Title: The Political Economy of Hydrocarbon Wealth and Fuel Prices

Authors:
Paasha Mahdavi
Michael Ross

Publication Date:
(insert date)

Series:
EEG State-of-Knowledge Paper Series

Permalink:
(insert link)

Keywords:
Electricity, economic development, economic growth, energy policy

Abstract:
All governments either tax or subsidize the consumption of fossil fuels. These pricing policies have far-reaching consequences not only for the environment, but also for governance and economic development. In this state-of-knowledge paper, we examine previous research on fossil fuel subsidies, noting areas that are understudied in the context of determinants of price policies and causes for policy reform. We then describe new data on implicit gasoline taxes and subsidies, report global trends, and explore the relationship between oil wealth and government policies. We conclude with actionable ideas for future research projects.

Energy and Economic Growth
Applied Research Programme

Series Name: EEG State-of-Knowledge Paper Series
Paper No.: 5.1
Issue Date: (insert date)

The Political Economy of Hydrocarbon Wealth and Fuel Prices

Paasha Mahdavi and Michael Ross

EEG State-of-Knowledge Paper Series

Oxford Policy Management
Center for Effective Global Action
Energy Institute @ Haas

The Applied Research Programme on Energy and Economic Growth (EEG) is led by Oxford Policy Management in partnership with the Center for Effective Global Action and the Energy Institute @ Haas at the University of California, Berkeley. The programme is funded by the UK Government, through UK Aid. Over the course of five years, EEG will commission rigorous research exploring the links between energy economic growth, and poverty reduction in low-income countries. This evidence will be specifically geared to meet the needs of decision makers and enable the development of large-scale energy systems that support sustainable, inclusive growth in low income countries in South Asia and Sub-Saharan Africa.

The EEG Working Paper Series showcases the 18 State-of-Knowledge papers produced in Phase 1 of the EEG programme. These papers address gaps in knowledge and data in six critical themes related to energy and economic growth: the links between electricity supply and growth, finance and governance aspects, large scale renewables, sustainable urbanization and energy efficiency, the role of extractives, and design of energy systems. Cross-cutting themes of gender, climate change, and data are also addressed in dedicated papers.

The Political Economy of Hydrocarbon Wealth and Fuel Prices

Paasha Mahdavi
(Georgetown University)

Michael Ross
(UCLA)

December 31, 2016

Prepared as a State-of-Knowledge Paper for the applied research program on Energy and Economic Growth, implemented by the Center for Effective Global Action (CEGA) and the UK Department for International Development (DfID)

Abstract

All governments either tax or subsidize the consumption of fossil fuels. These pricing policies have far-reaching consequences not only for the environment, but also for governance and economic development. In this state-of-knowledge paper, we examine previous research on fossil fuel subsidies, noting areas that are understudied in the context of determinants of price policies and causes for policy reform. We then describe new data on implicit gasoline taxes and subsidies, report global trends, and explore the relationship between oil wealth and government policies. We conclude with actionable ideas for future research projects.

The Applied Research Programme on Energy and Economic Growth (EEG) is led by Oxford Policy Management in partnership with the Center for Effective Global Action and the Energy Institute @ Haas at the University of California, Berkeley. The programme is funded by the UK Government through UK Aid. The views expressed in this paper do not necessarily reflect the UK Government's official policies.

1. Introduction

All governments either tax or subsidize the consumption of fossil fuels.[1] These pricing policies have far-reaching consequences: they affect greenhouse gas emissions, local air pollution, road congestion and traffic fatalities, and government finances. They also affect political stability and violence: over the last decade, attempts to raise gasoline prices have been followed by protests in at least 20 countries. The 2007 "Saffron Rebellion" in Myanmar was sparked by protests against gasoline price increases, while demonstrations against higher gas prices in Indonesia in 1998 and Kyrgyzstan in 2010 became part of larger movements that led to the fall of both governments.

Why do some countries subsidize fossil fuel consumption while others tax it? Why do their policies change, and why are these changes sustained or reversed? While much is known about the economic and environmental consequences of these taxes and subsidies, much less is known about the policies that bring them about. We suggest that this is partly because data on fossil fuel price policies have been limited. In the absence of these data, analysts have fallen back on selected case studies; while these are intrinsically valuable, they are difficult to use as a basis for causal inference without more complete data on the global distribution of price policies.

As a first step toward filling this gap, this paper describes an original data set on implicit taxes and subsidies for gasoline in 157 countries from 2003 to 2015 at the monthly level compiled by Ross and Mahdavi (2017). Compared to other types of energy policies, gasoline price policies are relatively easy to study: since it is sold in retail form in almost all countries, gasoline has a consumer price that is observable; since there is a single world market for petroleum, supply costs can be estimated using a common global benchmark.

Using the price gap method (measuring the gap between supply costs and retail prices), we can estimate implicit taxes and subsidies (Koplow 2009). Our data allow us to take measurements at monthly intervals; previous studies relied on estimates made at two-year intervals, which were too infrequent to capture many policy changes and reversals, and to link these policy changes to political events like elections, protests, or price shocks.

We begin with a brief review of previous research on fossil fuel subsidies[2] and pricing policies, noting areas that are understudied. The second section introduces our data on implicit gasoline taxes and subsidies, describes global trends, and explores the relationship between oil wealth and government policies.

---

[1] While we address a variety of fossil fuels throughout the paper, such as coal, natural gas, and crude oil, our focus is primarily on gasoline subsidies. This choice reflects both the predominance of existing scholarly work on gasoline as opposed to other fuels, and the ubiquity of gasoline as a product that is sold directly to consumers in all countries.

[2] Throughout the paper we refer to "fossil fuel subsidies" in general to refer to both states with implicit subsidies as well as states with low implicit taxes (note: we use "states" and "countries" interchangeably to refer to sovereign nation-states). In section two, we provide greater detail on our approach to measuring implicit gasoline prices.

Our data suggest that a dependence on oil exports is a necessary but not sufficient condition to explain gasoline subsidies: all 22 of the "persistent subsidizers" in our data are oil dependent, but not all oil-dependent states are gasoline subsidizers. We demonstrate that there have been heterogeneous responses within countries to new oil and gas discoveries, using the cases of Bolivia, Brazil, and Vietnam.[3]

We also examine a second policy dimension, the degree to which governments used fixed or floating prices to adjust to changes in world markets. Fixity policies tend to complicate the issue of subsidies, since subsidies in price-fixing states will fluctuate automatically with the global oil price. To demonstrate this we extend our analysis of the subsidizers to June 2016 to show how their subsidies have dwindled due to a combination of falling crude oil prices and policy changes.

Finally, we close with actionable ideas for future research projects that can take this issue forward for both scholars and practitioners in the energy sector.

2. Past Research

The number of studies of fossil fuel subsidies has ballooned in recent years – 61 of the 74 studies we reviewed have been published since 2010 – but there has been widespread international support for subsidy reform since the 1990s:[4]

- The World Bank's World Development Report 1992 documented large fossil fuel subsidies around the world and estimated the reductions in global carbon emissions that would result from their elimination (Larsen and Shah 1992);
- A 1995 study by two IMF economists provided the first comprehensive data on gasoline and diesel prices around the world, noted their wide variation, and argued that they were almost certainly too low in some states and too high in others (Gupta and Mahler 1995);
- A study of fossil fuel prices and subsidies among members of the Organization of Petroleum Exporting Countries (OPEC), prepared by statisticians from the OPEC Secretariat, emphasized the inefficiency of the subsidies and documented current and planned fuel price reforms in Iran, Nigeria, Algeria, Indonesia, Saudi Arabia, Venezuela and Kuwait (Paga and Birol 1995);
- The 1999 edition of the *World Energy Outlook*, produced annually by the International Energy Agency, was dedicated to an analysis of fossil fuel subsidies in eight large non-OECD countries, and includes both country case studies and a

[3] While there is no direct connection between natural gas and gasoline, we include it to show how the rents from new gas fields (or hypothetically, any natural resource) can be distributed via fuel subsidies.

[4] Rentschler and Bazilian (2016) provide a detailed survey of the literature on fossil fuel subsidy reform, covering the definition and estimates of the subsidies, their adverse social, economic, and environmental effects, the national and international initiatives underway to implement reforms, principles for the design of reforms, and lessons from past reform efforts.

quantitative analysis that estimated the economic and environmental gains from their removal (IEA 1999).

- The Intergovernmental Panel on Climate Change's Third Assessment Report, released in 2001, also included a summary discussion of fossil fuel subsidy reform (IPCC 2001).[5]

2.1. Measuring fossil fuel subsidies

Over time, researchers have tried to better measure the size of the subsidies. As Kojima and Koplow (2015) note, estimates for fossil fuel subsidies vary from half a trillion to two trillion dollars per year, depending on the choice of alternative definitions, assumptions, and methods (e.g., Parry et al. 2014, Coady et al. 2015, Davis 2014, 2016). A majority focus on consumer subsidies rather than producer subsidies, which may be larger but more difficult to estimate; they also tend to focus on "pre-tax" subsidies (defined as subsidies that arise when energy is sold at a price below the marginal cost of supply) rather than "post-tax" subsidies (defined by Coady et al. 2015 as those that arise when energy is sold for less than the marginal supply cost, plus a consumption tax and a Pigouvian tax that reflects the cost of environmental externalities).

For countries able to produce energy resources at below-market costs, an alternative way to define the pre-tax subsidy is to measure the gap between local prices and the opportunity cost, rather than the marginal cost of supply. Consider Saudi Arabia, for instance, where the cost of refining gasoline from local oil produced at $3-$6 per barrel is cheaper than buying refined gasoline from the international market based on $50 per barrel crude. Here the effective pre-tax subsidy is quite large when comparing local prices to the opportunity cost of selling this oil on the market, yet quite small when comparing local prices to the marginal cost of supply.

There has also been an effort to better estimate some of the undesirable features of these subsidies, including that they entail large deadweight losses (Davis 2014), are badly targeted and often captured by middle and upper income groups (del Granado et al. 2010), encourage fossil fuel consumption (Charap 2013, Fattouh and El Katiri 2013), and discourage fuel-saving innovations among automobile firms (Aghion et al. 2016).

