Is environmental policy a secondary trade barrier? An empirical analysis

Josh Ederington and Jenny Minier
Department of Economics, University of Miami

Abstract. Should international trade agreements be extended to include negotiations over environmental policy? The answer depends on whether countries distort levels of environmental regulations as a secondary means of providing protection to domestic industries; our results suggest that they do. Previous studies of this relationship have treated the level of environmental regulation as exogenous, and found a negligible correlation between environmental regulation and trade flows. In contrast, we find that, when the level of environmental regulation is modelled as an endogenous variable, its estimated effect on trade flows is significantly higher than previously reported. JEL Classification: F1, F14, F18

Est-ce que la politique environnementale est une barrière commerciale secondaire? Une analyse empirique. Est-ce que les accords commerciaux internationaux doivent être étendus pour couvrir la politique environnementale? La réponse dépend du degré de distorsion que les pays introduisent dans leur politique environnementale pour protéger leurs industries nationales. Nos résultats suggèrent que cet impact est important. Des études antérieures de cette relation ont traité la politique environnementale comme exogène, et ont montré qu'il existe une co-relation négligeable entre politique environnementale et flux commerciaux. Au contraire, nous révélons que, quand la politique environnementale est considérée comme variable endogène, son effet sur les flux commerciaux est plus élevé de manière significative que ce qu'on a noté antérieurement.

1. Introduction

Environmental advocates and labour unions have long pushed for governments to expand trade agreements (such as GATT/WTO or NAFTA) to

We would like to thank Arik Levinson, Chris Magee, Bob Baldwin, Dan Trefler, Werner Antweiler, Keisuke Hirano, Kerry Anne McGeary, two anonymous referees, and seminar participants at the World Congress of the Econometric Society meetings in Seattle and the Spring 1999 Midwest International Economics Conference for comments on various stages of this paper. Any remaining errors are, of course, our own. Email: ederington@miami.edu

Canadian Journal of Economics / Revue canadienne d'Economique, Vol. 36, No. 1
February / février 2003. Printed in Canada / Imprimé au Canada

0008-4085 / 03 / 137–154 /

include cooperation over domestic policies, such as environmental or labour standards. Two main arguments have been advanced for requiring countries' domestic policies to conform to international standards. The first is the 'level playing field' argument: the idea that it is unfair for countries to gain a comparative advantage in trade through lax environmental or labour standards. Economists generally dismiss this argument as a misunderstanding of the principle of comparative advantage, claiming that there are legitimate reasons for diversity in environmental regulations across countries (e.g., differences in preferences, natural endowments, or population density), and that differences in comparative advantage arising from regulatory differences are part of the argument for mutually beneficial trade (see, e.g., Bhagwati and Srinivasan 1996).

The second argument for expanding international trade agreements to cover domestic policies is that, as countries ratify agreements constraining their ability to pursue trade goals through trade policy, there will be unilateral incentives for governments to distort domestic policies as a secondary means of protection.[1] Assuming that countries have incentives to erect barriers to trade, one means of decreasing imports within an industry is to relax environmental standards (or other domestic regulation) in that industry. However, while lax regulatory standards may be unilaterally optimal, they are inefficient for the world economy (since they lead to a global loss of trade). Therefore, international cooperation over environmental policies that deters countries from relaxing their environmental standards as a trade barrier can lead to increased global welfare. Clearly, these arguments about the potential use of domestic policy as a means of trade protection can be categorized as 'second-best' arguments, since the most direct means of affecting trade flows is through trade policy. However, when countries are constrained in their ability to set trade policy freely (e.g., by an international trade agreement), these second-best arguments provide theoretical justification for international cooperation over domestic policy as well.

While many economists concede that it is possible for second-best models to offer a theoretical justification for incorporating domestic policies into international trade agreements, they remain unconvinced of the empirical importance of these second-best arguments. For example, Krugman (1997, 177) concludes that 'while it is possible to devise second-best models that offer some justification for demands for harmonization of standards, these models – on the evidence of this collection, at any rate – do not seem particularly convincing' (see also Bhagwati and Srinivasan 1996).

1 For example, Copeland (1990) examines negotiation over one trade barrier, leaving a secondary trade barrier (e.g., non-tariff barriers, domestic legislation) to be set non-cooperatively. He shows that trade liberalization will induce substitution toward the less efficient, non-negotiable instrument of protection due to countries' incentives to maintain levels of protection.

What is the empirical evidence? Second-best models typically rest on the joint assumptions that (i) countries use domestic regulations as a means of manipulating trade flows; and (ii) trade flows are in fact responsive to regulatory choices. Previous empirical studies of environmental regulations and trade (e.g., Leonard 1988; Kalt 1988; Tobey 1990; Grossman and Krueger 1994; and Low and Yeats 1992) have examined the second hypothesis (that environmental regulation has a significant impact on trade flows). These authors argue that if stringent environmental regulations are a major source of comparative disadvantage, then the most regulated industries should also have the highest levels of import penetration, controlling for the type of industry. They typically find little support for this proposition. Thus, 'second-best' arguments for cooperation over environmental regulation are often dismissed as being of little practical importance.

