Tighter US Lead Pollution Standards Shifted Industry to Mexico

A key concern in environmental policy debates is that tighter pollution regulations in richer countries may lead to the relocation of dirty production activities to poorer countries with weaker regulations. This could have adverse health effects on the “pollution haven” countries’ populations.

In North-South Displacement Effects of Environmental Regulation: The Case of Battery Recycling (NBER Working Paper 29146), Shinsuke Tanaka, Kensuke Teshima, and Eric Verhoogen find that the tightening of airborne lead standards in the United States in 2009 was associated with a shift in recycling of used lead-acid batteries from the US to Mexico and a decline in infant health near Mexican battery-recycling plants.

Battery recycling is well-suited to empirical study. First, the industry is an intensive emitter of lead, a particularly noxious pollutant linked to retarded fetal growth, lower IQ and educational achievement, and other adverse outcomes. Second, a sharp regulatory change occurred in 2009 when the US tightened the National Ambient Air Quality Standard for lead by a factor of 10 while the standard in Mexico remained unchanged. Third, there are reliable data that permit tracking of the relocation of battery recycling.

The researchers focus on the locations of battery-recycling plants in the US and on ambient lead levels at monitoring stations nearby, on used lead-acid battery (ULAB) trade flows from the US to Mexico, on the locations of ULAB recycling plants in Mexico, and on the birthweight of infants born to mothers who live near these plants. Birthweight is a particularly well-measured and fast-responding health outcome with regard to lead pollution.

After the United States restricted lead emissions, the Mexican lead-acid battery-recycling industry expanded rapidly, and the incidence of low birthweight infants near recycling plants in Mexico increased.

![Used Lead-Acid Battery Exports from the US, 2002–2015](image-url)

**Used Lead-Acid Battery Exports from the US, 2002–2015**

- **Millions of batteries per month**
  - 2.5
  - 2.0
  - 1.5
  - 1.0
  - 0.5
  - 0

- **Exports to Mexico**
- **Exports to the rest of the world**
- **Implementation of stricter ambient lead standard**

Source: Researchers’ calculations using data from the US Census Bureau Foreign Trade Division
clinging plants was sharply higher in 2008–13 than in 2003–08. Value added rose by 62.2 percent over the five-year period from 2003–08 and by 243.2 percent from 2008–13. Between 2008 and 2013, the incidence of low-birthweight infants increased significantly within a two-mile radius of Mexican battery-recycling plants relative to areas two to four miles away. Health effects were concentrated among mothers in hospitals run by the Mexican Ministry of Health. These women tended to be of lower socioeconomic status than mothers in other hospital types. The researchers conclude that the tightening of the US lead regulation induced the relocation of battery recycling and caused negative health spillovers in Mexico.

— Lauri Scherer

South Korea’s Industrial Policy: Growth with Inefficiency

Between 1965 and 1990, four “tigers”—South Korea, Taiwan, Singapore, and Hong Kong—were among the leaders in a period of rapid industrialization and economic growth that became known as the East Asian Miracle. Some analysts have linked this growth to these countries’ reliance on government cultivation and support of strategic industries. However, the overall efficacy of this form of industrial policy remains debatable.

Two recent papers—one using firm-level balance sheets, the other using plant-level production data—examine the long-term effects of a high-profile example of industrial policy: South Korea’s Heavy and Chemical Industry (HCI) Drive of 1972 to 1979, which targeted development in steel, nonferrous metal, electronics, machinery, chemicals, and shipbuilding. This push was concentrated in nine southeastern regions of the country, where the Korean government built large HCI complexes. Both studies estimate the impacts of the HCI Drive by comparing firms’ long-term growth in targeted industry-region pairs with that in non-targeted industries or regions.

In The Long-Term Effects of Industrial Policy (NBER Working Paper 29263), Jaedo Choi and Andrei Levchenko find that a subsidized firm that received the average credit subsidy during this period experienced 8.6 percent higher annual sales growth between 1982 and 2009 than a comparable nonrecipient firm. The Heavy and Chemical Industry Drive of 1972 to 1979 increased the size and output of targeted firms and industries but was also associated with increased misallocation of resources.

