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Environmental policy in an integrated world economy

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Environmental Policy in an Integrated World Economy

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Abstract

This paper critically assesses the literature on the relationship between economic integration and the environment. In particular, we investigate how trade liberalization and capital market integration affect environmental policy and thus environmental quality. Conversely, we also study how environmental policy can be used to serve non-environmental (trade policy) goals. The interaction between economic integration and environmental policy is not only approached from a traditional social welfare maximizing perspective, but – as a novelty – also includes the emerging political-economic literature on this set of issues. This altered perspective leads us to substantially different results. Moreover, we present the substantial empirical evidence for both perspectives. This allows us to put the theoretical findings in perspective.

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1. INTRODUCTION.....	1
2. ENVIRONMENTAL DECISION-MAKING IN PRE-INTEGRATION ECONOMIES.....	2
2.1. NORMATIVE ECONOMIC POLICY ANALYSIS.....	2
2.2. POLITICAL-ECONOMIC ANALYSIS.....	6
3. ENVIRONMENTAL POLICY IN AN INTEGRATED WORLD ECONOMY: THE NORMATIVE VIEW.....	14
3.1. THE SOCIAL WELFARE MAXIMIZING PERSPECTIVE	14
3.2. CLASSIFICATION OF MODELS	15
3.3. TRADE CUM ENVIRONMENT MODELS	19
<i>a) Welfare implications of trade liberalization when environmental policy is exogenous.....</i>	<i>19</i>
<i>b) Partial equilibrium analyses.....</i>	<i>21</i>
<i>c) General equilibrium analyses.....</i>	<i>23</i>
<i>d) North-South models.....</i>	<i>27</i>
<i>e) Imperfect competition.....</i>	<i>31</i>
3.4. FACTOR MOBILITY	34
<i>a) Single commodity models.....</i>	<i>35</i>
<i>b) Multi-sector models.....</i>	<i>38</i>
<i>c) Imperfect competition.....</i>	<i>40</i>
3.5. SUMMARY	44
4. ENVIRONMENTAL POLICY IN AN INTEGRATED WORLD ECONOMY: THE POLITICAL-ECONOMIC VIEW.....	46
4.1. TRADE CUM ENVIRONMENT MODELS	47
<i>a) The Influence of Environmental Concerns on Endogenous Trade Policy Formation.....</i>	<i>51</i>
<i>b) Simultaneous Determination of Trade and Environmental Policies.....</i>	<i>56</i>
<i>c) The Influence of Economic Integration on Environmental Policy and the Environment.....</i>	<i>61</i>
4.2. FACTOR MOBILITY	65
4.3. SUMMARY	66
5. THE EMPIRICAL EVIDENCE.....	67
5.1. 'ENVIRONMETRICS'	67
5.2. THE INFLUENCE OF ENVIRONMENTAL POLICY ON THE PATTERN OF TRADE	69
5.3. THE INFLUENCE OF THE TRADE REGIME ON THE ENVIRONMENT	74
5.4. ENVIRONMENTAL CONTROL AND THE RELOCATION OF INDUSTRIES	77

5.5. POLITICAL-ECONOMIC INTERRELATIONS	80
5.6. SUMMARY	82
6. APPENDIX: GAINS FROM TRADE IN THE PRESENCE OF A NEGATIVE ENVIRONMENTAL EXTERNALITY.....	84
6.1. POLLUTION OCCURS IN PRODUCTION	84
6.2. POLLUTION OCCURS IN CONSUMPTION	85
7. REFERENCES.....	86

1. Introduction

This paper critically surveys the current debate on the interdependence of global economic integration and environmental policy. In particular, we seek answers to two questions: First, how does global economic integration influence the environment and environmental policy-making? The main concern is here whether the debilitation of the coercive power of the nation states, which is incidental upon global economic integration, gives rise to a downward competition of environmental standards with the consequence of global environmental plight (eco-dumping). The second - related - question asks to what extent environmental policy is likely to affect economic integration: How are trade patterns, profits and capital allocations influenced by environmental policy and is there a real danger that governments use environmental policy instruments for protectionist ends (eco-protectionism)?

We look at these issues both from the traditional perspective of a social welfare maximizing government as well as from a political-economic viewpoint. The former perspective allows us to assess how a given (trade or environmental) policy affects the environment, the allocation of resource and the pattern of trade which, as a consequence, provides a basis for rational policy decisions. This normative approach, however, does not give rise to a realistic portrayal of actual policy formation since it disregards the self interest of policy-makers and the influence of special interest groups in the political process. To provide a realistic portrait of the political process is at the heart of the endogenous policy approach, which builds upon the traditional approach and looks at optimization in the economic and political sphere under different market forms and institutional settings.

In order to assess the environmental impact of economic integration it is advisable to begin the investigation with the status quo ante. For even in a relatively closed economy environmental policy-making is not likely to yield first-best results. The reasons are twofold: first, the government cannot be expected to have all the requisite information at its disposal, and second, the government's objective may well have less altruistic objectives than the

maximization of social welfare, defined in some way or other. We therefore begin our survey with a section on environmental decision-making in a pre-integration economy with the intention of elaborating on the constraints which environmental policy-making is subject to if integration effects can be neglected. Since the informational aspects are well known and adequately dealt with in the textbook literature, our focus in this section will be on the political-economic dimension.

We then continue to analyze environmental policy-making in an economy which is exposed to completely free international trade and factor movements. Global economic integration gives rise to further policy constraints since, in open economies, differences in environmental standards across countries are liable to exert a distinct influence on the international flows of trade and investment with consequences for social welfare in general and employment in particular. Section 3 surveys the normative literature which is based on the „benevolent dictator“ portrait of government behavior. The political-economic literature is surveyed in section 4. The last section of the paper looks at the empirical evidence from both perspectives and therefore critically reflects upon the relevance of the theoretical predictions.

2. Environmental decision-making in pre-integration economies

2.1. Normative economic policy analysis

The environment is not polluted out of sheer malice; individual agents engage in pollution-generating activities because they regard their behavior to be rational in the sense of a cost-benefit comparison. The cause of excessive environmental pollution is the sharing of the environment by a great number of people. Their behavior generates negative externalities which are an impediment to collective optimality - the agents are caught in an n-person Prisoners' Dilemma.

In general, collective optimality does not call for a completely unpolluted environment. The collectively optimal level of an pollution-generating activity is strictly positive if, at the activity-level zero, the marginal benefits of the activity are higher than the marginal costs incurred by the victims of the pollution. Zero pollution in this case is not *collectively* optimal since at a sufficiently low activity level the polluter's benefit is higher than the victims' costs. In other words, the victims of pollution could always be compensated by the polluter so that in the end everybody would be better off than in a state of zero pollution. It is collectively efficient to choose the activity level at which social marginal cost equals social marginal benefits.¹

Externalities and Prisoners' Dilemma situations represent the classic justifications for government intervention [cf. Mueller (1989), ch. 2]. There are basically three ways of imposing the socially optimal solution by official authority in a Prisoners' Dilemma. The first is to simply outlaw the *strategies* which give rise to excessive external costs; the second is to change the *payoffs* in such a way that the use of the socially undesirable strategies is no longer individually optimal.² The third is to change the *rules of the game*, i.e. the economic constitution. Cleverly chosen rules may well give rise to a spontaneous and satisfactory coordination of the individual agents' behavior. By assigning unambiguous property rights to the environment, the prisoners' dilemma in the pollution game resolves itself via negotiations between polluters and victims if *transaction costs* are negligible and contracts can be made binding. Negotiations result in the social optimum, as in the case of a central regulator. According to the Coase theorem this is true, independent of how the property rights to the environment are assigned.

¹ The classical reference for this 'Samuelson condition' is Samuelson (1954). Of course, Pareto optimality presupposes that compensation actually takes place.

² Instead of manipulating the strategy set or the payoffs, one could, in principle, also tinker with the set of players. By merging, for example, two firms, an upstream polluter and a downstream victim, the externalities are internalized and the inefficiency disappears. This solution however is feasible for two *producers*, but in general not feasible for producer/consumer and consumer/consumer externalities.

Clearly, the Coasian preconditions are hardly ever satisfied. Transaction costs are omnipresent and, as a rule, they vary positively with the number of agents involved in the transaction. The standard conclusion is therefore that assigning property rights to the environment can only work in those few cases in which the number of polluters and victims is small. However, this conclusion is probably too pessimistic. Instead of interpreting property rights as *user rights*, they can be interpreted as *rights to sue*. If laws are passed which guarantee certain standards of environmental quality, victims of pollution can bring an action against identifiable polluters. The „right to sue“ interpretation of the property-rights approach has similar consequences to the „user right“ interpretation if the number of polluters is small and the legislator succeeds in setting reasonable pollution standards.

Unfortunately, assigning property rights to the environment does not solve all the problems associated with excessive environmental pollution; passive measures which change the rules governing the economic process in most cases do not suffice in bringing about completely satisfactory outcomes. This can only be achieved if the government actively intervenes in the economic process.

The instruments to implement environmental policy objectives can be grouped in non-regulatory and regulatory instruments, depending on whether they change the payoffs or the feasible strategy set of the polluting agents.³ The classical *non-regulatory instrument* internalizes the externalities by levying an appropriate tax on the use of the environment; "appropriate" meaning in this context - as was noted by Pigou in 1920 - that the tax rate equals the marginal external costs at the optimal level of a pollution-generating activity. At a first glance the Pigovian tax scheme looks very attractive. The practical implementation of a Pigou tax is however not easy since the determination of the optimal tax-rate presupposes a great deal of information about the shape of the marginal benefit and marginal cost curves.

³ For a more detailed discussion of the available environmental policy instruments, see Siebert (1995).

These technical problems fortunately do not represent an insurmountable impediment for the implementation of non-regulatory measures. After all, if it is not possible to determine the optimal tax-rate precisely, one can still use an approximation. This is the rationale for two instruments which closely resemble the optimal one. The first instrument, the *pollution tax*, is simply a Pigovian tax without the underlying optimization calculus. The major shortcoming of arbitrary pollution taxes is that the ensuing level of pollution cannot be predicted very accurately because the relevant information is usually not available. To circumvent this problem, marketable *emission certificates* can be issued. Using this type of instrument, the government (arbitrarily) predetermines the total level of pollution. The price of the certificates is then established by market forces.⁴

The second class of instruments, *regulations and prohibitions*, restricts the strategy set in the "pollution game." From the point of view of traditional economic policy analysis the most important feature of these instruments is that they are inefficient. The requirement is that the constraints set by the government have to be the same for all polluters - the rule of equal treatment must not be violated. However, since not all polluters are the same, this rule, which is certainly sound in the abstract, brings about rather unfavorable results when applied to pollution standards. Apart from being inefficient in the static sense, regulatory environmental policy instruments also turn out to be dynamically inefficient. In the long run, for example, firms usually have the option of introducing cleaner production technologies. Politically predetermined pollution standards, however, destroy all incentives to seek and implement more ecological technologies.

These comments demonstrate that environmental policy does not pose any serious problems as far as normative economic theory is concerned. The reasons for the excessive pollution of

⁴ Instead of punishing bad behavior by making pollution-generating activities more expensive, one could, in principle, also reward good behavior by subsidizing ecological substitutes. Subsidies, however, are less efficient than taxes. Instead of neutralizing the existing distortion they distort relative prices even more, albeit in an ecological manner.

the environment are well understood and appropriate environmental policy instruments are available. In spite of all that, one observes that environmental policies are introduced only very hesitantly. In addition one observes that the environmental policy instruments which are actually implemented usually exhibit a regulatory character and are thus inefficient. To understand why the political process brings about these perverse inefficiencies we now turn to political-economic reasoning.

2.2. Political-economic analysis

The purpose of this section is to investigate environmental policy-making from a positive point of view. Unlike traditional normative economic policy analysis, we are thus not concerned here with advancing policy recommendations for the benefit of the policy makers. Our objective is rather to explain why environmental policy is conducted in the manner actually observed.

The basic insight of political economy is that efficiency considerations are less important in determining economic policy than the redistribution of income and wealth. This is not to say that the political process is not able to realize potential efficiency gains. On the contrary: if efficiency gains can be realized without any serious conflicts arising over distribution, the requisite policies will be implemented. Quite often, however, available efficiency-improving measures are not taken. In these cases the political agents cannot agree on the specific design of the measure, because of implications with regard to distribution. The political process sometimes even introduces inefficient measures. This can happen if the gainers from such a measure happen to form a political winning coalition.

The political-economic view is based on a specific image of "homo politicus." Using the economic model of behavior, it is maintained that all political agents, i.e. voters, politicians, interest groups and public bureaucrats, can be modeled as rational utility maximizers. The

preferences of political agents are usually assumed to derive from rather elementary and tangible desires such as the maximization of income. A full fledged political-economic investigation as a rule, entails four steps: (1) specification of the objectives of the involved political and economic agents, (2) identification of the gainers and losers from the proposed policy measure, (3) description of the institutional setting governing the interaction between policy-makers and the economic agents, and (4) analysis of the political influence exerted by the economic interests in order to arrive at explanations or predictions of economic policy-decisions. This final step of the analysis presupposes that the mode of operation of the political process is well understood. The analysis therefore needs to be based on a tractable model of the political process.

The approaches used in endogenous policy theory to model the political process differ with respect to the transaction costs implicitly assumed to accrue in the political process. Transaction costs are a necessary ingredient of political-economic models, since in a world without transactions costs the political outcome would always be collectively optimal. This follows immediately from the Coase theorem. The most popular modeling approaches are the following.⁵

1. The *median voter model* of direct democracy and the representative-democracy pendant thereof, i.e. the *spatial models of electoral competition*. The only transaction costs assumed to accrue in these models are the costs of bargaining over the redistribution of gains and losses associated with policy changes. These costs are assumed to be prohibitive.
2. The interest group approach, i.e. political-support-function models and rent-seeking models are based on the assumption of imperfectly informed voters. High information costs on the part of the voters provide the politicians with

⁵ See Ursprung (1990) for details.

discretionary power which they use to benefit special interests in exchange for political support.

3. The interest-group cum electoral-competition approach combines aspects of electoral competition and rent-seeking interest groups by merging probabilistic voting behavior (i.e. imperfectly informed politicians) with the standard assumption of imperfectly informed voters.
4. Models of political corruption essentially assume that economic policy is for sale. Such a behavior is only conceivable if monitoring of the agent (the government) by the principals (the voters) is very costly.

To address the puzzle of the observed inadequate level of environmental protection we now proceed to identify the gainers and losers from environmental protection. (Pollution is assumed to result from production and the policy instrument is assumed to be a pollution tax.) We then evaluate the strength of the policy's impact on the various interests, the extent to which these interests are amenable to organization, and the visibility of the interest groups' political activities. We do that with the intention of measuring the political impact of the various gainers and losers in order to arrive at a bird's-eye explanation (which is fairly independent of specific institutional settings) of the above puzzle. The results are summarized in Table 1. The first column lists the most important interests affected by a pollution tax on production. The entries in the second, third and fourth column assess the economic stake of these interests, describe how easy or difficult it is to organize these interests in a cohesive lobby, and evaluate the degree of visibility of the activities carried out by the respective lobbies. The political impact of the various interests varies positively with their economic stake and their amenability to organization. Visibility in the political process is of additional advantage if a lobby's objective is in line with the general interest (median voter interest) and comes at a disadvantage otherwise. The entries in the last column aggregate these three

determinants and provide an overall measure of the political impact of the affected interests. The individual entries are self-evident, but of course debatable.⁶

Looking at the last column of Table 1, one notices at once that the producers of the offending good represent the only cohesive interest group. Similarly cohesive counter-lobbies which may be able to present a bold front to the polluters only exist if foreign competitors of these producers take the part of the environmentalists, or, alternatively, if the emission tax revenues are cleverly earmarked. It is therefore hardly surprising that the *overall level of environmental protection* turns out not to be adequate in systems of representative democracies where pressure group behavior tends to determine the political outcome.

We now turn to the second puzzle of environmental policy: why are regulatory instruments more popular than the more efficient non-regulatory instruments? There are many reasons for this phenomenon. The first one has to do with *rent-shifting*. Consider again an instance of pollution via production. Implementing an output restriction instead of a pollution tax, of

⁶ The economic impact of the consumers of the offending good depends on whether close (domestic) or even perfect (imported) substitutes are available. For detailed comments on this approach, see Ursprung (1992).

