

October 2022

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Productivity Growth before and during the Pandemic

Between 2010 and 2019, US productivity grew more slowly than in any other decade of the post-World War II era. The business sector grew by an average of 1.1 percent per year, less than half of the 2.5 percent average annual growth from 1950 to 2009. Analysts have struggled to explain this slowdown during the longest business cycle expansion in US history and why productivity growth in 2020 soared to 4.1 percent, a sudden surge during a year marked by the short but sharp pandemic recession.

In [A New Interpretation of Productivity Growth Dynamics in the Prepandemic and Pandemic Era US Economy, 1950–2022](#) (NBER Working Paper 30267), [Robert J. Gordon](#) and [Hassan Sayed](#) challenge the widespread notion that deviations of productivity growth from its long-run trend result solely from autonomous “productivity shocks.” Rather, the researchers show that these deviations from trend, which they call “productivity gap changes,” are strongly procyclical. As growth in output fluctuates, due to such demand-driven components as consumer durables, fixed investment, and inventory investment, firms react by adding or cutting total hours of work—that is, total employment times

weekly hours per job. But the hours response is partial and lags the change in output. Since productivity changes are by definition equal to output changes minus changes in hours

workers, and this was followed by a gradual pace of rehiring after 2009. Because the cuts were so large, it took nearly a decade for hiring to recover, which is a major reason pro-

Hiring recoveries following excess layoffs during the Great Recession and the pandemic led to slow productivity growth in both the 2010–19 and 2021–22 periods.

of work, productivity changes surge upward in the current quarter as the counterpart of the slow response of labor hours and then fall back as labor hours gradually complete their lagged response.

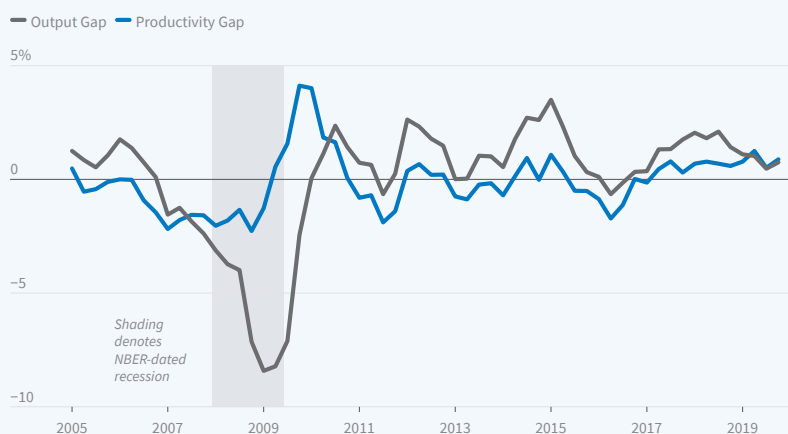
The researchers argue that the strong productivity growth experienced in 2009 and slow productivity growth during 2010–19 were both due to “excess layoffs” as firms panicked during the Great Recession and fired

workers, and this was followed by a gradual pace of rehiring after 2009. Because the cuts were so large, it took nearly a decade for hiring to recover, which is a major reason pro-

To understand the rebound in productivity growth in 2020, the researchers construct a quarterly database of productivity levels and changes for 17 industries that they sort into three groups: goods, work-from-home services, and contact services. They conclude that the official data substantially overstate aggregate productivity growth in the second quarter of 2020, when the recession occurred, and understate it in the third quarter because pandemic-driven lockdowns skewed the data by dramatically shift-

US Business Sector Output and Labor Productivity Gaps, 2005–19

Four-quarter moving average change in the deviation from trend



ing the industry mix away from low-productivity contact services, like restaurants and hotels, and toward high-productivity work-from-home industries, such as information technology and financial services. Over the nine quarters between 2020 and early 2022, productivity growth in the goods industries was negligible, productivity in contact services declined at an average annual rate of 2.6 percent, and work-from-home industries accounted for all of the economy's overall pos-

itive productivity growth achievement, posting a strong 3.3 percent growth rate. The researchers link the upsurge of efficiency in work-from-home industries to recent surveys showing self-assessments of greater efficiency and unmeasured extra work hours during time previously spent commuting.