In this paper, we argue that previous research estimated only a small effect of environmental regulations on trade flows because these studies treated the level of environmental regulation as exogenously determined (implicitly assuming away the possibility that trade considerations may play a role in the setting of environmental policy). Not only do second-best models argue that environmental regulations are set endogenously, this hypothesis is supported by anecdotal evidence, which suggests that concern with international competition has played a role in setting environmental regulation. Some of the earliest national environmental legislation (such as the U.S. Federal Water Pollution Control Act of 1970) mandated studies of the effects on U.S. competitiveness of environmental regulations on U.S. firms. More recently, Presidents Reagan and Bush established committees (the Task Force on Regulatory Relief and the Council on Competitiveness, respectively) with the stated goal of relaxing domestic regulations that adversely affected U.S. trade competitiveness. In addition, there are several cases of countries' challenging foreign environmental regulations as disguised forms of protection.[2]

We argue that the endogeneity of environmental regulation may have biased downward previous estimates of the effect of environmental regulation on trade flows. For example, if countries tend to (endogenously) relax environmental regulation on those industries facing strong import competition, then net imports and the level of environmental regulation may appear to be only weakly correlated across industries, even if stringent environmental regulations are a major source of comparative disadvantage.

This argument parallels that of Trefler (1993), who noted that previous estimates of the small impact of trade barriers on trade flows are biased

2 The United States has challenged Canada's low stumpage fees and 10-cent levy on metal beer cans as disguised forms of protection, while the European Community has challenged the U.S. Corporate Average Fuel Economy mileage standards and 'gas guzzler' taxes as trade protection masquerading as environmentalism. See Esty (1994) for more complete discussions of these cases.

because they ignore the theory of endogenous protection (that increased imports intensify lobbying for protection, leading to higher levels of protection). After controlling for simultaneity between trade barriers and imports, trade barriers have a large effect on trade flows. In contrast to Trefler (1993), who examined the relationship between *trade barriers* and trade flows, in this paper we are concerned with the impact of *environmental regulation* on trade flows.[3]

We attempt to address this concern directly by estimating the impact of environmental regulations on net import levels while controlling for simultaneity between net imports and environmental policy. To do this, we estimate a system of simultaneous equations: an equation modeling the determination of environmental protection, and an equation modeling the determination of net imports. In section 2 we present a discussion of the political economy and terms-of-trade theories as applied to the endogenous determination of environmental regulation. In section 3 we present the estimation results, and section 4 concludes.

2. Theory

Standard theories of why countries impose trade barriers revolve around two basic (and non-mutually exclusive) explanations. Political economy theories argue that industries demand protection in exchange for political support. The other strand of the literature, which focuses on strategic theories of protection, argues that countries strategically alter trade flows in order to gain some type of market advantage (e.g., a terms-of-trade advantage). In this section, we apply these theories to the endogenous setting of environmental regulation and discuss the factors that may influence the stringency of environmental regulation.

The political economy literature is rooted in the work of Stigler (1971) and Peltzman (1976), who view the level of an industry's regulation as determined endogenously by self-interested regulators serving special interest groups. This literature models trade protection as a function of a lobbying process, in which industries provide political support in exchange for protection from foreign competition (e.g., Caves 1976; Brock and Magee 1978; Hillman 1982). A parallel body of literature has attempted to identify the industry characteristics that determine the effectiveness of an industry's lobby (with respect to protection) (e.g., Ray 1981a,b; Marvel and Ray 1983; Baldwin 1985).

3 In addition, our work differs from Trefler (1993) in that: (1) we use net imports rather than imports as the dependent variable; (2) we do not use a Tobit specification for the environmental cost equation; and (3) we use a panel data set, which allows us to include industry fixed effects (a significant improvement over both Trefler 1993 and the existing trade and environment literature).

While this previous literature has often focused on explicit trade barriers, within the context of the political economy literature, trade and environmental regulations are substitutes in the sense that either policy can be used to implement transfers of wealth.[4] In political economy models, equilibrium levels of regulation and protection achieve an optimal distribution of income for given levels of political influence. Thus, changes in the underlying conditions will require a restructuring of regulatory levels to maintain political equilibrium. One can view the formulaic tariff cuts of the Kennedy and Tokyo rounds of GATT negotiations as exogenous shocks to that political equilibrium. Countries will respond by using non-tariff policies (e.g., environmental regulations) to offset the losses to preferred industries resulting from the reductions in tariff rates.

Several theories provide explanations of why political strength varies by industry; we use these to specify the determinants of the stringency of environmental regulations across industries. Olsen (1968) argues that the effectiveness of a lobby will be low when coordination is costly (i.e., when free-riding is more of a problem). Caves (1976) argues that protection may be increasing in industry size, as greater size implies greater support for the politician. In Trefler (1993), unions represent existing lobbies that can be redirected towards lobbying for trade protection, and in Magee, Brock, and Young (1989), protection is aimed at the disadvantaged, since these groups have a lower opportunity cost of lobbying.

Finally, the political economy literature suggests that governmental policies will be related to trade variables. For example, a common concern is that regulations will be relaxed in industries that face significant foreign competition.[5] Other research has suggested that domestic policies are related to an industry's level of *net imports*. Such research is motivated by the empirical observation that rates of trade protection are positively related to imports (or import shocks) and negatively related to exports within an industry (e.g., see Trefler 1993). To explain this preference for import industries, some point to Corden's 'conservative social welfare function' that places a greater weight on aiding those who have suffered adverse economic fates (and a lower weight on those who have enjoyed gains) relative to the economy at large (see Corden 1974).[6] A second explanation for providing political support to import

4 Note that, to the extent that tariffs and environmental policy are functions of similar lobbying processes, they will be complementary (since industries with strong lobbies are able to achieve both higher tariff barriers and lower levels of environmental regulation). However, controlling for the strength of the lobby, tariffs and environmental policy will act as substitutes (since an otherwise-identical industry with less tariff protection will be compensated with relaxed environmental regulations). For a discussion of this with respect to tariff and non-tariff barriers, see Marvel and Ray (1983).

