OVERVIEW

DETOX DEVELOPMENT

REPURPOSING ENVIRONMENTALLY HARMFUL SUBSIDIES

Richard Damania, Esteban Balseca, Charlotte de Fontaubert, Joshua Gill, Kichan Kim, Jun Rentschler, Jason Russ, and Esha Zaveri

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Contents

FIGURE

MAPS

TABLE

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Main Messages

Detox Development: Repurposing Environmentally Harmful Subsidies examines how subsidy reform can help safeguard the world's foundational natural assets—clean air, land, and oceans. These assets are critical for human health and nutrition and underpin much of the global economy. But subsidies for fossil fuels, agriculture, and fisheries are driving the degradation of these assets and harming people, the planet, and economies. These subsidies exceed US$7 trillion per year—or about 8 percent of global gross domestic product. This includes both explicit subsidies—which are direct public expenditures totaling about US$1.25 trillion—and implicit subsidies—which measure the societal impacts of externalities and amount to more than US$6 trillion.

The report has the following key findings:

Fossil fuel subsidies

- **Fossil fuel usage—incentivized by vast subsidies—is a key driver of the 7 million premature deaths each year due to air pollution.** About 94 percent of the world's population is exposed to unsafe particulate matter ($PM_{2.5}$) concentrations. The health burden of air pollution is particularly high in industrializing middle-income countries. Poor and marginalized groups are often exposed to higher levels of pollution and are less able to afford adequate health care.
- **Countries around the world actively paid about US$577 billion in 2021 to artificially lower the price of polluting fuels such as oil, gas, and coal.** By underpricing fossil fuels, governments not only incentivize overuse, but also perpetuate inefficient polluting technologies and entrench inequality. Of all subsidies to the energy sector, about three-quarters go to fossil fuels.
- **By increasing fossil fuel prices, subsidy reform can reduce the incentives to use polluting fuels—but the effectiveness of this instrument can be limited.** When polluting fuels are expensive, people reduce their consumption. On average, a 10 percent increase in the unit price of energy results in a short-run reduction of consumption of about 2 percent. This means the demand for energy is only sluggishly responsive to prices, especially when cleaner alternatives are unavailable or unaffordable.
- **Fossil fuel subsidy reforms are pro-poor.** In nearly all countries, richer households consume significantly more energy than poorer ones, and thus lose more when subsidies are removed. Even when looked at as a share of income, poor people are not necessarily hit harder by subsidy reform; it depends on the country context.
- **Subsidy reform could reduce air pollution and save up to 360,000 lives by 2035 in 25 high-pollution, high-subsidy countries. But it is more effective when accompanied by complementary policies.** For instance, ensuring the availability and affordability of clean technologies, addressing information and capacity constraints, and addressing behavioral biases are ways to increase the effectiveness of subsidy reform.

Agricultural subsidies

- **Richer countries spend more on agricultural subsidies than poorer countries, even when seen relative to total agricultural production.** The largest subsidizers are China, the European Union, Indonesia, Japan, and the United States. However, low- and middle-income countries spend a larger share of their subsidy budget on coupled subsidies, which are the most distorting and environmentally damaging. Subsidies in high-income countries tend to be uncoupled from production—such as those directed to agricultural research and infrastructure—and thus are less harmful.
- **Agricultural subsidies tend to benefit wealthier farmers—because wealthier farmers use more inputs and produce more outputs—and usually fail to improve productivity or efficiency.** In some countries, this is offset by channeling more subsidies to poorer regions, or by subsidies making up a larger share of poor households' incomes. The report also finds that higher levels of coupled subsidies lead to lower farm-level technical efficiency. Decoupled subsidies, however, which are not linked to production decisions, have no impact on the efficiency of production.
- **Subsidies incentivize excessive fertilizer usage to the extent that it suppresses agricultural productivity, degrades soils and waterways, and damages people's health.** More than half of global agricultural production now occurs in regions where fertilizer is suppressing rather than increasing productivity. This means there is significant room to reduce fertilizer use with positive impacts on crop production. Yet the opposite is achieved by subsidies, as excessive fertilizer application is not absorbed by crops and runs off into waterways. Inefficient subsidy usage is responsible for up to 17 percent of all nitrogen pollution in water in the past 30 years, which has large enough health impacts to reduce labor productivity by up to 3.5 percent.
- **Agricultural subsidies are responsible for the loss of 2.2 million hectares of forest per year, equivalent to 14 percent of global deforestation.** Agricultural subsidies in rich countries are driving significant tropical deforestation around the world. For instance, livestock subsidies in the United States drive deforestation in Brazil by increasing the demand for soybeans as feedstock. In turn, subsidy-driven deforestation causes the spread of vector-transmitted diseases—including 3.8 million additional cases of malaria each year, with an economic impact of up to US$19 billion per year.

Fishery subsidies

- **Subsidies are a key driver of excess fishing capacity, dwindling fish stocks, and lower fishing rents.** The negative impact of subsidies is even greater when fisheries are not managed sustainably and already severely depleted. Repurposing subsidies without incentivizing increased fishing capacity is of paramount importance to safeguarding remaining stocks.
- **Yet, if fisheries remain as open-access regimes, repurposing subsidies may have little impact.** Since much of the overfishing by subsidized fleets occurs in the open seas (a global public good) or in exclusive economic zones in low- and middle-income countries, subsidy reform needs to be coupled with reforms to access regimes.

- **Repurposing all fishery subsidies may cause major harm to small-scale, artisanal fishers.** But well-targeted reforms can lead to triple wins, where ecosystem sustainability improves, fishing fleets of all sizes increase their catches and revenues, and the fishery sector becomes distributionally more progressive.

Principles for repurposing harmful subsidies

Subsidy *reforms* are more than just subsidy *removal* and should consist of a package of measures that mitigate the downside risks of reform—including political opposition and adverse impacts on vulnerable groups—while maximizing their contribution to sustainable development.

- **Building public acceptance and credibility** is key, especially when political opposition threatens to derail reform efforts. Effective communication and transparency are needed to build credibility of assurances to address the adverse consequences of reform.
- **Complementary measures** are necessary when price-based instruments (such as subsidy reductions) are insufficient to solve environmental externalities. For instance, improving public transit can help replace fossil fuels, and laws can protect endangered natural capital.
- **Social protection and compensation** are an imperative in all contexts where subsidy removal may threaten the livelihoods of vulnerable groups and increase poverty.
- **Carefully sequenced reforms** can reduce the disruption from large price shocks due to the one-off removal of subsidies and enable households and firms to adjust gradually.
- **Sound strategies for reinvesting reform revenues** can ensure that subsidy reforms help to deliver on development priorities, such as infrastructure, health, and education—while lending credibility to the public good objectives of subsidy reform.