The researchers develop a simulation of their 2007–19 regression analysis to estimate the effects of excess layoffs in 2020 and rebound rehiring in 2021–22. They project

that rehiring will continue for several years at an annual rate that is about 2.5 percent per year faster than otherwise as industries rehire the employees they cut during the pandemic lockdowns. This rehiring phenomenon explains both why the US economy in 2022 has been characterized by positive employment growth despite negative GDP growth, and why productivity growth was negative in the first two quarters of 2022.

— *Laurent Belsie*

Temporary Layoffs and the Dynamics of Cyclical Unemployment

In the US labor market, about one-third of all unemployment spells begin with temporary layoffs. Some workers who are placed on temporary layoff, however, are never recalled to their former job. They may at some point be told by their former employer that recall is no longer an option. They join the “jobless unemployed,” a group that usually takes longer than those on temporary layoff to find a job.

In [Temporary Layoffs, Loss-of-Recall and Cyclical Unemployment Dynamics](#) (NBER Working Paper 30134), [Mark Gertler](#), [Christopher K. Huckfeldt](#), and [Antonella Trigari](#) study workers who expected to be recalled when they entered unemployment, but who never were. They find that temporarily laid off workers who at some point learned that they would not be recalled account for a sizeable fraction of the long-term unemployed in post-WWII recessions.

The role of temporary layoffs has varied across different economic downturns. Accounting for loss-of-recall, temporary layoffs accounted for 36 percent of the increase in unemployment in recessions during the 1980s, compared with 17 percent of the increase in the Great Recession, and 98 percent of the increase during the COVID recession.

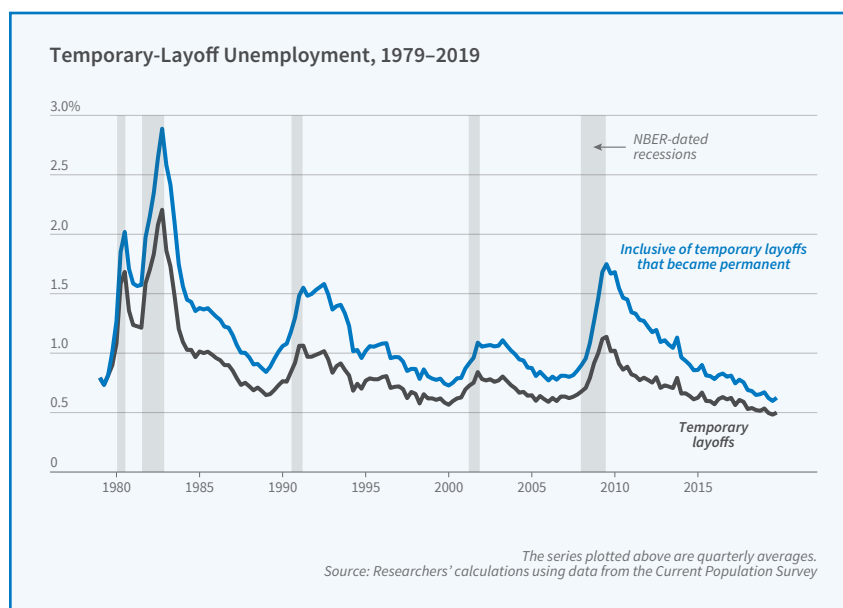
Temporary layoffs that turn into permanent job loss are an important contributor to overall unemployment.

The researchers develop a framework for analyzing hiring and layoff decisions. Firms experience shocks in their costs of production, which leads to changes in their labor demand. They can adjust their labor forces with temporary and permanent layoffs, recalls, periodic wage renegotiation, and new hires from among the jobless unemployed. The researchers calibrate this model using data from the monthly Current Population Survey (CPS) between 1978 and 2019, focusing on the probability of worker transitions between employment, temporary-layoff unemployment, and jobless

unemployment. This model successfully reproduces labor market dynamics in the CPS.