Table 1: Gainers and losers from environmental taxes: economic stake, amenability to organization, visibility of the lobby and resulting political impact (losers' entries are printed **bold**).

affected interests		economic stake	amenability to organization	visibility	resulting political impact
offending good	producers	very high	high	low	very strong
	consumers	none to high	low (high)	low (high)	small to medium
substitutable ecological goods	producers	low	low	high	weak
	consumers	marginal	nil	---	nil
imported substitutes	producers	medium	medium	low	medium
	consumers	marginal	nil	---	nil
consumers of the environment		low	low	high	rather weak
beneficiaries of tax revenues	neutral utilization	marginal	nil	---	nil
	earmarked utilization	medium	low	medium	medium
organized environmentalists		low	high	high	medium

course, shifts the tax revenues from the general fund of government receipts to the regulated producers. Since the beneficiaries of additional tax revenues do not form a cohesive interest group, the producers' lobbying activities will in general carry the day and the industry will be regulated [cf. Buchanan and Tullock (1975)]. The second reason has to do with *rent creation*. If a pollution tax is levied on the output of an oligopolistic industry, the industry's output and the firms' profits are reduced. If, however, the same output reduction is imposed by an output constraint, the firms' profits may well rise. The reason is that regulation turns competing firms into cartels, which could not have been enforced otherwise. Regulation can thus create cartel rents. Since the regulated industry's increased profitability attracts new entrants, the market needs to be closed to new entrants by official authority if post-regulation industry-output is not to increase. Such entry barriers represent an additional advantage (*rent protection*) for the regulated firms which thus have three reasons to strongly prefer output constraints over pollution taxes: rent shifting, rent creation, and rent protection. It is therefore not surprising that industries sometimes even initiate regulation via the political process [cf. Stigler (1971)].

Interestingly, environmentalists, as a rule, also strongly prefer regulatory instruments. The environmentalists' attitude is usually explained by their inability to accept that the environment, just as any other economic good, has a price which is reflected in the pollution tax rate. They see the idea that people should have the right to pollute only if they pay the appropriate price for it, as immoral if not downright obscene. Moreover, if one advocates, as the environmentalists often do, a zero-pollution solution, prohibiting pollution-generating activities is indeed simpler than setting a prohibitive pollution tax rate. Even though these explanations do have a ring of truth, there are probably other, more tangible reasons for the environmentalists' opposition to the policy instruments compatible with a free market economy. First of all, they may simply want to support the strongest interest group - the producers - in order to make sure that some environmental policy measure - namely quotas - is taken at all. Secondly, they may consider the industrialists, who, after all, represent the most effective lobby against environmental policies, to be their arch enemies. Since industrialists are

usually thought to endorse a free market economy, the environmentalists may attempt to forge a coalition with the socialists who, of course, are prone to advocate regulatory policy instruments. Thirdly, the leaders of environmentalist pressure groups may be interested in regulation for personal reasons. The (relative) success of regulatory policy measures depends on the assistance of experts. Environmentalist exponents may therefore expect to obtain rents in the form of consulting contracts or positions in the regulatory body if regulation is introduced. Whatever the reasons for the environmentalists' attitude might be, the environmentalists find themselves in a awkward position which Yandle (1989), tongue in cheek, describes as follows: "Like bootleggers and Baptists, the two groups [environmentalists and industrialists, H.U.] argue separately for rules that restrict output." (p. 758).

So far we have treated politicians as passive brokers of various interests. Politicians, however, have interests of their own, i.e. interests which transcend the narrowly defined re-election constraint. One way of describing the behavior of politicians is to portray them as rent seekers. Politicians seek or extract rents by setting rents [cf. Appelbaum and Katz (1987) or Ursprung (1990)]. In other words, rents can only be extracted from private agents if the politician is in a position to offer the private agents a deal. The politician thus needs to have some kind of political discretion at his disposal. Pollution taxes do not leave politicians with a great deal of discretion; they apply to all polluters equally and they can easily be enforced. Regulatory constraints, on the other hand, tend to be highly discriminatory across firm types, industries and regions. Additional discretion is created by the administrator's policing task which "is dimensionally different from that under the tax" [Buchanan and Tullock (1975), p. 141]. It involves the monitoring of the individual firms' quotas as well as the enforcement of the barriers to entry. Since such discretion can be transformed into political support or even pecuniary rewards, politicians will always propose regulation instead of non-regulatory

measures if the economic constitution does not restrict their choice set accordingly.⁷ Regulation, finally, is also favored by public bureaucrats since regulation, unlike pollution taxes, usually comes with a dramatic increase of administrative tasks. An expansion of the public bureaucracy clearly benefits upper-echelon administrators who, in the course of the expansion, are more likely to be promoted, thereby receiving higher salaries [cf. Niskanen (1971)].

Considering the "grand" coalition of interests favoring regulatory measures over free market instruments, it should be clear why environmental politics has in practice so little in common with the normative prescriptions of economic policy analysis. If individual activities are coordinated by markets, this lamentable neglect of social-welfare considerations does not do any harm. Adam Smith's invisible hand of the market will see to it that the moral deficiencies of acting economic man are neutralized in the aggregate. The coordination mechanism of the (democratic) political process, however, does not possess this healing capacity. The only all too visible claw of coercive government not only fails to neutralize the selfishness of economic agents, but the selfish behavior of political agents creates additional inefficiencies on its own.

⁷ Using this basic idea it has been shown elsewhere [Hillman and Ursprung (1988)] that politicians always prefer voluntary export restraints to tariffs. In a nutshell, the argument runs as follows: "Rival candidates place no value on revenue that might derive from a tariff, since revenue accrues to the general fund of government receipts to which the candidates have no claim. However, while the candidates have no means of appropriating or benefiting from the revenue from a tariff that they might propose, there is a prospective benefit from the benefits transferred to firms by export constraints. The latter rent, whether secured by foreign or domestic firms, can be transformed via the political process (if only partially) into campaign contributions, thereby affecting the candidates' ultimate concern, their probabilities of attaining political office." [Quoted from Hillman (1989), pp. 100-101.]

3. Environmental policy in an integrated world economy: The normative view

3.1. The social welfare maximizing perspective

In this section we switch perspective to ask how would a government act if there were no political process and the government were committed only to the well-being of the people it ruled? As a benevolent dictator, not bound by reelection constraints *and* benevolent towards its subjects, the government would maximize a social welfare function (SWF). Underlying this SWF approach of course is the (unrealistic) assumption that either individuals are sufficiently homogeneous or that gainers from a certain policy compensate losers, so that only the net effect must be considered. Although this approach apparently neglects a whole dimension and therefore cannot explain the actual outcome of (environmental) policy, it serves as a reference point and thus as a point of departure for more realistic – political-economic – analyses. The analysis of markets' reactions to environmental and trade policy has to be amended by the analysis of the endogenous formation of these policies.

In looking at the interdependence of trade policy and environmental policy in the context of growing internationalization two questions catch the eye. First, how does increased integration of goods and factor markets affect environmental policy? In particular, does trade liberalization and the abolition of capital controls deteriorate the environment? And if so, what mechanism can be designed to prevent prisoners' dilemmas created by increased international competition? Second, if in the course of economic integration governments forgo the use of traditional trade instruments such as tariffs and quotas, will they resort to other available instruments, environmental policy being a prominent example? Could they use environmental standards to create rents for domestic producers („ecoprotectionism“) or to gain an edge over their competitors („ecodumping“)? Should then, as a consequence, environmental policy be harmonized? These are the questions we are concerned with in this section.

To be sure, these issues can be raised from the traditional social welfare-maximizing perspective as well as from a political-economic viewpoint. The answers will be very

different. In this chapter we survey the papers that regard a country as an entity and neglect domestic distributional conflicts and policy formation in different institutional settings. Most papers to date have been written from this traditional SWF perspective; the more recent political-economic approach on trade and environment is still in its infancy.

3.2. *Classification of Models*

The articles on the interdependence of economic integration and the environment from a SWF perspective now form a fairly large body of literature, which is impossible to cover in toto. However, we hope to have included the bulk of the most important contributions to each class of models. Models can be distinguished according to (i) the transmission channels through which one country's policy affect the other country, (ii) the size of the economy, (iii) the market form of the economies concerned, and (iv) whether the models are partial or general equilibrium. Moreover, models differ in the kind of policy instrument(s) available, i.e. whether the government pursues environmental policy or trade policy (the other being exogenously fixed), or both; and whether they use taxes, quotas, or tradable permits. Lastly, the source of externality may be in production or in consumption.

We look at the distinguishing features in some more detail before we turn to the models themselves, starting with the *transmission channels* through which governmental policies feed into the other governments' calculus. Countries can be linked solely through commodity trade or through commodity and factor trade.⁸ In the former case, trade policy will affect the sectoral production pattern as well as the consumption pattern and thereby also the level of pollution as pollution-intensities of production or consumption of their respective goods differ across sectors. Environmental policy has the same effect because it likewise changes

⁸ In this survey we deliberately disregard models in which goods or factor trade is only intersectoral, but not transboundary, such as Forster (1977) and Yohe (1979). They deserve credit for providing the building blocs for the international models.

relative prices; in addition, it might have a direct effect on pollution levels as it caps overall pollution (or per unit of output). If also factors are mobile internationally, environmental and trade policy will not only impact on the intersectoral allocation of resources and thereby their remuneration (via the Stolper-Samuelson effect), it will additionally affect the international allocation of factors. The arbitrage condition of equal gross prices for goods is supplemented by a second arbitrage condition of equal gross prices for internationally mobile factors. The third transmission channel is transboundary pollution, in which case environmental and trade policy affects the level of domestically relevant pollution not only through their effect on domestic production but also on foreign production.

Another criterion is the *country size*; small open economies take international factor and commodity prices as given, whereas large countries influence world prices through their trade and environmental policies (optimal tariff argument and its analogon for environmental regulation). While trade models are typically *general equilibrium* models, which take into account the interaction of factor and goods markets, there are also *partial equilibrium* approaches to trade and environment. This neglect of spillover effects to other markets and the endogeneity of all prices in an economy might be justified if the market is small; it often allows us to derive sharper results than in a general equilibrium framework. Models are also characterized by the *market form*: perfect competition yields different outcomes than imperfect competition. In a general equilibrium framework, monopolistic competition models for example can portray the role of scale economies and product diversity. Strategic trade policy considerations are typically modeled in a partial equilibrium duopolistic setup, where governments try to shift profits to ‘their’ domestic firms through policy intervention. Both types of models have of course been applied to environmental policy. The majority of models, however, still assumes perfect competition.

First we will survey the models where goods are mobile, but factors are not (Sect. 3.3). Then we will integrate factor mobility (Sect 3.4). Within each group, we start with partial equilibrium analyses and study subsequently how results are altered when general equilibrium

feedback effects are taken into account. Also we will differentiate between small country and large country models and discuss the few imperfect competition models separately. Moreover, we distinguish a special class of general equilibrium models that deal with pollution in a North-South context as they explicitly deal with a special asymmetry of the countries involved. Unless indicated otherwise, pollution is assumed to be caused in production. For each model it will become clear what the available policy instruments are. A taxonomy of the models surveyed in this chapter is presented in table 2.

Table 2: The traditional integration & environment literature surveyed

	<i>Trade Models</i>		<i>Factor Mobility (and Trade)</i>	
Partial Equilibrium	<u>SMOPEC</u>	Anderson (1992)		
	<u>LOPEC</u>	Krutilla (1991) Anderson (1992) Ludema & Wooton (1994)		
	Imperfect Comp.	Barrett (1994) Conrad (1993, 1995) Kennedy (1994)* Ulph (1994, 1996)	Imperfect Comp.	Ulph & Valentini (1997)
General Equilibrium	<u>SMOPEC</u>	McGuire (1982) Ulph (1994)* Copeland (1994)	<u>SMOPEC</u>	Oates & Schwab (1988) Rauscher (1993) Copeland (1994)
	<u>LOPEC</u>	Pethig (1976) Siebert (1977) Asako (1979) McGuire (1982) Rauscher (1991a, 1994) Ulph (1994)*	<u>LOPEC</u>	Long & Siebert (1991) McGuire (1982) Merrifield (1988)* Rauscher (1991b*, 1992*, 1993*)
			Imperfect Comp.	Markusen, Morey, Olewiler (1993, 1995) Pflüger (1996) Markusen (1997)
	North- South	Chichilnisky (1994) Copeland & Taylor (1994, 1995*, 1997)	North- South	Chichilnisky & Di Matteo (1996) Copeland & Taylor (1997)

* includes (also) transboundary pollution, otherwise only local pollution.

LOPEC: Large Open Economy

SMOPEC: Small Open Economy

North-South models all assume perfect competition.

3.3. *Trade cum Environment Models*

a) *Welfare implications of trade liberalization when environmental policy is exogenous*

We first analyze the influence of trade policy, notably trade liberalization, on welfare in the presence of an environmental externality when environmental policy is exogenous. Pethig (1976) is a good point of departure. He analyzes a negative externality that occurs in production and does not generate any transboundary effects. These are standard assumptions which are shared by the other papers reported below unless indicated otherwise. Pethig shows in a simple and rather specialized general equilibrium model that traditional propositions of international trade theory, *viz.* the law of comparative advantage and the factor price equalization theorem, continue to hold when environmental resources are incorporated. The endowment with environment depends on environmental regulation, and therefore endowment ratios and trade pattern is policy-induced. Yet, it is no longer certain that both countries will gain from free trade. The country that exports the pollution-intensive good will suffer from higher pollution after opening up to trade, which might offset the traditional gains from trade. The country that exports the cleaner good will unambiguously be better off. Asako (1979) obtains a similar result: a small departure from autarky will make the exporter of the pollution-intensive good worse off; for supermarginal deviations from autarky the net effect of higher pollution and higher consumption is a priori undetermined.⁹

Anderson (1992) corroborates these results using the traditional graphical analysis in a partial equilibrium setting. A small open economy with no environmental policy gains from opening up to trade if this increases the *imports* of pollution-intensive commodity. Not only does the country realize the traditional gains from trade (i.e., with a world price below the autarky price the increase in consumer rent exceeds the reduction in producer rent after a switch to free

⁹ Siebert (1977) obtains a very similar set of results. Only for brevity's sake we refrain from reporting details of his setup.

trade); the overall gain from trade, including the welfare effects of the externality, is larger than in the absence of the negative externality because this negative externality is reduced. The reason for this is that with no environmental policy correcting for the externality, the marginal social costs exceed the marginal private costs. Thus, reducing domestic production and increasing imports yields an additional gain that amounts to this cost difference integrated over the reduction in output. Conversely, if the world market price for the dirty good is larger than the autarky price, increased production for exports raises the pollution level, which runs counter the traditional gains from trade: the net effect can have either sign. This is formally shown in a short appendix (page 84).

Matters are different if the externality occurs in consumption. Trade liberalization makes imports cheaper and thus increases under normal circumstances their consumption. Thus if the import good causes pollution, trade liberalization will reduce environmental quality. If the consumption of the export good causes pollution, the environmental quality is only reduced if consumption of the export good is increased through the trade liberalization. This is the case if the income effect from gains from trade more than offsets the relative price effect from liberalization. The effects are summarized in table 3.

Table 3: The effect of trade liberalization in the absence of environmental policy
(or environmental policy adjustment)

	pollution occurs in production	pollution occurs in consumption
Good X is the export good	Free trade increases	Free trade may increase pollution

	Pollution	if income effect is dominant
good X is the import good	Free trade decreases Pollution	Free trade increases Pollution

b) Partial equilibrium analyses

However, if an optimal environmental policy is in place, trade liberalization will unambiguously enhance welfare also in the case of pollution-intensive exports.¹⁰ A production tax internalizes the negative externality and limits the increase in production after trade has been liberalized. Pollution increases, and so does consumption, such that the social benefit and the social costs from exports are equalized at the margin. Anderson goes on to show that trade taxes could also be used to reduce environmental degradation, but that they would be inefficient. The first-best solution is of course a tax on the activity that causes the negative externality.¹¹

The results carry over to the large country case, altered only by a terms of trade effect. If a large country opens up to imports, welfare increases for the reasons stated above. Yet this increase is smaller than in the small country case, because the world market price rises due to the additional demand. This reduces the consumer surplus. Liberalizing pollution-intensive exports is still beneficial if environmental policy (i.e. a production tax on dirty exportables) is optimal. But the additional supply on world markets reduces the world market price and thereby the increase in national welfare. Anderson notes that if pollution is transboundary the welfare gain may even be larger than in the small country case because production and thus pollution abroad is reduced. This additional gain could overcompensate the negative terms of

¹⁰ Recall that if not indicated otherwise, pollution is assumed to occur in production.

