Episode 183. How the United States cleaned up container ship pollution

Episode webpage

April 30, 2023

Transcript

(lightly edited)

Chad Bown: Container shipping is dirty.

Nowadays, the world is rightly concerned about climate change. The carbon dioxide emitted from those big ships, carrying tens of thousands of metal boxes all around the world, does contribute to global warming.

At the same time, carbon dioxide is not the only kind of airborne pollution that comes from shipping. Container ships also emit particulate matter that hurts air quality and that has a more immediate negative impact on human health.

In 2012, American regulators at the Environmental Protection Agency finally began to do something about maritime emissions and particulate matter.

This episode explores those EPA regulations. It examines how container ship operators responded to the new rules. It also describes potential lessons for environmental regulators of container shipping in the rest of the world.

To do all that, I will be joined by a very special guest.

Michelle Marcus: I'm Michelle Marcus, and I'm from Vanderbilt University.

Chad Bown: Michelle Marcus is an economics professor at Vanderbilt University. Michelle is an environmental economist, she is a health economist, and she has some brand-new research on the human health impacts of pollution regulations for container shipping.

Chad Bown: Hi, Michelle.

Michelle Marcus: Hi, Chad.

Chad Bown: You are listening to an episode of *Trade Talks*, a podcast about the economics of trade and policy. I'm your host, Chad Bown, the Reginald Jones Senior Fellow at the Peterson Institute for International Economics in Washington.

Chad Bown: Tell us about the environmental problem of particulate matter.

Michelle Marcus: Particulate matter is a type of air pollution. It's a term used for all sorts of different particles that are flying around in the air. Some particles, like dust or smoke, we can see with the naked eye, but others are really small and they can actually be breathed deep inside your lungs and even get into your bloodstream.

And those very, very small particles tend to pose the greatest risk to health. They can lead to heart attacks, asthma, respiratory problems, and even death.

Chad Bown: Where does particulate matter come from?

Michelle Marcus: Particulate matter comes from a lot of different places. Sometimes from natural sources – like dust or soot from wildfires or volcanoes. But other times particulates actually form in the air after a complex reaction of chemicals like sulfur dioxide and nitrogen oxides, which come from the burning of fossil fuels.

You can think of industrial activity – factories, power plants – but also these can come from transportation sources like cars, trucks, airplanes, and even ships.

Chad Bown: Historically, what types of policies have regulators put in place to try to tackle this particular pollution problem?

Michelle Marcus: This problem has been a source of focus for regulators for a long time, and the majority of regulation has focused on reducing emissions from cars – through things like catalytic converters – or installing scrubbers on plants. But we haven't seen a lot of regulation focusing on reducing emissions from ships.

Chad Bown: Why was it a problem that regulation had focused mainly on land-based emissions and not on ships? Is international trade an important source of emissions of particulate matter?

Michelle Marcus: International trade is really important. In terms of volume, over 80% of international trade goes on cargo ships. And these cargo ships historically have used fuel that leads to a lot of particulate matter being released.

They tend to have really high concentrations of sulfur content in ship fuel – much higher than what was allowed in cars. Sulfur content in ship fuel was around 3,500 times higher than what was allowed in cars.

Maritime shipping emits as much particulate matter as about half of global road traffic. It's quite a lot and quite harmful to health if you happen to live near a place that cargo ships tend to go.

Chad Bown: In the United States, where do the cargo ships tend to go?

Michelle Marcus: There are a number of really large ports in the United States – e.g., Los Angeles, San Francisco, Boston, Baltimore, New Orleans. All of these big cities have large ports which have a lot of cargo ship traffic. But even commuting between these cities ships are releasing emissions along heavily trafficked routes that go along coastal communities.

Historically, not only in the United States, but international standards for ship exhaust have been very weak as compared to other sources of transportation.

Chad Bown: Michelle's research here is super important. Half of the American population lives in either these cities or along US coasts and within 200 kilometers of heavy ship traffic. Trade has increased a lot over the last 50 years, with more and more of it coming in from Europe or

Asia by container ship. Pollution coming from those ships was impacting the health of a lot of Americans.