Flows from temporary layoff to jobless unemployment can slow the pace of economic recovery following a downturn. The researchers find that if there were no transitions from temporary to permanent layoff—if all layoffs remained temporary—then during a typical downturn, the unemployment rate would peak slightly earlier and it would be several tenths of a percent lower throughout the recovery. They attribute this to a reduction in firms' costs of hiring when they rehire laid off workers rather than conduct a search for a new employee.

Interventions like the Paycheck Protection Program (PPP) during the COVID recession discouraged firms from permanently letting workers go, and likely decreased the number of individuals moving from temporary layoffs to jobless unemployment. To assess the impact of this program, the researchers create a series of “lockdown shocks,” with a growing fraction of workers laid off, as well as



a “social distancing” shock that reduced the productivity of labor and capital. The productivity reductions were applied in April 2020, September 2020, and January 2021. In these scenarios, the PPP—modeled as

a subsidy to firms—reduced unemployment by cutting the number of workers who transitioned from temporary layoffs to jobless unemployment. The simulations suggest that the PPP program lowered the unem-

ployment rate by about 2 percentage points over the first six months of the pandemic, and by roughly 1 percent for the next twelve months.

—Linda Gorman

STEM Summer Programs and Students’ Educational Outcomes

Governments and many private organizations have invested in programs to support diversity in the science, technology, engineering, and mathematics (STEM) pipeline, including summer programs for high school students. There is little rigorous evidence of the efficacy of these programs, however. In [STEM Summer Programs for Underrepresented Youth Increase STEM Degrees](#) (NBER Working Paper 30227), [Sarah R. Cohodes](#), [Helen Ho](#), and [Silvia C. Robles](#) find that students offered seats in STEM summer programs are more likely to enroll in and graduate from college.

The researchers conducted a randomized controlled trial of a suite of summer programs aimed at increasing the number of underrepresented students pursuing STEM degrees and careers. They collected information on students from their program application through college graduation, with or without a STEM degree. In the summers of 2014, 2015, and 2016, cohorts of high-achieving, STEM-interested students were randomized into one of four groups, three STEM-focused programs plus a control group. The programs were held in the summer between the junior and senior years of high school. The programs were held at an elite technical university in the Northeast. They differed in their modality and intensity: six weeks full-time on-site, one week full-time on-site, or six months with periodic meetings online. Students were selected into the randomization pool based on their academic preparation as well as a holistic assessment of need

that included whether they had backgrounds that were underrepresented in STEM fields.

Participation in all three programs increased the likelihood of application to,

college after four years. The STEM summer programs also increased enrollment at *Barron’s* magazine’s most competitive colleges, and the likelihood of application to, acceptance

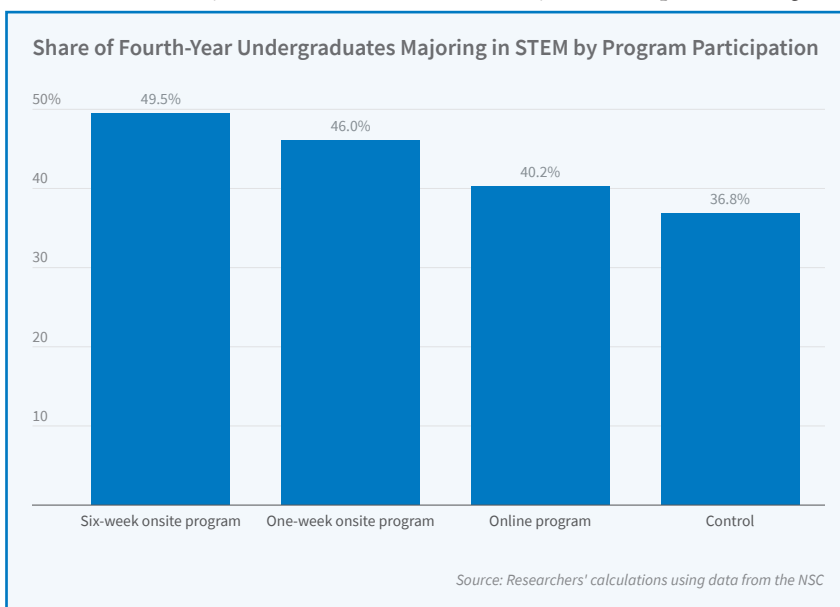
Students who participated in STEM summer programs at a major US university were more likely to remain enrolled in college through their senior year than students in a control group.