¹¹ To be even more precise, the first best is a tax on the emission itself, the second best is a tax on the pollution-intensive production, and trade taxes are at most third-best.

trade effect. Domestic production and pollution has risen, but the increased pollution is more than offset by increased consumption possibilities due to the optimal environmental taxation. In the large country case, this taxation of exportables not only internalizes the negative externality, it also improves the terms of trade as it curbs production.

This interdependence of terms of trade and environmental considerations is what Krutilla (1991) studies in his partial equilibrium model of a large open economy. It is clear that a first-best policy consists of a standard Pigouvian tax and the standard optimal tariff (see Markusen 1975a).¹² If however the government is circumscribed in the use of tariffs, say it is limited to zero tariffs by a free trade agreement, the optimal tax will deviate from the Pigouvian tax. For example, for a production externality the second best tax on production will exceed (fall short of) the Pigouvian tax, if the country is a net exporter (importer) of the respective good. In the case of exports the tax reduces export supply and realizes a monopolistic surplus beyond the environmental benefit caused by lower production. A production tax on import-competing pollutive goods not only reduces domestic pollution, it also increases world demand and therefore deteriorates the terms of trade. The optimal tax is thus lower than the Pigouvian tax, such that the marginal loss of additional environmental damage is offset by the marginal benefit of reduced import costs. If the negative externality occurs in consumption, the optimal tax is smaller than the Pigouvian if the country is an exporter and higher if the country imports the good. The reasoning is the same as before, only the tax has the opposite impact: a tax on consumption reduces the demand for imports and improves the terms of trade, but it increases the export supply, which deteriorates the terms of trade. If the tariff is positive, but cannot be changed, the deviation from the Pigouvian tax is smaller in all cases since a reduction in international trade reduces the tariff revenue.

¹² This argument of course disregards a possible retaliation, which might (but need not) annihilate the gains from setting optimal tariffs. See Johnson (1953) on this.

In a rather special partial equilibrium model, Ludema and Wooton (1994) take one step further by incorporating strategic interaction. The polluting good is only consumed at home, but produced in the foreign and the home country. The externality, however, is created only through foreign production, but occurs only in the home country after the good has been exported. Perfect competition prevails; Home levies an import tariff and Foreign an export tax. Welfare functions are the sum of consumer and producer surplus plus tariff revenue less the externality for the home country and the sum of tax revenue and producer surplus for the foreign country. In the Nash equilibrium the sum of trade taxes exceeds the world-optimal level (which would exactly internalize the externality) for the standard terms-of-trade reasons. The externality gives Home a reason to further increase its tariff; as a consequence, Foreign reduces its export tax and is worse off. If abatement is possible at some increasing costs and Foreign can tax production of the pollutant, it will adopt a combination to export tax and pollution tax. Abatement is costly for the foreigners who do not suffer from the externality anyway, but it reduces the level of the domestic tariff and thereby increases foreign welfare. Rising abatement costs produce an inner solution. If trade taxes are restricted to zero as would be the case in a free trade agreement, Foreign levies a pollution tax to improve its terms of trade, thereby incurring the wasteful abatement costs. Results are a straightforward extension of Markusen (1975a) and Krutilla (1988) and they demonstrate the principles at work; yet the special setup seems restrictive. It is hard to justify that the externality should result only from the domestic consumption of the foreign exports. If the externality occurred in domestic consumption the optimal policy would be a consumption tax cum import tariff, which is covered by Krutilla (1988). Results are analogous for production externalities.

c) General equilibrium analyses

The above results were derived in partial equilibrium settings, which do not account for the feedback effects in other sectors. In particular, they disregard changes in factor allocation and

remuneration throughout the economy, as well as production and trade pattern as a consequence of environmental control. We now turn to general equilibrium models, which do not suffer from this drawback.

McGuire (1982) studies the effects of environmental regulation in a two sector Heckscher-Ohlin model. Both commodities are produced with capital and labor; one – polluting – sector uses the environment as the third factor of production. One way of modeling environmental control is to levy a tax on the use of the environment, which raises the price of the environment and thereby its usage. Another alternative is to issue tradable pollution permits which can be auctioned off. Optimality requires that the value marginal product of the environment is equal to its (shadow) price. McGuire shows that for linear homogeneous production functions with equal pairwise elasticities of substitution σ_{KE}, σ_{LE} , increased regulation is equivalent to negative neutral technical progress. Factor rewards and factor allocation change in the course of tightened environmental control. In a small open economy, the factor used intensively in the regulated (polluting) sector will be worse off while the other factor unambiguously gains. To see this, assume that the pollutive sector is relatively labor-intensive. Reduced environmental input caused by tighter control drives down the marginal productivities of labor and capital in this sector (given the assumption of equal and positive elasticities of substitution for all factors). This leads to an outflow of the factors into the other sector until marginal productivities are equalized again; the production of the polluting sector shrinks, the other sector's production increases and both production processes have become more labor-intensive. Labor's (capital's) marginal physical product declines (rises), and so do their remunerations since commodity prices are given for a small open economy. If environmental regulation differs across countries, factor price equalization no longer holds and factors are used in different proportions internationally in the production of a given commodity. In the case of a large open economy tightened control leads to an increase of the world price for the pollutive commodity and thereby benefits the factor used intensively in the production of the regulated good in the rest of the world (Stolper-Samuelson effect).

Rauscher (1991a) analyzes optimal environmental policy in a simple Heckscher-Ohlin model, where one sector produces with capital only and the other sector uses capital and environment as inputs; the welfare function is additive separable in consumption and environmental quality. He shows that for a small open economy it is optimal to increase environmental standards (reduce emissions) in the course of trade liberalization if the country exports the non-polluting commodity, because the demand for the dirty good can be satisfied partly by imports. The result is reverse if the country exports the pollution-intensive good.¹³ For a large open economy, Rauscher (1991a) shows how environmental policy affects the terms of trade. He corroborates Anderson's and Krutilla's finding in a general equilibrium setting. If the home country exports the clean good, it will increase its emissions in order to reduce its imports and thereby raise the relative price of its exports. Conversely, the exporter of the dirty good will reduce its emissions to improve its terms of trade. The above result assumed that the foreign country leaves its emission level constant. This will not be the case, however, if the foreign country levies a (constant) emission tax. If the home country exports the dirty good and reduces its emissions to improve its terms of trade, the other country will shift capital from the clean sector into the dirty sector, as this production has become more profitable. This increases the marginal productivity of environmental use and, therefore, with a constant emission tax will increase emissions in the foreign country. With pollution being transboundary it is hence possible to obtain the perverse result that pollution is increased in the home country although it has reduced its own emissions. In that case, the second-best tax on the production of exportables must be lower than in the case of only local pollution.¹⁴ Note

¹³ Bommer and Schulze (1996) show that the result is turned upside down, if the political sector is taken into consideration. It is the government's balancing of opposing interests that drives this result; in Rauscher's setup – like in all the papers surveyed in this section – heterogeneity of people and thus distributional conflicts are neglected. We will take up this point in section 4 when we discuss political-economic models.

¹⁴ Also the first-best policy (from a national perspective) has to account for transboundary pollution. In the case that the foreign country sets emission taxes, the Pigouvian tax remains the same, but the optimal tariff is altered. If higher world prices increase foreign emissions, it is optimal to impose tariffs higher than the standard optimal tariff on pollution-intensive imports. This drives down world prices even further and reduces foreign emissions. Conversely, if the export good is environment-intensive export taxes should be lower than in the

that this model still does not portray strategic interaction of the two countries since the policy of the foreign country remains unaltered.

Rauscher (1994) extends his previous results by introducing a third, nontradable good. He assumes that the two countries are completely specialized in the production of one of the two tradables and produce in addition a nontradable good. Both sectors use environment and capital as factor inputs; the social welfare function is additively separable in the each of the three consumption goods and the environmental quality; the model is of the Heckscher-Ohlin type. He shows that a small country will equally regulate pollution in the two sectors. Moreover, Rauscher modifies in his model the general finding that a large economy should increase the price of the factor it is relatively well endowed with in order to improve its terms of trade. In the context of environmental policy this means for instance that the exporter of dirty goods should tighten its environmental standards beyond the Pigouvian level. In his model, a reduction of the environmental input throughout the economy diminishes the marginal product of capital in both sectors. It is however unclear in which sector this is more pronounced. If the return to capital is squeezed stronger in the nontradable sector, capital will move out to the tradable sector, which might (but need not) actually increase the production of exportables and thereby deteriorate the terms of trade. This might call for sector-specific environmental standards. Under additional, however reasonable assumptions, Rauscher shows that a reduction of emissions in the tradable sector reduces its output and improves the terms of trade. An increase of the environmental input in the nontradable sector, however, remains ambiguous: it raises the marginal product of capital, thereby attracting capital from the tradables sector – the terms of trade tend to improve. On the other hand, the increase of emissions boosts output and therefore reduces the price of nontradables. That tends to decrease capital's remuneration in this sector and drives capital out to the tradable sector,

case of only local pollution. See Ulph (1994) on this and an analysis of emission standards, which yield different results.

which deteriorates the terms of trade. Policy recommendations for this sector thus depend on the parameter values. Note however, that these results are driven a) by the assumed complete specialization and b) by the fact that both sectors use environment as an input.

Copeland (1994) extends the analysis to many sectors and many trade and pollution distortions and studies the welfare effects of piecemeal trade and environmental policy reforms. With many distortions present, it is impossible to establish general propositions on welfare improving reforms, as follows from the theory of the second best. Rather, Copeland emphasizes the importance to consider the interdependence of these two policy fields and hence the need to coordinate policy reforms. For special cases he derives welfare improving reform schemes: If strongly polluting industries are also subject to substantial trade protection, an equiproportionate reduction in either trade barriers or pollution distortions will generally (but not necessarily) improve welfare. Important for the analysis is the identification of spillover effects of policy reforms – the reduction of one distortion may exacerbate (or reduce) another distortion. In that respect, quotas may be preferable to taxes as they tend to annihilate (undesired) spillovers. In a sense, Copeland's paper is the consequent generalization of the low dimension analyses reported above and he incurs all indeterminacies known for instance from high dimensional issues in international trade; it is an application of general models of policy reforms in open economies to the case of trade and environmental reforms.¹⁵

d) North-South models

In the Heckscher-Ohlin framework, trade patterns are determined by relative factor endowments which are assumed exogenous; the endowment with „environment“ as a factor of production, however, is not exogenously given. To be sure, a country with huge wooded areas

¹⁵ For higher dimensional issues in international trade see e.g. Ethier (1984), for the analysis of piecemeal policy reforms see, inter alia, Vousden (1990) or Dixit (1985).

is better able to absorb CO₂ emissions than other countries; but the amount of environmental inputs available to the production process (i.e., the permitted quantity of emissions) is predominantly determined by environmental regulation. Regulation is of course the outcome of a political process, which needs to be studied from a political-economic perspective, but within the fictitious framework of a benevolent government maximizing a social welfare function it reflects the preferences of a representative individual. This link is explicitly established by Copeland and Taylor (1994). They assume two regions, North and South, that are identical save for the level of the human capital of their work force. Both regions produce a continuum of goods with the help of labor, measured in efficiency units, and environmental input; pollution is local. The income difference in per capita income levels is the driving force of their model: Because environmental quality is a superior good, the richer North imposes stricter pollution taxes than the South to exactly offset the marginal damage. In other words, pollution is optimally provided in autarky and trade. Trade liberalization has three effects on environmental quality: The scale effect of increased economic activity raises pollution; the technique effect describes the switch to cleaner production processes which is triggered by a rise in income levels and thus in pollution taxes. Lastly, the composition effect reflects the pattern of international specialization. Because the relative price of pollution-intensive goods is higher in the North, the South specializes in the production of dirty goods. Under the model's assumptions, pollution in the North decreases, but increases in the South and world pollution rises in the course of trade liberalization. Since pollution taxes are set optimally, both regions gain from trade.

In a companion paper, Copeland and Taylor (1995) investigate the case of transboundary pollution. Now, uncoordinated national environmental policy cannot eliminate market failures and, consequently, gains from trade need not arise. As before, free trade and sufficiently different human-capital levels lead to a concentration of pollution-intensive industries in the South, which has laxer environmental standards, and increased global pollution. Now, however, the population of the North is also exposed to this exacerbated pollution, but does

not have the leverage to efficiently reduce pollution through Pigouvian taxes. In the resulting non-cooperative Nash equilibrium the North loses from trade while the South gains. This is because the South can commit to lower environmental standards (due to lower per capita incomes); this leaves the North with the option to accept higher pollution or to cut back its production of pollution. In Copeland and Taylor's (1995) model, the North exactly offsets the increase in emissions originating from the South if factor prices are equalized, so that global pollution remains constant.¹⁶ The reduction of emissions is equivalent to a reduction in factor endowment and therefore shifts the budget constraint inwards. The result that the North unambiguously loses from trade depends on the specifics of the model; however the basic switch in perspective remains valid in a much wider class of models. With only local pollution and non-Pigouvian pollution taxes the exporter of the pollution-intensive good is potentially worse off (because pollution increases domestically). In the case of transboundary pollution and internationally different preferences, the finding is reverse. The exporter of the cleaner goods suffers from increased – global – pollution. If this effect is strong enough to offset the gains from trade in terms of increased consumption, the country's welfare is diminished. The rationale behind this result is that a region cannot unilaterally internalize the global externality and that the lower preference for environment gives the high-pollution country a strategic advantage as it can commit to higher emissions. That makes cooperation difficult. Copeland and Taylor demonstrate that international trade in pollution permits would curb global pollution as it equalizes the price of the environment and eliminates the pollution-haven effect. A globally efficient solution of course requires that each country sets the emission tax equal to the global marginal damage of their emissions. To obtain such a solution side payments may be needed (cf. Markusen 1975b).

¹⁶ If factor prices are not equalized, because income levels and therefore endowments differ by too much, global pollution will rise. Copeland and Taylor (1995) produce a number of other interesting results. For instance they show that transfers from the North to the South reduce pollution in the South and raises it in the North. This may increase North's welfare.

While Copeland and Taylor (1994, 1995) focus on income differences, and thus differences in environmental regulation, as the sole reason for trade, in their 1997 sequel paper they also include differences in relative factor endowments as determinants of trade and pollution patterns. While the North is richer and tends to have more stringent regulation, the (richer) Northern countries tend to be also more capital abundant. If more capital intensive production tends to be more polluting, the resulting trade pattern depends on the relative strength of the two opposing effects. If income differences are small and thus - given equal national utility functions - environmental taxes are similar, trade patterns are determined by differences in relative factor endowments: the more capital abundant North exports the pollution intensive capital intensive good. Conversely, if relative endowment differences are small but income levels are not, the North will specialize in the production of the clean good.¹⁷ They portray this interaction of two reasons for trade in a specific factors model with labor and capital being the specific factors and pollution being the mobile factor; pollution is assumed to be confined within national boundaries. As in their previous papers, pollution is endogenously determined through utility maximization of the representative agent. They show that if the endowment effect dominates the income effect world pollution falls with free trade: The North specializes in the dirty good but with stricter regulation than the South has in place. If matters are reverse world pollution increases; which is basically the result of their 1994 paper.

Chichilnisky (1994) focuses on a different reason for North-South trade in environment-intensive goods; she shows that ill defined property rights in the South create trade between otherwise identical regions. In a two region model, two tradable goods are produced by two factors, capital and environment. Both countries are identical in tastes, technologies and

¹⁷ There is a small inconsistency in their model: Richness should be defined in per capita levels as individual income of the representative agent determines his preference for environmental quality, as Copeland and Taylor (1994) argue correctly. With only two primary factors of production, capital and labor, however, differences in relative endowment are proportional to differences in per capita income levels. It is thus not possible that countries are similar in endowment ratios but unlike in per capita income levels. This inconsistency is yet easily removed if labor is measured in efficiency units and labor is unequally efficient across countries. It is

endowment, except for the fact that property rights of the global common, the environment, are poorly defined in the South, but well defined and protected in the North. This leads to an overuse of the resource in the South as the resource is underpriced. International trade exacerbates the problem: trade equalizes factor and goods prices and thereby exports the misallocation to the North. The South overproduces the environment-intensive good, and the World overconsumes it. Apparent comparative advantages need no longer reflect actual comparative advantages.¹⁸

e) Imperfect competition

Up to now we have discussed only papers which analyze environmental policy in a perfectly competitive framework. Yet many industries are characterized by scale economies, leading to *imperfectly competitive markets* and international intra-industry trade. This observation raises the question of how environmental policy is pursued when market power and thus profits are an issue. Governments have an incentive to behave strategically in order to shift rents from foreign to domestic producers; they do this by committing to a certain environmental policy prior to the production decisions of the firms, with the intention of giving domestic firms a competitive edge over their foreign competitors. The literature on strategic environmental policy closely follows the strategic trade literature, as introduced by Spencer and Brander (1983) and Brander and Spencer (1985). Examples are Barrett (1994), Conrad (1993, 1995),

then again different human capital levels that account for income differences apart from different physical capital intensities as in Copeland and Taylor (1994, 1995).

