



Technological Advances Play Key Role in Cleaner Environment

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The U.S. manufacturing sector has made significant gains in reducing air pollution. As one example, emissions of sulfur dioxide (SO₂) declined by 66 percent between 1972 and 2001. Some have questioned whether the reductions in air pollution are the result of advances in pollution abatement and new production processes, or whether they are largely a consequence of shifting the production of pollution-intensive goods overseas. If the latter is true, a good portion of the environmental gains in the United States may be illusory. A related issue is whether developing countries have become dumping grounds for manufacturing processes that are too dirty or too expensive to clean up in the United States.

Environmental Improvement: Technology Versus Offshoring of Pollution-Intensive Operations

Arik Levinson, an economist at Georgetown University, investigated the reasons for the reductions in air pollution in the manufacturing sector. Levinson examined four common air pollutants: sulfur dioxide, nitrogen dioxide, carbon monoxide, and volatile organic compounds. Using data from the Environmental Protection Agency, he found that the cleanup of U.S. manufacturing is largely attributable to changes in technology rather than changes in the mix of U.S. manufacturing activity associated with offshoring.¹ His approach was to divide the U.S. manufacturing sector into 450 industries and then use a model that allows one to separate out the effects of technology and composition changes (i.e., changes in the mix of industries here and abroad). With such a detailed disaggregation of the manufacturing sector, it is less likely that the role of technology is exaggerated because a more aggregative approach risks misclassifying composition changes that occur within broadly defined sectors.

The separate impacts of composition and technology are shown in the following table where the air pollution index for manufacturing (with 1987 = 100) under different scenarios is presented. To begin with, the real value of manufacturing output increased by 24 percent between 1987 and 2001. Had there been no change in the way goods are produced (that is, no technological change) and had the composition or mix of industries in the U.S. manufacturing sector remained the same, air pollution would have increased from the index value of 100 in 1987 to 124 in 2001, or by 24 percent. This is the pure scale effect from more activity. If the effect of the changing composition of U.S. manufacturing were taken into account while technology was held constant, air pollution would have increased by 13 percent rather than 24 percent. In fact, air pollution *decreased* from 100 to 75 over this period, or by 25 percent. Altogether, the index of pollution was reduced by 49 percentage points due to the change in the composition of the manufacturing sector and to technological change. Technological change accounted for 38 percentage points, or 78 percent of the reduction in air pollution.

Decomposing the Effects of Changes in Industry Composition and Technology on Air Pollution Reduction, 1987 – 2001

	Air Pollution Index in 2001 (1987 = 100)	Air Pollution, 1987 - 2001
1. Scale Effect	124	+24%
2. Composition + Scale Effects (holding technology constant)	113	+13%
3. Actual Pollution (includes effects of scale, composition and technology)	75	-25%

Further, Levinson found that the composition of imports of manufactured goods shifted toward industries that pollute **less**, not more. That is, much of the production that was shifted offshore involved the production of goods that were less, not more, pollution-intensive. Adjusting the results shown in the table above for this effect, Levinson concludes that composition changes and increased imports of pollution-intensive goods explain only about 10 percent of total pollution reductions from manufacturing during the period 1987-2001.

Are Developing Countries Being Used as Pollution Havens?

An earlier study by Clark, Marchese, and Zarrilli (CMZ) asked whether offshore operations were motivated by the cost of complying with stricter environmental regulations in the United States.² Some have argued, for example, that lax environmental regulations in developing countries attract “dirty” industries. CMZ developed an economic model to identify factors that influence a company’s decision to engage in offshore production in developing countries. These factors included: the product’s labor intensity and compensation; the ad valorem tariff rate; a “dummy” variable to capture quantitative import restraints (e.g., import quotas); transportation costs; the total value of imports as a share of the total domestic market supply; and the pollution abatement costs expressed as a percentage of shipment values. The model was tested using data on companies in more than 370 4-digit SIC manufacturing industries.

The variables affected the likelihood of offshoring an assembly operation in a predictable way with the exception of pollution abatement costs. For example, the higher transportation costs are, the lower is the probability that an assembly operation would be moved offshore. CMZ found, however, that the greater pollution abatement costs, the

¹ Arik Levinson, “Technology, International Trade, and Pollution from U.S. Manufacturing,” *The American Economic Review*, December 2009, Volume 99 (5), pp. 2177-2192. *The American Economic Review* is one of the economic profession’s most prestigious journals.

² Don P. Clark, Serafino Marchese, and Simonetta Zarrilli, “Do Dirty Industries Conduct Offshore Assembly in Developing Countries?,” *International Economic Journal*, Autumn 2000, Volume 14 (3), pp. 75-86.

lower the probability that an assembly operation would be moved offshore. This contradicts the claim that developing countries are becoming pollution havens for companies that are subject to environmental regulation in the United States. CMZ's explanation for this finding is that technology, skilled labor and the capital intensive manufacturing activities based on the comparative advantage of remaining in the United States are sufficient to offset the abatement costs associated with pollution-intensive processes. The latter are likely to remain in the United States unless the other factors impacting location decisions are too great.

Technology and the Environment

The message from Levinson's research is that technological change has played the lead role in contributing

to a cleaner environment. This belies the claim that the reduction in harmful air emissions in the United States has largely been a consequence of offshoring activities by manufacturers. Technology's lead role should be taken as good news. It shows that the progress that has been made in cleaning up the environment is real rather than illusory.

Claims that manufacturers are using developing countries as pollution havens also are debatable judging by the evidence provided by CMZ. A more accurate conjecture might be that when a U.S. manufacturer constructs a facility in a developing country, that facility will incorporate a technology that has better pollution controls (as well as a more efficient manufacturing process) than might be normally found in that country's existing plants even though environmental controls there may not be as stringent as those in the United States.