Environmental Economics in the Policy Arena: Past, Present, Future

Richard D. Morgenstern

Calidad del Aire, Cambio Climático y Salud en Bogota

Bogota, Colombia

July 25, 2018

Topics

- Basic history of economics in environmental decisions
- Background on Colombia/Bogota
- IMF analysis of corrective taxes in Colombia, selective other countries
- New developments in Medellin/Aburra Valley
- New developments in benefit cost analysis
  - Retrospective Analysis of Regulation
  - Big data: Satellites reveal striking new information on pollution
  - Trump Administration initiatives

Transportation policy: 30,000 foot view

- Long history of regulation, government subsidies around the world
  - Emphasis on regulation of fuel economy for autos, trucks
  - Wide use of subsidies for roads, mass transit
  - Limited fuel taxes, other economic instruments (Europe is main exception)
- Economics is starting to drive new policies
  - Private finance and toll roads increasingly important in many countries
  - Budget pressures limiting transit subsidies
  - Interest in carbon taxes or equivalent policies growing world wide
  - Local areas taking the lead on new initiatives: congestion charges (London, Singapore); scrappage incentives (many cities); new fuel taxes (Medellin)

Beyond transportation, economics has growing role in environmental decisionmaking

- In the beginning…
  - 1970s limited data/analysis available
  - Early resistance from environmental community to use of economics
  - Much has changed, today we focus on three issues:
- Major gains over last 30 years years
  - Extensive development of environmental economic data/analysis
  - US, EU, many developing nations, World Bank, others embrace economic analysis of the environment
- Recent developments: two examples
  - Retrospective analysis
  - Satellite data
- Challenges in Trump era
  - Concerns about overregulation
  - Claims that benefits overstated; costs understated
  - Revision to social cost of carbon; questions about ancillary benefits, other issues

Background 1: Colombia

- Polluter Pays Principle included in 1974 Code on Renewable Natural Resources and Environmental Protection
- *Tasas Retributivas* currently used for water discharges
- Responsibilities split between national and regional authorities
- 2016: Colombia pledged to reduce 2030 GHG emissions 20% below BAU and “explore the use of market instruments…that guarantee the principles of transparency and environmental integrity, which result in real, permanent, additional, verified mitigation outcomes and prevent double counting.”
- Initial carbon tax implemented 2017

Background 2: Bogota--many developments

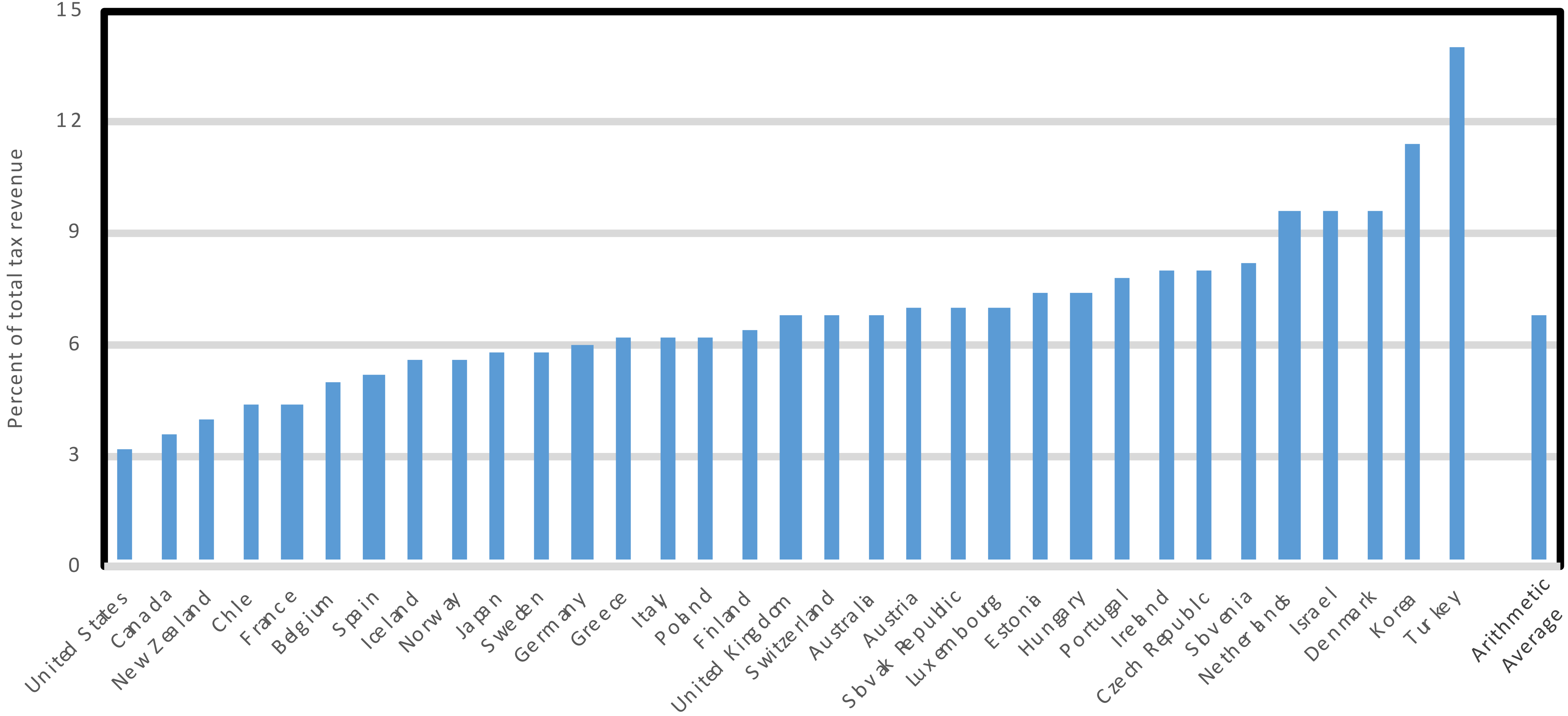
- Good News
  - Transmilenio
  - Pico y placa
  - No car day
  - Tighter standards for fuels (SO_2) and buses
  - Bike lanes
  - New air quality modeling
- Bad News
  - High $PM_{2.5}$ levels: 3-8 x WHO standard
  - Rising vehicle registration/usage: trucks, buses, autos
  - SO_2 content of fuels
  - Diesel emissions from multiple sources
  - ‘Transmileno’

Growing Interest in Environmental or 'Corrective Taxes'

Based on widely accepted economic principles*: taxes on fossil fuels should be set at a level such that energy prices reflect their associated environmental side effects…local air pollution damages, congestion costs, and related damages generally large enough to warrant higher fuel taxes, even leaving climate concerns aside.*

Source: IMF

OECD Revenues from Environmentally-related Taxation, 2008



Source: OECD (2010)

Goals of environmental taxation

- Cost effective tools needed to improve local air quality and achieve CO_2 reductions (per Paris Climate Agreement)
- Correct for negative externalities
  - Dismantle subsidies
    - Pretax subsidies exist when price is below cost of supply
    - Tax subsidies can exist if taxes fail to fully correct for externalities
  - Develop appropriate corrective taxes based on local air pollution/carbon damages; for vehicles also factor in congestion and accident externalities
- Raise revenues to finance public expenditures, including general government needs, compensation to low income groups, support of environmentally-related activities. Broader tax reform may also be possible.

Case of multiple externalities: auto fuel taxes

- Four issues: local pollution, CO_2, traffic congestion, traffic accidents
- Fuel taxes help on all issues but not equally so. Over time, as fuel economy improves manufactures can cut back on abatement technologies and still meet initial emissions/mile standards
- Other instruments attractive supplements to control VMT and, especially, congestion and accidents, e.g., electronic tolls that vary with congestion

Principles of Environmental Taxation

- Environmental taxes often preferred to traditional regulatory instruments
  - Can exploit *broadest* set of emission reduction opportunities
  - Uniform price equates marginal abatement costs across firms, households and sectors, thereby promoting economic efficiency, growth
- Taxes should equal marginal damages and be levied directly on emissions source
- Productive use of revenues important piece of puzzle
- Empirical research needed on the size of local externalities/damages
- Cap and trade similar to taxes if two conditions apply
  - Includes price stability provisions, e.g., a ‘safety valve’ or ‘price collar’
  - Allowances are auctioned and revenues used productively
  - Coverage is similar, e.g., upstream vs downstream design

Local pollution damages/benefits can be measured

- Comprehensive measures, typically involve three steps
  - Link emissions reductions to air quality improvements
  - Estimate human health effects based on dose-response relationships (mortality and morbidity), other relevant physical effects, e.g., crop damage
  - Monetize health (and other physical) effects (most controversial step)
- Of course, uncertainties abound. For example…
  - Modeling secondary pollution formation via atmospheric chemistry is difficult
  - Valuation of ‘statistical lives’ is particularly challenging: estimates vary widely
  - Quantification/monetization of morbidity effects improving but still limited

