Economic Policy Institute
Briefing Paper
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A NEW LOOK AT ENVIRONMENTAL PROTECTION AND COMPETITIVENESS

by Eban Goodstein

For some 25 years, economists have been searching for competitiveness impacts of environmental regulation. Until recently, the expectation has been that the increasing costs imposed by regulation should impose some visible penalty. But in a recent survey article in the *Journal of Economic Literature*, Adam Jaffe et al. (1995) report that economists haven't found much. Firms have not been fleeing the developed countries to set up shop in less-regulated "pollution havens," and the available evidence shows no consistent impact of environmental regulation on the import or export performance of U.S. firms.

This question of competitiveness has taken on new urgency during the international negotiations surrounding a global warming treaty. Will regulations requiring carbon emission reductions put U.S. industry at an international disadvantage? This paper seeks to shed some light on this question by reviewing current thinking on regulation and imports, summarizing the exhaustive literature review undertaken by Jaffe et al., and reporting on new information about the relationship between environmental regulation and import performance in U.S. manufacturing.

Jaffe and his co-authors — Steven Peterson, Paul R. Portney, and Robert N. Stavins – examined two decades of research looking for a negative impact of environmental regulation on competitiveness. They concluded: "studies attempting to measure the effect of environmental regulations on net exports, overall trade flows, and plant location decisions have produced estimates that are either small, statistically insignificant, or not robust to tests of model specification." In other words, the studies found no observable impact.

The new research reported in this paper generally confirms the view of Jaffe et al., but it also finds that, over the 1979-89 period, *industries that spent more money complying with environmental regulations actually demonstrated superior performance against imports from developed countries*. The result is statistically significant. A similar pattern was observed for imports from developing countries, but the relationship was not as strong.

Why no pollution havens?

If the costs of environmental regulations placed firms at a competitive disadvantage, one would expect to find evidence of firms relocating to cheaper "pollution havens." But in their survey article, Jaffe et al. (1995) found this not to be the case, and they offered three possible explanations. First, the costs of regulatory compliance are small relative to total business costs; second, most trade is among countries of the OECD (Organization for Economic Cooperation and Development), which have comparable regulations, so any trade flow effects will be small; and, third, the data are too poor to reveal such effects.

However, for some industries, even when compliance costs are relatively high, international competitiveness effects are still not apparent. For example, while individual oil refineries face compliance costs as a share of operating costs on the order of 20% (Ditz et al. 1995), Goodstein (1994) found no increase in the import share of refined petroleum products over the period 1975-91, despite the dramatic increase in the import share of crude oil. **Figure 1** brings this work up to date: through 1995 the import share of petroleum products was holding constant at around 12%. Moreover, some studies that have looked specifically at the determinants of developing country location have found no large or consistent effects.[1]

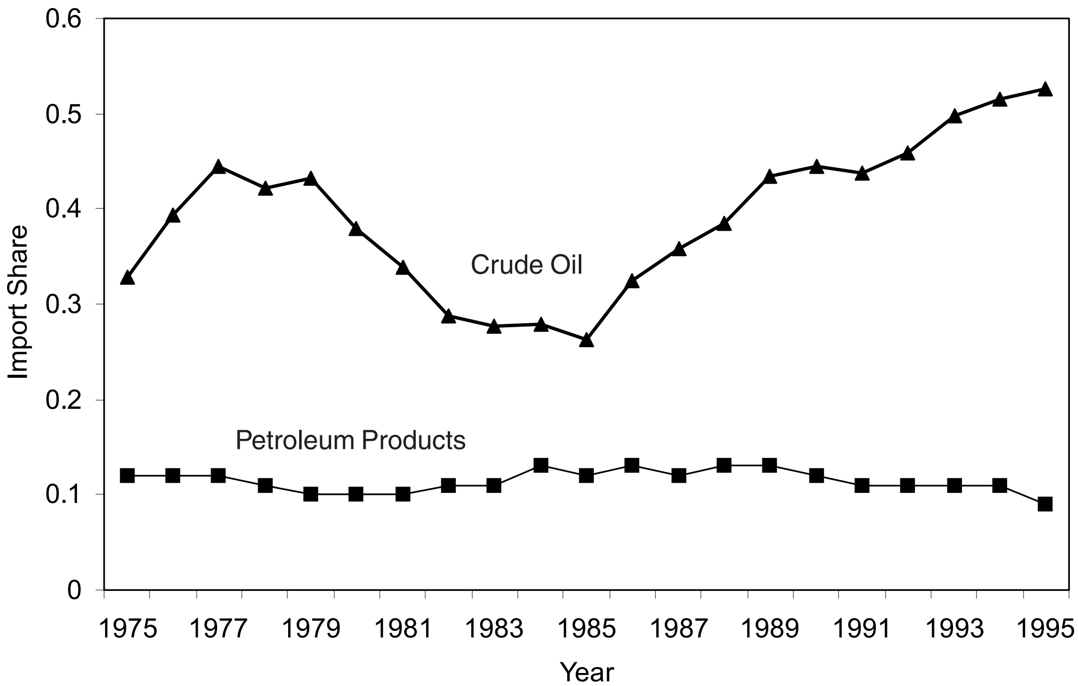
Another possible explanation for the absence of harmful competitive effects is the so-called "Porter hypothesis" (Porter 1991 and Porter and van der Linde 1995), which says that environmental regulation, while imposing short-run costs on firms, actually enhances their long-run competitiveness. Jaffe et al. provide a clear, if skeptical, overview of the ways in which this might happen: from favoring forward-looking firms that develop products in future demand; to reducing inefficiencies in production, in particular through speeding investment in modern processes; to promoting "outside-the-box" thinking; to forcing an expansion in research and development (R&D) spending. While economists have long recognized that these factors exist and might partially offset compliance costs (Barbera and McConnell 1990), Porter and van der Linde argue that these spurs to innovation in fact *dominate* compliance costs.

In their response to Porter and van der Linde, Palmer et al. (1995) dismiss the evidence supporting the Porter hypothesis as anecdotal, and they point to data revealing aggregate compliance costs that are quite large. But the basic objection to the Porter position is a theoretical one. First, how is it possible in a relatively competitive market for firms to systematically overlook profit opportunities? And second, even if this were happening, is it plausible that government regulators know better, and can provide an intelligent guiding hand to industry?

One possible response to this line of criticism is the following. The basic problem (if not market failure) in question is American management's alleged "short-term view." This perspective, that U.S. capital systematically "underinvests," is also associated, though less exclusively, with Porter (Blair

FIGURE 1

Import Shares of Refined Petroleum Products and Crude Oil



Source: U.S. Department of Energy, Monthly Energy Review.

1995, Porter 1992, Scherer 1988, Yamamoto 1990). Briefly, the argument as posed by Blair is that the reliance of American firms on equity financing — as opposed to the European and Japanese method of bank-based financing — induces a subtle but undesirable focus on investments with short-term payoffs.[2]

If we grant an American bias toward short-term profitability at the expense of long-term viability, environmental regulation can help overcome this problem. Government actions that force firms to speed up investment in physical capital and at the same time rethink manufacturing production processes get them into a more competitive, longer-term frame of mind. Such a theory does not require the guiding hand of the bureaucracy.