5 In contrast to these concerns, the political economy model of Gulati (2001) suggests that a movement towards free trade can actually lead to a tightening of environmental regulations.

6 In discussing this literature, Baldwin (1989) notes the work of Kahneman and Tversky (1979, 1984) on how individuals place greater weight on losses than on comparable gains.

industries (or those experiencing a recent surge in imports) is that such support is a means of risk-sharing where industry losses are shared with society (e.g., see Hillman 1982). The main conclusion of this literature is that the trade characteristics of an industry can (and do) significantly affect the level of governmental support received.

A second strand of literature investigates the strategic incentives countries have to distort their domestic regulations when faced with foreign competition (e.g., see Markusen 1975; Barrett 1994). While these authors suggest that foreign competition may influence the setting of environmental standards, they do not find an unambiguous correlation between the degree of foreign competition and the stringency of environmental regulations.[7] However, in a perfectly competitive environment, the relationship between *net imports* and strategic incentives is clearer. For example, Markusen (1975) demonstrates that, since a tax on production increases the world price of the good, if the good is imported, then the terms of trade worsen and the importing country will face more than the full costs of its regulations. Thus, countries will have an incentive to undertax production of the import-competing good. Alternatively, if the good is exported, then some of the costs of the regulation will be passed on to foreign consumers; providing countries with an incentive to overtax production of the export good. Note that the predictions of the terms-of-trade and political economy theories are identical in that both predict that the stringency of environmental regulations will be decreasing in net imports.

3. Estimation

Previous empirical studies of environmental regulation and trade have been concerned with the extent to which environmental regulation affects trade flows (see Levinson 1996 for a survey of this research). Their primary hypothesis is that, if stringent environmental regulations are a major source of comparative disadvantage, a country's most regulated industries should have the highest levels of import penetration. This hypothesis is often tested by attempts to measure the correlation between measures of environmental stringency and trade flows across industries. We repeat (and expand upon) these tests using data on U.S. manufacturing industries.[8]

To measure the stringency of environmental regulation, we employ (cross-sectional) time-series data on pollution abatement costs of 4-digit SIC U.S. manufacturing industries from 1978 to 1992. (Because of missing environmental

7 For example, Barrett (1994) argues that foreign competition can lead to either relaxing environmental standards or strengthening environmental standards depending on the form of competition and market structure.

8 We focus on U.S. manufacturing industries, since the U.S. is the only country to provide time series data on pollution abatement costs; all data and sources are described more completely in appendix A.

cost data for 1979 and 1987 these years are excluded from the analysis.) Both the stringency of environmental laws and the degree to which they are enforced should be reflected in the costs incurred by firms subject to environmental regulations, and so environmental compliance costs are used as a proxy for the stringency of U.S. environmental regulations and enforcement. Shanley (1992) and Eads and Fix (1984) describe the Reagan administration's environmental strategy as characterized as much by changes in the severity of the enforcement of laws as by changes in the laws themselves.[9] Data on environmental abatement costs are provided by the Census Bureau's Pollution Abatement Costs and Expenditures (PACE) survey, which provides information on the pollution abatement costs incurred by firms since 1972 at the 4-digit SIC level. To measure environmental stringency facing each industry, we use the proportion of total direct costs in that industry spent on satisfying environmental regulations.[10]

3.1. Net imports specification

To estimate the effect of environmental regulations on trade flows, we follow Grossman and Krueger (1994) and regress net imports scaled by domestic production (M_{it}) on the level of environmental regulation (t_{it}) and trade barriers (τ_{it}) within the industry, and a vector of factor intensity variables, $\boldsymbol{F}_{it}^{n}$:[11]

$$M_{it} = \mu_i + \mu_t + \beta_1 \cdot t_{it} + \beta_2 \cdot \tau_{it} + \beta_3 \cdot \boldsymbol{F}_{it}^{n} + \eta_{it} \tag{1}$$

We include μ_i and μ_t to control for industry- and time-specific effects. The dependent variable (M_{it}) is U.S. net imports (imports minus exports) scaled by total U.S. shipments in industry i at time t. The stringency of environmental regulations t_{it} is measured by the ratio of pollution abatement costs to total costs of materials in industry i at time t, while (τ_{it}) is estimated by dividing duties by import volume to give a measure of average ad valorem tariffs for

9 More specifically, the administration's policies consisted of: (i) a reduction in the dollar amount of civil penalties assessed; (ii) the adoption of more exclusive screening criteria for identifying potential violators; (iii) reduced discretion for field personnel and greater reliance on state, local and trade associations as substitute enforcers; and (iv) the adoption of a less threatening and more flexible posture toward regulated industries.

10 The PACE survey provides data on both pollution abatement operating costs and capital expenditures on pollution abatement. As in Levinson (2001), we use pollution abatement operating expenses rather than capital expenses because (i) capital expenses on abatement are difficult for respondents to separate from other capital expenses; and (ii) abatement capital expenditures are highest when new capital investment occurs, and so industries experiencing high levels of new investment are likely to have high abatement capital expenditures, regardless of the stringency of environmental legislation.