WORLD BANK GROUP

Methodology for Valuing the Health Impacts of Air Pollution

Discussion of Challenges and Proposed Solutions

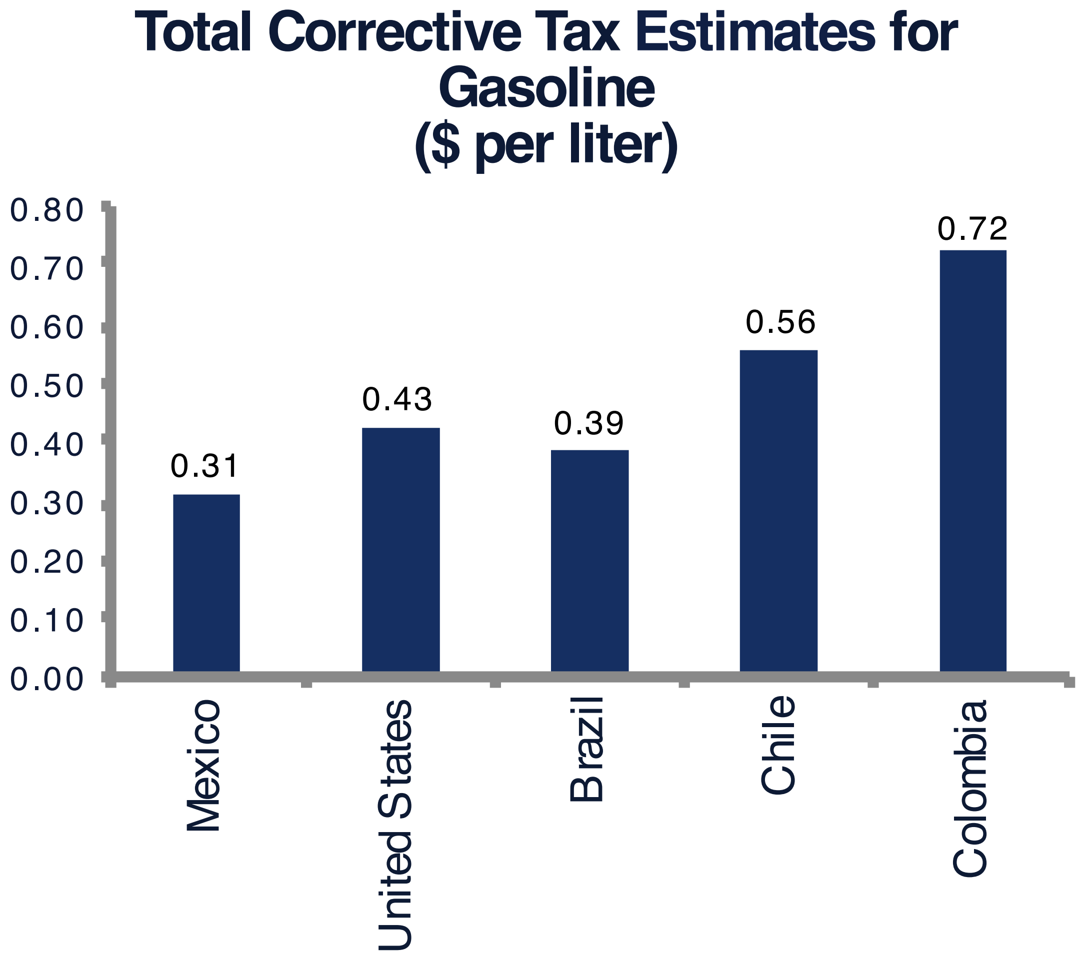
Urvashi Narain and Chris Sall

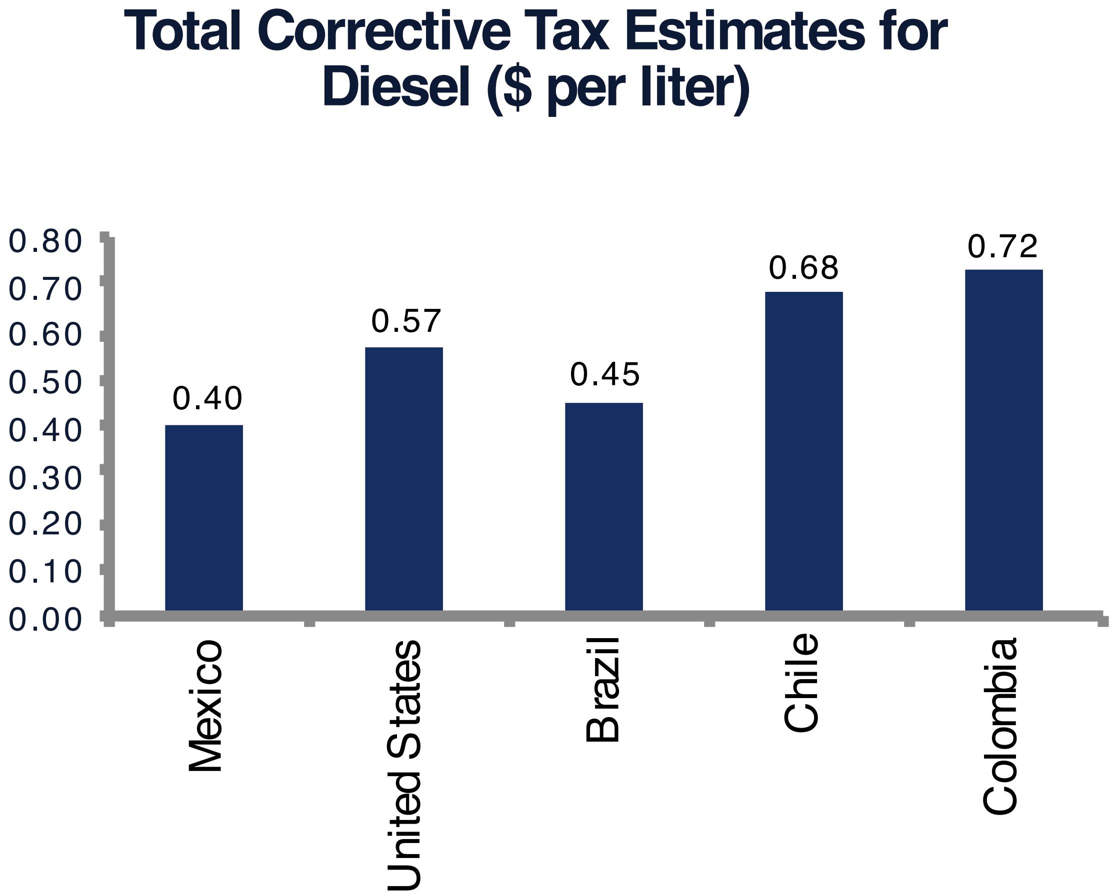
Environment and Natural Resources Global Practice

Values of Statistical Life Estimates

• U.S.	$1.3-12.7 million USD
• U.K.	2.0 - 2.3
• Canada	3.0 - 8.0
• Australia	2.6
• Mexico	0.9
• Colombia	0.9 -1.0
• Peru	1.5
• Malaysia	1.0