acceptance at, and enrollment in the host university, with the largest magnitudes coming from the six-week program. Eighty-seven percent of students in the control group attended a four-year college immediately after high school graduation, and the programs increased this by 2 to 4 percentage points. However, by the fourth year of college, enrollment among the control group dropped to 75 percent, most likely reflecting students dropping out of college or taking time off before completion. In contrast, those offered a seat in any one of the three STEM summer programs were 3 to 12 percentage points more likely to still be enrolled in a four-year col-

lege after four years. The STEM summer programs also increased enrollment at *Barron’s* magazine’s most competitive colleges, and the likelihood of application to, acceptance

at, and enrollment in the host institution for the STEM programs. The STEM programs also increased on-time college graduation. Only 53 percent of students in the control group graduated within four years from any four-year school, despite being an academically talented group. For those who were randomly chosen to attend the six- or one-week STEM programs, the graduation rate was 8 percentage points higher. For the online program, it was 1.6 percentage points higher. In the control group, 34 percent of students graduated within four years with a STEM degree—64 percent of degree recipients. The six-week program increased the rate at which students graduated with a STEM degree to 50.7 percent. The corresponding percentages were 46.8 percent for the one-week program and 37.2 percent for the online program. Most of these effects could be attributed to shifts in the quality of the institutions that graduates of the STEM summer programs, versus the control group, chose to attend.

—Lauri Scherer



Foreign and Domestic Ownership of Rwanda's Coffee Industry

Firms vary widely in their management practices and productivity, especially in low-income countries. In [Acquisitions, Management, and Efficiency in Rwanda's Coffee Industry](#) (NBER Working Paper 30230), [Rocco Macchiavello](#) and [Ameet Morjaria](#) find that Rwandan coffee mills become more productive after they are acquired by a foreign firm, but not when they are acquired by a domestic one.

Coffee mills purchase coffee cherries — beans that have not yet had the outer pulp removed — from farmers and convert them into parchment coffee, an intermediate stage in bean processing. Managers are responsible for supervising employees in charge of each step of the process, developing relationships with farmers to source cherries, overseeing hiring of seasonal workers and agents, and paying farmers and workers.

The number of Rwandan mills has grown rapidly, from a handful in 2002 to 310 in 2017. Until 2011, all mills were owned domestically, typically by their builders. Some owners were individuals who owned a stand-alone mill; others were groups that owned two or more mills. After 2011, foreign multinationals began acquiring mills. By 2017, over 50 percent of mills were under group ownership, including a sixth of mills owned by seven foreign groups.

The researchers conducted several mill-level surveys over the last decade to collect information on operational aspects: price and quantity of input, quantity and quality of output, production cost, employment, mill manager characteristics, and key managerial practices. They also interviewed all CEOs of group-owned mills to ask how they target mills for purchase,

what alternative target mills they considered, and details of acquisitions that failed, enabling them to create multiple counterfactuals for comparison to the target mill.

As the industry grew and consolidated, foreign owners improved mill performance by better implementing good management practices, compared to domestic owners.