While most studies focus on the size and composition of the subsidies, a series of analyses by Kojima (2009, 2012, 2013, 2016) have instead looked at the problem of "price fixity" – documenting the price-adjustment mechanisms in a large number of states, measuring the pass-through rates of several major price shocks, and articulating why price fixity tends to have perverse economic and environmental consequences. To our knowledge, these are the only general studies to focus on price fixity.

[5] McFarland and Whitley (2014) offer a comprehensive account of the intergovernmental organizations supporting fossil fuel reform. Terton et al. (2016) include policy reforms to fossil fuel pricing as a potent tool to reduce emissions within the Intended Nationally Determined Contributions (INDCs) of countries participating in the COP21 meetings in Paris in November 2015.

2.2. The politics of fossil fuel subsidies

If fossil fuel subsidies are so transparently wasteful, why do governments maintain them? There's a strong agreement among most recent studies that subsidy policies are profoundly shaped by politics. As Rentschler and Bazilian (2016, 2) state, "Experience shows that political economy challenges create some of the most serious barriers to reforming both producer and consumer subsidies."

There are two broad approaches to the politics of fossil fuel subsidies. The most common looks at broad political and economic factors that are present in democracies and autocracies alike. An influential paper by Victor (2009, 7) suggested that "in most cases subsidies exist because they are rooted in a political logic that is often difficult to alter." Democratic governments are compelled to provide subsidies, despite their wasteful qualities, because pro-subsidy interest groups are well organized and political leaders have no other readily available mechanisms for compensating them. Yet he also notes the 'populist paradox,' that unaccountable governments are often the ones providing the largest subsidies; this occurs, he argues, because subsidies are a readily-available and highly visible way to deliver benefits to supporters. Again, because they are easy to deliver they are favored by governments that tend to be administratively weak.[6]

These arguments are rarely disputed, but they remain difficult to evaluate in a rigorous way. Some researchers use country-level case studies to flesh out these ideas, identifying the actors that support or oppose reform and detailing government efforts to reduce subsidies while avoiding political protests; some of the most detailed work has focused on the Middle East and North Africa, where fossil fuel subsidies are especially large (Sdralevich et al. 2014, Fattouh and El-Katiri 2016). Segal (2012) argues that in places like the Middle East, large resource revenues are spent on propping up energy subsidies in response to resource nationalistic demands that "oil wealth belongs to the people."

Several papers have used a quantitative approach. Cheon et al. (2013) regress annual data on gasoline prices from 2002 to 2009 on measures of a country's status as an oil producer (proxied by OPEC membership), a measure of perceived bureaucratic quality, and a measure of democracy; each variable is statistically associated with gasoline subsidies in some models, although the democracy measure appears to be more robust. They interpret their findings as supporting the claim that countries with a weak bureaucratic capacity are more likely to provide subsidies, because it is an administratively simple way to deliver benefits to their population.

Hochman and Zilberman (2013) also use regression analysis to look at political factors associated with implicit gasoline and diesel subsidies. Using a simple OLS model with random effects, they report that higher subsidies are simultaneously associated with OPEC membership and a dummy variable measuring status as an oil exporter, as well as

[6] Strand (2013) offers a game-theoretic model that captures some of these core ideas; in it, fossil fuel subsidies are maintained in both autocracies and democracies with weak institutions, because they are easier to observe, easier to commit to, easier to deliver, or better targeted to core constituencies than other types of public goods or patronage.

several measures of autocratic governance. In a fixed effects model they report that measures of autocracy continue to be associated with subsidies, although they cannot test their claims about oil wealth because they measure it with time-invariant dummy variables.

Aside from these studies there has been little quantitative analysis of the politics of fossil fuel subsidies. The above studies have important limitations. They are based on annual or biannual observations, and hence do not cover infra-annual changes in taxes or subsidies; hence a short-lived attempt at reform will likely go unrecorded, and more gradual or subtle changes in subsidies could be overlooked. They make no effort to account for endogeneity or spurious correlations: for example, oil wealth might simultaneously cause fuel subsidies and authoritarian rule. Moreover, some of the right-hand side variables are imprecise and time-invariant (both studies use dummy variables to account for the effects of oil), based on perceptions, and may be highly correlated with other potentially important causes of subsidies.

2.3. Why and how do governments reform fossil fuel subsidies?

The analysis of the causes of the subsidies is at least partly connected to arguments about how governments that wish to remove them but face political opposition should carry out reforms. Victor (2009), for example, recommends that reform strategies include a political strategy to compensate powerful interests that could block any changes.

Major studies of reform strategies, based on case studies, have been carried out by both the World Bank (Vagliasindi 2012) and IMF (Clements et al. 2013), each of which has produced a series of guidelines for governments. Their conclusions are similar, even if there are differences in emphasis. Both emphasize the importance of strengthening the social safety net, delivering targeted compensation to the poor, and developing a broad communication strategy to explain the value of subsidy removal and promote public trust. The Clements et al. study also underscores the value of comprehensive energy sector reform, phased price increases, efficiency improvements in state-owned enterprises to reduce producer subsidies, and the introduction of automatic pricing mechanisms that can depoliticize future price changes. Coady et al. (2012) further stress the importance of pricing mechanisms, advocating a medium-term price-smoothing formula such that governments can maintain a certain level of market-based pricing while also shielding consumers from short-term price shocks.

Rentschler and Bazilian (2016) provide a synthesis of the recommendations from earlier studies – including the IMF and World Bank research – that also discusses the important role of fiscal pressures in driving reforms. Since the subsidies are concentrated in oil dependent countries, these fiscal pressures are often driven by movements in global oil prices, although it is unclear whether reforms are more likely when prices are high (since both subsidies and government revenues are high) or low (which makes subsidies small but also makes it harder for governments to fund them).

The case study literature on reform draws on rich material and yields important insights, but also has limitations: without a more complete data base with well-calibrated policy measures, it is difficult to know if the sample of countries is representative; the World Bank and IMF might be more inclined to draw on cases that are more successful, or that portray its policy advice in a favorable light; and it might be hard to control for confounding factors, or measure gradations of policy change.

2.4. Studies on non-liquid fossil fuel subsidies

Most of the research on fossil fuel subsidies focuses on liquid fuels; only a handful also discuss coal subsidies, generally at the case study level.[7] Pre-tax coal subsidies are exceptionally hard to measure because coal is often sold directly to government-owned utilities through long-term contracts, and hence may have no observable retail price (Victor 2009). It is also hard to determine the supply cost of coal, as there is no single international reference price.

The most complete estimate of global energy subsidies finds that pre-tax coal subsidies are "negligible," representing just 0.01 percent of global GDP in 2013 – compared to petroleum (0.34 percent), electricity (0.23 percent), and natural gas (0.16 percent).[8] Post-tax subsidies for coal, however, a very large – amounting to 3.9 percent of global GDP in 2015, larger than for petroleum, natural gas, and electricity – reflecting coal's status as the most carbon-intensive and air-pollution intensive energy product. About three-quarters of the coal subsidy comes from the external cost of local air pollution, and the remaining quarter from carbon pollution. By value, pre-tax coal subsidies were concentrated in the advanced industrialized states, Eastern Europe, the former Soviet Union, and Asia; as a fraction of regional GDP, they also were significant in Sub-Saharan Africa (Coady et al. 2015).

2.5. Emerging themes from prior research

The literature on subsidies for fossil fuels – particularly gasoline and diesel – tends to cluster around three themes. First, there is consensus around their negative impacts on society: fuel subsidies are regressive in that upper class consumers are the primary beneficiaries; subsidies increase the long-term consumption of carbon-intensive fuels; and low prices hinder innovation of climate-change-mitigating technologies, particularly in emerging markets.

Second, albeit with room for more debate, studies emphasize the role of politics in understanding the origins and persistence of transportation fuel subsidies. Oil exporters and resource-reliant states are the most likely to subsidize energy as a result of populist,

[7] On the case of Germany, see Storchmann (2005) and Frondel et al. (2007); on the case of China, see Lin and Jiang (2011) and Lin and Li (2012).

[8] Bast et al. (2015), however, shows that between 2007 and 2014 about $9 billion per year in public finance (largely through Export Credit Agencies) went to support coal development; the three largest contributors were (from largest to smallest) were Japan, China, and South Korea. Other OECD states and Russia provided most of the rest of the finance.

distributive policies. Weak states with low institutional capacity are also likely to enact subsidies and to maintain them over time given the difficulties of reform. Consumer behavior is an additional factor in the durability of subsidies, as citizens come to expect low prices based on their own perceptions of the "fair price" of fossil fuels.

Third, agencies such as the World Bank and IMF recommend a host of strategies for reforming fossil fuel subsidies. Acknowledging the inherent political challenges for states to remove subsidies, these studies advocate gradual changes via price-smoothing mechanisms, targeted compensation to poor consumers, and broad-based public relations campaigns to educate consumers about the costly effects of fuel subsidies.

3. How Have Price Policies Changed Over Time?

Unfortunately, these studies are limited by the inconsistent measurement of fossil fuel taxes and subsidies. Although there are more data on gasoline prices in particular compared to other types of fossil fuel subsidies, measures of gasoline subsidies are still insufficient for a close analysis of the many mechanisms hypothesized in the literature. The state-of-the-art data have been limited to a single price every other year for most countries, which is far too infrequent to allow for proper study of policy changes and the impact of the hydrocarbon sector on prices. To address this lacuna, we collect retail gasoline prices at the monthly level for 157 countries from 2003 to 2015.[9]

Following previous studies, we measure implicit taxes and subsidies using the price gap method, which is simply the difference between the observed retail price in each country and a global benchmark price.[10] This approach is appropriate to the topics introduced above because it yields a single figure that represents the net per-unit value of all taxes and subsidies. It also provides a measure that can be readily compared across countries

[9] Data were collected from primary sources such as national government ministry reports and websites, central banks, state-owned enterprises, and government decrees. Secondary sources included documents and data from, among others, the European Commission, FAO, OAPEC, and the World Bank and IMF. Where possible, we used prices from the first day or week of the month as the monthly price for regular-graded gasoline (between 87 and 90 octane). Further details on the data collection process, including a summary of primary and secondary sources used to assemble price data, can be found in Ross, Hazlett, and Mahdavi 2017.