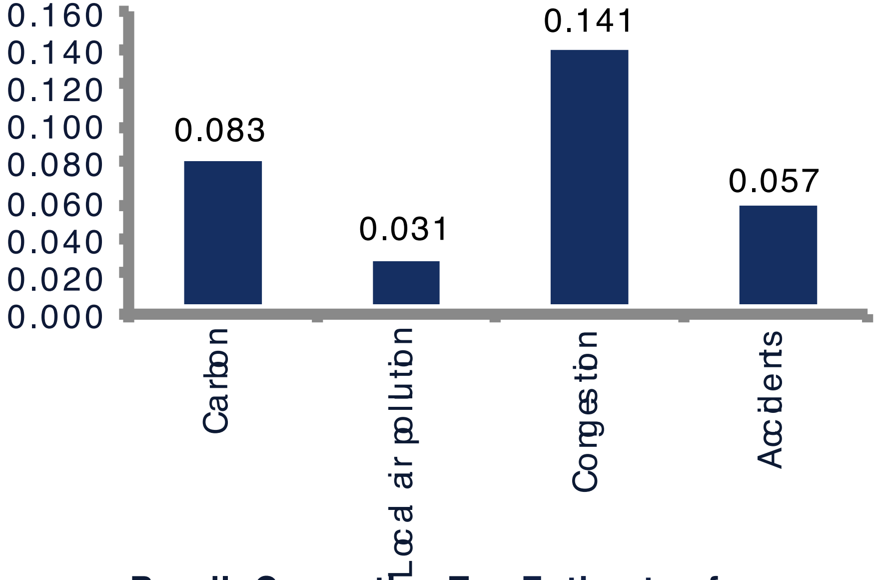
Source: World Bank, 2016



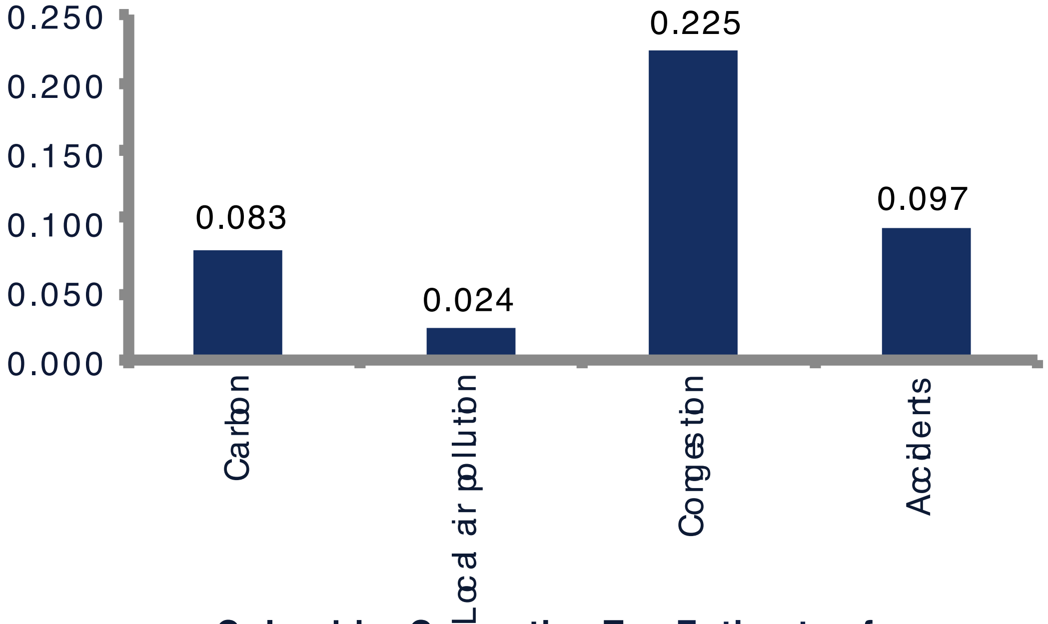


Source: Fiscal Affairs Department of the International Monetary Fund

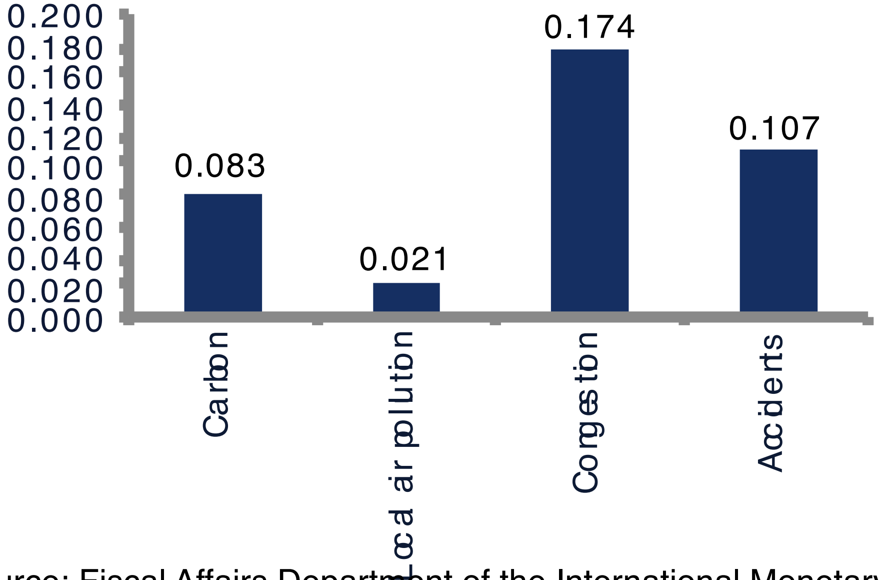
Mexico: Corrective Tax Estimates for Gasoline ($ per liter)



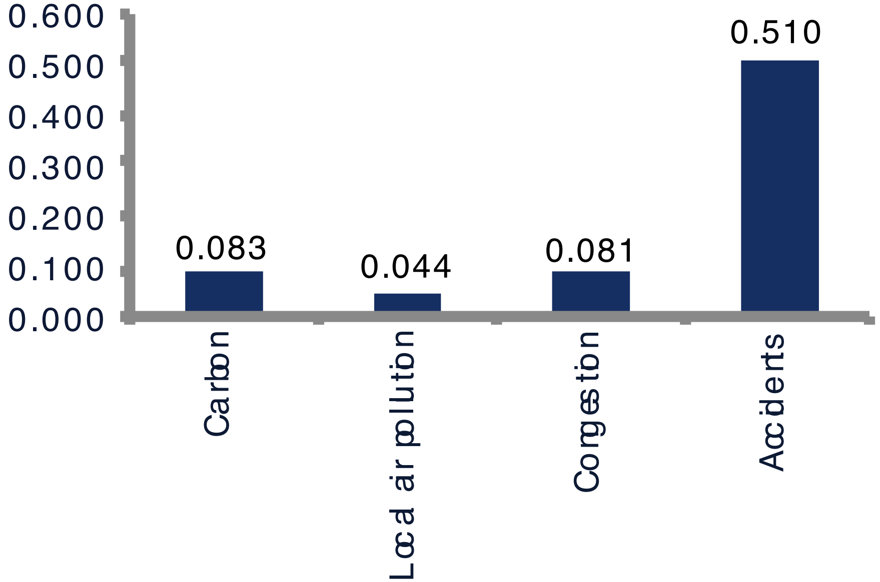
US: Corrective Tax Estimates for Gasoline ($ per liter)



Brazil: Corrective Tax Estimates for Gasoline ($ per liter)

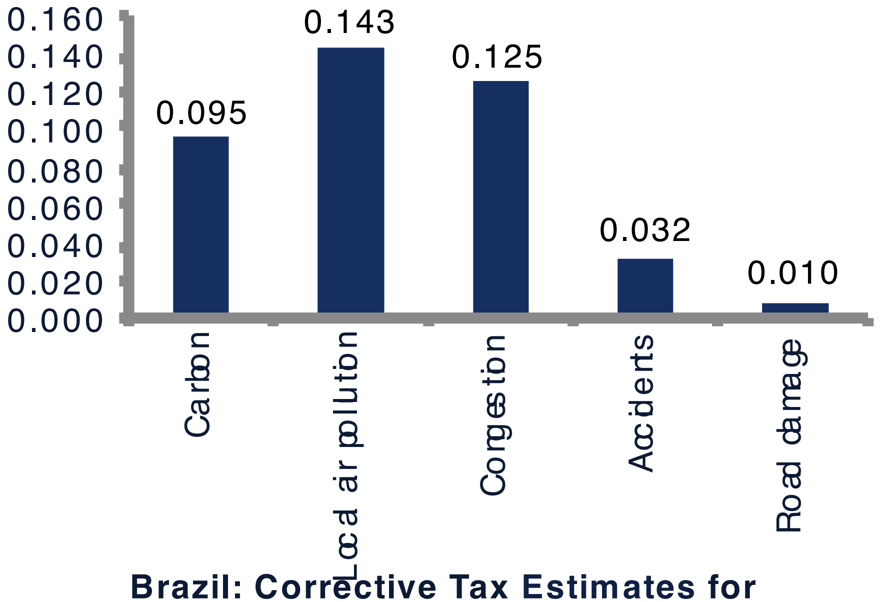


Colombia: Corrective Tax Estimates for Gasoline ($ per liter)