When and how did US policy makers begin to recognize the problem?

Michelle Marcus: The first time that this problem was addressed on a national scale was in 2012 when the US Environmental Protection Agency introduced its first large regulation on maritime emissions by establishing the North American Emission Control Area, or ECA.

The ECA extends about 200 nautical miles from both the US and Canadian coastlines. And the regulation essentially required that all commercial ships – i.e., container ships, cruise line ships, fishing trawlers – all of these ships had to operate within the North American ECA using low sulfur fuel or by installing abatement equipment, typically a scrubber.

The regulation focused on lowering sulfur content in fuel. Sulfur has a particularly terrible smell. If you've ever walked near a port, you might have smelled rotten eggs. This is related to the sulfur that's coming from ship fuel.

The idea for this policy was to get cargo ships to reduce their emissions and if they didn't do so, they could face expensive fines.

Chad Bown: How did the operators of these cargo ships respond when faced with this new regulation?

Michelle Marcus: Most cargo ships chose to use low-sulfur fuel. This was pretty easy for them because these ships typically have multiple fuel tanks on board already, and so they could use low-sulfur fuel in one tank and high-sulfur fuel in another tank. And then when they approach the regulated area, they could switch from using high-sulfur fuel to low-sulfur fuel in order to comply with the policy.

But it's important to remember that this newly required fuel was really expensive. And fuel makes up the largest part of cargo ships' operating costs. They did not like this and they complained a lot about this policy. They estimated it would cost the shipping industry somewhere around $3 billion per year.

Chad Bown: Let's turn now to your research on the impact of this 2012 regulation for maritime emissions. What specifically do you examine?

Michelle Marcus: We focus on two things. First, we want to see whether the policy reduced pollution.

And second, we want to see whether that reduction in pollution positively impacted human health. For human health, particulate matter can affect pretty much everyone's health – i.e., kids, adults, everyone. But some groups, like children and the elderly, tend to be more sensitive to air pollution. We look at a variety of health outcomes, including overall mortality. But most of our outcomes focus on the health of infants. And this is for a couple reasons.

First, particulate matter is really bad for pregnant women and infants. This is a stage where infants are developing their lungs, their brain and particulate matter can be very harmful to that process. And looking at infants is especially important because poor health at birth has been shown to affect later life outcomes. Poor health at birth leads to worse earnings, lower cognitive function, lower IQ, worse educational outcomes, and even an increase in welfare uptake.

Second, measuring the impact of pollution on adult health can be a little bit more difficult. Once you're an adult, you've been exposed to pollution throughout your lifetime. It can build up over time leading to cumulative effects in terms of bad health outcomes. And so for adults, it's often difficult to separate current exposure to pollution from previous exposure to pollution early in your life.

For those reasons, a lot of researchers focus specifically on infant health at birth when looking at pollution.

Chad Bown: How pollution affects the health of infants is critical. Particulate matter pollution can be especially damaging in utero and while babies are young, as their bodies are really just getting started.

Particulate matter is bad for older kids and adults too, it is just harder to estimate how bad, since the longer you live, the greater the cumulative buildup of lots of things that have polluted your body, that researchers would need to control for.

So it is quite common for economists to see if an environmental policy is effective by first examining how it impacts infant mortality and the birth weight of babies, even though this really is just a part of the story when it comes to overall human health.

Chad Bown: In 2012, the United States imposed this new uniform regulation that limits maritime emissions within 200 miles of its coastline. What did you find?

Michelle Marcus: It's good news and bad news. First, the good news. Emissions fall, and we see that air quality does in fact improve. Not only that, but infant health improves as well.

The regulations saved around 200 infant lives per year and resulted in about 1500 fewer low birth rate infants per year, which is quite substantial.

Chad Bown: Saving the lives of 200 babies and reducing low birth rate infants of 1500 more sounds amazing, and it seems like that should be enough.

But researchers and regulators are also often asked to do something called a cost-benefit analysis. And comparing the costs and benefits requires putting the benefits – i.e., a human life – into a common unit with the cost of the new policy, which is typically measured in terms of dollars spent.