A third possible explanation for the absence of harmful competitive effects is that environmental regulations act as subtle import barriers. The persistence of an American refining industry in the face of high compliance costs, for example, may reflect a comparative advantage on the part of American firms in meeting American product standards. Indeed, because the EPA consults with domestic regulated parties when designing regulations, such regulations may consciously or unconsciously favor the competitive position of regulated entities. This import barrier hypothesis is given some support by the recent GATT (General Agreement on Tariffs and Trade) ruling in a case brought by Venezuela against the United States regarding standards for reformulated gasoline.[3]

U.S. net exports and environmental regulation

As noted above, Jaffe et al. (1995), surveying the literature on competitiveness and environmental regulation, find essentially no impact. Most of the researchers they looked at compared industries with high regulatory compliance costs, like paper, metal refining, or chemicals, against industries with low compliance costs, like textiles and other light manufacturing. These compliance costs are reported to the government in the form of an annual Pollution Abatement and Control Expenditure (PACE) survey; the data from this survey are available to researchers by standard industrial classification (SIC) code at the four-digit level. (There are about 430 four-digit industries.)

The topics of five of the studies reviewed by Jaffe et al. are closely related to the new findings reported in the next section. These studies are discussed below.

Kalt (1988), working at the two-digit SIC level, found that manufacturing industries with high abatement costs had a significantly worse net export performance compared to industries with low abatement costs over the period 1967-77. Oddly, however, the relationship was much stronger when heavily regulated chemicals were excluded.

Robison (1988) found that the abatement content of two-digit U.S. imports, including those for manufacturing and nonmanufacturing industries, rose relative to U.S. exports, primarily over the period 1977-82. However, this finding may result from a peak-to-trough comparison. If the import income elasticity of "dirty" products, say chemicals, is less than clean imports, say textiles, then in a severe downturn like 1982 the abatement content of imports would rise. This hypothesis is leant some credence by the fact that Robison found no significant change in the abatement content of the import-export ratio over the (approximately) peak-to-peak period 1973-77.

Grossman and Krueger (1991) looked at the impact of abatement costs on U.S. imports from Mexico at the three-digit SIC level, U.S. imports from Mexico at the three-digit level entering under off-shore assembly provisions, and the two-digit sectoral pattern of value-added in the Maquiladora region. They compared the composition of U.S. imports from Mexico with the composition of U.S. production as a whole in 1987. Only in one case — off-shore assembly imports — was the relationship significant, and it worked in the opposite direction than expected. Imports appeared to be higher in industries with lower pollution abatement costs, thus hinting at a Porter-like positive impact of regulation on competitiveness.

Sorsa (1994) showed that, on net, heavily regulated U.S. industries exhibited significantly superior export performance than average over the period 1970-90. While the U.S. share in world exports fell from 14.5% to 11.4%, the share of "environmentally sensitive" manufacturing fell less — from 16% to 14%.

Finally, Tobey (1990), using a qualitative measure of international stringency of regulation, found no impact on 1975 net exports of 23 countries in five pollution-intensive sectors.

Table 1 summarizes this discussion: Kalt and Robison, both working at the two-digit level, found evidence for negative impacts of regulation on net exports. However, the former result was sensitive to model specification, and the latter is suspect because of business cycle influences. Grossman and Krueger (using three-digit data) and Sorsa (at the two-digit level) found a positive relationship between regulation and competitiveness. Finally, Tobey found no relationship.

One problem with all of these studies is the fact that important confounding factors were left

TABLE 1
Previous Studies of Regulation and Competitiveness

Study	Impact of Regulation on Net Export Performance	Level of Data Aggregation	Business Cycles Accounted For?	Confounding Factors Accounted For?	Developing/ Developed Country Differences Accounted For?
Kalt	Negative, But Not Robust	High	Partially	Partially	No
Robison	Negative	High	No	No	Canada Only
Sorsa	Positive	Medium	Partially	No	No
Grossman & Krueger	No Relation, Generally, Positive in One Case	Medium	Not Applicable	Partially	Mexico Only
Tobey	No Relation	Medium	Not Applicable	Partially	Yes

out of the analysis. We might expect heavily regulated industries to be in capital-intensive, raw-materials-intensive, highly concentrated, or declining sectors of the economy. All of these factors should independently affect net-export performance. For example, consider Sorsa's finding of a very simple positive relationship between export performance and environmental regulation. If heavily regulated industries also happen to be capital intensive, than they may be hard targets for importers to crack. Thus, Sorsa's results may simply reflect the confounding influence of the omitted variables, disguising a true negative impact of regulation on competitiveness. (Economists call this kind of "untrue" correlation an "omitted variables bias.")

While Sorsa and Robison look at simple bivariate correlations, Kalt and Grossman and Krueger presented somewhat more sophisticated models. Kalt looked at the change in net export levels, controlling for the change in the levels of the capital stock, R&D spending, human capital, and unskilled labor. Grossman and Krueger included in their model human and physical capital shares, the tariff rate, and industry injury rates. Tobey, working at the country level, included variables measuring the net capital stock, worker literacy, and land and natural resource endowments.

The relative merits of these excellent studies aside, they are each hindered by three serious problems: (1) the use of highly aggregated data, (2) the failure to consider the impact of the business cycle, and (3) the failure to account for confounding factors. In addition, only Grossman and Kreuger and Robison separate out developing- from developed-country imports.

This year, however, thanks to the efforts of the National Bureau of Economic Research (NBER), a new dataset has become available that allows these four problems to be addressed. The section that follows uses this new dataset.

A new look at environmental regulation and import competitiveness

The new research reported here improves on existing work in several ways: first, it exploits the large NBER dataset, unavailable to previous researchers; it controls for the confounding effects of related variables; it separately evaluates developing- and developed-country imports; it explores changes in imports across similar periods in the business cycle; and it includes results through the late 1980s. This report looks only at imports, however, since the export data are not yet available.

The NBER dataset does two novel things. First, it provides a comprehensive listing of imports by four-digit SIC codes through the early 1990s. Second, it breaks down imports into the United States by country of origin.[4] Since the issue at hand is competitiveness, this paper looks only at "import-sensitive industries" — those with a greater than 5% import share at the end of the period.[5] In 1979, there were 201 such industries; by 1989 the number had grown to 283. We use this new data to provide first a broad and then a more statistically detailed look at the relationship between environmental regulation and import competitiveness.

A look at the top 20

Tables 2 through 4 provide listings of the top 20 industries by growth in the less-developed-country (LDC) import share; growth in the developed-country (DC) import share; and environmental cost share, for the periods 1973-79 and 1979-89.

Table 2, which includes the top 20 industries by LDC import growth, shows that the fastest-growing imports from LDCs were textiles, shoes, and leather goods; in both periods, these accounted for roughly three-fourths of the top import industries. Nonferrous metals and watches were fast growers in the early period, but were replaced by video and audio equipment in the second. Pottery and tableware made both lists, as did one processed food industry (edible oils, replaced by fish). Only three of the top 20 in the early period were industries with higher-than-average environmental costs; only one in the latter. It seems, then, that, low-wage industries, not "dirty" ones, dominate the list of LDC import leaders.

Table 3 illustrates the fastest-growing import industries from the developed world. In the 1970s, import growth was dominated by machine tools and automobiles, along with a couple of specialty wood and paper product industries, cameras, jewelry, and alcoholic beverages. The 1980s list shows some overlap with the 1970s, but high-tech industries replaced autos, wood, and paper products, and nonferrous metals crept into the list. Once again, most (at least three-quarters) of the industries on the list had lower-than-average environmental cost shares. So, as with the LDCs, the reasons for the import gains must lie elsewhere. Only wood products and nonferrous metals stand out as possible candidates for industries hampered by environmental regulation. However, most of the developed countries (especially by the 1980s) had regulations in these industries that were roughly comparable to those in the United States.