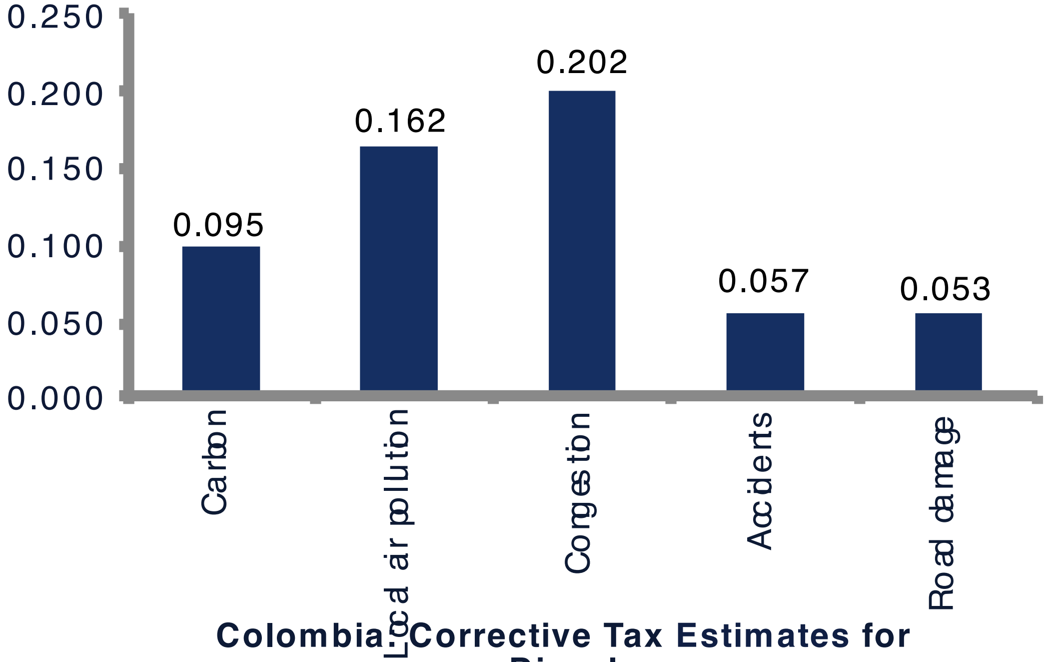


Source: Fiscal Affairs Department of the International Monetary Fund

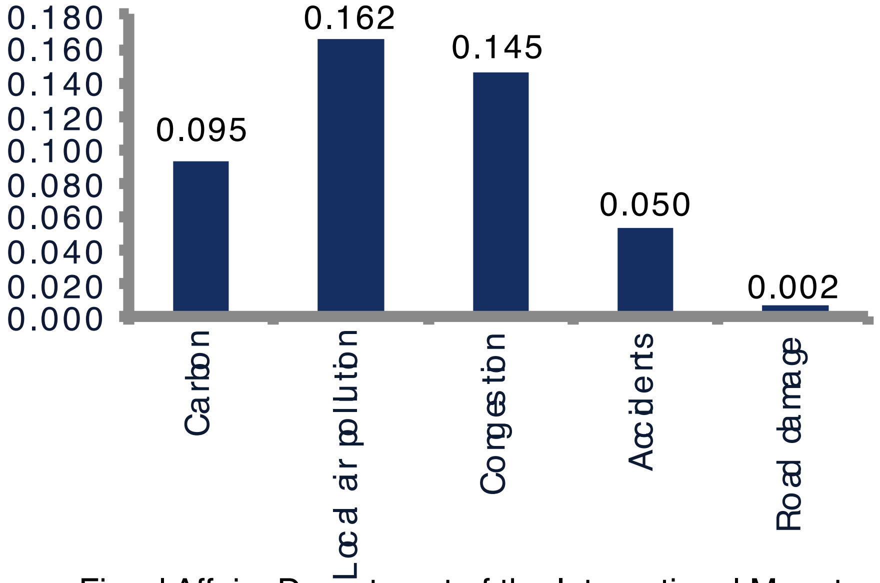
Mexico: Corrective Tax Estimates for Diesel ($ per liter)



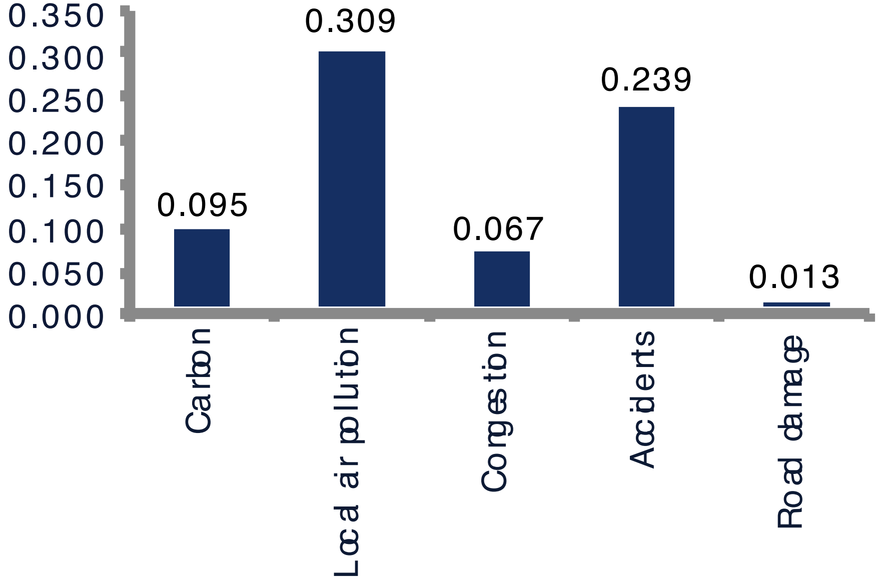
US: Corrective Tax Estimates for Diesel ($ per liter)



Brazil: Corrective Tax Estimates for Diesel ($ per liter)



Colombia: Corrective Tax Estimates for Diesel ($ per liter)



Source: Fiscal Affairs Department of the International Monetary Fund

Exciting new economic analysis in Medellin to improve air quality

- Developed baseline emission/congestion projections
- Estimated mortality, other health, environmental congestion impacts
- Monetized damages
- Identified policy options (fuel taxes, subsidies for scrappage, etc)
- Modeled benefits of alternative policies
- Estimated costs
- Compared benefits and costs, analyze cost-effectiveness of policies
- Developed clear recommendations
- Guillermo Rudas will discuss results

New developments in environmental economics

- Retrospective analysis of past policies
- Big data: use of satellite data to measure pollution levels

Retrospective Analysis

- In the US, ex ante studies – RIAs – now commonly done for major rules….helpful but limited
- Evidence-based analysis on actual performance is critical for understanding the true societal effects of these rules

- Pre-regulatory
  - Forecast emissions with and without the rule
  - Translate emissions into environmental outcomes
  - Estimate benefits associated with environmental outcomes
  - Estimate costs relative to no regulation baseline
- Ex post
  - More information available on firms’ compliance strategies, actual emissions and costs
  - Counterfactual no-regulation baseline is never observed for regulated entities, but can be inferred

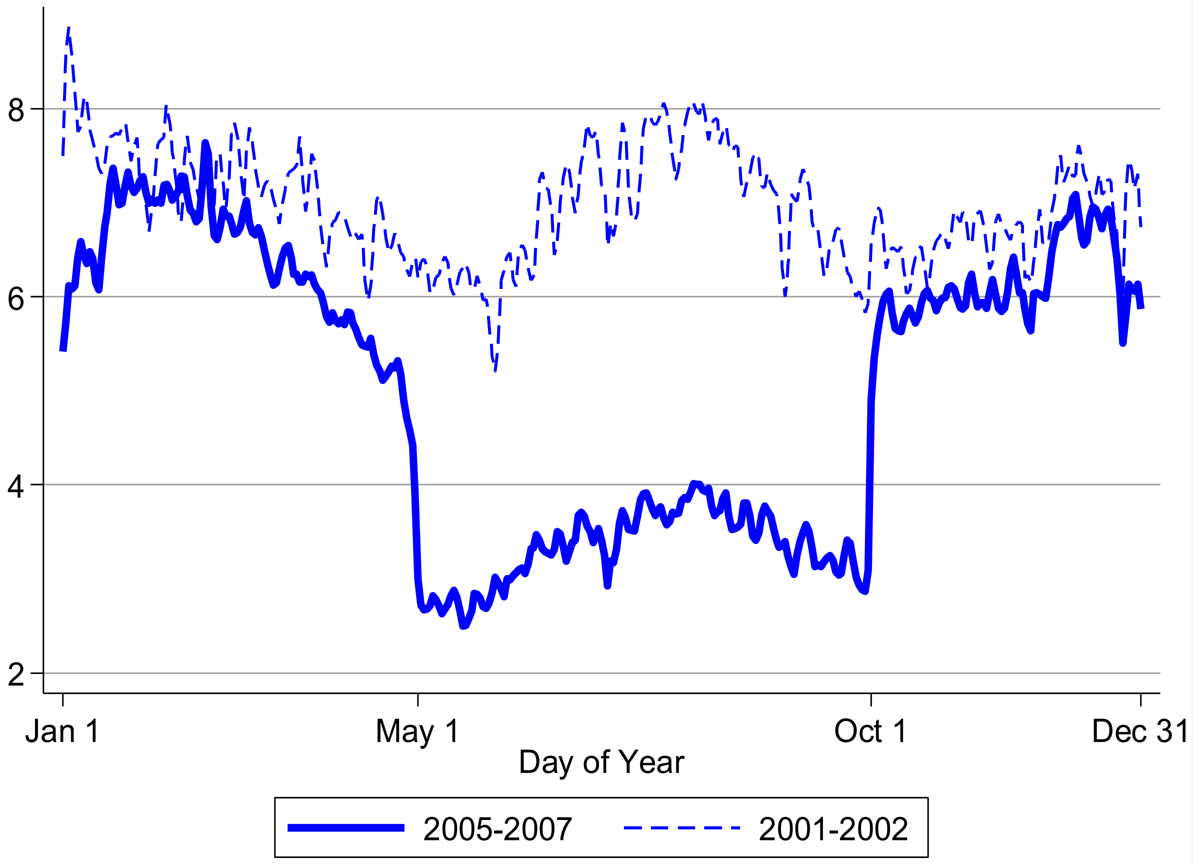
- Can support innovation in regulatory design, guide development of new rules and potentially support reform of poor performers