11 It is recognized by empirical trade economists that cross-industry regressions of trade flows on factor intensities are not a valid test of the Heckscher-Ohlin model of international trade. Our motivation for including factor intensity variables in the regression is simply to act as industry controls to better address the relationship between environmental regulations and trade flows.

each industry. Data on trade volume and import duties are taken from the NBER Trade Database, while industry data are provided by the Census of Manufacturers.

The factor intensity variables (F_{it}^n) measure the human and physical capital intensity of each industry. To calculate the (direct) factor shares of both types of capital, we employ a method proposed by Grossman and Krueger (1994) in which we assume that the payroll expenses of an industry represent the combined payments to unskilled labour and human capital. Payments to unskilled labour in an industry are calculated by taking the product of the number of workers in the industry and the average yearly income of workers with less than a high school education in that industry.[12] The factor share of human capital is then determined by dividing the remaining portion of the payroll by value added for the industry. The share of physical capital in value added is then calculated by subtracting the payroll share (to unskilled labour and human capital) of value added from one. Data on value-added and industry payroll were provided by the Census of Manufacturers.

3.2. Environmental regulation specification

Both the political economy and the terms-of-trade theories suggest that higher levels of net imports may result in the relaxation of environmental regulations. However, relaxed environmental regulations in an industry would result in lower levels of net imports. These two effects can be isolated by simultaneously estimating an import equation and an environmental regulation equation. Following our theory of endogenous regulation, we model the level of environmental protection in an industry as a function of trade flows, tariffs, and a vector of political-economy variables. We follow previous empirical studies on endogenous protection (e.g., see Trefler 1993) in assuming that this function can be approximated by a linear regression.[13] In appendix B, we discuss the sensitivity analysis of our specification.

$$t_{it} = \alpha_i + \alpha_t + \delta_1 \cdot \tau_{it} + \delta_2 \cdot M_{it} + \delta_n \cdot \boldsymbol{P}_{it}^n + \epsilon_{it}. \tag{2}$$

As before, t_{it} measures the stringency of environmental regulations in industry i at time t; τ_{it} are industry-level tariffs; and M_{it} are industry-level net imports (scaled by domestic industry production). $\boldsymbol{P}_{it}^n$ is a vector of political economy

12 The average income for a worker in manufacturing with less than a high school education was calculated for each year from the Current Population Survey.

13 We follow Trefler (1993) and Ray (1981a,b) in treating tariffs as regressors in the endogenous policy equation. The argument for treating tariffs as exogenous regressors is that tariff levels over the time period studied were a result of a linear tariff-cutting formula adapted in the Tokyo Round (1973–79) and themselves were functions of previous binding tariff rates. Over the time period studied, U.S. trade policy was often carried out through the use of non-tariff barriers such as quotas. Owing to data limitations, we are not able to incorporate measures of non-tariff barriers in this paper. However, we do include industry-level dummy variables to control for general industry-specific factors.

variables. Based on our theory of endogenous regulation, we expect that higher levels of imports and lower levels of exports in an industry will be correlated with less stringent environmental regulations (i.e., $\delta_2 < 0$).

Section 2 describes the theoretical bases for our choice of explanatory variables in equation (2). To capture the extent of the free-riding problem in each industry's lobby, we include the four-firm concentration ratio and the number of firms in the industry. To measure industry size (a proxy for political importance), we include the value of shipments. Since unions represent groups that can easily be mobilized to lobby for protection, we include the percentage of workers in each industry who are union members. To capture the Magee, Brock, and Young (1989) hypothesis that protection is targeted towards disadvantaged groups, we include industry unemployment rates. To measure adverse economic shocks, we include changes in import penetration, changes in export penetration, and recent industry growth. Finally, total trade is included as an estimate of the degree of foreign competition.[14]

It should be noted that pollution abatement costs t_{it} reflect not only the stringency of environmental regulations on an industry, but also the 'dirtiness' of the industry. For example, the chemical and paper-milling industries incur high abatement costs because they produce large amounts of pollution. To account for these industry-specific differences, we use a fixed-effects model (i.e., we include industry-specific indicator variables (α_i) in equation (2)). In addition, to control for economy-wide trends in environmental regulation over time, the regression also includes time dummy variables (α_t).

3.3. Estimation

Following previous work, we first treat the level of environmental regulation as exogenous and estimate equation (1) by OLS. Next, we simultaneously estimate equations (1) and (2). Simultaneous estimation allows us to treat both the level of environmental regulation and the level of import penetration as endogenous variables. Equation (1) captures the positive effect of changes in environmental regulation (t_{it}) on net import levels (M_{it}), while equation (2) captures the negative effect of changes in net import levels on the stringency of environmental regulation. The political economy variables (P_{it}^n), and factor intensities (F_{it}^n) are used as instrumental variables to isolate the effect of environmental regulation on import penetration. Because of concerns about contemporaneous correlation in the trade variables, we use lagged values for all of the trade variables that serve as instruments in the model.[15] We use three-stage least squares to estimate the model, which allows us to control for both simultaneity and cross-equation correlations of disturbances in the model. To address possible specification error, we also include results estimated by

14 'Total trade' is measured as the sum of imports and exports, divided by the value of shipments. More complete definitions and data sources for all variables appear in appendix A.

