Fossil fuel subsidies, income inequality and poverty. Evidence from developing countries

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Fossil fuel subsidies, income inequality and poverty Evidence from developing countries[☆]

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Abstract

The past two decades have witnessed widespread attempts to reform fossil fuel subsidies in developing countries. If the reforms are likely to improve economic efficiency, the expected effects on income distribution and poverty are more controversial. This paper reviews the recent literature that examines the impacts of fossil fuel subsidies and their reform on income inequality and poverty. It identifies the different channels that have been explored in the literature and surveys the empirical evidence on the importance of these channels in practice. Drawing on diverse country experiences, it also discusses why fossil fuel subsidies are particularly challenging to reform and highlights several ways in which efforts to reform may be feasible and successful.

Keywords: fossil fuel subsidies, developing countries, distributional impact, subsidy reform

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1. Introduction

Throughout the world, and particularly in developing countries,[1] the energy sector has been subjected to heavy-handed governmental interventions. Across countries and time periods, governments have responded to high fuel prices by making extensive use of a broad array of subsidies instruments to offset higher prices. The different dimensions covered by these instruments include government intervention in market operations in order to affect costs or prices, direct transfer of funds to recipients, excise-tax concession on fuel, under-pricing of access to a natural resource harvested by final consumer, regulated price (IEA et al., 2010). For developing economies, the most commonly articulated reason to regulate fossil fuel prices is based on distributional concerns (Commander, 2012): the aim is not only to protect local industries –notably energy intensive industries– and domestic consumers from volatile international prices, but also households with low incomes by facilitating their energy access.

For decades, fossil fuel subsidies have led to a number of economic inefficiencies and have also contributed negatively towards the protection of the environment (through increased emissions of greenhouse gas and other air pollutants).[2] Fossil fuel subsidies also create winners and losers among households. The literature has put a great emphasis on their negative impact on income distribution. It has been argued that such distortions have added to inequality since in most developing countries richer households tend to capture the bulk of subsidies, skewing the existing income distribution. Furthermore they tend to reduce fiscal space for other spending items –such as health and education– that are more beneficial to lower income households. It is indeed striking to note that fossil fuel subsidies remain disproportionately important in developing countries, compared to the relatively small shares of public social spending (Bril-Mascarenhas and Post, 2015).

These adverse effects have created incentives for significant policy reforms at global and national levels. In the 2009 G20 summit, heads of state stated that the reform of inefficient fuel subsidies was a central theme of their policy agenda. This commitment has been repeated in the 2016 G7 summit, where the largest advanced economies came to the agreement that fossil fuel subsidies would be completely removed by 2025. Fossil fuel subsidy removal has also become an issue of greater significance to the international community, being now an important item of the new United Nations sustainable development agenda adopted by world leaders in September 2015. Finally, the Paris Agreement at COP21 in 2015 has provided a further impetus for reform.

Over the past decade, several countries have managed to reform their subsidies successfully, yet phasing out fossil fuel subsidies is still a major global challenge. In 2016,

[1] By developing countries, we refer to countries that are not classified as advanced economies.

[2] As an illustration, Stefanski (2014) estimates that, between 1980 and 2010, 36% of global carbon emissions were driven by fossil fuel subsidies.

fossil-fuel consumption subsidies still accounted for an estimated total of $260 billion, against $241.6 billion for investment in renewable energy excluding large hydro (IEA, 2017). Although economists have argued against fossil fuel subsidies, vested interests' political forces continue to dominate energy policy in developing countries. Furthermore, increases in relative prices resulting from subsidy reduction/removal negatively affect poverty because poor households usually spend a relatively higher share of their household budget on their spending and often are unable to further reduce their consumption rates (Bacon et al., 2010; Fattouh and El-Katiri, 2013). A critical issue discussed in the literature is therefore to what extent and in what form should adequate compensatory measures that better target the poorest sub-groups be coupled to domestic reforms in the energy sector.

The aim of this paper is to review the evidence on the effects of fossil fuel subsidies and their reform on income distribution and poverty in developing countries. In particular this article aims to address the following questions: what are the mechanisms through which fossil fuel subsidies as well as their removal affect income inequality and poverty? Do experiences vary across countries, across types of fossil fuels and, if so, why? How can the adverse impacts exerted by the removal of fossil fuel subsidies be mitigated? What are the general lessons we can draw from the experience of countries that have been successful in reforming fossil fuel subsidies? To this end, we review and synthesize the recent literature that investigates the impacts of fossil fuel subsidies on income inequality and poverty, as well as the different methodologies that have been used to assess such impacts. We also examine the extent to which reforms can succeed in reversing trends on income inequality and poverty, and we explore the sustainability of these reforms.

The paper proceeds as follows. To set the stage, section 2 begins by reviewing the different definitions and measurement methods of fossil fuel subsidies. In section 3, we summarize the key stylized facts that characterize the importance of fossil fuel subsidies as well as their costs and their distributional impact in developing countries. In section 4, we discuss the issue of fossil fuel subsidy reforms in these economies by reviewing the existing methodologies and their results. Section 5 offers a broad picture of the main motivations and challenges associated with reforming energy subsidies. Section 6 concludes and points out limitations and potential future research direction.

2. Fossil fuel subsidies: conceptual issues

2.1. Defining fossil fuel subsidies

A quick review of the literature shows that there is no common definition or understanding of what constitutes a subsidy. The Global Subsidies Initiative (GSI) provides a broad definition, based on the World Trade Organization's Agreement on Subsidies and Countervailing Measures (WTO, 2016), which reflects the variety of policies that

a subsidy can encompass. In the case of fossil fuels, such policies include the following categories: (i) direct transfers from government budgets to producers and consumers of fossil fuels; (ii) all government revenue forgone in terms of uncollected revenue or levies on extracted fossil fuels and fossil fuels sold to consumer; (iii) goods or services provided below-market rates and/or goods purchased above-market rates and (iv) income or price support (Beaton et al., 2013).[3]

Detailed information on all forms of subsidies is often not readily available. An influencing factor in the provision of information is that some subsidies are themselves based on non-transparent mechanisms. For example, in their study on the Middle East and North Africa (MENA) region, Fattouh and El-Katiri (2013) emphasize several forms of fossil fuel subsidies that can be more difficult to identify and quantify, such as cross-subsidies and implicit subsidies. Cross-subsidies occur when consumer groups pay an energy price higher than its supply costs to support affordable rates to other groups. For example, countries such as Lebanon, Yemen, Egypt, Libya, and Syria all charge their industrial customers considerably higher electricity prices than residential customers. In most South Asian countries and in some Latin American and Caribbean countries (Ecuador, Honduras), industrial electricity tariffs are also higher than residential tariffs (ADB, 2016; Di Bella et al., 2015). Implicit subsidies are less transparent and more difficult to calculate. They typically occur in oil and gas producing countries, where a national oil company can be mandated to sell petroleum products for the domestic market at below-international prices but above-production costs. In this case, the government does not need to make an explicit transfer to compensate the national oil company for financial losses. Hence, the implicit subsidy entails a transfer from the government to the final consumers without such a transfer appearing explicitly on state oil companies' records or in the government budget (Cheon et al., 2015). Finally, in many countries, subsidies suffer from dense administrative channels: they are disbursed not only at the national level, but by state or provincial, county and local governments too, which adds an additional degree of difficulty of recording all subsidies (Koplow, 2009; Vidican, 2015).

Consequently, research on the effects of fossil fuel subsidies has focused on a narrow definition based on consumer and producer subsidies that are easier to measure than others. As such, international organizations summarize the different policies by defining a subsidy, with the Organization for Economic Co-operation and Development (OECD), as *"any measure that keeps prices for consumers below the market level or keeps prices for producers above the market level or that reduces costs for consumers and producers by giving direct or indirect support"* (OECD, 2005) or, with the International Energy Agency (IEA), as *"any government action directed primarily at the energy sector that lowers the cost of energy production, raises the price received by energy producers or low-*

[3]Examples of these four types of subsidies can be seen in Figure A.1 in Appendix.

ers the price paid by energy consumers" (IEA, 2015). The International Monetary Fund (IMF) also proposes a definition of subsidies based on the distinction between consumer and producer subsidies: *"consumer subsidies arise when the prices paid by consumers, including both firms (intermediate consumption) and households (final consumption), are below supply costs, including transport and distribution costs. Producer subsidies arise when prices are above this level"* (Clements et al., 2013).

Producers and consumers subsidies, and in particular the latter which are more important,[4] are then the most commonly studied component of subsidies. But even these subsidies are relatively easier to measure than other forms of subsidies, detailed information by geographic region, beneficiaries (by fuel type, industry, consumer or producer), type of support mechanism, or other attributes, is often not readily available, especially when the analysis requires highly disaggregate data or long periods of time (Sovacool, 2017). The lack of reporting is especially pronounced in developing countries. As a result, most studies often rely on empirical indicators calculated and provided more consistently and systematically by several international organizations.

But, even if one limits the analysis to these latter data, measurement concerns remain. One of the most significant ones is related to the measure of the benchmark or efficient price, i.e. the price that would prevail in the absence of subsidies. Indeed, if the definition of the efficient price is fairly straightforward for producers, it is less direct for consumers. The efficient producer price simply represents the cost of supplying the product to the consumer (or opportunity cost). The definition of the efficient consumer price is less straightforward because, in practice, it should include, in addition to the opportunity cost, additional taxes reflecting the environmental costs (or externalities) associated with energy consumption, and/or reflecting the need to tax all consumption to raise revenue (Coady et al., 2017). This results in country-specific or individual reference prices because quality and definitional problems make it difficult for a similar rule to hold for a large number of countries *vis-à-vis* one given efficient consumer price. Another consequence is that each international organization applies its own definition of the efficient consumer price, resulting in the application of a variety of methods in measuring fossil fuel subsidies (Bárány and Grigonyté, 2015).

[4] According to Merrill (2014), consumer subsidies totaled $548 billion against $88 billion estimated for producer subsidies in 2013. However, it is important to recognize that, in contrast to consumer subsidies, subsidies to producers are harder to quantify.

2.2. Measuring fossil fuel subsidies: differences across international organizations[5]

The simplest and most widely used approach to measure fossil fuel subsidies is the price-gap approach. This approach, as its name suggests, consists in measuring, for each type of fossil fuel consumed or produced, the gap between the current domestic price (actually paid by or officially charged to an end user) and the price that would prevail under free markets (market-based transaction price, net of transport and distribution costs). The amount of subsidies is then calculated by multiplying this price gap by the affected volume produced or consumed (Koplow, 2009). Using the price-gap approach, the IEA provides annual estimates of fossil fuel consumer subsidies for 40 developing countries.[6] Due to its relative simplicity, this approach can easily be implemented and is thus widely used by most empirical studies. However, its suitability for tracking subsidies' patterns across countries and fossil fuel products is questioned for a variety of reasons,[7] the most common being measurement challenges that reduce the accuracy of price-gap calculations. Specifically, prices in the world market are assumed to express the opportunity costs to domestic producers and consumers of a given commodity. In practice, world prices themselves may be affected by subsidies or other distortions. This is why many energy exporting countries and the Organization of the Petroleum Exporting Countries (OPEC) disagree with this approach, arguing that the reference price for energy exporting countries should not be the world price of the fossil fuel but rather its cost of production. Moreover, as reference prices depend on the conditions of the energy market, price-gap calculations do not pick up subsidies across energy sources in a consistent way (Kojima, 2015). Finally, the price-gap approach only measures transfers that affect energy prices to consumers and producers. The partial nature of this approach means that neither policies nor government programs that support industries or economic agents, without influencing the final price, are taken into account (Kojima, 2015). As a consequence, this approach does not provide much guidance for designing or implementing reforms on the ground (ADB, 2016).