Michelle Marcus: One way that economists and regulators try to do this is by using a concept called the value of a statistical life. This just gives us a way to quantify these benefits to health. When we use the EPA's value of a statistical life, we find that this regulation saved about $2 billion per year in terms of saved lives. And we can compare this to the cost of the policy which was about $3 billion.

Of course, this isn't a full accounting of the costs and benefits of the policy. If we wanted to fully account for the benefits, we would want to include benefits not only on infants, but also on kids, adolescents, adults, and the elderly. And these benefits would be quite a bit higher and so it would clearly exceed the cost of the policy.

Chad Bown: Again, in terms of the benefits, looking at the positive health effects on infants is just the tip of the iceberg. Below the surface are more, harder-to-measure benefits to the health and outcomes for kids, adults and the elderly. And if you added all those up, the

cumulative benefits would be a lot bigger than the $3 billion cost of cleaner, but more expensive fuel.

That's the good news. But you also said there was bad news. What's the bad news?

Michelle Marcus: The bad news was that this policy was only about half as effective as the regulators expected it would be. This was actually pretty puzzling to us.

One of the things that came to mind was the idea that when regulators were creating their predictions about how effective they expected the policy to be, they didn't really have the ability to capture any sort of behavioral response that might happen.

One of the things we examined is whether container ships changed their behavior in response to the regulation.

Chad Bown: Why? Why would container ships change their behavior in response to this regulation? What's the theory?

Michelle Marcus: The regulation required this cleaner fuel, but this clean fuel was really expensive. Estimates were ranging from about 30 to 50 percent higher costs than the high-sulfur fuel they had been using before. And because fuel accounts for about 75 percent of their operating costs, this mattered a lot to them.

When ships are optimizing their routes, they have a lot of choices to make about the route that they take, the port that they go to, how quickly they get there, and all of those can be choices that affect the realized cost on air pollution.

Chad Bown: Now, there is no allegation that container ship operators were cheating or breaking the rules.

But the idea is that the ship operators are changing their behavior in response to the regulation. This low-sulfur fuel was more expensive. This ship operators might change their routes to avoid having to use the more expensive fuel.

Michelle does not have the details on shipping routes. But she does have the details of the regulation itself. And those details make it more likely that ships would adjust their routes in

order to continue to use that low cost, high sulfur, high-polluting, fuel along three specific coastline areas of the United States.

Michelle Marcus: We take advantage of the fact that the emission control area covered 200 nautical miles from the coast of participating countries. In this way, the regulation applied within the exclusive economic zones of these participating countries. But because Mexico, the Bahamas, and Cuba did not participate, there were parts of Southern California, Texas, and Florida, where the ECA boundary did not extend the full 200 nautical miles, but was actually much closer to the coastline.

In these areas, ships could actually continue to use high-sulfur fuel much closer to the coast, and population centers. Ships could alter their routes into these ports to continue using the cheaper but highly polluting fuel.

Chad Bown: The United States and Canada are both part of this North American Emission Control Area. But other countries are not.

For the United States, think of a US map and its exclusive economic zone heading away from its coastline out into the ocean. Almost everywhere, this extends out 200 nautical miles.

But there are three weird places in the United States where it does not extend the full 200 miles, because other countries are right next door.

The first two places are Southern California and Texas, which butt up against Mexico. The third is Southern Florida, which is right next to the Bahamas and Cuba. Unlike Canada, Mexico, the Bahamas, and Cuba are not part of the North American ECA.

In those three geographic areas, because the American exclusive economic zone did not extend out the full 200 miles, the theory was that high-emitting ships could evade the regulation, continue to pollute much closer to the American coastline, and continue to hurt infant health.

When it comes to potential changes in shipping behavior impacting these three geographic areas due to this new policy, what did you find?

Michelle Marcus: The effect of the policy was weaker in these geographic areas where this responsive behavior was most likely to occur. This suggests that cargo ships may have been changing their behavior and their emissions in response to these incentives.

