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GLOBAL POLLUTION AND INTERNATIONAL TRADE

By

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Duane Chapman*

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In 1984, the two industrial accidents in Mexico City and Bhopal, India, raised new concern about industrial safety and environmental protection. In Bhopal, 2,000 persons died and 200,000 were injured by exposure to the toxic chemicals[1]. In Mexico City, the explosion at the gas facility killed 500 persons, injured 4,000, and caused 31,000 persons to leave their damaged homes[2].

In my opinion, both accidents are related to the absence of adequate monitoring and adequate standards of performance. The Bhopal and Mexico City accidents illustrate a growing problem: developing countries are adopting modern production technology without adopting the modern technology for worker safety and environmental protection that is used in industrial economies. Developed countries gain by having lower cost consumer goods imported from manufacturing centers in developing countries. Developing countries ("DCs") gain by increased exports, higher GNP, and higher per capita incomes.

However, there are losses. Industrialized countries ("ICs") lose manufacturing and the middle income workers in manufacturing enterprises. DCs experience worker health and safety problems, increased levels of public health hazards from air and water pollution and toxic metals exposure, lesser life spans, and more illness.

The question arises as to whether strict environmental controls in ICs may actually increase global levels of transfrontier pollutants. Under some circumstances, according to economic theory, this may happen. Imagine some

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[1] <u>New York Times</u>, March 21, 1985. Also January 28, 30, 31, and February 3, 1985.

[2] Yasuda Insurance Company, <u>Safety Engineering</u>, 1985:24:1, pp. 53-55.

significant world pollutant, say aerosol sulfur, is effectively reduced by 80% of its free market, nonregulated level in an IC group. Suppose sulfur controls are essentially nil for DC producers. Further, suppose 90% of the pollutant intensive product is consumed in the ICs, and production is equally divided between ICs and DCs. Assume 10 million metric tons of consumption, and, if uncontrolled, one unit of pollutant for one unit of product.

Within this illustration, global emission are 6 million metric tons.

Now suppose the IC group tightens its control policy to 90% of potential emissions. This raises the average IC cost by 33%, and allows DC producers to increase their share of IC markets by 33%.

Now developing country producers still hold the market for 1 million tons in their region, but have increased their sales in the IC group from 4 million tons to 5.3 million tons. IC production declines from its original 5 million tons to its new 3.7 million tons. Global emissions rise from 6 million tons to 6.7 million tons, notwithstanding the new 90% control in ICs.

Average global control declined from its earlier 40% to a lower 33%. Table 1 summarizes.

In three sectors I have examined, I think this general process is taking place on a world wide basis. The sectors discussed are silverware, copper, and automobiles. I have chosen these three goods because one is a simple consumer item made with potentially toxic materials, the second is a pollutant-intensive intermediate good, and the third is a complex final product. All three see global competition among producers.

SILVERWARE

The worker safety and environmental dimensions arise from the metals and

Table 1. Stricter Controls May Increase Emissions

I. Original Shares, million tons and percents

	Developing Countries (DCs)	Developed Countries (ICs)	Global Totals
Consumption, mtons	1	9	10
% of market, by DCs	100%	44%	50%
% of market, by ICS	0%	56%	50%
Total Production, mtons	5	5	10
Pollutant Control, %	0%	80%	40%
Emissions, mtons	5	1	6.0

II. Shares with Stricter Controls in Developed Countries

	Developing Countries (DCs)	Developed Countries (ICs)	Global Totals
Consumption, mtons	1	9	10
Cost increase, %	0%	33%	--
% of market, by DCs	100%	59%	63%
% of market, by ICs	0%	41%	37%
Total Production, mtons	6.3	3.7	10
Pollutant Control, %	0	90%	33%
Emissions, mtons	6.3	0.4	6.7

chemicals employed. A silverware plant uses steel, copper, nickel, chrome, lead, gold, silver, aluminum, and powerful industrial chemicals used in metal finishing. Because of the unusual hazards arising from contact with these materials, their use is strictly regulated in the U.S.

The general production method is to cut a blank from metal coil, stamp the blank, grind the form, perhaps plate the stock, and polish and clean. The shop noise, if uncontrolled, is at a level comparable to a room full of chain saws and power mowers.

With equipment lacking safety features, productivity is enhanced by worker direct contact with moving machinery. But this is at a cost of smashed or cut hands and arms.

U.S. standards require air filtration to remove the toxic metal particles, solvents, and cleaners from the workplace without worker contact.

U.S. standards require treatment of these wastes so that effluent water approaches drinking water standards, and storage or burial of the sediment at certified locations.