15 Results do not differ significantly when contemporaneous values are used.

two-stage least squares.[16] Table 1 presents the results for OLS, two-stage least squares, and three-stage least squares of the import penetration regression (equation (1)), as well as three-stage least squares estimation of the environmental regulation regression (2).

In the OLS estimate of equation (1) in regression 1, the coefficient of interest is that on the environmental regulation variable (β_1). This coefficient estimate is positive and statistically significant (in line with the theory of comparative advantage): industries facing higher relative pollution abatement costs tend to have higher levels of net imports. However, as in previous research, this estimate is quantitatively small. Taken literally, this estimate implies that an industry in which environmental costs rose by 1 percentage point could expect net import penetration to increase by only 0.53 of a percentage point (the implied elasticity, computed at the means of each variable, is 0.089). This estimate suggests that environmental regulations have little effect on trade flows and are only a minor source of comparative disadvantage. The other coefficient estimates are as expected: both human and physical capital are sources of comparative advantage for the United States (indicated by negative coefficient estimates), and tariffs lead to lower levels of net imports.

However, as previous research has done, the OLS approach treats the level of environmental regulation as exogenous. Such an assumption is critical, since, if it is the case that the government endogenously relaxes environmental regulations facing industries with high levels of net imports, then estimates of β_1 that treat the level of environmental regulation as exogenous will be biased downward. In regressions 2 and 3, we relax this assumption. Regressions 2 and 3 report the results of equation (1) estimated by two-stage and three-stage least squares, respectively, and regression 4 reports the results of estimating equation (2), with net imports treated as an endogenous variable.

In regressions 2 and 3, the magnitude of the coefficient estimate on environmental regulation (β_1) is now much greater than the OLS estimate. Indeed, when the level of environmental regulation is modelled as an endogenous variable, we estimate that an industry with pollution abatement costs 1 percentage point higher than otherwise identical industries will have a net import ratio over 30 percentage points higher (the implied elasticity, computed at the means from the 3SLS estimate, is over 60 times higher than in the OLS regression, at 5.8). This estimate is both quantitatively and statistically significant and calls into question earlier claims that there is little correlation between trade flows and levels of environmental regulation. Using the Hausman (1978) specification test, we can reject the null hypothesis that the level of environmental regulation is exogenous; the test statistics of 20.5 and 35.5, for tests of 2SLS and 3SLS against OLS, respectively, have p-values of 0.000,

16 Although 3SLS is more efficient than 2SLS, this is true only under the assumption that the equations in the system are correctly specified; 2SLS is more robust to specification error. See Greene (2000).

TABLE 1
Regressions

Dependent variable	(1) OLS Net imports	(2) 2SLS Net imports	(3) 3SLS Net imports	(4) 3SLS Env. reg.
Environmental regulation	0.531	37.37	34.95	
	(0.193)	(8.14)	(7.61)	
	0.006	*0.000*	*0.000*	
Tariff	−2.59	−2.59	−2.56	−0.127
	(0.170)	(0.636)	(0.595)	(0.051)
	0.000	*0.000*	*0.000*	*0.014*
Human capital	−0.784	−2.63	−2.45	
	(0.141)	(0.664)	(0.621)	
	0.000	*0.000*	*0.000*	
Physical capital	−0.529	−0.813	−1.21	
	(0.099)	(0.375)	(0.340)	
	0.000	*0.030*	*0.000*	
Net imports				−0.097
				(0.030)
				0.001
(Lagged) import change				0.045
				(0.011)
				0.000
(Lagged) export change				−0.086
				(0.023)
				0.000
(Lagged) total trade				0.052
				(0.013)
				0.000
Industry size				0.011
				(0.076)
				0.887
% union				−0.008
				(0.006)
				0.176
Unemployment				0.015
				(0.010)
				0.153
Number of companies				0.0004
				(0.001)
				0.530
Concentration ratio				−0.010
				(0.004)
				0.024
Growth				−0.001
				(0.001)
				0.367
R^2	0.934	0.077	0.185	0.391
Observations	3,188	3,188	3,188	3,188
Industries	374	374	374	374
Hausman test statistic $\chi^2(4)$		20.5	35.5	
p-value		*0.000*	*0.000*	

NOTES: Data are U.S. 4-digit SIC manufacturing industries over the period 1978–92. Constant terms vary by time periods and by industry. Standard errors appear in parentheses; p-values in italics. Reported OLS R^2 includes the estimated effects of the industry and time groups. 2SLS and 3SLS reported R^2s are computed using actual, not instrumented, values of environmental cost and net imports and so are not constrained to be greater than zero. Hausman test statistics are of 2SLS and 3SLS, respectively, against OLS; they are distributed $\chi^2(4)$.

suggesting that OLS estimation is inappropriate. Thus, it appears that when treated as an endogenous variable, stringent environmental regulations can be a major source of comparative disadvantage.

The results of the environmental regulation regression (regression 4 in table 1) are interesting in their own right, since to our knowledge, they are the first attempt to empirically estimate whether U.S. environmental regulations are systematically affected by political and competitiveness concerns. For this paper, the relationship of greatest concern is that between net imports and abatement cost. In the simultaneous equation estimate of regression 4, the coefficient estimate on net imports is negative and statistically significant (in accord with the predictions of both the political economy and terms-of-trade theories). Thus, our estimation provides support for the predictions of the standard theories of protection that governments will tend to undertax (and underregulate) import industries, and overtax (and over-regulate) export industries.