In The Plant-Level View of an Industrial Policy: The Korean Heavy Industry Drive of 1973 (NBER Working Paper 29252), Minho Kim, Munseob Lee, and Yongseok Shin find similar evidence that targeted industry-regions saw higher growth during and after the HCI Drive. These effects persisted until at least 1987, when the researchers’ data end. They document growth in targeted industry-regions as a whole, as well as in the average number of employees per plant in these sectors. In particular, they find an increase in the number of very large plants.

An increase in the size and output of industries targeted by the HCI Drive does not imply that these industries became more productive. Indeed, while this push increased both aggregate labor productivity and plant-level total factor productivity (TFP), it did not increase aggregate TFP at the industry-region level. This is because resource misallocation increased substantially in targeted industry-regions, as resources were directed to lower-productivity uses. The researchers suggest that this may be explained by chaebols—megaconglomerate firms, mostly family owned—that preferentially attracted support in the HCI Drive. If this misallocation had been avoided, average TFP in the targeted industry-regions would, on
Public-school enrollment has fallen during the COVID-19 pandemic as parents have shifted their children to homeschooling and private schools.

In *The Pandemic’s Effect on Demand for Public Schools, Homeschooling, and Private Schools* (NBER Working Paper 29262), Tareena Musaddiq, Kevin M. Stange, Andrew Bacher-Hicks, and Joshua Goodman find that the impact varies across grades and across racial and economic groups. Results also differ depending on whether public schools offered instruction fully in class, remotely, or in a hybrid model. The researchers analyze student-level data from Michigan and nationally representative surveys from the US Census.

In Michigan in the autumn of 2020, kindergarten enrollment dropped 10 percent from the previous year; for all grades the decline averaged 3 percent. Among previous public-school students, the percentage of those leaving for alternatives was highest in the lower grades. Before the pandemic, 4 percent of the state’s public elementary students did not re-enroll the following year; in the autumn of 2020, that rate was over 6 percent. The share of kindergarteners not returning for first grade almost doubled, from 4 to nearly 8 percent. Exit rates remained elevated through the eighth grade. More high school students returned to public schools than in the past.

Most Michigan parents who pulled their children from public schools opted to teach them at home, with a smaller share shifting them to private schools. This trend was most pronounced in districts that offered a fully in-person or hybrid option; districts that went entirely remote saw more students exiting for private schools.

The national figures from the US Census Household Pulse Survey are similar to those in Michigan. Public school enrollment fell 3 percent, with the lower grades taking the biggest hit. Kindergarten numbers declined by 13 percent, while high schools saw a 0.4 percent increase in enrollment.

Nationwide, 7.3 percent of households reported at least one child being homeschooled in September 2020, up from 4.5 percent before the pandemic. The researchers estimate that a state that offered every student in-person instruction in September 2020 would have seen homeschooling rates more than double.

Among Michigan kindergarteners, enrollment drops were highest among Black students, at 19 percent, and among low-income students, at 11 percent. The researchers note that these communities faced higher rates of COVID-19 cases than the general population.

The racial and ethnic trends were different among already enrolled, older students in public school. The exit rate among White students in the autumn of 2020 was 6.2 percent, nearly double the rate of the previous year. Among Black and Hispanic students, the exit rate rose by less than 1 percentage point. Higher-income students’ exit rates rose by 2.7 percentage points, compared with 1.9 percentage points.

---

What the COVID-19 Pandemic Meant for Public Schools

Public-school enrollment has fallen during the COVID-19 pandemic as parents have shifted their children to homeschooling and private schools.

In *The Pandemic’s Effect on Demand for Public Schools, Homeschooling, and Private Schools* (NBER Working Paper 29262), Tareena Musaddiq, Kevin M. Stange, Andrew Bacher-Hicks, and Joshua Goodman find that the impact varies across grades and across racial and economic groups. Results also differ depending on whether public schools offered instruction fully in class, remotely, or in a hybrid model. The researchers analyze student-level data from Michigan and nationally representative surveys from the US Census.

