response of other groups. In simple terms we could say it depends on whether lobbying effort by different groups are strategic substitutes or strategic complements.

In terms of expected utilities there are going to be two types of effects. First, for a given level of output by the rival producer, an interest group is going to be better off with a government of its own type setting environmental policy, at both the state and federal level. Second, though, there are the effects of strategic competition. When policy is set at the state level, profits are always higher when the other state's government is environmental. The simple reason is that an environmental government will restrict the rival firm's output, allowing the domestic firm to expand its output. Moreover, having two environmental governments may be better than two industrial governments if the environmental governments set emission limits which take outputs closer to the level which maximises joint profits. Differences in state government types are obviously less important when policy is set at the federal level, but they do have some influence through the impact of the incentive compatibility and individual rationality constraints. Of course having policy set at the federal level eliminates environmental dumping, which is harmful not just to the environment, but also to profits, since it leads to too much output being produced.

3.3.3 Symmetric Cases.

Experiments 1 and 2 in Table 1 show the results for the two symmetric cases when lobbying costs are 1 and 10 respectively. Before comparing the results of the two experiments, it is worth noting the pattern of lobbying. When policy is set at the state level, environmental groups lobby their own and the other state, and in fact lobby the other state more intensively, while industry groups lobby only their own state. Environmental groups spend more on lobbying than industrial groups so there is a greater than 50% chance of an environmental government being elected. When policy is set at the federal level, environmental groups lobby only in the rival nation state while industrialists lobby only in their own state; both groups lobby the federal government. Industrialists do more lobbying at the state level than at the federal level, while environmentalists lobby more than industrialists at the federal level, so the probability of electing an environmental government is less than 50% at the state level and more than 50% at the federal level. The rationale for these patterns follows from the point made above, that, whether policy is set at state or federal level, domestic profits are always higher when the other state government is environmental. To encourage this outcome, domestic environmental groups lobby for the rival state environmental party, but domestic industrialists desist from lobbying for the rival industrial party. The fact that with both state and federal decision-making environmentalists put in more lobbying effort than industrialists reflects the fact that having environmental governments can be beneficial to industry if that results in industry output which gets closer to the monopoly level. This basic pattern of lobbying behaviour persists across all the experiments we have conducted.

We now compare the results of Experiment 2 with Experiment 1 to assess the effect of increasing lobbying costs symmetrically. When policy is set at the state level, all groups reduce their lobbying in both state elections, and the probabilities of electing environmental governments falls towards 50%. This is because the increase in costs causes a greater reduction in lobbying by environmentalists than by industrialists, which reflects the fact that at the lower level of costs environmentalists were doing more lobbying, so the same increase in k means a greater increase in marginal lobbying cost for environmentalists. The expected gross utilities of all groups fall; both groups are worse off because increasing the likelihood of two industrial governments increases the likelihood of states with higher output, and hence lower profits, and this is reinforced for environmentalists by increased pollution. When we consider net utility, the first point to note is that the reduction in effort induced by the increase in lobbying costs, more than compensates for the increase in the parameter of the lobbying cost function, so the costs of lobbying for each group falls. Thus, there is an offsetting benefit for both groups of lower lobbying costs, and in the reported case this is sufficient to cause net utility for industrialists to rise, while for environmentalists net utility is still lower than in experiment 1; however both these results for net utilities can be reversed for low values of λ. Gross welfare in both states falls, because of the increased likelihood of outcomes with low profits and high pollution, while net welfare rises because of the reduction in lobbying costs. When policy is set at the federal level, the increase in lobbying costs causes all groups to reduce lobbying in all elections, but the probability of environmental governments rises (slightly) at the state level and falls at the federal level. Because there is no environmental dumping, gross utility now falls for environmentalists and increases for industrialists, reflecting the change in probabilities of electing their types of

governments at the federal level. The reduction in lobbying costs is an additional benefit for industrialists, so their net utility always rises, while the reduction in lobbying costs is usually sufficient to also cause net utility for environmentalists to rise, except when λ and υ are high. Gross welfare always falls but net welfare always rises.

Finally note that in both experiments, all interest groups and both states are better off when policy is set at the federal level.

3.3.4 The 'Democratic Deficit' Problem.

We now try to capture the notion that decision-making is less democratic when policy is set at the state rather than federal level. The way we capture such a difference in our model is to vary the cost of lobbying at state and federal level and so vary the probabilities of electing governments (or more generally 'capturing' agencies) that pursue policies in the interest of a particular group. Now even in the international relations literature it is not clear whether a 'democratic deficit' is consistent with more or less lobbying at the federal than state level (McGrew (1998)). A broad definition of democratic deficit is that it occurs whenever institutions, be they national or supra-national, fall short of the general principles of democracy. Of course some of these principles may be quite subjective but others such as participation and accountability are widely accepted.

One view of the 'democratic process' would be that it consists of elections in which lobbying plays no influence (so there is an equal probability of electing an

environmental or industrial government, reflecting the underlying distribution of environmentalists and industrialists in the population). A second view would be that, provided there were no asymmetries between interest groups, lobbying is part of the democratic process and a 'democratic deficit' arises at the federal level if there is less scope for lobbying at the federal than state level, so that at the federal level decisions are taken by 'technocrats' with no consideration for the views of different groups in society. It is reasonable to ask whether it is truly more democratic if policy decisions are taken under the influence of lobbying pressure. Certainly, this is a view put forward both in the debate over the European Union and its implications for national sovereignty and also in the globalisation debate. In the latter, development and environmental NGOs consistently refer to bodies such as WTO of being undemocratic since they do not take enough account of the views of civil society (which the NGOs believe to be representative of ordinary citizens). There is some support for this view in the political competition literature where it has been shown how competition amongst lobby groups can lead to optimal policy outcomes. [15]

It is this second view of the 'democratic deficit' that we shall examine, but the other view of the democratic deficit leads to precisely the opposite effects of those we report here. Thus we shall take as our base case Experiment 1, where there are low costs of lobbying ($k = 1$) for all groups in all elections, and compare this with Experiment 3 where $\forall g = 1,...,4,\ k_{gi} = 1,\ i = 1,2;\ k_{gF} = 10$, so all groups now face higher costs of lobbying at the federal level. Obviously we are interested only in comparing the results of Experiments 1 and 3 when policy is set at the federal level.

[15] See for example, Becker (1983) and Wittman (1989).

The effects can be summarised in three stages. First, lobbying efforts of all groups in all elections are reduced, slightly at the state level, most markedly at the federal level, so the probabilities of electing environmental governments fall slightly at the state level and more sharply at the federal level. Second, expected gross utilities of environmentalists (industrialists) fall (rise) reflecting the lower (higher) probability of having a federal government with the same utility function. Expected gross welfare also falls, again reflecting the fact that outcomes with all industrial governments are bad for the environment without necessarily benefiting profits. Finally, the reduction in lobbying costs reinforces the increase in gross utility of industrialists, but for environmentalists the benefit of lower lobbying goes in the opposite direction to the change in expected gross utility. For the central parameter values used in Table 3.1, net utility of environmentalists falls. But, when λ is low (so difference in government types does not matter so much), then the reduction in lobbying costs is sufficient to cause the net utility of environmentalists to rise. However, net welfare rises, so that the reduction in lobbying is overall a good thing. This result does not go through when both λ and υ are high.

Thus when 'democratic deficit' is interpreted to mean too little lobbying at the federal level, this is generally good for industrialists but not environmentalists, although net welfare usually rises. However these effects are all rather small. As noted, the other interpretation of 'democratic deficit' as leading to too much influence of lobby groups at the federal level has exactly the opposite effects. Note again that, despite the democratic deficit, all interest groups and both states are better off when policy is set at the federal level than at the state level.

3.3.5 Producer Bias.

We now explore the implications of the claim that industrialists exert more influence than environmentalists, by assuming that environmentalists face higher lobbying costs than industrialists. We begin with the case where this is true for all elections, so in Experiment 4 we assume that $\forall i \quad k_{gi} = 10, g = 1,2;\ k_{gi} = 1,\ g = 3,4$ and compare the results with those for Experiment 1.

When policy is set at the state level, we get the obvious direct effect that by raising the costs of lobbying for environmentalists, they reduce their lobbying in both elections. This leads industrialists to somewhat reduce their lobbying efforts (strategic complements) but the net effect is a substantial reduction in the probability of electing environmental governments in each state. Expected gross utility of all groups falls, because the configuration with two industrial governments has significant environmental dumping, which reduces joint profits. Obviously environmentalists lose more than industrialists because of the increased pollution. Expected gross welfare also falls, and despite the reduction in lobbying, expected net utilities and welfare also fall. So when policy is set at the state level, increasing the influence of industrialists is undesirable evèn for industrialists.

When policy is set at the federal level, the increase in lobbying costs for environmentalists again leads to a sharp reduction in lobbying by environmentalists in all elections. But now while industrialists respond by also cutting their lobbying at state level, they raise it slightly at federal level, though when there is a large difference

in government types (λ large) they also reduce lobbying at the federal level. In total, lobbying by industrialists falls. Probabilities of electing environmental governments fall sharply in all elections. Now, while the expected gross utility of environmentalists always falls, that of industrialists usually rises, (unless the difference in damage costs, υ, is large), because, when policy is set at the federal level, the configuration of having all governments industrial does not lead to environmental dumping, and so what happens to gross utility generally reflects the change in probability of electing the type of federal government. Expected gross welfare always falls. Finally, the reduction in lobbying costs again reinforces the increase in gross utility of industrialists so that their net utility always rises, and the reduction in lobbying costs is sufficient to cause net utility of environmentalists also to rise, except when λ is large, i.e. the effect of not having its own type of government is particularly high. Net welfare always rises.

Thus there are sharp differences between the effects of producer bias when policy is set at the state or federal level. When policy is set at the state level, giving too much influence to industrialists is undesirable from everyone's perspective because of the impact of environmental dumping, but when policy is set at the federal level, then all parties can be better off, though for environmentalists this is only because they no longer incur as high lobbying costs, and environmentalists do not gain when the difference in government types is very large. It should also be noted that the effects of producer bias on net utilities and welfare are quite marked when policy is set at the state level, but very much less so when it is set at the federal level.

In Experiment 4 we assumed that environmentalists faced higher lobbying costs than industrialists in all elections. But the concern about greater influence by industrialists

arises particularly in the discussions about supra-national bodies like WTO, so in Experiment 5 we model a variant of producer bias in which environmentalists face higher lobbying costs than industrialists only at the federal level. In comparing this with the base case, Experiment 1, we are obviously interested only in the case where policy is set at the federal level. The story is similar in many, but not all, respects to that in Experiment 4. Environmentalists reduce their lobbying in all elections, very slightly in state elections, almost as much in federal elections as in Experiment 4. Industrialists now reduce their lobbying efforts in all elections, except when there are high values of both λ and υ. Probabilities of electing environmental governments fall slightly in state elections, but markedly in the federal election. Expected gross utility of environmentalists falls, and of industrialists rises, except again for the case where there are high values of both λ and υ. The reason for this is the same as in Experiment 4, though it is less likely that industrialists have lower gross utility in Experiment 5 than in Experiment 4, because the probabilities of industrial state governments is lower in Experiment 5. Expected net utilities of environmentalists now always fall, because their reduction in lobbying costs is lower (because the reduction at state level is small), while the increase in net utility for industrialists may not go through when there are high values of λ and υ. Gross welfare falls, and net welfare rises, again except when there are high values of λ and υ. So when there is producer bias only at the federal level, this now always reduces the net utility of environmentalists, and, with large differences between government types and between high and low damage costs, may also reduce the net utility of industrialists.

Thus having producer bias only at the federal level makes it certain that environmentalists are worse off, and raises the possibility that industrialists can be

worse off. It is important to note again that in both Experiments 4 and 5, all interest groups, even environmentalists, and both states are better off when policy is set at the federal level.

3.3.6 'North-South Divide'.

Finally, we study the effect of introducing significant differences between states in the costs of lobbying, which we shall take to characterise the differences between the 'North' where lobbying is relatively cheap (perhaps reflecting longer-established interest groups, easier access to funds etc) and the 'South' where lobbying is relatively expensive for the opposite kinds of reasons. We shall take state 1 to be the North and state 2 to be the South. In Experiment 6 we begin with the case where the South has higher costs of lobbying in all elections - so we assume that $\forall i = 1,2, F \quad k_{gi} = 1, g = 1,3;\ k_{gi} = 10,\ g = 2,4$; again we compare the outcomes of Experiment 6 with those of the low cost symmetric case in Experiment 1.

We begin with the case where policy is set at the state level. We start with the obvious effect that both interest groups in the South (state 2) now do significantly less lobbying than in the symmetric case, with Southern industrialists cutting their lobbying in the South, and Southern environmentalists cutting their lobbying in both the South and, more sharply, in the North. This triggers a complex reaction by Northern lobby groups. In the North, the sharp reduction in lobbying by the Southern environmentalists causes Northern environmentalists to raise their lobbying in the North, to partially compensate for the reduction by Southern environmentalists,

although overall lobbying by environmentalists in the North falls; Northern industrialists generally increase their lobbying, but only slightly, and not for all parameter values. In the South the marked reduction in lobbying by both Southern industrialists and Southern environmentalists leads to a small reduction in lobbying by Northern environmentalists. The net effect of all these changes is that the probability of electing environmental governments falls quite sharply in the North and rises quite sharply in the South. So there is now a much higher probability of getting a configuration of an Industrial government in the North and an Environmental government in the South. This outcome is one which is bad for profits in the South and good for profits in the North. It is the effect which dominates what happens to expected gross utilities. So both groups in the North have higher expected gross utility, and this is true for environmentalists despite the fact that the probability of an environmental government in the North has fallen. Similarly, both groups in the South are worse off, and again this is true, usually, for environmentalists despite the increased probability of electing an environmental government, except in the case where there are high values of both λ and υ. Expected net utilities follow the pattern of expected gross utilities, except that when there are high values of λ the reduction in lobbying costs by Southern environmentalists can make net utility of environmentalists in the South rise. Expected gross welfare rises in the North and falls in the South, and this is mostly true for expected net welfare, except in the case when there are high values of both λ and υ, when the reduction in lobbying costs for Southern environmentalists can cause expected net welfare in the South to rise.

We now turn to the case where decisions are set at the federal level. Again both groups in the South cut their lobbying sharply in all elections, but recall that, at the

state level, the Southern environmentalists are lobbying in the North, the Southern industrialists in the South. The groups in the North cut their lobbying in the state elections (the pattern of lobbying at the state level makes them strategic complements), but it is more complex at the federal level where there is a mixture of strategic complements and substitutes; Northern environmentalists increase their lobbying (though overall environmental federal lobbying falls) while the Northern industrialists generally cut their lobbying (except when there are high values of λ and υ). The net effect of this is that, as when policy is set at the state level, there is sharp decrease in the probability of electing an environmental government in the North, and a sharp increase in the South, while at the federal level the probability of electing an environmental government rises somewhat, except when there are high values of λ and υ, and Northern industrialists increase lobbying at the federal level. The probabilities of electing different configurations of state governments changes in the same way as when policy is set at the state level, and despite the increased probability of electing a federal environmental government, these very sharp changes in probabilities at the state level feed through the incentive compatibility constraints and individual rationality constraints to generate the same pattern of changes in expected gross and net utilities, gross and net welfare, as when policy was set at the state level; i.e. both groups in the South are worse off, both groups in the North are worse off, welfare rises in the North and falls in the South; moreover, this is true for all parameter values. So, the pattern is very much the same as when policy was set at the state level, except in more extreme form: the North is always better off, the South always worse off, and this is very largely driven by the strategic competition between states when policy is set at the state level. It should be noted that these

This comes across quite sharply when we consider our final experiment, 7, where the higher lobbying costs for the South are incurred only in federal elections. So again we are compare the outcomes of Experiments 1 and 7 only for the case where policy is set at the federal level. All the action now takes place in the federal elections. Both groups from the South reduce their lobbying sharply, while both groups from the North increase their lobbying (strategic substitutes effect dominates strategic complements). There is a general reduction in lobbying at the state levels, but to a trivial extent. So the probabilities of electing environmental governments at the state level are almost unchanged, while there is a small reduction in the probability of electing an environmental government at the federal level. It is this effect which now drives what happens to expected gross utilities. Environmentalists are made slightly better off, industrialists slightly worse off. But because these effects in terms of expected gross utilities are slight, what affects expected net utilities is dominated by the change in lobbying costs, so that, paradoxically, net utilities of both groups in the North fall, net utilities of both groups in the South rise. While expected gross welfare falls slightly in both states, net welfare falls in the North and rises in the South. So when the asymmetry between the North and the South occurs only at the federal level, our analysis shows that because there is no great change in the balance of lobbying between environmentalists and industrialists, and hence no great change in the probabilities of different configurations of government types, the main effect on net utilities and welfare comes from the change in lobbying costs, and this benefits the South and harms the North, although these effects are small.

Thus a North-South divide only causes significant effects when the asymmetry is at the state as well as federal level. This is because the very asymmetric pattern of

lobbying at the state level (environmentalists lobby mainly in the rival state, industrialists in the home state) that emerges in our model causes marked changes in probabilities of electing environmental governments between states. In turn, this increases the likelihood of asymmetric state governments – industrial in the North, environmental in the South – with asymmetric effects on profits (higher in the North and lower in the South) and this drives the effects on utilities and welfare, even when policy is set at the federal level. When this state-level effect does not arise, groups benefit from having higher lobbying costs because their reduction in lobbying effort reduces total lobbying costs. Finally, we note again that in both Experiments 6 and 7, all interest groups and both states, even in the South, are better off when policy is set at the federal level.

3.4 Conclusions.

This chapter has been concerned with the design of international environmental governance to deal with problems of strategic competition in environmental policies between nation states where, due to globalisation, trade policy instruments are disallowed. We have used a simple model of imperfectly competitive trade between countries, which results in environmental dumping when nation states set their policies independently. Consequently there is a need for coordination of the environmental policies of nation states, which we have assumed takes place through a supra-national body ('federal government'). We have been concerned with two issues that have arisen in debates about ceding responsibility from nation states to a supra-national agency: asymmetry of information between the supra-national agency and nation states, and asymmetries in the influence exerted by special interest groups in political processes, between national and supra-national levels of authority ('democratic deficit'), between environmentalists and industrialists ('producer bias') and between nation states ('North-South divide').

There are three broad messages that emerge. First, the asymmetries don't always produce expected results. For example, industrialists can lose from having a producer bias and the North can be worse off and the South better off even if the South has less political influence. Second, by far the most significant effects come when the asymmetries occur at state level. The main factor behind this is the effect on strategic competition between state governments. If asymmetries occur in lobbying costs occur only at the federal level, then their effects are modest. Finally, all interest groups and states are better off when policy is set at the federal level rather than the state level.

This suggests that whatever asymmetries exist in the operation of influence in the political process are far outweighed by the benefits of international coordination of environmental policies. So, while there may well be arguments for reforming supra-national agencies to make them less susceptible to asymmetric influence, these would appear less important than ensuring that appropriate international coordination takes place.

To incorporate all the above elements we have obviously had to simplify many aspects of the model. In chapter 4 we extend the model by allowing for transboundary pollution, providing a further incentive to engage in strategic competition in environmental policies.

Table 3.1. Numerical Simulations

Experiment 1 Experiment 2 Experiment 3 Experiment 4 Experiment 5 Experiment 6 Experiment 7

State	symmetric1	symmetric10	dem deficit	prod bias	prod bias fed	n-s	n-s fed
*l*11	1.313	0.353	1.313	0.325	1.313	2.370	1.313
*l*21	4.567	1.235	4.567	1.190	4.567	0.799	4.567
*l*31	3.436	0.843	3.436	3.388	3.436	3.522	3.436
*l*41	0.000	0.000	0.000	0.000	0.000	0.000	0.000
*l*12	4.567	1.235	4.567	1.190	4.567	4.325	4.567
*l*22	1.313	0.353	1.313	0.325	1.313	0.121	1.313
*l*32	0.000	0.000	0.000	0.000	0.000	0.000	0.000
*l*42	3.436	0.843	3.436	3.388	3.436	0.686	3.436
q1	0.608	0.584	0.608	0.364	0.608	0.480	0.608
q2	0.608	0.584	0.608	0.364	0.608	0.764	0.608
GU1	1245.572	1241.517	1245.572	1204.853	1245.572	1261.007	1245.572
GU2	1245.572	1241.517	1245.572	1204.853	1245.572	1234.339	1245.572
GU3	1381.891	1379.927	1381.891	1361.933	1381.891	1412.803	1381.891
GU4	1381.891	1379.927	1381.891	1361.933	1381.891	1353.184	1381.891
NU1	1234.280	1233.267	1234.280	1197.247	1234.280	1248.848	1234.280
NU2	1234.280	1233.267	1234.280	1197.247	1234.280	1231.071	1234.280
NU3	1375.989	1376.372	1375.989	1356.195	1375.989	1406.603	1375.989
NU4	1375.989	1376.372	1375.989	1356.195	1375.989	1350.831	1375.989
GW1	1313.732	1310.722	1313.732	1283.393	1313.732	1293.762	1313.732
GW2	1313.732	1310.722	1313.732	1283.393	1313.732	1293.762	1313.732
NW1	1296.538	1298.917	1296.538	1270.049	1296.538	1288.140	1296.538
NW2	1296.538	1298.917	1296.538	1270.049	1296.538	1275.403	1296.538

Federal	symmetric1	symmetric10	dem deficit	prod bias	prod bias fed	n-s	n-s fed
*l*11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
*l*21	3.656	0.896	3.649	0.725	3.531	0.804	3.655
*l*31	4.081	1.023	4.075	3.536	3.985	3.649	4.080
*l*41	0.000	0.000	0.000	0.000	0.000	0.000	0.000
*l*12	3.656	0.896	3.649	0.725	3.531	3.363	3.655
*l*22	0.000	0.000	0.000	0.000	0.000	0.000	0.000
*l*32	0.000	0.000	0.000	0.000	0.000	0.000	0.000
*l*42	4.081	1.023	4.075	3.535	3.985	0.940	4.080
*l*1F	1.173	0.259	0.259	0.243	0.239	1.946	1.489
*l*2F	1.173	0.259	0.259	0.243	0.239	0.050	0.149
*l*3F	0.990	0.209	0.209	0.941	0.930	0.524	1.245
*l*4F	0.990	0.209	0.209	0.941	0.930	0.257	0.125
q1	0.478	0.484	0.478	0.276	0.476	0.280	0.478
q2	0.478	0.484	0.478	0.276	0.476	0.692	0.478
qF	0.529	0.517	0.517	0.340	0.341	0.627	0.527
GU1	1372.190	1372.020	1372.005	1368.946	1369.221	1401.989	1372.156
GU2	1372.190	1372.019	1372.005	1368.946	1369.220	1344.889	1372.155
GU3	1427.915	1428.062	1428.054	1430.032	1430.140	1461.996	1427.941
GU4	1427.914	1428.062	1428.053	1430.031	1430.139	1391.258	1427.940
NU1	1364.818	1367.671	1365.014	1366.021	1362.702	1394.440	1364.369
NU2	1364.818	1367.671	1365.013	1366.021	1362.701	1341.649	1365.365
NU3	1419.098	1422.613	1419.534	1423.339	1421.767	1455.203	1418.843
NU4	1419.098	1422.612	1419.533	1423.338	1421.767	1386.514	1419.541
GW1	1400.053	1400.041	1400.029	1399.489	1399.680	1431.993	1400.048
GW2	1400.052	1400.040	1400.029	1399.488	1399.680	1368.074	1400.048
NW1	1383.864	1390.243	1384.518	1389.871	1384.789	1417.650	1383.164
NW2	1383.863	1390.242	1384.517	1389.871	1384.788	1360.089	1384.859

Chapter 4

Global Environmental Governance, Political Lobbying and Transboundary Pollution.

Abstract.

Nation states acting independently may set environmental standards, which are too weak from a global perspective either because of strategic trade reasons or because of transboundary pollution. In such circumstances it is argued that environmental policy should be co-ordinated at a supra-national level. But this raises a concern that agencies which may do this, such as WTO or WEO, are alleged to suffer from lack of democratic accountability and are liable to capture by powerful groups such as transnational companies or northern governments. In chapter 3, we developed a model to encapsulate these considerations, and showed that, despite such political shortcomings in decision-making at the supra-national level, all parties would still be better off if policy was co-ordinated at the supra-national level. However, in that chapter the only rationale for supra-national coordination of environmental policy was to overcome strategic trade incentives to set weak environmental policies. In this chapter we extend our earlier model to allow for transboundary pollution. We show that transboundary pollution increases the amount of political lobbying and increases the magnitude of the effects of the various political shortcomings we modelled. However, only two results do not carry over at high levels of transboundary pollution, and our main conclusion – that it is desirable to set environmental policy at the supra-national level despite political shortcomings at that level – is strengthened by the introduction of transboundary pollution.