¹⁸ In this model of identical countries, no trade would occur. The poorly defined property rights only establish an incentive for trade.

In an extension of her model, Chichilnisky and Di Matteo (1996) show under assumptions that South-North migration triggered by wage differentials decreases the exploitation of the resource in the South and is therefore welfare-improving for the South, but may deteriorate North's welfare.

Kennedy (1994), and Ulph (1996).¹⁹ The basic setup is this: In a partial equilibrium model, two firms in two different countries produce solely for a third market. The production of the good involves only local pollution, which the firm can abate at convex abatement costs. The remaining emissions produce social damage, which is convex in the emissions. The government maximizes a social welfare function which is equal to the difference of net profits of the domestic firm (total revenue minus production and abatement costs) and the social damage. In a two stage game, governments move first by setting environmental standards or emission taxes,²⁰ then the two producers seek to maximize profits in a Nash competition.

First, strategic environmental policy is again only second best; if governments have standard trade policy instruments available, like production subsidies, there is no need to distort environmental policies (Barrett 1994 and Conrad 1993). Within the second-best framework, the results are as follows (see Barrett 1994). If producers compete in quantities (Cournot competition), governments will set emission standards lower than what is environmentally optimal.²¹ This shifts the domestic producer's reaction curve outwards and *ceteris paribus* increases his output. If the foreign government did not react that would shift profits to the domestic producer. (The reason for this is that the government can commit the producer to higher output which leads to a reduction in foreign output.) In the resulting Nash equilibrium, however, both countries set standards too low, which increases emissions and total output, and, hence, reduces both firms' profits as well as the social welfare. This finding is in stark contrast to the case of a large country exporting pollution-intensive goods produced under perfect competition. In that framework, the large country has an incentive to tighten

¹⁹ Since strategic trade models are well known, we restrict the exposition to a necessary minimum. Although this branch of the literature is relatively recent, there are more contributions than we can survey. For a survey see Ulph (1994).

²⁰ Most papers analyze either emission standards (Barrett 1994) or emission taxes (Conrad, Kennedy 1994); Ulph (1996) introduces a third stage where governments choose the instrument prior to choosing the level at which it is adopted.

environmental standards beyond the Pigouvian level, whereas here, the incentive is quite reverse.

The aforementioned Cournot competition of the duopolists describes a scenario of “ecological dumping”; however, this result is not robust. First, if the domestic industry is oligopolistic (instead of being just a single firm), the strategically optimal environmental policy might be tighter or laxer than the environmentally optimal policy. The reason for this ambiguity is that while lower environmental control shifts profits from the foreign producers to the domestic industry, a tighter emission standard reduces domestic output which is already too high – domestic firms would be better off if they colluded and reduced their output. Strict environmental policy is an imperfect substitute for this collusion. Second, if firms compete in prices and not in quantities (Bertrand competition) the results are reversed. Governments then have an incentive to set environmental standards stricter than the Pigouvian level to induce their firms to raise prices. This is not surprising as it is a well known result in the strategic trade literature (see Eaton and Grossman 1986). Ulph (1994) and Conrad (1995) show that these results derived for emission standards carry over to the case of emission taxes. The above non-robustness results cast serious doubt on the usefulness and possible policy implications of the literature on strategic environmental policy.²²

²¹ Environmentally optimal emission standards are characterized by the equality of marginal damage of pollution with marginal abatement costs.

²² The strategic environmental policy model has been extended in many ways. For instance, introducing domestic consumers tends to further lower the optimal standard, as domestic output is too small under imperfect competition to begin with. The social welfare function additionally includes the domestic consumer rent. Of course, this is again only a second-best policy. Moreover, if pollution is transboundary, the rent shifting incentive is reinforced (Kennedy 1994). With local pollution the shifting of profits and thus production to the home country incurs the social cost of higher pollution. This is not (as much) the case with global pollution as the increase of domestic pollution is (partly) offset by the reduction of foreign originated global pollution.

3.4. *Factor Mobility*

As one major result of the previous section, we have seen that free trade leads to a specialization of countries in environmental-intensive or -extensive goods according to their relative endowments. Given optimal environmental policies free trade will benefit all countries, including the exporter of the pollution-intensive good. Introducing international factor mobility raises at least two issues: First, if trade and factor mobility are substitutes, differences in relative factor endowments could give rise to factor movements instead of trade, the factor content of which reflects these endowment differences. This is particularly important if trade alone cannot bring about factor price equalization (FPE). Yet, even if factor endowments are not too different, factor prices will hardly be equalized through trade, because of the domestic ‘distortions’ created by environmental policies. Optimal environmental policies (emission standards or taxes) typically differ between countries as pollution levels differ.²³ This is a direct consequence of free trade and the resulting specialization of the production structure. Unequal regulation causes factor prices to differ which would otherwise have been equalized through trade (McGuire 1982). If, however, optimal environmental policies cannot be sustained when they trigger factor movements, is free trade still advantageous for all participating countries? And, as a second set of issues, how does environmental policy affect the allocation of capital and, conversely, how does increased factor mobility feed back to a (second-best) environmental policy?

There are basically three approaches to the analysis of international factor mobility and the environment. The first looks at factor mobility only and uses the traditional MacDougall-Kemp model, which is a single-good general equilibrium model where trade occurs only to pay interest on foreign investment (Oates and Schwab 1988, Long and Siebert 1991, Rauscher 1991b, 1992, 1993). Alternatively, multi-commodity models incorporate the interaction of

²³ Another reason for different levels of regulation is of course diverging national preferences with respect to environmental quality, see for instance Copeland and Taylor (1995).

trade patterns and international factor mobility (McGuire 1982, Merrifield 1988). While these are perfect competition general equilibrium models, a quite different approach looks at location decisions in imperfectly competitive markets (Markusen, Morey, Olewiler 1993, 1995, Pflüger 1996, Markusen 1997) We start with the first approach.

a) Single commodity models

Oates and Schwab (1988) analyze in a traditional neoclassical setup how a small open economy with mobile capital and immobile workers should optimally tax capital and set emission standards. The environment serves as a third input in the production. Pollution is only local and they assume that each firm is allowed to emit pollutants in a fixed, administered proportion to its labor force, which makes the model *de facto* a two factor model. If tax revenues are redistributed to the - identical - residents, it is optimal not to tax capital²⁴ and to set emission standards such that the marginal rate of substitution between consumption and environmental quality equals the marginal product of the environment. Neither the capital allocation is distorted, nor is the environmental policy suboptimal, although jurisdictions compete for mobile capital. If, however, jurisdictions must rely on capital taxation to finance public goods (or the government seeks to maximize revenue according to the Brennan and Buchanan (1980) hypothesis), environmental standards will be set at inefficiently low levels. Laxer environmental policy does not only increase domestic production along with pollution, it attracts also capital, which now generates additional revenue and thus finances additional public goods. The marginal social benefit from improving the environment (i.e. the marginal rate of substitution between consumption and better environmental quality) now exceeds the marginal social costs, which is the reduction in production possibilities. The reason is that an

²⁴ This is a standard result in the tax competition literature, which we will not elaborate any further. For a survey of this literature see Koch and Schulze (1997).

improvement of the environment creates a positive externality for the other countries as capital exits the country and diminishes the tax revenue. Governments must take this into account. As a result, environmental standards are too low and the public good is underprovided. This result is an extension of a standard result in the tax competition literature, *viz.* that public goods are underprovided because competing governments are not able to internalize the positive externalities they create through taxation of mobile capital.

Long and Siebert (1991) corroborate the first result of Oates and Schwab (1988) that decentralized environmental policy formation is also globally efficient if capital is mobile and pollution remains local. Their finding hinges on the assumption that there are no other distortions such as capital taxes (as we have seen) and that countries are either too small to be able or unwilling to act strategically. Long and Siebert remove the second assumption and show in a standard single-good neoclassical model with two large countries how governments can use environmental taxes to manipulate international capital flows. A capital exporting country will set environmental standards too low, curb the capital outflow and thus improve its factor terms of trade. The resulting equilibrium is globally inefficient as expected. Long and Siebert go on to show that if pollution spills over to the other country, decentralized environmental policy is unable to produce efficient equilibria as in the case of goods mobility.

Rauscher's (1991b) setup is similar. He analyzes a neoclassical two-country model with mobile capital and emissions as factors of production. (Long and Siebert assume capital and labor as production factors and the use of capital produces emissions) Within this framework he shows the factor terms of trade effect of environmental policies. The increase of emissions in the capital exporting country reduces the capital export, thereby raising the proceeds from it, and increases the transboundary pollution; it thus hurts the capital importing country. Conversely, rising emissions in the capital importing country increase the capital imports and the rental rate, but increase again transborder pollution – the sign of the externality for the other country is indeterminate. Increased capital market integration (modeled as lower mobility costs) causes the capital exporter to lower his emissions. The

marginal productivity of emissions has decreased due to the outflux of capital and so has marginal utility of consumption as income increases following the integration. In order to re-equate the (reduced) marginal utility of emission from higher consumption with the (constant) disutility of emissions due to pollution, emissions have to be reduced. For the capital importing country the effect is ambiguous because marginal utility of consumption has decreased as well, but marginal productivity of emissions has increased due to the inflow of capital. Also welfare effects are ambiguous.²⁵ Rauscher (1993) studies trade patterns, trade-induced changes in emissions, factor terms of trade effects and welfare effects of increased capital mobility in a unified framework. The twist is that emissions serve as a factor of production and generate pollution, together with foreign emissions, which not only cause disutility of the eye-sore type (deterioration of environmental quality), but also reduce overall productivity of the economy.²⁶ As a result, an increase in emissions has a factor-augmenting and a productivity-reducing effect, which work in opposite directions. This constitutes another source of ambiguity. While many of his results generally are ambiguous, he shows that increased capital mobility is welfare-enhancing if the country is small and environmental policies are optimal. Large open economies may lose from increased capital mobility even if environmental policies are optimal. The reason is that the efficiency gain is countered by a negative terms of trade effect and higher *transborder* pollution for the capital exporting country; the impact of altered *domestic* pollution on welfare is zero if optimal policies are in place.

²⁵ Note that Rauscher's results hold only under the assumption of zero third derivatives of the production functions. This restricts the power of his results. Rauscher (1992) analyzes the effect of economic integration in a three-country model, which is otherwise similar to his (1991b) paper. Welfare results are again generally ambiguous. We refrain from reporting them due to space limitations.

²⁶ Rauscher's idea behind that formulation is that „industries that rely on clean air and water, e.g. agriculture and tourism, are negatively affected by environmental damage.“ (Rauscher, 1993: 3). That would call for a multi-sector model which would then allow for the explicit analysis of sectoral interests with respect to pollution. A political-economic analysis would be the appropriate consequence of this insight. Because Rauscher has chosen a single good model, he portrays this public input aspect of environmental quality as an efficiency parameter. Merrifield (1988) had a similar idea, namely that pollution damages the capital stock; in

b) Multi-sector models

The models reported so far bury some important aspects of the relationship between environmental policy on the one hand and international trade and factor movements on the other. Because they are essentially single commodity models, they cannot portray the effect of environmental policy on the production and trade structure when factors are mobile across countries. For instance it will turn out that sectors or factors are very differently affected by environmental regulation and that the impact of this very regulation depends on whether the affected factors, being sector-specific or not, have an escape option by moving abroad.

McGuire (1982) shows in a two sector Heckscher-Ohlin model with one polluting sector that internationally different regulation destroys the link between national factor prices established through trade. With one factor being mobile internationally this gives rise to factor movements until factor rewards are equalized intersectorally and internationally. In the Heckscher-Ohlin model this implies that the country with the stricter regulation will entirely lose the regulated industry if the country is small. If the country is large, say the world consists of two countries, the factors will flow out of the more heavily regulated industry until one country is completely specialized and factor prices are equalized again. Factor and goods prices are altered in the course of this adjustment.

Rather than looking at the impact of environmental regulation on the production structure within a country, Merrifield (1988) focuses on the different effects of abatement requirements versus production taxes when countries are completely specialized. In a two-country model with transborder pollution each economy produces a single composite commodity with the help of internationally mobile capital and immobile labor. Production generates emissions

his setup the negative efficiency parameter is not premultiplied by the production function but by the capital stock.

which can be abated through abatement technology, which in turn is produced by capital and labor. Governments can levy production taxes to reduce output and hence emissions or impose a minimum ratio of abatement technology to output. Finally, pollution damages the capital stock so that abatement increases the efficiency of the existing capital stock used in the final good's production. His results are this: Only an increase in abatement requirement will unambiguously reduce pollution. A production tax in country A may or may not increase pollution in A. The tax on A's production increases consumer prices, reduces demand and diminishes factor prices in A; consequently, some capital moves to country B and increases output there. If B's output is more (less) pollution-intensive than in A, total pollution increases (decreases) and therefore total capital stock in efficiency units is reduced (augmented). The bulk of this diminished (additional) capital is taken from A (employed in B). A unilateral increase in abatement requirement reduces pollution and therefore is likely to increase the capital stock in efficiency units in both countries (unless the abatement technology is terribly capital-intensive), capital's remuneration declines. The imposing country's production declines (under normal demand conditions) due to the additional input requirement, this enhanced scarcity can be alleviated if the country absorbs most of the additional capital.

Copeland and Taylor (1997) study capital mobility in a two-sector specific factors model with capital and labor being sector-specific and pollution being the mobile factor (cf. page 67). The North is richer and imposes therefore a higher tax on environmental consumption. Because free trade equalizes commodity prices and the shadow price of pollution is higher the North, the wage rate and return to capital must be lower in the North (technology is equal and perfect competition ensures zero profits). If capital becomes mobile, it will migrate to the

South either until all capital has exited the North or until the shadow price of pollution has been endogenously equalized, which implies equal factor prices and incomes.²⁷

c) Imperfect competition

Like most other models on factor mobility, the models that describe environmental policy under international capital mobility assume perfect competition and perfect divisibility of capital. That ensures continuous relocation of capital as regulation changes. With imperfectly competitive markets, not amorphous capital but entire firms change location as parameters, like emission or capital taxes, vary. Consequently, marginal changes in policy can lead to discrete jumps in national welfare. Markusen, Morey and Olewiler (1993) show this in a two firms, two country, two stage model: In stage one the firms decide whether to enter, where to produce and whether to export to the other country if they set up only one plant. Stage two is a simple one shot Cournot game. Firms' decisions depend on the pollution tax set by the domestic government, the foreign country remains passive. They show how the resulting market structure feeds back to prices, pollution, tax revenue, and firms' profits. These partial welfare effects move in opposite directions so that results can be derived only for given parameter values.

In an extended version Markusen, Morey and Olewiler (1995) incorporate strategic interaction of the governments.²⁸ They set up a two country, two sector general equilibrium model, with one sector being perfectly competitive and clean and the other sector consisting of one polluting company only. This monopolistic firm decides whether to produce in one location

²⁷ Because regulation is endogenous, McGuire's (1982) extreme result of complete specialization need not occur; in other words, if per capita levels are equalized before all capital has left the North, both regions continue to produce both commodities.

²⁸ Note that if capital is relocated discretely instead of continuously Bertrand equilibria such as this will exist only under very restrictive assumptions; see Koch and Schulze (1998) and Schulze and Koch (1994) on this.

only (and to costly export to the other), with a plant in each country, or not at all. The decision depends on the values for taxes of both countries, plant-specific fixed costs, and transportation costs. The identical countries solely tax production of the monopolistic, dirty good, but at potentially different rates for exports and domestic consumption. A lower tax rate will increase effective demand, thereby tending to make two plants profitable; at the same time it will attract the single plant to the home country, which leads to large discrete welfare changes. Governments will undercut each other's tax rates in order to attract the single plant or, in the case of two plants, to induce the monopolist to close down its plant in the other country and to export to it from the own country. In the first case, the country moves away from a no plant situation, having to import at high costs, and receiving no revenue; in the second case, the country experiences a welfare gain as long as the export tax revenue exceeds the disutility from increased pollution. Undercutting will come to a standstill when capturing the other market does no longer make sense, i.e. the disutility from additional pollution (through exports) is just offset by additional tax revenues on the exports. Then the domestic tax is set as high as possible without losing the domestic plant.²⁹

Ulph and Valentini (1997) extend the strategic environmental policy analysis by allowing for intersectoral linkages which provide an incentive for agglomeration. There are two industries, upstream and downstream, with one firm of each type owned by the residents of each of the two countries. Transport costs for the intermediates establish an incentive for agglomeration, transport costs of the final good create an incentive for market proximity. Governments levy an emission tax which is equal to a production tax as emission/output ratio is fix. The game is in three stages: First governments set their environmental policy, then firms locate their plants (none, one, or one in each country), finally, firms choose their output. Like Markusen et al., Ulph and Valentini find multiple equilibria and that marginal shifts in the tax rates may lead to

²⁹ In a sense, Markusen, Morey and Olewiler's 1995 model is a refined version of a Bertrand game that yields the analogon to the well known result that in equilibrium prices equal marginal costs.

discrete jumps in location and welfare. The agglomeration effects reinforce the discontinuity. Further, they show that tax increases may lead to an attraction of firms because of changed agglomeration incentives. Lastly, hysteresis effects may emerge due to agglomeration: An increase of taxes may drive out firms which do not return in the course of a subsequent tax reduction. This paper is located at the intersection of strategic trade (environmental policy) literature and the geography and trade literature and derives a rich set of results. However, like other papers of the strategic trade literature, its setup is rather special and it is not entirely clear how robust the results are.