Finally, **Table 4** shows the top 20 industries by environmental cost share. Note that, even for these heavily regulated industries, the share of environmental spending out of total sales is fairly small — topping out at 2.7% for the nonferrous metals industry in 1979 and falling to around 0.5% for the No. 20 industry in both lists.[6] Table 4 shows, once again, that there is no evidence of wide-

TABLE 2
Top 20 Industries by Increased Import Share From Less-Developed Countries, 1973-79 and 1979-89

SIC Code	Industry	Import Share **1979**	Change in Share, LDC	Change in Share, DC	Share of Env. Op. Costs
1973-79					
2279	Carpets, NEC	0.675	0.460	-0.019	0.000
3021	Rubber and Plastics Footwear	0.453	0.270	-0.027	0.001
2386	Leather and Sheep-lined Clothing	0.562	0.260	-0.075	0.000
2385	Waterproof Outerwear	0.414	0.254	-0.071	0.000
3149	Footwear, Except Rubber, NEC	0.572	0.224	-0.016	0.001
3151	Leather Gloves and Mittens	0.281	0.170	-0.029	0.000
3339	Primary Nonferrous Metals, NEC	0.736	0.166	-0.058	0.013
3873	Watches, Clocks and Parts	0.367	0.141	0.004	0.000
3269	Pottery Products, NEC	0.494	0.137	0.004	0.002
2381	Fabric, Dress, and Work Gloves	0.324	0.131	-0.025	0.000
3171	Women's Handbags and Purses	0.366	0.128	-0.023	0.000
2361	Girls Dresses and Blouses	0.170	0.128	0.004	0.000
2331	Womens' Dresses and Blouses	0.170	0.126	0.004	0.000
2342	Bras, Girdles and Allied Garments	0.176	0.124	0.001	0.000
3161	Luggage	0.228	0.110	-0.056	0.000
2079	Edible Fats and Oils, NEC	0.110	0.102	0.007	0.001
3131	Footwear, Cut Stock	0.160	0.098	0.029	0.001
3263	Semivitreous Table and Kitchenware	0.694	0.087	0.113	0.006
3172	Personal Leather Goods, NEC	0.220	0.083	-0.027	0.000
2292	Lace Goods	0.260	0.080	-0.020	0.000
MEAN		0.151	0.029	0.005	0.002

SIC Code	Industry	Import Share **1989**	Change in Share, LDC	Change in Share, DC	Share of Env. Op. Costs
1979-89					
3149	Footwear, Except Rubber, NEC	0.854	0.365	-0.083	0.000
3144	Women's Footwear, Except Athletic	0.668	0.357	-0.086	0.000
2386	Leather and Sheep-lined Clothing	0.882	0.331	-0.010	0.000
2091	Canned and Cured Fish and Seafood	0.504	0.306	0.036	0.000
3021	Rubber and Plastics Footwear	0.774	0.303	0.018	0.000
3131	Footwear, Cut Stock	0.441	0.300	-0.019	0.000
3263	Semivitreous Table and Kitchenware	0.722	0.276	-0.248	0.003
3151	Leather Gloves and Mittens	0.542	0.263	-0.002	0.000
3161	Luggage	0.488	0.259	-0.000	0.000
2371	Fur Goods	0.487	0.246	0.089	0.000
2385	Waterproof Outerwear	0.643	0.229	0.001	0.000
3269	Pottery products, NEC	0.639	0.212	-0.067	0.001
2384	Robes and dressing Gowns	0.253	0.200	0.004	0.000
2389	Apparel and Accessories, NEC	0.304	0.195	0.050	0.000
3651	Household Audio and Video Equip.	0.627	0.194	0.051	0.000
2341	Women and Children's Underwear	0.215	0.188	0.008	0.000
2363	Children's Suits and Coats	0.318	0.188	0.016	0.000
2337	Women's Suits and Coats	0.318	0.188	0.016	0.000
3172	Personal Leather Goods, NEC	0.433	0.186	0.027	0.000
2381	Fabric, Dress and Work Gloves	0.517	0.186	0.007	0.000
Mean		0.197	0.045	0.031	0.001

Note: NEC stands for "not elsewhere classified."
Source: Author's analysis of NBER. See "Data Sources" in Technical Appendix.

TABLE 3
Top 20 Industries by Increased Import Share From Developed Countries, 1973-79 and 1979-89

SIC Code	Industry	Import Share **1979**	Change in Share, LDC	Change in Share, DC	Share of Env. Op. Costs
1973-79					
3911	Jewelry, Precious Metal	0.350	0.043	0.122	0.000
3263	Semivitreous Table and Kitchenware	0.694	0.087	0.113	0.006
2492	Particleboard	0.095	-0.000	0.091	0.006
3541	Machine Tools, Metal Cutting Types	0.193	0.030	0.084	0.000
3547	Rolling Mill Machinery	0.101	0.001	0.076	0.001
3546	Power Driven Hand tools	0.128	0.006	0.069	0.000
3144	Women's Footwear, Except Athletic	0.397	0.063	0.067	0.001
2084	Wines, brandy and Brandy Spirits	0.291	-0.025	0.067	0.000
2271	Woven Carpets	0.282	0.051	0.066	0.000
2429	Special Product Sawmills, NEC	0.341	0.000	0.065	0.002
3554	Paper Industries Machinery	0.176	0.003	0.061	0.001
3713	Truck and Bus Bodies	0.182	-0.004	0.046	0.001
3711	Motor Vehicle and Car Bodies	0.182	-0.004	0.046	0.001
3253	Ceramic Wall and Floor Tile	0.348	0.038	0.045	0.001
3031	Reclaimed Rubber	0.052	-0.006	0.043	0.000
3551	Food Products Machinery	0.111	0.002	0.042	0.000
3542	Machine Tools, Metal Forming Types	0.080	0.005	0.041	0.000
2661	Building Paper and Board Mills	0.052	-0.000	0.039	0.002
3553	Woodworking Machinery	0.082	0.003	0.038	0.000
3861	Photographic Equip. and Supplies	0.104	0.006	0.038	0.001
MEAN		0.151	0.029	0.005	0.002

SIC Code	Industry	Import Share **1989**	Change in Share, LDC	Change in Share, DC	Share of Env. Op. Costs
1979-89					
3636	Sewing Machines	0.670	0.027	0.271	0.000
3541	Machine tools, Metal Cutting Types	0.388	0.013	0.182	0.000
2299	Textile Goods, NEC	0.491	-0.162	0.170	0.001
3537	Industrial Trucks and Tractors	0.289	0.079	0.145	0.000
3661	Telephone Apparatus	0.236	0.063	0.141	0.000
3623	Welding Apparatus, Electrical	0.193	0.008	0.138	0.000
3281	Cut Stone and Stone Products	0.368	0.096	0.137	0.001
3566	Speed Changers, Drivers, Gears	0.237	0.035	0.132	0.000
3576	Scales and Balances	0.223	0.033	0.131	0.000
3552	Textile Machinery	0.478	0.010	0.126	0.000
2283	Wool Yarn Mills	0.217	0.024	0.117	0.000
3332	Primary Lead	0.225	0.004	0.111	0.008
3555	Printing Trades Machinery	0.238	0.005	0.109	0.000
3574	Calculating Machines	0.462	0.108	0.104	0.001
3333	Primary Zinc	0.435	-0.015	0.104	0.014
3764	Space Propulsion Units and Parts	0.135	0.005	0.101	0.002
3724	Aircraft Engines and Engine Parts	0.135	0.005	0.101	0.000
3674	Semiconductors and Related Devices	0.313	-0.009	0.100	0.001
3553	Woodworking Machinery	0.265	0.085	0.098	0.000
2295	Coated fabrics, Not Rubberized	0.149	0.029	0.097	0.002
Mean		0.197	0.045	0.031	0.001

Note: NEC stands for "not elsewhere classified."