More extensive than the price-gap approach in terms of its policy coverage, the second approach –the inventory approach– is based on the WTO definition. This approach then takes into account a wider set of transfers by quantifying supports to energy consumption

[5]There are three methods of assessing subsidies that are usually used: the price-gap approach, the inventory approach, the hidden cost approach. These methods are more complementary than mutually exclusive (Beaton et al., 2013; Kojima, 2015). We focus only on the two first approaches (the price-gap approach and the inventory approach) as the last one (the hidden cost approach) encompasses distortions (such as the excess costs of generating and distributing fuel products that are not covered by revenues from rate-payers) that go beyond the strict definition of subsidies (Kojima, 2015).

[6]Estimates for the three most recent years are freely downloadable from the website of the IEA `http://www.worldenergyoutlook.org/resources/energysubsidies/fossilfuelsubsidydatabase/`

[7]Koplow (2009) provides a detailed discussion of the advantages and limitations of this approach.

through the examination of individual government programs. In particular, the advantage of this approach is that it provides a breakdown of aggregate subsidies, facilitating the design and implementation of reforms (ADB, 2016)). This approach is used by the OECD and involves measuring all fossil fuel subsidies that are explicitly included in the general government budget. The methodology is the same as the one implemented for indicators of agricultural price distortions and consists to provide explicit subsidies estimates through Producer Support Estimates (PSEs) and Consumer Support Estimates (CSEs). However, the OECD does not provide indicators for fossil fuels as comprehensive as for agriculture. Indeed, while this approach gives a real measure of the budgetary cost of government policy distortions by focusing on explicit subsidies, one of its main limitations, compared to the price-gap approach, is the difficulty of obtaining consistent data across countries. As a result, measurement problems are also severe and the comparability across countries and fossil fuels is more of an issue than in the case of the price-gap approach. Finally, estimates fixed on the basis of the inventory approach are not directly comparable with those derived from the price-gap approach. Indeed, while in OECD's estimates, explicit (i.e. on-budget) fuel subsidies are taken account regardless of countries, they relate to fossil fuel-importing countries only, in the estimates provided by the IEA (Kojima, 2015).

The IMF also develops its own approach by taking account of a "Pigouvian" (or "corrective") tax reflecting the environmental costs (or externalities) associated with energy consumption, in addition to other consumption taxes. These environmental costs arise either through fossil fuel combustion (CO2 emissions, outdoor air pollution from fine particulates) or the use of road fuels in vehicles (traffic congestion, accidents and road damage). Therefore, two measures of consumer subsidies exist in the IMF approach: pre-tax and post-tax consumer subsidies. Pre-tax differ from post-tax consumer subsidies in that the benchmark price in the former corresponds to the supply cost while in the latter it also includes all taxes affecting consumption (the "Pigouvian" tax for internalizing environmental externalities and the consumption tax to contribute to revenue objectives). Hence, post-tax are typically much higher than pre-tax consumer subsidies, primarily due to the large environmental cost of energy consumption (IEA, 2015; Clements et al., 2013; Parry et al., 2014). However, while the IMF approach ensures that energy prices reflect the full costs of their use, the extent to which these costs, such as environmental costs, can be directly attributed to the production or use of a particular fuel is widely debated (Kojima, 2015). The database provided by the IMF includes petroleum product subsidies for 176 countries, while the country sample is smaller for other types of energy. Regarding pre-tax subsidy calculations, their main drawback is that they are not strictly comparable across countries and types of fossil fuel, as different methodologies are used, depending on the type of energy. For example, subsidies for petroleum products are calculated by using mainly the price-gap approach and PSEs for OECD countries, whereas

natural gas and coal subsidies are estimated for 56 countries using multiple approaches and multiple data sources (Kojima, 2015).[8]
Table 1 lists the different assessment methods used by these international organizations, including the definition of fossil fuel subsidies, as well as the strengths and weaknesses of each of these methods.

3. Overview of the Evidence

3.1. The importance of fossil fuel subsidies in developing countries

The empirical literature reporting the importance of fossil fuel subsidies focus in most cases on data provided by the IMF or the IEA. In addition, some studies analyze the patterns of energy price pass-through, i.e. the responses of domestic fuel prices to international price shocks, across geographical areas. Pass-through coefficients allow evaluating the extent by which government policies adopt market-based pricing and thus provide indirect estimates of subsidies. For example, Kpodar and Abdallah (2017) assess the dynamic pass-through of crude oil price shocks to retail fuel prices for 162 countries from 2000 to 2014. Kojima (2016) analyses petroleum product pricing in 65 developing countries, building on a survey of end-user prices for gasoline, diesel, and kerosene in July 2012, and estimates pass-through coefficients from January 2009 to July 2012. Ross et al. (2015) measure monthly pass-through patterns for gasoline price over a sample of 157 countries from January 2000 to December 2012. Although methodological differences among the various studies imply that the results are not always directly comparable, a number of regularities may be highlighted.
First, price reductions caused by subsidy programs may be large. It is not uncommon to find average subsidization rates[9] above 70% (in essence subsidizing more than third-fifth of global consumption), as exemplified by subsidies in Algeria, Iran, Kuwait, Saudi Arabia and Venezuela (Sovacool, 2017). Fossil fuel subsidies seem indeed concentrated in the Middle East, North Africa, and Pakistan region (MENAP). According to Coady et al. (2017) subsidies in this group of countries accounted for 47% of the global total in 2013,

[8]The figures for 2013 and 2015 are available at `https://www.imf.org/en/News/Articles/2015/09/28/04/53/sonew070215a`

[9]The average subsidization rate is calculated as the ratio of the subsidized price to the reference price of the fossil fuel.

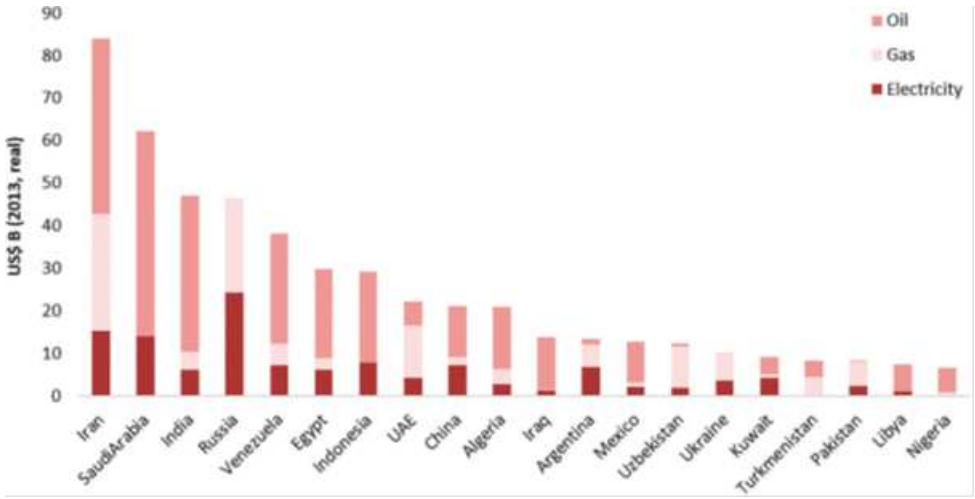
Table 1: *Definitions and methods for measuring fossil fuel subsidies: A comparison across international organizations*

International organization	Definition of fossil fuel subsidies	Assessment method	Data sources	Strengths	Weaknesses
IEA	Government actions that result in prices paid by end users below full cost of supply (based on international benchmarks)	Price-gap approach	IEA and secondary data sources, and an annual survey identifying countries that set energy prices below the full cost of supply	Less data-intensive than other methods Good indicator of pricing distortions	Ignores distortions that do not affect price levels Does not capture gross inefficiencies resulting in high prices Does not provide much guidance for designing or implementing reforms on the ground
OECD	Government, producer and consumer support mechanisms	Inventory approach	Based on official government data, with inputs from experts	Mapping out all sources of subsidies, and often all measures of support beyond subsidies Provides a breakdown of aggregate subsidies, facilitating the design and implementation of reforms	Data intensive Operational inefficiencies are not necessarily captured
IMF	Pre-tax: price paid by consumers below a benchmark price, producers above the benchmark Post-tax: pre-tax plus taxes below efficient levels	Price-gap approach for consumer subsidies Inventory approach for producer subsidies	Based on IMF, IEA, and OECD data Wider sources for post-tax estimates	Two sets of subsidy estimations: pre-tax and post-tax subsidies Larger country coverage, in terms of petroleum product subsidies	Difficulty to monetize externalities Data intensive Prone to very large variations in estimates

Source: from Kojima (2015) and Sovacool (2017)

against 18% for Emerging and Developing Asia. Even if the MENAP region accounts for a lowest share of post-tax subsidies (9% of the global total in 2013), post-tax subsidies still remained important in this region, by accounting for 13-18% of the regional GDP in 2013 (Coady et al., 2017). The finding seems robust to the empirical method used and appears to hold across time periods. The estimates provided by the IEA (Figure 1) evidence that in 2014 Saudi Arabia (78.9%), Iran (73.8%), Iraq (62.4%), Libya (80.2%), Algeria (56.7%) and Egypt (53.7%) had some of the highest subsidization rates in the world (Rentschler and Bazilian, 2017). Kpodar and Abdallah (2017) calculate the median pass-through coefficients for gasoline, diesel and kerosene for different groups of countries and find that MENA countries exhibited the lowest pass-through coefficients from 2000 to 2014. Ross et al. (2015) show that gasoline prices were furthest away from a benchmark energy price in the oil-rich Middle East (including North Africa) over the 2000-2012 period. Moreover, their results evidence that while most regions of the world went toward higher pass-through rates, the Middle East maintained pass-through rates close to zero from 2003 and 2012.