Pflüger (1996) studies the effects of environmental taxes on firm location in a general equilibrium imperfect competition model. In his two region model, a competitive sector produces only with labor and its products is traded costlessly. This ties down internationally the wage rate. Then there is an imperfectly competitive sector of the Dixit-Stiglitz-Krugman type, producing with labor and emissions. Its goods are traded at some cost. The fixed amount of start-up capital per firm determines the number of firms as the capital stock is given; profits are redistributed to the representative agents. Imperfectly competitive firms locate according to the demand conditions and the availability of emission certificates. An increase in the foreign emission tax rate attracts additional firms to the home country. This reduces the prices for these newly domestically produced goods as transportation costs are saved (home market effect), it also raises tax revenue and pollution at home. Depending on the disutility of pollution, the net effect can have either sign leading to a competitive equilibrium with tax rates that are either too high or too low to internalize the negative externality. Because Pflüger only studies symmetric equilibria, he finds that both regions are worse off, having failed to attract additional firms and having suboptimal taxes in place.³⁰

³⁰ Of course, it would be very interesting to study asymmetric equilibria to see whether some country would gain from such a competition which led to a welfare-inferior situation for the aggregated world. This would parallel results from the tax competition literature, see for instance Bucovetsky (1991). Moreover, it would be interesting to include a second instrument like a tax on production.

Markusen (1997) analyzes the impact of environmental regulation on market structure and welfare in a general equilibrium two country-two sector model. His setup follows earlier work with Venables (1995). One sector produces under constant returns to scale, the other sector is described by scale economies, caused by fixed costs on the firm level as well as on the plant level, and free entry. The imperfectly competitive sector produces with labor only, which is mobile between sectors, the other sector uses an additional sector-specific factor. While factors are not mobile internationally, plant location is. The number and type of firms depend on the (relative) marginal costs, the two types of fixed costs and the transportation costs. There are national firms that produce only in one country and may or may not export to the other market, and multinational firms which produce in both markets, but incur the firm-specific fixed costs only in the country of residence. Trade policy is reflected in the level of the transport costs while environmental policy might fall on fixed or marginal costs. Markusen derives a set of interesting results in his simulation study. Increased protection tends to lead to the emergence of multinationals while the intensification of environmental control tends to shift the regime away from multinational firms towards national firms. Protection tends to reduce the output fall caused by intensified environmental control, but reduces welfare. Stated differently, free trade leads to a stronger relocation of plants in the less regulating country which is welfare superior than the introduction of trade barriers.³¹ Multinational firms smooth the cost increase through stricter regulation in one country over both countries. Lastly, increases of fixed costs lead to exit of firms, but reduce welfare only mildly whereas rising variable costs reduce output per firm and thereby scale economies, which reduces welfare considerably.

In a literal sense, Markusen's model is not about environmental policy as such, because the negative externality is left in the background. It rather demonstrates how (policy-induced?)

³¹ This argument does not consider any welfare effects from changes in pollution, as Markusen does not model the environmental externality. Taking this effect into consideration would reinforce his result.

changes in the cost structure affect the market structure, including regime shifts. However, environmental regulation and trade policy are a special application of his general model in that they affect relative costs and international arbitrage; the impact of environmental policy on the externality would have to be modeled explicitly in order to derive „true“ welfare results. One of the merits of this model is to show that environmental policy might have very different effects on allocation and welfare, depending on whether they affect fixed or variable costs. This important difference, once noted, might be useful to rank specific environmental policy instruments.

3.5. *Summary*

The literature on trade and environment is quite extensive, and we were only able to select some representative contributions to it. It is striking that a large part of the literature follows very closely the traditional trade literature and the public economics literature.

What have we learnt from the normative perspective on the relation of trade and environment?

We list below the main conclusions as we draw them.

1. Without environmental policy in place and local pollution, trade liberalization is beneficial for the country specializing in the clean goods, but may deteriorate welfare in the country exporting the pollution-intensive goods as its pollution increases. If environmental policy is optimal, all countries benefit from free trade although world pollution rises.
2. Large countries can use environmental policy to improve their terms of trade; this is, however, only a second-best policy when they are circumscribed in the use of tariffs. Through environmental control they increase the relative scarcity of the factor they are relatively well endowed with, which increases the relative price of their exportables.

3. Internationally different endowments with „environment“ as a factor of production are mostly caused by different degrees of environmental control. They might in turn be determined by the representative individual's preferences, which are income-dependent as environmental quality is a superior good. Alternatively, if property rights are more poorly established in some countries, they will have inferior environmental control and thus overproduction of environment-intensive goods.
4. In the case of transboundary pollution and internationally different preferences for pollution, trade liberalization may actually decrease the welfare of the country with a high preference for environmental quality. A policy that is optimal from a global perspective calls for international coordination, as a nationally optimal policy will not lead to an internalization of the environmental damage for strategic reasons.
5. If markets are imperfectly competitive, say with one national firm only, strategically acting governments will set environmental policies too low when firms engage in Cournot competition. This incentive is reinforced if the pollution-intensive good is also consumed domestically and if pollution is transboundary. Yet, environmental policy may be too strict if the domestic industry is oligopolistic, and will be too tight if firms compete in prices (Bertrand competition). In other words, results are not robust.
6. If capital is mobile and commodities are traded only to settle the invisible trade balance (one-good MacDougall-Kemp model), environmental policy has effects on factor trade analogous to its effects on goods trade – it can be used to improve the terms of trade if countries are large. If optimal environmental policies are in place and countries behave non-strategically, capital mobility enhances welfare.
7. In a Heckscher-Ohlin model with international trade capital mobility leads to the abolition of the polluting sector in the country with stricter regulation. This contrasts the earlier result that free trade is beneficial if all countries adopt optimal

environmental policies. With capital mobility this is not feasible for the country with higher preference for nature - it loses its sector altogether to the more polluting country.

8. If markets are imperfectly competitive, environmental policy targeted at attracting capital can lead to discrete jumps in welfare; it will increase tax revenue and pollution, but save transport costs and hence decrease domestic prices. Depending on the net effect on utility of increased home production, competition may lead to too high or too low environmental taxes. Environmental policy that falls on the fixed costs has less severe impacts than environmental policy that increases variable costs, because scale economies are reduced.

4. Environmental Policy in an Integrated World Economy: The Political-Economic View

We now pick up the thread from part 2 and turn to the political-economy aspects of the interrelationship between economic integration and environmental policy-making. Just as in the previous part we first survey models which analyze trade and environmental policies in a regime of low international factor mobility. We then turn to a regime of high international capital mobility and address the so-called industrial flight hypothesis, i.e. the issue of industry relocation induced by environmental regulation (production standards). This is, of course, an issue most ardently discussed issues in the political arena. Since the literature on the political-economy aspects of economic integration and environmental policy is still in its infancy, we will discuss the few existing contributions in somewhat more depth than we did in the previous part.

4.1. *Trade cum Environment Models*

Even though it appears expedient to formulate trade and environmental policies separately, these policy domains have never been neatly kept apart in the political sphere. Anderson and Blackhurst, in their influential 1992 collection of papers on the *Greening of World Trade Issues*, introduce the political-economy view into the scholarly debate by pointing out that „the trade/environment area has an above-average risk of being exploited by special-interests groups to their own benefit and at the expense of the general interest.“ In their capacity as members of the Economic Research Division of the GATT Secretariat they emphasize in particular „the risk that traditional protectionist groups will manipulate environmental concerns in order to reduce competition from imports“ (p. 20).³² While the influence of environmental interests on endogenous trade policy (ecological protectionism) is of course very conspicuous, it should be noted that the reverse relation, i.e. the influence of international trade on the determination of environmental policy (ecological dumping), plays a similarly notorious role in endogenous policy formation. In any case, it is obvious that both policy regimes are determined simultaneously in the political process; regarding one of the two policy domains as exogenous is clearly not a matter of political reality, but rather of analytical convenience.

Using the distinction between exogenous and endogenous treatment of the two policy domains as the main feature of the models covered in this section, we arrive at the taxonomy presented in Table 4. Notice that the upper right-hand cell refers to models in which neither of the two policies is formed in a way that could lay claim to a realistic portrait of the political process. One can thus subsume in this cell the normative models surveyed in part 3. We begin our survey with the upper left hand cell, i.e. with a model in which environmental policy formation is not analyzed. The focus is thus on the nexus singled out by Anderson and

Blackhurst in the above quote: To what extent can environmental concerns be exploited by protectionist interests? We then turn to models in which trade and environmental policies are determined simultaneously and end up by presenting in a last section models addressing the question as to whether a downward competition of environmental standards („race to the bottom“) is inevitable in the course of global economic integration.

³² Hoekman and Leidy (1992) and Leidy and Hoekman (1994) also delve for political-economic interrelations between trade and environmental policies and put special emphasis on the injury criteria in contingent protection

Table 4: The political-economic literature on trade and environment

	Trade policy endogenous	Trade policy exogenous
Environmental policy exogenous	Section 4.1. a): <i>Hillman & Ursprung (1992, 1994)</i> - LOPEC - imperfect competition, - partial equilibrium	Part 3
Environmental policy endogenous	Section 4.1. b): <i>Schleich (1997)</i> - SMOPEC - perfect competition, - general equilibrium <i>Rauscher (1997)</i> - SMOPEC/LOPEC - perfect comp. - partial equilibrium	Section 4.1. c): <i>Bommer & Schulze (1997)</i> - SMOPEC and LOPEC - perfect competition - general equilibrium <i>Fredriksson (1997,1998)</i> <i>Aidt (1998)</i> -SMOPEC -perfect competition -general equilibrium <i>Bommer (1996)*</i> -LOPEC -imperfect competition - partial equilibrium

* includes also transboundary pollution, otherwise only local pollution, SMOPEC: small open economy.

a) The Influence of Environmental Concerns on Endogenous Trade Policy Formation

The political influence of environmental groups on the determination of international trade policy has been formally portrayed in a model based on political competition in Hillman and Ursprung (1992 and 1994). The focus on trade policy implies that first best intervention is ruled out. This framework lends itself to answering two kinds of interrelated questions. The first question is, will environmental groups use their political influence to support free trade or protectionist policies (if they are aware that they might be able to influence trade policy)? In other words, are environmental groups agents of free trade or protectionism? A further aspect of this question concerns the potential for consensus or conflict of interest among environmental groups in different countries: Do environmental groups in different political jurisdictions have a common objective in the trade policies that they seek? If environmental groups in two trading economies both seek mutual free trade or mutual protectionism, there is consensus; if one group seeks protectionism and the other free trade, there is a conflict of interest. Strategic elements may also in principle affect environmentalists' decisions regarding support for alternative trade policies: a Prisoners' Dilemma arises if the environmental interest groups in two trading economies confront a mutually beneficial policy choice that maximizes the aggregate environmental gains (or minimizes losses), but it is nevertheless individually optimal for country's environmentalists to defect and choose the alternative policy. To state a major finding in advance, the environmentalists' position depends on whether the externality occurs in production or in consumption and whether they care about environmental quality also abroad. After having established the trade-policy stance of the environmentalists, the second question arises as to how exactly the environmentalists influence trade policy-making. To answer this second question, the political process needs to be portrayed.

To establish the interest of environmentalists in influencing trade policy, Hillman and Ursprung, following their 1988 article, use a partial equilibrium model of a representative import-competing oligopolistic industry. The trade policy choices are restricted to the policy

pronouncements of two competing candidates or political parties. The losers from protectionist trade policies are foreign producers seeking market access, and the gainers are domestic import-competing producers. Domestic consumers are of course also losers from protectionist policies, but, on grounds of free-rider problems and small stakes in the outcome of policy determination, consumers can be presumed to be "rationally ignorant" (as they in general are) with respect to the trade policy that is to be adopted for any one industry. The protagonists with sufficient stakes in the outcome are producers who gain or lose as domestic market access to imports is denied.

In this well established framework, Hillman and Ursprung now introduce environmental interests as a third group seeking to influence the political determination of trade policy. The issue is, whether the environmentalists side with the free trade or the protectionistic candidate and, consequently, whose prospects are improved through the entry of the environmentalists into the political arena.

The answer to this first set of questions - are environmentalists agents of free trade or protectionism, do national environmental groups have common cause with the trade policies of their comrades abroad, and do they confront strategic considerations as in a Prisoners' Dilemma? - depend upon the source of the adverse environmental impact (which lies in the consumption or production of a good) and on whether the environmentalists' concerns with the adverse environmental impact transcends their national boundaries. One can define as "green" an environmentalist who is concerned with the adverse environmental impact in his home country only, and as "supergreen" an environmentalist who is concerned with an adverse environmental impact both in his home country and in the country of his foreign trading partner.³³

³³ Some environmentalists are especially concerned about spillovers, i.e. domestic actions which cause pollution abroad. 'Greens' do not have these concerns. 'Supergreens' do, but notice that their concerns are much more encompassing. A true supergreen cares about the state of the environment independent of the source of pollution. Of course, if the pollution is global, this distinction becomes meaningless.

When the adverse environmental impact is associated with *domestic consumption*, the environmentalists described as greens oppose imports, because this increases the domestic price and therefore curbs domestic consumption and environmental degradation. The greens are thus allies of protectionist domestic interests. The benefits of this political alliance are greater, the less competitive is domestic industry. The greens would ideally wish production to be undertaken by a protected monopolist - for the higher concentration in the domestic industry, the greater the decline in domestic production, and therefore in autarky the greater the decline in domestic consumption (the cause of the adverse environmental impact). The protectionist policy not only reduces consumption by curbing imports, but also allows domestic producers to take advantage of reduced import competition to exploit their domestic market power, thus further decreasing consumption - and domestic consumption is minimized when there is a domestic monopoly. Supergreens as well as greens are protectionist agents in these circumstances: supergreens wish to minimize consumption everywhere, which again is achieved by protectionist policies in each country.

However, when the source of the adverse environmental impact is *domestic production*, the situation is more complex and environmentalists confront strategic problems in their choice of which trade policy to support. Environmentalists who are greens wish to minimize production at home, and benefit if imports replace domestically produced output in domestic consumption. However, imports produced abroad disadvantage the foreign environmentalists, who are concerned with pollution in their own country. Therefore a potential conflict arises between environmental interest groups in the two trading economies, and the environmental interest groups potentially confront a Prisoners' Dilemma. The potential for the Prisoners' Dilemma is present, because of the incentive confronting environmentalists in each country to "free ride" off one another, by supporting free trade policies at home that increase pollution abroad via foreign production for export. The best outcome for environmentalists in both countries is mutual protectionism, where no country's environmentalists free ride off the other.

Whether the Prisoners' Dilemma arises to confront the environmentalists in two trading economies depends in a somewhat complex way upon market structures in the industries producing the offending good in the two economies, and on the degree of substitutability in consumption between the domestically produced good and imports in each economy. The prospects for defection (free riding behavior) depend upon the foreign supply response in producing imports for domestic production. Asymmetries in market structures in two trading economies therefore give rise to asymmetries in free riding incentives. When market structures are similar, there are shared benefits from a mutual end to free-riding, that is, from protectionist policies in each economy. Substitutability in consumption affects the likelihood of a Prisoners' Dilemma in support for trade policies, since with low substitutability, protection evokes a lower domestic output response - in the limiting case of zero substitutability, protection would not affect domestic output (and hence domestic pollution) at all. Lower levels of substitutability therefore expand the range of combinations of market structures in the two trading economies for which there is no Prisoners' Dilemma and environmentalists in both economies support protectionist policies.