In Michigan in the autumn of 2020, kindergarten enrollment dropped 10 percent from the previous year; for all grades the decline averaged 3 percent. Among previous public-school students, the percentage of those leaving for alternatives was highest in the lower grades. Before the pandemic, 4 percent of the state’s public elementary students did not re-enroll the following year; in the autumn of 2020, that rate was over 6 percent. The share of kindergarteners not returning for first grade almost doubled, from 4 to nearly 8 percent. Exit rates remained elevated through the eighth grade. More high school students returned to public schools than in the past.

Most Michigan parents who pulled their children from public schools opted to teach them at home, with a smaller share shifting them to private schools. This trend was most pronounced in districts that offered a fully in-person or hybrid option; districts that went entirely remote saw more students exiting for private schools.

The national figures from the US Census Household Pulse Survey are similar to those in Michigan. Public school enrollment fell 3 percent, with the lower grades taking the biggest hit. Kindergarten numbers declined by 13 percent, while high schools saw a 0.4 percent increase in enrollment.

Nationwide, 7.3 percent of households reported at least one child being homeschooled in September 2020, up from 4.5 percent before the pandemic. The researchers estimate that a state that offered every student in-person instruction in September 2020 would have seen homeschooling rates more than double.

Among Michigan kindergarteners, enrollment drops were highest among Black students, at 19 percent, and among low-income students, at 11 percent. The researchers note that these communities faced higher rates of COVID-19 cases than the general population.

The racial and ethnic trends were different among already enrolled, older students in public school. The exit rate among White students in the autumn of 2020 was 6.2 percent, nearly double the rate of the previous year. Among Black and Hispanic students, the exit rate rose by less than 1 percentage point. Higher-income students’ exit rates rose by 2.7 percentage points, compared with 1.9 percentage points.
points among low-income students. How the enrollment patterns of 2020 will affect public schools over the longer term is an open question. The researchers outline a scenario in which White and higher-income students, who showed the highest exit rates during the pandemic, are slow to return, while Black and lower-income students who delayed starting school flood into kindergarten and first grade classes.

— Steve Maas

International Reserve Management in Emerging Market Economies

When global financial risk spikes, emerging market economies can experience widened credit spreads, plunging investment, capital flow reversals, and heightened speculation about impending debt crises. If a country’s central bank accumulates international reserves during good times, it can “lean against the wind” by selling those reserves in bad ones. Management of international reserves by central banks can alleviate the financial market instabilities created by global shocks that increase business financing costs, thereby mitigating the worst effects of economic downturns and helping governments to service debt when borrowing costs increase.

In International Reserve Management, Global Financial Shocks, and Firms’ Investment in Emerging Market Economies (NBER Working Paper 29303), Joshua Aizenman, Yin-Wong Cheung, and Xingwang Qian track the investment behavior of 21,447 publicly traded firms in 46 emerging economies. They explore the impact of active international reserve management policies that were pursued by some central banks over the 2000 to 2018 period. The researchers estimate that active reserve management is positively associated with business investment. Larger firms with higher cash flows and more rapid sales growth tend to be more responsive than other firms. Financially unconstrained firms are 4.5 times more responsive than financially constrained firms. For the purpose of the study, financial constraints are defined by access to external fund sources, the ratio of tangible assets to long-term liabilities, and an estimate of the firm’s cost of external financing.

The researchers find that higher country credit spreads — larger differences between the risk-free interest rate and the interest rate charged to borrowers in that country — are negatively associated with firm investment. Managing international reserves to narrow country credit spreads is therefore one channel through which active reserve management supports firm investment. About 22 percent of the effect of active reserve management on the investment behavior of unconstrained firms, and 36 percent of the effect on financially constrained firms, is mediated by the impact of this policy on country spreads. The researchers also find that active international reserve management has a more substantial effect on firm investment in countries with capital controls.

— Linda Gorman

Analysis of the behavior of 21,447 firms in 46 emerging economies finds active central bank management of international reserves increases business investment.