Figure 1: *The 20 largest subsidizers of energy consumption*

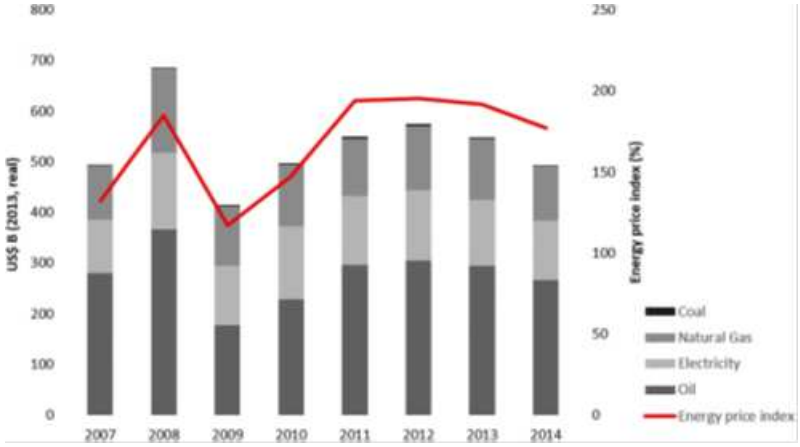


Source: Rentschler and Bazilian (2017); IEA data

Second, the size of fossil fuel subsidies varies depending on the product category. According to Coady et al. (2017), petroleum was the most heavily subsidized product in 2013 with a total of subsidies reaching 0.34% of global GDP, followed by electricity (0.23%) and natural gas (0.16%) while the size of coal subsidy was very small (0.01%). This result is also confirmed by the analysis in Rentschler and Bazilian (2017), who report

the IEA estimates for consumer subsidies from 2007 to 2014 (Figure 2). However, this ranking breaks down when post-tax subsidies are assessed, coal becoming the biggest source (52%) of subsidies (Coady et al., 2017). The intuition behind this result is rather straightforward: post-tax subsidies are directly linked to environmental damage and coal is the most carbon-intensive and air pollution intensive fuel per unit of energy. But, as shown in Table 2, the distribution of subsidies across fuel products also varies significantly across regions. Among developing economies, kerosene often has the lowest pass-through followed by diesel then gasoline. For the advanced economies and emerging Europe, by contrast, the pattern is mixed (Coady et al., 2017).

Figure 2: *Global consumer subsidies for fossil fuels*



Source: Rentschler and Bazilian (2017); IEA data

Third, fossil fuel subsidies are characterized by fluctuations from year to year. The positive correlation with movements in international energy prices of the product in question is largely responsible for this pattern. In particular, large changes in global consumer subsidies for fossil fuels tend to occur during periods of international price spikes, as in 2008 (Figure 2). As shown in Table 2, on average, the pass-through coefficients indicate that many countries failed to fully pass through the increase in international oil prices during the 2008 oil price crisis, resulting in sizeable fuel subsidies. Conversely, falling energy prices in the international market provide the opportunity for reducing the real value of the price wedge on imported subsidized products and therefore for reducing the costs of the subsidies. However, of particular note is that, for developing countries, the pass-through was slightly lower during July 2014 to December 2014 than it was during the preceding similar period (July 2008 to February 2009) where oil prices fell sharply.

Table 2: *Median pass-through coefficients by country groups and over time*

	January 2005-Dec. 2006	January 2007-June 2008	July 2008-February 2009	March 2009-June 2014	July 2014-Dec. 2014	Average
Gasoline median pass-through						
Advanced Economies	138	159	146	168	121	146
Commonwealth of Independent States	..	..	37	58	0	32
Developing Asia	172	73	61	76	64	89
Emerging Europe	..	153	136	167	132	147
Latin America and the Caribbean	136	93	86	102	58	95
Middle East and North Africa	..	41	1	16	0	15
Sub-Saharan Africa	172	91	82	85	39	94
All countries	146	108	97	97	69	101
Diesel median pass-through						
Advanced Economies	143	184	164	164	106	152
Commonwealth of Independent States	..	..	31	48	26	35
Developing Asia	187	78	61	57	47	86
Emerging Europe	..	182	164	167	108	155
Latin America and the Caribbean	119	100	76	92	39	85
Middle East and North Africa	..	33	1	13	0	12
Sub-Saharan Africa	170	108	58	58	39	86
All countries	155	125	93	82	56	102
Kerosene median pass-through						
Advanced Economies	..	..	..	..	..	..
Commonwealth of Independent States	..	..	..	..	..	..
Developing Asia	141	54	27	44	44	62
Emerging Europe	..	..	..	..	..	..
Latin America and the Caribbean	150	107	92	84	40	95
Middle East and North Africa	..	38	0	14	0	13
Sub-Saharan Africa	197	82	58	49	31	83
All countries	175	85	45	46	26	75

Note: For a positive change in international oil prices, a pass-through coefficient lower than 100 percent corresponds to an increase in subsidies. Conversely, a pass-through coefficient of more than 100 percent implies constant or lower subsidies. Source: Coady et al. (2017)

Kojima (2016) depicts the influence of the fall in oil prices at the end of 2014 in reducing energy distortions particularly in major oil producers. He evidences that for many countries these price reforms have been rather limited to announcements as the rise in oil prices between January and May 2015 makes it harder for governments to hold their commitment to pricing reform. The failure of pass through to decrease significantly during the latest low price period suggests that despite recent progress in reforming fuel subsidies and fuel pricing, government price control is still pervasive in developing economies.

3.2. Distribution of fossil fuel subsidies

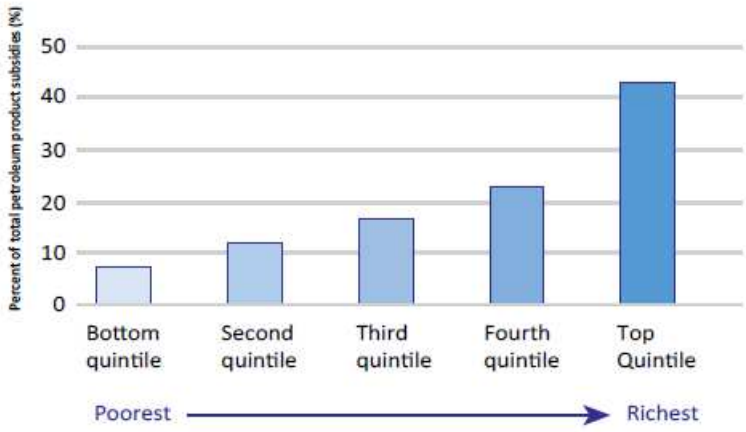
Although several approaches can be used to assess the distribution of fossil fuel subsidies, the common consensus in the empirical literature is that the allocation of their benefits among households has gone in the opposite direction from the one that has supported their implementation. Indeed, while fossil fuel subsidies were expected to protect the real incomes of the poorest households from high and rising energy prices and encourage them to use high-quality fuels, there is overwhelming evidence that they are in fact regressive and that they have failed to shift fuel consumption patterns of the poor. The most usual way of showing the regressive nature of fuel subsidies consists in calculating the share of fuel subsidies received by the household sector divided into income deciles or quintiles. A regressive distribution of subsidies simply means that the share of subsidies that goes to lower income groups is smaller than their share in aggregate income or in population.[10] In their 2010 joint report,[11] the IEA, OPEC, OECD and the World Bank estimated that, out of the $409 billion spent on fossil fuel consumption in 2010, only 8 percent went to the poorest 20 percent of the population (IEA et al., 2010). Inequality income driven by fossil fuel subsidies has also been reported by studies conducted in developing countries. Arze del Granado et al. (2012) calculate the distribution of fossil fuel subsidies among different income groups for a panel of 20 developing countries, relying on case studies undertaken by the IMF and the World Bank. They show that, during the period covered by their study (from 2005 to 2009), fossil fuel subsidies were globally regressive: on average, the richest 20 percent captured 42.8 percent of all benefits from fuel subsidies, against only 7.2 percent for the poorest (Figure 3). Sdralevich et al. (2014) also observe for the MENA region that, according to household surveys conducted between 2003 and 2009, the poorest quintile in Egypt, Jordan, Mauritania, Morocco, and Yemen received only about 1 to 7 percent of total diesel subsidies,

[10] In the literature, it is usual to distinguish between relative and absolute progressivity. A subsidy is relatively (absolutely) progressive if the share of subsidies received by low income households is more than the share of these households in total income (in population).

[11] This report was prepared for submission to the G-20 Summit Meeting Toronto (Canada), 26-27 June 2010.

against 42 to 77 percent for the richest quintile. Finally, the African Development Bank estimated, in its 2012 report, that in Africa, 44.2 percent of fossil fuel subsidies went to the richest 20 percent, while the poorest 20 percent benefited from only 7.8 percent of these subsidies (AFDB, 2013).

Figure 3: *Distribution of subsidy benefits by consumption quintile*



Source: Whitley and van der Burg (2015); data from Arze del Granado et al. (2012)

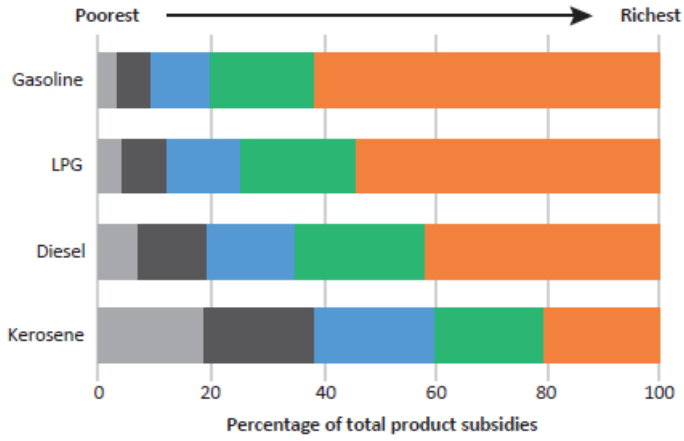
The unequal distribution of subsidies across income groups has also been confirmed by studies based on single country case experiences. Relying on data from the 2008 National Socioeconomic Survey, Dartanto (2013) reports that in Indonesia, between 2000 and 2011, 61 percent of oil and gas revenues went to fuel and electricity subsidies and that 72 percent of these subsidies were enjoyed by the group of the richest 30 percent. In terms of amounts per month and per capita, the richest income group received largely more fuel subsidies (10 times larger) than the lowest income group. The same general pattern holds for Ghana. Cooke et al. (2015), using data from the Ghana Living Standard Survey collected in 2005-2006, find that 78 percent of fuel subsidies benefited the wealthiest group, while less than 3 percent of subsidy benefits reached the poorest quintile. Salehi-Isfahani et al. (2015) undertake a similar analysis for Iran. Their study, based on data from the 2009 Household Expenditure and Income Survey, shows that the share of the total energy subsidies going to the richest decile was 19.2 percent (more than three times) compared that the to 6.0 percent received by the poorest decile.

Another approach –albeit less common– to evaluate the extent of inequality associated to fossil fuel subsidies is to use rank-dependent measures. Soile and Mu (2015) evaluate the distribution of fuel subsidies relative to that of household expenditure in Nigeria by

comparing their respective Gini coefficient measures and Lorenz concentration curves. Their results, based on data from the Harmonized Living Standard Survey of 2009-2010, suggest that the welfare associated to fuel subsidies was less equally distributed than that measured by household expenditure, showing that subsidies exacerbated rather than reduced inequalities.