Example: NOx Budget Program

- Trading program to reduce NOx in 19 Eastern states during the summer ozone season
- Program operated from May 1 to September 30, 2003-2008 (replaced by CAIR)
- Program covered 2,500 electricity generating units and industrial boilers
- Deschenes, Greenstone, Shapiro AER (2017) used two sets of controls:
  - Difference between regulated units in the summer v. winter
  - Difference between regulated units in states covered by the NBP v. EGUs in non-regulated states

NBP's Aggregate Impact on NO_x Emissions

[Emissions in Thousand Tons]



Note: Graph depicts fitted NO_x residuals after partialing day-of-week indicators.

Major, new benefits revealed

- Reduction in medication purchases: saved $800 million in defensive investments annually
  - Evident in short-acting and long-term control respiratory medications
  - Almost as large as abatement costs associated with NBP
- Also significant reduction in mortality rate -- prevented 2,500 summertime deaths each year, primarily age 75+ population
  - Monetized value of reduction in mortality (age-adjusted VSL) $\approx$ $1500 million
- Arguably, there is basis to tighten the standard

Big Data: Satellite information on pollution

New study by Daniel Sullivan, Alan Krupnick (RFF)

Air quality regulations depend on monitors

- In the US, Air Quality Standards (NAAQS) set as part of CAA
  - 12 $\mu g/m^3$ PM2.5 annual average (set in 2012)
- Compliance (usually at county level) measured with past 3 years of monitor data.
  - "Design value"
- Design value > NAAQS → Non-attainment
- Non-attainment leads to more stringent requirements on industry and transportation.

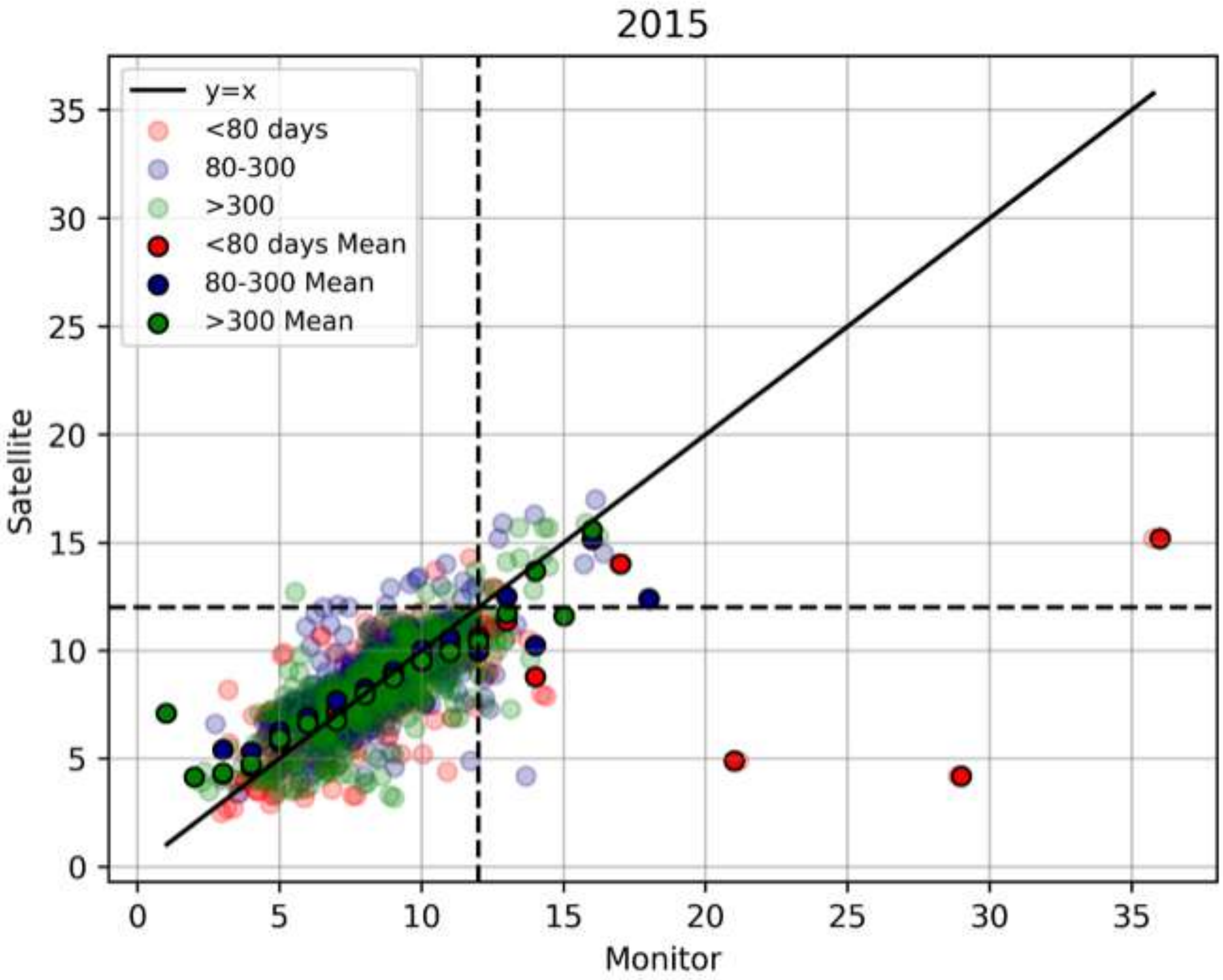
But monitors have some issues

- Monitors are expensive, sparse.
- Most monitors do not operate every day and
  - Zou (2017) finds evidence that polluters reduce emissions when the monitors are turned on.
  - This implies monitors underestimate true exposure.
- Local regulators place monitors.
  - Grainger et al. (2017) find monitors placed in cleaner parts of county
  - Local politics may also affect monitors (e.g., Wisc.)

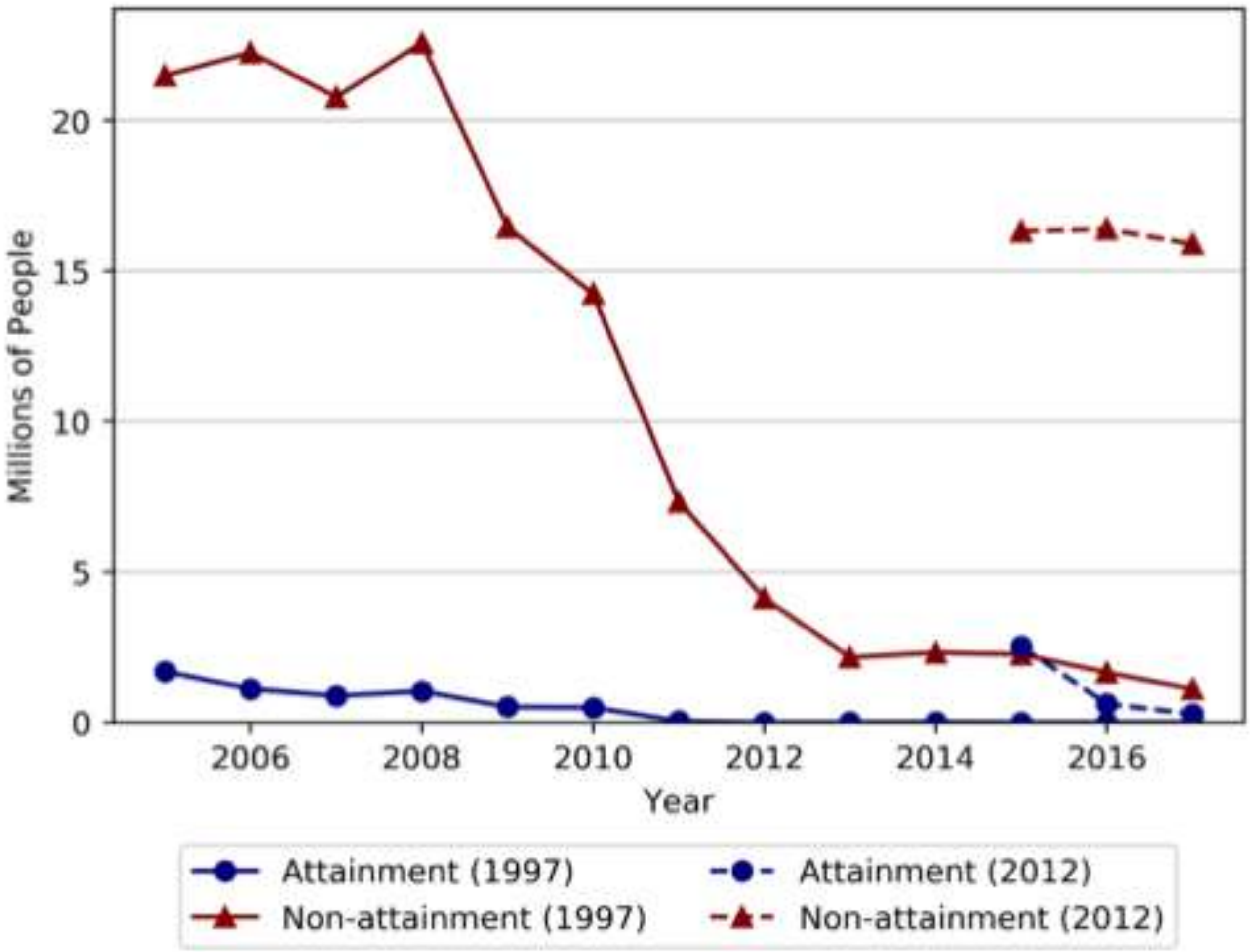
- Sullivan, Krupnick data: EPA 1999-2017 (compliance monitor, days operation, precise location)