In a U.S. plant, the average production worker may retire after 20 years or more in production work, without experiencing occupational illness or injury.

In an uncontrolled developing country plant, the average production worker manages 6-8 months' work. Even an economist may infer potentially crippling respiratory and internal toxicity impact.

Table 2 outlines my estimate of the cost impact of the difference in protection technologies. Note that air and water pollution control and OSHA regulations constitute about 25% of the U.S. cost. I also assume that U.S. materials (copper, acids, etc.) are more costly, reflecting in part the

Table 2. Silverware Set Cost Illustration

	U.S.		Korea	
Retail Price, U.S.	$60		$40	
Profit	0%	$0	18%	$7.20
Taxes	10%	$6.00	10%	$4.00
Interest	3%	$1.80	3%	$1.20
Admin.; misc.	14%	$8.40	14%	$5.60
Advertising	4%	$2.40	0%	$0
Distribution	2%	$1.20	12%	$4.80
Selling	14%	$8.40	14%	$5.60
Packaging	6%	$3.60	6%	$2.40
Labor	6%	$3.60	6%	$2.40
Material, metals, chemicals	16%	$9.60	17%	$6.80
Environment, OSHA	25%	$15.00	0%	$0
	100%	$60.00	100%	$40.00

same differences in workplace and environmental standards.

Labor costs per unit product may not differ greatly. I assume that seven minutes of U.S. labor are paid $30 per hour in wages and social insurance, or $3.60 per set. I assume that 96 minutes of developing country labor are paid $1.50 per hour or $2.40 per set. I assume a transportation cost of an additional $3.60 per set to bring the developing country product to the U.S.

Table 2 shows a developing country advantage of $18 per set for environmental and OSHA protection in the silverware manufacture and in the purchase of metals and chemicals, themselves produced without comparable standards.

Notwithstanding the labor cost and other differences, it appears that the cost advantage for imported silverware is equivalent to the avoidance of modern control technologies. We may assume that the external social cost is borne by the DC workers, and by the general population exposed to highly toxic metals and chemicals in their air, water, and fish.

We may ask if the ultimate depository of uncontrolled toxic metal plating waste dumping would not be oceans and fisheries. The U.S. Council on Environmental Quality and the EPA had previously identified these heavy metal wastes as toxic priority pollutants. Threshold levels for aquatic life impact are measured in billionths of a gram of metal per gram of water[3].

COPPER

As noted, materials cost are also affected by worker safety and environ-

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3 Precisely, micrograms per liter for estuarine or ocean waters. A standard of 5 micrograms of copper per liter of water is 5 billionths of a gram (or ounce) of copper per gram (or ounce) of water. See U.S. Council on Environmental Quality, Annual Reports, 1980 (p. 115) and 1979 (pp. 132-33).

mental standards as well as wages, productivity, and capital investments. Metal processing is energy intensive, and requires either electrical energy or heat from coal, oil, or natural gas burning. In this context, it appears that South African coal plays a secondary but increasing role in energy production in Asian manufacturing centers. Japan has displaced France as the leading importer of South African coal, and South Korea purchases more coal from South Africa than from any other source[4].

Copper production is particularly sensitive to environmental policies. Copper ore typically contains sulfur equal to 125% of the copper content[5]. Since sulfur oxide is twice the weight of its sulfur content, we may assume that uncontrolled copper processing releases approximately twice the weight of the copper product.

This sulfur release is in addition to sulfur emissions from coal or oil used in generating electricity for copper processing. If we assume 100 million Btu's are required from mining through smelting to produce one ton of copper, we can estimate the magnitude of energy-linked sulfur emissions. At one extreme, assume a hypothetical all-electric process, required 300 MBtu (million Btu's) of coal energy to generate 100 MBtu of electricity. This ought to be reduced to, say, 240 MBtu to reflect the greater end-use efficiency for electricity[6].

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[4] Japan imports most of its coal, and the U.S. and Canada lead South Africa in the Japanese market. South Korean purchases of South African coal lag behind Australian coal imports, but lead imports from Canada and the U.S. Data from International Energy Annual 1983. South Africa has been the world's most rapidly growing producer and exporter of coal.

[5] U.S. Bureau of Mines, Copper, 1985, Preprint, p.17.

[6] Electrical processes are typically more efficient at end-use stages, so an all-electric in-situ process might need 80 MBtu of electricity, and 240 MBtu of primary energy to generate the electricity. A hypothetical all-coal process might need 100 MBtu of coal energy.