The averages reported above hide the fact that the impact of subsidies may vary considerably across types of fossil fuels. For instance, it is possible that the distribution of subsidies could be pro-rich for certain categories of fossil fuels and pro-poor for others. Indeed, given that the high level of regressivity of fossil fuel subsidies is due to inequalities in consumption, it is essential to operate a distinction between different fuel types as consumption inequality varies tremendously across fuel types. In particular, in developing countries, some fuels are largely used by poorest people, such as kerosene for example, while other "cleaner" energies are almost entirely consumed by the richest segment of the population (Coady et al., 2006). Bacon et al. (2010) use data obtained in nationally administered household expenditure surveys and report the shares of household expenditure devoted to energy at different income levels for Bangladesh, Cambodia, India, Indonesia, Kenya, Pakistan, Thailand, Uganda, and Vietnam. They note that the expenditure shares of biomass and kerosene generally decline with rising quintile. As a consequence, subsidies to these types of fuels are likely to be less regressive than those supporting "cleaner" fuels. Arze del Granado et al. (2012) analyze empirically whether there is evidence of such differences in the distribution of subsidies across various fuel products for a sample of developing countries. Their analysis suggests that gasoline and Liquefied Petroleum Gas (LPG) subsidies are relatively regressive. Kerosene subsidies are found to be the most progressive, as poor households tend to use relatively more this fossil fuel in developing countries (Figure 4). However, while kerosene subsidies seem more evenly distributed, differences remain large across regions and they can be regressively distributed in some countries. For example, their study shows that in Africa, kerosene subsidies are regressive, with more than 45 percent of these subsidies accruing to the top 2 income quintiles. Examining the access to fossil fuel types by income groups seems therefore particularly relevant in order to rigorously analyze the impacts of fossil fuel subsidies on income inequality.

Figure 4: *Distribution of petroleum product subsidies by income group*



Source: Whitley and van der Burg (2015); data from Arze del Granado et al. (2012)

Due to varying energy consumption patterns, fossil fuel subsidies' distribution can also vary across geographic regions within each country. By considering data that cover all the territory, estimates of subsidies fail to appreciate the differences across regions and especially between rural and urban contexts (Rentschler, 2016). In particular, poor urban households are more likely to have a better energy access and then higher energy consumption than poor households in rural areas. Indeed, many studies corroborate a lack of access to energy that affects rural areas disproportionately. For example, in Sub-Saharan Africa, over 85% of those who lack access to electricity live in rural areas, where energy access is very expensive. Whitley and van der Burg (2015) report that, over the period 2010-2012, access to energy in that part of the world grew faster than population growth in urban areas while it grew slower in rural areas. At the country level, Rentschler (2016) notes that, in Nigeria, the urban population spend a higher share of their income on energy, comparatively to rural households. Other studies have also found differences in the use of fuel types between rural and urban areas. The IEA (IEA, 2010) reports that, in all sub-regions of the developing world, people in rural areas account for the highest proportion of the population relying on traditional biomass. Bacon et al. (2010) find that, for all forms of modern energy except kerosene, the proportions of households using different sources of energy at similar income levels were generally higher in urban than in rural areas. One main implication of these rural-urban differences in energy consumption is that fossil fuel subsidies have generally failed to encourage more efficient fuel usage and management in rural areas, and that, all else constant, there is certainly a bias in the provision of subsidies towards the urban sector.

Estimates of the distribution of benefits generated by fossil fuel subsidies may even underestimate their real effect as other potentially important channels discussed below, through which subsidies may impact the income distribution, are ignored. Indeed, the implementation of fuel subsidies may worsen income distribution not only by being inefficient in targeting the poorest households but also by creating several market distortions (Coady et al., 2010; Dennis, 2016). In this case, many of the intended beneficiaries can never benefit from the subsidy Barnes and Halpern (2006). Conversely, if subsidies are financed by an inflation tax, the real benefit households or firms may receive from a fossil fuel subsidy may be much smaller, after adjustment for prices (Commander, 2012).
However, irrespective of these potential biases, there is a wide agreement in the empirical literature that fossil fuel subsidies do not necessarily support the poorest segment of society as the largest benefits from fossil fuel subsidies rather accrue to high-income groups. The main explanation of this concentration in favor of the richest households is due to the universal nature of fossil fuel subsidies: as the richest households consume more of the subsidized products and of others associated goods and services than the poorest households, they are therefore the biggest recipients of subsidies.

3.3. The costs of fossil fuel subsidies

These negative outcomes suggest that fossil fuel subsidies are less efficient than is expected. Ample empirical evidence shows that the economic and social costs of fossil fuel subsidies in developing countries are indeed large.
First, fossil fuel subsidies imply deadweight costs as with fossil fuels subsidized, the buyers' willingness to pay is below the opportunity cost of the product. Based on this argument, Davis (2014) finds that the total global deadweight loss associated with fuel subsidies reached $44 billion in 2012, assuming a long-run elasticity of demand for transportation of -0.6 and perfectly elastic supply. Even if these financial costs were uneven distributed among countries, with losses concentrated in countries with larger subsidies (Saudi Arabia and Venezuela), they highlight the importance of gains that could operate through removing fossil fuel subsidies.
Second, fossil fuel subsidies typically imply not only deadweight costs but also efficiency costs: they distort economic incentives and contribute to a misallocation of resources. Several studies depict substantial economic inefficiencies that are experienced throughout the Arab world (Fattouh and El-Katiri, 2013; IMF, 2017), in sub-Saharan Africa (Whitley and van der Burg, 2015) or in Asia (UNEP, 2016). Kojima (2016) also provides examples of the pitfalls of energy price controls, such as market distortions, market concentration, disincentives for investment, and market abuses. The existence of these efficiency costs has been used to justify the preference for better-targeted policies over fossil fuel subsidies. For example, Plante (2014) compares the efficiency impacts between fossil fuel subsidies and lump-sum transfers. Relying on simulations derived from a small

open economy model with a non-traded sector, he finds that subsidies not only lead to distortions in relative prices but also have negative consequences on inter-sectoral labor allocations and non-oil consumption. Its estimates show that fossil fuel subsidies reduce aggregate welfare, irrespective of their financial sources, in both net oil exporters and importers and that the losses are substantially higher under subsidies than under lump-sum transfers.

Finally, fossil fuel subsidies are an extremely costly approach of protecting the welfare of the low-income households. Arze del Granado et al. (2012) estimate that the cost of transferring 1 dollar to the group of the poorest 20 percent via gasoline and kerosene subsidies is around US$ 33 and US$ 5, respectively. Moreover, fossil fuel subsidies consume a large share of the government budget and distract from growth-enhancing investments which have positive effects on per capita income and are an important channel to reduce poverty. Indeed, the size of fossil fuel subsidies may seem staggering, compared to fiscal resources for other sectors, especially social sectors. In Egypt, government expenditure on such subsidies were comparable in size to public spending on health and education in 2008, as in Jordan prior to the country's 2008 reform of fuel prices. Yemen's expenditure on fuel subsidies in 2008 accounted for 34.1 percent of total government expenditure against 16.8 percent for combined expenditure on education, health and social transfers (Breisinger et al., 2012). According to the IMF Regional Economic Outlook for Africa, sub-Saharan African countries spent on average 3 percent of GDP on fuel subsidies in 2012, which was equivalent to their total public spending on health care (IMF, 2013). The IMF study on Latin America and the Caribbean reports that energy subsidies were equal, on average, to about 45 percent of spending in education and health in Latin America and the Caribbean over the period 2011-13 (Di Bella et al., 2015). Econometric studies find strong evidence of a crowding-out effect of energy subsidies on public social spending. Ebeke and Lonkeng Ngouana (2015), relying on a panel dataset covering 109 low and middle income countries over 2000-2011, estimate that 1 percentage point increase in energy subsidies to GDP led, on average, to a reduction of public spending in education and health by 0.6 percentage point of GDP. This suggests that removing fossil fuel subsidies would offer significant scope to reduce income inequalities by redirecting the resources saved by this policy reform to the economy through education and health spending.

Overall, the corollary of these results is twofold. First, the substantial leakage of benefits to higher-income households makes fossil fuel subsidies much more costly than a well-designed and well-targeted transfer program. Second, efficiency gains obtained by reforming the existing system of fossil fuel subsidies seem substantial; therefore the savings from their reform could finance policies more effective to combat poverty and decrease income inequalities. These conclusions fully mirror the arguments used by international organizations such as the IMF to prompt subsidy reforms in developing countries.

4. Fossil fuel subsidy reforms

In the 2000s, a movement away from market-price support and toward fossil fuel subsidy reforms has been observed in many developing countries. This movement has coincided with a dramatic increase in oil prices which has triggered rapid growth in the economic costs of fossil fuel subsidies. In particular, such evolution increased the import bill for importing countries, and thus the fiscal burden caused by energy subsidies. In exporting countries, domestic end-user prices lower than international energy prices implied rapid growth in the costs of subsidizing domestic consumption and similarly led to calls for a more efficient use of depletable natural resources. However, if it seems obvious that there are substantial gains that can be expected from subsidy reforms, such gains do not come easily and are tempered by adjustment costs as they often require transitional policies in order to avoid the poorest population being penalized by these reforms.

4.1. Welfare and distributional implications of subsidy reforms

Fossil fuel subsidies rely on policies designed to alter the resulting distribution of income from what would otherwise emerge under unfettered market system. As a result, the removal of these subsidies, by inducing a large effect on the price level, cause important changes in income and welfare distribution. These impacts will depend in turn on several factors, such as the type of subsidized fossil fuel, the importance of various fuels in households' budget, the extent to which fossil fuel prices affect prices of other goods and services also purchased by households, factors endowments and employment patterns of households and on where and to whom subsidies are intended. The main empirical challenge is then how to take into account these different channels through which subsidy reform may affect welfare and income distribution in a country.

In the literature, one can find two approaches for capturing these effects. One approach is to use statistical simulations based on partial equilibrium models in which only first-order welfare effects are considered. In this approach, the main sources of information rely on household survey data and input-output tables that respectively include information on households' expenditures on individual fuel products and the energy intensity of each sector. Budget shares of fuel expenditure items are combined to percentage increase in price due to the increase in fuel prices to quantify the direct effect of subsidies removal on households' real income. As with the direct effect, the indirect real-income effect is calculated by multiplying the budget shares of the various goods and services by the estimated percentage price increases in these sectors. The main advantage of this approach is that it ultimately yields an answer to the important question of how fuel subsidies' removal affect the welfare distribution within a country in a framework that explicitly accounts for linkages between fuel products and other goods and services.