The world's sustainable development goals are directly undermined by the roughly US$1.25 trillion in explicit subsidies paid every year to fossil fuel, agriculture, and fishery sectors. This report documents the hidden consequences of subsidies. It shows that subsidy reform can remove distorted incentives that obstruct sustainability goals, but it also can unlock significant domestic financing to facilitate and accelerate sustainable development efforts that would have greater, wider, and more equitable benefits.

Detox Development: *Repurposing Environmentally Harmful Subsidies*

Overview

Introduction

This report examines the impacts of subsidies on the world's stock of foundational natural capital—clean air, land, and oceans. These natural assets are critical for human health and nutrition and underpin much of the economy. Poor air quality is responsible for approximately one in five deaths globally, and, as new analyses in this report show, a significant amount of these deaths can be attributed to fossil fuel subsidies. Agriculture is the largest user of land worldwide, feeding the world and employing 1 billion people, including 78 percent of the world's poor. But agriculture is subsidized in ways that promote inefficiency, inequity, and unsustainability. And oceans, which support the world's fisheries and supply about 3 billion people with almost 20 percent of their protein intake from animals, are in a collective state of crisis, with more than 34 percent of fisheries overfished. This crisis is exacerbated by open-access regimes and capacity-increasing subsidies.

For each of these critical sectors, this report attempts to answer the following questions:

1. What is the magnitude of total subsidies in the natural resource space?
2. What are the impacts of these subsidies on equity, efficiency, and the environment, and what are the gains from reforming or eliminating them entirely?
3. How can governments reform, repurpose, or eliminate subsidies in ways that are sustainable and politically feasible?

Although the literature on subsidies is large, embedded in each of these questions are significant knowledge gaps that this report addresses using new data and methods. The aim is to enhance understanding of the magnitude, consequences, and drivers of policy successes and failures in order to render reforms more achievable.

Global magnitude of subsidies

The magnitude of subsidies for fossil fuels, agriculture, and fisheries combined is vast and likely exceeds US$7 trillion per year in explicit and implicit subsidies—or approximately 8 percent of global gross domestic product (GDP). Explicit subsidies are direct fiscal expenditures from governments or taxpayers to producers or consumers. These explicit subsidies total approximately US$1.25 trillion—around the size of a large economy such as Mexico. Of these explicit subsidies, fossil fuel subsidies account for around US$577 billion per year. By comparison, under the Paris Agreement on Climate Change, governments committed to raise US$100 billion annually in climate financing—just a fifth of what they spend to prop up fossil fuels. Agricultural subsidies exceed an estimated US$635 billion per year,

approximately 0.9 percent of GDP and 18 percent of agricultural value added for the 84 countries with available data. More than 60 percent of this amount is in the form of coupled support, which distorts producers' decisions and leads to harmful environmental and economic impacts. And global fishery subsidies are estimated at about US$35 billion per year. Out of this amount, US$22 billion are identified as harmful subsidies that can lead to overcapacity and overfishing—often in international waters or the exclusive economic zones (EEZs) of low-income coastal countries.

While explicit subsidies are large, implicit subsidies, which measure the impacts of uncorrected externalities, are even larger and represent some of the most challenging environmental problems today. Implicit subsidies for fossil fuels amounted to an estimated US$5.4 trillion in 2020, or more than 6 percent of global GDP, with the impacts of local air pollution and global climate change constituting more than 75 percent of the total. For agriculture, implicit subsidies are harder to estimate. Total greenhouse gases from agriculture are approximately 6.8 gigatons of carbon dioxide equivalent per year, or about US$272 billion to US$544 billion worth of external damages that are not internalized by the producers or consumers of agricultural products. Some studies (for example, Pharo et al. 2019) estimate the environmental damages from agriculture to exceed US$3.1 trillion per year, split almost equally between damages from greenhouse gases and costs due to the destruction of natural capital like land and water degradation. For fisheries, the largest implicit subsidy is the lack of regulations to prevent overfishing. Estimates suggest that the lack of regulations results in lost economic benefits of US$83 billion per year, representing an implicit subsidy that is nearly 20 percent of the size of the total sector. These estimates are summarized in table O.1.

The report examines the distributional, efficiency, and environmental effects of these subsidies, starting with subsidies that affect air quality. In addition, it unearths new policy-relevant findings on important questions that have remained largely unanswered. For instance, new evidence is provided on the effects of changes in commodity prices on the loss of tropical forests, the responses of agricultural yields to fertilizer use across countries and regions, the distributional incidence of air pollution across countries, and some of the hidden consequences of coal power.

TABLE O.1 Estimates of annual explicit and implicit subsidies, by sector

Sector	Explicit subsidy estimates	Implicit subsidy estimates
Fossil fuels	• US$577 billion: estimate for 191 countries (Parry, Black, and Vernon 2021)	• US$5.4 trillion: impacts from local air pollution, greenhouse gas emissions, road congestion, and forgone tax revenues (Parry, Black, and Vernon 2021)
Agriculture	• US$635 billion: estimate for 84 countries (based on data from Gautam et al. 2022)	• US$548 billion to US$1.1 trillion from greenhouse gas emissions (chapter 1 of this report) • US$5.3 trillion (Pharo et al. 2019), which includes: – US$1.5 trillion from greenhouse gas emissions – US$1.7 trillion from natural capital loss – US$2.1 trillion from pollution, pesticides, and antimicrobial resistance
Fisheries	• US$35.4 billion: estimate for 152 countries (Sumaila, Ebrahim, et al. 2019; Sumaila, Skeritt, et al. 2019)	• US$83 billion: lost economic benefits from open access (World Bank 2017)
Total	• US$1.25 trillion	• US$6 trillion to US$10.8 trillion

Source: World Bank.

Part I: Air

The report begins by examining air pollution, which is one of the most far-reaching environmental crises facing the world. Air pollution is a toxic medley of many different pollutants from many different sources, including fine particulate matter ($PM_{2.5}$), nitrogen oxides, sulfur dioxide, and black carbon. Many of these pollutants are generated directly through the excessive combustion of cheap fossil fuels in a wide range of sectors, including transport systems, power generation, industrial processes, and residential heating. The entrenched overuse of polluting fossil fuels in these sectors is due, in part, to systematic underpricing of fossil fuels, which discourages the transition to less polluting technologies. Air pollution is exacerbated further through agricultural practices, cooking with solid fuels, but also dust storms and forest fires, all of which reduce air quality both outdoors and inside people's homes.