[10] We use the spot price for conventional refined gasoline at the New York Harbor as reported by the US Energy Information Agency. This benchmark price represents the marginal cost of supplying gasoline to consumers in importing countries; for exporting countries it represents the opportunity cost to the government of selling gasoline to the international market. To simplify our analysis we assume local distribution costs are fixed for all countries and years at 10 cents per liter in constant 2015 US dollars. This estimate is drawn from Coady et al. (2015), which uses a similar figure for the cost of bringing refined gasoline to retailers. Though distribution and other local costs may vary by location, we expect those unobserved differences to change slowly, and thus may affect cross-country comparisons but not within-country comparisons over time.

and over time, as we derive prices in constant 2015 US dollars from observed retail prices in local currencies per liter of gasoline.[11]

3.1. Global trends in gasoline subsidies and taxes

From 2003 to 2015, global gasoline prices increased slightly by a compound annual growth rate (CAGR) of 2.22 percent (Figure 1). In this same time period, the mean gasoline tax across all countries rose at a similar CAGR of 1.44 percent. But since these countries have varying rates of gasoline consumption, a more appropriate metric to capture the global per-liter average tax is calculated by weighting each country's price by its gasoline consumption in that year. This consumption-weighted measure paints a different picture of how subsidies have changed over time: the implicit global mean tax, weighted by gasoline consumption, fell by a CAGR of 1.18 percent (Figure 2).

[Figure 1 here]

[Figure 2 here]

Both Figures 1 and 2 display a number of countries with prices routinely below the benchmark, indicative of durable implicit gasoline subsidies over time; note that the y-axis in Figure 1 represents prices whereas in Figure 2 we use our measure of implicit taxes and subsidies. Who are these subsidizers? If we look at the relationship between average taxes/subsidies and average petroleum wealth across the 2003-2015 period, it becomes clear that the countries with the lowest taxes and highest subsidies are petrostates (Figure 3).

[Figure 3 here]

The relationship holds when we use measures based on net exports, such as oil exports per capita (Figure 4) or the World Bank WDI measure of fuel exports as a percentage of total exports (Figure 5). Indeed, these latter measures slightly improve the fit of the plotted regression line.[12]

[Figure 4 here]

[Figure 5 here]

Countries such as Angola, Ecuador, Malaysia, and the Middle East oil exporters all maintain implicit subsidies, while producers such as Mexico and Russia keep prices only

[11] We use monthly exchange rates from the IMF International Financial Statistics; to convert from nominal to real dollars, we use monthly inflation rates from the US Federal Reserve Economic Database.

[12] A regression of implicit taxes on logged oil income per capita as the independent variable gives an R^2 of 0.167 and F-statistic of 29.8. Regressing taxes on logged exports per capita increases R^2 to 0.288 and the F-statistic to 60.3. Using the WDI measure of fuel exports as a percentage of total exports drops the sample size by 13 states, but the fit improves to an R^2 of 0.337 and F-statistic of 70.5.

slightly above the benchmark price. Indeed, of the twenty-two countries with "persistent subsidies" over time—defined as having a median price below the median benchmark between 2003 and 2015—all were economically dependent on petroleum exports.[13]

Countries with no oil income are all comfortably above the benchmark, though there remains considerable variation in taxes across these states. However, the data also reveal that petroleum wealth does not necessitate subsidized fuel: some of the highest gasoline prices in the world are found in the European oil and gas producers of Denmark, the Netherlands, and Norway.

Turning to the temporal aspect of the data, how did taxes and subsidies change over time within countries? In Figure 6, we compare each country's prices (in real 2015 US dollars) in the first six months of 2003 (x-axis) to prices in first six months of 2015 (y-axis), with the size of each country label proportional to average gasoline consumption across the period.

[Figure 6 here]

Countries above the 45-degree diagonal had higher taxes in 2015 than in 2003, while those below had lower taxes; the majority of countries fall along or near the diagonal, suggesting that price policies remained largely constant in these states. Only two states exhibited noticeable subsidy-to-tax reforms in the timeframe of study: Angola and Yemen, both in the top left quadrant of the figure. Similarly, only two states reverted from taxes to subsidies: Malaysia, only slightly so, and Trinidad, both in the bottom right quadrant. The figure also reveals countries such as Malawi and Mauritania where implicit taxes increased substantially in real terms, from $0.50/liter and $0.27/liter in 2003 to $1.12/liter and $0.85/liter in 2015, respectively. In contrast, implicit taxes in countries such as Bolivia and Chad declined over time, from $0.80/liter and $0.45/liter in 2003 to $0.25/liter and $0.13/liter in 2015, respectively.

3.2. Varieties of gasoline pricing policies

The data also reveal different categories of pricing policies in terms of month-to-month variation. Despite the variation in implicit tax amounts, most countries plotted in Figure 1 have prices that largely track changes in the benchmark. Hence we see a host of trend lines moving in parallel but with different intercepts. These countries exhibit market-based prices wherein month-to-month changes in the benchmark are largely passed on to consumers. On the other end of the spectrum are the group of countries, typically below

[13] Medians are calculated across the full 2003-2015 period, such that a country can still be a persistent subsidizer if its local price is on occasion above the benchmark. The persistent subsidizers group comprises Algeria, Angola, Azerbaijan, Bahrain, Ecuador, Egypt, Indonesia, Iran, Iraq, Kuwait, Libya, Myanmar, Malaysia, Nigeria, Oman, Qatar, Saudi Arabia, Sudan, Trinidad and Tobago, United Arab Emirates, Venezuela, and Yemen. By "economically dependent on petroleum exports" we mean fuel exports made up more than 15 percent of total merchandise exports, averaged over the 2003-15 period, according to data from the World Development Indicators.

the benchmark, with relatively flat prices that change only sporadically. These countries exhibit a fixed-price system wherein prices are set by governments with little regard to the month-to-month fluctuation in global prices.

The degree of price fixity—the extent to which prices are regulated by governments or allowed to fluctuate with the market—does not perfectly overlap with the degree of taxation. Figure 7 shows the relationship between average implicit taxes/subsidies in the 2003-2015 period and average price fixity, as measured by the fraction of non-missing months between 2003 and 2015 in which prices exhibited month-to-month changes. A value of "0" reflects a country whose local prices remained perfectly flat throughout the 2003-2015 period; a value of "1" indicates that prices changed every month (if not every day). Countries with consecutive months of missing prices are not assigned a fixity value. Countries are loosely sorted into quadrants using the thresholds of relatively fixed vs. variable prices (x-axis) and of implicit taxes versus subsidies (y-axis).

[Figure 7 here]

While all of the twenty-two persistent subsidizers have fixed prices, there are forty-three states with implicit taxes and fixed prices, with changes at most once every two months (top left quadrant of Figure 7). The majority (twenty-seven) of these countries are in sub-Saharan Africa, where governments regulate prices based on smoothing formulas in order to shield consumers from the volatility of global supply costs. The Central African Republic, for example, maintains highly fixed prices—changing only eleven times in 156 months—that include some of the highest taxes in the developing world.[14] Other states with relatively fixed prices and net implicit subsidies include Bangladesh, Gabon, Paraguay, Tunisia, and Uzbekistan.

Policies in the group of persistent subsidizers—countries with fixed-price systems and net implicit subsidies—have changed in light of the oil price collapse of summer 2014. The average retail price of gasoline in these states included a $0.42/liter net subsidy in January 2014; by June 2016, the average subsidy dropped to $0.07/liter (Figure 4).

[Figure 8 here]

Feeling the pressure of sustained low prices, governments in these oil-exporting states have begun reforming long-established subsidies. Four of these states have net implicit taxes as of June 2016: Angola, Nigeria, Sudan, and Yemen. Others, such as Bahrain, Iran, Oman, Saudi Arabia, and Venezuela have increased prices but still remain subsidizers.[15]

[14] The average retail price of gasoline in CAR between 2003 and 2015 is $1.72/liter in constant 2015 dollars, with implicit taxes of $1.02/liter.

[15] Venezuela's retail price of 6 Bolivars per liter in June 2016 is above the benchmark price, if we use the official exchange rate of 9.975 bolivar to 1 US dollar. If we use black market exchange rates (which range up to 1,500 bolivar per 1 US dollar), it is far below the benchmark of $0.49 per liter in June 2016.

Yet nearly all of these states continue to maintain fixed prices.[16] This implies that when global oil prices rise, net taxes in these states will likely revert to net subsidies. Consider the case of Nigeria, where in May 2016 the government raised prices for the first time in sixteen months, rising by 67% to 145 naira per liter ($0.72/liter). Should the price of oil increase, and with it the global market price for gasoline, the Nigerian government could return to a system of high implicit subsidies by simply doing nothing and maintaining the fixed price of its gasoline. The same pattern would hold true in Sudan and Venezuela. These kinds of cases raise the interesting, and to this point largely unexamined, question of whether subsidy reform is meaningful without changes to price fixity.

3.3. Fuel discoveries and pricing policies

The composition of major petroleum-exporting states can change over time with the declining exports from countries such as Indonesia and Egypt, and the discovery of giant oil and gas fields in new places such as Ghana and Uganda. What impact do these new discoveries have on fossil fuel subsidies? While there is little discussion, let alone consensus, in the scholarly literature on this question, we can form an initial understanding of these impacts by again looking to the gasoline price database. Here we briefly review three interesting cases of large hydrocarbon discoveries in emerging markets: Bolivia, Brazil, and Vietnam.