However, if fuel consumption is assumed to be fixed, as it is the case, then the real income direct effect can be overestimated since following the rise in fuel price, households can substitute away from fuel. As such, this approach is more useful for *ex-ante* evaluation of fossil fuel subsidies as well as their reform and is more likely to be representative of short-term household welfare responses to energy price fluctuations. Moreover, the results depend in a crucial way on assumptions and estimates of parameters that are typically not known, as the degree of pass-through from higher petroleum costs to prices in other sectors of the economy. These parameters are usually estimated through a price-shifting model, as developed in many studies provided by the IMF (see for example (Anand et al., 2015; Arze del Granado et al., 2012; Coady et al., 2006). This model assumes that all petroleum products are within the controlled sector and that all other products are cost-push sectors, i.e. sectors where higher input costs are passed on fully to output prices. An alternative approach uses computable general equilibrium (CGE) models, which involve setting out a fully articulated system of demand and supply functions for each of the various sectors of the economy. These models are able to trace the overall welfare effects of subsidies and their reform as they account for further indirect welfare effects which are bound to occur as changes in energy prices also impact production costs and factor incomes. CGE models used by different studies to analyze reform scenarios are conceptually similar: they rely on the assumptions that all agents (firms, households or government, etc.) seek to optimize a certain behavior and that the market clears for all goods. These models are usually calibrated on data collected from national Social Accounting Matrices (SAM). Finally, multi-region CGE models provide a more sophisticated framework for incorporating the general equilibrium welfare effects of subsidies and their reforms at the global level. Among these models, the Global Trade Analysis Project (GTAP) model[12] is considered to be one of the most commonly used global CGE model for analyzing multi-country policy scenarios and welfare impacts of fossil fuel subsidy removal because it allows comparing the outcome of subsidy reforms between countries with different economic structures.

Dennis (2016) takes this approach by using a version of the GTAP model which comprises 59 regions, with a focus on isolating the 20 developing countries for which there are subsidy data, and 21 sectors with the petroleum sector being one of them and other petroleum dependent sectors (such as land transportation, and the oil and gas sectors) all being separate sectors. He finds that although subsidies removal offers attractive sources of revenue from the perspective of efficiency, they can be less attractive from the perspective of distributional impact, in particular in net petroleum importing economies. Because households spend a part of their incomes on fuel imports in those countries, they

[12]The standard GTAP framework is documented in Global Trade Analysis: Modeling and Applications, T.W. Hertel (ed.), published in 1997 by Cambridge University Press. `https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=4840`

may indeed incur an overall welfare loss due to higher prices of petroleum products. The decline restricted to these countries is however marginal and estimated on average to reach 0.08%. Wesseh and Lin (2017) undertake a similar analysis for Ghana, to estimate the impact of the removal of imported refined oil subsidies. In order to simulate the effect of such policy, they implement a 48% shock to tax on imports of refined oil in Ghana within the GTAP model (version 8), based on the 2005 SAM for Ghana. Their analysis shows a high negative impact of fossil fuel subsidies removal on Ghanaian households' welfare, with a decline of real income by 15.13%, as a result of the fall in wages. However, in those multi-region CGE models, estimated welfare impacts are primarily based on national averages, and cannot trace how these impacts may vary across household income groups. Yet, because fossil fuel subsidies are unevenly distributed, households in different parts of the welfare distribution will be differentially impacted by subsidy reforms. For example, households that spend a higher share of their budget on fuel products and/or goods more fuel intensive will be more impacted by subsidies removal. One way to get an idea about the distributional impact of subsidy reforms is to analyze the pattern of real-income changes across households at different levels of income. While the partial equilibrium approach provides a less resource-intensive approach for incorporating such distributional effects of subsidy reforms, CGE models allow capturing the total distributional effects across households caused by economy-wide impacts of subsidy reforms.

An example of the studies relying on the partial equilibrium approach is the framework developed by Arze del Granado et al. (2012) which considers a common increase (by $0.25 per liter) in retail prices of fuel products in several developing countries. The study shows a significant impact of increasing fuel prices on real incomes. Indeed this increase results on average in a 5.4% decline in household real incomes, stemming to a large extent from the indirect effect that operates through increases in relative prices of other goods and services. This study also shows that the welfare effects of increasing fuel price are region-specific: welfare losses are higher in the Middle East while smaller in South and Central America. Moreover, the direct impact of increasing fuel prices exerts distributional effects that heavily depend on the nature of the fuel product. Whereas the direct impact is strongly regressive for kerosene, it is progressive for gasoline and electricity, except in the Middle East and Central Asia region. Overall, the study finds that the fuel prices increase is associated, in average, with a percentage decrease in welfare that is very similar across income groups, simply because fossil fuel subsidies benefit more to higher-income groups. The perception that the total impact of removing subsidies on certain fuels may be more harmful for higher-income groups is supported by some country case studies. For example, Anand et al. (2015) examine the likely distributional incidence of reforming fuel subsidies in India. Their simulation estimates suggest that on average eliminating fuel subsidies would decrease households real incomes by around 4 percent. The total impact is progressive, partly reflecting large price increase for LPG

and its relative importance in the consumption of higher-income households.
Subsidy reforms might also affect households' welfare through the response of employment opportunities of individuals to changes in relative prices of goods induced by these reforms. Analyses that take into account this additional transmission channel rely on CGE models and support the previous finding that subsidies reforms are progressive. For example, Clements et al. (2007) look at the distributional implications in Indonesia of an increase of oil prices by one-fourth of their current level. They estimate the overall welfare effects of this price shock using an amended CGE model calibrated on data from the 1995 Indonesian SAM. Since the model takes into account the possibility to productive sectors to adjust their levels of production to higher prices, differences in consumptions patterns are now magnified by differences in employment patterns. As a result, urban and high income groups are more impacted by the increase in oil prices as the capital-intensive sectors where they are mostly employed experience the biggest drop in production. This result is consistent with the findings of the Asian Development Bank on Indonesia (ADB, 2016). The same type of approach for Malaysia supports the finding that energy prices increases lead to a higher decrease in urban household incomes than in rural ones. Calibrating a CGE model using a SAM for 2005, Solaymani (2016) finds higher income losses for the urban households because the incomes from industrial sectors decrease more significantly than agricultural and services sectors, following energy prices increases.
However, these findings are also debated. Indeed, a number of studies have found that removing fuel subsidies can also be regressive, showing that reforming policies could lead to a possible trade-off between efficiency and distributional concerns. Coady et al. (2006) examine the implications of fuel subsidies' removal on the distribution of household welfare in different developing countries (Bolivia, Ghana, Jordan, Mali, and Sri Lanka). Their study relying on a partial equilibrium approach yields insights about the real income effect of removing fossil fuel subsidies and provides additional support that the welfare effects of increasing fuel price are region-specific. For example, while the direct effect is approximately neutral in Bolivia and Mali, it is regressive in Ghana, Jordan and Sri Lanka. This difference stems from the fact that in the latter countries the poorest households tend to use heavily kerosene that in addition experiences a relatively large price increase following the implementation of the reform. The estimates also confirm that the distribution of the indirect effect is either very slightly progressive or neutral, with the exception of Bolivia. Overall their study illustrates that households are adversely affected by the price increase (a 50 percent average increase in fuel prices results on average in a 4.6 percent decrease in real incomes), with the poor bearing disproportionate welfare losses. Indeed, although a substantially higher proportion of the aggregate burden is borne by higher income groups, the distribution of the total effect is regressive, except in Mali. Cooke et al. (2015) undertake a similar analysis based on

a partial equilibrium and price-shifting model for Ghana. Their analysis shows that removing fossil fuel subsidies would be substantially regressive: the reform would result in a 2.1 percent decline in the real spending of the lowest-income households compared with a 1.56-1.86 percent decrease for the other households. The authors explain this result by the importance of kerosene in the consumption of the poorest households. Using a SAM-based model to project short-term impacts on the removal of subsidies in Indian households, the Asian Development Bank finds that the largest relative negative impacts would be experienced by households in areas where household heads are either self-employed or low-skilled labor (ADB, 2016). Therefore, while reform-induced changes in relative prices of goods can result, under certain circumstances, in an inequality reduction, they may also widely hurt the poorest segment of the population because this population relies much more on subsidies than does the richest population and is also the least able to cope with increases in fuel prices.

4.2. Fossil fuel reforms and poverty alleviation

Indeed, a particular concern with subsidy reforms is their potential adverse welfare impact on poverty. Subsidy reforms lead to an increase in the price of fuel products and other goods which in turn may disproportionately affect the spending behavior of poor households. Indeed, if poorer households spend less money on energy and other goods, their spending accounts for a greater share of their income. Changes in relative prices of goods might also affect the poverty depth by dropping below the poverty line low income households that were previously above the poverty line.[13] Therefore, many scholars argue that transitional policies may be needed to mitigate the negative impacts of subsidy reforms on lower-income households. Subsidy reforms are then usually discussed by considering the important role of gradual subsidies reduction programs and/or complementary policies to facilitate transitions and support the poorest. Some studies have been carried out *ex-post* to identify various factors contributing to the success or failure of subsidy reforms. Examples include discussions of subsidy reforms in Iran (Salehi-Isfahani et al., 2015) and in Ghana (Cooke et al., 2015). Other studies have been conducted *ex-ante* to help design a reform policy, including countries as Nigeria (Rentschler, 2016; Siddig et al., 2014), Indonesia (Clements et al., 2007; Dartanto, 2013) and Malaysia (Solaymani, 2016). Again the size of the effects exerted by subsidy reforms on poverty will depend on several factors, such as the exposure of the poor to changes in relative prices through income and employment opportunities, the size of the price shock,

[13]Several poverty measures can be considered: (i) the headcount index, which measures the proportion of the population that is counted as poor; (ii) the depth of poverty, measured as the mean distance separating the population from the poverty line, with the non-poor being given a distance of zero and (iii) the severity of poverty, calculated as a weighted sum of poverty gaps (as a proportion of the poverty line) in order to take into account inequality among the poor.

as for welfare analysis and on how sensitive the poverty line is to price changes (when the poverty line is determined endogenously). Therefore, the magnitude of these effects will differ across studies according to the extent to which they are incorporated into the analysis and to which they are accompanied by complementary policies for mitigating the negative effects of subsidy reforms.

On the empirical side, the most common method to integrate complementary policies involves simulating, in addition to the effects of subsidy reforms, the likely effectiveness of existing or potential safety net expenditures in mitigating any adverse effects of removing price-support policies on poor households. In partial equilibrium frameworks, household-survey data, combined with knowledge of the design of any existing safety net programs, are used to simulate the potential for such programs to protect the poorest households during the reform process. In CGE models, welfare-improving reform packages can be added by including government and investment and examining the welfare impact of raising capital goods and/or cash transfers facilitated through savings made by governments from removing subsidies to fossil fuels. However, regardless of which approach is used, most of the studies find a significant impact of subsidy reforms on poverty and highlight the important role of complementary policies and gradual programs in mitigating this negative effect.