They combined surveys with administrative data on processing capacity, input procured, and ownership history to document and understand performance differences. By comparing mills that changed ownership type, the researchers find that foreign acquisition increases the likelihood that the mill is operational in any given year. While both foreign- and domestic-owned mills expand processing capacity and employment, foreign-owned mills are able to source more cherries from farmers. In comparison to domestic stand-alone mills, foreign-owned

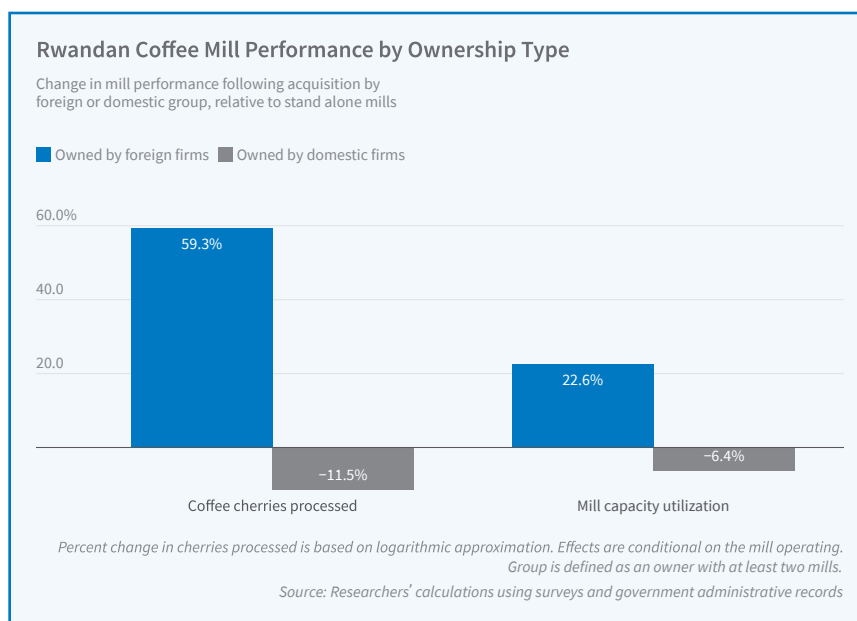
ences in processing technology across mills or differential access to sources of finance. They do find, however, that managers at foreign-owned mills are different: they are

younger, more educated, and have higher ability. These manager characteristics can explain around a quarter of the differences in performance between foreign-owned and domestic-owned mills.

The researchers argue that the rest of the performance differences seem to be driven by managerial practices. However, they note both groups' managers equally attempt management changes — suggesting lack of knowledge and lack of incentives are unlikely to be drivers of performance differences. Implementation differences could drive the performance differences.

Organizational capabilities post-acquisition are different across the two groups. Foreign firms deploy several complementary practices to support implementation: they grant managers more autonomy to implement changes, and they ensure that managers do not misuse their increased autonomy through a combination of monitoring (via IT infrastructure) and paying them wages above their market salary.

Managers of domestic-group mills report facing more resistance from farmers and workers when making management changes; the groups' different pre-acquisition capabilities might explain this. Personal relationships in the community are important for domestic groups (which are barely mentioned by foreigners). The



mills have 23 percent greater capacity utilization. Labor productivity, the ratio of output to labor, is similar for individual-owned and foreign-owned mills, but 25 percent lower for mills owned by domestic groups.

The researchers rule out the possibility that the performance differences between foreign and domestic groups is due to differ-

importance of these relationships in driving target selection is reflected in mill managers' birthplaces — around 70 percent of managers of domestic-group mills were born in the same district as their mills,

compared to only around 20 percent of managers of foreign-group mills.

These findings highlight the possibility that while domestic groups' embeddedness in the local community creates

opportunities to invest, it can also create pressure to maintain status-quo relational arrangements, hindering implementation of management changes.

—Whitney Zhang

Misperceiving the Mortality Reduction Benefits of COVID-19 Vaccines

Clinical trials and post-market studies showed that COVID-19 vaccines are highly effective at reducing COVID-19 mortality, yet only about 67 percent of the US population has received two doses of the vaccines. In [How Undervalued Is the COVID-19 Vaccine? Evidence from Discrete Choice Experiments and VSL Benchmarks](#) (NBER Working Paper 30118), [Patrick Carlin](#), [Brian Dixon](#), [Kosali Simon](#), [Ryan Sullivan](#), and [Coady Wing](#) suggest that survey respondents substantially undervalue the vaccines' benefits.