The only other variables that are statistically significant in regression 4 are tariffs, the trade variables, and the concentration ratio of the industry. As the political economy theory predicts, the coefficient on the concentration ratio is negative (i.e., the more concentrated the industry, the stronger the lobby and therefore the lower the cost of regulation imposed on the industry). However, the coefficient on tariffs is also negative (i.e., the higher the tariff within an industry, the lower the amount of environmental regulation), contradicting the theories of section 2, and suggesting that tariffs and environmental regulations are complements.[17] Finally, the coefficients on the trade variables appear to provide more support for the strategic theories of environmental regulation than the political theories, since many of the predictions of the political economy models are contradicted.[18] Specifically, we find that industries with higher levels of trade, as well as recent increases in imports and decreases in exports, are more likely to have stringent levels of environmental regulation.

Although our results provide a strong case against treating the level of environmental regulation exogenously, there are some qualifications that must be attached. As with any instrumental variable estimation, misspecification of the environmental regulation equation may bias the results of the net import regression. For example, although the trade variables are lagged to avoid contemporaneous correlation, there may be concerns about using past import changes as an instrumental variable (since past changes in import penetration could be correlated with the current level of net imports in the industry). Likewise, one might be concerned about treating the level of unemployment in an industry as an exogenous variable. To address these

17 A similar result was found by Marvel and Ray (1983), who discovered that tariff and non-tariff barriers are complements (in the Kennedy Round, a decrease in tariffs was correlated with a decrease in non-tariff barriers as well).

18 Our results do agree with some political economy models; for example, Gulati (2001) predicts that trade can lead to increased environmental regulations, as we find.

concerns, we conduct multiple specification tests. Our conclusions appear quite robust to alternative specifications, with the exception of excluding all of the trade variables; results appear in appendix B.

As regression 4 shows, the United States tends to endogenously undertax import-competing industries and over-tax export industries. Previous research that treated the level of environmental regulation as exogenous did not capture this effect and thus produced potentially biased estimates of the effect of environmental regulations on imports. Accounting for this simultaneity results in estimates of the impact of environmental regulations on trade flows significantly higher than previous estimates.

4. Conclusions

An important empirical issue behind questions of whether international trade agreements should include negotiations over environmental policy is whether countries actually distort levels of environmental regulation as a secondary means of providing protection to domestic industries. In this paper, we investigated the hypothesis that environmental policy has been used as a secondary trade barrier and estimated the impact of environmental regulation on trade flows when environmental policy is modelled endogenously. We found empirical support for modelling environmental policy endogenously and also found that environmental policy has a much stronger impact on net import levels than had previously been reported. As with any instrumental variable analysis, this result must be interpreted with some caution, since it will be sensitive to the choice of instruments. However, our results do suggest that previous estimates of the small impact of environmental regulations on trade flows based on cross-industry regressions should be viewed with scepticism, because they treat the level of environmental regulation as exogenous. This result is important, since this previous research has often been used to justify the claim that a country's environmental regulations are not a valid area of international negotiation.

In this paper we also offer some empirical insights into the determinants of U.S. environmental policy. Specifically, our results reveal a tendency to set less stringent regulations on import-competing industries and more stringent regulations on export industries. However, a fully specified model of how environmental regulations on endogenously determined has yet to be constructed. Such a model (perhaps based on the Grossman and Helpman 1994 model of endogenous trade protection) would assist in informing future empirical research on this question.

A second concern is the cross-industry studies of the effect of environmental regulations on import penetration. Such studies typically assume that an increase in regulation (i.e., pollution abatement costs) will have the same effect on trade flows across disparate industries. An interesting line of future enquiry is to estimate whether certain industries are more sensitive to changes in environmental regulations than others.

Appendix A: Variable definitions

TABLE A1
Variable definitions and means

Variable	Mean	Definition	Source
Environmental regulation	0.011 (0.019)	Gross annual pollution abatement operating costs as percentage of total cost of materials	CIR, CM
Tariff	0.042 (0.044)	Ratio of duties paid to customs value	NBER
Human capital	0.210 (0.093)	$\frac{\text{(total payroll–payments to unskilled labour)}}{\text{value added}}$	CM, CPS
Physical capital	0.609 (0.122)	$1 - \frac{\text{total payroll}}{\text{value added}}$	CM
Net imports	0.068 (0.446)	Imports minus exports (defined below)	NBER
*Imports**	0.008 (0.129)	Ratio of (customs value of) imports to total shipments	NBER
*Exports**	0.005 (0.036)	Ratio of exports to total shipments	NBER
*Total trade**	0.260 (0.399)	Imports plus exports (defined above)	NBER
Industry size	0.007 (0.012)	Value of shipments (millions)	CM
% union	0.240 (0.127)	% of workers in industry who are union members	CPS
Unemployment	0.076 (0.039)	Industry unemployment	CPS
Number of companies	0.766 (2.044)	Number of firms in industry (thousands)	CM
Concentration ratio	0.405 (0.210)	% of industry shipments produced by four largest firms	CM 1987, 1992
Growth	1.043 (0.238)	Ratio of size at time t to size at time $t-1$	CM
Observations	3,188		
Number of industries	374		

NOTES: As used in the analysis, imports and exports are one-year changes; all trade variables (total trade, and changes in imports and exports) are lagged one year.