Air pollution is one of the leading causes of mortality, estimated by the Global Burden of Disease study at about 7 million premature deaths each year worldwide. The health burden of air pollution is particularly high in rapidly industrializing middle-income countries. In low-income countries, where air pollution levels are still relatively low, there is a window of opportunity to follow a cleaner, more efficient development trajectory. There is also growing evidence that exposure to, and impact from, air pollution is not distributed equally and that there are discriminating feedback effects. As health and productivity suffer, air pollution reinforces socioeconomic inequalities. Poor and marginalized groups are often exposed to higher levels of pollution and are less able to afford adequate health care. Overall, the implications of unsafe air pollution for health and productivity can affect development prospects and the growth out of poverty and inequality.

The report then turns to the underpricing and overuse of polluting fuels, which are a significant driver of the world's vast air pollution challenges. It presents evidence that the power, transport, residential, and industrial sectors are key sources of ambient air pollutants. Fossil fuels are a leading driver of air pollution, although their exact contribution differs across sectors, types of air pollutants, countries, and studies. Countries around the world actively paid around US$577 billion in 2021 to lower the price of these polluting fuels—in particular, oil, gas, and coal—artificially. By underpricing fossil fuels, governments not only incentivize their overuse, but also perpetuate the use of inefficient polluting technologies and entrench inequality. Of all subsidies to the energy sector, about three-quarters go to fossil fuels.

The scale of underpricing of fossil fuels goes far beyond explicit subsidies—at US$5.4 trillion in 2020, implicit fossil fuel subsidies are equivalent to more than 6 percent of global GDP. This measure is essentially an estimate of the negative externalities associated with fossil fuel consumption, including the social cost of carbon emissions, local air pollution, road congestion, and forgone tax revenues. At US$2.5 trillion a year in 2020, local air pollution is the single largest environmental cost of fossil fuels—far more than the size of explicit subsidies. Removing explicit fossil fuel subsidies alone cannot bring fuel prices to their socially optimal level: the appropriate policy mix is needed to tackle the implicit subsidy.

In this context, "getting the price right" implies reflecting the societal costs of air pollution in fossil fuel prices; it also calls for complementary measures. Prices are crucial in setting the incentives for reducing the consumption of polluting fuels. But their effectiveness in reducing air pollution depends on how responsive consumption choices are to prices and how responsive pollution levels are to consumption choices. When polluting fuels are expensive, people reduce their consumption, but only to a limited extent. On average, a 10 percent increase in the unit price of energy results in a short-run reduction of consumption of around 2 percent, although estimates vary across energy types, sectors, and countries. Thus, the demand for energy is inelastic—it is sluggishly responsive to prices, especially in

the short term, when cleaner alternatives are unavailable or unaffordable. This fact has implications for the design and reform of fuel subsidies.

Next, the report documents that the vast burden of air pollution affects almost all of humanity and is distributed unequally. It presents new evidence showing that globally 94 percent of the world population are exposed to concentrations of toxic $PM_{2.5}$ that are considered "unsafe" by the World Health Organization—that is, over 5 micrograms per cubic meter ($\mu g/m^3$). For 2.8 billion people, pollution levels are "hazardous," with $PM_{2.5}$ concentrations over 35 $\mu g/m^3$, which implies an all-cause mortality rate that is more than 24 percent higher than in safe areas. The vast majority of people facing such hazardous levels of air pollution live in middle-income countries, where polluting activities like manufacturing dominate the economy while productive capital (for example, technology) and regulations rarely prioritize environmental quality.

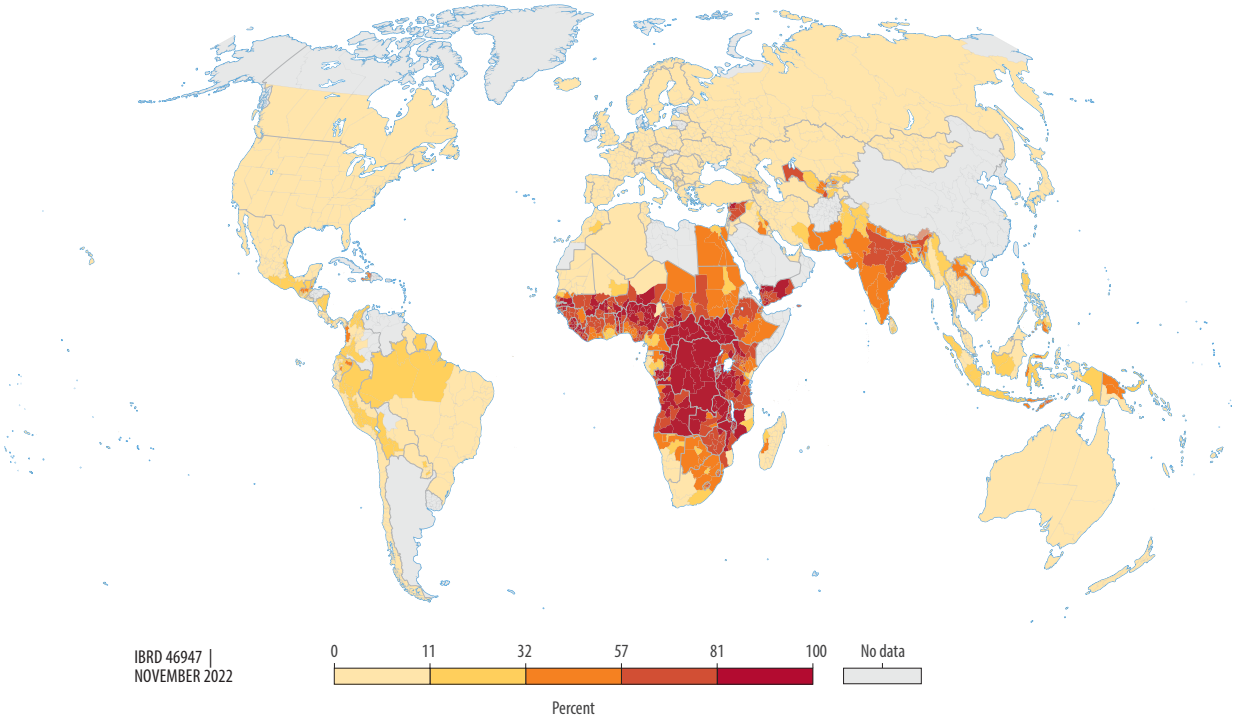
New evidence on toxic air pollution from the world's coal power plants illustrates the magnitude of unequal exposure. This report provides a new large-scale evaluation of pollution from coal-fired power plants that models pollution trajectories and analyzes income in the vicinity of more than 3,800 coal plants located in 71 countries. It shows that 2.32 billion people—almost a third of the world's population—are exposed to toxic sulfur dioxide (SO_2) emissions from coal-fired power plants. Expensive to build, coal power plants tend to be located in richer countries and in richer regions within countries. Globally, the burden of air pollution from coal plants falls on higher-income countries, but locally, this pattern reverses.