4.1 Introduction.

Recent 'anti-globalisation' protests, have focussed on the perceived harmful effects of globalisation, especially on the global environment. One aspect of this concern is that in a more competitive global market, nation states, acting independently, may engage in a 'race-to-the-bottom' in setting weak environmental standards in order to gain a strategic trade advantage, and in particular to respond to possible threats of delocation by transnational companies. Another reason why nation states acting independently may set environmental standards which are too weak from a global perspective is when they are dealing with transboundary or global pollution. In both cases, to counter such weak standards, it is argued that environmental policies of nation states should be co-ordinated at a supra-national level, perhaps through bodies such as WTO or the proposed World Environmental Organisation (WEO). But this in turn raises concerns, also expressed in the protests, about the way such supra-national agencies operate. First there is a concern that supra-national bodies may not be as well informed about environmental conditions in different states as national governments. Second there is a concern that there is a 'democratic deficit' in decision-making at the supra-national level, with bodies such as WTO being unaccountable and prone to being captured by special interests of transnational companies or northern governments, rather than by environmentalists or southern governments. The protests can thus be seen as a sign of frustration arising from the realisation of a need to move international environmental governance beyond the nation state level, but with a distrust of the existing supra-national agencies that might accomplish this.

In chapter 3 we addressed the question whether deficiencies in political processes at the supra-national level were sufficient to call into question the desirability of coordinating environmental policy at the supra-national level. To answer the question we set up a model in which there was strategic environmental policy competition between nation states, policy could be set at national or supra-national level, there was asymmetric information about environmental damage costs between state governments and the supra-national agency, and both state governments and the supra-national agency could be influenced by lobbying activities by both environmental and industrial special interest groups. By allowing for asymmetries in lobbying costs, we could vary the level of political influence between national and supra-national levels (the 'democratic deficit' problem), between different nation states (the 'North-South divide') and between environmentalists and industrialists ('producer bias'). We analysed what effect these biases might have, and showed they were not always straightforward (e.g. environmentalists might be better off with a democratic deficit, the South could be better off with less influence). More importantly we showed that no matter what asymmetries in political influence there might be, all parties were always better off when policy was set at the supra-national level.

However, in chapter 3 the only rationale for wanting to coordinate environmental policy at the supra-national level was to overcome strategic trade considerations. In this chapter we extend that model to also allow for transboundary pollution. We show that transboundary pollution increases the extent of political lobbying and magnifies the effects of the various asymmetries in lobbying costs. However, it only changes a couple of our previous results: at high levels of transboundary pollution

environmental groups are made worse off by a democratic deficit, and net welfare falls if there is producer bias. Our main result – that supra-national coordination of environmental policy is desirable despite asymmetries in political influence – is strengthened by the introduction of transboundary pollution.

4.2 The Model.

4.2.1 The Economic Setting.

We consider a partial equilibrium model of an industry with two identical firms each located in a different state, denoted $i = 1, 2$. These two states form a federation. The two firms produce a good, which is sold outside the two states. Firm i has total revenue and cost functions: $R(x_i, x_j)$, $C(x_i)$ respectively, with standard properties. The production of the good causes emissions of a pollutant. These emissions can be abated but only at a cost. By appropriate choice of units, emissions by firm i are: $x_i - b_i$ where b_i is its abatement level; total abatement costs are the strictly convex function $B(b_i)$. The only instrument available to control pollution by each firm is an emission limit, denoted e_i. Firm i takes as given its emission limit and the output of the other firm and chooses its own output (Cournot competition) and abatement to maximise profits, net of abatement costs: $\pi(x_i, x_j, e_i) \equiv R(x_i, x_j) - C(x_i) - B(x_i - e_i)$. Assuming that both emission limits bite, the resulting equilibrium profit function for firm i is denoted $\Pi(e_i, e_j)$.

Unabated emissions cause environmental damage in both states. Total pollution, T_i, in state i consists of domestic emissions plus some proportion $\alpha \in (0,1)$ of the other state's emissions: $T_i = e_i + \alpha e_j$. $\alpha = 0$ corresponds to the non-transboundary pollution case considered in chapter 3, while $\alpha = 1$ would correspond to a global pollutant like CO2. The value of α is common to both states and is public information. The damage

cost function in state i is denoted $\delta_i D(T_i)$ where δ_i is a parameter and D is a strictly convex function. Welfare in state i is given by

$$W(e_i, e_j, \delta_i) \equiv \Pi(e_i, e_j) - \delta_i D(T_i).$$

To capture asymmetries of information between state and federal level, we suppose that the damage cost parameter, δ_i, in each state is known only to the state government in power[1]. To keep things simple, we suppose that in state i =1, 2, δ_i can take one of only two values, δ_L and δ_H, $\delta_L < \delta_H$, with probabilities p and 1- p respectively, independent of what happens to damages in the other state. Note that this implies that, *ex ante*, both states are identical. We denote the expected value of damage costs by $\bar{\delta} \equiv p\delta_L + (1-p)\delta_H$.

4.2.2 The Political Setting.

In each country there is an environmental lobby group and an industrial lobby group; we denote the environmental lobby groups in states 1 and 2 by g = 1, 2, respectively, and the industrial lobby groups in states 1 and 2 by g = 3, 4, respectively. The two types of lobby group are distinguished by the importance they attach to environmental damage. This is represented by a parameter in the utility function γ, which can take two values. Environmentalists attach greater weight to environmental damage than in

[1] In some cases it may be inappropriate to assume that a federal government is less well informed than a state government about damage costs even if pollution is local. However even if that were true, there remains the issue of whether the information could be made verifiable in court. If not then the federal government will still need to design its environmental policy to be self-enforcing. This may change the formulation of the problem but not we believe the basic results of this chapter. We are grateful to Joe Swierbinski for this point.

the welfare function ($\gamma_g = \gamma_H > 1$, g = 1,2) whilst industrialists attach less weight than it has in the welfare function[2] ($\gamma_g = \gamma_L < 1$, g = 3,4). The utility of group g in state i is given by

$$U(e_i, e_j, \delta_i, \gamma_g) \equiv \Pi(e_i, e_j) - \gamma_g \delta_i D(T_i) .$$

Elections are held to elect the policy makers in both states and at the federal level[3] and electoral competition takes place between two parties that are representatives of the interests of the lobby groups [4]. It follows that the policy maker will be biased towards greater or less environmental protection than represented in the welfare function. So, state government i will set its policy to maximise its "utility function"

$$U(e_i, e_j, \delta_i, \gamma_i) \equiv \Pi(e_i, e_j) - \gamma_i \delta_i D(T_i) ,$$

where once again γ_i can be either high or low depending on whether the government of state i is environmentally or industrially biased. Similarly, a federal government will set policy using its utility function

$$U_F(e_1, e_2, \delta_1, \delta_2, \gamma_F) = \Pi(e_1, e_2) + \Pi(e_2, e_1) - \gamma_F(\delta_1 D(T_1) + \delta_2 D(T_2)) .$$

[2] We could think of the weight attached to environmental damages in the welfare function, 1, as the weight that might be attached by a utilitarian welfare function which added the utilities of all groups in a state, and if preferences are symmetrically distributed this would be the same as the utility of the median voter.

[3] Although we refer to there being governments at state and federal level, we have in mind that the "federal government" may refer more generally to some supra-national agency such as NACEC or a putative WEO which is unlikely to be "elected". In this more general context we interpret "elections" as some process by which special interest groups try to "capture" the agency; this process is uncertain and depends on lobbying efforts by special interest groups just as described in the electoral process.

[4] Having a government in power, which acts solely in the interests of the group that it represents, corresponds to what Roemer (1999) calls the "militant" view of how special interest governments behave.

Whether the outcome of an election produces an environmental or industrial government is a random process, but the probability of electing, say, an environmental government is influenced by the amount of lobbying done in each election by each special interest group. We assume that each group can lobby in each election, but the environmental special interest groups lobby only for an environmental government and similarly for industrial special interest groups. Groups choose their lobbying effort to maximise their expected utility net of the costs of lobbying. We shall need to distinguish between *gross* and *net* utilities of special interest groups, where net utilities are gross utilities minus the costs of lobbying. In a similar way we shall distinguish between gross and net welfares of states.

To complete our broad description of the model, we assume that prior to any of the above activity taking place there will be a *constitutional* decision about whether environmental policy should be set at the state level, in which case policy will be set by the state governments acting independently to maximise utility, so we will have a non-cooperative equilibrium and environmental dumping; or whether it is to be set at the federal level, in which case the federal government acts to maximise its utility, but there will be no environmental dumping. This constitutional decision will be based on the expected *welfare* which each state expects to derive from the subsequent political process. We assume that policy will only be set at the federal level if both states derive higher expected net welfare from this constitutional choice.[5]

[5] Note that if policy is set at the state level, then we need to track the types of governments elected in the two states. There are four configurations of state government types which we denote by $\tilde{\Gamma}_s = (\gamma_1, \gamma_2), s = 1,...,4$, where: $\tilde{\Gamma}_1 = (\gamma_H, \gamma_H); \tilde{\Gamma}_2 = (\gamma_H, \gamma_L), \tilde{\Gamma}_3 = (\gamma_L, \gamma_H); \tilde{\Gamma}_4 = (\gamma_L, \gamma_L)$ with probabilities: $\tilde{Q}_s$, s = 1, ...,4, where $\tilde{Q}_1 = q_1 q_2; \tilde{Q}_2 = q_1(1-q_2); \tilde{Q}_3 = (1-q_1)q_2; \tilde{Q}_4 = (1-q_1)(1-q_2)$. If policy is set at the federal level then we need to know the configuration of government types elected in the two states and the federal government. There are eight configurations denoted:

4.2.3 The Game.

Formally we have a six stage game: in stage 1 there is a constitutional choice whether to set policy at state or federal level; in stage 2, lobby groups decide how much lobbying effort to undertake in each election; in stage 3 elections are held; in stage 4 state governments learn their true damage costs; in stage 5 either state or federal governments set emission limits; finally in stage 6 firms set their levels of output and abatement. We now describe each stage in more detail.

(i) Stage 6: Firms Choose Outputs and Abatement.

Firm i takes as given its emission limit, e_i, and the output of the other firm, x_j, and chooses its own output, x_i, and hence abatement, $b_i = x_i - e_i$, to maximise profits, net of abatement costs: $\pi(x_i, x_j, e_i) \equiv R(x_i, x_j) - C(x_i) - B(x_i - e_i)$. The first-order condition is: $R_1 - C' - B' = 0$, i.e. marginal revenue equals marginal cost plus marginal abatement cost. Solving the pair of first-order conditions for the two firms yields the equilibrium outputs $X(e_i, e_j)$, $j = 1,2, i \neq j$, and substituting back into the profit function yields the equilibrium profit function $\Pi(e_i, e_j)$. From the equilibrium profit function we can derive the equilibrium (gross) welfare function for each state $W(e_i, e_j, \delta_i) \equiv \Pi(e_i, e_j) - \delta_i D(T_i)$. Similarly, it is possible to define the equilibrium (gross) utility functions for each interest group:

$\hat{\Gamma}_f = (\gamma_1, \gamma_2, \gamma_F), f = 1,...,8$, where $\hat{\Gamma}_1 = (\gamma_H, \gamma_H, \gamma_H), \hat{\Gamma}_2 = (\gamma_H, \gamma_H, \gamma_L)$, etc. with probabilities: $\hat{Q}_f, f = 1,...,8$ where $\hat{Q}_1 = q_1 q_2 q_F, \hat{Q}_2 = q_1 q_2 (1 - q_F)$, etc.

$U(e_i, e_j, \delta_i, \gamma_g) \equiv \Pi(e_i, e_j) - \gamma_g \delta_i D(T_i)$ and for each government; these have similar properties to the equilibrium welfare function.

(ii) Stages 4 & 5: State Governments Learn Damage Cost And Set Emission Limits

We take these stages together since at the end of stage 4 each state government knows only its own damage cost parameter δ_i and this affects how governments set their emission limits. We consider separately the cases where policy is set at the state and federal levels.

Policy Set at the State Level.

For any given configuration of government types $\tilde{\Gamma}_s$, $s = 1,\ldots,4$ the emission limits in the two states are set as the equilibrium of a Nash game in which each state government knows its own damage costs but not those of its rival. So each state has to take as given the emission limits set by the other state depending on whether it has high or low damage costs. This means there are four equilibrium emission limits to be determined: $\tilde{e}_1(\tilde{\Gamma}_s, \delta_L)$, $\tilde{e}_1(\tilde{\Gamma}_s, \delta_H)$, $\tilde{e}_2(\tilde{\Gamma}_s, \delta_L)$, $\tilde{e}_2(\tilde{\Gamma}_s, \delta_H)$, and correspondingly four first-order conditions to determine them. For example, if state 1 has low damage costs, it will take as given the low damage cost and high damage cost emission limits of state 2 and choose $\tilde{e}_1(\tilde{\Gamma}_s, \delta_L)$ to maximise expected utility:

$$pU\left\{\tilde{e}_1(\tilde{\Gamma}_s, \delta_L), \tilde{e}_2(\tilde{\Gamma}_s, \delta_L), \delta_L, \gamma_1\right\} + (1-p)U\left\{\tilde{e}_1(\tilde{\Gamma}_s, \delta_L), \tilde{e}_2(\tilde{\Gamma}_s, \delta_H), \delta_L, \gamma_1\right\}.$$

There will be three other similar first-order conditions: for state 1 with high damage costs, state 2 with low damage costs and state 2 with high damage costs.

Knowing the four equilibrium emission limits we can now calculate for configuration s expected (gross) welfare of each state i, $\widetilde{W}_{is}$, and expected (gross) utility for each group g, $\widetilde{U}_{gs}$. For example, for environmentalists in state 1, we have [6]:

$$\widetilde{U}_{1s} = p\widetilde{U}_{1s}(\delta_L) + (1-p)\widetilde{U}_{1s}(\delta_H)$$

Policy Set at the Federal Level.

For any configuration of three government types, $\hat{\Gamma}_f$, f =1,...,8, the federal government needs to provide incentives for the state governments to reveal their private information. These incentives consist of both the choice of emission limits and the use of financial transfers, M. Thus the federal government solves a standard mechanism design problem in which it asks state governments to announce their damage cost parameters, and depending on their announcements it will set each state an emission limit and a financial transfer. These are chosen to maximise the expected utility of the federal government, subject to both a set of incentive compatibility constraints, to ensure the state governments reveal their true damage costs, and a set of individual rationality constraints, that no state government with its given political weight and damage cost parameter would be worse off than in the case where

[6] Where $\widetilde{U}_{1s}(\delta_L) = pU\left(\widetilde{e}_1(\widetilde{\Gamma}_s, \delta_L), \widetilde{e}_2(\widetilde{\Gamma}_s, \delta_L), \delta_L, \gamma_H\right) + (1-p)\,U\left(\widetilde{e}_1(\widetilde{\Gamma}_s, \delta_L), \widetilde{e}_2(\widetilde{\Gamma}_s, \delta_H), \delta_L, \gamma_H\right)$ and

environmental policy was set at the state level. It is because these incentive compatibility constraints and individual rationality constraints are expressed in terms of the utilities of the state governments, and hence depend on the type of state governments elected, that the choice of emission limits depends on the types of all governments, and not just on the type of the federal government.

Formally, the federal government must choose the set of policy instruments[7]: $\hat{e}^1_{LL}, \hat{e}^1_{LH}, \hat{e}^1_{HL}, \hat{e}^1_{HH}, \hat{e}^2_{LL}, \hat{e}^2_{LH}, \hat{e}^2_{HL}, \hat{e}^2_{HH}, M^1_L, M^1_H, M^2_L, M^2_H$ to maximise:

$$
\begin{aligned}
& p^2 \left\{ U(\hat{e}^1_{LL}, \hat{e}^2_{LL}, \delta_L, \gamma_F) + M^1_L + U(\hat{e}^2_{LL}, \hat{e}^1_{LL}, \delta_L, \gamma_F) + M^2_L \right\} \\
& + p(1-p) \left\{ U(\hat{e}^1_{LH}, \hat{e}^2_{HL}, \delta_L, \gamma_F) + M^1_L + U(\hat{e}^2_{HL}, \hat{e}^1_{LH}, \delta_H, \gamma_F) + M^2_H \right\} \\
& + p(1-p) \left\{ U(\hat{e}^1_{HL}, \hat{e}^2_{LH}, \delta_H, \gamma_F) + M^1_H + U(\hat{e}^2_{LH}, \hat{e}^1_{HL}, \delta_L, \gamma_F) + M^2_L \right\} \\
& + (1-p)^2 \left\{ U(\hat{e}^1_{HH}, \hat{e}^2_{HH}, \delta_H, \gamma_F) + M^1_H + U(\hat{e}^2_{HH}, \hat{e}^1_{HH}, \delta_H, \gamma_F) + M^2_H \right\} \\
& - \{ pM^1_L + (1-p)M^1_H + pM^2_L + (1-p)M^2_H \}
\end{aligned}
$$

subject to the incentive compatibility constraints:

$$
\begin{aligned}
& pU(\hat{e}^1_{LL}, \hat{e}^2_{LL}, \delta_L, \gamma_1) + (1-p)U(\hat{e}^1_{LH}, \hat{e}^2_{HL}, \delta_L, \gamma_1) + M^1_L \geq \\
& pU(\hat{e}^1_{HL}, \hat{e}^2_{LH}, \delta_L, \gamma_1) + (1-p)U(\hat{e}^1_{HH}, \hat{e}^2_{HH}, \delta_L, \gamma_1) + M^1_H
\end{aligned}
\qquad (1a)
$$

$$
\begin{aligned}
& pU(\hat{e}^1_{HL}, \hat{e}^2_{LH}, \delta_H, \gamma_1) + (1-p)U(\hat{e}^1_{HH}, \hat{e}^2_{HH}, \delta_H, \gamma_1) + M^1_H \geq \\
& pU(\hat{e}^1_{LL}, \hat{e}^2_{LL}, \delta_H, \gamma_1) + (1-p)U(\hat{e}^1_{LH}, \hat{e}^2_{HL}, \delta_H, \gamma_1) + M^1_L
\end{aligned}
\qquad (1b)
$$

$\tilde{U}_{1s}(\delta_H) = pU\left(\tilde{e}_1(\tilde{\Gamma}_s, \delta_H), \tilde{e}_2(\tilde{\Gamma}_s, \delta_L), \delta_H, \gamma_H\right) + (1-p)U\left(\tilde{e}_1(\tilde{\Gamma}_s, \delta_H), \tilde{e}_2(\tilde{\Gamma}_s, \delta_H), \delta_H, \gamma_H\right)$.

$$pU(\hat{e}^2_{LL},\hat{e}^1_{LL},\delta_L,\gamma_2)+(1-p)U(\hat{e}^2_{LH},\hat{e}^1_{HL},\delta_L,\gamma_2)+M^2_L \geq$$
$$pU(\hat{e}^2_{HL},\hat{e}^1_{LH},\delta_L,\gamma_2)+(1-p)U(\hat{e}^2_{HH},\hat{e}^1_{HH},\delta_L,\gamma_2)+M^2_H \quad (1c)$$

$$pU(\hat{e}^2_{HL},\hat{e}^1_{LH},\delta_H,\gamma_2)+(1-p)U(\hat{e}^2_{HH},\hat{e}^1_{HH},\delta_H,\gamma_2)+M^2_H \geq$$
$$pU(\hat{e}^2_{LL},\hat{e}^1_{LL},\delta_H,\gamma_2)+(1-p)U(\hat{e}^2_{LH},\hat{e}^1_{HL},\delta_H,\gamma_2)+M^2_L \quad (1d)$$

and the individual rationality constraints:[8]

$$pU(\hat{e}^1_{LL},\hat{e}^2_{LL},\delta_L,\gamma_1)+(1-p)U(\hat{e}^1_{LH},\hat{e}^2_{HL},\delta_L,\gamma_1)+M^1_L \geq \tilde{U}_{1s}(\delta_L) \quad (2a)$$

$$pU(\hat{e}^1_{LH},\hat{e}^2_{HL},\delta_H,\gamma_1)+(1-p)U(\hat{e}^1_{HH},\hat{e}^2_{HH},\delta_H,\gamma_1)+M^1_H \geq \tilde{U}_{1s}(\delta_H) \quad (2b)$$

$$pU(\hat{e}^2_{LL},\hat{e}^1_{LL},\delta_L,\gamma_2)+(1-p)U(\hat{e}^2_{LH},\hat{e}^1_{HL},\delta_L,\gamma_2)+M^2_L \geq \tilde{U}_{2s}(\delta_L) \quad (2c)$$

$$pU(\hat{e}^2_{HL},\hat{e}^1_{LH},\delta_H,\gamma_2)+(1-p)U(\hat{e}^2_{HH},\hat{e}^1_{HH},\delta_H,\gamma_2)+M^2_H \geq \tilde{U}_{2s}(\delta_H) \quad (2d)$$

The utilities on the right-hand side of the individual rationality constraints are derived from the solution to the model when policy is set at the state level; configuration $\tilde{\Gamma}_s$ of types of state governments whose utilities are used on the RHS of equation (2) is

[7] To save notation we omit the dependence of these policy instruments on the configuration of government types $\hat{\Gamma}_f$.

[8] Our justification for imposing these constraints even though a prior constitutional stage has decided that policy should be set at the federal level is that it may represent less formal structures such as the EU. Here, even at the implementation stage, state governments may an incentive to defect from the constitutionally agreed decision.

the same as the configuration of state government types found in configuration $\hat{\Gamma}_f$ for which the mechanism design problem is being solved.

Incentive compatibility constraints (1a) and (1b) are for state 1 with low and high damage costs respectively, while (1c) and (1d) are for state 2 with low and high damage costs respectively. Similarly individual rationality constraints (2a) and (2b) are for state 1 with low and high damage costs, while (2c) and (2d) are for state 2 with low and high damage costs respectively.

So for any configuration of government types, f, we solve the mechanism design problem above. We can then calculate expected welfare for each state i =1,2, $\hat{W}_{if}$, and expected utility for each group g =1,...,4, $\hat{U}_{gf}$. The calculation of the expressions is straightforward, but we omit the details because they are cumbersome to write out.

(iii) Stage 3: Elections.

Let l_{gi} be the amount of lobbying done by group g in election i = 1, 2, F, and assume that the probability of electing an environmental government in election i is given by:

$$q_i = \frac{1 + l_{1i} + l_{2i}}{2 + L_i} \qquad \text{where } L_i = \sum_{g=1}^{g=4} l_{gi} \tag{3}$$

Note that in the absence of lobbying the probability of electing an environmental government is 0.5. It is straightforward to show that that $0 < q_i < 1$ and that:

$$\frac{\partial q_i}{\partial l_{gi}} = \frac{(1-q_i)}{(2+L_i)}; \qquad \frac{\partial^2 q_i}{\partial l_{gi}^2} = -\frac{2(1-q_i)}{(2+L_i)^2}; \qquad g = 1, 2,$$

$$\frac{\partial q_i}{\partial l_{gi}} = -\frac{q_i}{(2+L_i)}; \qquad \frac{\partial^2 q_i}{\partial l_{gi}^2} = \frac{2q_i}{(2+L_i)^2}; \qquad g = 3, 4.$$

So q_i is an increasing, concave function of lobbying efforts by environmental groups and a decreasing convex function of lobbying efforts by industrial groups.

If policy is set at the state level, then, from the earlier stages of the game there will be four possible configurations of state government types, $\tilde{\Gamma}_s$ each with probability $\tilde{Q}_s$, s= 1,...,4. For each such configuration, the previous section allows us to calculate expected (gross) welfares and utilities $\tilde{W}_{is}, \tilde{U}_{gs}$. So we can now take expectations over all possible configurations $\tilde{\Gamma}_s$ to derive the expected gross welfare and utility for each state and group as:

$$\tilde{W}_i = \sum_{s=1}^{s=4} \tilde{Q}_s \tilde{W}_{is}; \qquad \tilde{U}_g = \sum_{s=1}^{s=4} \tilde{Q}_s \tilde{U}_{gs}$$

Similarly, if policy is set at the federal level we can calculate expected (gross) welfares and utilities across all configurations $\hat{\Gamma}_f$, f= 1,..., 8 :

$$\hat{W}_i = \sum_{f=1}^{f=8} \hat{Q}_f \hat{W}_{if}; \qquad \hat{U}_g = \sum_{f=1}^{f=8} \hat{Q}_f \hat{U}_{gf}$$

(iv) Stage 2: Lobbying.