### International Reserve Management and Firm Investment

<table>
<thead>
<tr>
<th>Percent change in firm investment in emerging markets associated with a one percent increase in active international reserve management</th>
<th>+6%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favorable shock (decrease in VIX)</td>
<td>5</td>
</tr>
<tr>
<td>Unfavorable shock (increase in VIX)</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>-3</td>
<td></td>
</tr>
<tr>
<td>-4</td>
<td></td>
</tr>
<tr>
<td>-5</td>
<td></td>
</tr>
</tbody>
</table>

Source: Researchers’ calculations using data from the IMF, FRED, and Thomson Reuters

During a financial shock associated with a 60 percent increase in the VIX, a one percent increase in active international reserve management raises firm investment by four percent.

Magnitude of financial shock, measured as percent change in the VIX

Shaded region represents the 95% confidence interval.
Improved Market Access Helps the Fishermen of Remote Amazonia

In the impoverished communities of the Brazilian Amazon, one of the most remote settings in the world, fishermen harvest a huge, prehistoric, air-breathing fish called a pirarucu. Historically, they have sold the fish to middlemen who wield significant market power, resulting in a large gap between the price the fishermen receive and the price charged to the consumer.

In Big Fish in Thin Markets: Competing with the Middlemen to Increase Market Access in the Amazon (NBER Working Paper 29221) Viva Ona Bartkus, Wyatt Brooks, Joseph P. Kaboski, and Carolyn E. Pelnik study an intervention that enabled communities to bring the fish to market directly and thereby increased incomes as much as 27 percent.

Fishing for pirarucu is straightforward: the fish must come to the surface to breathe, at which point they are harpooned. But because the fish are perishable, delivering them to market is a challenge. Prior to the intervention, direct access to the final market involved multiday ferry rides to Manaus, the capital city of Amazonas. Instead of making this journey, most fishermen sold to middlemen who have boats that permit faster delivery. The middlemen, part of a cartelized supply chain, brought the catch to outside markets. The intervention, initiated by a nongovernmental organization, involved community-financed procurement of boats, ice, and fuel to enable fishermen to cut out the middlemen.

Fundação Amazonas Sustentável (FAS) — the leading nongovernmental environmental organization in Brazil — focuses on sustainable economic development of both the Amazon’s natural resources and its river communities. FAS’s Bolsa Floresta program, Bradesco Bank, and the state of Amazonas pay a monthly subsidy to households in river communities who promise to care for the forest. Communities that choose to participate in the boat-buying effort forego their Bolsa Floresta payments for the period of time needed to pay for a boat, approximately three years.

In evaluating the intervention, the researchers find that income in boat-acquiring communities rose by 27 percent relative to income in the control communities. The intervention also raised consumption, including food expenditures. They did not find a significant increase in fishing, notable in a situation where overfishing could plausibly be a concern. Rather, they found an increase in the price fishermen received for the fish.

A community-financed program to procure boats, ice, and fuel enabled impoverished communities to avoid middlemen in trade, boosting incomes and increasing food consumption.

The researchers find that boat investments are cost effective: boats can be paid for in under three years, well within the lifespan of the typical boat. They also find that, in the first year of the intervention, communities continued to sell to middlemen, but they may have earned a higher price when doing so. This may have reflected a risk-mitigation strategy, as communities continue to sell a substantial portion of their pirarucu to known buyers while also organizing their own boats.

The researchers explored why, if the intervention was cost effective, community members had not implemented such a strategy on their own. They suggest that the lack of a boat constituted a poverty trap, especially in the presence of a cartel with market power in pricing. Middlemen were capable of financing the large fixed cost of a boat, but poor communities were not. Market power enabled the middlemen to pay below-market prices for fish, thus creating a poverty trap even though the natural cost structure did not make this an inevitable outcome.

— Lauri Scherer
Effects of the First Court Ruling against School Segregation

The Supreme Court’s *Brown v. Board of Education* ruling in 1954 is widely viewed as the seminal decision outlawing racial segregation of schools. But a decade earlier, in *Mendez v. Westminster*, a federal district court ruled against segregation of Mexican Americans in California schools. This case was the first successful challenge to segregation based on the Equal Protection Clause of the 14th Amendment to the US Constitution. Filed against school districts in Orange County, the case never reached the national level because the defendants decided not to pursue it after losing at the appellate level in 1947.