Although coal plants tend to be located in richer countries and regions, new evidence in this report shows that plants tend to be situated upwind of poorer areas and hence pollute poorer neighborhoods. Specifically, downwind areas have higher SO_2 concentrations and house poorer populations, as measured by GDP per capita, than upwind areas. This observation holds in countries rich and poor alike. The regressive environmental burden of air pollution reinforces the social marginalization and low-income status of affected communities.

More generally, the report presents new evidence, which finds that approximately 1 in 10 people exposed to unsafe levels of air pollution lives in extreme poverty. While it has long been conjectured that the burden of pollution falls disproportionately on the poor in low- and middle-income countries, evidence of this link has remained anecdotal, due to the paucity of data. This report fills this gap in the literature. It estimates the extent of exposure of the poor to unsafe and hazardous levels of air pollution, within and across countries (map O.1). For the extreme poor, the same level of air pollution likely implies more severe health risks than for higher-income households—for instance, due to inequitable access to affordable health care. This inequity risks creating pollution-induced poverty traps whereby poor people are more exposed to pollution, which impedes their productivity and ability to climb out of poverty. And when location influences poverty, the economic prospects of subsequent generations are even lower.

The report then turns to the potential distributional benefits of reforming fossil fuel subsidies. The analysis is based on the estimated benefits of subsidy reform in 35 high-pollution, high-subsidy countries. Results emphasize that fossil fuel subsidy reform tends to be pro-poor: in absolute terms, richer households consume significantly more energy than poorer ones and thus lose more when subsidies are removed. The richest income group loses—again, in absolute terms—on average, 13 times more from subsidy removal than the poorest. Yet results also show that, as a share of income, poor households are not necessarily hit harder by subsidy reform than high-income people: it depends on the country context. Results suggest that, relative to income, energy consumption is of similar size across income groups, and, in relative terms, the richest income group loses, on average, 10 percent more than the poorest.

MAP O.1 Regional distribution of air pollution and poverty: Share of population exposed to unsafe levels of $PM_{2.5}$ and living in poverty at US$3.20 a day



Source: Rentschler and Leonova 2022.
Note: $PM_{2.5}$ = fine particulate matter.

The analysis also highlights that explicit subsidy reform can reduce air pollution and save lives, but is more effective when accompanied by complementary policies. Removing fossil fuel subsidies could reduce concentrations of $PM_{2.5}$ by 2 percent to 40 percent, depending on the country considered. These air quality benefits are largest in countries with large subsidy programs for the most polluting fuels and where fossil fuel consumption is highly responsive to price changes. Reforming explicit fossil fuel subsidies in 25 high-pollution, high-subsidy countries could save about 360,000 air pollution deaths between 2022 and 2035. While this savings is significant, it is but a fraction of the 4.5 million annual deaths associated with outdoor air pollution around the world. These estimates highlight that fossil fuel subsidy reform does not automatically yield large environmental and health benefits, since outcomes depend on a host of factors such as demand elasticities, pollution intensities, and technology. In some cases, subsidy reforms can even lead to detrimental substitution effects if unaddressed.

Removing explicit fossil fuel subsidies is just the first step in a suite of complementary policy measures. In fact, explicit subsidies are dwarfed by the magnitude of the social costs of fossil fuels, so removing explicit subsidies alone will not fix climate change or air pollution. Addressing the problem means fully reflecting the health and societal costs of air pollution in the price of fossil fuels. In addition to prices, complementary policies are needed to curb air pollution and enable the transition to clean, efficient technologies—for instance, by ensuring the availability and affordability of clean alternatives, addressing information and capacity constraints, and addressing individual biases.

Part II: Land

Part II of the report turns to agriculture, the largest user of land, and begins with an overview of agricultural support and subsidies around the world. It describes the main policy objectives of agricultural support—to provide price stability and food security, support farmers' incomes and livelihoods, and improve environmental outcomes—and how subsidies may or may not help to achieve these goals. In addition, it provides an in-depth analysis of the composition of explicit agricultural subsidies around the world. It also presents new data on the magnitude of irrigation subsidies. A new survey finds that 38 of the largest developing-country irrigators spend nearly US$5 billion per year on building, operating, and maintaining irrigation infrastructure. This amount comes to approximately US$195 per year per hectare of farmland that is equipped for irrigation.

Richer countries spend more on agricultural subsidies than poorer countries, even when calculating spending as a share of total agricultural production value. The largest subsidizers are China, the European Union, Indonesia, Japan, and the United States. However, while richer countries tend to spend more money on subsidies, they employ different types of subsidies. Low- and middle-income countries spend a larger share of their subsidy budget on coupled subsidies, which are the most distorting and lead to inefficiencies and harmful environmental impacts. High-income countries are more likely to provide subsidies that are uncoupled from production decisions—like agricultural research and development and infrastructure—and thus have more benign impacts.

One of the most commonly stated objectives of subsidies is to improve efficiency, but this report finds that subsidies often have the opposite effect. To examine this issue, the report starts with a global overview, examining the cross-country impact of subsidies over time. It finds that higher levels of subsidies lead to lower farm-level technical efficiency. However, decoupled subsidies are found to have no impact on the efficiency of production, which follows from the fact that they do not distort production decisions. Market price support may also be less distortive than more direct fiscal subsidies, since it often does not (directly) alter the relative prices of inputs. In addition, the report presents results from two meta-analyses of the economics literature, which examine the efficiency impact of input subsidies and efficiency. The meta-analyses show that, while input subsidies may lead to higher output and yields overall, they often reduce the efficiency of production. Finally, the report conducts deeper dives into two countries—Malawi and Nigeria—to examine the impacts of recent subsidy reform efforts. In agreement with the prior two analyses, the results find that subsidies in these countries reduce farm-level efficiency. In Malawi, reforms that reduced the amount of fertilizer subsidy that farmers receive led to an increase in technical efficiency. In contrast, in Nigeria reforms that increased the amount of fertilizer subsidy led to a reduction in technical efficiency.

Even if subsidies impair efficiency, they may be warranted if they alleviate poverty and promote greater equity where it is needed. Accordingly, the report presents two new analyses examining the distributional consequences of subsidies. The first investigates the spatial distribution of output subsidies across 16 countries. A novel approach is taken that combines data sets on the spatial distribution of crop production and crop-specific subsidy information to examine where, within countries, agricultural subsidies are accruing most often. A data set on spatially disaggregated GDP is then overlaid to determine whether those regions are richer or poorer, on average. The analysis finds that explicit subsidies tend to accrue to poorer regions at higher rates per unit of agricultural production. Thus, while most subsidies based on production

(that is, input and output subsidies) accrue in larger shares to wealthier farmers because they use more inputs and produce more outputs, there is evidence that, in some countries, this result is offset by channeling more subsidies to poorer regions.