Source: Author's analysis of NBER. See "Data Sources" in Technical Appendix.

TABLE 4
Top 20 Industries by Environmental Cost Share, 1973-79 and 1979-89 Average

SIC Code	Industry	Import Share **1979**	Change in Share, LDC	Change in Share, DC	Share of Env. Op. Costs
1973-79					
3333	Primary Zinc	0.345	0.021	0.018	0.027
2611	Pulp Mills	0.376	0.002	-0.062	0.026
3332	Primary Lead	0.110	0.033	0.015	0.024
2873	Nitrogenous Fertilizers	0.143	0.033	0.007	0.019
3331	Primary Copper	0.055	-0.012	-0.014	0.015
2621	Paper Mills	0.155	0.001	0.003	0.014
3339	Primary Nonferrous Metals, NEC	0.736	0.166	-0.058	0.013
3241	Cement, Hydraulic	0.080	-0.000	0.020	0.012
3313	Electrometallurgical Products	0.321	0.051	0.021	0.011
2819	Industrial Inorganic Chemicals, NEC	0.121	-0.004	0.007	0.011
3334	Primary Aluminum	0.078	0.013	0.000	0.011
3312	Blast Furnaces and Steel Mills	0.109	0.007	0.024	0.011
2861	Gum and Wood Chemicals	0.069	0.009	0.008	0.009
2865	Cyclic Crudes and Intermediates	0.118	0.004	-0.013	0.009
2816	Inorganic Pigments	0.122	0.014	0.034	0.007
2492	Particle Board	0.095	-0.000	0.091	0.006
3263	Semivitreous Table and Kitchenware	0.694	0.087	0.113	0.006
2499	Wood Products, NEC	0.079	0.022	-0.004	0.005
2833	Medicinals and Botanicals	0.250	-0.014	-0.027	0.005
2061	Raw Cane Sugar	0.198	-0.039	-0.003	0.004
MEAN		0.151	0.029	0.005	0.002

SIC Code	Industry	Import Share **1989**	Change in Share, LDC	Change in Share, DC	Share of Env. Op. Costs
1979-89					
2812	Alkalies and Chlorine	0.070	0.006	0.029	0.020
3333	Primary Zinc	0.435	-0.015	0.104	0.014
3331	Primary Copper	0.160	0.036	0.068	0.012
2611	Pulp Mills	0.328	0.026	-0.074	0.012
3241	Cement, Hydraulic	0.128	0.052	-0.004	0.010
2819	Industrial inorganic Chemicals, NEC	0.186	0.013	0.052	0.008
3332	Primary Lead	0.225	0.004	0.111	0.008
2861	Gum and Wood Chemicals	0.118	0.037	0.012	0.008
2833	Medicinals and Botanicals	0.334	0.039	0.045	0.007
2621	Paper Mills	0.179	0.005	0.018	0.007
2822	Synthetic Rubber	0.118	0.010	0.041	0.007
2869	Industrial Inorganic Chemicals, NEC	0.080	0.010	0.038	0.006
2865	Cyclic Crudes and Intermediates	0.118	0.006	-0.006	0.006
2879	Agricultural Chemicals, NEC	0.077	0.012	0.057	0.005
2892	Explosives	0.051	-0.000	0.016	0.005
2492	Particle Board	0.118	0.007	0.016	0.005
2816	Inorganic Pigments	0.128	0.001	0.005	0.005
3334	Primary Aluminum	0.154	-0.000	0.076	0.005
2874	Phosphatic Fertilizers	0.104	-0.000	0.085	0.005
3313	Electrometallurgical Products	0.468	0.134	0.013	0.005
Mean		0.197	0.045	0.031	0.001

Note: NEC stands for “not elsewhere classified.”

Source: Author’s analysis of NBER. See “Data Sources” in Technical Appendix.

spread pollution havens in developing countries; only four of the top 20 had greater-than-average import gains in the 1970s and only two in the 1980s. The only repeat industry across the two LDC lists is electrometallurgical (specialty finished metal) products.

With respect to developing-country imports, the top 20 regulated industries show an essentially neutral picture. In both periods, close to half of the industries had greater-than-average import growth, and half had fewer than average. This 50-50 split is what one would expect from countries with comparable environmental regulations. No competitiveness advantage or disadvantage appears in the data.

Before moving on to evaluate the full dataset, it is instructive to look more closely at one particular industry. In the early 1980s, researcher Jeffrey Leonard (1984) made the case that one of the industries that appears frequently in these lists — nonferrous metal smelting — has been the partial victim of environmental regulation. As anyone who has been to Copper Hill, Tenn. or driven by the now-closed lead smelter at Kellogg, Idaho can attest, metal smelting prior to the 1970s was a poisonous business. Much of the vegetation in these areas was killed by the emissions, and the sites remain visibly damaged even today.

Table 5, which provides a closer look at the nonferrous metals industry, indeed reveals, as Leonard also found, a large increase in imports. With the exception of the "not elsewhere classified" category, the other four industries in the table show approximately a 10-point increase in the combined import share over the period 1973-89; all five industries are also well above the average in their environmental compliance cost share.

TABLE 5
The Nonferrous Metals Industries

SIC Code	Industry	Import Share 1979	Change in Share, LDC	Change in Share, DC	Share of Env. Op. Costs
1973-79					
3331	Primary Copper	0.055	-0.012	-0.014	0.015
3332	Primary Lead	0.110	0.033	0.015	0.024
3333	Primary Zinc	0.345	0.021	0.018	0.027
3334	Primary Aluminum	0.078	0.013	0.000	0.011
3339	Primary Nonferrous Metals, NEC	0.736	0.166	-0.058	0.013
Mean		0.151	0.029	0.005	0.002
SIC Code	**Industry**	**Import Share 1989**	**Change in Share, LDC**	**Change in Share, DC**	**Share of Env. Op. Costs**
1979-89					
3331	Primary Copper	0.160	0.036	0.068	0.012
3332	Primary Lead	0.225	0.004	0.111	0.008
3333	Primary Zinc	0.435	-0.015	0.104	0.014
3334	Primary Aluminum	0.154	-0.000	0.076	0.005
3339	Primary Nonferrous Metals, NEC	0.460	-0.228	-0.048	0.004
Mean		0.197	0.045	0.031	0.001

Note: NEC stands for "not elsewhere classified."
Source: Author's analysis of NBER. See "Data Sources" in Technical Appendix.

However, note that the primary source of this increased import competition came from developed countries, not LDCs. Only in lead did developing countries make (modest) above-average gains in import penetration from 1973-79. Although in the 1970s LDCs did increase their import share in the NEC category dramatically (by 16 points), those gains were more than reversed in the 1980s. Note also that the import gains for the developed countries came mostly in the 1980s, by which time roughly comparable environmental regulations were in place in these nations as well as in the United States. Thus, the Table 5 data clearly suggest that environmental regulation did not play a significant role in the loss of import competitiveness in the metals sector.