Satellite data can fill the gaps

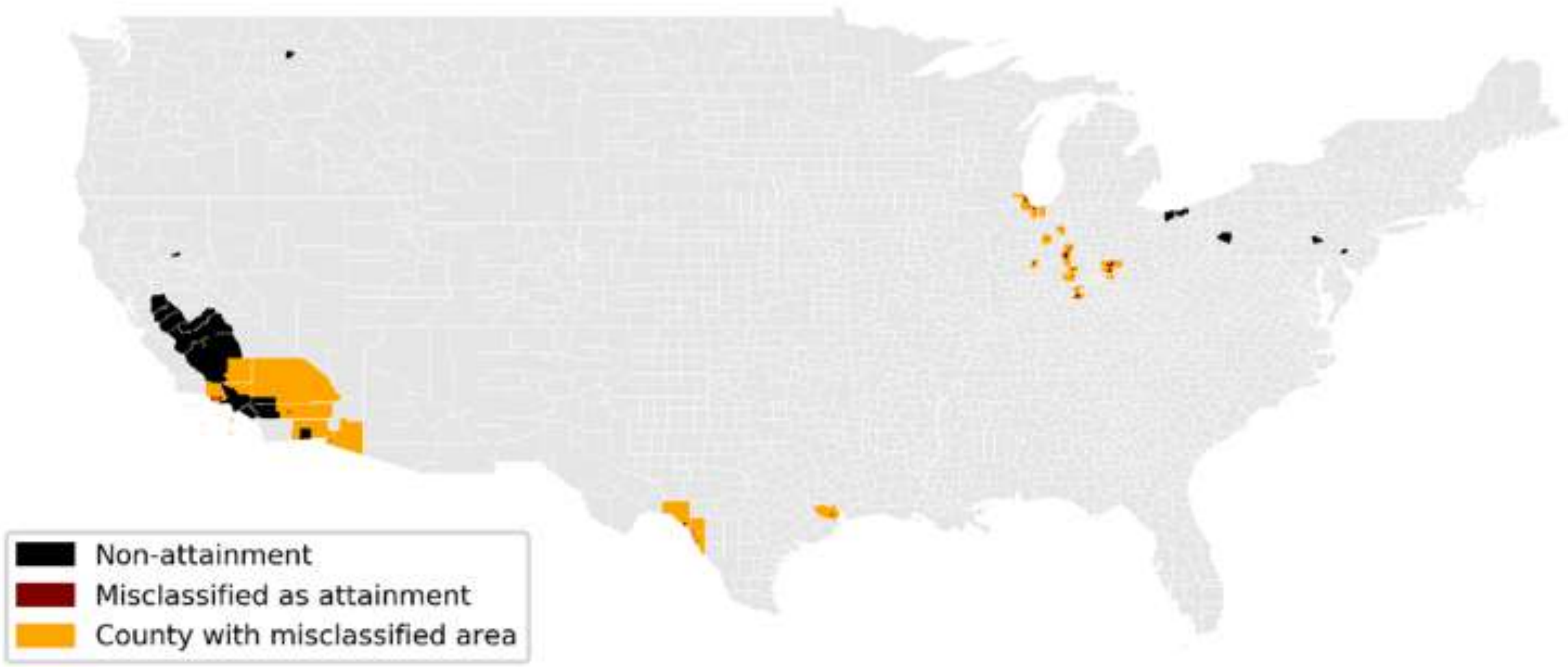
- Composite data from van Donkelaar et al. (2015: global calibration; 2018: North America calibration).
  - MODIS, MISR, SeaWIFS (polar orbit)
  - GEOS-Chem (chemical air transport model)
  - 0.01° × 0.01° spatial resolution (~1 km sq.)
  - Annual average μg/m^3 PM2.5
- Issues:
  - Actually measures aerosol optical depth (solar radiation at top minus radiation reflected back)
  - Need calibration to PM2.5
    - Calibration with ground-based monitors and complex algorithm


2015
y=x
<80 days
80-300
>300
<80 days Mean
80-300 Mean
>300 Mean
Satellite
Monitor
0
5
10
15
20
25
30
35

Population over NAAQS, by attainment status



Areas that could be non-attainment



Mortality benefits of proper classification

- Monitors over the NAAQS see ~2 $\mu g/m^3$ PM2.5 incremental reduction.
- If misclassified areas also saw this improvement:
  - 3,321 fewer deaths, from Lepeule et al. (2012) CR
  - $30 billion in welfare gain (VSL $9 million)
- What about parts of non-attainment areas away from a monitor?

Conclusions: satellite data (Sullivan, Krupnick)

- Satellite data on PM2.5 opens up many areas for research and improving lives by better targeting pollution cleanup efforts
- It also challenges existing regulatory systems
- But, the algorithm for translating AOD to PM2.5 is far from perfect, although without significant bias if carefully and thoughtfully done
- Even with PM2.5 relatively low in the U.S., $30 billion mortality damage could be avoided over 2 or more years if misclassifications of attainment areas were ended.
- Much more could be saved if all of a non-attainment county's high concentration areas were targeted for mitigation.

Major Trump Administration Proposals on Environmental Regulation

- Seek to rollback Obama-era rules (fuel economy standards, CPP, other s); distinguish ‘conduct’ of analysis from ‘use in decisionmaking’
- Major areas of dispute
  - General science: revive old debates about transparency, possibly ban certain studies
  - Reduce $PM_{2.5}$ benefits (introduce threshold based on ambient standard or LML)
  - Limit consideration of ancillary benefits: e.g., MATS counting large PM benefits
  - Expand scope of costs: plant closures, jobs lost, cumulative benefits, some CGE effects
  - Revisit social cost of carbon (domestic vs int’l benefits; discount rate; etc)
- Potential for improved analysis
  - Good housekeeping: stress marginal (vs average) costs; improve baseline estimation, treatment of uncertainty, etc
  - Push for retrospective analysis of new rules (not just ‘lookbacks’)
    - How do regulated entities actually respond?
    - Historically limited research area
    - If done properly, could improve future rules, RIAs, and may support reform of existing regs
    - Challenges are methodological/data related: possibly build into new rule design?

Setting the Price of Carbon: Two Approaches

- Shadow price of carbon
  - Calculates implicit price of carbon
  - Tied to specific emission reduction target, e.g.