At a world average energy content of 18 MBtu per ton of coal, this is 13 tons of coal, and at, say 1% sulfur, this is approximately 0.25 tons of sulfur oxide. Summarizing: for all-electric copper processing, 500 pounds of sulfur oxide may be released from fossil fuel burning for each ton of product copper. I would speculate that sulfur regulations for fossil fuel burning in Japan and the U.S. add 2¢ to 5¢ per pound of copper, this in addition to sulfur released from the copper processing itself.

If we consider world copper production on the order of 10 million metric tons annually, we must consider potential sulfur emissions on the order of 20-25 million metric tons annually. This is of course in addition to other coal, oil, and metal ores sulfur emissions.

In general, summary data on pollution emissions and worker health and safety protection are not readily available. Rieber reports that all Japanese smelters and many European smelters exceed U.S. sulfur removal rates[7]. I assume that sulfur control in Asia, Africa, and Latin America is, on average, minimal.

Overall data on environmental protection in copper are summarized in Table 3. For existing facilities, full compliance with air, water, land, and worker protection at U.S. standards may add, as a representative value, 33¢ per pound to production costs. August 1985 sees world copper prices at 67¢ per pound. The implication is that U.S. copper producers cannot simultaneously pay for environmental protection -- and produce copper.

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[7] Michael Rieber, Prepared Statement, in U.S. House Subcommittee on Mining, Forest Management, and Bonneville Power Administration, Hearing, U.S. Assistance to Foreign Copper Producers and the Effects on Domestic Industries and Environmental Standards, 98th Cong., 1st Session, May 20, 1983, p.262.

Table 3. Environmental Protection Costs for Copper, ¢ per pound copper.

Mining and Milling	10¢ - 15¢
Traditional Reverbatory Smelting	
90% control	15¢
98% control	23¢
Flash or Noranda Furnace	?

Sources: Banghart (p.214), Kinneberg (p.199), and Rieber (p.240), all in U.S. House Committee, op. cit.

U.S. copper production from domestic mines has declined by one-third since 1983, while consumption continues at 2.2 million metric tons. Mines, smelters, refineries, and manufacturers have closed throughout the country[8].

Note that, in Table 3, the first 90% removal costs 1/6 of a cent for each 1% removed. But the next 8% is much more costly: a 1¢ cost increase for each 1% removed.

I believe that the theoretical possibility in Table 1 is in fact materializing in copper: stricter U.S. controls are increasing global emissions of sulfur and global acid deposition.

AUTOMOBILES

The competitive position of Japanese automobiles is recognized. Surprisingly, the debate about relative costs excludes environmental considera-

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[8] Copper, op. cit., p.13, and U.S. Bureau of Mines, "Copper in the United States," May 1985, p.9.

tions, focusing wholly on wages, productivity, and management[9]. Each of the world's 500 million motor vehicles requires some few thousand pounds of steel, aluminum, copper, and chrome.

As the world economy becomes increasingly linked through trade in manufactures, we must recognize that the worldwide movements of materials as part of this process create new patterns for global transfrontier pollutants.

An Asian automobile imported into North America will be produced through this world economy. With little domestic ore, Japan imports steel from Korea and Taiwan. South Korea and Taiwan, also lacking iron ores and coal, import ores from Australia, Brazil, and India. Coal used in Korea, Taiwan, and Japan will have been mined in Korea, or shipped from the U.S., Canada, Australia, or South Africa. Similar patterns exist for copper, lead, and nickel.

The hypothesis which explains the tentative data on these patterns is that Japanese industry uses Korea, Taiwan, and perhaps the Philippines to process materials in ways which would be unacceptable in Japan itself, and then exports the automobiles for sale in the United States. The Japanese-North American link accounted for 38% of world trade in passenger cars in 1981[10].

Cole and Yakushiji report cost differences in U.S.-Japanese manufacturing at about $1,500 in country and about $500 landed in the U.S. While they survey production practices and labor cost in depth, they emphasize materials and supplier cost differences. Unfortunately, the absence of analy-

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9 For example: the basic study by Cole and Yakushiji has no reference to worker safety, air, or water pollution control in materials processing or in automobile fabrication. Robert E. Cole and Taizo Yakushiji, eds., The American and Japanese Auto Industries in Transition, Ann Arbor, University of Michigan, 1984.

10 Cole and Yakushiji, p.52.

Table 4. Possible Sources of Japanese-U.S. $500 Cost Differences in Automobiles

	Pollution Standards	Wage Level and Labor Productivity	Other
Iron and steel	$-250	$-150	
Copper and non-ferrous metals	-250	-25	
Other suppliers: textiles, rubber, glass, etc.	-100	-75	
Auto manufacture	0	-650	
U.S. taxes and transport	———	———	$+1,000
	$-600	$-900	$+1,000

Note: the sum of differences in landed cost is $500, for a car costing about $9,000. According to Cole and Yakushiji, the wage and productivity differential is split in three ways: production workers, management, and capital.