In summary, a simple examination of the top 20 industries measured along a variety of scales shows that pollution havens, if they exist, cannot be a major cause of increased imports in import-intensive industries. And indeed, a closer look at nonferrous metals, perhaps the most likely candidate to breed a pollution haven, found no evidence that one exists. We now turn to an examination of the full dataset.

The overall regulation and competitiveness picture

Figure 2 graphs the change in the less-developed-country import share against the environmental cost share for all 201 industries for the period 1973-79. Note that most of the industries are clustered around the means — very close to zero for the environmental cost share and about .03 for the increase in the import share. (A few of the outlying industries are labeled; to identify the other top 20, refer to Tables 2-4.)

Is there a pattern in this data? The downward sloping line is the "line of best fit," or "regression line," for the data. However, in this case, the regression line is not very far from a straight line stretching across at .03 on the Y axis, "the mean line." And, indeed, the weak negative relationship observed between the two variables is not statistically significant. Put another way, the regression line and the mean line are not different enough to matter. There is simply no pattern in the data — at first glance, for LDCs in the earlier period, environmental costs and import performance are unrelated.

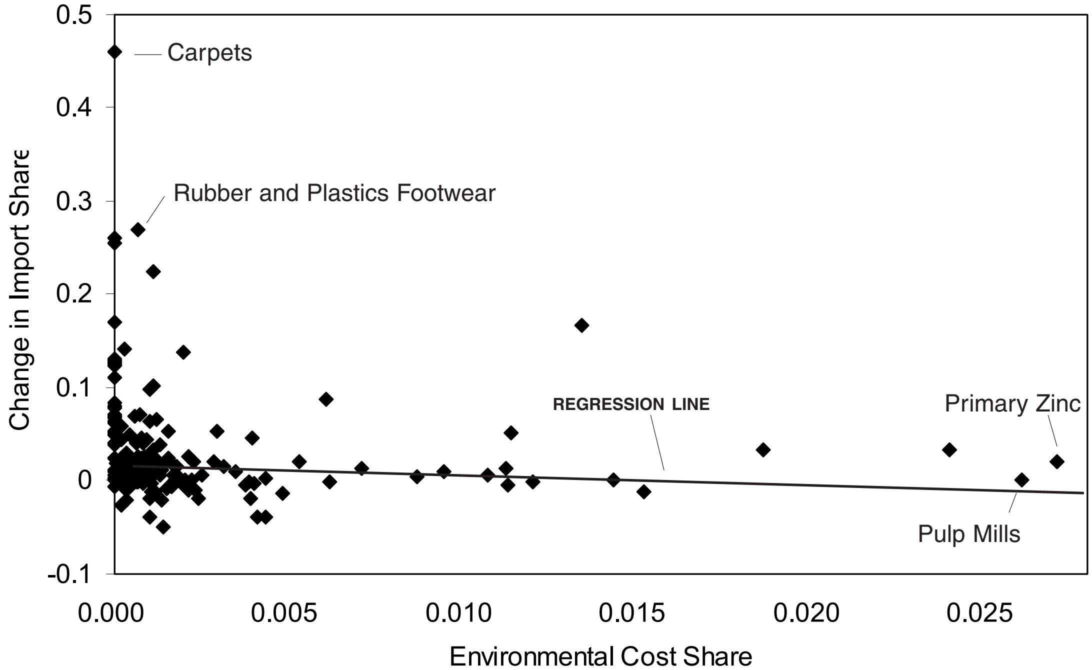
Figure 3 uses the same format to show LDC data for the latter period. The regression line here is also sloping downward, but much more steeply. Indeed, in this simple bivariate graph, there is a statistically significant negative relationship between the two variables. The graph thus shows a clear correlation: industries with higher environmental regulations faced less import competition from LDCs in the 1980s.

However, this is not necessarily a "true" correlation. Were these industries more successful *because* they had high environmental regulations (the Porter hypothesis at work)? Or could industries with high environmental regulations be competitive for some unrelated reason? For example, as discussed above, if heavily regulated industries are *also* capital or raw material intensive, they may face less import competition for that reason.

To control for confounding factors, economists use a technique called multivariate regression analysis. **Table 6** lists variables that could be behind any true observed relationship between regulation and import performance. (For more detail on the construction of the variables, the reason for their inclusion, and regression results and analysis, refer to the Technical Appendix.)

FIGURE 2

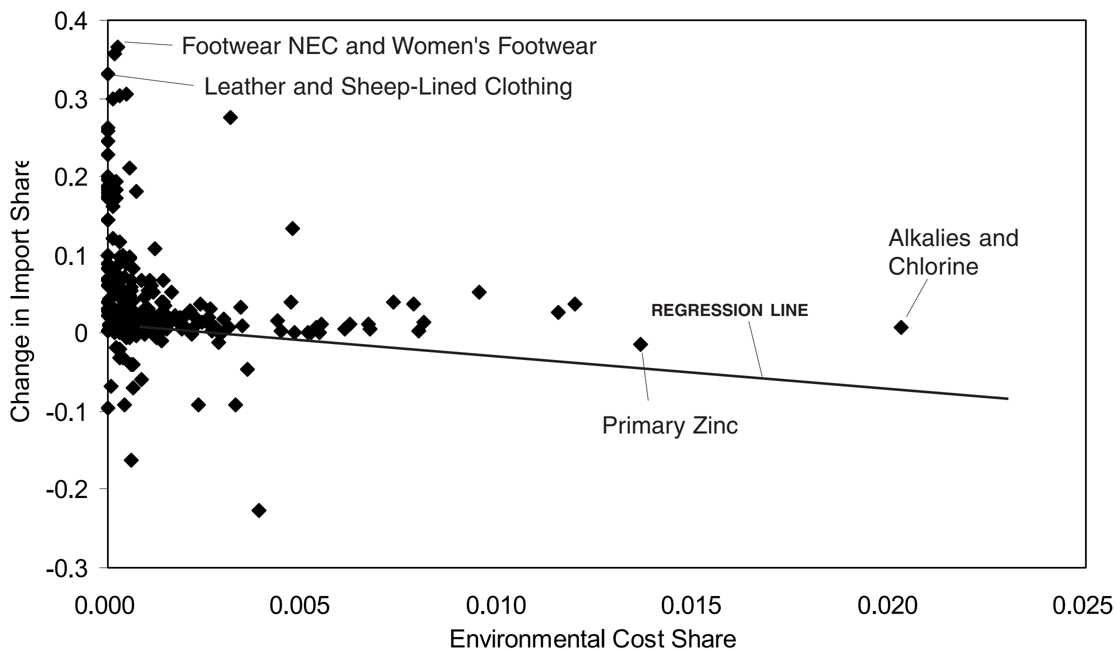
Import Growth From Less-Developed Countries Vs. Regulatory Costs, 1973-79



Note: Regression line is based on weighted least squares.
Source: Author's analysis of NBER. See "Data Sources" in Technical Appendix.

FIGURE 3

Import Growth From Less-Developed Countries Vs. Regulatory Costs, 1979-89



Note: Regression line is based on weighted least squares.
Source: Author's analysis of NBER. See "Data Sources" in Technical Appendix.