The researchers conducted a survey on the Microsoft news website between February and March 2021, when vaccines were just becoming widely available. Those who clicked to participate in the survey were presented with two questions. The first asked whether the participant would be willing to pay a price to receive a COVID-19 vaccine four months early, where the price was randomly assigned to be \$50, \$100, \$200, \$500, or \$1,000. The second asked whether the participant would agree to accept a cash payment for delaying the second dose of the vaccine by three months. The randomly assigned payment amounts were \$5, \$10, \$50, \$100, or \$200.

Using the Department of Health and Human Services' \$11.4 million benchmark for the value of a statistical life (VSL) and estimates of the COVID-19 vaccines' mortality reduction rate, the researchers cal-

In a survey, Americans valued a first dose of a COVID-19 vaccine at about 2 percent and a second dose at about 32 percent of the amount implied by value of statistical life calculations.

culate that a typical respondent should be willing to pay \$2,761 to receive the first vaccine four months early and should require a \$619 payment to agree to delay the second dose. In contrast, participants' choices in the experiment suggest that the median person was willing to pay only \$50 for the first dose, and willing to accept only \$200 to delay the second dose. The

calculation. They find that respondents value the first dose at about 2 percent of this value, and the second dose at about 32 percent.

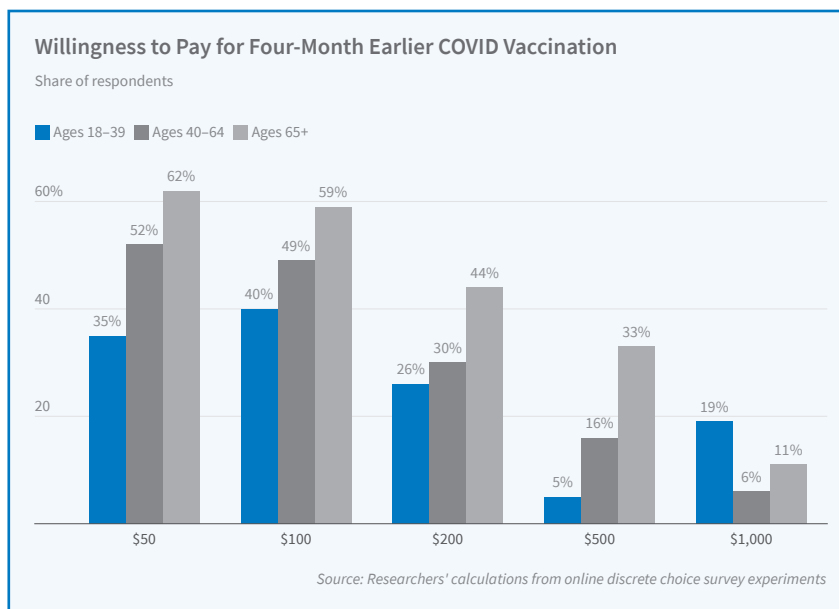
In the absence of perceptual errors, people should be less price sensitive to the timing of the first vaccine than the second since the reduction in mortality from receiving the first dose early is greater than the increase in mortality from delaying the second. The survey results suggest just the opposite. A 10 percent increase in price reduced reported demand for early take-up of the first shot by about 8 percent, while increasing the cash payment offer for delaying the second shot reduced demand by only 2.6 percent.

The researchers find less price sensitivity in the willingness to pay for an early first dose among older respondents and those who are vaccine hesitant.

They do not find any

impact of the local severity of COVID-19. Counterintuitively, a higher cash payment reduces the willingness to delay the second dose for those who are vaccine hesitant. It is also more effective at inducing people to delay a second dose when COVID-19 is more locally severe.

—Whitney Zhang



researchers posit that these results are due to misperceptions of the vaccines' benefits. Respondents appear to underestimate the benefits of the vaccine.