Table A1 defines variables used in the tables and gives means and standard deviations of each variable. Definitions of sources and further details follow.

CIR: *Current Industrial Reports: Pollution Abatement Costs and Expenditures* reports by the Census Bureau / U.S. Department of Commerce, 1972–92. The data from 1989–92 are provided at the 4-digit 1987 SIC level; we used the concordance described for the *Census of Manufacturers* data to allocate those data to 1972 SIC industries. Pollution abatement operating costs include all costs of operating and maintaining plant and equipment to abate air or water pollutants, and expenses to private contractors or the government for solid waste management. Pollution abatement operating costs were not collected in

1987, and totals by industry were not reported in 1979, so these years are dropped from our sample. Owing to the incompatibility (in the treatment of small plants) between the data collected in the first several years and those from later years, we include only data since 1978 (see Levinson 2001).
CM: *Census of Manufacturers* (1978–92). The 1987 *Census* provides data on value added, value of shipments, and total costs of materials at the 4-digit 1972 SIC level. The 1992 *Census* provides these data for only 1987 SIC industries. We used a concordance based on 1987 domestic production (value of shipments) ratios to allocate the data into 1972 SIC industries (the 1987 *Census* provides data for both the 1987 and 1972 SIC industries).
CPS: *Current Population Survey* (1978–92), May supplemental surveys.
NBER: NBER Trade Database. This database provides U.S. import and export data for 1972–94. For 1972–88, these data are provided at the 8-digit MSIC (import-based SIC) level. We aggregated these data to the 4-digit level and then used a concordance (generously provided by Chris Magee) that allocates MSIC imports to SIC industries in proportion to domestic production to convert these data to 1972 SIC industries. For 1989–94, the data are provided at the 4-digit 1987 MSIC level. We converted these data to 1972 MSIC industries using the concordance provided in the NBER database (which allocates 1987 MSIC imports to 1972 MSIC industries in proportion to their 1988 customs value ratios – import data for 1988 are presented for both 1972 and 1987 MSIC industries).

Appendix B: Sensitivity analysis

Our primary concern is that the estimate of β_1 may be biased, owing to the presence of endogenous regressors in the environmental regulation equation. To address this possibility, we follow a procedure suggested by Spencer and Berk (1981) in testing for exogeneity. Specifically, assume that variable P^k in the environmental regulation equation is suspected of being endogenous. We first estimate (2) using 2SLS treating P^k as an exogenous variable in the system, and then estimate (2) using 2SLS with P^k treated as an endogenous variable. The Hausman test statistic based on the difference between these two estimators is reported in column 2 of table B1. For each of our instruments, we cannot reject the null hypothesis that the variable is exogenous.[19]

Following Trefler (1993) and as a second check on our results, in column 1 of table B1 we report estimates of β_1 when each of the instruments is treated as an endogenous variable (with 2SLS estimation, this is equivalent to simply omitting the suspected variable from the list of instruments). Although there is

19 Similar results were found when we repeated the above test using 3 SLS estimation, with the exception that the null hypothesis of exogeneity was rejected for unemployment. However, treating unemployment as endogenous resulted in coefficient estimates of β_1 that are larger than the estimates reported in table 1.

TABLE B1
Sensitivity analysis

	(1) β_1 (s.e)	(2) Hausman $\chi^2(11)$	(3) P-value
(Lagged) import change	32.21 (7.43)	1.83	*0.999*
(Lagged) export change	35.34 (7.79)	0.29	*0.999*
(Lagged) total trade	17.99 (4.75)	0.004	*0.999*
Industry size	39.20 (8.70)	11.02	*0.442*
Union	38.13 (8.42)	2.18	*0.998*
Unemployment	52.70 (13.5)	12.0	*0.364*
Number of companies	37.51 (4.58)	3.23	*0.987*
Concentration	43.43 (9.93)	8.29	*0.687*
(Lagged) growth	42.83 (9.93)	11.94	*0.368*

NOTES: β_1 reports the estimate of β_1, the coefficient on environmental regulation in the import equation, when the instrument is treated as endogenous in 2SLS estimation (see text for details). Standard errors appear in parentheses. The Hausman test statistic is based on the environmental regulation regression estimated by 2SLS as in table 1, compared with 2SLS with the instrument in question treated as endogenous, following Spencer and Berk (1981); it is distributed $\chi^2(11)$. P-values indicate the probability with which one cannot reject the null hypothesis that the instrument is exogenous, based on the Hausman test.

some variation in the estimates of β_1, all of the estimates are significantly larger than they are under OLS estimation, and all are statistically significant. Thus, our results are robust to small changes in the choice of instruments.

We repeated this analysis with various groups of instruments omitted from the analysis. We find that the magnitude of our estimate of β_1 is robust with the exception of the case when all of the trade variables are omitted as instruments.[20] Specifically, when total trade, changes in imports, and changes in exports are omitted from the environmental regulation regression, our estimate of β_1 is neither statistically significant nor significantly different from the OLS estimate. (Of course, omitting the trade instruments leaves us with a single statistically significant instrument in the environmental regulation equation.)