Assume that if group g expends lobbying effort l_{gi} in election i then it incurs a cost $0.5k_{gi}.(l_{gi})^2$ where k_{gi} is a parameter which, as we shall see, can be varied to allow for the three asymmetries referred to in the introduction. We now determine the levels of lobbying effort by each special interest group in each election, and hence the probabilities of different types of government being elected.

Policy Set at the State Level.

It is clear that since the type of federal government has no influence on utilities or welfare, and since lobbying is costly, each interest group g will not lobby at the federal level. Denote by $\tilde{l} = (\tilde{l}_{11}, \tilde{l}_{12}, ..., \tilde{l}_{41}, \tilde{l}_{42})$ the vector of eight lobbying efforts $\tilde{x}_{gi}$ by interest group g =1,...,4 in the election in state i = 1,2. Denote by $\tilde{Q}_s(\tilde{l})$ the probability of electing configuration $\tilde{\Gamma}_s$ of state governments, given $\tilde{l}$. Then each special interest group will take as given the lobbying efforts by all other groups and choose $\tilde{l}_{g1}$ and $\tilde{l}_{g2}$ to maximise

$$\sum_{s=1}^{s=4} \tilde{Q}_s(\tilde{l})\tilde{U}_{gs} - \sum_{i=1}^{i=2}[0.5k_{gi}(\tilde{l}_{gi}^2)].$$

There will be eight first-order conditions, where e.g. the first-order condition for $\tilde{l}_{g1}$ is:

$$\left\{\tilde{q}_2(\tilde{l})(\tilde{U}_{g1}-\tilde{U}_{g3})+(1-\tilde{q}_2(\tilde{l}))(\tilde{U}_{g2}-\tilde{U}_{g4})\right\}\frac{\partial\tilde{q}_1}{\partial\tilde{l}_{g1}}=k_{g1}\tilde{l}_{g1}. \qquad (4)$$

(4) has a standard interpretation. The RHS is the marginal cost of lobbying by group g in state i and the LHS is the marginal benefit, where the term in square brackets is the difference in expected utility to group g from having an environmental rather than industrial government in state i, and the remaining term is just the marginal effect on the probability of having an environmental government elected in state 1 from a bit more lobbying by group g. $\tilde{l}$ is the solution to the eight first-order conditions (4). Define equilibrium lobbying costs as $\tilde{K}_g(\tilde{l}) \equiv \sum_{i=1}^{i=2} 0.5k_{gi}(\tilde{l}_{gi})^2$. We can now establish the equilibrium levels of *gross* utility for each interest group and *gross* welfare for each state:

$$\tilde{U}_g^G = \sum_{s=1}^{s=4} \tilde{Q}_s(\tilde{l})\tilde{U}_{gs}, \qquad g = 1,\ldots,4,$$

$$\tilde{W}_i^G = \sum_{s=1}^{s=4} \tilde{Q}_s(\tilde{l})\tilde{W}_{is}, \qquad i = 1, 2.$$

Similarly, equilibrium levels of *net* utility for each group and *net* welfare for each state are

$$\tilde{U}_g^N = \tilde{U}_g^G - \tilde{K}_g(\tilde{l}), \qquad g = 1,\ldots,4.$$

$$\tilde{W}_i^N = \tilde{W}_i^G - \sum_g \tilde{K}_g(\tilde{l}) \qquad \text{for } i = 1, g = 1, 3; \text{ for } i = 2, g = 2, 4.$$

Policy Set at the Federal Level.

We proceed in a similar way when policy is set at the federal level. $\hat{l} = (\hat{l}_{gi})$ is the vector of lobbying efforts by groups g = 1,...,4 in elections i = 1, 2, F. $\hat{Q}_f(\hat{l})$ is the probability of electing configuration $\hat{\Gamma}_f$, f = 1,...,8 of governments types given lobbying efforts $\hat{l}$. Interest group g takes as given the lobbying efforts by all other groups and chooses $\hat{l}_{g1}, \hat{l}_{g2}$ and $\hat{l}_{gF}$ to maximise

$$\sum_{f=1}^{f=8} \hat{Q}_f(\hat{l})\hat{U}_{gf} - \sum_{i=1}^{i=F} 0.5k_{gi}(\hat{l}_{gi}^2).$$

There will be 12 first-order conditions to determine $\hat{l}$ where, for example, the first-order condition for $\hat{l}_{gF}$ is:

$$k_{gF}\,\hat{l}_{gF} = \frac{\partial \hat{q}_F(\hat{l})}{\partial \hat{l}_{gF}} \left\{ \hat{q}_1\hat{q}_2(\hat{U}_{g1} - \hat{U}_{g5}) + \hat{q}_1(1-\hat{q}_2)(\hat{U}_{g2} - \hat{U}_{g6}) + (1-\hat{q}_1)\hat{q}_2(\hat{U}_{g3} - \hat{U}_{g7}) + (1-\hat{q}_1)(1-\hat{q}_2)(\hat{U}_{g4} - \hat{U}_{g8}) \right\} \quad (5)$$

Equation (5) has exactly the same interpretation as equation (4). We solve these 12 first-order conditions simultaneously to determine the equilibrium vector of lobbying effort $\hat{l}$. Then define equilibrium lobbying costs for each group by $\hat{K}_g(\hat{l}) \equiv \sum_{i=1}^{i=F} 0.5k_{gi}(\hat{l}_{gi})^2$.

The equilibrium levels of *gross* utility for each interest group and *gross* welfare for each state are

$$\hat{U}_g^G = \sum_{f=1}^{f=8} \hat{Q}_f(\hat{l})\hat{U}_{gf}\,, \qquad g = 1,..,4,$$

$$\hat{W}_i^G = \sum_{f=1}^{f=8} \hat{Q}_f(\hat{l})\hat{W}_{if}\,, \qquad i = 1, 2,$$

and the equilibrium levels of *net* utility for each group and *net* welfare for each state are

$$\hat{U}_g^N = \hat{U}_g^G - \hat{K}_g(\hat{l}), \qquad g = 1,..,4,$$

$$\hat{W}_i^N = \hat{W}_i^G - \sum_g \hat{K}_g(\hat{l}) \qquad \text{for } i = 1, g = 1, 3; \text{ for } i = 2, g = 2, 4.$$

(v) Stage 1: Constitutional Choice.

States will only agree to yield environmental policy to a federal body if neither expects to be made worse off, that is iff $\hat{W}_i^N \geq \tilde{W}_i^N$. Furthermore this inequality is strict for at least one state meaning that at least one state expects to be made better off. Note that the *ex post* individual rationality constraints defined in (2) do not guarantee that these *ex ante* individual rationality constraints will be satisfied, because the *ex post* constraints are expressed in terms of government utility, while the *ex ante* constraints are expressed in terms of expected welfare.

Given the complexity of this six-stage game it has not been possible to determine closed form solutions to the full model; in the next section we set out a special case of the model, for which we then report numerical results.

4.3 A Special Case.

In this section we set out a special case of the model, extending the special case used in Ulph (1997) by allowing for transboundary pollution. In that model, the two firms produce a homogenous good and face a linear inverse demand function with intercept A and unit slope. There are no costs of production but there are quadratic abatement costs, $0.5b^2$ and the damage cost is a quadratic function of total pollution: $D(T_i) = 0.5(e_i + \alpha e_j)^2$. It is then straightforward to show that utility for state i is:

$$U(e_i, e_j, \delta_i, \gamma_i) = 3(2A - e_j)^2 + 18e_i(2A - e_j) - 37e_i^2 - 64\delta_i\gamma_i(e_i + \alpha e_j)^2 \quad (6)$$

We can use this formulation to calculate emission levels when policy is set at the state or federal levels. It is possible to derive explicitly the emission limits for the state case but not so for the federal case. However, what we are interested in is not emission limits for each configuration of government types but rather expected welfare and utilities over *all* configurations of government types. We now describe how we set the various parameters of our model.

4.3.1 Choice of Parameter Values.

There are five key parameters in our model, $\overline{\delta}, \lambda, \upsilon, k$ and α. We use three values of expected damage costs, $\overline{\delta} = 0.1, 0.3$ and 0.5, implying that in a completely unregulated economy, expected pollution damage costs would lie between 7.5% and 37.5% of GNP. For the measure of dispersion in damage costs, υ, and the dispersion

in political weights, λ, we use the values 0.25, 0.5 and 0.75. The final figure, say in the case of υ, implies that damage costs in the high cost country are seven times greater than in the low cost country.[9] The main qualitative results reported are not sensitive to variations in parameter values, so we report detailed results only for the mid-point case where $\bar{\delta} = 0.3$, $\upsilon = 0.5$, and $\lambda = 0.5$ and indicate which results do not carry over to other parameter values[10]. For the cost of lobbying parameter we have chosen the two values $k = 1$ and $k = 10$. By varying these we can capture the asymmetries of influence which are the focus of the chapter. The parameter reflecting transboundary pollution, α, takes values 0, 0.2, 0.4, 0.6, 0.8 and 1. The first of these corresponds to chapter 3, the last reflects the 'global warming' scenario. [11]

4.3.2 Interpreting the Results of the Numerical Experiments.

In Tables 4.1 to 4.5 we present results for a number of 'experiments' using different assumptions about lobbying costs for the central case set of parameters: $\bar{\delta} = 0.3; \upsilon = \lambda = 0.5$. For each experiment, whether policy is set at the state or federal level, we present the following results: the equilibrium lobbying efforts by the four interest groups, *l*11,...,*l*4F; the equilibrium probabilities of electing a green government in each election: q1,...,qF; the gross and net expected utilities for each group, GU1,...,GU4, NU1,...,NU4; and the gross and net welfares for each state, GW1, GW2, NW1, NW2.

---

[9] $\bar{\delta}, \lambda$ and υ can then be used to calculate $\delta_L = (1-\upsilon)\bar{\delta}$, $\delta_H = (1+\upsilon)\bar{\delta}$, $\gamma_L = (1-\lambda)$ and $\gamma_H = (1+\lambda)$.

[10] These produce welfare losses when policy is set at the federal level between 0.8% and 1.3% of GNP, which is within the range found by Katz and Rosenberg (1994) who calculated the costs of rent seeking as a percentage of GNP for a number of countries, and showed that this varied from 0.19% to 5.43%.

[11] Probability, *p*, is simply set as 0.5. *A* simply denotes the level of demand for the product and is just set equal to 10.

The effects of variations in lobbying costs on net utilities and welfare can briefly be described as follows. Changes in lobbying costs will affect lobbying effort. This in turn will affect the probabilities of different configurations of government types, and consequently, expected gross utility and welfare. Combining these various effects enables us to calculate the changes on expected net utilities and welfare.

When changes in lobbying costs affect only some groups, the changes in lobbying behaviour will have a *direct effect* on the behaviour of groups whose costs have changed, and an *indirect strategic effect* on the response of other groups. In simple terms we could say it depends on whether lobbying effort by different groups are strategic substitutes or strategic complements.

In terms of expected utilities there are going to be two types of effects. First, for a given level of output by the rival producer, an interest group is going to be better off with a government of its own type setting environmental policy, at both the state and federal level. Second, though, there are the effects of strategic competition. When policy is set at the state level, profits are always higher when the other state's government is environmental. The simple reason is that an environmental government will restrict the rival firm's output, allowing the domestic firm to expand its output. Moreover, having two environmental governments may be better than two industrial governments if the environmental governments set emission limits which take outputs closer to the level which maximises joint profits. Differences in state government types are obviously less important when policy is set at the federal level, but they do have some influence through the impact of the incentive compatibility and individual

rationality constraints. Of course having policy set at the federal level eliminates environmental dumping, which is harmful not just to the environment, but also to profits, since it leads to too much output being produced.

The major effect of introducing transboundary pollution will be that for any given level of emissions, while profits remain unchanged, *total* pollution in each state will be higher the greater is the extent of transboundary pollution. This will make all groups worse off. Since environmental groups place a greater weight on the environment their reduction in utility will be relatively greater than that of industrial groups. It is this factor, which at higher levels of transboundary pollution will reverse some of the results from the previous chapter.

4.3.3 Symmetric Cases.

Table 4.1 shows the results of our benchmark case, Experiment 1, for the symmetric case when lobbying costs are 1 for all groups in all elections. We first note the pattern of lobbying. When policy is set at the state level (Table 4.1(a)) and $\alpha = 0$, environmental groups lobby both states, but more intensively abroad. Industrial groups concentrate their lobbying effort at home. The reason, as noted in chapter 3, is the effect of strategic competition: all parties are better off when the rival state has a green government, but, given our assumptions about lobbying behaviour, only environmental groups can increase the chance of the rival state being environmental. When $\alpha > 0$, there is an additional reason for groups to want the rival government to be green: to reduce emissions which result in transboundary pollution, but again only environmental groups can increase the chances of rival governments being green. As

α rises, environmental groups increasingly lobby in the rival state, and reduce their lobbying at home, eventually to zero. Industrialists respond by increasing their lobbying at home. The reduction in lobbying by environmentalists in their own state causes the probability of electing an environmental government to fall.

When policy is set at the federal level (Table 4.1(b)) the basic pattern of lobbying remains the same regardless of the value of α, which reflects the fact that the federal government deals with the transboundary pollution. Environmentalists lobby in the rival state, industrialists lobby at home and all groups lobby at the federal level. Both groups expend most of their effort lobbying at the state level but environmentalists lobby relatively more at the federal level. This is reflected in the relative probabilities. The probability of electing an environmental government at the state level is lower than at the federal level. As α increases, lobbying effort increases in all elections, except that at high values of α (> 0.6) lobbying at the federal level falls, first for industrialists, then for environmentalists. However, unlike the state case, the higher the value of α the greater the probability of electing an environmental government at both levels, but significantly so at the federal level.

In Experiment 2 we assess the effect of increasing lobbying costs symmetrically to 10 for all groups in all elections. When policy is set at the state level (comparing Table 4.2(a) and Table 4.1(a)), the major change is that all groups reduce their lobbying, more so for environmental groups. Since environmentalists were previously lobbying more, the increase in k implies a greater increase in their marginal lobbying cost. This results in a lower probability of electing an environmental government. When $\alpha = 0$ expected gross utilities of all groups fall. The greater possibility of having two

industrial governments increases the chances of higher than optimal output, and hence lower profits. There is also a loss from higher pollution. Despite the increase in lobbying costs, the total cost of lobbying is lower for both groups since they expend much less lobbying effort. This means that in terms of net utility there is an offsetting benefit. For industrialists this is sufficient to cause net utility for industrialists to rise. When $\alpha > 0$ net utility is higher also for environmentalists. This reflects the fact that since greater lobbying takes place at higher values of α the marginal gain from reduced lobbying effort is greater also. At higher values of α this gain widens for both groups. The patterns in gross and net welfare mirror those of gross and net utility since the same factors are involved. Gross welfare in both states falls while net welfare rises. The pattern in gross welfare is also unaffected by transboundary pollution whereas the margin in net welfare widens as α increases.

When policy is set at the federal level, (comparing Table 4.2(b) with Table 4.1(b)), the increase in k causes all groups to reduce lobbying in all elections, but the probability of a green government rises (slightly) at the state level and falls at the federal level. This, together with there being no environmental dumping is reflected by lower gross utility for environmentalists and higher for industrialists. The reduction in total costs of lobbying is an additional benefit for both groups. For industrialists then their net utility always rises, while the reduction in lobbying costs is usually sufficient to also cause net utility for environmentalists to rise, except when there are high values of λ and υ. Gross welfare always falls but net welfare always rises. When $\alpha > 0$ we see the same pattern as at the state level. Gross welfares and utilities are largely unaffected and the disparities in net welfares and utilities are exacerbated.

Finally note that in both experiments, all interest groups and both states are better off when policy is set at the federal level. Not surprisingly, the gains to having policy set at the federal level increase as the level of transboundary pollution increases.

4.3.4 Asymmetries In Influence At The Federal Level.

(i) The 'Democratic Deficit' Problem.

We now try to capture the notion that decision-making is less democratic when policy is set at the federal rather than state level. The way we capture such a difference in our model is to vary the cost of lobbying at state and federal level and so vary the probabilities of electing governments (or more generally 'capturing' agencies) that pursue policies in the interest of a particular group.

Even in the international relations literature it is not clear whether a 'democratic deficit' is consistent with more or less lobbying at the federal than state level (McGrew (1998)). The view we take is that, provided there were no asymmetries between interest groups, lobbying is part of the democratic process and a 'democratic deficit' arises at the federal level if there is less scope for lobbying at the federal than state level. In essence decisions at the federal level are taken by 'technocrats' with no consideration for the views of different groups in society.[12] T It is reasonable to ask whether it is truly more democratic if policy decisions are taken under the influence of lobbying pressure. Certainly, this is a view put forward both in the debate over the

European Union and its implications for national sovereignty and also in the globalisation debate. In the latter, development and environmental NGOs consistently refer to bodies such as WTO of being undemocratic since they do not take enough account of the views of civil society (which the NGOs believe to be representative of ordinary citizens). There is some support for this view in the political competition literature where it has been shown how competition amongst lobby groups can lead to optimal policy outcomes. [13]

Thus we shall take as our base case Experiment 1, where there are low costs of lobbying ($k = 1$) for all groups in all elections, and compare this with Experiment 3 (Table 4.3) where $\forall g = 1,...,4,\ k_{gi} = 1,\ i = 1,2;\ k_{gF} = 10$, so all groups now face higher costs of lobbying at the federal level. Obviously we only compare Experiments 1 and 3 when policy is set at the federal level (i.e. we compare Table 4.3 and Table 4.1(b)).

For $\alpha = 0$, the lobbying effort of all groups in all elections is reduced, very slightly at the state level, markedly at the federal level (very similar to Table 4.2(b)). Expected gross utilities of environmentalists fall, and expected gross utilities of industrialists rise, reflecting the lower probability of having an environmental federal government. Expected gross welfare also falls, again reflecting the fact that industrial governments generally increase environmental damage without necessarily increasing profits. Finally, the reduction in lobbying effort reduces total lobbying costs for both groups. For industrialists this reinforces the increase in gross utility. For environmentalists

[12] An alternative view is that the 'democratic process' consists of elections in which lobbying plays no influence so that the probabilities reflect the underlying distribution of environmental and industrial preferences in the population. This view leads to precisely the opposite effects of those we report.
[13] See for example, Becker (1983) and Wittman (1989).

this benefit outweighs the lower probability of a green federal government. In terms of net utility then, when $\alpha = 0$, all parties are better off with a democratic deficit.

As α increases, the same qualitative effects are at work, but for higher values of α the reduction in lobbying costs for environmentalists is not sufficient to offset the reduction in the probability of electing a federal government. This is rather different from the outcome in Experiment 2 where increasing lobbying costs in all elections led to environmentalists being significantly better off. The difference here is that because the reduction in lobbying costs takes place only at the federal level, the saving from reduced lobbying effort is lower and not sufficient to compensate for the reduction in the probability of electing a federal environmental government.

The lack of access to policymaking at a supra-national level appears to be good for industrialists and good for environmentalists where transboundary pollution is low, but bad for environmentalists when transboundary pollution is high. In terms of net welfare though, both states seem to be better off, certainly not worse off. Note again that, despite the democratic deficit, all interest groups and both states are better off when policy is set at the federal level than at the state level.

(ii) Producer Bias.

We now explore the implications of the claim that industrialists exert more influence than environmentalists, particularly in the discussions about supra-national bodies like WTO. In Experiment 4 environmentalists face higher lobbying costs than industrialists but only at the federal level. Thus, we assume $\forall g\, k_{gi} = 1, i = 1,2$,

$k_{gF} = 10$, $g = 1,2$ and $k_{gF} = 1$, $g = 3,4$. and compare it with the base case (i.e. compare Table 4.4 with Table 4.1(b)).

For $\alpha = 0$, all groups reduce their lobbying in all elections: for environmentalists, very slightly in state elections but considerably in federal elections. The greater probability of having industrial governments at all levels implies laxer standards which increase profit levels but also increases environmental damage. This hurts environmentalists more than it hurts industrialists. As a result, expected gross and net utilities fall for environmentalists but rise for industrialists. Gross welfare is slightly reduced but net welfare is higher.

With $\alpha > 0$ all the above effects go through, except that the magnitude of the gains and losses to industrialists and environmentalists are greater, and at high levels of transboundary pollution the losses in net welfare for environmentalists now outweigh the gains to industrialists, so that net welfare is lower. That is, high levels of environmental damages can outweigh gains from extra profits. This may give some credence to the fears of environmentalists that, with global pollutants, if policy is set at a federal level, their lack of influence may be damaging. It is important to note again though, that all interest groups, even environmentalists, and both states are better off when policy is set at the federal level.

(iii) 'North-South Divide'.

Finally, we study the effect of introducing significant differences between states in the costs of lobbying at the federal level, which we shall take to characterise the

differences between the 'North' where lobbying is relatively cheap (perhaps reflecting longer-established interest groups, easier access to funds etc) and the 'South' where lobbying is relatively expensive. We shall take state 1 to be the North and state 2 to be the South. In Experiment 5 the higher lobbying costs for the South are incurred only in federal elections so we assume that $\forall i = 1,2\ k_{gi} = 1$ for g = 1,..,4 but $k_{gF} = 1$ for g = 3,4 and $k_{gF} = 10$ for g = 1,2; again we compare this with the base case (i.e. compare Table 4.5 to Table 4.1(b)).

We begin with the results for $\alpha = 0$. At the federal level Southern groups reduce their lobbying sharply, whilst Northern groups increase their lobbying (strategic substitutes effect dominates strategic complements). There is a small reduction in the probability of an environmental government at the federal level and this is reflected in lower expected gross utility for both environmental groups and higher gross utility for both industrial groups.[14] Indeed, in terms of net utilities these effects are dominated by the reduction in total lobbying costs. Reduced lobbying by the South results in a net utility gain for its groups whilst increased lobbying from the North results in a net utility loss. This pattern is repeated with welfare. Gross welfare is slightly lower for both nations but the North experiences a net welfare loss whilst the South, a net welfare gain. When the asymmetry between the North and the South occurs only at the federal level, since there is no great change in the balance of lobbying between groups there is no great change in the probabilities of different configurations of government types. Thus the main effect on net utilities and welfare comes from the change in lobbying costs, which benefit the South and harms the North.

[14] Lobbying and hence probabilities are virtually unaffected at the state level.

The introduction of transboundary pollution increases the size of these effects, but not the pattern, so results of this experiment are robust to this introduction. Finally, we note again that all interest groups and both states, even in the South, are better off when policy is set at the federal level.

(iv) Summary.

In this section we have considered three forms of asymmetry in lobbying costs at the federal level: a democratic deficit (less lobbying at federal than state level), producer bias (environmentalists have higher lobbying costs than producers at federal level) and North-South divide (the South faces higher lobbying costs at federal level than the North). Without transboundary pollution, the democratic deficit increased net utility for both industrialists and environmentalists, producer bias reduced net utility for environmentalists and increased it for industrialists, but with net welfare increasing, while the North-South divide increased net welfare for the South and reduced it for the North. Where these results are counter-intuitive, it is because the effects of asymmetric lobbying costs on gross utilities and welfare are small, and outweighed by benefits of reduced lobbying costs, so groups (environmentalists, the South) can benefit from having less influence. With transboundary pollution the effects of asymmetries on both gross utilities and welfare and on lobbying costs get bigger, with effects on environmentalists being particularly marked. Now, at high levels of transboundary pollution, a democratic deficit does reduce the net utility of environmentalists, and producer bias does reduce net welfare. So some of the

conclusions from chapter 3 do get reversed when we introduce transboundary pollution.[15]

[15] In chapter 3 we also considered producer bias and North-South divide where asymmetric lobbying costs between groups existed at both state and federal elections. These produced somewhat different results than with asymmetries only at the federal level but it turns out that the results carry through with transboundary pollution. To save space, we do not report the details of these.