When those conditions are present that give rise to the Prisoners' Dilemma, the environmentalists in different countries confront a problem of international coordination if they are to be effective and not work at cross-purposes to one another. However, such international coordination is difficult, because of the gains to any one country's environment from defection. On the other hand, environmentalists who are supergreens do not confront the potential for Prisoners' Dilemma situations when deciding which trade policy to support. The supergreens internalize the potential conflicts, since they seek to minimize the total adverse environmental impact associated with international trade in both countries. Hence, the supergreens have no incentive to free ride off each others' imports, and they support protectionist candidates.

Overall, then, only a sufficiently asymmetric market structure or the potential for the Prisoners' Dilemma stand in the way of the solution that environmentalists are agents of, or

supportive of protectionist interests. Under such circumstances, environmental interests can be "captured" by protectionist producer interests. Moreover, it may be more effective for protectionist producer interests to channel their financial political contributions – that are the expression of political support – via environmentalist interest groups: It is politically more rewarding to plead protectionism via the environmental cause than via the self-interest of producer rents in an import-competing industry.

In order to assess the *influence* of environmental trade-policy preferences, Hillman and Ursprung proceed to endogenize the competing parties' trade policy pronouncements by assuming that the parties' constituencies, on the basis of the publicized trade policy platforms, provide them with financial contributions which, in turn, determine the probability of electoral success specified as campaign contributions received relative to the political opponent. The policy pronouncements are assumed to be chosen with a view to maximizing the probability of election. This portrait of the political process in which two games take place (the policy pronouncement game played by the political parties and the subsequent campaign contribution game played by the interest groups) represents an application of the interest-group-cum-electoral-competition approach which Rauscher (1997, p. 221) regards to be the most realistic approach to modeling the political process.

When environmentalists are absent from the political arena it has been demonstrated [cf. Hillman and Ursprung (1988)] that the outcome of political competition is the following: if policy pronouncements are made in terms of tariffs, each candidate takes an extreme position on the spectrum of policies, in that one assumes a policy of free trade and the other a policy of prohibitive protection; if however policy pronouncements are made in terms of VERs, the political equilibrium is characterized by the announcement of a common policy which, in general, implies incomplete protection. These clean results, however, do not survive if environmental interests enter the political arena. In the tariff regime, environmental interests can, for example, give rise to a partial convergence of the trade policy stances in a manner which is detrimental to the environmental interests and in a VER regime the result of complete

convergence at an intermediate level of protection continues to hold only as long as environmental concerns do not exceed a lower bound, i.e. for sufficiently strong environmental concerns the political process either generates complete polarization or an extreme policy outcome (autarky or free trade).

b) Simultaneous Determination of Trade and Environmental Policies

An approach which has especially been designed to explain the *structure* of policy measures is the corruption approach developed by Grossman and Helpman. In its simplest version [cf. Grossman and Helpman (1994)] lobbies offer the incumbent government contributions which are contingent on the policy decisions taken. Since contributions are aimed at influencing the government's policy and not - as was the case in the interest-group cum electoral-competition approach - at affecting the election outcome, the portrayed interaction between organized interest groups and the government meets the circumstances of corruption. The objective of the government is to maximize political support which is specified as a weighted sum of social welfare and total financial contributions received.

Grossman and Helpman (1994) use this modeling framework to investigate the structure of trade policy across industries in a general-equilibrium specific-factor model of a small open economy. In their model no pollution externalities are supposed to exist. Dixit (1995) has introduced more than one policy instrument in the Grossman-Helpman model, i.e. production and consumption taxes/subsidies, still assuming no pollution. In a recent paper, Schleich (1997) extended the Dixit model to develop a positive theory of trade *and* environmental policy. To that end he assumes that either consumption or production of some industry output generates pollution and that the government can use domestic policies (consumption or production taxes and subsidies) and/or trade policy measures (tariffs and subsidies on imports and exports). The government cares about the environment since pollution is assumed to

directly affect social welfare and thereby political support; environmental interest groups, however, are assumed not to compete with the producer interests in the bribery contest.

The qualitative features of the political-economic equilibrium of Schleich's model are quite intuitive. In the case of *pollution via consumption*, the equilibrium policy when only consumption taxes/subsidies are available is simply the Pigou tax. When consumption *and* trade policies are available, trade policy is applied to benefit the organized and to harm the unorganized producer interests and consumption policy is used to adjust the domestic consumer prices to reflect world prices plus the Pigou tax. Political-support maximization and social-welfare maximization thus give rise to identical consumer prices and hence to the same level of pollution; the inefficiency of the political process makes itself be felt solely in the protection of organized producer interests. When only trade policies are available, pollution via consumption calls for an import tariff or an export subsidy since either reduces domestic consumption. The political support and the environmental motive of trade-policy intervention thus reinforce each other for organized industries.

In the case of *pollution via production* it is not optimal for the government to apply trade policies when production policies are available since both policies change producer prices but trade policies in addition also distort consumer prices. When production policies *are* available, organized clean industries obtain a production subsidy and organized polluting industries either a subsidy or a tax, depending on the political support impact of pollution as compared to the potential financial contribution of the industry. When only trade policy is available, organized clean industries obtain import tariffs or export subsidies and polluting industries in addition an import subsidy or an export tax, the joint effect being again ambiguous. Interestingly, it is also ambiguous whether production policy or trade policy alone will generate more pollution.

In his recent monograph, Rauscher (1997) attempts to answer a similar set of questions: Can too lax *environmental production standards* be explained by the particularities of the political

process in open economies and are there incentives to abuse *environmental consumption standards* as an instrument of disguised protection? In contrast to the paper by Schleich, Rauscher employs a partial equilibrium model to analyze these issues. To justify this choice he convincingly argues that neglecting general-equilibrium repercussions of policy measures is not unrealistic in a positive model portraying the behavior of political agents who are usually unaware of the general-equilibrium effects of their activities. The second main difference between the two models consists in the modeling of the political sector. Rauscher uses the political-support-function approach which assumes that the policy-maker's objective is a weighted average of the interests directly affected by the respective policy measures. This modeling approach has its roots in the pioneering work by Stigler (1971) and Peltzman (1976) on regulatory capture and can be interpreted as a reduced form of a more complicated model of political-economic interactions such as a voting game under incomplete information [cf. Yang (1995)] or a Grossman-Helpman type model of corruptible politicians.

Rauscher considers a single import-competing industry. The imported good and the domestically produced good which is not exported are incompletely substitutable in consumption, the domestic firms are price takers, the production technology exhibits constant returns to scale and uses the environment (pollution) and a specific factor which is fully employed. The government can use three instruments to protect the environment from pollution and/or the domestic industry from import competition. The first instrument is a consumption tax which, in principle, can be used to internalize consumption externalities. If the consumption tax on the imported good, however, contains an element of discrimination against imports, the surtax is nothing but an import tariff. Consumption taxes (tariffs), of course, directly increase the consumer price of the respective good and thus, via reduced demand, have a positive influence on the environment. The government may, secondly, specify product standards for the two goods in order to put a cap on pollution via consumption. Product standards increase the unit-costs of production and, on the other hand, decrease pollution via consumption at home. They also have a great potential for being abused

as hidden protectionist measures, maybe even more so than consumption taxes. The third policy measure is an emission tax on the production process. Emission taxes also increase the unit-costs of production and reduce pollution and thus have very similar qualitative effects as product standards.

Social welfare maximization in this framework gives rise to the standard optimality conditions: the optimal tax rates equal the marginal environmental damage and the optimal product standards are chosen such that the marginal cost of increasing product quality equals the marginal improvement in environmental quality. Rauscher compares this first-best policy with the result that emerges if one or more of the policy instruments are captured by an interest group. To portray the capture of policy instruments he assumes that the government maximizes political support encompassing traditional social welfare, the rents accruing to the owners of the industry-specific factor, and the interests of the environmentalists, i.e. the quality of the domestic environment (greens) and environmental quality abroad (supergreens). Assuming that environmental quality is a linear function of pollution Rauscher arrives at the following conclusion for the capture of a single instrument. As a consequence of the political influence of the specific-factor interests, quality requirements which imported goods have to meet are too high, the tax on consumption of the imported good is also too high and the tax on consumption of domestic goods is too low. The influence of the environmental interests (for example with respect to emission taxes) is less straight forward: since policies that reduce domestic emissions and consumption of the domestic good (direct effect) tend to raise foreign emissions and the consumption of the foreign good (indirect effect), their position always depends on the parameters of the model. If the direct effects of environmental regulation however dominate the indirect effects, then industrial and green interests have a common interest in strict standards for the quality of the foreign good and high taxes (tariffs) on the consumption of the foreign good. Since the protectionist content of quality standards can more easily be obfuscated than that of tariffs, such standards are likely to be the first choice if environmental and trade protection are to be combined. Somewhat surprising is the result that

industry and green interests may both advocate and thus implement high emission taxes and strict quality standards for the domestically produced good. This result, however, is an artifact of the model in which the sector-specific factor is used for production *and* pollution abatement.

If *all* available policy instruments are subject to special interest capture, the political-support maximizing policy palette becomes even more counter-intuitive and perhaps also counterfactual. A large weight of the *industry interests* in political support brings about low consumption taxes levied on the domestic good, *high* emission taxes, and *high* environmental quality standards of domestic goods. A large weight of the *green interests* yields the standard results and a large weight of the *supergreen interests* leads to higher tariffs and to less restrictive quality standards for the imported good. Just as in the model by Schleich surveyed above, the mechanism which generates these striking results is the feature that the government always uses the most efficient instrument to secure political support from the respective interests. Owners of specific production capital are offered low consumption taxes, owners of pollution-abatement capital are offered high product standards and emission taxes, and supergreens are offered tariffs in exchange for political support.

Rauscher concludes that his model obviously still lacks some of the aspects which are important in the real policy-making process and he singles out one feature which he suspects to represent the most prominent omission, namely obfuscation [cf. Magee et al. (1989), ch. 18]. To properly model obfuscation, however, one needs to introduce incomplete information and the strategic use thereof. We turn to a model using such a set-up in section 4.2. Rauscher closes his analysis by adding some remarks on how the derived results may change in a large economy framework.

c) The Influence of Economic Integration on Environmental Policy and the Environment

The question as to how an given round of trade liberalization is likely to influence environmental policy-making is investigated in a recent paper by Bommer and Schulze (1997). The model used by these authors is basically a standard perfect-competition, two-sector trade-model with sector-specific factors. The standard model is augmented by the assumptions that, firstly, the environment is used as an additional factor of production (pollution) and, secondly, environmental regulation is endogenized via a political-support maximizing government. The focus of the paper is thus on the general equilibrium effects of inter-industry trade on factor remuneration which, in turn, influences environmental regulation.

In the model by Bommer and Schulze the income-redistribution effect of environmental policy is a consequence of the assumption that one sector relies (more) on the environment as an additional input to its production process. This could, in principle, be either sector; since however industrial countries' export sectors tend to be more polluting than the import-competing sectors, it is assumed that only the export sector uses the environment in the production process. The negative environmental effects of production can be restricted by environmental standards set by the regulator which brings about the crucial redistribution effects: tight environmental standards reduce the productivity of capital and labor in the „dirty“ export industry and drives labor from the dirty export industry to the „clean“ import competing industry where the productivity of capital is enhanced. The two sectors compete with each other for the mobile factor, i.e. labor, and since the dirty export sector is directly affected by environmental regulation, inter-industry labor movements affect the import-competing sector as well. The resulting conflict of interests with respect to environmental policy is readily identified: environmentalists and the owners of capital in the import-competing sector favor tight environmental regulation whereas the owners of capital in the export sector and workers favor a more lenient regulation.

The regulator maximizes political support (which derives from the capitalists' residual claims in the two sectors, the wage rate and the level of pollution) by balancing the various sources of political support at the margin. The result depends, of course, on the overall state of the economy which, in turn, is determined by the ruling constraints. Starting out from a political-economic equilibrium of a protectionist trade-policy regime, an exogenous policy shift towards a more liberal trade policy will change the conditions on which environmental policy-making is based. Trade liberalization increases profits earned in the export sector, reduces profits earned in the import-competing sector, and increases the wage rate in terms of the import good and thus presumably also benefits labor interests. Since environmental regulation is portrayed as a restriction on total pollution, trade policy does not affect the interest of the environmentalists.

Trade liberalization, by benefiting the export sector and labor interests, and hurting the import-competing sector thus disturbs the economic basis underlying the prior political-support maximization calculus. In order to re-establish a political support-maximizing equilibrium, the government will transfer some of the liberalization gains from the export industry and from labor to the losers of economic integration by tightening the environmental standards. Environmental policy and trade policy are substitutive tools for income redistribution, but they do have a different substitution relationship for environmental interests who gain from a policy substitution which works according to the rule „share the gain and share the pain.“ The overall conclusion of the paper by Bommer and Schulze is thus that trade liberalization in industrial countries where the export sector is more polluting than the import-competing sector will give rise to an endogenous shift in environmental regulation towards tighter standards with the consequence that environmental quality improves with increasing trade integration.

Fredriksson (1997) also deals with the determination of environmental policies in small open economies. Even though the focus of this model is not on the effects of trade liberalization, some insights with respect to trade integration can be gained from Fredriksson's model. The political sector is portrayed with the help of the corruption approach pioneered by Grossman

and Helpman (1994). However, unlike the model by Schleich (1997) [cf. section (b) above] which also employs this approach, trade policy is assumed to be given - a regime of free trade prevails. Moreover, Fredriksson restricts his analysis to only two sectors, the clean numeraire sector which only uses labor in the production process, and a dirty sector which pollutes the environment via production by using labor and capital as inputs. A second difference as compared to the model by Schleich consists in the specification of the agents' preferences. There are three types of agents: workers and capitalists who only care for their respective market incomes and environmentalists who also care for the environment. Workers are assumed not to form a lobby group but environmentalist and industrialists do.

Explicitly taking into account lobbying by environmentalists, Frederiksson (1997) arrives at the following result: the equilibrium pollution tax varies negatively and total pollution varies positively with the given producer price. The producer price can be interpreted to be composed of the world market price and a component reflecting protectionist trade policy intervention (e.g. a tariff). We can thus conclude that trade integration, in this model, gives rise to a more restrictive environmental policy and to a cleaner environment.³⁴ The intuition behind this result is straight forward. First of all, environmental policy in general deviates from the welfare maximizing policy because not all interest form lobbies. This property of the model is a consequence of the employed refinement criterion and provides the scope for non-trivial endogenous policy responses. The unambiguous effects of trade integration are, secondly, due to the fact that the industrialists' *marginal* profits decrease as the producer prices decrease, whereas marginal pollution remains constant. This gives the lobby of the environmentalists an advantage vis-à-vis the lobby of the industrialists. Pollution itself decreases in the course of trade integration because the direct effect of the producer price on output is augmented by the

³⁴ This interpretation of Fredriksson's model assumes that redistribution effects via tariff revenues do not influence the result. A more general analysis including tariff revenue effects is to be found in Fredriksson (1998).

indirect political effect which also reduces production via a more restrictive environmental policy.

A generalization of Fredriksson's model is to be found in Aidt (1998). Aidt's model consists of many industries each of them producing an internationally traded good. The environment is polluted via production in all industries and all individuals care about market income *and* the state of the environment. In this general set-up the overall level of pollution can go either way as compared to the efficient level. Unambiguous results only emerge in very special cases.

Trade integration, by its very nature, does have international consequences. Merely on account of this, restricting the analysis to the framework of a small open economy cannot really do justice to the investigated phenomenon. Moreover, it is often observed that national policy-makers are very hesitant to forge ahead with restrictive environmental policies in the form of production standards if their main trading partners are not following suit. Because policy-makers show consideration for the competitive standing of domestic producers, international harmonization is often seen as a prerequisite for strict environmental policies. Bommer (1996) acknowledges this fact and investigates the scope for environmental policy harmonization in the course of trade integration. He uses a two-country model akin to the industrial-organization models developed by Ludema and Wooton (1994) and Barrett (1994) to portray the economy and the political-support-function approach to portray the polity. Bommer's model encompasses two asymmetries. Firstly, the political influence of the environmental interests need not be the same in the two countries and, secondly, trade integration may have different consequences for the producers located at home and abroad. Trade liberalization in such a context thus changes the political impact of the involved interests across countries and Bommer shows that for reasonably calibrated models it is quite possible that trade liberalization gives rise to a harmonized environmental policy in cases where harmonization has not been feasible in the pre-integration environment. This result is robust with respect to the existence of international environmental spillovers.