The Incahuasi gas and condensate field in southeastern Bolivia, discovered in October 2004, is currently the country's largest gas field. Its discovery cemented Bolivia as a major energy exporter in South America, second only to Venezuela in natural gas supply. Prior to this and other major gas discoveries, Bolivia maintained fossil fuel subsidies using a regulated but flexible price system: from January 2000 to October 2004, prices were changed about once every two months. But two months after the Incahuasi discovery, the government fixed the price of gasoline at 4.79 Bolivianos or roughly $0.75 per liter—a price which has remained fixed ever since (Figure 5).[17]

[Figure 9 here]

In Brazil, the Jubarte-Campos oil discovery in January 2001 prompted a wave of new offshore discoveries and spurred the country's oil resurgence. Much like Bolivia, prices in Brazil prior to these discoveries were regulated by the government, albeit with low taxes instead of subsidies (Kojima 2013). In the two years after the Campos discoveries, however, implicit taxes on gasoline fell 35% from $0.81/liter in January 2001 to $0.53/liter in December 2003 (Figure 6). While we cannot infer any causal relationship between the two, anecdotal evidence suggests that the government used revenues from the oil resurgence (and revenues from the marketing of oil products) to finance implicit subsidies, particularly cross-subsidies for LPG and diesel (de Oliveira and Laan 2010).

[Figure 10 here]

[16] Trinidad is the exception, with prices that fluctuate monthly.
[17] Bolivia's government attempted price reforms in December 2010 to raise fuel prices between 57% and 73%, only to be met with protests and riots.

Vietnam experienced a wave of oil and gas discoveries in 2003-2005, with two major finds bookending the period: the White Lion giant gas field in November 2003 and the Te Giac Trang giant oil field in August 2005. Vietnam's government historically regulated fuel prices to smooth out market fluctuations (Kojima 2013). Yet since these major discoveries, implicit taxes on gasoline have not only increased but prices have also become more volatile (Figure 7).

[Figure 11 here]

Far from a comprehensive assessment of the impact of discoveries, these three cases offer an initial glimpse of how prices respond to major oil and gas finds. While in Bolivia and Brazil, new petroleum discoveries prompted price fixity and lower taxes, respectively, in Vietnam these discoveries ushered in higher prices and greater price volatility. The differences across these cases points to the need for more systematic research in order to discern which patterns predominate across emerging markets, particularly in countries with little prior experience in petroleum production.

Using our measures of implicit taxes and subsidies, we find that overall there has been a rapid growth in the size of subsidies after 2003, when rising global oil prices created a growing wedge between the international supply cost of fossil fuels and the fixed prices of many oil-producing states. While this wedge narrowed as oil prices collapsed following August 2014, the continuance of price fixity policies may set the stage for the return of subsidies when prices increase once again.

5. Concluding Thoughts and Directions for Future Research

The collapse in oil prices since August 2014 has led to far-reaching changes in the subsidies landscape, which are not yet widely appreciated. Pre-tax consumer subsidies for gasoline and diesel, which had been the focus of campaigns by both intergovernmental organizations and non-governmental organizations, have shrunk while post-tax subsidies have mushroomed. This new landscape suggests new areas for research. For example, rather than focus narrowly on the question of pre-tax subsidies, scholars could instead look at the broader issue of prices – whether or not they connote pre-tax subsidies – and hence also address the broader question of post-tax subsidies.

Our literature review highlights both substantial progress and important deficits in the fossil fuel subsidies literature, emphasizing the need for an improved understanding of government policies and why they change over time. The data we present on implicit gasoline taxes and subsidies offers a first step toward a deeper analysis of these policies. Together our literature review and data suggest four new research directions.

5.1. The sources of changing taxes and subsidies

Above we summarize the apparent correlation between fossil fuel exports and government pricing policies; a logical next step would be to causally identify some important sources of policy change. One avenue of research might entail a closer look at the effects of oil shocks – perhaps from new discoveries or global price shocks – on both tax and subsidy levels, and on price fixity. Other possible (and measurable) sources of policy change could include elections, changes in political leadership, changes in government accountability, fiscal or monetary crises, and IMF conditionality.

5.2. The sources of changing fixity policies

The oil price collapse may have temporarily erased the problem of pre-tax consumer subsidies for gasoline and diesel, but it appears to have had little effect on the more difficult problem of fixity reform. Without a mechanism for regular price adjustments, post-tax subsidies will reappear once oil prices rise. It is not obvious that changes in tax and subsidy levels and changes in fixity policies are caused by the same mechanisms. Research on changes in price fixity would be an important complement to research on changes in taxes and subsidies, and could have important implications for policymakers.

5.3. Price policies for coal, natural gas, and non-gasoline fuels

Our review highlights the need for detailed, cross-national data on subsidies and taxes for fossil fuels beyond gasoline, such as coal, natural gas, and fuels such as diesel, propane, kerosene, and residual fuel oils. Global data on price policies for coal and natural gas—despite differences in consumption patterns compared to transportation fuels—would be a critical improvement to the study of subsidies in the electricity sector. Current research is largely limited to electricity subsidies in the OECD countries, along with China and India; future research could uncover the determinants and consequences of variation in price policies and policy reform in the energy sector using new data with broader coverage, particularly in low-income states.

5.4. The microfoundations of subsidies and subsidy reform

Little attention has been devoted to the microfoundations of fossil fuel price policies, particularly the issue of behavioral responses to price policies and reforms. This includes, for example, how typical consumers perceive gasoline taxes and subsidies, what they believe is a "fair" price, and how they respond to changes in prices. In fact, there is a behavioral economics literature on perceptions of price fairness (Kahneman et al. 1986a, 1986b, Bolton et al. 2003) and responses to price changes (Tversky and Kahneman 1991, Morewedge et al. 2009), that might ultimately provide clues about how citizens respond to changing prices.

There are also many empirical studies on the price elasticity of consumer fuel demand (e.g., Brons et al. 2008, Havranek et al. 2012, Levin et al. 2015), differences in consumer responses to price changes and tax increases (Dieler et al. 2014, Rivers and Schaufele 2015), and consumer expectations about future prices (Anderson et al. 2011). Most of these studies are based on data from OECD states; one exception is a recent study by

Arzaghi and Squalli (2015) that estimates price and income elasticities for gasoline demand in 32 fuel-subsidizing countries.[18]

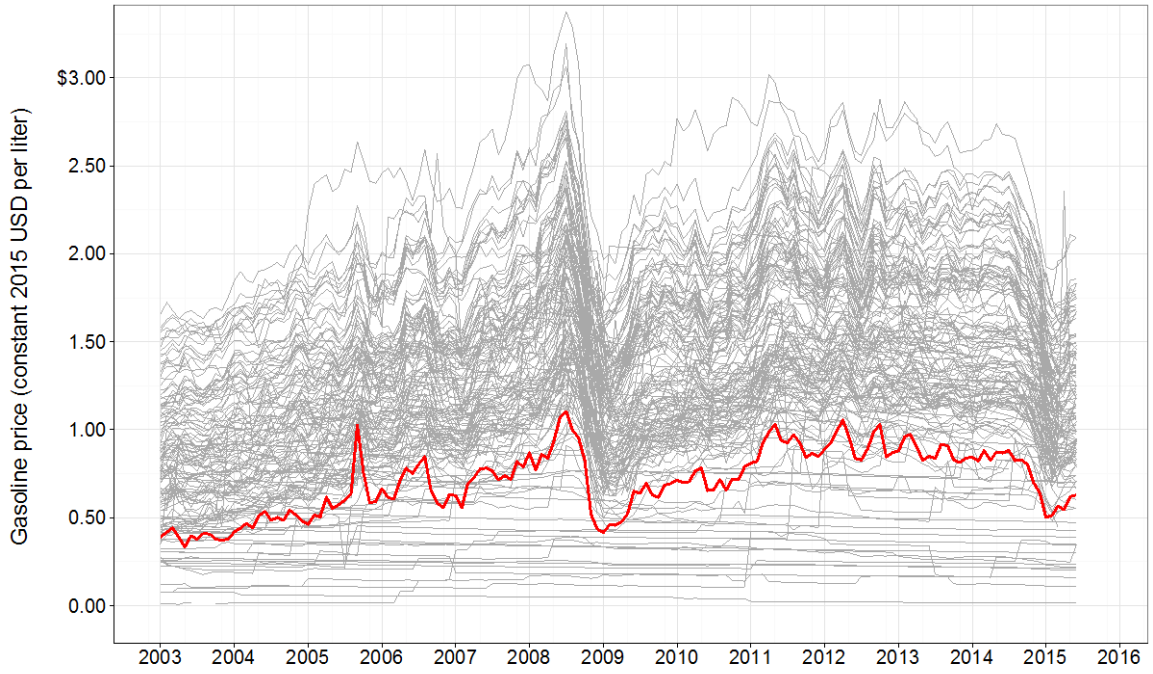
A richer understanding of the microfoundations of fuel prices and price reforms could ultimately yield insights into how governments effectively change entrenched policies. To discover the specific mechanisms underlying consumer attitudes towards fuel prices and policy reforms, researchers could employ behavioral experiments and randomized survey experiments. For example, researchers could build on randomized control trials of government service provision to see whether the trust in government gained by citizens as a result of effective service delivery can affect public support for subsidy reform. In addition, researchers could design survey experiments to measure consumer reactions to subsidy reform based on different scenarios of how governments would distribute post-reform surpluses. These studies would be particularly appropriate to undertake in fuel-exporting countries considering the removal of pre-tax subsidies or fixed-price policies.

5.5. Concluding thoughts

The taxes and subsidies that governments place on fossil fuels have far-reaching consequences, but they have been difficult for scholars to analyze – beyond a handful of OECD states – due the scarcity of data. We use a new dataset of monthly prices for 157 countries to begin casting light on these policies and how they vary. Beyond our preliminary analysis, we hope that our data will open up new avenues of research – including those suggested above – for other scholars working in this important area. While the collapse in oil prices since mid-2014 has changed the subsidies landscape, many challenges lie ahead for policymakers working to develop energy policies that meet critical fiscal, environmental, and political objectives.

[18] For meta-analyses of the literature on gasoline price elasticities, see Brons et al. (2008), and Havranek et al. (2012).