For example, Salehi-Isfahani et al. (2015) evaluate the short-term effects of the Iran's energy subsidy reform program of 2010, using data from the 2010 Household Expenditure and Income Survey. Comparing the observed poverty rates before and after the reform, they note that removing subsidies would have increased the poverty rate from 13.4 percent to 20.2 percent in rural areas and from 10.3 to 12.0 percent in urban areas. This amounts to an increase in the national poverty rate of 3.3 percentage points. However, according to the authors, cash transfers, intended to compensate households for price increases and implemented at the same time, have been successful by lifting out of poverty about 8 percent of the rural population and 3.2 percent of the urban population, i.e. a reduction in the national poverty rate of 4.7 percentage points. Cooke et al. (2015), by simulating their partial equilibrium model on real incomes in Ghana, find that poverty would increase by 1.5 percentage points following the fuel subsidy removal. Their results also conjecture an increase in the poverty depth and the severity of poverty of approximately 0.5 and 0.28 percentage points, respectively. The negative impact of the reform on the poor could be however cushioned by expanding Ghana's cash transfer programme which provided monthly payments to 72,000 poor and vulnerable households in 2013. The authors estimate that an expansion of this programme to 150,000 households in 2014, 300,000 households in 2015 and 500,000 households in 2016 would reverse the impact of the fuel subsidy removal, reducing the poverty headcount by 1.6 percentage points in 2014 and 2.3 percentage points in 2016. Rentschler (2016) examine the likely consequences on poverty of subsidy reform in Nigeria. The author uses the statistical

simulation model developed by Araar and Verme (2012) and applies it to a household survey (Harmonized Nigeria Living Standard Survey of 2009/2010) to identify the first-order welfare effects of the reform.[14] He finds that the consequent price increase in energy goods (petrol, kerosene, and electricity) could result in an increase in the national poverty rate by 3-4% on average and in the poverty gap as a large group of near-poor households would be pushed into poverty through the reform induced price shock. He estimates that the redistribution of revenues saved by this reform could result in a reduction of the national poverty rate by about 1% compared to pre-reform levels. He notes, however, that, although universal cash transfers can reduce poverty, the substantial leakage of benefits to states with higher energy consumption but low pre-reform poverty rates makes such an approach much less attractive than a direct transfer program directly targeted to poor households.

Analyses of subsidy reforms using CGE models support the partial equilibrium findings that the poorest households would face significant losses from the removal of fossil fuel subsidies. For example, Clements et al. (2007) examine the likely short-term consequences of a reduction in petroleum subsidies in Indonesia. The authors focus on production changes generated by a 25 percent increase in petroleum prices through a CGE calibrated on data from the 1995 SAM of Indonesia. Their results show that rising petroleum prices would result in an increase of 0.6 percentage points in the poverty headcount index and that this increase would be more significant in urban areas (0.8) than in rural areas (0.6). Moreover, even if real output remains unchanged due to an increase in private sector investment, the poverty headcount index poverty could still increase, albeit by a smaller amount (0.2 percentage points). Solaymani (2016) provides a formal assessment of the long-run implications of energy subsidy reform in Malaysia for different measures of poverty using a static poverty focused CGE model. Its study finds an increase in the headcount ratio, the poverty gap and the poverty severity among all household types, indicating that a cut in government energy subsidies would exacerbate poverty among all household groups in Malaysia. The energy subsidy reform is also predicted to have a more detrimental effect on the urban poor, as energy account for a higher share of average urban household expenditure. The empirical literature based on CGE models also highlights the fact that, when one evaluates reforms that liberalize energy prices, it is extremely important to capture the nature of the policy compensation instruments used. Dartanto (2013) extends the analysis for Indonesia developed by Clements et al. (2007) to allow for a broader set of policy instruments, including different scenarios of revenues' reallocation (government spending versus government transfers to households). Simulations, including subsidy, government consumption and transfers,

[14] In this simulation model, only the direct welfare effects of the reform are considered, i.e. welfare effects that occur when a removal of fuel subsidies increases households' cost of maintaining energy consumption.

are based on data from the 2005 Indonesian SAM. The CGE microsimulation results show that reducing fuel subsidies by 25% increases poverty incidence by 0.259 percentage points. However, if the saved money is fully allocated to government spending and transfers, the adverse impact can be cancelled out; even the poverty incidence will be reduced by 0.27 percentage points. Moreover, a budget reallocation, more targeted towards government spending rather than on government transfers, performs better in terms of poverty reduction. This is because increases in government spending exert positive revenue effects through higher job opportunities which gradually increase the factor incomes of unskilled, semi-skilled and skilled non-agricultural labors and tend to over-compensate for the increase in expenditure as a result of the subsidy reform. In turn, a larger government transfer to households appears less redistributive because of the increase in prices of food commodities through a larger demand for these products which reduces the welfare of households, particularly those of low income groups that spend a large proportion of their budget on food. Breisinger et al. (2012) undertake a similar analysis for Yemen. They evaluate the direct and indirect effects of reforming fossil fuel subsidies on poverty and simulate the impact of three alternatives for spending the savings from reform (budget deficit reduction, direct income transfers to the poorest 30 percent of households and public investment in infrastructure in addition). According the authors, the reform in Yemen gives rise concerns regarding its impact on the poorest households as, without compensation, it is expected to involve an increase of the poverty rate from 2.6 to 3.0 percentage points. Again the analysis shows that investment in infrastructure in addition to direct transfers would be a better poverty reduction strategy, compared with a policy only consisting in direct transfers. Indeed, although direct transfers to the poorest tend to cushion some of the negative effects due to higher fuel prices, they alone do not generate sufficient growth to alleviate all of the negative effects of subsidy reform. Siddig et al. (2014) analyze the implications of reducing Nigeria's subsidies on imported petroleum products on poor households and assess its interaction with complementary policy measures. These measures include the introduction of either a subsidy on domestic petroleum product production or a government transfer scheme targeted towards the poorest households, i.e. rural households. Their framework is based on the GTAP model which incorporates some of country specific information, to give a more realistic description of the impacts of the subsidies reform on rural and urban households within Nigeria. Their analysis finds that a transfer of government income to rural households is the most effective policy to alleviate poverty. Indeed, estimates show that only this policy leads to an increase in real income (from 2.3 to 7.6 percent) for all rural households that are also the poorest. Applying the same GTAP model but for Ghana, Wesseh and Lin (2017) test the efficiency of different policy options for mitigating the adverse effects coming from the removal of subsidies on refined oil imports. They found that the introduction of policies aimed at improving agricultural productivity coupled with a reduction in trade

transaction costs offers a more effective way of protecting real incomes by stimulating economic growth.

Finally, some studies focus on transitional subsidy reforms to understand the proportionate change in household incomes and the resulting effects on income poverty induced by different cuts in fossil fuel subsidies. From a public policy perspective, this approach helps to inform a policy discussion on the appropriateness and design of sequential subsidy reforms. For example, Dartanto (2013) simulates the effect of subsidy reforms on poverty in Indonesia, through four subsidies reduction scenarios (25%, 50%, 75% and 100%). He finds that the headcount index and the share of the population living below the poverty line increases as subsidies go down. Breisinger et al. (2012) undertake a similar analysis for Yemen, by distinguishing two reform paths: (i) an accelerated one, wherein all fuel subsidies are lifted within one year; (ii) a more gradual one, where subsidies are phased out over a period of three years. Their results support the fact that rapid phasing-out of fuel subsidies leads to an initial drop in growth and a sharper spike in poverty, while gradual reductions smooth the growth and poverty effects. Similarly, Siddig et al. (2014) provide a formal assessment of the implications of subsidies removal in Nigeria by simulating the effects of a complete and of a partial removal of the subsidies on imported petroleum products. Their study finds a higher decrease in real incomes of all household groups under the complete removal scenario due to the resulting higher price of petroleum products. The perception that implementing a progressive reform in Nigeria is more attractive from a distributional perspective is also supported by Rentschler (2016). In his study, Rentschler (2016) discusses the implications of subsidy reforms by testing two types of policies: under the first one, subsidies are reduced by 50% on all considered energy goods, while under the second one the government removes the overall amount devoted to subsidies. Compared to the pre-reform poverty headcount rate of 60%, a 100% reduction of subsidies is estimated to instantly increase the rate to 63.3% against 61.8%, under the 50% reduction scenario.

These results have two important implications for reform policy analysis. First they demonstrate that a distinction must be made between a complete removal of fossil fuel subsidies and a partial one which causes a less negative impact on poverty, due to a slower fuel price growth. Second, they emphasize the fact that implementing policies that play a positive role in pro-poor growth (social and infrastructure spending, agricultural productivity improvements) can be a more efficient approach to mitigate the adverse effects of higher energy prices on the real incomes of poor households relative to a direct government transfer to poor households. However, as highlighted by Wesseh and Lin (2017), this will depend on the institutional capacities of governments to design and implement such policies and the ability of poor households to fully benefit from such policies.

Table 3 sums up the main methodologies and results used to analyze the poverty impacts of subsidy reforms.

Table 3: *Fossil fuel reforms and poverty alleviation: main studies and results*

Studies	Country/period	Types of reform/Impact	Complementary policies/Impact
Partial equilibrium approach			
Salehi-Isfahani et al. (2015)	Iran 2010-2011	Energy subsidy reform program of 2010: increase in the poverty rate from 13.4 percent to 20.2 percent in rural areas and from 10.3 to 12.0 percent in urban areas	Cash transfer: reduction in the poverty rate from 20.2 percent to 12.0 percent in rural areas and from 12.0 percent to 8.8 percent in urban areas
Cooke et al. (2015)	Ghana 2013	Fuel subsidy reform carried out in early 2013: increase in national poverty by 1.5 percentage points	Expansion of the Ghanas national cash transfer program: reduction in the poverty headcount by 1.6 percentage points in 2014 and 2.3 percentage points in 2016
Rentschler (2016)	Nigeria 2009/2010	100% (or 50%) reduction of subsidies: increase in the poverty headcount rate from the pre-reform rate of 60.0% to 63.3% (or 61.8%)	Redistribution of revenues saved by this reform: reduction of the national poverty rate by about 1% compared to pre-reform levels
CGE model			
Clements et al. (2007)	Indonesia 1995	25% increase in prices: increase of 0.6% in the poverty headcount index	Real output is maintained by higher private sector investment: increase of 0.2% in the poverty headcount index
Dartanto (2013)	Indonesia 2005	Removing 25% of fuel subsidies: increase in the poverty rate by 0.259 percentage points	Money fully allocated to government spending: decrease in the poverty rate by 0.27 percentage points; Reallocation of 50% to government spending, transfers and other subsidies: decrease in the he poverty rate by 0.277 percentage points
Breisinger et al. (2012)	Yemen 2007	Scenario 1: all fuel subsidies are lifted within one year: the poverty rate exceeds the baseline poverty rate by 3 percentage points; Scenario 2: subsidies are phased out over a period of three years: the poverty rate is elevated by only 0.5 percentage points compared with the baseline rate	Fuel subsidy reform are used for: budget deficit reduction (Scenario A); budget deficit reduction and direct income transfers to the poorest one-third of households (Scenario B); budget deficit reduction, direct income transfers targeted to the poorest one-third of all households, and productivity-enhancing investments in infrastructure (Scenario C). By the end of the six-year simulation period, reduction in the poverty rate by about 6 percentage points (accelerated reform scenario 1C) and 4 percentage points (gradual reform scenario 2C)