TABLE 6
Variables Controlled for in Multivariate Regression Analysis

Independent Variable	Definition*	Mean** (Std Err) 1973-79	Mean** (Std Err) 1979-89	Expected Sign
Prod. Worker Wages as Share of Sales	Share of Production Worker Wages in Shipments, Mean Value Across the Period	.136 (.050)	.154 (.057)	+
Concentration Ratio	Four-Firm Concentration Ratio, 1977 or 1987	38.7 (21.1)	39.3 (19.3)	+
Raw Mat. Costs as Share of Sales	Share of Raw Material Costs in Total Shipments, 1972	.036 (.084)	.047 (.104)	-
Capital-Labor Ratio	Ratio of Real Value of the Capital Stock to the Number of Industry Employees, 1979 or 1989	81.7 (107.9)	57.4 (71.4)	-
Growth Rate of Sales	Percentage Increase in Real Shipments Plus Imports	.090 (.408)	.070 (.328)	+

* For more details on the data sources and definition for this and other variables, see the Technical Appendix.
** These values are drawn from subsamples restricted to industries for which the import share was greater than or equal to 5% in 1979 and 1989, respectively. Thus, changes across the two business cycles are partially due to a larger sample size in the latter period.

Source: Author's analysis of NBER. See "Data Sources" in Technical Appendix.

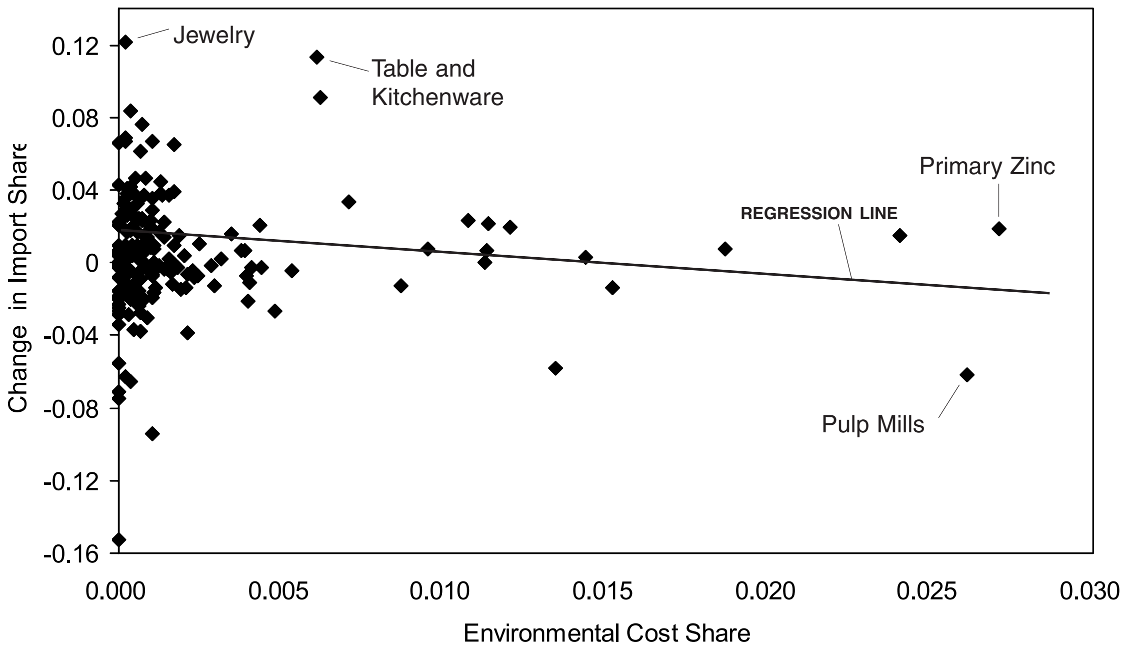
When controlling for these factors, the statistical significance of the downward-sloping line in Figure 3 disappears. Although the line of best fit is similar to the one in the diagram, we cannot say with any confidence that the observed correlation is not due to these other confounding factors.

Figure 4, which looks at the data for the developed countries in the 1970s, shows results similar to those found for the same period for the LDCs: a weak though, in this case, statistically significant negative relationship. However, when the confounding factors are added in, the statistical power disappears. So, as is the case for the LDCs, in the earlier period there is simply no relationship between environmental costs and import performance in the sample of 283 industries.

But the story is different in the final figure. **Figure 5** illustrates the data for developing countries in the period 1979-89; here, as for the LDCs, we start out with a steeply sloping downward line, which is statistically significant. But unlike the LDCs, when the effects of additional variables are added in, the strength of the downward slope to the line does not go away. Indeed, in the full model, the negative relationship between import penetration and the degree of regulation is significant at the 99% level of confidence. The data are thus telling us that, for developing countries in the 1980s, industries facing higher environmental compliance costs actually faced less intense import competition.

FIGURE 4

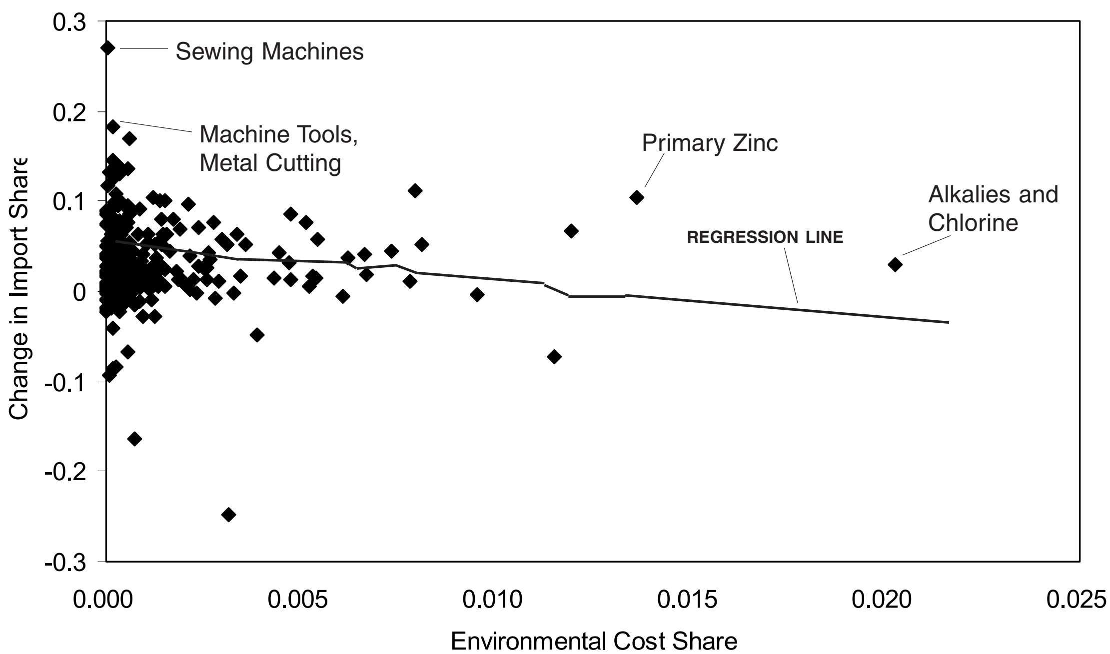
Import Growth From Developed Countries Vs. Regulatory Costs, 1973-79



Note: Regression line is based on weighted least squares.
Source: Author's analysis of NBER. See "Data Sources" in Technical Appendix.

FIGURE 5

Import Growth From Developed Countries Vs. Regulatory Costs, 1979-89



Note: Regression line is based on weighted Llast squares.
Source: Author's analysis of NBER. See "Data Sources" in Technical Appendix.