Figure 1. Real gasoline prices per liter over time, 157 countries 2003-2015.



Note: Individual country price trends are drawn in grey and the global benchmark price (New York Harbor conventional refined gasoline) is shown in bold red.

Figure 2. Implicit taxes/subsidies over time, 157 countries 2003-2015.

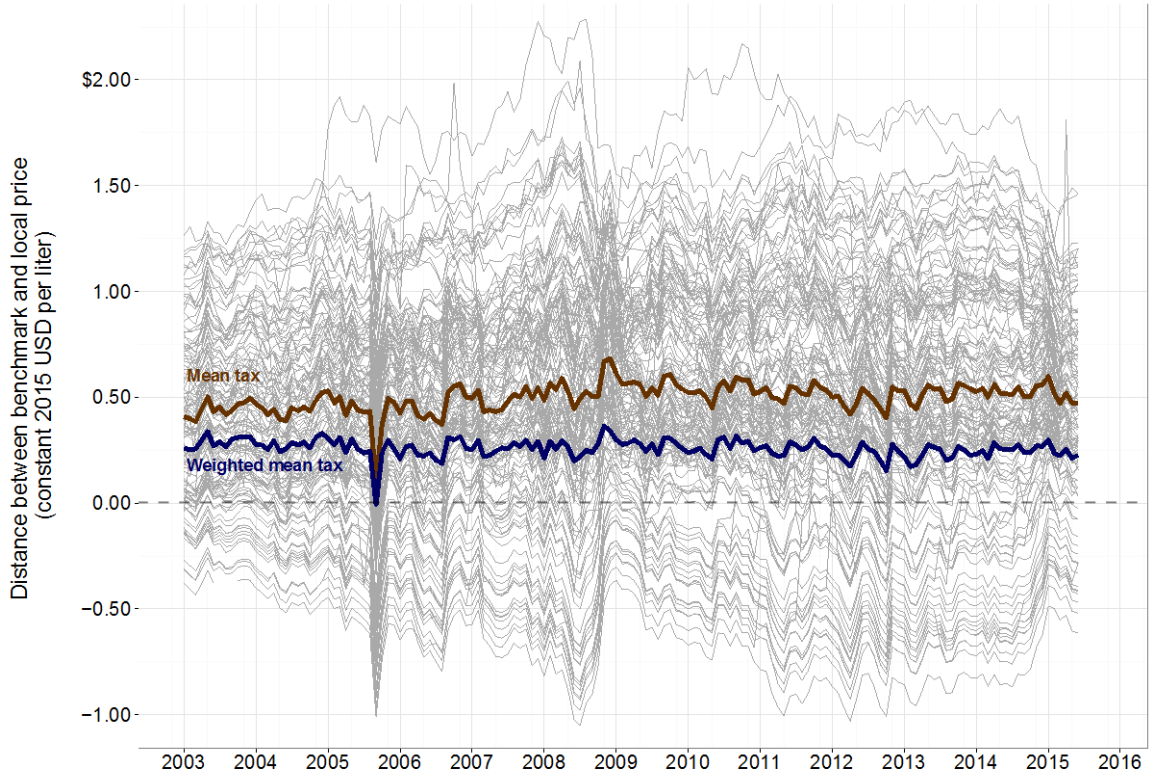
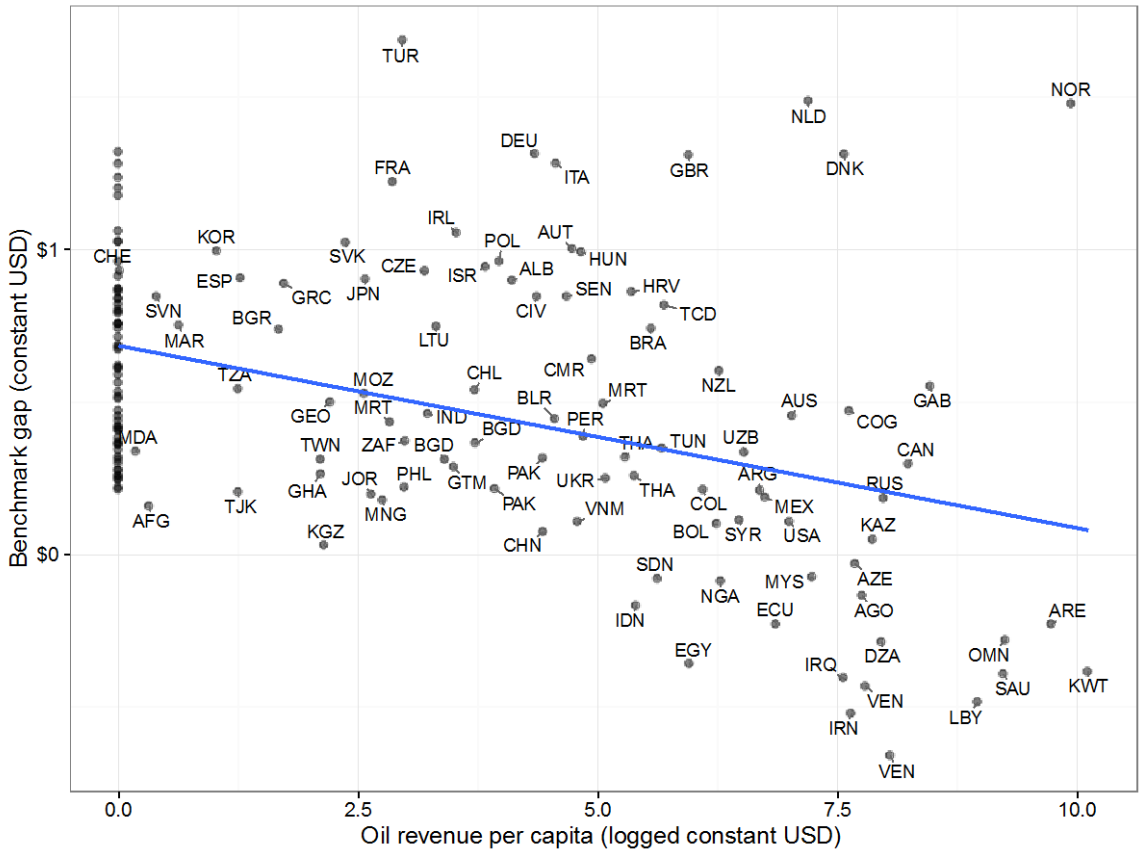
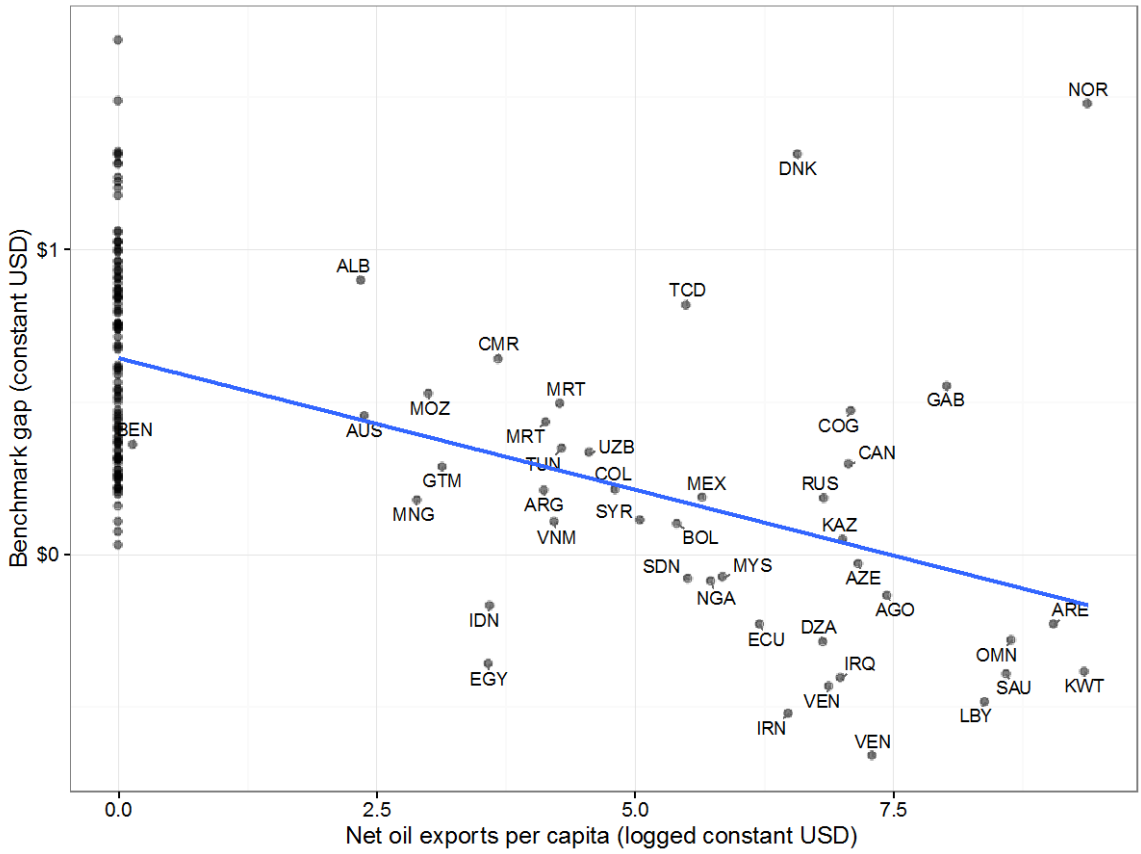


Figure 3. Implicit taxes/subsidies vs. oil income per capita (logged), country averages 2003-2015.



Note: benchmark gap refers to the distance between the local price and the global benchmark in constant 2015 US dollars per liter. Oil revenue per capita is calculated annually as oil production times oil price divided by population, and averaged across the 2003-2015 period.

Figure 4. Implicit taxes/subsidies vs. net oil exports per capita (logged), country averages 2003-2015.



Note: countries with net oil imports (negative net oil exports per capita) are fixed at 0 in the plot.