Studies	Country/period	Types of reform/Impact	Complementary policies/Impact
GTAP model			
Siddig et al. (2014)	Nigeria 2006	Complete removal of the subsidies on imported petroleum products; partial removal of subsidies so that petroleum product prices do not increase more than 10 percent of the baseline price of fuel	Introduction of a subsidy on domestic petroleum product production; Introduction of a government transfer scheme, targeting rural households. Transfer of government income to rural households leads to an increase in real income (from 2.3 to 7.6 percent) for all rural households that are also the poorest.
Wesseh and Lin (2017)	Ghana 2005	Full removal of subsidies: decline in real income of households by 15%	Increase in agricultural productivity : 10.7% rise in the real income of households; reduction in trade transaction costs with Sub-Saharan Africa : reduction in households' real income by 13.9%; Increase in agricultural productivity + reduction in trade transaction costs with Sub-Saharan Africa: 12% rise in the real income of households

Source: Authors

5. What leads to successful subsidy reforms? Lessons from country experiences

In recent years, many developing countries around the world have accumulated experience with a variety of subsidies reforms. Several research and reports have taken account these concrete case studies in order to identify the causal mechanisms that underlie successful and unsuccessful subsidy reforms over time and across countries. For instance, Vagliasindi (2012, 2013), and more recently Kojima (2016) and Sovacool (2017), have used a set of case studies to identify the strategies common to successful subsidy reforms. Similarly, the evaluation of subsidy reforms undertaken by the IMF looks at both successful and failed reforms across fossil fuel types and countries to glean lessons about "what works, what doesn't work and why" (Clements et al., 2013).[15] Finally, some regional reviews also identify commonalities in the reform strategies in sub-Saharan Africa (Alleyne, 2013; Whitley and van der Burg, 2015), in the MENA region (Sdralevich et al., 2014; van Beers and Strand, 2013), in Gulf Cooperation Council countries (IMF, 2015), in Latin America and the Caribbean (Di Bella et al., 2015) or in Asian countries (ADB, 2016; Beaton et al., 2013).[16]

While these studies differ according to the extent to which a reform can be considered as successful,[17] they highlight several differences –among countries, among policy instrument choices, and over time within a particular country– in completing and implementing subsidy reforms (Table 4). In particular, the initial conditions policymakers face play a crucial role in the design and space of reforms. In combination, these conditions led to a series of obstacles to reform and dictate the nature of reforms that will be implemented. The wave of subsidy reforms has also stimulated the development of studies that are looking more specifically on the political economy of reforms, i.e. the political constraints that condition the timing, speed and sequencing of subsidy reforms (Commander, 2012; Strand, 2013; Victor, 2009; Vidican, 2015). These analyses show that subsidy reforms that are efficient in economic terms may not be politically viable, and that less than optimal policies may be maintained or adopted due to some form of political constraint.

[15] Clements et al. (2013) analyze 28 country cases that illustrate different examples of subsidy reforms. They find that, out of these reform episodes, 12 cases describe situations where the reform process was successful, although in other cases reforms led to more less direct gains (11 cases) or did not succeed (5 cases). Moreover, they highlight that, despite IMF-supported program during some reform episodes, reforming subsidies has proved difficult and not all reforms, under these programs, have been successful.

[16] Three experiences (experiences in India, Indonesia, and Thailand) are more specifically discussed in the ADB report.

[17] These differences can be explained by distinct definitions or understandings of what constitutes a successful reform or/and the simple fact that reforms have been evaluated at different times. For example, in Table 4, one reason why IMF studies evidence relatively more partially successful or unsuccessful reforms is that their assessment of reforms has been made earlier than the one undertaken by Sovacool (2017).

Table 4: *Energy subsidy recent reform episodes*

Country	Year(s)	Energy source	Description/result	Sovacol(2017)	IMF studies*
Central and Eastern Europe and Commonwealth of Independent States					
Turkey	1998	Electricity	Removal of fossil fuel subsidies put competitive pressure on electricity suppliers and turned their net losses into profitability	Successful	Successful
Armenia	1994	Electricity	Scaled back electricity subsidies by 22% of GDP from 1994 to 2004	Successful	Successful
Poland	1990-1998	Coal			Unsuccessful
	1998	Coal	Forced the coal sector to improve its efficiency and substantially reduced fiscal transfers	Successful	Successful
Emerging and Developing Asia					
Indonesia	1997	Fuel			Unsuccessful
	2003	Fuel			Unsuccessful
	2005-2009	Oil and gas	Oil and gas Subsidies declined from 3.5% of GDP in 2005 to 0.8% in 2009, though they increased recently in 2013 due to protests	Successful	Partially successful
Philippines	1996	Oil and gas	Government successfully removed energy subsidies equivalent to 0.1% of national GDP	Successful	Successful
	2001-2006	Electricity	Subsidies dropped from 1.5% of national GDP to 0%	Successful	Successful
Latin America and Caribbean					
Brazil	1990-2002	Oil and gas	Lowered subsidies for oil and gas from 0.8% of GDP to revenue generating in 2002	Successful	Successful
	1993-2003	Electricity	Lowered subsidies equivalent to 0.7% of GDP	Successful	
Chile	Early 1990s	Fuel			Unsuccessful
	1995	Coal	Removed its subsidies after it became apparent that coal production prices were extraordinarily high ($95 per ton) compared to other countries ($54 in Brazil, $52 for the United States). The removal actually raised incomes by almost 1% among all Chilean households and cut emissions of carbon dioxide and particulate matter by nearly 8%	Successful	
Mexico	1999, 2000, 2001	Electricity			Unsuccessful
Peru	2010	Oil and gas	Lowered subsidies for petroleum equivalent to 0.1% of GDP	Successful	Partially successful

Country	Year(s)	Energy source	Description/result	Sovacol(2017)	IMF studies*
Middle East and North Africa					
Egypt	2014	Oil and gas, electricity	Policy is implemented using four pillars, namely: set different prices for petroleum products based on energy generation efficiency; increase the efficiency of energy use; provide support to certain sectors to promote switching from conventional energy sources to clean energy sources; and apply the fuel subsidy smartcard system to ensure that subsidies are received by target beneficiaries. Projected to reduce emissions by 14.88% by 2020	Successful	
Iran	2010	Oil and gas	Reduced annual growth in the national consumption of petroleum products to zero	Successful	Partially successful
Jordan	2005-2012	Oil and gas	Gradually removed all fossil fuel subsidies by 2008, resulting in price increases ranging from 16% for gasoline to 76.5% for LPG. Energy subsidies declined from 5.8% of GDP in 2005, to 2.6% in 2006, to 0.4% in 2010 while in November 2012 the government of Jordan announced that it had removed the remaining subsidies on oil products	Successful	
Mauritania	2008	Fuel			Unsuccessful
	2011	Oil and gas	Subsidies declined from 2% of GDP to close to zero in one year	Successful	
Morocco	2015	Electricity	Has carefully reformed subsidies whilst at the same time expanding investment into renewable energy through ambitious targets and to people through the development of a national safety net. Carbon emissions expected to decline 6.6% by 2030	Successful	
Yemen	2005-2010	Oil and gas	Subsidies dropped from 8.7% of GDP in 2005 to 7.4% in 2011	Successful	Partially successful
United Arab Emirates	2014	Oil and gas, electricity	Has introduced a new fuel pricing policy, which will put the UAE in line with global prices to support the national economy, lower fuel consumption and protect the environment. Fossil fuel subsidies will decline 14.41% by 2020	Successful	Partially successful

Country	Year(s)	Energy source	Description/result	Sovacol(2017)	IMF studies*
Sub-Saharan Africa					
Ghana	2005	Oil and gas	Removed subsidies to the degree that they realigned the price of energy by 50%	Successful	Partially successful
Kenya	2001-2008	Electricity	Subsidies dropped from 1.5% of GDP in 2001 to 0% in 2008	Successful	Successful
Namibia	1997	Oil and gas	Removed subsidies equal to about 0.1% of GDP	Successful	Partially successful
Niger	2011	Oil and gas	Removed subsidies equivalent to 0.9% of GDP	Successful	Partially successful
Nigeria	2011-2012	Oil and gas	Subsidies declined from 4.7% of GDP to 3.6% of GDP	Successful	Partially successful
Uganda	1999	Electricity	Subsidies declined equivalent to the amount of 2.1% of GDP	Successful	Successful

*Note: * include Clements et al. (2013) and IMF (2015)*

From this second type of literature, it is possible to explain and illustrate obstacles often encountered in attempting to reform fossil fuel subsidies and a number of strategies that various countries have used in trying to overcome these obstacles.

5.1. The drivers of subsidy reforms

Experiences in developing countries indicate that the decision to enter in a subsidy reform process has been often triggered by both domestic and international factors. These include not only the share of energy in consumers' expenditures and the energy dependence of the economy, the level of development, the degree of institutional quality but also shifts in international energy prices and the role of international financial institutions.

The degree of energy dependence implies different types of impact resulting from fossil fuel subsidies, which in turn, involves different incentives to reform (Vagliasindi, 2012, 2013). For example, fossil fuel subsidies are typically associated with direct fiscal expenses in importing countries. In oil-producing countries, this is not the case. Subsidies represent foregone revenue rather than direct expenses (Lindebjerg et al., 2015). The result is that fluctuations of international price around longer-term trends play a major role in subsidy reforms of both exporting and importing nations, but in opposite directions. When international prices are high, fears of more pronounced fiscal deficits may cause net energy importers to remove or reduce fossil fuel subsidies. On the other hand, in fossil fuel-exporting countries, governments might be more attracted to reform when low international prices lower their resource exports (Rentschler and Bazilian, 2017). This argument related to energy prices shocks can be extended to any exogenous shock that aggravates economic conditions and increases the cost of not adopting reforms. For instance, attempts at reforming fossil fuel subsidies in the East Asian countries have tended to occur after the Asian financial crisis, which disproportionately affected their fiscal deficits (Lindebjerg et al., 2015). Conversely, removing subsidies, by raising energy prices, can increase inflationary pressures that adversely impact real incomes and competitiveness. These negative impacts can explain governments reluctance to relinquish fossil fuel subsidies or their motivation to maintain price controls. The impact of higher prices on inflation may however differ considerably, depending on the strength of second-round effects on wages and the prices of other inputs (Alleyne, 2013).