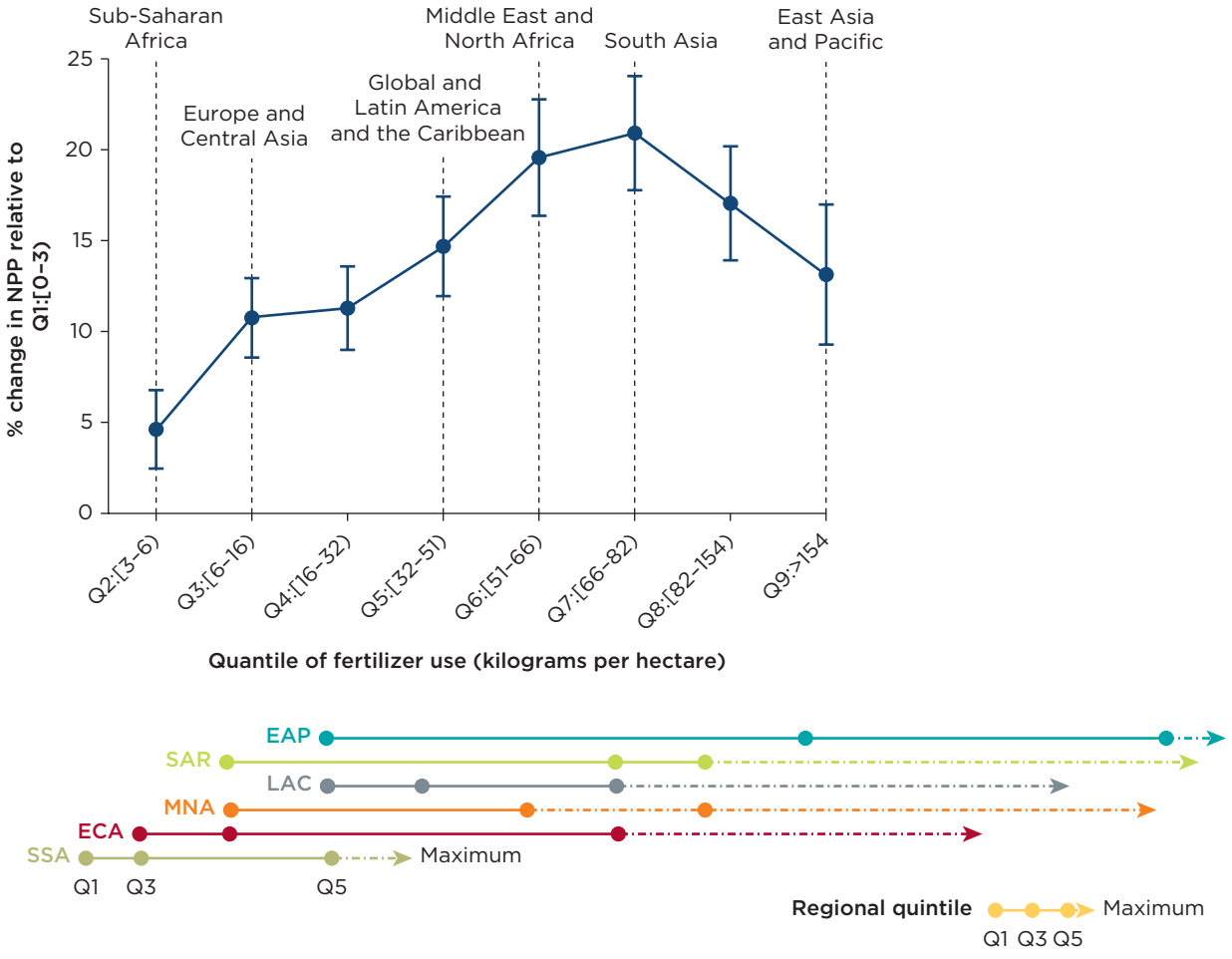
The spatial analysis is complemented with microdata to drill down into country-specific cases of the distributional impacts of input subsidies on income. These case studies show that poorer households typically have lower participation rates and receive a lower share of the total subsidy. Indeed, in Malawi and Tanzania, for every US$1 of input subsidy given to support a household in the bottom 20 percent of the country's income distribution, at least US$5 is spent supporting a household in the top 20 percent of the country's income distribution, even though these programs were designed specifically to target poorer households. Nevertheless, given that subsidies make up a significant portion of the household income of lower-quartile households, eliminating these subsidies without compensation would be very harmful. While the overall results of the distributional analysis are mixed and depend on country- and program-specific factors, subsidies clearly are typically not the best instruments available to policy makers to address rural poverty and development.

When subsidies distort farmers' decisions, they lead to spillover impacts on the environment; hence the report explores the main environmental externalities in detail, starting with novel research and results on the impact of agricultural subsidies on global water quality. By distorting the amount of inputs that farmers employ, subsidies lead to increased and unbalanced fertilizer application, much of which is not absorbed by crops and runs off into waterways. A global analysis uses gridded data on agricultural inputs and crop yields to explore the relationship between fertilizer use and agricultural production. It finds that, in many areas—particularly in the East Asia and Pacific and South Asia regions, but also in parts of other regions as well—the marginal benefits of applying additional nitrogen fertilizer is actually negative (figure O.1). This finding reflects the excessive use of subsidized nitrogen. In general, crops absorb only a very small portion of the nitrogen applied to the soil, with the remainder aggravating soil chemistry and running off into waterways. Indeed, more than half of global agricultural production occurs in regions where the marginal effectiveness of applying additional fertilizer is negative, implying that there is significant room to reduce fertilizer use and have benign or even positive impacts on crop production (figure O.1).

Globally, the inefficient use of input subsidies is responsible for up to 17 percent of all nitrogen pollution in water in the past 30 years. Input subsidies lead to the overapplication of fertilizer in many areas. When fertilizer is overapplied, little ends up being absorbed by the plant, with the rest running off into nearby waterways, causing nitrogen pollution. Nitrogen pollution in water can have significant health impacts, and in most parts of the world treatment plants do not remove it from drinking water. The buildup of nitrogen can lead to hypoxic zones, where algal blooms suck oxygen out of waterways, killing off other forms of plant and animal life. These spillover effects on water also have implications for human health. Although it is known that nitrogen in water is responsible for fatally inflicting what is known as blue baby syndrome, which starves infants' bodies of oxygen, studies have also shown that children who survive endure longer-term damage throughout their lives. Exposure to nitrogen pollution in early life can result in stunted growth and impaired development of infants, which could lead to poor productivity of future generations. In areas of the world where input subsidies are particularly large, new research finds that subsidy-induced increases in water pollution have large enough health impacts to reduce labor productivity by between 2.7 percent and 3.5 percent.