4.2. *Factor mobility*

The integration of the world economy has recently gained additional momentum by way of increased international capital mobility. Some analysts even single out a high degree of capital mobility as the dividing line between international integration and globalization. Whatever the significance of capital mobility may be, it is clear that international capital mobility adds a new dimension to the political-economic interaction in the environmental policy game. Crucial in this context is not so much the fact that multinational firms in some cases actually choose to withdraw from a jurisdiction, either in order to avoid high domestic production standards or to take advantage of soft ones abroad. It is rather the potential for respective political threats that emerge if the exit option becomes viable. The scope for strategic relocation is exacerbated in the presence of informational asymmetries since, by transmitting deceptive information, firms may well be able to avoid unwelcome production standards even if these standards are absolutely compatible with production at the ancestral location.

The political-economic literature on environmental policy making in a globalized world is practically non-existent. An exception is Bommer (1998b) who analyzes to what extent *partial* industry relocation can take place for purely strategic reasons, i.e. as a means of indirect rent-seeking to signal to the home government an alleged loss of competitiveness attributed to overly restrictive environmental production standards. Such costly signals are individually rational if they convince the receiver to back down from a proposed policy with the consequence of larger domestic profits in the future. Bommer combines the political support function approach with a simple model portraying the interaction between a domestic monopolist and an uninformed regulator. Foreign direct investments undertaken by the monopolist represent the only way of signaling the producer's inability to adapt to a proposed production standard. In this framework Bommer shows that partial relocation which is not profitable from an economic viewpoint may nevertheless be carried out (i.e. such a

behavior may be part of a perfect Bayesian equilibrium of the analyzed signaling game), in order to deter the regulator from imposing further regulatory constraints. Moreover, it can be shown that import competing firms are more likely to take refuge in strategic relocation the more international trade is liberalized. For export firms trade liberalization has the opposite effect.

4.3. Summary

Looking at the political-economic literature on environmental policy-making in open economies from a bird's-eye perspective, three interrelated impressions intrude into one's mind. First, this literature convincingly demonstrates that the extent and scope of the deformities of the policy-formation process are such that by neglecting these aspects, the casual observer is led to a completely inadequate picture of the state of affairs. Only by calling attention to and by analyzing in depth the political-economic forces underlying the political process can one ever hope to be in a position „to design laws and institutions that will properly constrain interest group behavior or harness it to the public interest“ [Hoekman and Leidy (1992), p. 241]. Because of the complexity of the political-economic relationships - this is the second observation - one can not expect to arrive at general results which in a straightforward manner then give rise to recommendations for constitutional design. Normative statements which are worth their salt need to be based on the prevailing institutional situation and economic circumstances. The third insight refers to the often heard argument that the increasing integration of the world economy will give rise to environmental plight. Even though the surveyed literature clearly shows that economic integration does have strong consequences with respect to distribution, a careful analysis of the interaction of the attendant political forces does not support this unequivocal judgment. It rather transpires that economic integration can have positive or negative effects on environmental policy and the environment.

Given this general result, the notorious critics of economic integration, including environmental organizations and „green“ political parties, would be well advised to rethink their position.

5. The Empirical Evidence

5.1. *‘Environmetrics’*

Whatever their different views on government behavior are, both the traditional social welfare-maximizing and the political-economic approach suggest that governments’ environmental policies are effective. In particular, they assume that environmental control, and thus the availability of environment as a resource for production, influences the trade pattern and the international allocation of mobile capital. This is by no means clear — whether regulation actually matters is of course an empirical question. In this section, we review the empirical evidence on the relationship of trade, international factor allocation, and environment.³⁵ To state a major finding in advance: The evidence is mixed.

The main difficulty is how to measure the quality and the availability of ‘the environment’ as production factor or, respectively, the stringency of environmental regulation. Two approaches have been used, both suffer from severe shortcomings. The Environmental Control Costs (ECC) approach measures the total costs of compliance with environmental regulation, which includes capital costs of abatement equipment (including depreciation), operating costs of environmental management, and R & D expenditures for abatement technology. The ECC as measure for the severity of controls have shortcomings. First, it is debatable whether ECC so defined cover all relevant costs caused by environmental regulation. Chapman (1991) argues that ECC have been highly underestimated since they do not comprise workplace health and safety costs. Low (1992) criticizes that ECC refer only to „end-of-pipe“ expenditures and not

to all capital expenditures related to environmental considerations. Moreover, outright prohibitions that do not lead to increased abatement, but to different production processes altogether are not covered by this measure. Second, ECC represent at best only the costs of meeting a certain regulation, whereas the costs depend on the regulation itself and the firm's output and pollution decision; it is not a direct measure of how strict a regulation is. For instance, a firm in a country with more lenient standards may incur higher ECC than in a more regulated economy, because it chooses a different factor input combination as a consequence of different factor prices, including that for the environmental use (pollution). Yet, the ECC do indicate how important the environment is as a cost factor compared to total production costs.³⁶

The second approach measures the actual discharge of pollutants per unit of output; it is based on data from the Toxic Release Inventory (TRI) as published by the US Environmental Protection Agency (EPA). These data on toxic release of 15,000 US companies are matched with their output data as published by the US Bureau of Census and aggregated over industries to yield sectoral pollution intensities. It is therefore a more direct measure of the real environmental consumption of the individual sectors than the ECC approach. However, adding up the physical amount of all 320 toxic releases – whether atmospheric, effluent, or solid – per dollar of output does not take into account the various harmfulness of the pollutants. To address this obvious shortcoming, Lucas et al. (1992) weigh the different toxic releases, based on the EPA's Human Health and Ecotoxicity Database that divides the emissions into four groups. They use linear weights (1 to 4) as well as exponentially formed weights (1, 10, 100, 1000). Clearly, this procedure remains somewhat arbitrary, and thus, toxic release data are only a very crude measure for the real environmental harm that sectoral

³⁵ We cannot be complete; other surveys of the empirical literature include Dean (1992), Jaffe et al. (1995), and Bommer (1998a).

production does. Yet, there are no better data available, so we must rely on these measures if we want to shed some light on the empirical relevance of the theoretical claims.

Next we turn to empirical studies on the relationship between international trade patterns and environmental regulation. More specifically, we ask the following questions: How important is the environment as a factor of production? Do differences in environmental regulation and, consequently, in relative factor endowments explain the existing pattern of trade? Conversely, does the trade regime have an impact on the level of environmental degradation? Do more open economies tend to pollute more than closed ones or vice versa? Do firms relocate in order to escape too strict environmental regulations? Lastly, is there any empirical evidence for existence of strong political-economic forces behind economic integration and environmental policy-making?

5.2. The Influence of Environmental Policy on the Pattern of Trade

We turn first to the question whether differences in environmental regulation can explain trade patterns. Walter (1973) looks at the importance of ECC for the US trade. He uses ECC data from the late 1960s and a 1966 input-output table to determine the effect of environmental regulation on trade. ECC comprise capital costs for pollution abatement equipment (including depreciation costs), operating and management costs for the equipment, and R & D expenditures in environmental technology. He finds that ECC amount on average to 1.75 percent of the total value of US exports and 1.52 percent of US imports (assuming that foreign producers have the same ECC as import competing US producers).

This is a rather small fraction, and therefore ECC should not influence trade flows or output decisions. The output response is subject to some empirical studies, which are summarized by

³⁶ They do not, however, account for benefits of lower pollution for the firm itself. Inasmuch as pollution abatement reduces damages of the production equipment, the ECC overstate the true costs of abatement to the

Ugelow (1982): For instance, OECD (1978) studies output effects of ECC in Japan, the Netherlands, Italy and the US; Yezer and Philipson (1974) do the same thing for selected US industrial sectors. They all reach the conclusion that the increase in prices and the reduction in output are rather small, so that the effect of environmental policy on production (and hence trade) are clearly of second order. Richardson and Mutti (1976, 1977) estimate domestic and import market supply and demand functions for 81 industries in a general equilibrium approach. They find that output and price reactions to (existing) ECC are rather small, but that they might range up to 5 percent for selected industries if the polluter-pays-principle prevails. If general equilibrium effects through changes in income and exchange rates are taken into consideration, the already small effects are decreased further.

Robison (1988) analyzes the effect of an overall price increase of 1 percent (brought about by a rise in ECC) on sectoral output and the balance of trade. He uses a partial equilibrium model that accounts for inter-industry trade in intermediate goods, and bases his results on input-output tables and estimated trade elasticities. The neglect of moderating general equilibrium effects implies that his results establish an upper bound for the actual reaction of trade balance and production to the increase of ECC. The one percent price increase due to risen ECC seems incremental in terms of total costs; compared to the existing level of ECC this is quite substantial. Robison estimates the average ECC as a share of total export as 0.37 percent in 1973 and 0.72 percent in 1982. ECC's share in total imports have risen from 0.48 percent in 1973 to 0.99 percent in 1982.³⁷ Like Walter (1973), data availability forces him to assume that the ECC of the imports are equal to the ECC of the import-competing US sectors.³⁸ His results show that the total (and individual sectors') output reaction is negligible; the sectors'

firm (Jaffe et al. 1995).

³⁷ This implies that ratio of ECC content of imports to exports has risen from 1.15 in 1973 to 1.39 in 1982 - the U.S. have specialized in cleaner products.

³⁸ This shortcoming is not specific to these two studies, in fact it is shared by all other empirical studies. The empirical analyses focus basically on composition effects, but do not measure international differences in regulation.

trade values decline between 0.12 percent and 7.08 percent, averaging 2.69 percent. The trade balance reduces net by 0.67 percent. In other words, the doubling of ECC has only very moderate effects on aggregated output and trade.

Tobey (1990) measures the impact of environmental policy on the pattern of trade by testing whether the Heckscher-Ohlin model of international trade better explains the existing pattern of trade when it accounts for the differing degrees of environmental policies. Out of 64 3 digit SITC industries he selects the 24 most pollution-intensive industries, i.e. those that have direct and indirect pollution abatement costs exceeding 1.85 percent of total costs. They are aggregated into five groups (mining, paper, chemicals, steel, and nonferrous metals) and, subsequently, their trade vectors are regressed on a set of factor endowments (various kinds of labor, land and natural resources). A dummy variable for the stringency of environmental policy should then capture the effect of environmental regulation on the trade pattern. It turns out to be insignificant. An omitted variable test corroborates the result. If ECC influence the net exports, but are omitted from the regression, the error term should have a negative sign relatively more often in the group with more stringent regulation (industrialized countries) than in the group of less developed countries. Tobey however is unable to reject the null hypothesis of equal distribution of errors for both groups. Kalt (1988) also applies a Heckscher-Ohlin model and regresses changes in net exports on changes in ECC, among other variables. He finds that this relationship is insignificant for the whole population of 78 sectors, but becomes significantly negative if applied only to manufacturing sectors. His time coverage is 1967 - 77.

Low (1992) looks at the pollution content of Mexican exports to the U.S., again using for Mexican industries pollution abatement data which were compiled for the U.S. He shows that Mexico is not overly dependent on pollution-intensive industries, only 18 out of 123 3-digit SIC industries incur ECC exceeding one percent of total output. The weighted average of all industries is only 0.54 percent. Mexico's export of dirty goods (those goods, where the ECC are greater than 0.5 percent of total output) accounts only for a little over 10 percent of total

exports. However, those dirty exports to the U.S. have increased three times as fast (9 percent annually) as all commodities together (3 percent p.a.). The traditionally more lenient environmental policy of Mexico has not led to a specialization in production of dirty goods, although it might have some impact on sectoral growth. The latter effect could be caused by different reasons, such as structural shifts in the course of development, as we will see below.

Ferrantino (1997) shows that abatement costs did not have any significant impact over time on the ‘revealed comparative advantage’ of the U.S., i.e. its sectoral trade pattern. Rather the trade patterns of the dirty industries followed closely the overall trend. He concludes that the overall level of abatement costs³⁹ is too small to constitute a major (dis-)advantage. US pollution abatement operating costs have steadily risen from 0.3 percent of output value in the early 1970s to 0.8 percent in 1992 (averages for manufactures). Although abatement costs are concentrated in only a few sectors, „pollution abatement operating costs and capital expenditures amount to around [only, G.S.] two or three per cent of total costs for some of the dirtiest industries.“ (Ferrantino 1992; 52).

Recently, Beers and Bergh (1997) have challenged the common finding that environmental regulation does not affect the trade pattern. Using a gravity model they regress bilateral trade for 21 OECD countries on GDP, population, and land area of both countries, distance, dummies for customs unions and neighbors, and two different indices of stringency of environmental regulation. The index that turns out significant is constructed as the unweighted average of the ranks that a country has with regard to energy intensity per unit GDP and the change therein, normalized to lie in the unit interval. They find this index to have a significant negative impact on total bilateral trade flows and for the trade in goods of non-resource based pollution-intensive industries. Note, however, that they do not look at *sectoral* but only aggregated cross-country differences in trade performance due to regulation so that possible

³⁹ He draws on the data from *Current Industrial Reports* and *Pollution Abatement Costs and Expenditure*, published by the US Department of Commerce (various years).

structural changes due to environmental regulation are blurred. Moreover, it is not clear that the index actually reflects differences in regulation. First, it is constructed from a ranking that does not take the actual differences in regulation into account; second, energy intensity of production is at best an indirect measure of overall environmental regulation – it may as well be influenced by different factor prices for other factors which influence the factor combination, or by a different sectoral composition of output (with sectorally different energy intensities) over which the authors aggregated, to name just two influences. Lastly, subsidized energy may go in hand with stringent regulation of emissions. Still, their measure tries to capture possible indirect effects of government regulation on productivity through higher input prices (energy), which the ECC do not cover.

To summarize these findings, it seems fair to conclude that environmental *policy* overall has but a very limited effect on the trade pattern. This result may in part be due to the unsatisfying data quality and the conceptual difficulties with ECC as a measure for stringency of environmental regulation (Jaffe et al. 1995). The most important reason, however, is obviously the very small fraction the ECC contribute to total production costs. This renders the comparative advantage created by more lenient environmental regulations relatively unimportant compared to other sources of comparative advantages such as differences in technologies, and in endowments with natural resources, human and physical capital, labor, and other production factors. At most, it may have an effect on selected high-polluting industries or firms at the margin.⁴⁰ But if environmental policy hardly affects the trade pattern, we can still pose the opposite question: How does the trade regime affect the pollution pattern? Does pollution change as a byproduct of trade liberalization? We present the empirical evidence on this issue below.

⁴⁰ See also Ulph (1993) for a calibrated imperfect competition model for the fertilizer industry. He finds a significant impact of environmental policy. Things may be different for environmental policies explicitly targeted at reducing the energy content of production in order to reduce global warming. This might have an impact on energy prices and thus on terms of trade, see Clark et al. (1996).

5.3. *The Influence of the Trade Regime on the Environment*

Trade liberalization affects the environment mainly through three channels: First, the countries restructure their production according to their comparative advantage, which implies a change in overall pollution because sectors pollute to different extents (composition effect). Second, liberalization yields a better factor allocation and thus increases production – and pollution (gains from trade or income effect). The income effect is moderated through a higher preference for the environment and political considerations (cf. Bommer and Schulze, 1997) which lead to stricter environmental control (regulation effect). Last, liberalization often goes together with increased technology transfer, which includes cleaner production processes and more efficient abatement equipment (technology effect).⁴¹ These effects could be discerned if data for toxic releases or ECC were available for a variety of countries; since this is not so, only the effects of increased income and altered composition can be analyzed. Still this presupposes that the ranking of industries according to their pollution content is equal internationally.

Lucas, Wheeler, and Hettige (1992) use 1987 toxic release data for 15,000 US manufacturing firms as published by the EPA (cf. p. 68), match them with individual output data and aggregate them to sectoral data to obtain toxic release per \$ of output. They assume that these pollution intensities are equal for some 80 countries and the time span 1960 to 1988. They confirm the result of an inverse U-shaped relationship between GDP per capita and total toxic release from manufacturing output per unit of GDP.⁴² The decline in pollution intensity (not in levels!) for high income countries is due to a declining share of manufacturing output in GDP, not to a less toxic mix of industries within manufacturing. In fact, the relationship for pollution per unit of manufacturing output goes the other way. The growth in toxic intensity has been far more rapid in developing countries. They rank the countries according to a price

⁴¹ See Wheeler and Martin (1992) for a case study on the wood pulp industry. They show that open economies tend to adopt cleaner technologies more rapidly. The technology transfer effect could, in principle, also go the other way and include new and dirtier products.

distortion index and find that the change in pollution intensity depends crucially on the trade regime and the growth rate. Open economies had a toxic-neutral change in the 70s and a strong shift towards less-toxic structures in the 80s, whereas closed economies had a rapid change towards more polluting structures. The trend was much more pronounced for fast growing economies. Their results are reinforced by a similar study by Birdsall and Wheeler (1992) for Latin American countries.