- Social cost of carbon
  - Measure of damages/benefits of carbon reduction
  - Estimated initially by US (Obama Administration)

The Social Cost of Carbon (SCC)

- The SCC for a given year is an estimate of the present value of the damage caused by a one metric ton increase in CO_2 emissions in that year or, equivalently, the benefits of reducing CO_2 emissions by the same amount in that year
- The goal is to provide a comprehensive measure of the monetized value of the net damages from global climate change, e.g., changes in net agricultural productivity, energy use, human health effects and property damages

SCC: Some Details

- 3 models used in computations (DICE, FUND, PAGE)
- Key inputs: probability disribution for equilibrium climate sensitivity, various scenarios for economic, population, and emissions growth
- Discount rates (constant): 2.5%, 3%, 5%
- Limitations: incomplete consideration of catastrophic and non-catastrophic impacts; adaptation; technological change
- IPCC: "it is very likely [the SCC] underestimates the damage costs because they cannot include many nonquantifiable impacts"

Social cost of CO_2, 2010-2050

(2007 dollars per metric ton of CO_2)

	Discount rate			
	Average			95th
Year	5%	3%	2.5%	3%
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50.0	100.0
2035	11.2	36.0	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65.0	136.2

US National Academy of Sciences (2017)

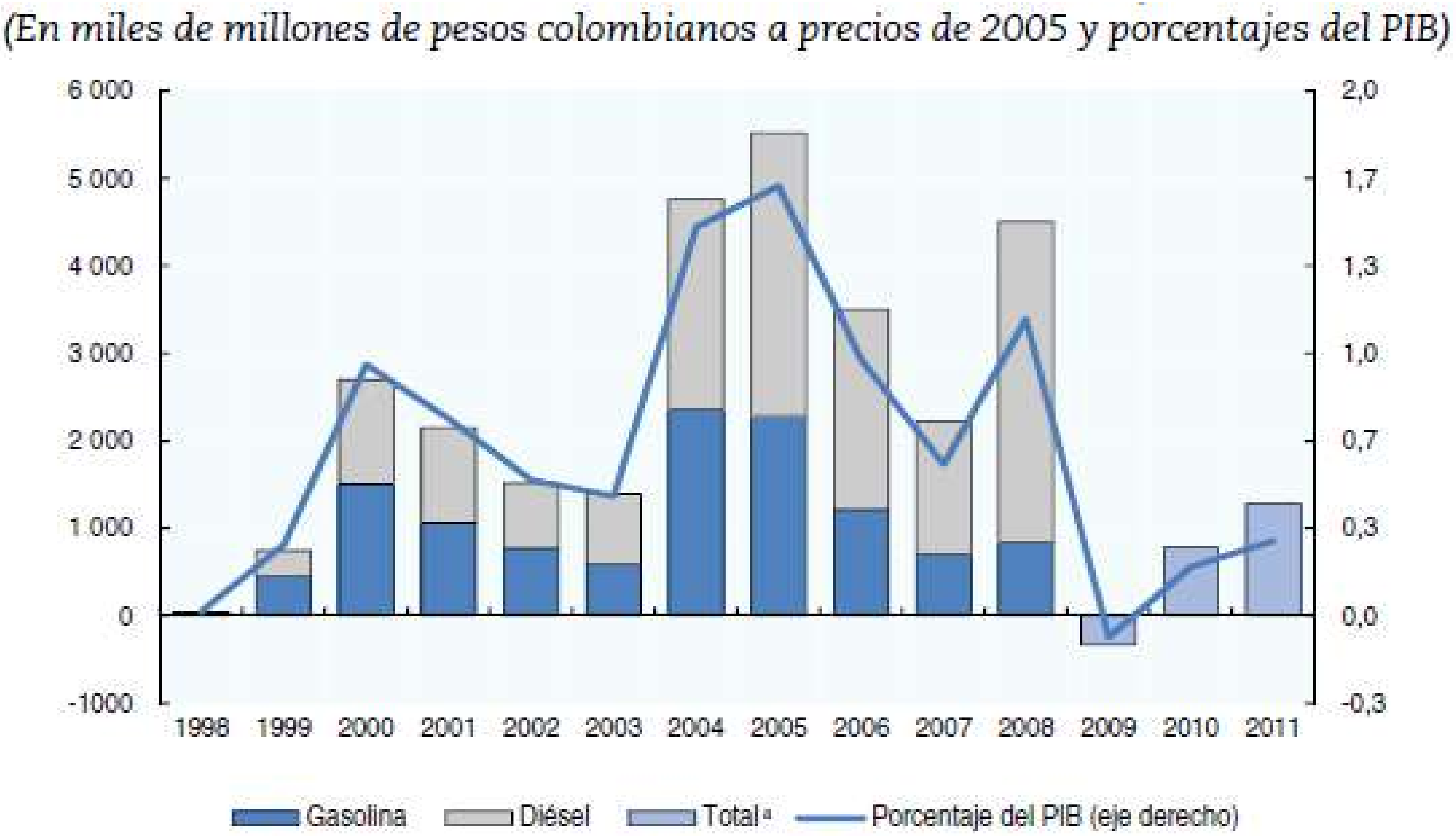
- Recommends ‘unbundling’ black box framework for SCC
- Recommends dropping fixed discount rates and, instead, focusing on the relationship between economic growth and discounting, which would help accounting for uncertainty over long time periods
- Proposes series o specific modeling changes
- Noting that calculating damages for the US alone is ‘feasible in principle’, the report says the ability to do so is limited by existing methodologies
- Calls for updating every five years

Trump Administration proposal

- Use 7% discount rate
- Focus on domestic as opposed to international benefits
- Reduces value of social cost of carbon to $1 - $6 in the year 2020, down from the Obama administration's central (inflation adjusted) 2020 estimate of $45