4.4 Conclusions.

In this chapter we have analysed the question of how asymmetries in political influence between different special interest groups or between different nation states may affect the desirability of setting environmental policy at the supra-national rather than national level, especially when these asymmetries in influence occur at the supra-national level. More particularly, we have been concerned with the robustness of conclusions we reached on answers to this question in chapter 3 when we extend the rationale for having environmental policy set at the supra-national level from simply dealing with strategic trade incentives for nation states to set too lax environmental standards to also allowing for transboundary pollution. Our general finding is that introducing transboundary pollution increases the level of political lobbying, and that the various asymmetries in lobbying costs we analyse have bigger effects in terms gross and net utilities and welfares. However, in only two cases does this lead to any change in overall conclusion: with high levels of transboundary pollution then a democratic deficit at the supra-national level of decision-making can make environmentalists worse off, not better off, while producer bias at the supra-national level can reduce net welfare. However, our main finding in chapter 3 is strengthened by the introduction of transboundary pollution. That is, although transboundary pollution increases the effects of asymmetries in lobbying costs at a supra-national level, it also substantially increases the gains to having policy set at this level.

Table 4.1 (a) Low Cost Symmetric Case At State Level (Experiment 1)

Alpha	0.0	0.2	0.4	0.6	0.8	1
*l*11	1.313	1.063	0.530	0.000	0.000	0.000
*l*21	4.567	5.694	7.110	8.678	10.119	11.713
*l*31	3.436	4.303	5.217	6.197	7.257	8.436
*l*41	0.000	0.000	0.000	0.000	0.000	0.000
*l*12	4.567	5.694	7.110	8.678	10.119	11.713
*l*22	1.313	1.063	0.530	0.000	0.000	0.000
*l*32	0.000	0.000	0.000	0.000	0.000	0.000
*l*42	3.436	4.303	5.217	6.197	7.257	8.436
q1	0.608	0.594	0.582	0.574	0.574	0.574
q2	0.608	0.594	0.582	0.574	0.574	0.574
gu1	1245.572	1186.289	1122.337	1055.981	990.087	922.200
gu2	1245.572	1186.289	1122.337	1055.981	990.087	922.200
gu3	1381.891	1363.800	1342.360	1318.620	1293.572	1266.213
gu4	1381.891	1363.800	1342.360	1318.620	1293.572	1266.213
nu1	1234.280	1169.513	1096.919	1018.324	938.890	853.604
nu2	1234.280	1169.513	1096.919	1018.324	938.890	853.604
nu3	1375.989	1354.543	1328.750	1299.416	1267.240	1230.630
nu4	1375.989	1354.543	1328.750	1299.416	1267.240	1230.630
gw1	1313.732	1275.044	1232.349	1187.300	1141.830	1094.206
gw2	1313.732	1275.044	1232.349	1187.300	1141.830	1094.206
nw1	1296.538	1249.012	1193.320	1130.439	1064.301	990.028
nw2	1296.538	1249.012	1193.320	1130.439	1064.301	990.028

Table 4.1 (b) Low Cost Symmetric Case At Federal Level (Experiment 1)

Alpha	0	0.2	0.4	0.6	0.8	1
*l*11	0.000	0.000	0.000	0.000	0.000	0.000
*l*21	3.656	4.725	5.794	6.907	8.043	9.168
*l*31	4.081	5.157	6.183	7.213	8.229	9.173
*l*41	0.000	0.000	0.000	0.000	0.000	0.000
*l*12	3.656	4.725	5.794	6.907	8.043	9.175
*l*22	0.000	0.000	0.000	0.000	0.000	0.000
*l*32	0.000	0.000	0.000	0.000	0.000	0.000
*l*42	4.081	5.157	6.183	7.213	8.229	9.180
*l*1F	1.173	1.522	1.845	2.136	2.368	2.364
*l*2F	1.173	1.522	1.845	2.136	2.366	2.315
*l*3F	0.990	1.206	1.361	1.454	1.385	0.990
*l*4F	0.990	1.206	1.361	1.454	1.387	1.080
q1	0.478	0.482	0.486	0.490	0.495	0.500
q2	0.478	0.482	0.486	0.490	0.495	0.500
qF	0.529	0.542	0.557	0.574	0.603	0.649
gu1	1372.190	1344.065	1318.279	1295.193	1275.000	1252.519
gu2	1372.190	1344.064	1318.278	1295.192	1274.981	1251.721
gu3	1427.915	1410.031	1391.585	1373.155	1356.414	1343.588
gu4	1427.914	1410.030	1391.584	1373.153	1356.394	1342.798
nu1	1364.818	1331.745	1299.791	1269.060	1239.853	1207.638
nu2	1364.818	1331.744	1299.790	1269.058	1239.839	1207.013
nu3	1419.098	1396.007	1371.546	1346.083	1321.598	1301.024
nu4	1419.098	1396.005	1371.545	1346.082	1321.573	1300.082
gw1	1400.053	1377.048	1354.932	1334.174	1315.707	1298.053
gw2	1400.052	1377.047	1354.931	1334.173	1315.687	1297.259
nw1	1383.864	1350.704	1316.405	1280.969	1245.744	1210.608
nw2	1383.863	1350.703	1316.404	1280.968	1245.725	1209.836

Table 4.2 (a) High Cost Symmetric Case At State Level (Experiment 2)

Alpha	0	0.2	0.4	0.6	0.8	1
*l*11	0.353	0.292	0.149	0.000	0.000	0.000
*l*21	1.235	1.565	1.980	2.451	2.902	3.402
*l*31	0.843	1.100	1.376	1.676	2.004	2.371
*l*41	0.000	0.000	0.000	0.000	0.000	0.000
*l*12	1.235	1.565	1.980	2.451	2.902	3.402
*l*22	0.353	0.292	0.149	0.000	0.000	0.000
*l*32	0.000	0.000	0.000	0.000	0.000	0.000
*l*42	0.843	1.100	1.376	1.676	2.004	2.371
q1	0.584	0.576	0.568	0.563	0.565	0.566
q2	0.584	0.576	0.568	0.563	0.565	0.566
gu1	1241.517	1182.475	1118.795	1052.591	986.606	918.674
gu2	1241.517	1182.475	1118.795	1052.591	986.606	918.674
gu3	1379.927	1362.182	1341.003	1317.413	1292.393	1265.057
gu4	1379.927	1362.182	1341.003	1317.413	1292.393	1265.057
nu1	1233.267	1169.802	1099.073	1022.556	944.497	860.802
nu2	1233.267	1169.802	1099.073	1022.556	944.497	860.802
nu3	1376.372	1356.136	1331.541	1303.372	1272.315	1236.947
nu4	1376.372	1356.136	1331.541	1303.372	1272.315	1236.947
gw1	1310.722	1272.329	1229.899	1185.002	1139.500	1091.865
gw2	1310.722	1272.329	1229.899	1185.002	1139.500	1091.865
nw1	1298.917	1253.609	1200.714	1140.926	1077.313	1005.883
nw2	1298.917	1253.609	1200.714	1140.926	1077.313	1005.883

Table 4.2 (b) High Cost Symmetric Case At Federal Level (Experiment 2)

Alpha	0	0.2	0.4	0.6	0.8	1
*l*11	0.000	0.000	0.000	0.000	0.000	0.000
*l*21	0.896	1.216	1.542	1.884	2.236	2.588
*l*31	1.023	1.348	1.662	1.980	2.295	2.592
*l*41	0.000	0.000	0.000	0.000	0.000	0.000
*l*12	0.896	1.216	1.542	1.884	2.236	2.590
*l*22	0.000	0.000	0.000	0.000	0.000	0.000
*l*32	0.000	0.000	0.000	0.000	0.000	0.000
*l*42	1.023	1.348	1.662	1.980	2.295	2.594
*l*1F	0.259	0.359	0.456	0.545	0.619	0.628
*l*2F	0.259	0.359	0.456	0.545	0.619	0.615
*l*3F	0.209	0.269	0.313	0.341	0.323	0.219
*l*4F	0.209	0.269	0.314	0.341	0.324	0.239
q1	0.484	0.486	0.488	0.492	0.495	0.500
q2	0.484	0.486	0.488	0.492	0.495	0.500
qF	0.517	0.528	0.540	0.554	0.576	0.606
gu1	1372.020	1343.716	1317.675	1294.255	1273.453	1249.984
gu2	1372.019	1343.715	1317.674	1294.254	1273.435	1249.239
gu3	1428.062	1410.277	1391.944	1373.629	1357.009	1344.162
gu4	1428.062	1410.276	1391.943	1373.628	1356.990	1343.424
nu1	1367.671	1335.676	1304.754	1275.026	1246.542	1214.478
nu2	1367.671	1335.675	1304.753	1275.024	1246.528	1213.862
nu3	1422.613	1400.828	1377.638	1353.442	1330.142	1310.334
nu4	1422.612	1400.827	1377.637	1353.441	1330.119	1309.503
gw1	1400.041	1376.997	1354.810	1333.942	1315.231	1297.073
gw2	1400.040	1376.996	1354.809	1333.941	1315.212	1296.332
nw1	1390.243	1359.507	1327.583	1294.526	1261.453	1227.739
nw2	1390.242	1359.506	1327.582	1294.524	1261.435	1227.033

Table 4.3 The 'Democratic Deficit' (Experiment 3)

Alpha	0	0.2	0.4	0.6	0.8	1
*l*11	0.000	0.000	0.000	0.000	0.000	0.000
*l*21	3.649	4.713	5.778	6.887	8.020	9.149
*l*31	4.075	5.148	6.170	7.198	8.212	9.162
*l*41	0.000	0.000	0.000	0.000	0.000	0.000
*l*12	3.649	4.713	5.778	6.887	8.020	9.155
*l*22	0.000	0.000	0.000	0.000	0.000	0.000
*l*32	0.000	0.000	0.000	0.000	0.000	0.000
*l*42	4.075	5.148	6.170	7.198	8.212	9.167
*l*1F	0.259	0.359	0.456	0.545	0.619	0.628
*l*2F	0.259	0.359	0.456	0.545	0.619	0.615
*l*3F	0.209	0.269	0.314	0.341	0.324	0.219
*l*4F	0.209	0.269	0.314	0.341	0.324	0.239
q1	0.478	0.482	0.486	0.490	0.495	0.500
q2	0.478	0.482	0.486	0.490	0.495	0.500
qF	0.517	0.528	0.540	0.554	0.576	0.606
gu1	1372.005	1343.706	1317.671	1294.255	1273.455	1249.984
gu2	1372.005	1343.705	1317.670	1294.254	1273.436	1249.240
gu3	1428.054	1410.270	1391.940	1373.628	1357.009	1344.162
gu4	1428.053	1410.269	1391.939	1373.627	1356.990	1343.424
nu1	1365.014	1331.954	1299.940	1269.056	1239.378	1206.107
nu2	1365.013	1331.953	1299.939	1269.055	1239.363	1205.497
nu3	1419.534	1396.659	1372.411	1347.140	1322.771	1301.955
nu4	1419.533	1396.658	1372.410	1347.139	1322.748	1301.118
gw1	1400.029	1376.988	1354.806	1333.942	1315.232	1297.073
gw2	1400.029	1376.987	1354.805	1333.940	1315.213	1296.332
nw1	1384.518	1351.624	1317.546	1282.254	1246.916	1210.989
nw2	1384.517	1351.623	1317.545	1282.253	1246.898	1210.284

Table 4.4 Producer Bias (Experiment 4)

Alpha	0	0.2	0.4	0.6	0.8	1
*l*11	0.000	0.000	0.000	0.000	0.000	0.000
*l*21	3.531	4.554	5.589	6.685	7.846	9.065
*l*31	3.985	5.028	6.028	7.044	8.080	9.110
*l*41	0.000	0.000	0.000	0.000	0.000	0.000
*l*12	3.531	4.554	5.589	6.685	7.847	9.069
*l*22	0.000	0.000	0.000	0.000	0.000	0.000
*l*32	0.000	0.000	0.000	0.000	0.000	0.000
*l*42	3.985	5.028	6.028	7.044	8.081	9.114
*l*1F	0.239	0.333	0.426	0.515	0.601	0.635
*l*2F	0.239	0.333	0.426	0.515	0.601	0.622
*l*3F	0.930	1.135	1.290	1.395	1.365	1.029
*l*4F	0.930	1.135	1.290	1.395	1.367	1.123
q1	0.476	0.480	0.484	0.489	0.493	0.499
q2	0.476	0.480	0.484	0.489	0.493	0.499
qF	0.341	0.338	0.341	0.349	0.371	0.417
gu1	1369.221	1338.982	1310.677	1284.814	1261.838	1238.853
gu2	1369.220	1338.981	1310.677	1284.813	1261.826	1238.342
gu3	1430.140	1413.424	1396.032	1378.394	1361.482	1346.684
gu4	1430.139	1413.423	1396.031	1378.393	1361.470	1346.177
nu1	1362.702	1328.058	1294.150	1261.141	1229.247	1195.713
nu2	1362.701	1328.057	1294.149	1261.139	1229.239	1195.322
nu3	1421.767	1400.138	1377.030	1352.613	1327.904	1304.655
nu4	1421.767	1400.137	1377.029	1352.611	1327.888	1304.011
gw1	1399.680	1376.203	1353.355	1331.604	1311.660	1292.768
gw2	1399.680	1376.202	1353.354	1331.603	1311.648	1292.260
nw1	1384.789	1351.994	1317.825	1282.149	1245.491	1207.600
nw2	1384.788	1351.993	1317.824	1282.147	1245.478	1207.073

Table 4.5 'North – South' Divide (Experiment 5)

Alpha	0	0.2	0.4	0.6	0.8	1
*l*11	0.000	0.000	0.000	0.000	0.000	0.000
*l*21	3.655	4.723	5.791	6.903	8.039	9.167
*l*31	4.080	5.155	6.180	7.210	8.226	9.172
*l*41	0.000	0.000	0.000	0.000	0.000	0.000
*l*12	3.655	4.723	5.791	6.903	8.039	9.173
*l*22	0.000	0.000	0.000	0.000	0.000	0.000
*l*32	0.000	0.000	0.000	0.000	0.000	0.000
*l*42	4.080	5.155	6.180	7.210	8.226	9.179
*l*1F	1.489	1.955	2.389	2.781	3.095	3.080
*l*2F	0.149	0.195	0.239	0.278	0.309	0.302
*l*3F	1.245	1.534	1.741	1.866	1.776	1.268
*l*4F	0.125	0.153	0.174	0.187	0.178	0.138
q1	0.478	0.482	0.486	0.490	0.495	0.500
q2	0.478	0.482	0.486	0.490	0.495	0.500
qF	0.527	0.540	0.554	0.571	0.599	0.645
gu1	1372.156	1344.001	1318.172	1295.031	1274.738	1252.301
gu2	1372.155	1344.000	1318.171	1295.029	1274.718	1251.508
gu3	1427.941	1410.074	1391.647	1373.237	1356.515	1343.637
gu4	1427.940	1410.073	1391.646	1373.235	1356.495	1342.851
nu1	1364.369	1330.937	1298.550	1267.337	1237.636	1205.489
nu2	1365.365	1332.656	1301.117	1270.815	1241.929	1209.039
nu3	1418.843	1395.610	1371.033	1345.500	1321.106	1300.768
nu4	1419.541	1396.667	1372.395	1347.066	1322.502	1300.633
gw1	1400.048	1377.037	1354.910	1334.134	1315.626	1297.969
gw2	1400.048	1377.036	1354.909	1334.132	1315.607	1297.179
nw1	1383.164	1349.510	1314.673	1278.703	1243.115	1208.287
nw2	1384.859	1352.287	1318.604	1283.748	1248.824	1212.493

Chapter 5

Limiting Political Discretion and International Environmental Policy Coordination with Active Lobbying.

Abstract.

One of the concerns of the anti-globalisation movement is that trade liberalisation may lead to a race-to-the bottom between nation states in environmental standards. To counter this may require action by supra-national agencies, but this raises further concerns that such agencies may be less well informed about environmental issues in nation states than national agencies, and, more significantly, may be more prone to capture by special interest groups than national agencies. This raises two sets of constitutional choices for nation states: whether to set environmental policy at the national or supra-national level, and whether to take steps to limit political discretion by agencies at national or supra-national level. In chapter 2 we introduced a model to capture these concerns and showed that it would always be better, in terms of expected welfare, to set policy at the federal level, whether or not political discretion was limited, and that it would never pay to limit political discretion at the supra-national level unless it was also limited at the national level. In the model used in that chapter, limiting political discretion would imply harmonisation of environmental policies, even if, ex post, there were differences in environmental damage costs in different countries. However, in that chapter there was no explicit modelling of how special interest groups might capture agencies – there were simply exogenous probabilities that agencies might be captured by one group or another. In this chapter we extend the model of chapter 2 to allow for the probabilities of capture to depend on the level of lobbying effort by special interest groups. The costs of such lobbying are treated as pure waste. We show that the results of chapter 2 are broadly robust to the introduction of active lobbying. While we show that for some parameter values it would pay to limit political discretion at the supra-national level but not at the

national level, these cases are relatively rare, and moreover states are almost indifferent about whether or not to limit political discretion. So it remains the case that states would never have a strong preference for limiting political discretion at the supra-national level but not at the federal level.

5.1 Introduction.

The anti-globalisation movement has raised two concerns about the alleged impact of globalisation on the environment. The first is that liberalisation of trade and capital flows encourages a "race-to-the-bottom" in environmental standards[1] as independent nation states compete to attract footloose plants, especially those of multinational companies[2]. Assuming this concern was substantiated, this would lead naturally to a call to coordinate national environmental policies to overcome wasteful policy competition, perhaps through some supra-national agency such as WTO or, a putative World Environment Organisation (WEO). But this raises the second concern. It is claimed that that, in comparison to national agencies, supra-national agencies may be less well informed about environmental issues in nation states, and, more importantly, that they are less democratically accountable and are more likely to be captured by the interests of multinational companies and the countries of the developed world.

To limit the political influence of special interest groups it is sometimes argued that it is necessary to limit the discretion of agencies by mandating them to adopt simple measures, such as international harmonisation of environmental policies. Economists usually argue against such policies on the grounds of inefficiency, for if nation states differ in terms of their endowment of environmental resources or their preferences for a clean environment, then efficiency requires that these differences be reflected in the

[1] Without the emotive language of 'race-to-the-bottom' we are concerned with a situation where nation states acting independently would set weaker environmental standards than if the acted cooperatively. This need not imply that there are no environmental standards at all. Moreover, such a situation, sometimes called 'environmental dumping' can arise even if, as we shall assume, plants are immobile for the usual rent-shifting arguments. Of course it is well known that a necessary, but by no means sufficient, condition for environmental dumping to be plausible is that markets for international trade are imperfectly competitive.

environmental standards they set, whether cooperatively or non-cooperatively. However, if, as is likely to be the case, information about such differences is not public knowledge, then it may be difficult to tell whether the claim by a nation state to be allowed to set laxer environmental standards is based on a real difference in, say, preferences for a clean environment, or the result of special interest groups pressing for weaker standards. So policies such as harmonisation, which would be inefficient if one assumes welfare-maximising governments, may be justifiable if they limit the scope for political influence by special interest groups.

The concern about a race-to-the bottom in environmental standards can be criticised as having weak theoretical and empirical support[3], but we shall suppose that it has substance and address the implications of the second concern for the setting of environmental policy. In chapter 2 we address directly the question of whether the need for international coordination of environmental policies of nation states to overcome damaging policy competition requires harmonisation of policies to limit political influence. Borrowing the language of fiscal federalism, we suppose that environmental policy can be set either by (nation) states, or by a federal government (or supra-national agency). If policy is set by states they will engage in wasteful policy competition. To capture information asymmetries, we suppose that only when a state government comes to power does it learn the true value of environmental damage costs in that state. In particular this information is not available to either voters or to the federal government. Whether policy is set at the state or federal level, this asymmetry of information will affect how policy is set. To capture the impact of

[2] In this chapter we deal only with local environmental problems. In chapter 4 we showed that introducing transboundary pollution leaves the results broadly unaffected. So we believe that the main results of this chapter would go through with transboundary pollution.

special interest groups we suppose that there are two special interest groups – environmentalists and industrialists – who (respectively) put too high or low a weight on environmental damages, and that there are elections to choose governments at both state and federal level. However the governments that are elected act not to maximise social welfare, but to further the interests of whichever one of the two interest groups got them elected.

Prior to elections taking place, and state governments learning their true damage costs, the people in the two states have to make two, independent, constitutional choices. The first is whether to have policy set at the state or federal level. The second is whether, in the language of Boyer and Laffont (1999), to have 'social pooling' or 'political discretion'. Political discretion means simply that policy will be set by the appropriate governments (state or federal depending on the first constitutional choice) acting in the interests of whichever group elected them, but recognising that state governments will know the true value of damage costs in their own state. Social pooling restricts government behaviour by requiring the appropriate governments (state or federal) to implement environmental policies which maximise social welfare but using the expected value of damage costs in each state, which is the only information about damage costs available at the time these constitutional choices are made. Since it is assumed that *ex ante* both states have the same expected damage costs, social pooling implies harmonisation. Thus, relative to social pooling, political discretion gains by allowing policies to be fine-tuned to reflect the actual damage costs prevailing in the states, but loses because governments act to benefit only part of society, not all of society. The people in the two states make the two constitutional

[3] See recent surveys by Ulph (2000) and Rauscher (2001) for further discussion of the theoretical and empirical literature.

choices based on expected social welfare (taking expectations over which types of governments will be elected and which level of damage costs states might have).

Chapter 2 proved three results: (i) it always pays to set policy at the federal rather than state level; (ii) whether policy is set at the state or federal level, social pooling will be preferred to political discretion when there is a relatively large difference between the preferences of different interest groups and a relatively small difference between the potential damage costs states might have; (iii) it is never the case that social pooling would be preferred to political discretion if policy is set at the federal level, but political discretion would be preferred at the if policy is set at the state level. What this means is that the need to set policy at the federal level to overcome policy competition could not be used to justify harmonisation of environmental policies if such policies had not already been harmonised (albeit at a laxer level) when policy was set at the state level.

Now in chapter 2 there is no active lobbying behaviour by special interest groups in the sense that in any election the probability of electing a government which favours a particular interest group is given exogenously. Chapter 3 uses much of the same analysis as chapter 2 but allows for active lobbying in the sense that special interest groups can now influence the probability of electing a government that will act in their interests by undertaking expensive lobbying costs. Moreover, by varying the costs of lobbying for different groups in different elections, we captured a range of asymmetries in the political process, for example allowing industrial groups to have more influence than environmental groups if policy is set at the federal level, allowing interest groups in one state ('the North') to have more influence on policy at the

federal level than interest groups in the other state ('the South'). Now in this set-up, expending lobbying effort only makes sense if there is political discretion (for with social pooling governments are mandated to implement the same policy no matter which type of government is elected). Therefore in chapter 3 we assumed there would be political discretion and considered only one constitutional choice: whether policy should be set at state or federal level. We showed that no matter what the costs of lobbying might be and what the pattern of asymmetries might be, it was always better to have policy set at the federal level. So, at least within the context of the model we employed, the benefits of eliminating wasteful policy competition outweigh whatever flaws one might think the democratic process has at the both state and federal levels.

In this chapter we extend the analysis of chapter 2, in particular the constitutional choice between social pooling and political discretion, to allow for the active lobbying behaviour modelled in chapter 3. We show that the results of chapter 2 are broadly robust to the introduction of active lobbying. By this we mean that while there are now parameter values for which it would pay states to choose social pooling if policy was set at the federal level, but to choose political discretion of policy was set at the state level, these cases are relatively rare (less than 1% of all parameter values we searched) and in these cases states are almost indifferent between social pooling and political discretion. Thus it remains the case that there are no parameter values we have found for which states would have a significant preference for social pooling at the federal level and a significant preference for political discretion at the state level.

5.2 The Model.

5.2.1 The Economic Setting.

We consider a partial equilibrium model of an industry with two identical firms each located in a different state, denoted $i = 1, 2$. These two states form a federation. The two firms produce a good, which is sold outside the two states. Firm i has total revenue and cost functions: $R(x_i, x_j)$, $C(x_i)$ respectively, with standard properties. The production of the good causes emissions of a pollutant. These emissions can be abated but only at a cost. By appropriate choice of units, emissions by firm i are: $x_i - b_i$ where b_i is its abatement level; total abatement costs are the strictly convex function $B(b_i)$. The only instrument available to control pollution by each firm is an emission limit, denoted e_i. Firm i takes as given its emission limit and the output of the other firm and chooses its own output (Cournot competition) and abatement to maximise profits, net of abatement costs: $\pi(x_i, x_j, e_i) \equiv R(x_i, x_j) - C(x_i) - B(x_i - e_i)$. Assuming that both emission limits bite, the resulting equilibrium profit function for firm i is denoted $\Pi(e_i, e_j)$.