Conclusion

The consensus in the economics profession — reflected in the recent article by Jaffe et al. — is that environmental regulation has had no reliably measurable negative impact on the competitiveness of U.S. firms. Moreover, analysis of a newly assembled dataset reveals the opposite conclusion, at least in one case: in terms of import competition from developed countries in the 1980s, firms facing higher levels of regulation fared better than those without it. Whether this finding provides support for the Porter hypothesis — that environmental regulation, while imposing short-run costs, actually enhances a firm's long-run competitiveness — or supports the argument that regulations create salutary import barriers remains to be seen.

November 1997

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The author wishes to thank Dean Baker, Larry Mishel, Karen Palmer, Noelwah Netusil, and Jerrel Richer for comments.

Funding for this project was provided by The Nathan Cummings Foundation, the HKH Foundation, and the Wallace Global Fund.

Technical Appendix

This appendix provides a brief description of the multivariate regression analysis; more detail is available in Goodstein (1997).

Table 6 in the text summarizes the variables in the analysis. First, a higher production worker share in output should, all else equal, lead to a lower net export share, particularly in relation to developing countries. Second, the degree of monopoly, captured by the industry concentration ratio, may significantly *hurt* overall U.S. competitiveness (Karier 1991). According to Karier, highly concentrated industries earn a price premium and/or are characterized by x-inefficiency, either of which would make them good targets for importers and weak export competitors. However, high concentration ratios may also reflect entry barriers not captured by the capital-labor ratio, particularly for imports from developing countries.

Natural resource endowments probably play a large role in determining production locations for relatively dirty industries. If the relationship between raw material intensity and pollution is tight, then heavily regulated industries may be less footloose than industries in other sectors. This means that raw-material-dependent industries would be less likely to shrink in the face of import competition. The impact on the relative competitiveness of export industries should be similar: all else equal, raw material dependence should reflect a genuine comparative advantage, leading to better-than-average export growth.

The capital-labor ratio is included here as an entry barrier variable. Finally, the model incorporates a demand growth variable: rapidly growing industries should attract higher levels of imports and produce a growing share of exports. If highly regulated industries also face declining demand, and if declining demand discourages imports, and the demand variable is omitted, then a spurious negative correlation between regulation and import growth will emerge.

The estimation results are presented in **Tables A1** and **A2** for the less-developed countries and the developed countries, respectively. The first column in each of the tables shows the simple bivariate correlation between the environmental cost share and the deviation from the mean value of the change in the import share for the full sample of 430 industries. In all cases, the relationship is negative, and it is significant in two of the four.

The second column reports results of an identical regression, with the sample now restricted to industries with an import share greater than or equal to 5%. (Note that the number of eligible industries increases from 201 to 283 across the two business cycles.) Across the four regressions, at a minimum, the point estimate on the environmental cost share almost doubles when the sample is restricted; for the developed countries in the latter time period, the value displays a nine-fold increase. This suggests that the problem of downward bias due to a model misspecification discussed in Goodstein (1997) is important. Given this problem, further attention is restricted to regression results run on the sample of industries with a nontrivial import share.

In both the less-developed countries and the developed countries, the earlier period regressions reveal a similar small, negative relationship between the environmental cost share and the change in imports. The relationship is occasionally significant at the 5% level, but in both regressions the significance disappears at least by the time the raw material share is included.

By contrast, the same relationship is both larger (by a factor of 5 to 10) and more robust in the latter period regressions. For the developed countries, the environmental cost share displays a relatively stable negative coefficient (around -3) that is significant to at least the 5% level in all regressions and at the 1% level in the more complete models. For the less-developed countries, the relationship becomes smaller up to the addition of the raw materials variable, at which point the magnitude of the estimate stabilizes. The statistical power of the relationship also weakens as additional regresssors are added, finally disappearing with the addition of the capital-labor ratio.

The results for the less-developed countries clearly reflect a strong multicollinearity among most of the explanatory variables. And indeed, a look at the bivariate correlation coefficients of the independent variables confirms that environmental regulation is highly correlated with all the variables except market growth. Given this, the persistent strength of the environmental cost share variable in the developed countries is even more impressive. At the same time, the multicollinearity makes the lack of significance in the full regressions for the less-developed countries harder to interpret. Has the statistical relationship really gone away, or can we just not see it?

The production worker share variable behaves as expected, with the expected positive sign in most cases. It is also significant, especially for the developing countries, but the t-statistic falls as additional regressors are added. In the latter period for the developed countries, the variable actually shows up as negative and significant when it first appears, but this is easily understood as an omitted variable problem. High production worker shares are proxying for low concentration ratios; the coefficient switches signs and loses significance when the concentration ratio is added.

The concentration ratio performs as expected for the developed countries: the positive and always significant

TABLE A1
Regression Results for Imports From Less-Developed Countries

Dependent Variable: Change in Import Share, 1973-79

ENVSHR	-.284	-.582	-.233	-1.003[b]	-.692	-.595	-.589
	(-.938)	(-1.092)	(-.465)	(-1.978)	(-1.508)	(-.717)	(-7.03)
PRODSHR			.186[a]	.115[b]	.011	.008	.007
			(5.605)	(2.593)	(.230)	(.154)	(.116)
CONCRATIO				-2.6E-04[a]	-2.7E-04[a]	-2.6E-04	-2.6E-04[b]
				(-2.815)	(-2.747)	(-2.542)	(-2.529)
RAWSHR					-.026[c]	-.026[c]	-.027[c]
					(-1.869)	(-1.865)	(-1.816)
KLRATIO						-8.8E-06	-9.9E-06
						(-.141)	(-.153)
GROWTH							-8.2E-04
							(-.077)
CONSTANT	.006	.011[a]	-.011[b]	.014[c]	.027[a]	.027[b]	.028[b]
	(4.709)	(3.980)	(-2.336)	(1.687)	(2.658)	(2.488)	(2.275)
ADJUSTED R^2	-.000	.001	.133	.113	.067	.059	.051
N	430	201	201	150	119	119	119

Dependent Variable: Change in Import Share, 1979-89

ENVSHR	-3.377[a]	-5.924[a]	-4.720[a]	-3.936[b]	-2.468[c]	-2.501	-2.415
	(-2.984)	(-4.052)	(-3.080)	(-2.501)	(-1.667)	(-1.452)	(-1.421)
PRODSHR			.149[b]	.200[a]	.038	.038	-8.7E-04
			(2.418)	(3.049)	(.480)	(.479)	(-.011)
CONCRATIO				-1.8E-04	-9.9E-05	-1.0E-04	-9.2E-05
				(-1.361)	(-.698)	(.658)	(-.606)
RAWSHR					-.049[c]	-.015	-.048
					(-1.756)	(-.786)	(-.747)
KLRATIO						2.0E-06	-1.5E-05
						(.038)	(-.287)
GROWTH							-.025[b]
							(-2.601)
CONSTANT	.024[a]	.039[a]	.021[b]	.021[c]	.030[b]	.030[b]	.038[a]
	(9.044)	(9.860)	(2.473)	(1.731)	(1.998)	(1.980)	(2.483)
ADJUSTED R^2	.018	.052	.067	.097	.053	.049	.075
N	430	283	283	253	205	205	205

Note: Observations are weighted by the industry share in shipments. T statistics in parentheses.

a Significant at the 1% level.
b Significant at the 5% level
c Significant at the 10% level.