Determining the impact of segregation in California is complicated, because unlike in southern states that mandated separate schools for Blacks and Whites, in California segregation primarily occurred at the local level. Segregation was subtler: school boundaries were drawn to create Mexican zones, and any White children who happened to live in those areas were offered the opportunity to transfer out.

In the absence of official records designating which California districts practiced segregation, the researchers rely on historical accounts indicating that segregation was most prevalent in counties with a large share of Hispanic students. They assume that schools were segregated in counties that fell in the top quarter statewide in their concentration of Hispanics.

In those counties, Hispanic students who began schooling after *Mendez* took effect remained in school 0.9 years longer than students who began schooling a decade earlier. The post-*Mendez* cohort was 18.4 percent more likely to graduate from junior high school and 19.4 percent more likely to graduate from high school.

At the same time as Hispanics marked gains in educational attainment, their non-Hispanic White classmates showed a slight decline. The drop in attainment for non-Hispanic Whites was much smaller than the increase for Hispanics; the researchers conjecture that it might have resulted from a reallocation of resources.

Prior to the *Mendez* decision, Hispanic students in low-segregation counties — those in the 25 percent of counties with the lowest ratio of Hispanics to non-Hispanics — completed an average of 12 years of schooling, compared with nine years for their Hispanic peers in high-segregation counties. *Mendez* had no appreciable impact on the outcomes for Hispanics in low-segregation areas.

— Steve Maas

---

**Desegregation and Junior High School Attainment among Hispanics**

Percentage point difference in junior high completion probability, counties with a high vs low likelihood of segregation, relative to 1931 birth cohort

<table>
<thead>
<tr>
<th>Year</th>
<th>High Segregation</th>
<th>Low Segregation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1921</td>
<td>-30</td>
<td>0</td>
</tr>
<tr>
<td>1923</td>
<td>-20</td>
<td>10</td>
</tr>
<tr>
<td>1925</td>
<td>-10</td>
<td>20</td>
</tr>
<tr>
<td>1927</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>1929</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>1931</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>1933</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>1935</td>
<td>40</td>
<td>70</td>
</tr>
<tr>
<td>1937</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>1939</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>1941</td>
<td>70</td>
<td>100</td>
</tr>
<tr>
<td>1943</td>
<td>80</td>
<td>110</td>
</tr>
<tr>
<td>1945</td>
<td>90</td>
<td>120</td>
</tr>
</tbody>
</table>

*Source: Researchers’ calculations using data from the Integrated Public Use Microdata Series.*

NBER

The National Bureau of Economic Research is a private nonprofit research organization founded in 1920 and devoted to conducting and disseminating nonpartisan economic research. Its officers are:

- James M. Poterba — President
- John Lopinto — Chair
- Peter Blair Henry — Vice Chair
- Robert Mecklenburg — Treasurer

The NBER Digest summarizes selected Working Papers recently produced as part of the NBER’s program of research. Working Papers are intended to make preliminary research results available to encourage discussion and suggestions for revision. Neither the Working Papers nor the Digest have been subject to peer review or review by the NBER Board of Directors. The Digest is free. It is not copyrighted and may be reproduced with appropriate attribution of source. Please provide the NBER’s Public Information Department (caradin@nber.org) with copies of anything reproduced.

Requests for Digest subscriptions, changes of address, and cancellations may be sent to Digest, NBER, 1050 Massachusetts Avenue, Cambridge, MA 02138-5398 (please include the current mailing label), or emailed to subs@nber.org. Print copies of the Digest are only mailed to subscribers in the US and Canada; those in other nations may request electronic subscriptions at www.nber.org/dxsubscribe/.

Individual copies of NBER Working Papers are available online free of charge to affiliates of subscribing organizations, such as universities and colleges, and to employees of NBER corporate associates. All visitors to the NBER website receive three free downloads each year, after which there is a charge of $5 per downloaded paper. To place an order, please email the NBER's Subscriptions Department at subs@nber.org or call (617) 588-1405. A full subscription to the NBER Working Paper series entitles the subscriber to all new papers, recently more than 1,200 per year. The standard annual rate for a full digital subscription is $2,675; the online academic rate is $1,230. Hand-copy subscriptions and partial subscriptions also are available; rates may be found at nber.org/wpsubscribe.html.