Pollution damage in each state is caused only by emissions in the state (local pollution). The damage cost function in state i is denoted $\delta_i D(e_i)$ where δ_i is a parameter and D is a strictly convex function. Welfare in state i is given by

$$W(e_i, e_j, \delta_i) \equiv \Pi(e_i, e_j) - \delta_i D(e_i).$$

To capture asymmetries of information between state and federal level, we suppose that the damage cost parameter, δ_i, in each state becomes known only to the state government once it is in power[4]. To keep things simple, we suppose that in state i =1, 2, δ_i can take one of only two values, δ_L and δ_H, $\delta_L < \delta_H$, with probabilities p and 1- p respectively, independent of what happens to damages in the other state. Note that this implies that, *ex ante*, both states are identical. We denote the expected value of damage costs by $\bar{\delta} \equiv p\delta_L + (1-p)\delta_H$.

5.2.2 The Political Setting.

In each country there is an environmental lobby group and an industrial lobby group; we denote the environmental lobby groups in states 1 and 2 by g = 1, 2, respectively, and the industrial lobby groups in states 1 and 2 by g = 3, 4, respectively. The two types of lobby group are distinguished by the importance they attach to environmental damage. This is represented by a parameter in the utility function γ, which can take two values. Environmentalists attach greater weight to environmental damage than in the welfare function ($\gamma_g = \gamma_H > 1$, g = 1,2) whilst industrialists attach less weight than it has in the welfare function[5] ($\gamma_g = \gamma_L < 1$, g = 3,4). The utility of group g in state i is given by

[4] In some cases it may be inappropriate to assume that a federal government is less well informed than a state government about damage costs even if pollution is local. However even if that were true, there remains the issue of whether the information could be made verifiable in court. If not then the federal government will still need to design its environmental policy to be self-enforcing. This may change the formulation of the problem but not we believe the basic results of this chapter. We are grateful to Joe Swierbinski for this point.

[5] We could think of the weight attached to environmental damages in the welfare function, 1, as the weight that might be attached by a utilitarian welfare function which added the utilities of all groups in a state, and if preferences are symmetrically distributed this would be the same as the utility of the median voter.

$$U(e_i, e_j, \delta_i, \gamma_g) \equiv \Pi(e_i, e_j) - \gamma_g \delta_i D(e_i).$$

Elections are held to elect the policy makers in both states and at the federal level[6] and electoral competition takes place between two parties that are representatives of the interests of the lobby groups [7]. It follows that the policy maker will be biased towards greater or less environmental protection than represented in the welfare function. So, state government i will set its policy to maximise its "utility function"

$$U(e_i, e_j, \delta_i, \gamma_i) \equiv \Pi(e_i, e_j) - \gamma_i \delta_i D(e_i),$$

where once again γ_i can be either high or low depending on whether the government of state i is environmentally or industrially biased. Similarly, a federal government will set policy using its utility function

$$U_F(e_1, e_2, \delta_1, \delta_2, \gamma_F) = \Pi(e_1, e_2) + \Pi(e_2, e_1) - \gamma_F(\delta_1 D(e_1) + \delta_2 D(e_2)).$$

Whether the outcome of an election produces an environmental or industrial government is a random process. The probability of electing an environmental government is denoted by q_1, q_2, q_F for elections in state 1, state 2 and the federal level respectively. Each of these probabilities is influenced by the amount of lobbying

[6] Although we refer to there being governments at state and federal level, we have in mind that the "federal government" may refer more generally to some supra-national agency such as NACEC or a putative WEO which is unlikely to be "elected". In this more general context we interpret "elections" as some process by which special interest groups try to "capture" the agency; this process is uncertain and depends on lobbying efforts by special interest groups just as described in the electoral process.

[7] Having a government in power, which acts solely in the interests of the group that it represents, corresponds to what Roemer (1999) calls the "militant" view of how special interest governments behave.

done in each election by each special interest group[8]. We assume that each group can lobby in each election, but the environmental special interest groups lobby only for an environmental government and similarly for industrial special interest groups. Groups choose their lobbying effort to maximise their expected utility net of the costs of lobbying. We shall need to distinguish between *gross* and *net* utilities of special interest groups, where net utilities are gross utilities minus the costs of lobbying. In a similar way we shall distinguish between gross and net welfares of states.

To complete our broad description of the model, we assume that prior to any of the above activity taking place there will be two *constitutional* choices. The first is whether environmental policy should be set at the state level, in which case policy will be set by the state governments acting independently to maximise utility, so we will have a non-cooperative equilibrium and environmental dumping; or whether it is to be set at the federal level, in which case the federal government acts to maximise its utility, but there will be no environmental dumping. The second, independent, constitutional choice is between political discretion and social pooling. Under political discretion, state or federal governments will set policies to maximise utility, but the state governments will know their true damage costs. Under social pooling state or federal governments are mandated to implement policies which would maximise social welfare, based on the expected value of damage costs, $\overline{\delta}$. Since, as noted, both states have the same expected damage costs, social pooling will result in the same

[8] Note that if policy is set at the state level, then we need to track the types of governments elected in the two states. There are four configurations of state government types which we denote by $\Gamma_s = (\gamma_1, \gamma_2), s = 1,...,4$, where: $\Gamma_1 = (\gamma_H, \gamma_H); \Gamma_2 = (\gamma_H, \gamma_L), \Gamma_3 = (\gamma_L, \gamma_H); \Gamma_4 = (\gamma_L, \gamma_L)$ with respective probabilities: Q_s, $s = 1, ...,4$, where $Q_1 = q_1 q_2; Q_2 = q_1(1-q_2); Q_3 = (1-q_1)q_2;$ $Q_4 = (1-q_1)(1-q_2)$. If policy is set at the federal level then we need to know the configuration of government types elected in the two states and the federal government. There are eight configurations

policies being set in each state (harmonisation). These two constitutional choices will be based on the expected *net welfare* which each state expects to derive from the subsequent political process.

5.2.3 The Game.

Formally we have a six stage game: in stage 1 there is a constitutional choice whether to set policy at state or federal level; and whether to have social pooling or political discretion. In stage 2, lobby groups decide how much lobbying effort to undertake in each election; in stage 3 elections are held; in stage 4 state governments learn their true damage costs; in stage 5 either state or federal governments set emission limits; finally in stage 6 firms set their levels of output and abatement. We now describe each stage in more detail.

(i) Stage 6: Firms Choose Outputs and Abatement.

Firm i takes as given its emission limit, e_i, and the output of the other firm, x_j, and chooses its own output, x_i, and hence abatement, $b_i = x_i - e_i$, to maximise profits, net of abatement costs: $\pi(x_i, x_j, e_i) \equiv R(x_i, x_j) - C(x_i) - B(x_i - e_i)$. The first-order condition is: $R_1 - C' - B' = 0$, i.e. marginal revenue equals marginal cost plus marginal abatement cost. Solving the pair of first-order conditions for the two firms yields the equilibrium outputs $X(e_i, e_j)$, $j = 1,2, i \neq j$, and substituting back into the profit function yields the equilibrium profit function $\Pi(e_i, e_j)$. From the equilibrium

---

denoted: $\Gamma_f = (\gamma_1, \gamma_2, \gamma_3), f = 1,\ldots 8$, where $\Gamma_1 = (\gamma_H, \gamma_H, \gamma_H), \Gamma_2 = (\gamma_H, \gamma_H, \gamma_L)$, etc. with probabilities:

profit function we can derive the equilibrium (gross) welfare function for each state $W(e_i, e_j, \delta_i) \equiv \Pi(e_i, e_j) - \delta_i D(e_i)$. Similarly, it is possible to define the equilibrium (gross) utility functions for each interest group: $U(e_i, e_j, \delta_i, \gamma_g) \equiv \Pi(e_i, e_j) - \gamma_g \delta_i D(e_i)$ and for each government; these have similar properties to the equilibrium welfare function.

(ii) Stages 4 & 5: State Governments Learn Damage Cost And Set Emission Limits.

We take these stages together since at the end of stage 4 each state government knows only its own damage cost parameter δ_i and this affects how governments set their emission limits. We consider separately the four cases depending on the constitutional choices at stage 1: whether policy is set at the state or federal level; and whether there is political discretion or social pooling.

Policy Set at the State Level - Political Discretion.

For any given configuration of government types Γ_s, $s = 1,\ldots,4$ the emission limits in the two states are set as the equilibrium of a Nash game in which each state government knows its own damage costs but not those of its rival. So each state has to take as given the emission limits set by the other state depending on whether it has high or low damage costs. This means there are four equilibrium emission limits to be determined: $\tilde{e}_1(\Gamma_s, \delta_L)$, $\tilde{e}_1(\Gamma_s, \delta_H)$, $\tilde{e}_2(\Gamma_s, \delta_L)$, $\tilde{e}_2(\Gamma_s, \delta_H)$, and correspondingly four

---

Q_f, $f = 1,\ldots,8$ where $Q_1 = q_1 q_2 q_F$, $Q_2 = q_1 q_2 (1 - q_F)$, etc.

first-order conditions to determine them. For example, if state 1 has low damage costs, it will take as given the low damage cost and high damage cost emission limits of state 2 and choose $\tilde{e}_1(\Gamma_s, \delta_L)$ to maximise expected utility:

$$pU\{\tilde{e}_1(\Gamma_s, \delta_L), \tilde{e}_2(\Gamma_s, \delta_L), \delta_L, \gamma_1\} + (1-p)U\{\tilde{e}_1(\Gamma_s, \delta_L), \tilde{e}_2(\Gamma_s, \delta_H), \delta_L, \gamma_1\}.$$

There will be three other similar first-order conditions: for state 1 with high damage costs, state 2 with low damage costs and state 2 with high damage costs.

Knowing the four equilibrium emission limits we can now calculate for configuration s expected (gross) welfare of each state i, $\tilde{W}_{is}$, and expected (gross) utility for each group g, $\tilde{U}_{gs}$. For example, for environmentalists in state 1, we have [9]:

$$\tilde{U}_{1s} = p\tilde{U}_{1s}(\delta_L) + (1-p)\tilde{U}_{1s}(\delta_H)$$

Policy Set at the State Level – Social Pooling.

Irrespective of the configuration of government types, Γ_s, governments in each state are mandated to maximise expected welfare based on the expected value of damage costs. Thus the government in state $i = 1, 2$ takes as given the emission limit set by the other state, $\tilde{e}_j$, and sets its own emission limit $\tilde{e}_i$ to maximise $U(\tilde{e}_i, \tilde{e}_j, \bar{\delta}, 1)$, for which the first-order condition is $W_1(\tilde{e}_i, \tilde{e}_j, \bar{\delta}) = 0$. In the resulting Nash equilibrium it

[9] Where:
$\tilde{U}_{1s}(\delta_L) = pU(\tilde{e}_1(\Gamma_s, \delta_L), \tilde{e}_2(\Gamma_s.\delta_L), \delta_L, \gamma_H) + (1-p)U(\tilde{e}_1(\Gamma_s, \delta_L), \tilde{e}_2(\Gamma_s, \delta_H), \delta_L, \gamma_H)$ and

is clear that since the two states are *ex ante* identical, the equilibrium emission limits will be equal, $\breve{e}_i = \breve{e}_j = \breve{e}$. Expected (gross) social welfare for state i in configuration s is simply $\breve{W}_{is} = \breve{W} \equiv W(\breve{e}, \breve{e}, \bar{\delta})$; similarly, for each special interest group g in configuration s expected (gross) utility is simply $\breve{U}_{gs} = \breve{U}_g \equiv U(\breve{e}, \breve{e}, \bar{\delta}, \gamma_g)$.

Policy Set at the Federal Level – Political Discretion.

For any configuration of three government types, Γ_f, f =1,...,8, the federal government needs to provide incentives for the state governments to reveal their private information. These incentives consist of both the choice of emission limits and the use of financial transfers, *M*. We also assume that there is a cost of raising public funds to pay these transfers such that to raise 1 unit of the numeraire for public funds costs $(1+\sigma)$ units. Thus the federal government solves a standard mechanism design problem in which it asks state governments to announce their damage cost parameters, and depending on their announcements it will set each state an emission limit and a financial transfer. These are chosen to maximise the expected utility of the federal government, net of the cost of raising public funds, subject to both a set of incentive compatibility constraints,. to ensure the state governments reveal their true damage costs, and a set of individual rationality constraints, that no state government with its given political weight and damage cost parameter would be worse off than in the case where environmental policy was set at the state level. It is because these incentive compatibility constraints and individual rationality constraints are expressed in terms of the utilities of the state governments, and hence depend on the type of state

$\tilde{U}_{1s}(\delta_H) = pU\left(\tilde{e}_1(\Gamma_s, \delta_H), \tilde{e}_2(\Gamma_s, \delta_L), \delta_H, \gamma_H\right) + (1-p)U\left(\tilde{e}_1(\Gamma_s, \delta_H), \tilde{e}_2(\Gamma_s, \delta_H), \delta_H, \gamma_H\right)$.

governments elected, that the choice of emission limits depends on the types of all governments, and not just on the type of the federal government.

Formally, the federal government must choose the set of policy instruments[10]: $\hat{e}^1_{LL}, \hat{e}^1_{LH}, \hat{e}^1_{HL}, \hat{e}^1_{HH}, \hat{e}^2_{LL}, \hat{e}^2_{LH}, \hat{e}^2_{HL}, \hat{e}^2_{HH}, M^1_L, M^1_H, M^2_L, M^2_H$ to maximise:

$$
\begin{aligned}
& p^2 \left\{ U(\hat{e}^1_{LL}, \hat{e}^2_{LL}, \delta_L, \gamma_F) + M^1_L + U(\hat{e}^2_{LL}, \hat{e}^1_{LL}, \delta_L, \gamma_F) + M^2_L \right\} \\
& + p(1-p) \left\{ U(\hat{e}^1_{LH}, \hat{e}^2_{HL}, \delta_L, \gamma_F) + M^1_L + U(\hat{e}^2_{HL}, \hat{e}^1_{LH}, \delta_H, \gamma_F) + M^2_H \right\} \\
& + p(1-p) \left\{ U(\hat{e}^1_{HL}, \hat{e}^2_{LH}, \delta_H, \gamma_F) + M^1_H + U(\hat{e}^2_{LH}, \hat{e}^1_{HL}, \delta_L, \gamma_F) + M^2_L \right\} \\
& + (1-p)^2 \left\{ U(\hat{e}^1_{HH}, \hat{e}^2_{HH}, \delta_H, \gamma_F) + M^1_H + U(\hat{e}^2_{HH}, \hat{e}^1_{HH}, \delta_H, \gamma_F) + M^2_H \right\} \\
& - (1+\sigma)\{ pM^1_L + (1-p)M^1_H + pM^2_L + (1-p)M^2_H \}
\end{aligned}
$$

subject to the incentive compatibility constraints:

$$
\begin{aligned}
& pU(\hat{e}^1_{LL}, \hat{e}^2_{LL}, \delta_L, \gamma_1) + (1-p)U(\hat{e}^1_{LH}, \hat{e}^2_{HL}, \delta_L, \gamma_1) + M^1_L \geq \\
& pU(\hat{e}^1_{HL}, \hat{e}^2_{LH}, \delta_L, \gamma_1) + (1-p)U(\hat{e}^1_{HH}, \hat{e}^2_{HH}, \delta_L, \gamma_1) + M^1_H
\end{aligned}
\qquad (1a)
$$

$$
\begin{aligned}
& pU(\hat{e}^1_{HL}, \hat{e}^2_{LH}, \delta_H, \gamma_1) + (1-p)U(\hat{e}^1_{HH}, \hat{e}^2_{HH}, \delta_H, \gamma_1) + M^1_H \geq \\
& pU(\hat{e}^1_{LL}, \hat{e}^2_{LL}, \delta_H, \gamma_1) + (1-p)U(\hat{e}^1_{LH}, \hat{e}^2_{HL}, \delta_H, \gamma_1) + M^1_L
\end{aligned}
\qquad (1b)
$$

$$
\begin{aligned}
& pU(\hat{e}^2_{LL}, \hat{e}^1_{LL}, \delta_L, \gamma_2) + (1-p)U(\hat{e}^2_{LH}, \hat{e}^1_{HL}, \delta_L, \gamma_2) + M^2_L \geq \\
& pU(\hat{e}^2_{HL}, \hat{e}^1_{LH}, \delta_L, \gamma_2) + (1-p)U(\hat{e}^2_{HH}, \hat{e}^1_{HH}, \delta_L, \gamma_2) + M^2_H
\end{aligned}
\qquad (1c)
$$

$$pU(\hat{e}^2_{HL},\hat{e}^1_{LH},\delta_H,\gamma_2)+(1-p)U(\hat{e}^2_{HH},\hat{e}^1_{HH},\delta_H,\gamma_2)+M^2_H \geq$$
$$pU(\hat{e}^2_{LL},\hat{e}^1_{LL},\delta_H,\gamma_2)+(1-p)U(\hat{e}^2_{LH},\hat{e}^1_{HL},\delta_H,\gamma_2)+M^2_L \quad (1d)$$

and the individual rationality constraints:[11]

$$pU(\hat{e}^1_{LL},\hat{e}^2_{LL},\delta_L,\gamma_1)+(1-p)U(\hat{e}^1_{LH},\hat{e}^2_{HL},\delta_L,\gamma_1)+M^1_L \geq \tilde{U}_{1s}(\delta_L) \quad (2a)$$

$$pU(\hat{e}^1_{LH},\hat{e}^2_{HL},\delta_H,\gamma_1)+(1-p)U(\hat{e}^1_{HH},\hat{e}^2_{HH},\delta_H,\gamma_1)+M^1_H \geq \tilde{U}_{1s}(\delta_H) \quad (2b)$$

$$pU(\hat{e}^2_{LL},\hat{e}^1_{LL},\delta_L,\gamma_2)+(1-p)U(\hat{e}^2_{LH},\hat{e}^1_{HL},\delta_L,\gamma_2)+M^2_L \geq \tilde{U}_{2s}(\delta_L) \quad (2c)$$

$$pU(\hat{e}^2_{HL},\hat{e}^1_{LH},\delta_H,\gamma_2)+(1-p)U(\hat{e}^2_{HH},\hat{e}^1_{HH},\delta_H,\gamma_2)+M^2_H \geq \tilde{U}_{2s}(\delta_H) \quad (2d)$$

The utilities on the right-hand side of the individual rationality constraints are derived from the solution to the model when policy is set at the state level as set out in section 2.3.1 above; the configuration Γ_s of types of state governments whose utilities are used on the RHS of equation (2) is the same as the configuration of state government types found in configuration Γ_f for which the mechanism design problem is being solved.

[10] To save notation we omit the dependence of these policy instruments on the configuration of government types Γ_f.

[11] Our justification for imposing these constraints even though a prior constitutional stage has decided that policy should be set at the federal level is that it may represent less formal structures such as the EU. Here, even at the implementation stage, state governments may an incentive to defect from the constitutionally agreed decision. Actually, these constraints are frequently not binding, so we do not believe our result would be sensitive to dropping them.

Incentive compatibility constraints (1a) and (1b) are for state 1 with low and high damage costs respectively, while (1c) and (1d) are for state 2 with low and high damage costs respectively. Similarly individual rationality constraints (2a) and (2b) are for state 1 with low and high damage costs, while (2c) and (2d) are for state 2 with low and high damage costs respectively.

So for any configuration of government types, f, we solve the mechanism design problem above. We can then calculate expected welfare for each state i =1,2, $\hat{W}_{if}$, and expected utility for each group g =1,...,4, $\hat{U}_{gf}$. The calculation of the expressions is straightforward, but we omit the details because they are cumbersome to write out.

Policy Set at the Federal Level – Social Pooling.

Again, irrespective of the configuration of government types, Γ_f, the federal government is mandated to maximise total expected welfare based on the expected value of damage costs. Thus the federal government chooses e^*_1, e^*_2 to maximise $W(e_1^*, e_2^*, \bar{\delta}) + W(e_2^*, e_1^*, \bar{\delta})$, for which the first-order condition is $W_1(e_1^*, e_2^*, \bar{\delta}) + W_2(e_2^*, e_1^*, \bar{\delta}) = 0$. Again it is clear that since the two states are identical *ex ante*, the solution must require $e^*_1 = e^*_2 = e^*$. Expected (gross) social welfare for each state i in each configuration f is simply $W_{if}{}^* = W^* \equiv W(e^*, e^*, \bar{\delta})$; while expected (gross) utility for interest group g in configuration f is simply $U^*_{gf} = U_g{}^* \equiv U(e^*, e^*, \bar{\delta}, \gamma_g)$.

If we compare the two constitutional choices involving social pooling, it is clear from the properties of the welfare function that $e^* < \breve{e}$, $W^* > \breve{W}$, so that if social pooling is chosen at the constitutional stage, then it always be better to have environmental policy set at the federal level. Note the important point that social pooling implies that environmental policies will be *harmonised* across the two states, no matter what the *ex post* level of damage costs turns out to be in the two states.

(iii) Stage 3: Elections.

Let l_{gi} be the amount of lobbying done by group g in election i = 1, 2, F, and assume that the probability of electing an environmental government in election i is given by:

$$q_i = \frac{1 + l_{1i} + l_{2i}}{2 + L_i} \qquad \text{where } L_i = \sum_{g=1}^{g=4} l_{gi} \qquad (3)$$

Note that in the absence of lobbying the probability of electing an environmental government is 0.5. It is straightforward to show that that $0 < q_i < 1$ and that:

$$\frac{\partial q_i}{\partial l_{gi}} = \frac{(1-q_i)}{(2+L_i)}; \qquad \frac{\partial^2 q_i}{\partial l_{gi}^2} = -\frac{2(1-q_i)}{(2+L_i)^2}; \qquad g = 1, 2,$$

$$\frac{\partial q_i}{\partial l_{gi}} = -\frac{q_i}{(2+L_i)}; \qquad \frac{\partial^2 q_i}{\partial l_{gi}^2} = \frac{2q_i}{(2+L_i)^2}; \qquad g = 3, 4.$$

So q_i is an increasing, concave function of lobbying efforts by environmental groups and a decreasing convex function of lobbying efforts by industrial groups.

Since these probabilities depend on choices of lobbying at prior stages of the game, and these choices, in general, will differ depending on which of the four constitutional choices have been made. If policy is set at the state level, we shall denote by $\tilde{Q}_s$ and $\breve{Q}_s$ the probabilities of configuration of government types Γ_s, s = 1,...,4 occurring with political discretion and social pooling respectively. The previous section allows us to calculate expected (gross) welfares and utilities $\tilde{W}_{is}, \tilde{U}_{gs}$ with political discretion, and $\breve{W}_{is}, \breve{U}_{gs}$ with social pooling. So we can now take expectations over all possible configurations Γ_s to derive the expected gross welfare and utility for each state and group with political discretion and social pooling respectively as:

$$\tilde{W}_i = \sum_{s=1}^{s=4} \tilde{Q}_s \tilde{W}_{is}; \quad \tilde{U}_g = \sum_{s=1}^{s=4} \tilde{Q}_s \tilde{U}_{gs}; \quad \breve{W}_i = \sum_{s=1}^{s=4} \breve{Q}_s \breve{W}_{is}; \quad \breve{U}_g = \sum_{s=1}^{s=4} \breve{Q}_s \breve{U}_{gs};$$

Similarly, if policy is set at the federal level, we denote the probabilities of configuration of government types, Γ_f, f = 1,...,8 occurring with political discretion and social pooling by $\hat{Q}_f$ and Q^*_f respectively. So we can calculate expected (gross) welfares and utilities across all configurations Γ_f, f = 1,..., 8 with political discretion and social pooling respectively by:

$$\hat{W}_i = \sum_{f=1}^{f=8} \hat{Q}_f \hat{W}_{if}; \quad \hat{U}_g = \sum_{f=1}^{f=8} \hat{Q}_f \hat{U}_{gf} \quad W^*_i = \sum_{f=1}^{f=8} Q^*_f W^*_{if}; \quad U^*_g = \sum_{f=1}^{f=8} Q^*_f U^*_{gf}$$

(iv) Stage 2: Lobbying.

Assume that if group g expends lobbying effort l_{gi} in election i then it incurs a cost $0.5k_{gi}.(l_{gi})^2$ where k_{gi} is a parameter which, as we shall see, can be varied to allow for the three asymmetries referred to in the introduction. We now determine the levels of lobbying effort by each special interest group in each election, and hence the probabilities of different types of government being elected for the four possible constitutional choices.