The study calibrates these perceptual errors by dividing the reported willingness to pay for altering the timing of vaccination by the payment that would be implied by VSL

Health Effects of Cutting Air Pollution in US Coastal Waters

Maritime shipping emits half as much fine particulate matter as global road traffic. A decade ago, the United States in conjunction with the International Maritime Organization (IMO) issued new regulations to limit the emissions of oceangoing vessels. As a result, particulate pollution has fallen substantially in areas along US coastlines. In *Uncharted Waters: Effects of Maritime Emission Regulation* (NBER Working Paper 30181), [Jamie Hansen-Lewis](#) and [Michelle M. Marcus](#) study the impact of these regulations on health outcomes that have previously been found to be sensitive to pollution levels, as well as on the behavior of ship operators.

In 2012, the US created emission control areas (ECAs) where commercial ships are required to use expensive less-polluting fuel when within 200 nautical miles of the coast, or are required to install abatement equipment. The study finds that the ECAs cut the population-weighted average of fine particulate matter in counties near heavy ship traffic by 4 percent. This decline in fine particulate pollution coincided with a drop in the number of low birth weight babies of 1.7 percent on average in affected areas. Infant mortality decreased by 3.5 percent. The researchers estimate the new regulations led to 1,536 fewer

instances of low birth weight and 290 fewer infant deaths annually. This reduction in infant mortality, when valued using estimates of the value of a statistical life that are used by some

limited by national boundaries. Since Mexico does not have ECAs, portions of US states near it—such as California and Texas—have ECAs that are narrower than the 200 nautical

US regulations requiring ships within 200 nautical miles of shore to limit particulate emissions are associated with lower infant mortality and fewer instances of low birth weight.

US federal agencies, yields a monetary value that is close to the regulations' estimated cost of \$3.2 billion.

The study finds that the regulations only reduced ambient particulate levels by half as much as they were expected to. This could be due to a number of factors. For example, some ships changed their routes to avoid using the costlier fuel specified by the regulations. In addition, in some areas, the coverage of the ECAs is

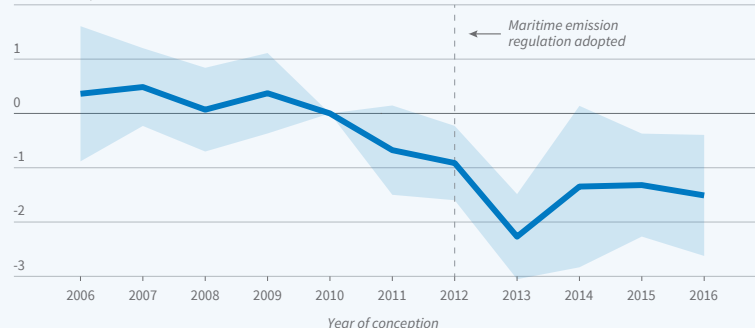
mile standard. South Florida's ECA is narrower because of its proximity to the Bahamas and Cuba. In US counties with an ECA boundary of less than 200 nautical miles, the reduction in particulates was about half of that experienced in counties with the full 200 nautical mile buffer. Counties far below the regulatory threshold for pollution levels saw smaller air-quality improvements than those at high risk of triggering penalties. The researchers hypothesize that those low-risk counties eased their efforts to control land-based emitters since they were unlikely to hit emission limits.

The researchers also suggest that individuals may have changed their behavior in response to the creation of ECAs, spending more time outdoors and thus exposing themselves to more particulates. Using a national activity database of individuals in counties near heavy ship traffic, the researchers find that the more the air quality improved, the more time they spent outdoors.

—Laurent Belsie

Maritime Emission Regulation and Infant Birth Weight

Difference in the rate of low infant birth weights between counties most and least affected by ship-exhaust pollution, relative to 2010
+2 births in 1,000



All births conceived after 2012, and some of those in 2012, were fully exposed to the policy reform; some of those in both 2011 and 2012 were partially exposed.
Source: Researchers' calculations using data from the EPA and the National Center for Health

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