This table is developed from input-output data and estimates in Duane Chapman, "A Social Tariff: Global Wage and Pollution Standards" in R.K. Pachauri, ed., Global Energy Interactions, Riverdale, Maryland, The Riverdale Company, in press, and in Cole and Yakushiji, op. cit.

sis of worker health and safety and air and water pollution control costs makes their unique study less valuable than its full potential.

The results of my review of input-output data and Cole-Yakushiji appear in Table 4. It appears that the difference in embodied pollution control costs is the same order of magnitude as the landed cost difference in the U.S.

ECONOMIC THEORY AND DISCUSSION

For each of the three commodities surveyed (silverware, copper, and automobiles), the net difference between selling prices in U.S. markets between the imported product and the domestic manufacture is comparable to the avoided cost advantage from lesser worker protection and pollution control standards for developing country producers.

As Japan implements standards comparable to those in North America, it will experience growing competition from countries without standards. If this hypothesis is correct, we would predict that South Korea, Taiwan, and other developing countries may develop their own finished product manufacturing facilities while maintaining their current materials processing practices. In this case, markets for pollution-intensive and worker-hazardous goods will increasingly find Japanese products displaced by other developing country manufacturers. Specifically, I can predict that Korean silverware and automobiles will displace Japanese products in U.S. markets. In world and U.S. copper markets, U.S. facilities meeting U.S. standards will continue to be displaced by producers not meeting these standards.

Economic theory has just begun to address these problems in the work on transfrontier pollution. Segerson[11], for example, summarized the state-of-

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11 Kathleen Segerson, "Unilateral Transfrontier Pollution: The Role of Economic Interdependence," <u>Land Economics</u> 61:1:February 1985, pp.83-87.

the-art in theoretical work. She emphasizes the possible roles that tariffs or bribes may play, and the interaction of trade with real income levels.

What is needed at this stage is for theorists to recognize the global consequences for worker health and safety and air and water pollution as currently determined by the implementation of national standards. Actual circumstances appear to me to be such that independent action by developed countries can, as discussed earlier, lead to higher levels of global pollution. This is the Saint's Curse: the harder an industrialized country tries by itself to attain worker and environmental protection, the worse the global situation.

This seems particularly relevant to toxic metals pollution of world oceans, and transnational movement of acid deposition and ozone.

Remedies appear to be: either international agreements or industrial country social tariffs linked to worker and environmental protection.

A major objection to this line of thinking is that it could represent a neo-colonial attitude, an America-knows-best response to developing country problems.

My rebuttal is in several parts. First, let's note the countries which may have experienced the greatest growth in mining and materials manufacturing: Brazil, Chile, Mexico, South Africa, India, South Korea, the Philippines, and Taiwan. Do we know whether industrial workers and affected populations are able to participate in the determination of standards in their countries? Do we know whether affected groups are informed about the relationships between metal processing and metal poisoning, or between respiratory illness and sulfur, particulate, and hydrocarbon emissions? If we do not answer these questions affirmatively, then we cannot suppose that current practices are those preferred.

Second, as noted above, some pollutants are global in consequence and transnational in movement. Therefore, every country has legitimate interest in practices with respect to these pollutants.

Finally, the Bhopal and Mexico City disasters are episodic events of an ongoing process. Developing countries are adopting modern production technologies but not protection technologies. Industrial countries not only offer technology, but also markets for products, financing for manufacturing investment, and often corporate affiliation. In certain cases, we may find that national or international law will hold liable the industrialized country participants in developing country damage.

In the first part of this century, individual states in the United States were arenas of competition for incentives for industrial development or relocation. Each state set its own standards for worker safety and environmental protection with consequent variations in manufacturing costs. In 1985, basic Federal standards determined by the Congress are implemented by the executive branch with the Occupational Safety and Health Administration, the Mine Safety and Health Administration, and the Environmental Protection Agency. The States participate in implementation. Western Europe is following a similar path. At some point the need for world conventions on these problems will, in a parallel manner, become evident.

Alternatively, industrialized countries should consider interim tariffs on imported goods which are manufactured without satisfactory standards. The results are qualitatively clear: higher product prices, protection of domestic manufacturing which meets modern standards, and a cessation in the growth of global pollutant emissions.

For the present, we may congratulate the sponsors of the First Conference on Environmental Economics in Mexico and Latin America, and hope that we may soon see initiatives to develop the necessary first steps in data and research.