Coupled producer support subsidies are also implicated in drawing down global groundwater supplies. By incentivizing inefficient levels of production, subsidies cause farmers to

FIGURE O.1 Change in global agricultural productivity due to the use of nitrogen fertilizer, by region and quantile of use



Source: World Bank.
Note: The figure shows point estimates and 95% confidence intervals of coefficients obtained for different quantiles of nitrogen fertilizer use from the second to the ninth quantile relative to the omitted first quantile. Vertical lines indicate where the median values of nitrogen fertilizer use lie for the global sample, and the different regions. The colored horizontal lines and dots below the graph indicate the bottom, middle, and top region-specific quintiles based on the regional distribution of fertilizer use. NPP = net primary productivity; EAP = East Asia and Pacific; ECA = Europe and Central Asia; LAC = Latin America and the Caribbean; MNA = Middle East and North Africa; SAR = South Asia; SSA = Sub-Saharan Africa.

extract ever-increasing levels of groundwater, often with little or no marginal cost to the farmer. While groundwater levels are notoriously difficult to measure, new evidence from the Gravity Recovery and Climate Experiment (GRACE) satellite allows for the visualization of the drawdown of this precious resource. New evidence finds that, at the mean level of subsidy exposure, agricultural areas around the world risk losing up to an additional 13.2 cubic kilometers of water per year due to subsidies, roughly equivalent to the total amount of water lost in California between 2011 and 2014 at the height of the drought.

Environmental spillovers from agricultural subsidies have further impacts and are also major drivers of global land use. Subsidies distort the incentives of farmers, causing them to shift their production toward subsidized agricultural products and to expand

their croplands so that they capture more of the subsidy. To explore this impact in more detail, the report presents a new analysis estimating the causal relationship between changes in commodity prices and deforestation. Since commodity prices determine the planting decisions of farmers, it follows that when prices for certain products are high, farmers will expand their cropland in order to produce more of that product. Indeed, the analysis finds that deforestation in most regions is highly sensitive to the prices of major forest-frontier commodities such as beef, sugarcane, wood, and soybeans. These risks are greatly underestimated in global trade and environmental discourse. As map O.2 shows, much of the forest in the Amazon is perilously close—less than 5 kilometers—to the agricultural frontier, suggesting the need to pay greater attention to the problem and the likely global consequences of tropical forest loss at scale.

The analysis finds that agricultural subsidies are responsible for the loss of 2.2 million hectares of forest per year or approximately 14 percent of annual deforestation. Deforestation leads to the release of 4.3 billion metric tons of carbon over a 20-year period. Using the World Bank's shadow price of carbon, the cost of deforestation only in terms of the carbon that is released is valued at between US$174 million to US$348 billion, but the loss of ecosystem services and biodiversity is surely much higher. In fact, agricultural subsidies in rich countries are driving significant tropical deforestation around the world. For instance, the report shows that livestock subsidies in the United States drive deforestation in Brazil by increasing the demand for soybeans as feedstock—a relationship that is likely not isolated to these two countries.

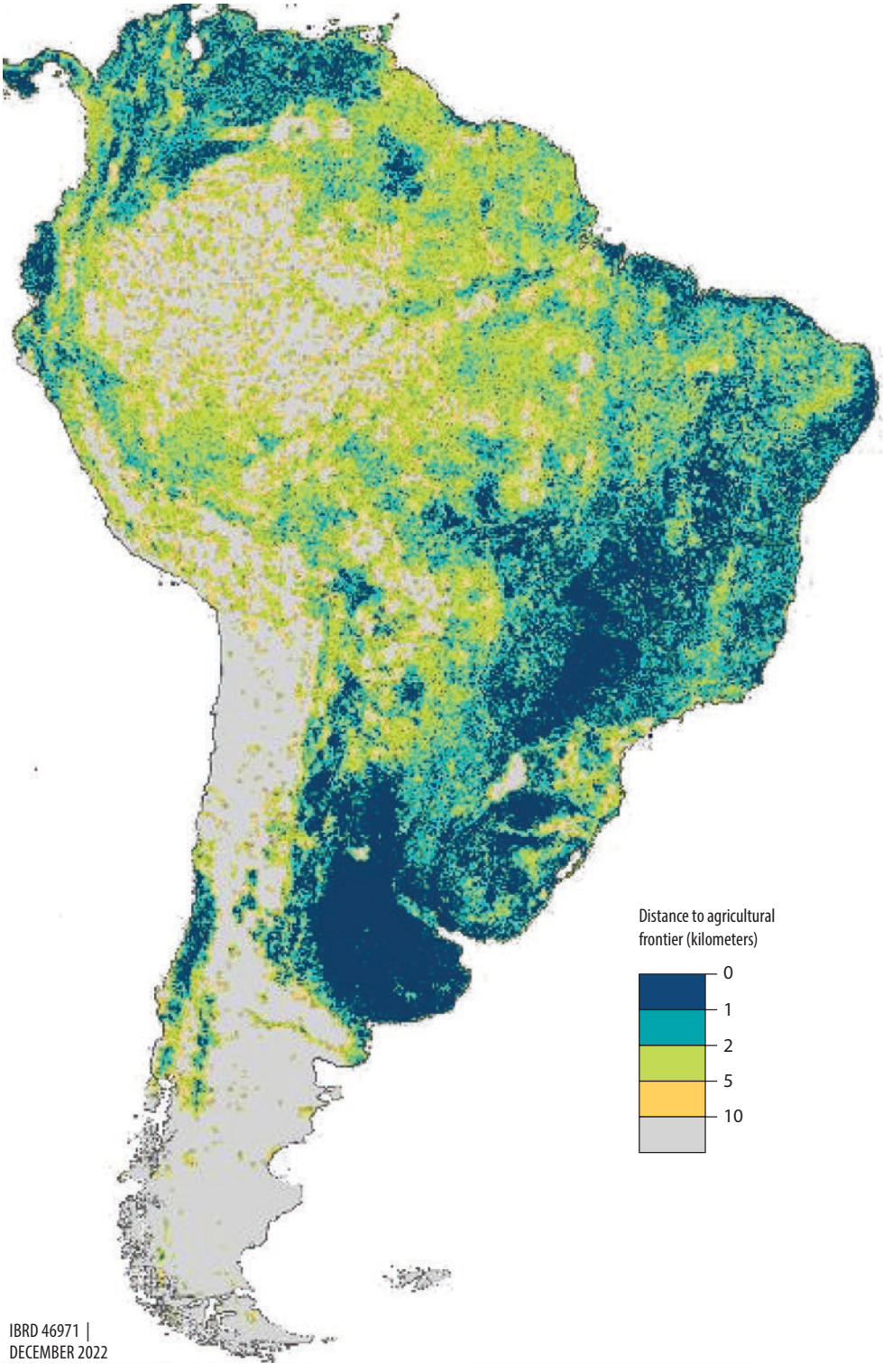
In addition to the environmental effect, impacts cascade into public health challenges. Deforestation increases the spread of communicable viruses or vector-transmitted diseases like malaria. The report presents the first global study using disaggregated data on the link between malaria transmission and deforestation. While all countries where malaria is endemic are at risk of increased malaria transmission due to deforestation, regions with dense tropical forests like the Amazon are particularly at risk (map O.3). Globally, deforestation from subsidies causes an estimated 1.3 million to 3.8 million cases of malaria each year, with an economic impact of between US$3 billion to US$19 billion per year. The results emphasize the interconnectedness between natural capital and human capital and the unexpected consequences of well-intentioned subsidies.