And in fact, if we look at areas that were fully exposed to the 200 nautical miles. The effect on pollution was actually about as large as the policymakers had expected.

And it was only in these areas very close to Mexico and the Bahamas, for example, where the pollution didn't decrease as much as regulators anticipated.

Chad Bown: Overall in the North American ECA, we have both good and bad news, but mostly good. The regulation on shipping emissions has reduced pollution and led to big positive gains for human health along most of the US coastline.

The main bad news is the regulation had only a limited impact on these three areas of California, Texas, and Florida. And that problem seems like it could be fixed once you convince Mexico, the Bahamas, and Cuba to implement the new regulations for their coastlines as well.

So let's talk about the rest of the world. During this period of the 2010s, is the rest of the world also implementing these sorts of regulations on maritime emissions?

Michelle Marcus: If you look at the 10 largest container ports there were no emission control zones in these areas. So places like Shanghai, Singapore, Hong Kong were not regulated. Most of the world had not yet adopted any emission standards for maritime fuel.

Chad Bown: What happened in 2020 and, in particular, for emissions regulations for the rest of the world?

Michelle Marcus: In 2020 the International Maritime Organization adopted a new global maritime emission standard that applies worldwide. And these standards set similar limits on the emission of maritime ships to what we saw in the North American ECA. Until this time, there had only been emission control areas in a few select parts of the world, including North America, the Baltic Sea, and the North Sea.

But, of course, these lower sulfur fuels are really costly. But on the good side, our estimates for the US suggest the health benefits are really quite large in terms of reducing pollution near high population centers and also in terms of protecting health.

Even though there's been a lot of pushback from industry with the adoption of these new 2020 standards, the benefits in terms of health improvements around the entire world are likely to be quite significant. We can learn a lot about what might happen globally from what we learned in North America.

Chad Bown: And if, as part of the global maritime emission standards, Mexico, the Bahamas and Cuba do now begin to apply this 2020 regulation as well, then that might alleviate the pollution problem continuing to face those regions of California, Texas, and Florida.

As my last question for you, I want to go back to your research on the human health outcomes in the United States and ask about environmental justice.

Historically, pollution in the United States has often been concentrated in geographic locations dominated by the poor, or by the non-white population, like Black individuals and Hispanic individuals.

Is that also the case for maritime emissions in the United States?

Michelle Marcus: This was something that we were actually very interested in. We started by looking at something similar to what had been looked at in the previous work, focusing on a land-based emission source that's related to maritime emissions, and the natural analog to that is ports.

If we look at who's living near ports, we see very similar patterns to what has been shown in the very broad environmental justice literature. We see that non-white individuals – i.e., Blacks and Hispanics – are more likely to live near port cities where ships dock and emit large amounts of particulate emissions as well.

But we wanted to acknowledge that ports aren't the only place where ships produce pollution. They also emit pollution as they travel along coastal communities in major shipping lanes. To capture the full impact of pollution exposure coming from maritime emissions, when we use this measure of exposure, we end up seeing a different demographic pattern in terms of who's

exposed. We found that the impact on Blacks were as about the same as the impact on White individuals, for example.

Chad Bown: Michelle, thank you very much.

Michelle Marcus: Thank you so much. This was really fun.

GOODBYE FOR NOW

Chad Bown: And that is all for *Trade Talks*.

A huge thanks to Michelle Marcus at Vanderbilt University. Do check out her brand-new paper with Jamie Hansen-Lewis from University of California Davis titled "Uncharted Waters: Effects of Maritime Emission Regulation." I will post a link to the paper on the episode page of the *Trade Talks* website.

Thanks to Melina Kolb, our supervising producer. Thanks to Sarah Tew, on digital. As always, thanks to Collin Warren, our audio guy. Do follow us on Twitter or Mastodon, we're on @Trade__Talks. That's not one but two underscores, @Trade__Talks.

<insert super funny double underscore joke here>. ■

Read more…

Hansen-Lewis, Jamie and Michelle M. Marcus. 2022. Uncharted Waters: Effects of Maritime Emission Regulation. NBER Working Paper No. 30181, October.