TABLE A2
Regression Results for Imports From Developed Countries

Dependent Variable: Change in Import Share, 1973-79

ENVSHR	-.483[b]	-1.004[b]	-.894[b]	-.596	-.583	.045	.186
	(-1.964)	(-2.426)	(-2.163)	(-1.484)	(-1.327)	(.057)	(.236)
PRODSHR			.058[b]	.025	-.022	-.041	-.075
			(2.127)	(.702)	(-.468)	(-.811)	(-1.397)
CONCRATIO				4.7E-04[a]	3.9E-04[a]	4.2E-04[a]	4.1E-04[a]
				(6.282)	(4.149)	(4.233)	(4.122)
RAWSHR					-.020	-.022[c]	-.028[b]
					(-1.559)	(-1.656)	(-2.062)
KLRATIO						-5.7E-05	-8.1E-05
						(-.955)	(-1.331)
GROWTH							-.018[c]
							(-1.764)
CONSTANT	.008[a]	.013[a]	.006[c]	-.009	.003	.006	.015
	(7.100)	(6.233)	(1.678)	(-1.412)	(.263)	(.618)	(1.315)
ADJUSTED R^2	.007	.024	.041	.215	.218	.218	.232
N	430	201	201	150	119	119	119

Dependent Variable: Change in Import Share, 1979-89

ENVSHR	-.304	-2.825[a]	-3.713[a]	-2.656[b]	-2.719[b]	-3.507[a]	-3.513[a]
	(-.333)	(-2.649)	(-3.321)	(-2.533)	(-2.396)	(-2.666)	(-2.663)
PRODSHR			-.110[b]	.021	-.072	-.062	-.060
			(-2.445)	(.488)	(-1.204)	(-1.023)	(-.962)
CONCRATIO				5.9E-04[a]	4.8E-04[a]	4.3E-04[a]	4.2E-04[a]
				(6.742)	(4.419)	(3.630)	(3.616)
RAWSHR					-.071[a]	-.125[b]	-.125[b]
					(-3.304)	(-2.485)	(-2.483)
KLRATIO						4.7E-05	4.8E-05
						(1.180)	(1.195)
GROWTH							.002
							(.213)
CONSTANT	.028[a]	.045[a]	.058[a]	.015[b]	.036[a]	.035[a]	.034[a]
	(12.828)	(15.603)	(9.471)	(1.908)	(3.129)	(3.000)	(2.891)
ADJUSTED R^2	-.002	.021	.038	.173	.251	.252	.249
N	430	283	283	253	205	205	205

Note: Observations are weighted by the industry share in shipments. T statistics in parentheses.

a Significant at the 1% level.
b Significant at the 5% level
c Significant at the 10% level.

estimates are consistent with an x-inefficiency/profit opportunity story. Confirming Karier's observations, more concentrated industries do indeed appear to be prime targets for foreign imports from developed countries. However, for the developing countries, the concentration coefficient has a negative sign, which is consistently significant in the earlier period. This suggests that, for developing countries, high concentration ratios are primarily reflecting entry barriers.

The raw material share variable is always negative, as expected, and is generally significant at least at the 10% level. The capital-labor ratio variable was never significant. Finally, the market growth variable had an unexpected negative sign in three of the four cases, and was significant in two of these. This would suggest that slower-growing rather than faster-growing industries faced more import competition. One explanation for this revolves around the high degree of correlation between the market growth and production worker share variables. If slow-growing industries were also low-wage industries, than market growth may be doing a better job proxying for high skill than the wage share variable. This would explain the negative sign.

Finally, the adjusted R^2 values reveal that the model does a much better job explaining the variance of the import share change for the developed countries than the less-developed countries. In addition, the concentration ratio and raw material share variables appear to be providing most of the explanatory power.

To summarize, the model performs generally as expected. The primary result is that there is no significant correlation between the level of regulation and import competitiveness for U.S. firms from either developed or developing countries across the first period, 1973-79. However, there is clearly a strong, robust, negative relationship between these variables for the developed country sample over the latter business cycle. The point estimates suggest that, all else equal, an increase in the environmental cost share of one standard deviation (.004) would lead to a decrease in the import share of around .012. This is about 15% of the mean value of the change in import shares over this period. A similar though statistically somewhat weaker pattern is observed for the less-developed-country sample over the same period. Multicollinearity between the principal independent variables clouds the statistical interpretation for this subsample.

As a whole, the results provide no support for the conventional view that environmental regulation undermines the import competitiveness of U.S. industry. However, the results are consistent with the predictions of either the Porter hypothesis or the import barrier hypothesis. The absence of a short-run positive impact on competitiveness is not troubling for either theory; both stories might predict that it should take some time for a domestic advantage from regulation to emerge. When the export data become available from the National Bureau of Economic Research, it will be possible to discriminate between these two theories: the Porter hypothesis suggests that regulation would improve the competitiveness of U.S. export industries, while the import barrier hypothesis predicts, if anything, a negative effect.

Data Sources

Shipment, employee, production worker wages, and real capital stock data at the four-digit SIC levels were obtained from the NBER file TRADJMA.DTA available on the NBER web site, nber.harvard.edu. These data are described in Abowd (1991). The data were then matched with four-digit information on operating costs for compliance with environmental regulations, as measured in the PACE survey. (These data were provided on disk courtesy of Prof. Wayne Gray, Clark University and NBER). Four-digit output price deflators were obtained from the NBER file ASM2, also at the NBER web site.

Raw material shares were calculated using data from *The Detailed Input-Output Structure of the U.S. Economy: 1972* (U.S. Department of Commerce, Washington, D.C.). Raw materials were defined as commodities 1.0100-10.0000 (livestock, agricultural, forest and fishery products and services, and mining) and 20.0100 (logging camps and contractors). Raw material shares were available only for 375 industries.

Four-digit import data, broken down by country of origin, were obtained from Disk 1 of the NBER Trade Database, compiled by Robert Feenstra and published on CD-ROM in 1996.

Endnotes

1. See the discussion in Jaffe et al. (1995), especially section 4. One recent study has at last uncovered some evidence of domestic location effects for four heavily regulated industries, including petroleum refining. Henderson (1996) finds that areas that consistently fail to meet standards for ozone air pollution attract 7-9% fewer heavily polluting plants than areas that have been in compliance for three consecutive years. One possible objection to this finding is that the author may be picking up a "greenfield" effect, unrelated to ozone compliance.

2. Put in this way, the underinvestment problem can take on a market failure cast. Foreign financial institutions, it is argued, force oligopolistic firms to act more like competitive firms in their pricing decisions, which in turn determine their ultimate market share and investment behavior.

3 "U.S. Defeated in Its Appeal of Trade Case," *New York Times*, May 30, 1996, p. D1. This example refers to an environmental regulation of a product – a product standard. However, the data used in this paper measure spending primarily on standards that effect the design of domestic manufacturing processes. Such design standards might improve the competitiveness of U.S.-based firms, for example, by making it harder to export more complex production technology.

4. The following are included as "developed" countries: Canada, Israel, Japan, Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, the U.K., Austria, Finland, Iceland, Norway, Sweden, Switzerland, Australia, and New Zealand.

5. Industries with trivial import shares are not important in competitiveness debates. For more on this issue, see Goodstein (1997).

6. In some years and for some industries, environmental costs rise to as high as 4% of total sales; this study uses averages across the sample years to avoid outliers.

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