The effects of subsidies on agricultural productivity, forest depletion, and the spread of diseases fall disproportionately on women, indigenous communities, and the poorest members of society. Many indigenous communities have less access to landownership and a higher dependence on local agriculture and forestry. They are the most severely affected by greater deforestation. The results of this report are a constant reminder of the social implications of subsidies in terms of gender relations and marginalized groups.

Part III: Oceans

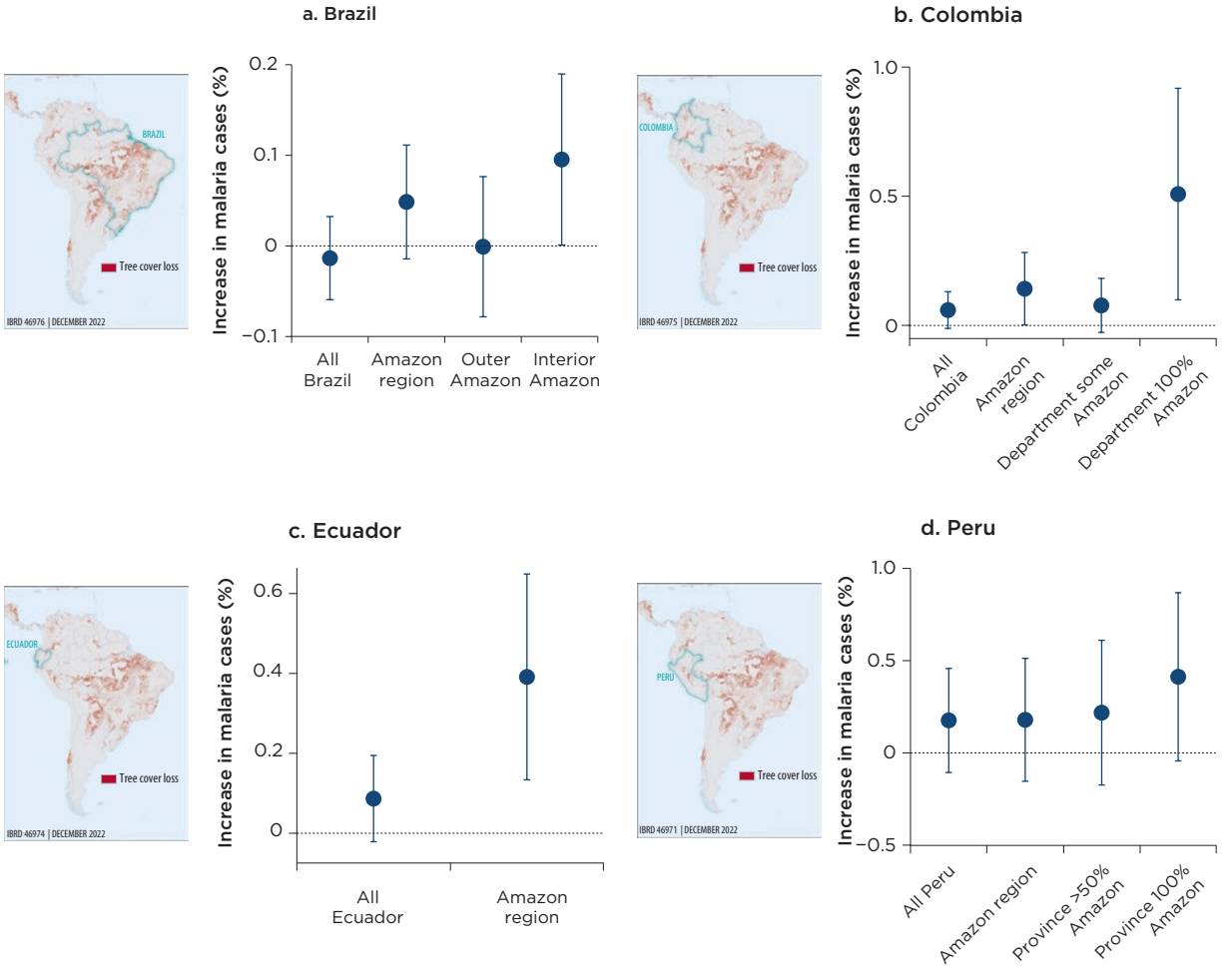
The report also explores the impacts of subsidies on fisheries, which provide much of the animal protein that feeds the world. Even though marine fish stocks are renewable, they are under serious threat. The many stressors include overfishing due to ineffective management and the perverse effects of government policies, such as the provision of harmful subsidies, effects of climate change, marine pollution like plastics and oil spills, acidification, and hypoxic zones generated by fertilizer and wastewater runoff, to name the most important.

MAP O.2 Distance to the agricultural frontier in South America



Source: Druckenmiller 2022.
Note: Forest cover loss is measured by distance to the agricultural frontier, which is classified by 30-meter pixels. Data on the extent of current crop production were obtained from the United States Geological Survey's Global Croplands database (https://www.usgs.gov/apps/croplands/app/map?lat=0&lng=0&zoom=2).

MAP O.3 Impact of deforestation on malaria transmission in select countries



Source: World Bank.
Note: Point estimates for the coefficients of tree cover loss from estimating equation B9.3.1 in box 9.3 are shown with 95% confidence intervals. The point estimates can be interpreted as the percentage increase in malaria due to a 1% increase in tree cover loss. The different windows within each panel indicate a different level of forest cover, going from regressions sampling the entire country (left) to regressions only on densely forested areas (right).