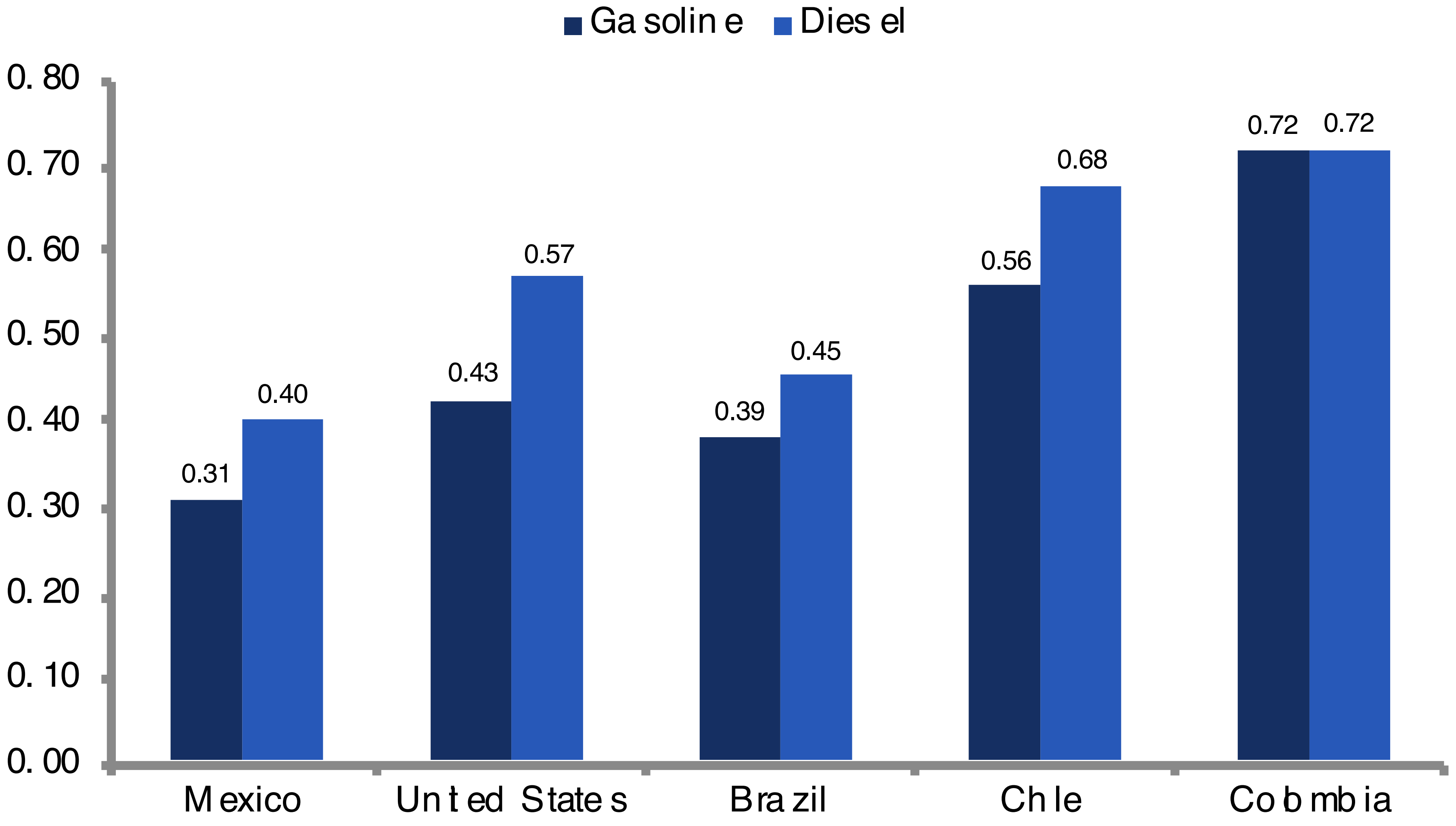
Thank You

Fuel Subsidies in Colombia, 1998-2011



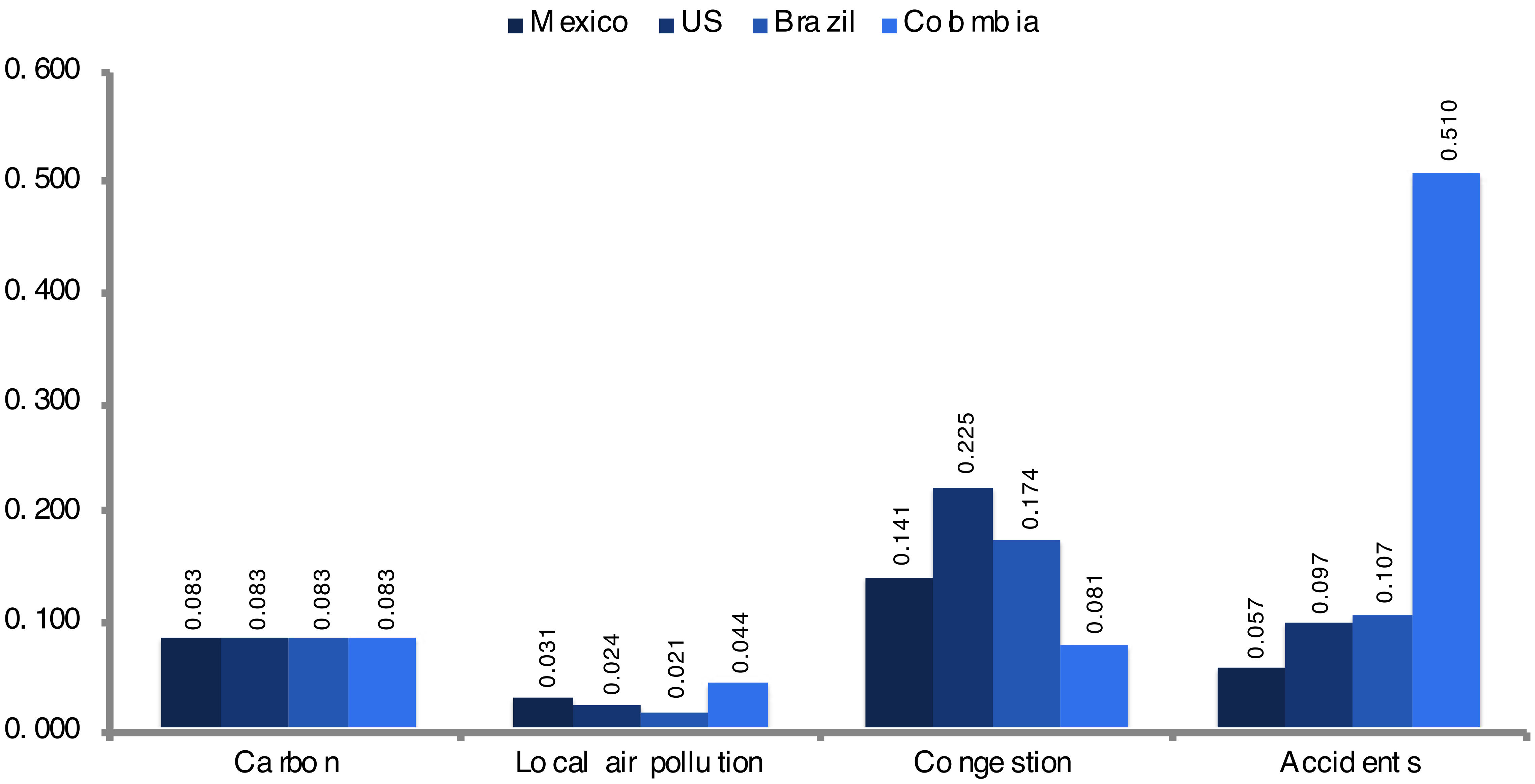
OECD,2014

Total Corrective Tax Estimates ($ per liter)

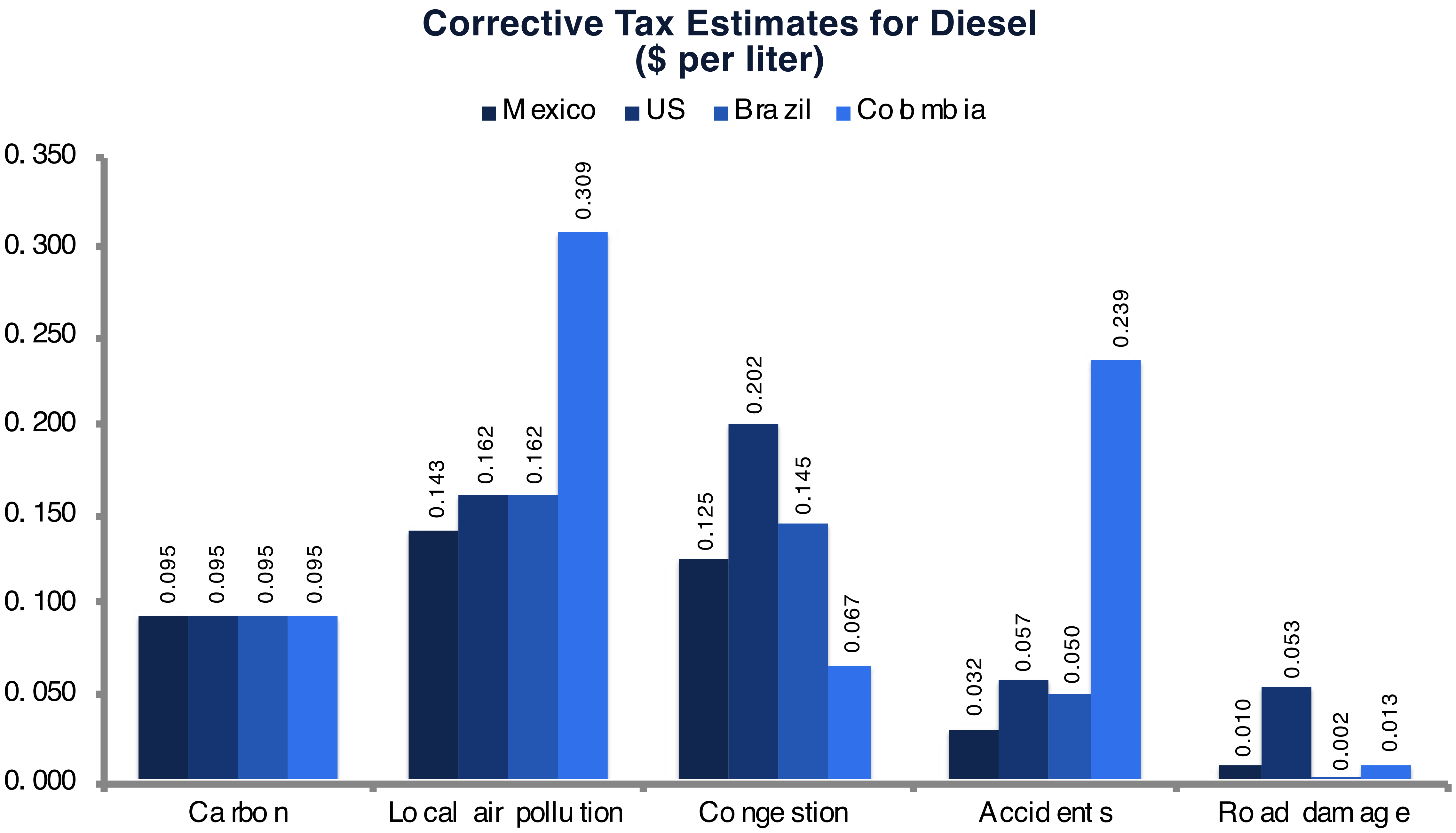


Source: Fiscal Affairs Department of the International Monetary Fund

Corrective Tax Estimates for Gasoline
($ per liter)



Source: Fiscal Affairs Department of the International Monetary Fund



Source: Fiscal Affairs Department of the International Monetary Fund

Background

- Ex ante studies – RIAs – now routine for major rules
- Federal environmental rules are the costliest of all regulations, but environmental rules also yield the most benefits
- Retrospective analysis (RA) seeks to identify actual outcomes
- Can support innovation in regulatory design, guide development of new rules, and potentially support reform of poor performers
- Cass Sunstein: ‘develop agency culture to support RA’