Policy Set at the State Level – Political Discretion.

It is clear that since the type of federal government has no influence on utilities or welfare, and since lobbying is costly, each interest group g will not lobby at the federal level. Denote by $\tilde{l} = (\tilde{l}_{11}, \tilde{l}_{12}, ..., \tilde{l}_{41}, \tilde{l}_{42})$ the vector of eight lobbying efforts $\tilde{l}_{gi}$ by interest group g =1,...,4 in the election in state i = 1,2. Denote by $\tilde{Q}_s(\tilde{l})$ the probability of electing configuration Γ_s of state governments, given $\tilde{l}$. Then each special interest group will take as given the lobbying efforts by all other groups and choose $\tilde{l}_{g1}$ and $\tilde{l}_{g2}$ to maximise

$$\sum_{s=1}^{s=4} \tilde{Q}_s(\tilde{l})\tilde{U}_{gs} - \sum_{i=1}^{i=2}[0.5k_{gi}(\tilde{l}_{gi}^2)].$$

There will be eight first-order conditions, where e.g. the first-order condition for $\tilde{l}_{g1}$ is:

$$\left\{\tilde{q}_2(\tilde{l})(\tilde{U}_{g1}-\tilde{U}_{g3})+(1-\tilde{q}_2(\tilde{l}))(\tilde{U}_{g2}-\tilde{U}_{g4})\right\}\frac{\partial\tilde{q}_1}{\partial\tilde{l}_{g1}}=\mu_{g1}\tilde{l}_{g1}. \qquad (4)$$

(4) has a standard interpretation. The RHS is the marginal cost of lobbying by group g in state i and the LHS is the marginal benefit, where the term in square brackets is the difference in expected utility to group g from having an environmental rather than industrial government in state i, and the remaining term is just the marginal effect on the probability of having an environmental government elected in state 1 from a bit more lobbying by group g. $\tilde{l}$ is the solution to the eight first-order conditions (4). Define equilibrium lobbying costs as $\tilde{K}_g(\tilde{l})\equiv\sum_{i=1}^{i=2}0.5k_{gi}(\tilde{l}_{gi})^2$. We can now establish the equilibrium levels of *gross* utility for each interest group and *gross* welfare for each state:

$$\tilde{U}_g^G=\sum_{s=1}^{s=4}\tilde{Q}_s(\tilde{l})\tilde{U}_{gs}, \qquad g=1,\ldots,4,$$

$$\tilde{W}_i^G=\sum_{s=1}^{s=4}\tilde{Q}_s(\tilde{l})\tilde{W}_{is}, \qquad i=1,2.$$

Similarly, equilibrium levels of *net* utility for each group and *net* welfare for each state are:

$$\tilde{U}_g^N=\tilde{U}_g^G-\tilde{K}_g(\tilde{l}), \qquad g=1,\ldots,4.$$

$$\tilde{W}_i^N=\tilde{W}_i^G-\sum_g\tilde{K}_g(\tilde{l}) \qquad \text{for } i=1,\ g=1,3;\ \text{for } i=2,\ g=2,4.$$

Policy Set at the State level – Social Pooling.

The lobbying equilibrium is trivial for social pooling. Since for each group g $\breve{U}_{gs} = \breve{U}_g \quad s = 1,...4$, i.e. expected utility is the same for all configurations of government types it makes no sense to incur any lobbying expenditure to change the probabilities of different electoral outcomes. So $\breve{l}_{gi} = 0 \quad \forall g, i$, and hence $\breve{Q}_s = 0.25$ s=1,…,4. Thus $\breve{U}_g^G = \breve{U}_g^N = \breve{U}_g \quad g = 1,...,4$; $\breve{W}_i^G = \breve{W}_i^N = \breve{W} \quad i = 1,2$.

Policy Set at the Federal Level – Political Discretion.

We proceed in a similar way when policy is set at the federal level. $\hat{l} = (\hat{l}_{gi})$ is the vector of lobbying efforts by groups g = 1,...,4 in elections i = 1, 2, F. $\hat{Q}_f(\hat{l})$ is the probability of electing configuration Γ_f, f = 1,…,8 of governments types given lobbying efforts $\hat{l}$. Interest group g takes as given the lobbying efforts by all other groups and chooses $\hat{l}_{g1}, \hat{l}_{g2}$ and $\hat{l}_{gF}$ to maximise

$$\sum_{f=1}^{f=8} \hat{Q}_f(\hat{l}) \hat{U}_{gf} - \sum_{i=1}^{i=F} 0.5 k_{gi} (\hat{l}_{gi}^2).$$

There will be 12 first-order conditions to determine $\hat{l}$ where, for example, the first-order condition for $\hat{l}_{gF}$ is:

$$k_{gF}\hat{l}_{gF} = \frac{\partial \hat{q}_{iF}(\hat{l})}{\partial \hat{l}_{gF}}\{\hat{q}_1\hat{q}_2(\hat{U}_{g1} - \hat{U}_{g5}) + \hat{q}_1(1-\hat{q}_2)(\hat{U}_{g2} - \hat{U}_{g6}) + (1-\hat{q}_1)\hat{q}_2(\hat{U}_{g3} - \hat{U}_{g7}) + (1-\hat{q}_1)(1-\hat{q}_2)(\hat{U}_{g4} - \hat{U}_{g8})\} \quad (5)$$

Equation (5) has exactly the same interpretation as equation (4). We solve these 12 first-order conditions simultaneously to determine the equilibrium vector of lobbying effort $\hat{l}$. Then define equilibrium lobbying costs for each group by $\hat{K}_g(\hat{l}) \equiv \sum_{i=1}^{i=F} 0.5k_{gi}(\hat{l}_{gi})^2$.

The equilibrium levels of *gross* utility for each interest group and *gross* welfare for each state are:

$$\hat{U}_g^G = \sum_{f=1}^{f=8} \hat{Q}_f(\hat{l})\hat{U}_{gf}, \qquad g = 1,..,4,$$

$$\hat{W}_i^G = \sum_{f=1}^{f=8} \hat{Q}_f(\hat{l})\hat{W}_{if}, \qquad i = 1, 2,$$

and the equilibrium levels of *net* utility for each group and *net* welfare for each state are

$$\hat{U}_g^N = \hat{U}_g^G - \hat{K}_g(\hat{l}), \qquad g = 1,..,4,$$

$$\hat{W}_i^N = \hat{W}_i^G - \sum_g \hat{K}_g(\hat{l}) \qquad \text{for } i = 1, g = 1, 3; \text{ for } i = 2, g = 2, 4.$$

Policy Set at the Federal Level – Social Pooling.

For the same reasons as with social pooling at the state level, it will not pay any group to incur any lobbying expenditure, so $l_{gi}^{*} = 0 \; \forall g,i$; $Q_f^{*} = 0.125$, $f = 1,\ldots,8$; $U_g^{*G} = U_g^{*N} = U^{*}$ $g = 1,\ldots,4$; $W_i^{*G} = W_i^{*N} = W^{*}$ $i = 1,2$.

(v) Stage 1: Constitutional Choice.

Which of the four possible constitutional choices – political discretion at the federal level, political discretion at the state level, social pooling at the federal level, or social pooling at the state level – will be selected depends on the net expected welfare for each state: $\hat{W}_i^N, \tilde{W}_i^N, W_i^{*N}, \bar{W}_i^N$. The choice will be the one which gives both states the highest net welfare.

5.2.4 Summary.

In this section we have set out our model which captures the key features of strategic environmental policy competition with two levels of government, informational asymmetries between the two levels, elected governments who pursue the objectives of special interest groups, lobbying by these groups to influence the outcome of the elections and constitutional choices to determine both the best level at which policy should be set and the extent to which political influence should be constrained. Given the complexity of this six-stage game it is not possible to find a closed form solution for the general model, so in the next section we set out a special case, for which we can derive some results.

5.3 A Special Case – Results Without Lobbying.

5.3.1 Special Case.

In this section we set out the special case we employed in earlier chapters. The two firms produce a homogenous good and face a linear inverse demand function with intercept A and unit slope. There are no costs of production but there are quadratic abatement costs, $0.5b^2$ and the damage cost is a quadratic function of total pollution: $D(e_i) = 0.5(e_i)^2$. It is then straightforward to show that the utility function for state i is:

$$U(e_i, e_j, \delta_i, \gamma_i) = 3(2A - e_j)^2 + 18e_i(2A - e_j) - (37 + 64\delta_i\gamma_i)e_i^2 \qquad (6)$$

We assume that $p = 0.5$ and that $\delta_H = (1+\lambda)\overline{\delta}$; $\delta_L = (1-\lambda)\overline{\delta}$ where $0 < \lambda < 1$, and λ is a measure of the dispersion of damage costs around expected value. Similarly we assume that $\gamma_H = 1+\upsilon$; $\gamma_L = 1-\upsilon$ where $0 < \upsilon < 1$ and υ is a measure of the dispersion of political weights for environmental damage costs.

5.3.2 Results Without Active Lobbying.

We summarise the results obtained in chapter 2 when there is no active lobbying, which would arise if the costs of lobbying, k_{gi}, are sufficiently high to make lobbying uneconomic.[12] In this case, there is no distinction between gross and net utilities or

[12] Also that chapter assumed that the social cost to raising public funds is sufficiently high to prevent financial transfers.

welfares, and because states are *ex ante* identical we can simplify notation and denote the welfare levels for each state under the four constitutional choices: social pooling at federal and state level, political discretion at state and federal level by $W^*(\bar{\delta}),\breve{W}(\bar{\delta}),\hat{W}(\bar{\delta},\lambda,\upsilon),\tilde{W}(\bar{\delta},\lambda,\upsilon)$ respectively; this notation shows that with social pooling expected welfare depends only on expected damage costs while with political discretion it also depends on the degrees of dispersion of damage costs and preferences of special interest groups. In chapter 2 we proved the following results[13]:

Result 1. $W^*(\bar{\delta}) \geq \breve{W}(\bar{\delta}) \quad \forall \bar{\delta}$. *With social pooling, states are at least as well off if policy is set at the federal level than if it is set at the state level.*

Result 2. $\hat{W}(\bar{\delta},\lambda,\upsilon) \geq \tilde{W}(\bar{\delta},\lambda,\upsilon) \quad \forall \bar{\delta},\lambda,\upsilon$. *With political discretion, states are at least as well off if policy is set at the federal level than if it is set at the state level.*

These results show that the benefits from eliminating policy competition between the states are greater than welfare losses due to either informational problems or activities of special interest groups.

Result 3: $$\frac{\partial \hat{W}}{\partial \lambda} > 0; \frac{\partial \hat{W}}{\partial \upsilon} < 0; \frac{\partial \tilde{W}}{\partial \lambda} > 0; \frac{\partial \tilde{W}}{\partial \upsilon} < 0;$$

$$\hat{V} \equiv -\frac{\partial \hat{W}/\partial \lambda}{\partial \hat{W}/\partial \upsilon} > \tilde{V} \equiv -\frac{\partial \tilde{W}/\partial \lambda}{\partial \tilde{W}/\partial \upsilon} > 0.$$

[13] These results were proved analytically using approximation arguments and so strictly hold for small values of λ and υ; however they were also confirmed by numerical results for a wide range of parameter values.

Whether policy is set at the state or federal level, expected welfare with political discretion increases with the dispersion in damage costs and decreases with the dispersion of preferences of special interest groups.

This result shows that the benefit from political discretion in being able to fine-tune policies to actual damage costs increases as the dispersion of damage costs increases, while the cost of political discretion from having policy influenced by special interest groups also increases as the dispersion of preferences of special interest groups increases. The slope of iso-welfare contours for political discretion in (λ,υ) space when policy is set at the federal level, $\hat{V}$, is greater than the slope of iso-welfare contours when policy is set at the state level, $\tilde{V}$.

Result 4. $\hat{W}(\bar{\delta},0,0)=W^{*}(\bar{\delta});\quad \tilde{W}(\bar{\delta},0,0)=\breve{W}(\bar{\delta})\quad \forall\bar{\delta}$.

Whether policy is set at the federal or state level, political discretion yields the same welfare as social pooling when the dispersions of damage costs and preferences of special interest groups are zero.

Result 4 is obvious. Putting together Results 3 and 4, for any value of $\bar{\delta}$ we can think of a constitutional indifference curve in (λ,υ) space between political discretion and social pooling when policy is set at the federal level, and similarly when policy is set at the state level. These indifference curves show the combinations of (λ,υ) for which political discretion and social polling yield equal welfare. Results 3 and 4 show that these indifference curves pass through the origin, are upward sloping and that the federal indifference curve lies everywhere above the state indifference curve (see Figure 5.1). For points lying above these indifference curves (i.e. when there is a

relatively large dispersion of preferences of special interest groups and relatively low dispersion of damage costs), social pooling is preferred to political discretion, while for points lying below these indifference curves, political discretion is preferred to social pooling. We can then define four possible regimes: I social pooling is preferred to political discretion at both state and federal level; II political discretion is preferred to social pooling at both state and federal level; III political discretion is preferred to social pooling at the federal level, but social pooling is preferred to political discretion at the state level; IV social pooling is preferred to political discretion at the federal level but political discretion is preferred to social pooling at the state level. Then the fact that the federal level indifference curve lies everywhere above the state indifference curve (other than at the origin) yields:

Result 5. *There are no parameter values for which Regime IV would be the outcome.*

Recalling that social pooling implies harmonisation of policies, what this result says is that the need to have policy set at the federal level rather than the state level to overcome policy competition could never lead to the harmonisation of policies if they had not already been harmonised (albeit at a laxer level) when policy had been set at the state level.

In the next section we discuss how these results are affected by assuming that lobbying costs are low enough to ensure that lobbying takes place.

5.4 The Effects Of Introducing Active Lobbying.

5.4.1 General Considerations.

Introducing active lobbying has two main effects. Firstly, unless the lobbying equilibrium produces symmetric lobbying effort between environmentalists and industrialists, the probability of electing an environmental government in any given election will no longer be 0.5, and hence the probabilities of different configurations of government types will change. This will affect both the *expected* utilities of different interest groups and *expected* state welfares. An interest group is better off if there is an increased probability of a configuration which has a government of its own type in office through simple direct preference association. This is true whether policy is set at the federal or state levels. When policy is set at the state level though, there are the additional, indirect, effects of strategic competition. In terms of profits, both domestic firms are better off if the government of the rival state is environmental. An environmental government will impose tougher emission standards and so restrict its domestic firm's output, allowing the rival firm to expand its output. Furthermore, if both states have environmental governments then the tougher standards will result in both firms reducing output but in so doing so will move output closer to the monopoly level, raising the profits of both firms. Also, of course, the reduced output means lower pollution levels so that there is a double gain and welfare is unambiguously raised. The state configuration where there are two industrial governments in power will obviously have the opposite effects. When policy is set at the federal level then the configuration of state government types will become less important although they will have some influence through the impact of the incentive compatibility and

individual rationality constraints in equations (1) and (2). The problem of environmental dumping is internalised when policy is set at the federal level and this results in both lower pollution of course but also higher profits by restricting output and reducing excessive competition.

The second effect is simply that lobbying costs are pure waste and so reduce net expected utilities and welfare.

We now note how lobbying effort and the cost of lobbying vary with the various parameters within our model. Firstly, $\partial L_i / \partial k < 0, \partial^2 L_i / \partial k^2 < 0$, that is lobbying effort is a decreasing concave function of the lobbying cost parameter. The sharp reduction in lobbying effort means that lobbying costs fall as k increases. $\partial L_i / \partial \bar{\delta} > 0$ for low values of $\bar{\delta}$ but for higher values $\partial L_i / \partial \bar{\delta} < 0$. This reflects the fact that if damage costs are either very low or very high there is not much variation in policies across different government types (in the first case even environmentalists would not want much regulation, in the second even industrialists would want tight regulation). If $\lambda = \upsilon = 0$ so that the states are identical, no lobbying is worthwhile and so Result 4 will still hold. $\partial L_i / \partial \upsilon > 0$ so, as we would expect, as the ideological positions of the two groups become more polarised more lobbying takes place. Finally, except for rather low values of $\bar{\delta}$, $\partial L_i / \partial \lambda > 0$, so greater dispersion in damage costs between the two states will induce greater levels of lobbying.

Now we are interested in how far the results derived for the case of no lobbying carry over when there is active lobbying. It is immediately obvious that since there is no

lobbying with social pooling, Result 1 carries over even if lobbying costs are low, so with social pooling it is always better to set policy at the federal level. The results we are interested in then are whether it always better to have policy set at federal level than at the state level with political discretion and active lobbying, and the comparison between social pooling and political discretion when there is active lobbying with political discretion, and in particular whether Result 5 still holds. We discuss these in reverse order.

As noted we are going to have to rely on numerical solutions to the full equilibrium with political discretion and active lobbying. We set the parameter for the level of demand, A = 10, and the social cost of raising public funds σ = 0.3. Neither is a key parameter. For expected damage costs we work with values $\bar{\delta}$ = 0.1, 0.3, ..., 0.9, which as noted in chapter 3 would imply that in a world with no environmental policy damage costs would lie between 7.5% and 67.5% of profits (GNP). Two other key parameters are λ, υ the dispersion of damage costs and political weights attached to damage costs respectively. Since we want to map out the indifference curves between social pooling and political discretion in $\lambda - \upsilon$ space, or equivalently calculate the proportions of $\lambda - \upsilon$ space that lie in each of the four Regimes I to IV, we take a fairly fine grid on these parameters, with each taking the 39 values 0.025, 0.05, ...,0.975, giving a grid of 1521 points. The final key set of parameters are the lobbying costs k_{gi}. We work mainly with values of 1 and 10. In the case of symmetric lobbying, $k_{gi} = k$, and parameter values $\bar{\delta} = 0.3$, $\lambda = \upsilon = 0.5$, these values of k produce welfare losses when policy is set at the federal level between 0.8% and 1.3% of GNP, which is well within the range found by Katz and Rosenberg (1994) who calculated the costs of rent seeking as a percentage of GNP for a number of countries, and showed that

this varied from 0.19% to 5.43%. However, in some cases we have explored a wider range of values for k.

5.4.2 Social Pooling or Political Discretion ?

In this sub-section we ask how active lobbying affects the comparison of expected net welfare between social pooling and political discretion. More specifically we are interested in what happens to the indifference curves between social pooling and political discretion in $\lambda - \upsilon$ space, or equivalently the proportions of $\lambda - \upsilon$ space that lie in each of the four Regimes I to IV. As already noted, expected net welfare with social pooling remains unaffected, so the question is how active lobbying affects expected net welfare with political discretion.

(i) Symmetric Lobbying.

We begin by considering symmetric lobbying costs $k_{gi} = k \quad \forall g,i$. To understand what happens to expected gross and net welfare, we need to begin by summarising the pattern of lobbying that arises, as reported in chapter 3. When policy is set at the state level, environmental groups lobby both states, and in fact lobby the other state more intensively, while industry groups lobby only their own state. The rationale for these patterns follows from the point made above, that, whether policy is set at state or federal level, domestic profits are always higher when the other state government is environmental. To encourage this outcome, domestic environmental groups lobby for the rival state environmental party, but domestic industrialists desist from lobbying for the rival industrial party. The second thing to note is that lobbying effort by

environmentalists exceeds that by industrialists. This reflects the fact that having environmental governments can be beneficial to industry if that results in industry output which gets closer to the monopoly level. Of course, this results in the probability of an environmental government being markedly higher than 0.5.

When policy is set at the federal level the difference in lobbying effort between the groups is not so pronounced. Environmental groups now lobby only in the rival state while industrialists still lobby only in their own state. All groups shift some of their lobbying effort to the federal level but environmental groups relatively more so. Industrialists now do more lobbying at the state level than at the federal level, while environmentalists lobby more than industrialists at the federal level. This results in increasing the probability of electing an environmental government at the federal level but reducing it at the state level. The rationale behind the pattern of lobbying is similar to before. Environmental groups realise it is the federal government which determines policies and so they concentrate their efforts at that level. Industrialists though realise that an environmental government at the federal level will impose tougher emission limits but in so doing increase the firms' market power and so are less inclined to exert extra resources at that level.

To assess the implications of introducing symmetric lobbying for the choice between social pooling and political discretion consider Table 5.1, where we use the parameter values $\bar{\delta} = 0.3$, and, for the symmetric lobbying case, $k = 1$. In the first column we show the percentage of the 1521 combinations of λ and υ which lie in each of the four Regimes I ... IV with No Lobbying, and, as we discussed earlier, there are no values which lie in Regime IV. Columns 2 and 3 present the results for symmetric

lobbying. In the third column we present the corresponding percentages for the case of active lobbying. But to understand the changes we have broken the overall change down into the two effects identified in 5.4.1. Thus in column 2 we show what happens if we ignore the costs of lobbying and consider only what happens to gross welfare due to the change in probabilities of different configurations of government types due to lobbying. To get to column 3 we then include the costs of lobbying and calculate net welfare. Finally, to help understand what is happening we show in the last two rows of columns 2 and 3 the average % change in expected welfare with political discretion when policy is set at the federal and state level respectively, averaged over all values of λ and υ.

Thus, moving from column 1 to column 2 we see that the introduction of active lobbying increases expected gross welfare because it increases the probability of electing green governments. This increase in expected gross welfare is greater when policy is set at the state level than at the federal level, partly because the increase in probability of electing a green government is greater but also because having a green government matters more when there is strategic competition between states. In terms of what happens to the indifference curves between political discretion and social pooling, both move upwards, but more so for the state than the federal level (Figure 5.2(a) shows the indifference curves for No Lobbying and Symmetric Lobbying with gross welfare). This means that Regime I (social pooling preferred at both levels) is reduced somewhat, while Regime II (political discretion preferred at both levels) increases quite markedly; this is because, without lobbying, the indifference curve at state level lay below the indifference curve at federal level, so the marked increase in the state level indifference curve has a big impact on Regime II, which lies below the

two indifference curves, and less impact of Regime I, which lies above both indifference curves. Regime III (political discretion preferred at the federal level, social pooling at the state) gets squeezed sharply, and now there is a similar proportion of Regime IV (social pooling preferred at the federal level, political discretion at the state level), again because the state indifference curve has now moved above the federal indifference curve in places.

When we introduce lobbying costs and move from column 2 to column 3 we see that lobbying costs have reduced expected welfare when policy is set at the federal level on average by 1.8 %, and by 2.25% when it is set at the state level. This reflects the fact that lobbying costs are greater when policy is set at the state level than at the federal level, as explained above. These effects on the different Regimes now go in exactly the opposite direction to those spelt out above. In net terms, welfare falls relative to no lobbying, and there is a bigger reduction in welfare when policy is set at the federal level than at the state level. The overall effect then is that Regime I increases sharply, Regime II stays about the same, Regime III is squeezed, and there still remain a small proportion of Regime IV cases, less than 1%. (Figure 5.2(b) shows the indifference curves for No Lobbying and Symmetric Lobbying with net welfare).

So we do get an overturning of Result 5 in when there is active lobbying: it is now possible to have parameter values for which social pooling is preferred when policy is set at the federal level while political discretion is preferred when policy is set at the state level, implying that harmonisation may be required when policy is moved from the state to federal level. However, these cases are relatively rare. Moreover, as Figure 2b makes clear, these cases lie on the borderline between Regime I and Regime II, so

the differences in net expected welfare between social and political discretion are very small; whether policy is set at state or federal level, both states are almost indifferent between social polling and political discretion.

We have carried out similar analyses for a wide range of parameter values: $\overline{\delta} = 0.1, 0.3, ..., 0.9, k = 0.1, 0.3, 0.5, 1, 10, 100$ and the same pattern of results obtains. The proportion of cases which lie in Regime IV with active lobbying never exceeds 1%, and for $k \geq 10$, we get no Regime IV cases.

We now consider a number of asymmetric cases. For these cases we restrict attention to just two values for k, 1 and 10, with some groups in some elections facing the lower parameter value and others the higher parameter value. The rationale for these differences in lobbying costs is set out for each of the three asymmetries we model in this chapter: democratic deficit, producer bias at federal level and producer bias at state and federal level. In chapter 3 we also modelled a further asymmetry in lobbying costs: between special interest groups in different states (North-South divide).

(ii) A 'Democratic Deficit'.