Figure 5. Implicit taxes/subsidies vs. fuel exports as percentage of total exports, country averages 2003-2015.

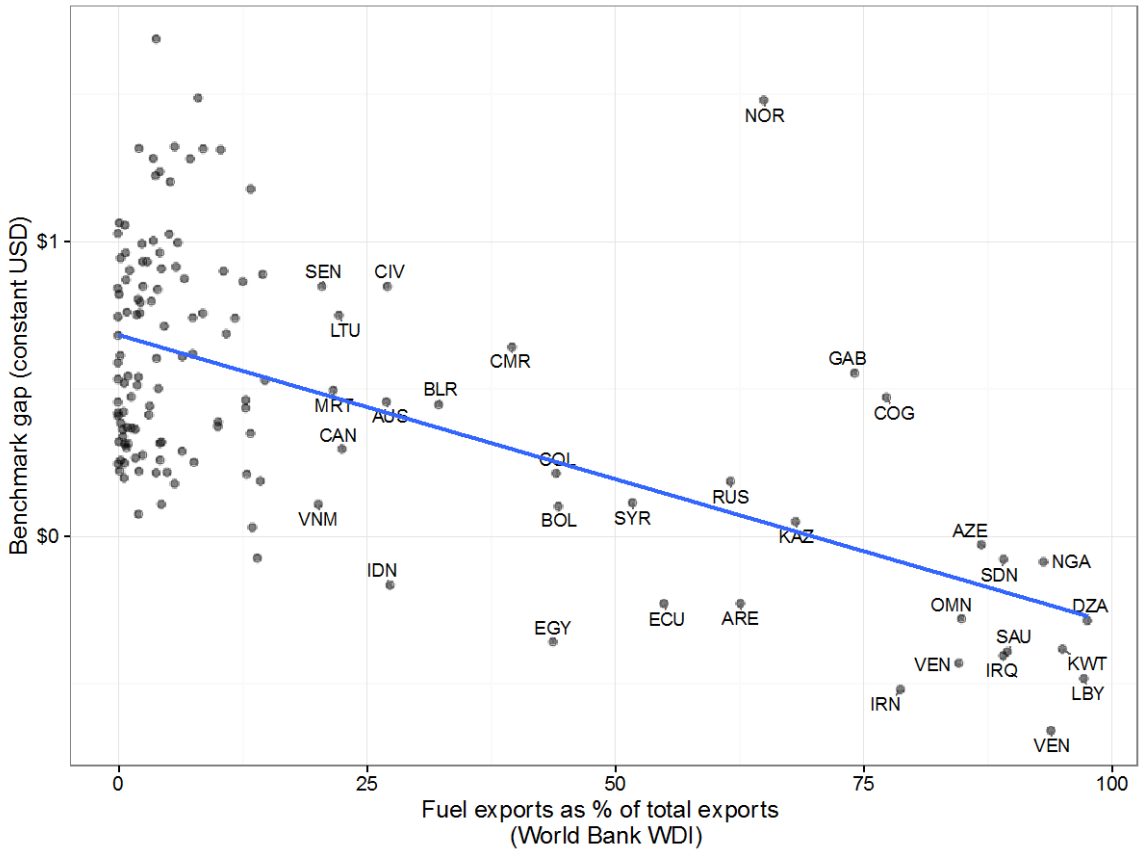
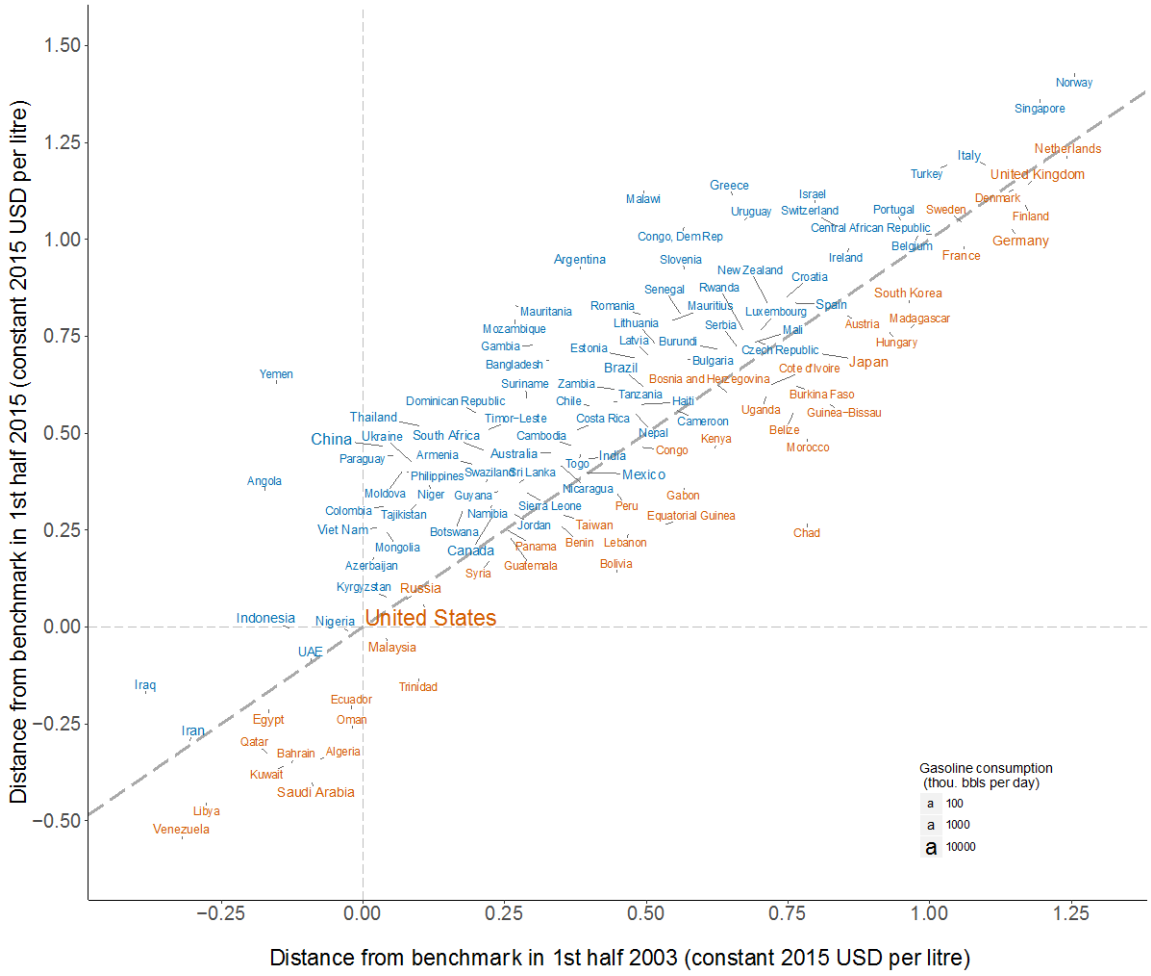


Figure 6. Price policies compared, first half 2003 vs. first half 2015.



Note: countries above the 45-degree dashed line increased their net taxes or reduced their net subsidies between January-June 2003 and January-June 2015, while countries below the 45-degree line reduced their net taxes or increased their net subsidies over the same period. Text size of each country is proportional to average gasoline consumption.

Figure 7. Implicit taxes/subsidies vs. price fixity, country averages 2003-2015.

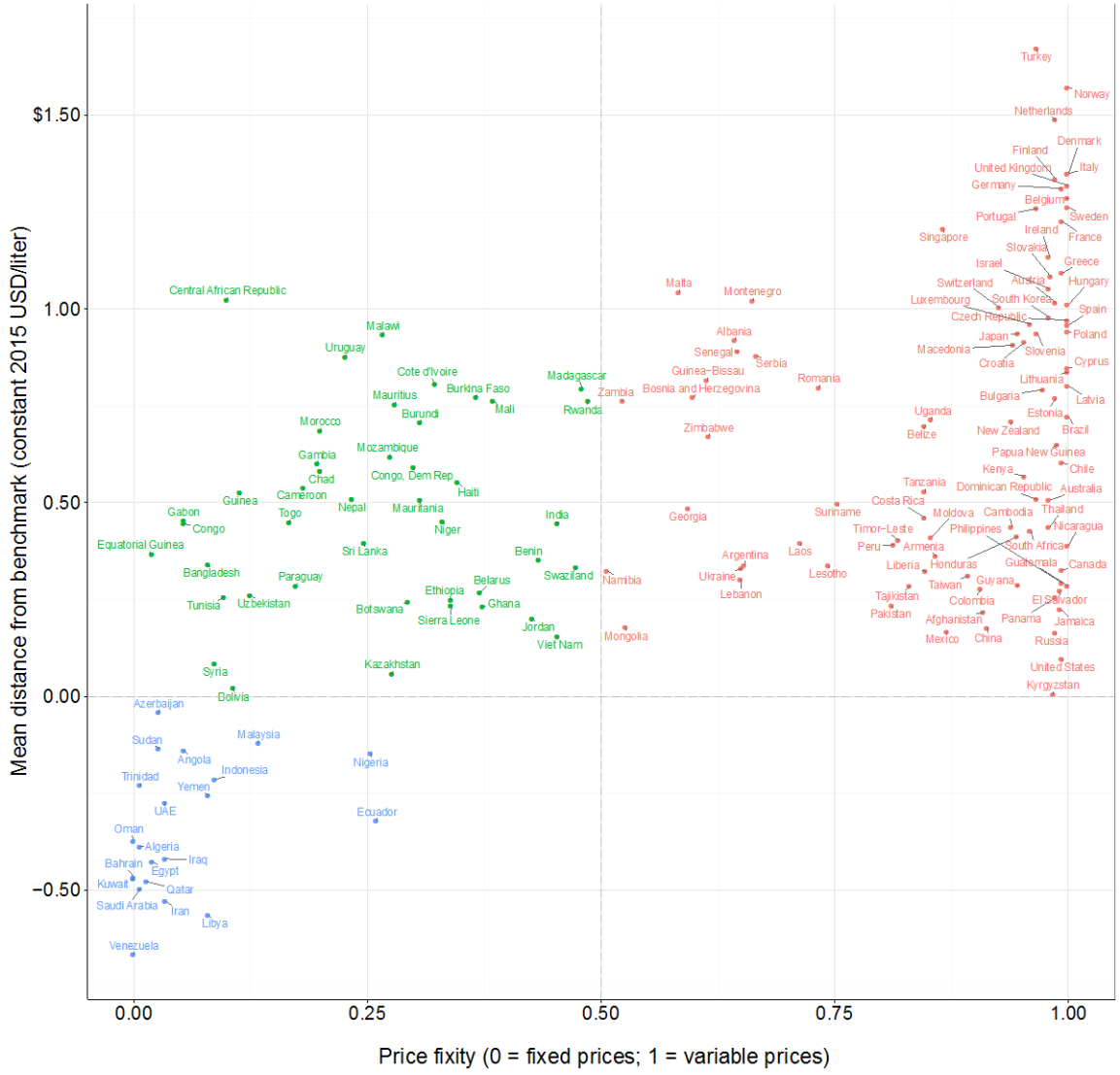


Figure 8. Implicit taxes/subsidies over time for selected countries, 2014-2016.