References

Baldwin, Robert (1985) *The Political Economy of U.S. Import Policy* (Cambridge, MA: MIT Press)

— (1989) 'The political economy of trade policy.' *Journal of Economic Perspectives* 3(4), 119–35

Barrett, Scott (1994) 'Strategic environmental policy and international trade,' *Journal of Public Economics* 54, 325–38

20 If anything, the magnitude generally increases; for example, the estimate when all statistically insignificant regressors are excluded results in an estimate of β_1 of 82.1, with a standard error of 23.2 and p-value of 0.000.

Bhagwati, Jagdish, and T.N. Srinivasan (1996) 'Trade and the environment: does environmental diversity detract from the case for free trade?' in *Fair Trade and Harmonization: Prerequisites for Free Trade?* ed. J. Bhagwati and R.E. Hudec, vol. 1 (Cambridge, MA: MIT Press)

Brock, William A., and Stephen P. Magee (1978) 'The economics of special interest politics: the case of the tariff,' *A.E.R. Papers and Proceedings* 68, 246–50

Caves, Richard E. (1976) 'Economic models of political choice: Canada's tariff structure,' *Canadian Journal of Economics* 9, 278–300

Copeland, Brian (1990) 'Strategic interaction among nations: negotiable and non-negotiable trade barriers,' *Canadian Journal of Economics* 23, 179–88

Corden, William (1994) *Trade Policy and Economic Welfare* (Oxford: Oxford University Press)

Eads, George C., and Michael Fix (1984) *Relief or Reform: Reagan's Regulatory Dilemma* (Washington, DC: Urban Institute Press)

Esty, Daniel C. (1994) *Greening the GATT: Trade, Environment, and the Future* (Washington, DC: Institute for International Economics)

Greene, William H. (2000) *Econometric Analysis*. 4th ed. (Saddle River: Prentice-Hall)

Grossman, Gene M., and Elhanan Helpman (1994) 'Protection for sale,' *American Economic Review* 84, 833–50

Grossman, Gene M., and Alan B. Krueger (1994) 'Environmental impacts of a North American Free Trade Agreement,' in *The U.S. Mexico Free Trade Agreement*, ed. P. Garber (Cambridge, MA: MIT Press)

Gulati, Sumeet (2001) 'The effects of choosing free trade on endogenous environmental regulation and welfare,' unpublished manuscript, University of Maryland

Hausman, Jerry A. (1978) 'Specification tests in econometrics,' *Econometrica* 46, 1251–71

Hillman, Arye L. (1982) 'Declining industries and political-support protectionist motives,' *American Economic Review* 72, 1180–7

Kahneman, Daniel, and Amos Tversky (1979) 'Prospect theory: an analysis of decision under risk,' *Econometrica* 47, 263–91

— (1984) 'Choices, values, and frames,' *American Psychologist* 39, 341–50

Kalt, Joseph P. (1988) 'The impact of domestic environmental regulatory policies on U.S. international competitiveness,' in *International Competitiveness*, ed. M.A. Spence and H.A. Hazard (Ballinger)

Krugman, Paul (1997) 'What should trade negotiators negotiate about?' *Journal of Economic Literature* 35, 113–20

Leonard, H. Jeffrey (1988) *Pollution and the Struggle for World Product* (Cambridge: Cambridge University Press)

Levinson, Arik (1996) 'Environmental regulations and industry location: International and domestic evidence,' in *Fair Trade and Harmonization: Prerequisites for Free Trade?* ed. J. Bhagwati and R.E. Hudec, vol. 1 (Cambridge, MA: MIT Press)

— (2001) 'An industry-adjusted index of state environmental regulatory stringency,' in *Behavioral and Distributional Effects of Environmental Policy*, ed. C. Carraro and G.E. Metcalf (Chicago: University of Chicago Press)

Low, Patrick, and Andrew Yeats (1992) 'Do "dirty" industries migrate?' in *International Trade and the Environment*, ed. P. Low (World Bank)

Magee, Stephen P., William A. Brock, and Leslie Young (1989) *Black Hole Tariffs and Endogenous Policy Theory* (Cambridge: Cambridge University Press)

Markusen, James R. (1975) 'International externalities and optimal tax structures,' *Journal of International Economics* 5, 15–29

Marvel, Howard P., and Edward J. Ray (1983) 'The Kennedy Round: evidence on the regulation of international trade in the United States,' *American Economic Review* 73, 190–7

Olsen, Mancur (1968) *The Logic of Collective Action* (Cambridge, MA: Harvard University Press)
Peltzman, Sam (1976) 'Toward a more general theory of regulation,' *Journal of Law and Economics* 19, 211–40
Ray, Edward John (1981a) 'The determinants of tariff and non-tariff restrictions in the United States,' *Journal of Political Economy* 89, 105–21
— (1981b) 'Tariff and non-tariff barriers to trade in the United States and abroad,' *Review of Economics and Statistics* 63, 161–8
Shanley, Robert A. (1992) *Presidential Influence and Environmental Policy* (London: Greenwood Press)
Spencer, David E., and Kenneth N. Berk (1981) 'A limited information specification test,' *Econometrica* 49, 1079–85
Stigler, George J. (1971) 'The theory of economic regulation,' *Bell Journal of Economics and Management Science* 2, 3–21
Tobey, James A. (1990) 'The impact of domestic environmental policies on patterns of world trade: an empirical test,' *Kyklos* 43, 191–209
Trefler, Daniel (1993) 'Trade liberalization and the theory of endogenous protection: an econometric study of U.S. import policy,' *Journal of Political Economy* 11, 138–60