One of the concerns of the anti-globalisation movement is that power has shifted from nation states to unelected bodies such as the WTO, so there is a 'democratic deficit' at this federal level. As noted in chapter 3, it is difficult to capture this concern in our framework, partly because it is not always clear from the political science literature whether a democratic deficit implies more or less involvement in the decision making process by special interest groups. In this section we model the view that lobbying is

part of the democratic process and a 'democratic deficit' arises at the federal level if decisions are taken by 'technocrats' without much scope for influence by different groups in society. It is reasonable to ask whether it is truly more democratic if policy decisions are taken under the influence of lobbying pressure. Certainly, this is a view put forward both in the debate over the European Union and its implications for national sovereignty and also in the globalisation debate. In the latter, development and environmental NGOs consistently refer to bodies such as WTO of being undemocratic since they do not take enough account of the views of civil society (which the NGOs believe to be representative of ordinary citizens). There is some support for this view in the political competition literature where it has been shown how competition amongst lobby groups can lead to optimal policy outcomes. [14]

So we capture a democratic deficit at the federal level by assuming $\forall g = 1,...,4\ k_{gi} = 1,\ i = 1,2;\ k_{gF} = 10$. Thus, all groups face the same costs of lobbying at the state level as in the symmetric lobbying case but now face higher costs of lobbying at the federal level. The results for this case are shown in Columns 4 and 5 of Table 5.1. Obviously the results when policy are taken at the state level are the same as in the symmetric case, so it is the impact of the change in lobbying costs at the federal level that we need to consider.

Lobbying efforts of all groups in all elections are reduced, slightly at the state level, more markedly at the federal level, so the probabilities of electing environmental governments fall slightly at the state level and more sharply at the federal level, relative to the Symmetric Lobbying case, although the probabilities are still higher

[14] See for example, Becker (1983) and Wittman (1989).

than in the No Lobbying Case. Thus the increase in gross welfare when policy is taken is taken at the federal level is positive relative to No Lobbying, but somewhat lower than in the Symmetric Lobbying. This means that the upward shift in the federal level indifference curve with gross welfare is slightly less than in the Symmetric Lobbying Case, so Regime I is somewhat bigger than with Symmetric Lobbying, and the squeeze on Regime III is also somewhat greater than with Symmetric Lobbying. The welfare costs of lobbying when policy is set at the federal level are somewhat lower than with the Symmetric Lobbying case (-1.14% compared to –1.21%), so on average net welfare is higher than in the symmetric case, though lower than with No Lobbying[15], increasing Regimes I and III slightly relative to the Symmetric Case.

The results of this way of modelling a democratic deficit are very similar to those of Symmetric Lobbying – so the higher cost of lobbying at the federal level has only very small implications for the choice between social pooling and democratic deficit. Perhaps surprisingly, relative to Symmetric Lobbying, states are slightly more likely to prefer political discretion at the federal level, because the costs of lobbying at the federal level have fallen. As noted in chapter 3, if we had taken the opposite view of the democratic deficit – that it implies too much lobbying by special interest groups at the federal level – the results would simply have gone in the other direction. But in either case the democratic deficit, as we have modelled it, does not have marked implications relative to the Symmetric Lobbying case.

In Table 5.1 we have presented results for the case where $\bar{\delta} = 0.3$, but we get very similar conclusions for all the other values of expected damage costs that we have run.

[15] This is only true on average; for very high values of λ and υ welfare is higher than with no lobbying.

(iii) Producer Bias – Federal Level.

It can be argued that the real concern of the anti-globalisation movement is not that all interest groups have less influence in bodies like WTO, but that groups like environmental NGOs have much less influence there than groups like TNCs. We capture this concern by assuming that only environmental groups face higher lobbying costs at the federal level, i.e. $\forall g = 1,...,4\ k_{gi} = 1, i = 1,2;$ but that $k_{gF} = 10$ for $g = 1,2$ and $k_{gF} = 1$ for $g = 3,4$. The results for gross and net welfare are shown in Columns 6 and 7 of Table 5.1.

As with the Democratic Deficit, the results when policy is set at the state level are exactly the same as with Symmetric Lobbying, and so it is only the impact on results when decisions are taken at the federal level that we need to report. Compared with Symmetric Lobbying, the higher costs of lobbying by environmentalists means that they reduce their lobbying in all elections, slightly in state elections, more markedly in the federal election. Industrialists also reduce their lobbying slightly (strategic complements), and now the probability of electing environmental governments is less than 50%. This means that when policy is set at the federal level, gross welfare now falls relative to No Lobbying. In terms of indifference curves with gross welfare, the federal curve falls slightly, the state curve still rises significantly. So Regime I is still significantly smaller than with No Lobbying but larger than with Symmetric Lobbying, and Regime III again gets significantly squeezed and Regime IV is slightly bigger than with Symmetric Lobbying.

The reduction in lobbying by all groups means that lobbying costs are now only about 1.08% of welfare when policy is set at the federal level, so despite the fact that gross welfare has fallen, the fall in net welfare, relative to No Lobbying, turns out to be almost exactly the same as with the Democratic Deficit, so not surprisingly the size of the four regimes is almost identical to that with the Democratic Deficit.

So, we get the perhaps rather surprising conclusion that having higher lobbying costs for only environmentalists at the federal level produces outcomes very similar to having higher lobbying costs for all groups at the federal level, at least in terms of the implications for the choice between social pooling and political discretion. Again our results are robust to different values of expected damage costs.

(iv) Producer Bias at State and Federal Levels.

The three cases of active lobbying we have considered so far – Symmetric Lobbying, Democratic Deficit and Producer Bias at Federal Level – have all produced very similar results in terms of the implications for the constitutional choice between social pooling and political discretion at state and federal level. The reason is that the major changes from the No Lobbying case have been determined mainly by what has happened when policy is set at the state level, and this has been the same for all three cases of active lobbying; the differences in lobbying costs at the federal level do not have much impact. The next model of active lobbying we consider extends the notion of producer bias by now assuming that environmentalists face higher costs of lobbying than industrialists in all elections. Specifically we assume that

$\forall i, k_{gi} = 10,\ g = 1,2;\ k_{gi} = 1,\ g = 3,4$. The results for gross and net welfare are shown in columns 8 and 9 of Table 5.1.

We begin by explaining what happens when policy is set at the federal level. This is similar to what happened when producer bias was only at the federal level, except that now environmentalists face higher lobbying costs in all elections, and the individual rationality constraints will reflect the different utility levels when policy is set at the state level (as described below). The effect of the higher lobbying cost in all elections is that environmentalists now reduce their lobbying markedly in all elections and the industrialists also cut their lobbying but not by as much. So the probability of electing environmental governments falls sharply at state and federal level, and expected gross welfare falls relative to the No Lobbying case, and by a somewhat greater amount than when producer bias occurred only in federal elections. However, comparing columns 8 and 9, there is now a much smaller cost of lobbying – only 0.7% of welfare – so that despite the bigger reduction in gross welfare compared with Producer Bias only at the Federal Level, the reduction in net welfare is now much smaller.

The major difference from having producer bias in federal and state elections arises when policy is set at the state level. Again environmentalists substantially reduce their lobbying at state level, and industrialists respond by slightly cutting their lobbying effort. The probability of electing environmental governments falls sharply, to under 40% in many cases. But the increased probability of having two industrial governments in power, which leads to a lot of strategic competition, means that expected profits fall sharply and expected damage costs rise, and even industrialists are made worse off. So expected gross welfare falls sharply policy is set at the state

level. Again the reduction in lobbying means that lobbying costs are now only 1.2% of welfare, compared to 1.5% in previous cases we have studied, but combined with the large reduction in gross welfare, net welfare is now substantially lower than in the No Lobbying case.

These effects mean that in terms of both gross and net welfare, the indifference curves between social pooling and political discretion fall when policy is taken at both federal and state level, with the falls being much more pronounced when policy is set at the state level. Compared to the No Lobbying case, in terms of gross welfare, Regime I now rises, and Regime II falls sharply reflecting a stronger preference for social pooling. Regime III also expands, since the indifference curves are getting further apart (see Figure 5.3); but now since the fall in welfare is bigger at the state than federal level, there are no Regime IV cases. In terms of net welfare, the falls in the indifference curves are even bigger, so Regime I gets even bigger, Regime II even smaller; but since the relative falls in welfare are not as marked as with gross welfare, Regime III falls slightly from the No Lobbying Case; but again in terms of net welfare, there are no Regime IV cases.

Thus when we get bigger falls in welfare at the state than at the federal level, Result 5 is reinforced. Again these results are robust to different values of $\overline{\delta}$.

(v) Summary.

When we introduce active lobbying with symmetric lobbying costs, then we have shown that we do get some overturning of the results with No Lobbying, in particular

it is now possible for some parameter values to get outcomes in Regime IV where social pooling is preferred to political discretion when policy is set at the federal level, but political discretion is preferred to social pooling when policy is set at the state level. But we do not see this as a serious violation of Result 5, because these cases are relatively rare, and the differences in expected net welfare between social pooling and political discretion are tiny. Because the major effect on net welfare of introducing active lobbying occurs when policy is set at the state level, introducing asymmetries in lobbying costs when policy is set at the federal level (as we did with Democratic Deficit and Producer Bias at the Federal level) produces results almost identical to Symmetric Lobbying. However when we introduce asymmetries in lobbying costs at the state level, as with Producer Bias at State and Federal levels, we get more pronounced changes in the results relative to Symmetric Lobbying, but this leaves Result 5 unaffected – we get no Regime IV cases.

So our overall conclusion is that Result 5 – our key result on constitutional choice between social pooling and political discretion with No Lobbying – is actually very robust to the introduction of active lobbying, even if there are asymmetries in lobbying behaviour. There are no cases for which there would be a strong preference for social pooling over political discretion when policy is set at the federal level and a strong preference for political discretion over social pooling when policy is set at the state level.

5.4.3 Policy Set at Federal or State Level?

The other aspect of constitutional choice we want to explore is whether policy should be set at the state or federal level. As we've already noted, when there is social pooling, there will be no lobbying activity no matter what lobbying costs are, so Result 1 is unaffected by the possibility of lobbying – with social pooling welfare will always be higher when policy is set at the federal level. So the only question is whether Result 2 - with political discretion welfare is always higher when policy is set at the federal level - carries over from no lobbying to active lobbying. This is the question we asked in chapter 3, and, based on numerical simulations, our conclusion was that Result 2 is robust to the introduction of active lobbying, even if there are the kind of asymmetries in lobbying costs modelled in this chapter (including the North-South Divide asymmetry). In the numerical simulations we reported for the choice between social pooling and political discretion we used a much wider range of parameter values than in chapter 3, and our conclusion remains that for all the kinds of lobbying modelled in section 5.4.2 we have not found any parameter values for which, with political discretion, it would be better to set policy at the state level rather than the federal level.

5.5 Conclusions.

Once again we have tried to address concerns raised in the anti-globalisation movement that liberalisation of trade and capital markets might lead to a race-to-the-bottom in environmental standards. If this is the case, then to overcome it may require a supra-national body to oversee the setting of environmental standards. This in itself though is problematic. There are concerns that both national governments and supra-national bodies can be captured by special interest groups, particularly TNC's. Furthermore, a supra-national body may be limited in the information it has about damage costs in individual states. To overcome asymmetries of information and the potential political influence of these special interest groups it might then be necessary to adopt what look like rather inefficient policies: e.g. requiring all states to adopt environmental standards as if they faced identical damage costs (equal to the best estimate of what damage costs might be) rather than allowing individual states to fine-tune their policies to what they know about their own damage costs.

In chapter 2 we set out a model which captured the above concerns: the potential for strategic environmental competition which can be mitigated by having policy set at a supra-national ('federal') level; asymmetries of information about damage costs between agencies (governments) at nation state and supra-national levels, only agencies at the state level learn the true value of their damage costs; agencies at national and supra-national levels can be captured by special interest groups. States then have two 'constitutional choices'. The first is whether to have policy set at the national or supra-national level. Secondly, whether to allow policy to be set by these agencies (with the advantage that state agencies will know true damage costs but with

the disadvantage of capture) – what we call political discretion – or to mandate that these agents implement policies based on the only information available at the constitutional stage i.e. maximising welfare based on expected damage costs – what we called social pooling. We showed that it was always better to set policy at the supra-national rather than national levels and that it was never the case that it would be desirable to use social pooling at the supra-national level and political discretion at the state level.

In chapter 3 we introduced a model of lobbying behaviour in which the probability of capture now depended on the amount of lobbying effort expended by different interest groups. We explored the question of whether with political discretion it remained the case that it was always better to set policy at the supra-national level, and concluded that it was, even with quite marked asymmetries in lobbying costs and lobbying behaviour.

In this chapter we used the model of lobbying behaviour to test whether the conclusions of chapter 2 about social pooling and political discretion were robust. We have found that they are in the sense that while there are some parameter values for which it might be desirable to have social pooling at the supra-national level and political discretion at the nation state level, these cases are rare and have very small differences in expected welfare under social pooling and political discretion. So it remains the case that there are no parameter values for which there would be a strong preference for social pooling at the supra-national level and a strong preference for political discretion at the nation state level. We also confirmed the results of chapter 3 for a wider class of parameter values.

So the use of policies such as harmonisation cannot be rationalised on the grounds that there is now a need to set policy at a supra-national level, and that harmonisation is a way of limiting discretion by agencies that might be captured by special interest groups; if that is true at the supra-national level, it should have been true when policy was set by nation states.

Figure 5.1. No Lobbying Case.

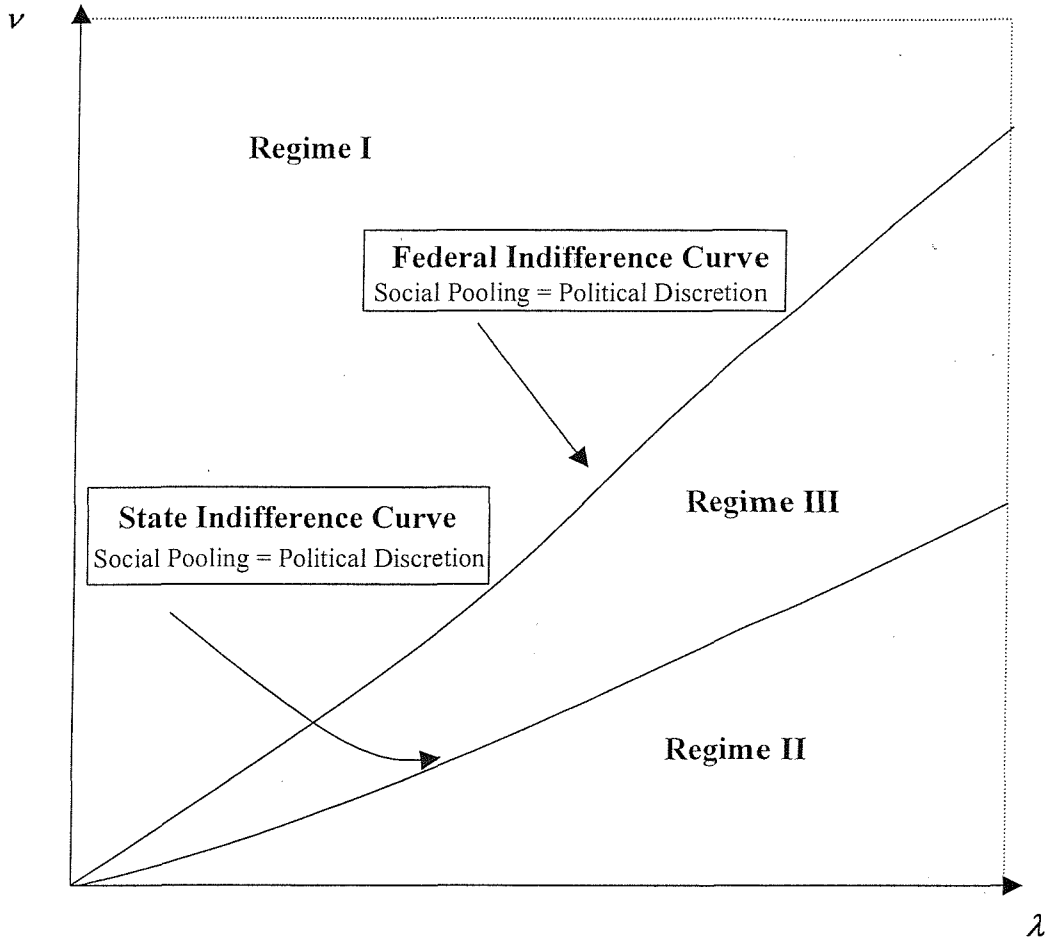


Figure 5.2a. Gross Welfare For Low Cost Symmetric Case.

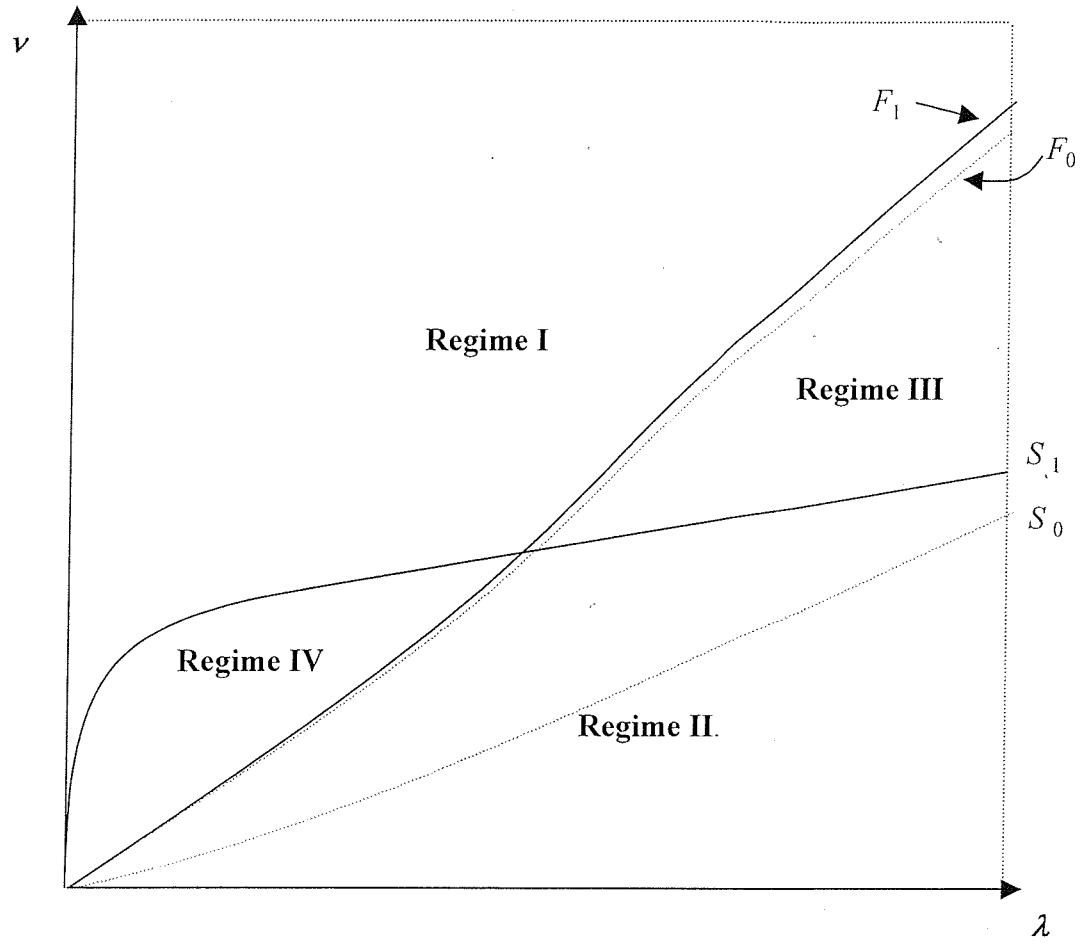


Figure 5.2b. Net Welfare For Low Cost Symmetric Case.

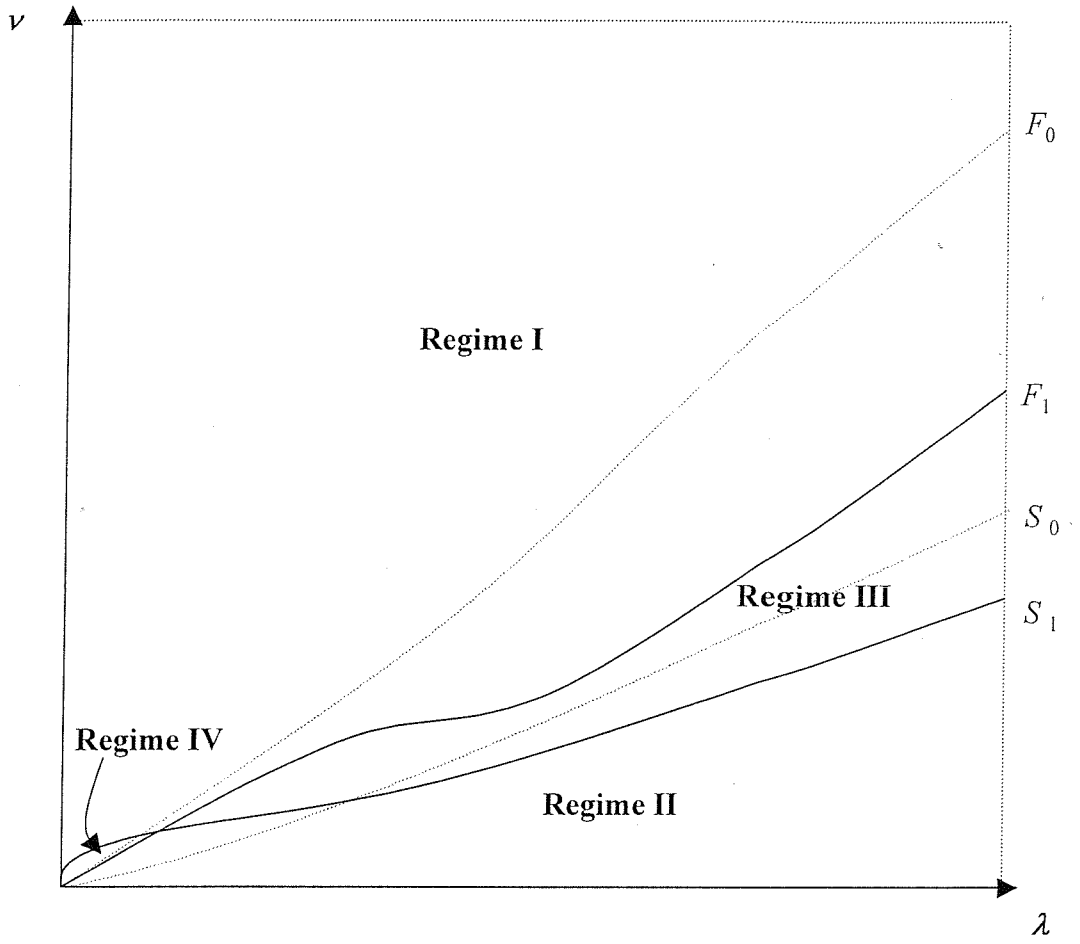


Figure 5.3. Producer Bias At State And Federal Levels.