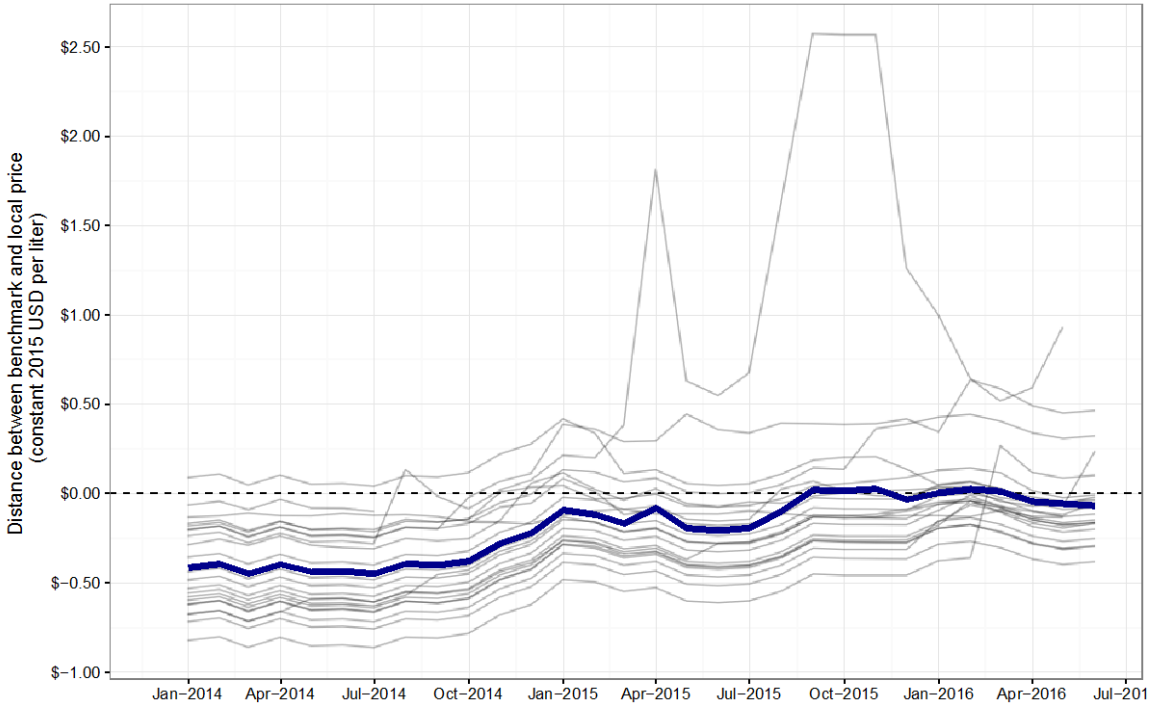


Figure 9. Bolivia

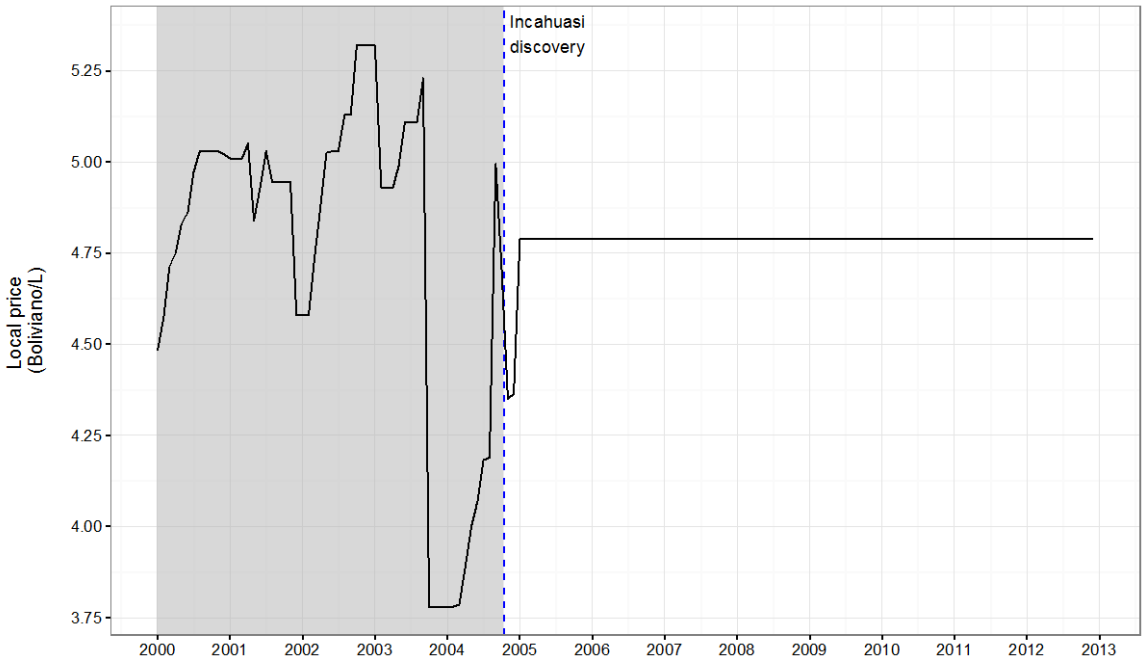


Figure 10. Brazil

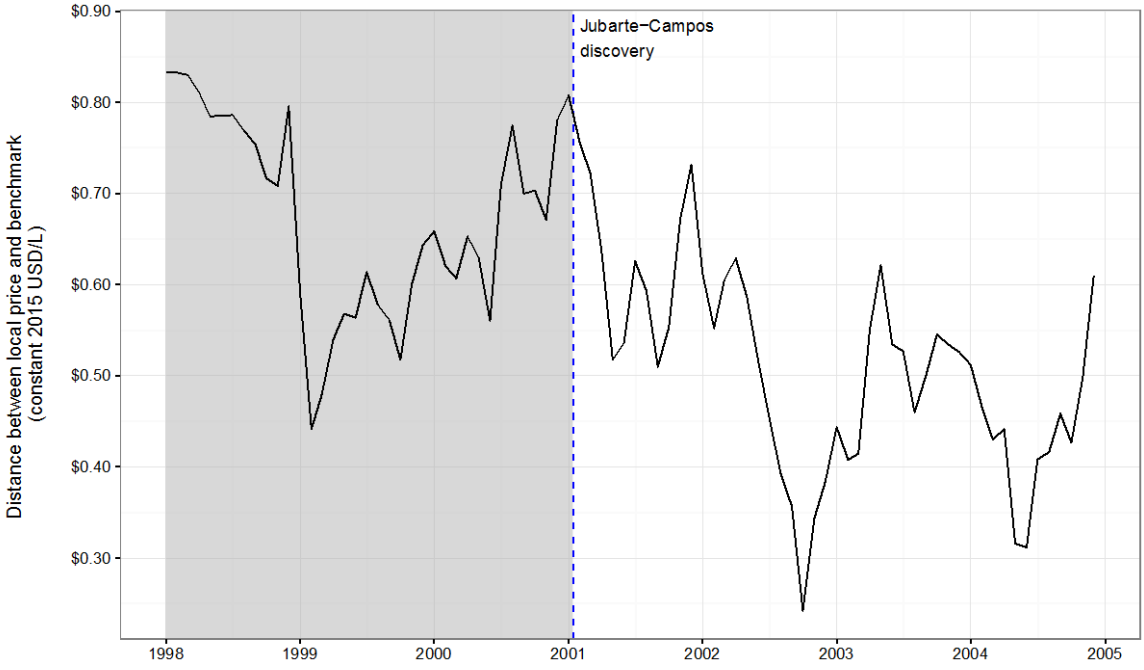
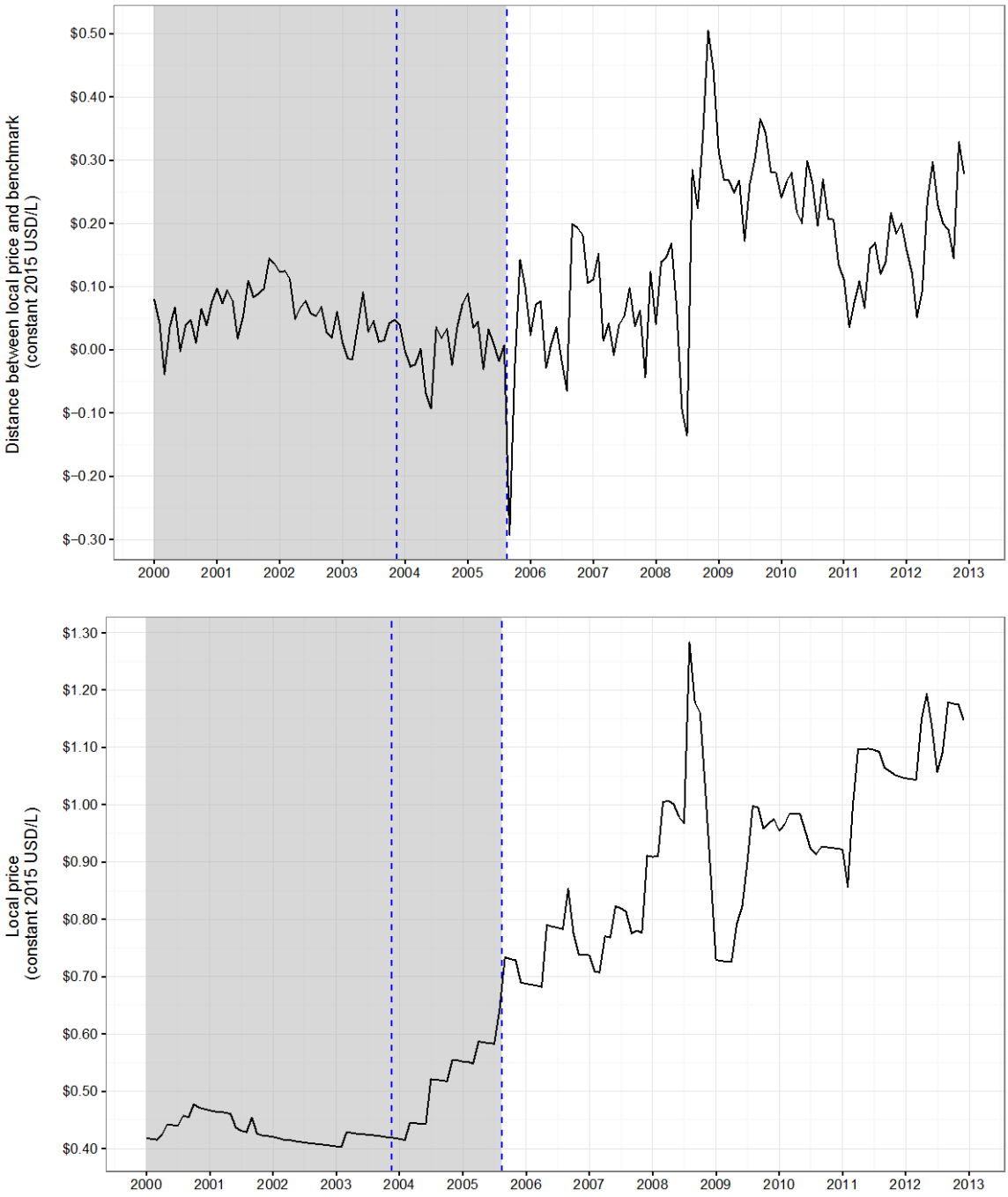