The link between income and environmental quality is considered by Grossman and Krueger (1995). They look at urban air quality and water pollution in different countries and regress them on per capita income. The big advantage of their study is that they have fairly reliable data from various cities and river basins in many developed and developing countries, which were compiled by the Global Environmental Monitoring System (GEMS). They find pollution to be an inverted U-shaped function of per capita income for most pollutants. The turning point is at an income level of 8,000\$ per capita. (See also Seldon and Song (1994) for a related analysis).

The change in the international trade in pollution-intensive goods is subject of the paper by Low and Yeats (1992). They identify 40 three digit SITC industries with ECC of at least 1 percent of total sales and analyze the changing composition of countries with a revealed comparative advantage in dirty industries. The latter is measured by the quotient of the share of country *i* in world exports of commodity *j* and the share of country *i* in total world exports. They find that in the period 1965-88 the share of dirty products in world trade has declined from almost 19 % to less than 16 %, and that the industrialized countries account for the lion's share (from 77% to 74% of world trade). The comparative advantage in dirty industries is dispersing, and the dispersion is greatest in direction of the LDCs. The deconcentration of comparative advantage occurred also in non-polluting industries, but at a much lower rate.

⁴² See Radetzki (1992) for a discussion of the link between growth and the environment.

Grossman and Krueger (1993) analyze the environmental consequences of the North American Free Trade Agreement (NAFTA). First, they test whether the US – Mexican trade pattern is influenced by the environmental regulation. They regress the ratio of US imports from Mexico to total US shipments per industry on the factor shares of labor, human capital, and physical capital, the injury rate as a proxy for labor standards, and the share of ECC in total output. They find the influence of ECC (and of the injury rate) to be small and insignificant. They repeat the exercise for the maquiladoras industries, primarily low skilled labor intensive assembly activities in Mexico along the US-Mexican border with an 80 % reexport requirement to the US. But even in this special case, that suggests itself as a chance to escape environmental regulation, they do not find any significant relationship between pollution abatement costs and sectoral activity in Mexico. In a second step, they calculate the expected changes in pollution due to the trade liberalization. They combine the predictions of the Brown, Deardorff and Stern (1992) computable general equilibrium model for sectoral changes after NAFTA with toxic release data for the sectors and find toxic releases decrease somewhat in Mexico (mainly due to a decline of chemicals) and increase in the US and Canada.

Bommer and Schulze (1997) look at the pollution content of trade before and after NAFTA. Like Grossman and Krueger, they combine estimated trade data changes from computable general equilibrium models with toxic release data. They find that US export production is more pollution-intensive than US imports (by 37 %), but that the toxic release content of expected trade *changes* is much more dramatic – the export changes are 2 and a half times dirtier than the imports changes.

These results on NAFTA liberalization are in line with the more general observation by Anderson (1993) who argues that developing countries tend to protect their import-competing and often dirty heavy industries, while discouraging their primary and labor intensive sectors. On the other hand, industrial countries often protect labor intensive sectors like textiles and agriculture. Trade liberalization will shift production to the sectors with comparative advantage: poor countries most likely will get relief from environmental pressure by

specializing in labor-intensive and relatively clean production whereas industrial countries will tend to specialize in dirtier industries. Middle income countries like the Asian tigers, however, are likely to experience a shift to pollution-intensive industries like steel and shipbuilding. This would be in accordance with the inverted U-shape relationship between pollution and development. There are more sectoral studies which reinforce these findings. For a survey confer Bommer (1998a).

To sum up, while the link of environmental policies to trade patterns is rather weak empirically, there is considerable empirical evidence that trade policy has a strong impact on environmental quality. It must be noted though, that most empirical papers apply US data on toxic release or environmental control costs also to foreign countries; this renders the measurement of actual changes in pollution caused by trade liberalization impossible. Thus, the analyses do not account for international differences in regulation and technology, but reflect at best the environmental consequences of changing composition and level of sectoral activity in the course of liberalization. Obviously, this is restrictive and consequently the results must be viewed with caution.

5.4. Environmental Control and the Relocation of Industries

Theoretical papers on environmental policy in the international context (cf. Section 3.3) suggest, and similar fears have been voiced in the political debate, that dirty industries will relocate to countries with lower environmental standards ('industrial flight hypothesis'). What is more, LDCs will strategically lower their standards to attract capital from industrialized countries ('pollution haven hypothesis'). Does this statement stand up to closer empirical investigation? Apparently, such an environmental control-induced capital flight has not happened on a large scale, otherwise the ECC would have significantly contributed to the explanation of the existing trade pattern. If compliance cost differences had established a significant comparative advantage this would have created incentives for restructuring of

resources within the LDCs and for foreign direct investment (FDI) to relocate. But the findings of Sections 5.2 - 5.3 contradict that notion. Still, for few selected sectors the difference in regulation could be considerable, especially if the low level of ECC was misleading as it did not reflect the 'true costs' of environmental regulation (see page 67). This could be one explanation for the small shift of comparative advantage in dirty industries towards the developing countries, as noted by Low and Yeats (1992).

Walter (1982) studies FDI from Western Europe, the U.S.A. and Japan and finds little evidence that it has been influenced by diverging environmental control. Duerksen and Leonard (1980) points out that most of the FDI in dirty industries has gone to other industrialized countries with similar standards. This pattern has been stable over time. Bartik (1988) showed that the location decision of the Fortune-500 firms within the U.S.A. was not (partly) determined by state-imposed pollution control expenditures, and that it had only a very small effect on the startup rate for new businesses (Bartik 1989). Leonard (1988) presents case studies of FDI in Ireland, Mexico, Romania, and Spain; he cannot find any systematic evidence that FDI in these countries was (partly) caused by US environmental regulations. The reason is that investment decisions are very complex and that ECC differences play only a very minor part in it as they are so small compared to other cost differences. Friedman et al. (1992) study the location decision of foreign capital within the United States. They show that environmental control, measured by the ratio of abatement expenditures in a state and the state GDP, is not significant in explaining the choice of state. It is not clear, though, that their indicator measures accurately the stringency of regulation. There are several more, mostly sectoral studies, surveyed by Pearson (1987) and Jaffe et al. (1995) which confirm the overall picture.

However, Gray and Walter (1983) observe relocation for copper-smelting, refineries, and chemical industry in response to regulation in Western Europe. And there is some evidence that developing countries use a more polluting technology. Leonard (1988) provides some evidence that for narrowly defined, highly pollution-intensive industries US environmental

regulation has led to some overseas investment. Diwan and Shafik (1992, table 15.1-2) report that developing countries account for only 22 percent of world output, but 43 percent of world carbondioxid emissions. This is due to lower emissions per unit of capital in the developed countries, which the authors attribute to stricter environmental policies. Ferrantino (1997) shows that US investment abroad of the pollution-intensive chemical industry is no different from all other manufactures; in particular FDI does not flow increasingly into developing countries which can be assumed to have more lenient environmental regulation. His research is motivated by the observation that although operating abatement costs are quite low, capital expenditures for abatement are significant at 10 % of total capital expenditures for US manufacturing.

Why then have not more industries moved to pollution havens, like McGuire (1982) implied? The first reason is the relatively small overall pollution abatement costs incurred in the North.⁴³ Savings would by far be too low to revise the location decision made for various other reasons, except maybe for very small and heavily polluting fraction of manufacturing. Birdsall and Wheeler (1992) and Wheeler and Martin (1992) offer additional explanations: Even if multinational firms located some of their production in developing countries with lower standards they might have strong incentives to apply higher 'Western' standards, because of fears that they might lose reputation and, as a result, consumers in their markets in developed countries („green consumerism“) or that their products may not meet the standards in the export markets.⁴⁴ If an environmental accident happens they might nevertheless be subject to liability claims. Moreover, firms invest in their equipment as a package – they install the latest, most efficient and cleanest equipment. To unbundle the equipment in favor of dirtier processes might not be profitable, it might not be feasible at all. If multinational firms

⁴³ ECC might constitute a nontrivial cost component in the South though, because the relative scarcity of capital makes the capital-intensive pollution abatement relatively more expensive than in the North.

⁴⁴ For instance' paper produced with chlorine has traces of dioxin and can therefore not be exported to Germany (Birdsall and Wheeler 1992).

duplicate the - cleaner - technology used in advanced countries with more stringent regulation, they might even have an incentive to lobby for higher environmental standards in order to raise domestic rivals' costs (Ferrantino 1997). The cleaner technology of multinational firms compared to domestic producers provides another argument for the liberalization of (sectoral) capital controls.

Levinson (1996) uses a conditional logit model of plant location choice to analyze the impact of different environmental regulations across US states on the geographical distribution of pollution-intensive industries. Using microdata from the census of manufactures and various measures of regulation stringency he finds very little evidence that regulation differences affect the interstate location of newly established plants. He also surveys the literature on interstate plant location and environmental regulation which reaches the same conclusion. He conjectures that it might simply be too costly to design different production processes for each location/regulation. Alternatively, the pollution-intensive industries may happen to be the least footloose. If environmental regulation differences do not affect the allocation even on the federal level, it is hardly surprising that it does not on the international level, where mobility costs are much higher.

5.5. Political-economic interrelations

Empirical studies on the political-economic linkage between trade and the environment are next to non-existent. We found only two papers which deserve to be mentioned in this context. Both of them deal with the „Baptist-and-bootlegger“ coalition issue: To what extent are the interests of environmentalists („Baptists“) captured and abused by domestic producers („Bootleggers“) who, of course, seek less august objectives than their coalition partners? Whereas the theoretical studies by Hillman and Ursprung (1991 and 1994) delineated the scope for „eco-protectionist“ coalitions by identifying circumstances of common interest, the studies by van Grastek (1992) and Körber (1998) provide empirical evidence for the

virulence of political alliances between environmentalists and industries who stand to gain from impeding domestic market access to foreign competitors.

Van Grastek (1992) addresses the question by asking whether the voting records of U.S. senators support the claim that protectionist bills are more likely to be supported if they can be presented in an environmental guise. His research strategy is to regress the senators' votes cast on issues linking trade and environment (probit analysis) on the strength of the protectionist, anti-protectionist and green interests in their respective constituencies (states). He uncovers strong evidence that linking environmental concerns with trade policy issues can increase congressional support for protectionist policies, i.e. „pure“ protectionist bills are less attractive to legislators than protectionist bills wrapped in a neat environmentalist cover. Given the protectionist stance of environmentalists, the „green connection“ might also make trade liberalization less attractive than it might otherwise be - the respective evidence presented by van Grastek is, however, not conclusive.

Cross section analyses of congressional voting undertaken with the intention to identify the political influence of interest-group activities has a long tradition in the political economy of trade policy [cf. Marks and McArthur (1990)]. Whether such investigations are meaningful or not hinges crucially on how well the political pressure exerted by interest-groups can be measured on the level of the single constituencies. Since there is little agreement on how to measure interest-group influences on the constituency level, various proxy variables have been constructed using a wide variety of data. As a consequence, the results of these studies will never be undisputed. An alternative approach would be to analyze the development of the legislative process over time (for meaningful time-series studies the track record of eco-protectionism, however, is still too short) or to focus on specific exemplary cases. Some cases of extraterritorial application of domestic environmental regulations have indeed attracted a great deal of attention, arguably the most notorious one being the tuna-dolphin case with the

attendant GATT ruling of 1991 which maintained that the U.S. violated Mexico's trade rights when it banned imports of tuna which were not dolphin safe.

The case study by Körber (1998) analyzes the political-economic reasons behind the policy change in the U.S. dolphin safe legislation which resulted in the controversial embargo against Mexican tuna. The fact that the U.S. canneries had to reverse their harvesting policy has traditionally been interpreted as being indicative of the rising strength of the U.S. environmentalist movement which was able to force a billion dollar industry into submission. The study by Körber however convincingly argues that the large U.S. companies derived benefits from this policy reversal, too. The new policy provided them with a leverage to reinstate the embargo against Mexico and to raise their smaller domestic rivals' cost while they themselves had lost their interest in the Eastern Pacific Ocean as a source of raw tuna.

To political economists the conclusion of these two authors will come as no surprise. Producers seeking protection from foreign competition find themselves more and more on the defensive. These interests could never have let the opportunity slip to capture a new ally with a seemingly immaculate political aura. Eco-protectionism, on the other hand, offers also environmental lobbies an important advantage: the producers harmed by environmental trade restrictions are foreign companies who have limited opportunity to participate in the domestic political process [cf. David Vogel's comment on van Grassek (1992)].

5.6. Summary

The empirical analyses have provided a somewhat mixed picture. They have been hampered by conceptual difficulties as well as insufficient data quality and availability, the latter of which made cross-country comparisons problematic. Given these caveats, the following results emerge: First, trade flows seem hardly be influenced by differences in environmental standards. Environmental control costs are too small in comparison to establish a substantial

comparative advantage. Second, the trade regime has a strong influence on environmental quality. While there seems to be an inverted U shape between pollution intensity and stage of development, it is remarkable that closed developing countries seem to be much more polluting than open economies. This difference is more pronounced, the faster the LDCs are growing. Trade liberalization leads thus to a reduction of pollution in developing countries, but may increase pollution in middle income and industrialized countries. Lastly, there is no evidence that firms from industrialized countries have relocated to a large extent to 'pollution havens' to escape stricter regulation.

6. Appendix: Gains from trade in the presence of a negative environmental externality⁴⁵

In this appendix we show in a simple setup how the gains from trade depend on the direction of trade and whether the externality occurs in production or consumption. Assume a two-good economy and that the (local) externality occurs only in connection with good X . We compare free trade with autarky. Pollution has a „shadow price“ q_X . Superscript f denotes free trade, superscript a autarky. Subscript p denotes production, subscript c denotes consumption.

6.1. Pollution occurs in production

The value of free-trade production is maximized at free-trade prices.

$$(1) \quad p_X^f X_p^f + p_Y^f Y_p^f > p_X^f X_p^a + p_Y^f Y_p^a$$

We use the balance-of-trade constraint on the left and the autarky market clearing conditions on the right hand side and obtain

$$(2) \quad p_X^f X_c^f + p_Y^f Y_c^f > p_X^f X_c^a + p_Y^f Y_c^a$$

We add and subtract the value of pollution in free trade and in autarky from the left and right-hand sides of (2) respectively.

$$(3) \quad p_X^f X_c^f + p_Y^f Y_c^f + q_X X_p^f - q_X X_p^a > p_X^f X_c^a + p_Y^f Y_c^f + q_X X_p^f - q_X X_p^a$$

Inequality can be rearranged to yield

$$(4) \quad p_X^f X_c^f + p_Y^f Y_c^f - q_X X_p^f > p_X^f X_c^a + p_Y^f Y_c^f - q_X X_p^a + q_X (X_p^a - X_p^f)$$

Letting RI denote „real income“ (utility), this can be written as:

$$(5) \quad RI^f > RI^a + [q_X (X_p^a - X_p^f)]$$

A sufficient condition for gains from trade is that the production of the polluting good decreases with trade. This will hold if X is the **import** good.

⁴⁵ We are indebted to Jim Markusen who suggested this appendix.

6.2. Pollution occurs in consumption

Equations (1) and (2) carry over to this case as well. Again, add the value of pollution in free trade and subtract the value of pollution in autarky on both sides of the inequality (2). Note that the externality occurs now in consumption.

$$(6) \quad p_X^f X_c^f + p_Y^f Y_c^f + q_X X_c^f - q_X X_c^a > p_X^f X_c^a + p_Y^f Y_c^f + q_X X_c^f - q_X X_c^a$$

rearrange (6) to obtain

$$(7) \quad p_X^f X_c^f + p_Y^f Y_c^f - q_X X_c^f > p_X^f X_c^a + p_Y^f Y_c^f - q_X X_c^a + q_X(X_c^a - X_c^f)$$

In analogy to the first case we can rewrite eq. (7) as

$$(8) \quad RI^f > RI^a + [q_X(X_c^a - X_c^f)]$$

A sufficient condition for gains from trade is that the consumption of the polluting good decreases with trade. This **may hold** if X is the export good, but **might not** due to increased income with trade; i.e. consumption of both goods can rise in the course of trade liberalization.⁴⁶ It does not occur if X is the import good.

⁴⁶ This effect might occur due to the „traditional“ gains from trade (which disregard environmental externalities), i.e. the enhanced consumption possibilities from trade liberalization.

7. References

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