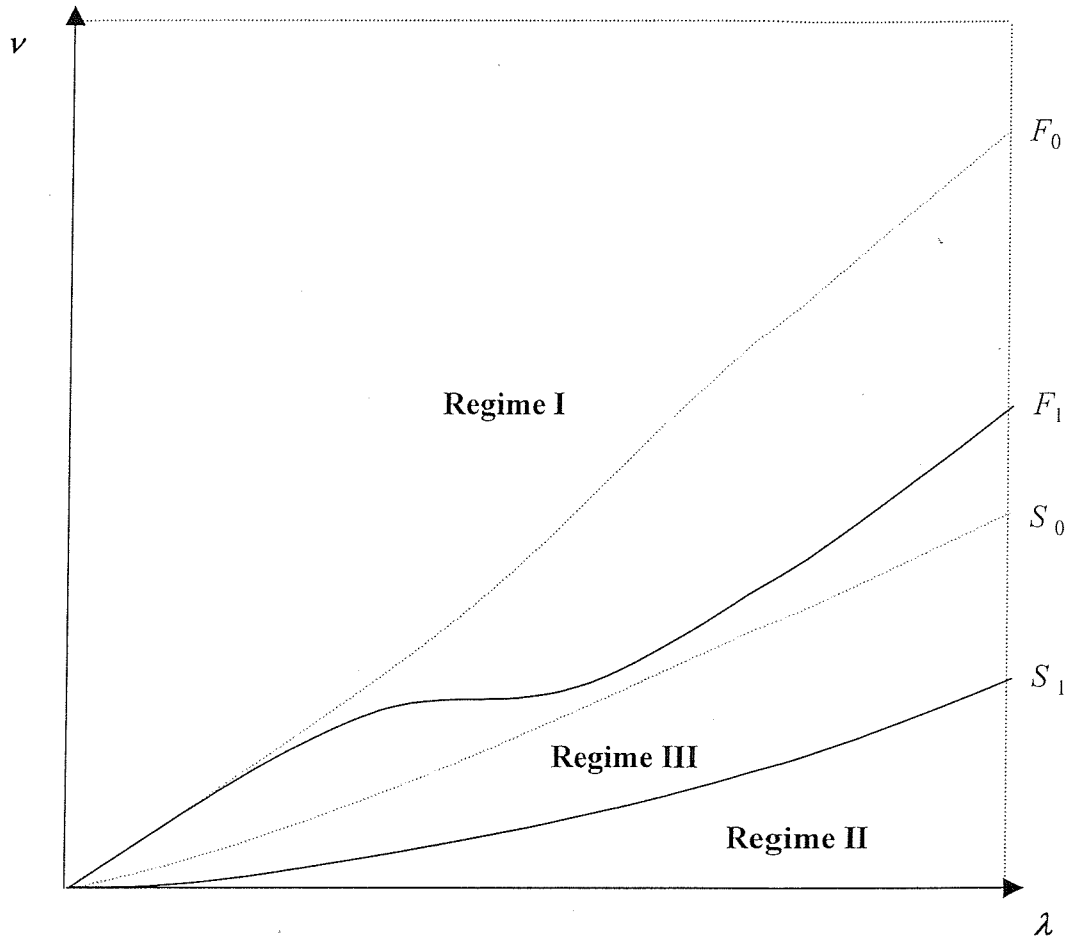


Table 5.1: Effect of Active Lobbying on Different Regimes ($\overline{\delta} = 0.3, \quad k = 1$).

Type of Lobbying:	No Lobbying	Active Lobbying							
		Symmetric		Democratic Deficit		Producer Bias Federal Level		Producer Bias Both Levels	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
Col. No.:	1	2	3	4	5	6	7	8	9
% of $\lambda - \upsilon$ space in Regime:									
I	59.8	51.7	75.6	52.0	75.1	53.2	75.2	63.3	74.2
II	17.4	31.3	17.6	31.3	17.6	31.3	17.6	11.0	8.4
III	22.8	9.1	6.3	8.9	6.8	7.6	6.7	25.7	17.4
IV	0.0	7.8	0.5	7.8	0.5	8.0	0.5	0.0	0.0
% Change in Welfare – Federal	-	0.02	-1.19	0.01	-1.13	-0.06	-1.14	-0.08	-0.78
%Change in Welfare – State	-	1.18	-0.35	1.18	-0.35	1.18	-0.35	-1.45	-2.65

Chapter 6

Conclusions and Areas for Further Research.

In this thesis we take a political economy approach to the setting of global environmental policy in a federal structure. This allows us to generate two routes by which fears of a 'race to the bottom' in international environmental standards or environmental dumping can be rationalised: strategic competition between two national governments in a world without trade barriers and the capture of policymakers by special interest groups. Policy can either be set non-cooperatively at the level of the nation state or cooperatively by a supra-national agency. Setting policy non-cooperatively results in emission standards which are laxer than first best. Setting policy cooperatively internalises this externality but there exists a further problem of asymmetric information between national governments and the supra-national agency about damage costs; these are private information that becomes available only to national governments and only when they come into power.

Chapters 2 and 5 consider some basic constitutional issues. A fundamental issue is the subsidiarity question: whether policy should be set at the national or supra-national level. Chapter 2 extends the previous literature by removing the assumption of welfare maximising governments and shows that it is always better to set policy at a supra-national level. The benefits of cooperating and eliminating incentives for damaging strategic competition outweigh the problems of asymmetric information associated with policy being set a higher level of government. The remaining chapters show that this result is robust to the introduction of active lobbying. A second constitutional issue is whether to allow politicians to set policy at their discretion or whether to tie their hands via social pooling which maximises the ex-ante expected value of damage costs. Politicians are assumed to be acting in the interests of or captured by special interest groups that place more or less weight on the environment than would a social

welfare maximiser. The benefit of discretion is that elected politicians have information regarding the actual level of damages but the drawback is that they are subject to this political influence. In our model social pooling also implies cross-state harmonisation of policies. This enables us to look at a third issue: whether policies should be harmonised at a supra-national level. The argument is that harmonisation at a supra-national level removes incentives for strategic competition when setting policy at the national level. In the context of this model we are looking to see if social pooling (harmonisation) would be preferred at the supra-national level if political discretion is preferred at the national level. In chapter 2 we show that social pooling is more appealing when the political parties are relatively more extreme and that social pooling is preferable when the difference in state's damage costs diverge. However, it is shown that social pooling (harmonisation) is never worthwhile at the supra-national level if it is not also better at the state level. In chapter 5 it is shown that these results are broadly robust to the introduction of active lobbying.

Chapters 3 and 4 are concerned with addressing the concerns that arise when policy is actually set at a supra-national level. Although international coordination of policies may bring about some benefits by eliminating strategic competition, its critics argue that it raises its own set of concerns. Specifically, it is claimed that ceding policy to a supra-national authority means a loss of democracy with policy making moving from elected national officials to un-elected and possibly unknown bureaucrats. Another concern is that policy making at a supra-national level is captured by powerful multinationals which have larger funds or greater expertise in gaining access to the policy making process. In a similar vein, it is argued that industrial, predominantly Northern nations exert an overwhelming influence in agencies such as the World

Trade Organisation. To address these concerns the model in chapter 2 is extended by allowing for industrial and environmental lobby groups in each country. Lobbying affects the probability of determining the political type of the national and supra-national governments. Lobbying activity is costly for all groups but by varying the costs amongst groups it is possible to model asymmetric influence or access to policy makers. By building into the model the concerns of critics such as the anti-globalisation lobby it is possible to assess how some of their arguments feed through. In chapter 3 the only motivation for international coordination of policies remains the removing of incentives to engage in environmental dumping. In chapter 4 a further motivation is to deal with problems associated with transboundary pollution. In these chapters it is shown that it is possible to have too much access to policy makers. For example, if lobbying is relatively cheaper for industrial groups then it may encourage them to expend greater than optimal levels of lobbying expenditure, resulting in lower utility than under symmetric lobbying influence. The main result of these chapters though, and also the thesis, is that despite the numerous distortions at work – asymmetric information, political bias, lobbying and transboundary pollution – welfare is higher when setting policy at a supra-national level. This suggests that the debate on trade and environment should shift away from whether international coordination of environmental policies should take place and instead focus on how to improve the operation and procedures of bodies such as the WTO, UN or any future World Environmental Organisation.

There are a number of avenues that remain open for possible further research. The model that is used in this thesis assumes that lobby groups – both industrial and environmental – are strictly national in nature (even though they are able to lobby

abroad). Clearly this is restrictive and it is readily seen that groups increasingly form large coalitions to lobby more effectively, particularly at the supra-national level. For example, the global environmental movement now incorporates not only national and international environmental lobbies but also other groups such as labour organisations. It may be useful to incorporate this trend into the model.

Another area that could possibly be looked into is the institutional structure. In this thesis it is assumed that policy is set solely and exogenously at the state or the federal level. Relaxing this assumption would allow for some form of joint policy making; this would allow us to look into the interesting and topical question of what is the optimal level of power to cede to a federal authority and at what point the loss of national sovereignty becomes damaging or beneficial in welfare terms.

It may also be possible to gain further insight by enriching the political foundations of the model. One possible route would be to see how the introduction of citizens with heterogeneous preferences would affect the results. In this thesis voters play no major role. Of course, citizens are not just voters but also consumers and members of the labour force. The introduction of consumer surplus and/or payments to labour may be interesting, as may the introduction of an active third interest group. Another possibility may be to endogenous parties platform selections. One option would be to allow for platforms to be influenced by interest groups.

Much of the debate over environmental dumping is concerned with the incentives to shift capital to the regions with the lowest standards, particularly following the

removal of many restrictions on the international flows of capital. It may be useful to introduce mobile factors of production.

Empirical work in this area is scarce and there may be some scope for improvement. Finally, the underlying economic model remains quite simplistic and it may be worthwhile to test the model by incorporating different functional forms.

REFERENCES

Aidt, T. (1998) "Political Internalisation of Economic Externalities and Environmental Policy", *Journal of Public Economics*, 69, 1-16.

Aidt, T. (2000) "The Rise of Environmentalism, Pollution Taxes and Intra-Industry Trade", University of Cambridge, DAE Working Paper No. 0017.

Alesina A. (1988) "Credibility and Policy Convergence in a Two-Party System with Rational Voters", *American Economic Review*, 78, 796-805.

Austen-Smith D. (1987) "Interest Groups, Campaign Contributions and Probabilistic Voting", *Public Choice*, 54, 123-139.

Austen-Smith D. (1991) "Rational Consumers and Irrational Voters: A Review Essay on Black Hole Tariffs and Endogenous Policy Theory, by Stephen Magee, William Brock and Leslie Young, Cambridge University Press 1989", *Economics and Politics*, 3, 73-92.

Austen-Smith, D. (1997) "Endogenous Informational Lobbying", *Nota di Lavoro* 27.97 FEEM, Milan.

Barrett, S. (1994) "Strategic Environmental Policy and International Trade", *Journal of Public Economics*, 54, 325-38.

Barrett, S. (1998) "Political Economy of the Kyoto Protocol", *Oxford Review of Economic Studies*, 14, 20-39.

Becker, G. (1983) "A Theory of Competition Among Pressure Groups for Political Influence", *Quarterly Journal of Economics*, 98, 371-400.

Bernheim, D. and M. Whinston (1986) "Menu Auctions, Resource Allocations, and Economic Influence", *Quarterly Journal of Economics*, 101, 1-31.

Besley, T. and S. Coate (1997) "An Economic Model of Representative Democracy", *Quarterly Journal of Economics*, 112, 85-114.

Bhagwati, J. (1971) "The Generalized Theory of Distortions and Welfare", in *Trade, Balance off Payments, and Growth*, North Holland, Amsterdam.

Bhagwati, J. (1996) "The Demands to Reduce Domestic Diversity among Trading Nations", in J. Bhagwati and R. Hudec (Eds.) Chapter 1.

Bhagwati, J. and H. Daly (1993) "Debate: Does Free Trade Harm the Environment ?", *Scientific American*, November, 17-29.

Bhagwati, J. and R. Hudec (1996) (Eds.) *Fair Trade and Harmonisation*, MIT Press, Cambridge, Mass.

Bhagwati, J. and T. Srinivasan (1996) "Trade and Environment: Does Environmental Diversity Detract from the Case for Free Trade", in J. Bhagwati and R. Hudec (Eds.) Ch. 4.

Bigano, A. (1999) "Environmental Dumping, Transboundary Pollution and Asymmetric Information: Some Insights for the Environmental Regulation of the European Electricity Market", Note di Lavoro 36/99, FEEM, Milan.

Black, D. (1948) "On the Rationale of Group Decision Making", *Journal of Political Economy*, 56, 23-34.

Boyer, M. and J-J. Laffont (1999) "Toward a Political Theory of the Emergence of Environmental Incentive Regulation", *Rand Journal of Economics*, 30, 137-157.

Brander, J. (1981) "Intra-industry Trade in Identical Commodities", *Journal of International Economics*, 11, 1-14.

Brander, J. (1995) "Strategic Trade Policy", in G. Grossman and K. Rogoff (Eds.) *Handbook of International Economics*, Vol. 3, Elsevier, Amsterdam.

Brander, J. and B. Spencer (1985) "Export Subsidies and International Market Share Rivalry", *Journal of International Economics*, 18, 83 –100.

Brock, W., S. Magee and L. Young (1989) *Black Hole Tariffs and Endogenous Policy Theory*, Cambridge University Press, Cambridge.

Buchanan J., R. Tollinson and G. Tullock (1980) *Toward a Theory of the Rent-Seeking Society*, Texas A&M University Press.

Calvert, R. (1985) "Robustness and the Multidimensional Voting Model: Candidate Motivations, Uncertainty and Convergence", *American Journal of Political Science*, 81, 82-108.

Conconi, P. (2003) "Green Lobbies and Transboundary Pollution in Large Open Economies" (forthcoming), *Journal of International Economics*.

Conrad, K. (1993) "Taxes and Subsidies for Pollution-Intensive Industries as Trade Policy", *Journal of Environmental Economics and Management*, 25, 121-135.

Conrad, K. (1996) "Optimal Environmental Polices for Oligopolistic Industries in an Open Economy", in C. Carraro, Y. Katsoulacos and A. Xepapadeas (Eds.) *Environmental Policy and Market Structure*, Kluwer, Dordrecht.

Deardorff, A. and R. Stern (2000) "What the Public Should Know About Globalization and the World Trade Organisation", *Discussion Paper 460*, School of Public Policy/ Department of Economics, University of Michigan.

Downs, A. (1957) *An Economic Theory of Democracy*, Harper Collins, New York.

Dijkstra, B. (1999) *The Political Economy of Environmental Policy*, Edward Elgar, Cheltenham, UK.

Eaton J. and G. Grossman (1986) "Optimal Trade and Industrial Policy under Oligopoly", Quarterly Journal of Economics, 101, 383-406.

Esty, D. (1994) "Toward a Global Environmental Organisation", in P. Kenen (Ed.) *Managing the World Economy: Fifty Years after Bretton Woods*, Institute for International Economics, Washington.

Esty, D. (1997) "Public Participation in the International Trading System Why the World Trade Organisation Needs Environmental NGOs", *International Centre for Trade and Sustainable Development*, Geneva, Switzerland.

Finus, M. (2000) "Game Theory and International Environmental Co-operation: A Survey with an Application to the Kyoto-Protocol", Nota di Lavoro, FEEM, Milan, Italy.

Finus, M. (2001) Game Theory and International Environmental Cooperation, Edward Elgar, Cheltenham, UK.

Frederiksson, P. (1997a) "The Political Economy of Pollution Taxes in a Small Open Economy", *Journal of Environmental Economics and Management*, 33, 44-58.

Fredriksson, P. (1997b) "Why Don't Environmental Regulations Influence Trade Patterns?", *mimeo*, World Bank.

Fredriksson, P. and N. Gaston (2000) "Environmental Governance in Federal Systems: The Effects of Capital Competition and Lobby Groups", *Economic Inquiry*, 38(3), 501-14.

Grossman, G. (1986) "Strategic Export Promotion: A Critique", in P. Krugman (Ed.) *Strategic Trade Policy and the New International Economics*, MIT Press, Cambridge, Mass.

Grossman, G. and E. Helpman (1994) "Protection For Sale", *American Economic Review*, 84, 833-850.

Grossman, G. and E. Helpman (2002) *Interest Groups and Trade Policy*, Princeton University Press.

Grubel, H. (1976) "Some Effects of Environmental Controls on International Trade: The Heckscher-Ohlin Model", in I. Walter (Ed.) *Studies in International Environmental Economics*, John Wiley, New York.

Helpman, E. and P. Krugman (1989) *Trade Policy and Market Structure*, MIT Press, Cambridge, Mass.

Hinich, M. and M. Munger (1997) *Analytical Politics*, Cambridge University Press,

Cambridge.

Hillman, A. (1989) The Political Economy of Protection, Harwood Academic Publishers, Chur.

Hillman, A. and H. Ursprung (1992) "The Influence of Environmental Concerns On the Political Determination of Trade Policy", in K. Anderson and R. Blackhurst (Eds.) *The Greening of World Trade Issues*, Harvester-Wheatsheaf, Hemel Hempstead, 195-220.

Hillman, A. and H. Ursprung (1994) "Greens, Supergreens and International Trade Policy: Environmental Concerns and Protectionism", in C. Carraro (Ed.) *Trade, Innovation, Environment*, Kluwer, Dordrecht, 75-108.

Hoel, M. (1997), "Environmental Policy with Endogenous Plant Location", *Scandinavian Journal of Economics*, vol. 99, pp. 241-259.

Horstman, I. and J. Markusen (1986) "Up the Average Cost Curve: Inefficient Entry and the New Protectionism", *Journal of International Economics*, 20, 225-48.

House of Commons (1996) "World Trade and the Environment", Fourth Report, Environment Committee, HMSO, London.

Kanbur, R., M. Keen and S. van Wijnbergen (1995) "Industrial Competitiveness, Environmental Regulation and Direct Foreign Investment", in I. Goldin and A. Winters (Eds.) *The Economics of Sustainable Development*, Paris, OECD, 289-301.

Karp, L., J. Zhao, and S. Sacheti (1997) "The Uncertain Benefits of Environmental Reform in Open Economies", *Working Paper* 818, Department of Agricultural and Resource Economics, UC, Berkeley.

Katz, E. and J. Rosenberg (1989) "Rent-Seeking for Budgetary Allocation: Preliminary Results For 20 Countries", *Public Choice*, 60, 133-145

Kennedy (1994) "Equilibrium Pollution Taxes in Open Economies with Imperfect Competition", *Journal of Environmental Economics and Management*, 27, 49-63.

Krugman, P. (1997) "What Should Trade Negotiators Negotiate About?", *Journal of Economic Literature*, 35 (1), 113-120.

Krutilla, K. (1991) "Environmental Regulation in an Open Economy", *Journal of Environmental Economics and Management*, 20, 127-142.

Leebron, D. (1996) "Lying Down with Procrustes: an Analysis of Harmonisation Claims", in J. Bhagwati and R. Hudec (Eds.) Ch. 2.

Levinson, A. (1996) "Environmental Regulations and Industry Location:

International and Domestic Evidence", in J. Bhagwati and R. Hudec (Eds.) Ch. 11.

Lewis, T. (1996) "Protecting the Environment when Benefits and Costs are Privately Known", *Rand Journal of Economics*, 27 (4), 819-847.

Mani, M., S. Pargal and M. Huq (1997) "Is There and Environmental 'Race to the Bottom' ? Evidence on the Role of Environmental Regulation in Plant Location Decisions in India", *Poverty, Environment and Growth Working Paper*, 15, World Bank, Washington.

Markusen, J., E. Morey and N. Olewiler (1993) "Environmental Policy when Market Structure and Plant Locations are Endogenous", *Journal of Environmental Economics and Management*, 24, 69-86.

Mayer, W. and J. Li (1994) "Interest Groups, Electoral Competition, and Probabilistic Voting for Trade Policies", *Economics and Politics*, 6, 59-77.

McGrew, T. (1998) "The World Trade Organisation: 'Technocracy Or Banana Republic'", in C. Thomas and A. Taylor (1998) (Eds.), *Global Trade And Global Social Issues*, Routledge.

Mueller, D. (Ed.) (1997) *Perspectives on Public Choice*, Cambridge University Press, Cambridge.

Neary, P. (2000) "Trade and the Environment: Theoretical and Policy Linkages", Paper presented to the European Association of Environmental and Resource Economists Annual Conference, Oslo.

Olsen, M. (1965) *The Logic of Collective Action*, Harvard University Press, Cambridge, Mass.

Osborne, M. and A. Slivinski (1996) "A Model of Political Competition with Citizen Candidates", *Quarterly Journal of Economics*, 111, 65-96.

Pigou, A. (1920) *The Economics of Welfare*, Macmillan, New York.

Panagariya A., K. Palmer, W. Oates and A. Krupnick (1993) "Toward an Integrated Theory of Open Economy Environmental and Trade Policy", Working Paper No. 93-8, Department of Economics, University of Maryland.

Pethig, R. (1976) "Pollution, Welfare and Environmental Policy in the Theory of Comparative Advantage", *Journal of Environmental Economics and Management*, 2, 160-69.

Persson T. and G. Tabelini (2000) *Political Economics*, MIT Press, Cambridge, Mass.

Porter, M. (1991) "America's Green Strategy", *Scientific American*, 264, p.168.

Porter, M. and C. van der Linde (1995a) "Green and Competitive: Breaking the

Stalemate", *Harvard Business Review*, September-October.

Porter, M. and C. van der Linde (1995b) "Toward a New Conception of the Environment-Competitiveness Relationship", *Journal of Economic Perspectives*, 9, 97-118.

Rauscher, M. (1994) "On Ecological Dumping", *Oxford Economic Papers*, 46, 822-840.

Rauscher, M. (1997) *International Trade, Factor Movements and the Environment*, Clarendon Press, Oxford.

Rauscher, M. (2001) "International Trade, Foreign Investment and the Environment", *Working Paper No 39*, University of Rostock.

Rodrik, D. (1995) "Political Economy of Trade Policy", in G. Grossman and K. Rogoff (Eds.) *Handbook of International Economics*, Vol. 3, Elsevier, Amsterdam.

Roemer, J. (1999) "The Democratic Political Economy Of Progressive Income Taxation", *Econometrica,* Vol. 67 No. 1, January.

Schleich, J. (1999) "Environmental Quality with Endogenous Domestic an Trade Policies", European Journal of Political Economy, 15, 53-71.

Schleich, J. and D. Orden (2000) "Environmental Quality and Industry Protection with Noncooperative versus Cooperative Domestic and Trade Policies", *Review of International Economics*, 8(4), 681-97.

Siebert, H. (1977) "Environmental Quality and the Gains From Trade", *Kyklos*, 30, 657-73.

Shrybman, S. (1990) "International Trade: In Search of an Environmental Conscience", *EPA Journal*, 16, 17-19.

Sturm D. (2001) "Choosing how to Compete: Is Environmental Policy the Optimal Instrument ?", *mimeo*, University of Munich.

Tyson (1992) *Who's Bashing Whom? Trade Conflict in High-Technology Industries*, Institute for International Economics, Washington.

Ulph, A. (1992) "The Choice of Environmental Policy Instruments and Strategic International Trade", in R. Pethig (Ed.) *Conflicts and Cooperation in Managing Environmental Resources*, pp. 111-129, Spinger-Verlag, Berlin.

Ulph, A. (1996) "Environmental Policy and International Trade when Governments and Producers Act Strategically", *Journal of Environmental Economics and Management*, 30, 265-281.

Ulph, A. (1997a) "International Trade and the Environment: A Survey of

Recent Economic Analysis", in H. Folmer and T. Tietenberg (Eds.) *The International Yearbook of Environmental and Resource Economics 1997/8*, Edward Elgar, Cheltenham, 205-242.

Ulph, A. (1997b) "International Environmental Regulation When National Governments Act Strategically", in J. Braden and S. Proost (Eds.) *The Economic Theory of Environmental Policy in a Federal System*, Edward Elgar, Cheltenham, 66-98.

Ulph, A. (2000) "Harmonisation and Optimal Environmental Policy in a Federal System with Asymmetric Information" *Journal of Environmental Economics and Management*, 39, 224-241

Ulph, A. (2001) *Environmental Policy, International Agreements and International Trade*, Oxford University Press, Oxford.

Ulph, A. and D. Ulph (1996), "Trade. Strategic Innovation and Strategic Environmental Policy – a General Analysis" in C. Carraro, Y. Katsoulacos and A. Xepapadeas (eds.) *Environmental Policy and Market Structure*, Kluwer, Dordrecht, 181-208.

Verbruggen, H. and O. Kuik (1997) "WTO Ministerial Conference in Singapore: Environmental Diversity Versus Harmonisation", *Environmental and Resource Economics*, 10, 405-413.

Walz, U. and D. Wellisch (1997) "Is Free Trade in the Interest of Exporting Countries when there is Ecological Dumping ?", *Journal of Public Economics*, 66, 275-91.

Wilson, J. (1996) "Capital Mobility and Environmental Standards: Is There a Theoretical Basis for a Race to the Bottom?", in J. Bhagwati and R. Hudec (Eds.) *Fair Trade and Harmonisation*, MIT Press, Cambridge, Mass.

Wittman D. (1983) "Candidate Motivation: A Synthesis of Alternative Theories", American Political Science Review, 77, 142-157.

Wittman D. (1989) "Why Democracies Produce Efficient Results", *Journal of Political Economy*, 97, 1395-1424.

World Trade Organisation (1996) Report of the Committee on Trade and Environment to the Singapore Ministerial Conference, WTO Publications, Geneva, Switzerland.

World Trade Organisation (1999) "Trade and Environment", Special Studies 4, WTO Publications, Geneva, Switzerland.

World Trade Organisation (2002) "Existing Forms of Cooperation and Information Exchange Between UNEP / MEAs and the WTO", Note by the Secretariat, Committee on Trade and Environment: Special Session, WTO Publications, Geneva, Switzerland.