Figure 11. Vietnam



References

Aghion, Philippe, Antoine Dechezleprêtre, David Hémous, Ralf Martin, and John Van Reenen. "Carbon Taxes, Path Dependency, and Directed Technical Change: Evidence from the Auto Industry." *Journal of Political Economy* 124, no. 1 (2016): 1–51.

Arze del Granado, Francisco Javier, David Coady, and Robert Gillingham. "The Unequal Benefits of Fuel Subsidies: A Review of Evidence for Developing Countries." *World Development* 40, no. 11 (2012): 2234–48.

Bast, Elizabeth, Alex Doukas, Sam Pickard, Laurie van der Burg, and Shelagh Whitley. "Empty Promises," Overseas Development Institute, 2015.

Brons, Martijn, Peter Nijkamp, Eric Pels, and Piet Rietveld. "A Meta-Analysis of the Price Elasticity of Gasoline Demand. A SUR Approach." *Energy Economics* 30, no. 5 (2008): 2105–2122.

Charap, Mr Joshua, Mr Arthur Ribeiro da Silva, and Mr Pedro C. Rodriguez. "Energy Subsidies and Energy Consumption: A Cross-Country Analysis." International Monetary Fund, May 16, 2013.

Cheon, Andrew, Johannes Urpelainen, and Maureen Lackner. "Why Do Governments Subsidize Gasoline Consumption? An Empirical Analysis of Global Gasoline Prices, 2002–2009." *Energy Policy* 56 (2013): 382–390.

Clements, Benedict, David Coady, Stefania Fabrizio, Sanjeev Gupta, Trevor Alleyne, and Carlo Sdralevich. "Energy Subsidy Reform: Lessons and Implications (Washington: International Monetary Fund)," 2013.

Coady, David, Mr Javier Arze del Granado, Luc Eyraud, and Ms Anita Tuladhar. *Automatic Fuel Pricing Mechanisms with Price Smoothing: Design, Implementation, and Fiscal Implications*. International Monetary Fund, 2013..

Coady, David, Ian WH Parry, Louis Sears, and Baoping Shang. "How Large Are Global Energy Subsidies?" International Monetary Fund, 2015.

Davis, Lucas W. "The Economic Cost of Global Fuel Subsidies." *The American Economic Review* 104, no. 5 (2014): 581–585.

de Oliveira, Adilson and Tara Laan. "Lessons Learned from Brazil's Experience with Fossil Fuel Subsidies and their Reform." International Institute for Sustainable Development, Geneva. 2010.

Fattouh, Bassam, and Laura El-Katiri. "A Brief Political Economy of Energy Subsidies in the Middle East and North Africa." *International Development Policy*, 2016.

———. "Energy Subsidies in the Middle East and North Africa." *Energy Strategy Reviews* 2, no. 1 (June 2013): 108–15.

Frondel, Manuel, Rainer Kambeck, and Christoph M. Schmidt. "Hard Coal Subsidies: A Never-Ending Story?" *Energy Policy* 35, no. 7 (2007): 3807–3814.

Griggs, David J., and Maria Noguer. "Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change." *Weather* 57, no. 8 (2002): 267–269.

Gupta, Sanjeev, and Walter Mahler. "Taxation of Petroleum Products: Theory and Empirical Evidence." *Energy Economics* 17, no. 2 (1995): 101–116.

Havranek, Tomas, Zuzana Irsova, and Karel Janda. "Demand for Gasoline Is More Price-

Inelastic than Commonly Thought." *Energy Economics* 34, no. 1 (2012): 201–207.
Hochman, Gal, and David Zilberman. "Fuel Prices across Countries: Dissecting the Political and Economic Factors," 2013.
International Energy Agency. *Looking at Energy Subsidies: Getting the Prices Right*. World Energy Outlook, 1999.
Kojima, Masami. "Fossil Fuel Subsidy and Pricing Policies: Recent Developing Country Experience." *World Bank Policy Research Working Paper*, no. 7531 (2016).
———. "Government Response to Oil Price Volatility: Experience of 49 Developing Countries," 2009.
———. "Oil Price Risks and Pump Price Adjustments." *World Bank Policy Research Working Paper*, no. 6227 (2012).
———. "Petroleum Product Pricing and Complementary Policies: Experience of 65 Developing Countries since 2009." *World Bank Policy Research Working Paper*, no. 6396 (2013).
Kojima, Masami, and Doug Koplow. "Fossil Fuel Subsidies: Approaches and Valuation." *World Bank Policy Research Working Paper*, no. 7220 (2015).
Koplow, Doug. "Measuring Energy Subsidies Using the Price-Gap Approach: What Does It Leave Out?" SSRN Scholarly Paper. Rochester, NY: Social Science Research Network, August 1, 2009.
Larsen, Bjorn, and Anwar Shah. "World Energy Subsidies and Global Carbon Emissions." Public Economics Division, World Bank, 1992.
Lin, Boqiang, and Zhujun Jiang. "Estimates of Energy Subsidies in China and Impact of Energy Subsidy Reform." *Energy Economics* 33, no. 2 (2011): 273–283.
Lin, Boqiang, and Aijun Li. "Impacts of Removing Fossil Fuel Subsidies on China: How Large and How to Mitigate?" *Energy* 44, no. 1 (2012): 741–749.
McFarland, Will, and Shelagh Whitley. "Fossil Fuel Subsidies in Developing Countries." Overseas Development Institute, August 2014.
Paga, Enrique, and Fatih Birol. "Domestic Pricing of Petroleum Products in OPEC Member Countries–an Overview." *OPEC Review* 19, no. 1 (1995): 15–36.
Parry, Ian WH, Mr Dirk Heine, Eliza Lis, and Shanjun Li. *Getting Energy Prices Right: From Principle to Practice*. International Monetary Fund, 2014.
Rentschler, Jun, and Morgan Bazilian. "Reforming Fossil Fuel Subsidies: Drivers, Barriers and the State of Progress." *Climate Policy*, 2016, 1–24.
Ross, Michael L, Chad Hazlett, and Paasha Mahdavi. "Global progress and backsliding on gasoline taxes and subsidies." *Nature Energy*, 2, no. 16201 (2017)
Sdralevich, Mr Carlo A., Miss Randa Sab, Mr Younes Zouhar, and Giorgia Albertin. *Subsidy Reform in the Middle East and North Africa: Recent Progress and Challenges Ahead*. International Monetary Fund, 2014.
Segal, Paul. "How to Spend It: Resource Wealth and the Distribution of Resource Rents." *Energy Policy* 51 (2012): 340–348.
Storchmann, Karl. "The Rise and Fall of German Hard Coal Subsidies." *Energy Policy* 33, no. 11 (2005): 1469–1492.
Strand, Jon. "Political Economy Aspects of Fuel Subsidies: A Conceptual Framework." *World Bank Policy Research Working Paper*, no. 6392 (2013).
Terton, Anika, Philip Gass, Laura Merill, Armin Wagner, and Eike Meyer. "Fiscal

Instruments in INDCs: How Countries Are Looking to Fiscal Policies to Support INDC Implementation." International Institute for Sustainable Development, 2015

Vagliasindi, Maria. *Implementing Energy Subsidy Reforms: Evidence from Developing Countries*. World Bank Publications, 2012.

Victor, David G. "The Politics of Fossil-Fuel Subsidies." Global Subsidies Initiative and International Institute for Sustainable Development, 2009