The report focuses on the effects of harmful subsidies on fisheries in three marine ecosystems—the Mauritanian EEZ, the northern South China Sea, and the East China Sea. These ecosystems were chosen for their contribution to food security, their size, and their diversity. While past research has examined the overexploitation that occurs due to the open-access nature of fisheries, this study is the first to examine the impacts of subsidies in a multiregional setting. The analysis finds that repurposing subsidies in ways that do not incentivize increased fishing capacity is critical to reducing overall fishing effort, increasing biomass, and ultimately increasing the rents captured by fishers. However, repurposing subsidies is not a panacea. If fisheries remain as open-access regimes, where any fleet is free to extract as much fish as it can carry, repurposing subsidies may have little impact. Indeed, the two policy changes of repurposing subsidies and closing open access must be targeted jointly in order to have a meaningful and positive effect. Further, repurposing all fishery subsidies is likely to cause major harm to

small-scale, artisanal fishers. Thus, targeted reforms are needed and can lead to triple wins, where ecosystem health and sustainability improve, fishing fleets of all sizes increase their catches and revenues, and the fishery sector becomes distributionally more progressive.

Capacity-enhancing subsidies are highly distorting, damaging, and in need of being repurposed, but the political obstacles are enormous since much of the overfishing by subsidized fleets occurs in the open seas (a global public good) or in EEZs of low- and middle-income countries, such as the Mauritanian fishery. As a result, the environmental costs of overfishing are imposed on the rest of the world and on future generations, while the benefits accrue to the country that subsidizes the fleet. Worse still, there is no incentive for countries to repurpose such subsidies, as they would lose their share of the catch to other subsidized fleets—the classic prisoner's dilemma. A lump-sum subsidy or one that is decoupled from production and capacity decisions would, of course, be much less harmful economically and environmentally.

Part IV: From evidence to action

The report closes by offering a pragmatic guide to the principles of designing effective reforms and avoiding common pitfalls of implementation. Repurposing environmentally harmful subsidies can have wide-ranging development benefits; if mismanaged, subsidy reforms can have counterproductive economic, social, and political consequences.

In order to devise effective subsidy reforms, policy makers need to assess potential risks that could derail reform efforts. First, simply removing subsidies may not be enough to cause the behavioral or technological shifts needed to fix negative externalities. People may face significant barriers, such as information, capacity, financial, or technical constraints, systemic risks, and uncertainty. Ignoring such barriers could result in unnecessarily high transition costs and missed opportunities. In addition, subsidy programs are often intricately linked to political interests and influence. Powerful interest groups can have outsized influence over policy processes, capture the message that is conveyed to the public, and mobilize formidable public opposition. Sometimes, second-best compromises are unavoidable and necessary to deliver the public benefits of subsidy reform.

To unlock the development dividend of subsidy reforms, policy makers need to anticipate and mitigate the possibility of significant resistance and transition costs, particularly in the short term, while the economic system adjusts. In short, subsidy *reforms* are more than just subsidy *removal*. Instead, subsidy reforms should consist of a package of measures that mitigate the downside risks of reform, while maximizing their contribution to sustainable development:

- *Building public acceptance and overcoming credibility gaps* is a prerequisite for reform, especially when political opposition threatens to derail reform efforts. Effective communication and transparency are key to addressing the trust deficits that may detract from the credibility of assurances to address the adverse consequences of reform.
- *Targeted complementary measures* may be necessary when price-based instruments (such as subsidy reform) alone are insufficient to solve environmental externalities. Improving public transit can facilitate switching away from fossil fuels; laws and regulations can protect critically endangered natural capital; and capacity-building programs can enhance the efficiency of subsidy reforms.

- *Social protection and compensation* are an imperative, especially in the short run, in all contexts where subsidy removal may threaten the livelihoods of vulnerable groups and increase poverty.
- *Carefully phased and sequenced reforms* can reduce the disruption from large price shocks due to the one-off removal of subsidies and enable households and firms to adjust gradually.
- *Sound strategies for reinvesting reform revenues* can ensure that subsidy reforms help to deliver on development priorities, such as infrastructure, health, and education. Even if reinvestment strategies are adjusted later on, formulating them early can lend credibility to the public good objectives of subsidy reform.

Reforming environmentally harmful subsidies is necessary—albeit not sufficient per se—for achieving the United Nations Sustainable Development Goals. As outlined throughout this report, "getting prices right" is widely regarded as being at the heart of an effective market-based solution to addressing pervasive environmental externalities. At its essence, this approach requires that the social and environmental costs of environmentally harmful activities are reflected in their prices. However, the roughly US$1.25 trillion in explicit subsidies paid every year to the world's fossil fuel, agriculture, and fishery sectors have the polar opposite effect. They incentivize the overconsumption of polluting inputs and the degradation and exploitation of valuable natural capital; they undermine the effectiveness of efforts to achieve sustainable development. This report unearths and provides estimates of many of the hidden consequences of subsidies. Not only does subsidy reform remove distorted incentives that undermine countries' ability to make progress toward these goals, but it also can unlock significant domestic financing to facilitate and accelerate sustainable development efforts that would have greater, wider, and more equitable benefits.

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Clean air, land, and oceans are critical for human health and nutrition and underpin much of the world's economy. Yet they suffer from degradation, poor management, and overuse due to government subsidies.

Detox Development: Repurposing Environmentally Harmful Subsidies examines the impact of subsidies on these foundational natural assets. Explicit and implicit subsidies—estimated to exceed US$7 trillion per year—not only promote inefficiencies but also cause much environmental harm. Poor air quality is responsible for approximately 1 in 5 deaths globally. And as the new analyses in this report show, a significant number of these deaths can be attributed to fossil fuel subsidies. Agriculture is the largest user of land worldwide, feeding the world and employing 1 billion people, including 78 percent of the world's poor. But it is subsidized in ways that promote inefficiency, inequity, and unsustainability. Subsidies are shown to drive the deterioration of water quality and increase water scarcity by incentivizing overextraction. In addition, they are responsible for 14 percent of annual deforestation, incentivizing the production of crops that are cultivated near forests. These subsidies are also implicated in the spread of zoonotic and vector-borne diseases, especially malaria. Finally, oceans support the world's fisheries and supply about 3 billion people with almost 20 percent of their protein intake from animals. Yet they are in a collective state of crisis, with more than 34 percent of fisheries overfished, exacerbated by open-access regimes and capacity-increasing subsidies.

Although the literature on subsidies is large, this report fills significant knowledge gaps using new data and methods. In doing so, it enhances understanding of the scale and impact of subsidies and offers solutions to reform or repurpose them in efficient and equitable ways. The aim is to enhance understanding of the magnitude, consequences, and drivers of policy successes and failures in order to render reforms more achievable.

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