Economic growth typically coincides with a rise in infrastructure and transports which in turn affect consumers' interests and policy reforms. This evolution creates political incentives –both on the demand (consumers') side and the supply (politicians') side– to exchange government transfers for political support. The model developed by Strand (2013) shows that, as policy decisions in democracies depend on the preferences of the broadest voter basis, fossil fuel subsidies can be an attractive policy when the majority of voters are affected by gasoline prices. This finding holds particularly for middle income

countries, where the middle class, composed mainly of car owners, represents a larger proportion of the voting population. For example, in Indonesia, the tendency of the government to subsidize the disparity between international and domestic prices –when it was large– has been associated with a high fuel demand as a consequence of a rapid growing of middle class (Dartanto, 2013). Interest groups' unequal ability to influence political choices also explains why in some countries, some sectors, such as industry and transport, receive more support than others in the reform process. For instance, the Brazilian government, when he removed subsidies during the 1990s, chose to remove initially subsidies (asphalt, lubricants, gasoline for airplanes) that were generally used by politically weak stakeholders, and ultimately the politically more difficult subsidies (Alleyne, 2013). However, structural changes that accompany economic development may also improve administrative capacity. This improvement may suffice to make fossil fuel subsidies less efficient instruments for achieving domestic social objectives, particularly in low-income countries, where fossil fuel subsidies are easiest and least costly to implement (Commander, 2012). Generally, it is expected that governments will be more prone to reform as their administrative capacity improves, along with their ability to provide public goods.

Finally, international financial institutions (such as the World Bank and the International Monetary Fund) and their engagement with member countries (through programs, surveillance, and technical assistance) may influence –for obvious reasons– governments to liberalize their policies and reduce fossil fuel subsidies. In addition to the policy conditions or advices they may impose on or deliver to developing countries, it is interesting to observe that these international organizations have also developed dedicated technical and financial assistance that can help countries to address different aspects of subsidy reforms. Ruggeri Laderchi (2014) mentions the example of the Energy Subsidy Reform and Delivery Technical Assistance Facility, hosted by the Energy Sector Management Assistance program (ESMAP), of the World Bank whose objective is to offer financing for multi-sectoral analysis of issues related to subsidy reforms.[18] The IMF's Fiscal Affairs Department has elaborated a manual on best practices in price subsidy reform (Gupta et al., 2000), intended to be a guide to policymakers on how to achieve the fiscal benefits of price-subsidy reform with minimal social disruption (Feltenstein, 2017).

5.2. The political sustainability of subsidy reforms

Another stylized fact is the persistence of fossil fuel subsidies in some countries. This trend, as presented in section 3.1, is reflected in the observed low energy prices pass-through particularly, in many current or past hydrocarbon exporters, where few subsidy

[18]including the analysis of the poverty, social, fiscal, macroeconomic, political economy, and climate change aspects of subsidy reforms.

reforms have been carried out as well as in other developing countries where subsidy reforms have proved to be difficult (Kojima, 2016).

The observed persistence of fossil fuel subsidies over time is explained largely by political economic considerations. Research in political economy and many applications to fossil fuel subsidies have shown how subsidies reform is often more a political exercise than a technical one. In these political-economic frameworks, fossil fuel subsidies are considered as an instrument of political control, by allowing the government to produce targeted benefits to politically influential groups and constituencies (Hartley and Medlock, 2008; Victor, 2009; Overland, 2010). By inducing a large effect on the price level and causing important short-term changes in income and welfare distribution, subsidy reforms can lead to large adjustment costs and create high political risks (Commander, 2012; Vidican, 2015). In extreme cases, the withdrawal of fuel subsidies can lead to major urban protests (Sovacool, 2017; Bril-Mascarenhas and Post, 2015). Examples of social conflict that have occurred include countries such as Indonesia (1997, 2003), Mauritania (2008) or Nigeria (2012).[19] Similarly, in countries where automatic fuel pricing mechanisms[20] have been adopted, governments have not been able to extend these supports in times of sharp increases in international prices (e.g., Gabon, Ghana, and Jordan) as they were often perceived to exacerbate social, economic and political tensions (Arze del Granado et al., 2012).

Some studies suggest that the type of political system influences fossil fuel subsidies and that the quality of institutions might play an important role in the reform process. For example, Commander (2012) shows that democracies tend to score better institutionally and are characterized, on average, by lower subsidies. Similarly, weak institutions tend to be associated with higher fossil fuel subsidies. Intuitively, these results make sense as the supply of public goods is typically higher in democracies than in autocracies. Moreover, in non-democratic regimes, the benefit to citizens of an energy subsidy –regardless of whether the general population does or does not support the regime– is found to be a more credible commitment to income redistribution than redistributive policies. These results are consistent with other empirical analyses. van Beers and Strand (2013) esti-

[19] In the immediate aftermath of the Asian financial crisis, the Indonesian government sought a loan by the IMF, including a specific commitment to eliminate fuel subsidies. Consequently, the government implemented a 71 percent increase of in the price of fuel, that led to mass demonstrations and social violence across the country and ultimately to Soeharto's resignation later that month (UNEP, 2016). In Mauritania, an attempt at energy subsidy reform took place in 2008. The reform contributed to a climate of political instability that culminated in a military coup in August 2008 (Alleyne, 2013). In 2012, the Nigerian government decided to remove the subsidy on imported petroleum products, causing the price of fuel to more than double. Prolonged strikes led the government to introduce a new subsidy that lowered the price of fuel (Siddig et al., 2014).

[20] These mechanism consist in adjusting domestic prices automatically at regular (e.g., monthly) intervals in line with international prices.

mate the influence of political and institutional variables on fuel prices for about 200 countries over the 1991-2010 period. Their results evidence that inefficient governance leads to a greater reluctance to reforms, reflecting in smaller domestic fuel prices and higher fossil fuel subsidies.

One main implication of these studies is that the removal of subsidies will not necessarily lead to more efficient social programs if subsidies are justified on grounds of weak government capacities (Commander, 2012; Victor, 2009). In poor countries in which governments redistributive capacities are weak, fossil fuel subsidies are often an important or the only substantive source of income redistribution. In this context, subsidy reforms can be considered as creating more losers than winners and be rejected on that basis. To illustrate this idea, Ebeke and Lonkeng Ngouana (2015) develop a political game in which the richest social strata is more easily inclined to support a high subsidy rate because the costs of public spending in countries, where institutions are weak, are typically higher relative to rents they might capture. The poorest social strata will make this situation to persist because the crowding-out of public spending by fossil fuel subsidies induces public services of poorer quality. The social benefits they might enjoy will then be lower, relative to the benefits associated to fossil fuel subsidies. Thus, even though low income households tend to have limited power as a collective entity, they can exert strong influence on policy actions by supporting the social claims of the middle and upper income households. Clearly, these studies that analyze the role of political regimes in subsidy reforms show that these reforms require not only sufficient and sustained political will and support to ensure that they are implemented, but sufficient political acceptance to ensure that they are sustainable and sustained.

Other studies highlight the role of uncertainty and information in the reform process. In these analyses, consumer subsides are not necessarily highly visible as they are often indirectly delivered either through domestic distributors such as national oil companies (Cheon et al., 2015) or through a variety of channels that both serve to strengthen their lack of transparency. Under such circumstances, it is likely that consumers will not have a clear perception of fossil fuel subsidies. For example, Whitley and van der Burg (2015) report that, in some North African countries (Morocco, Egypt), citizens were often ignorant about the scale of domestic fossil fuel subsidies. However, this misperception largely disappears with the implementation of subsidy reforms as these measures, by typically raising fuel prices, send a strong signal to consumers of the welfare costs they will incur (Bril-Mascarenhas and Post, 2015). Loss aversion usually produces a bias toward maintaining an inefficient status quo and against reform that would benefit the majority. Thus, subsidy reforms often relate more to what changes they will mean for consumers than to explanations of the complexity of the subsidies scheme. This is why more and better communication has often been put forward as a way to increase public understanding and acceptance of reforming (Clements et al., 2013; Vagliasindi, 2012,

2013). In particular, to launch and carry through any significant reform, reformers must convince the population of their capacity to anticipate changes and to ensure that these changes will be fair and reasonable. In Nigeria, continuous resistance to attempts to remove subsidy have prevailed because most times, government reneged on its promises on how the proceeds from the subsidy removal would be applied to improve the economy or raise the standard of living of the people (Soile and Mu, 2015). Similarly, taking the example of the reform of the gas subsidy in El Salvador, Calvo-Gonzalez et al. (2015) explain why this reform turned out to be highly unpopular, while it was expected to improve the welfare of around three-quarters of the population. Their study delivers two interesting results: first before the implementation of the reform, the level of information about the reform and doubts on the ability of the government to deliver compensations for losses incurred explained most of the low level of satisfaction. Second, the increase in the satisfaction rate over time has been essentially driven by the ability of the government to deliver compensations. Thus beyond the institutional capacity of governments for reform, for people to respond appropriately to subsidy reforms, they must be aware how they will affect them and on how governments will wisely use savings resulting from these reforms.

5.3. Sequencing and compensation schemes

Several developing countries have experienced different sequencing of reforms and different compensation schemes in order to mitigate the adverse impact of subsidy reforms. While empirical evidence on the timing, speed and sequencing of reforms reported in section 4.2 support phased reforms, country experience yield mixed results. Some experiences suggest that fast-paced reform is preferable where a country has sufficient credibility (e.g., Ghanas 2005 fuel price adjustment). Where government is strong or soon after elections, a big bang approach with a large initial adjustment may also be feasible (Alleyne, 2013). Conversely, gradual reforms are considered as an alternate means of allowing consumers to improve their energy efficiency and thus of mitigating the adverse impact of future rounds of price increases (Clements et al., 2013). But raising energy prices slowly can also not work because each round of price increases can intensify opposition to reform and stop further increases, as it happened in Iran with the unsuccessful reforms experienced before 2005 (Salehi-Isfahani et al., 2015).

The design of subsidy reforms is not restricted to the role played by the timing, speed and sequencing of reforms; it may also include government commitment to improve and enlarge social safety nets or to guarantee sufficiently high benefits in the face of inexistent social protection systems. Even the IMF has shifted its discourse and its intervention toward favoring compensation schemes. Indeed, while fiscal issues and concerns about allocative inefficiencies have always triggered the IMF to accelerate subsidy reforms, Feltenstein (2017) concludes, from his analysis of country examples over the 2006-2015

period, that the international financial institution has been increasingly considering social implications of such reforms.

Experiences in some developing countries have shown that subsidy reforms can incorporate an expansion of the size of social safety net –when such programs already exist– as an integral element of reform adjustments. Examples are Jordan where the budgetary savings from its reform of fuel prices in 2005 and 2008 were used to expand its social safety networks and Mozambique, where budgetary allocations to a range of social protection programs were increased substantially when the government increased fuel prices by 38 percent in 2008 (Alleyne, 2013). However, in others countries (such Egypt), this option has revealed itself not to be an appropriate one, on the ground that social safety nets had not yet succeeded to support the poor (Fattouh and El-Katiri, 2013).

Many other developing countries, where social assistance systems do not exist, are too costly to implement or inefficient, have sequenced their reforms by initially removing subsidies to goods mainly consumed by wealthier sectors (e.g. petrol), before those consumed by lower-income groups (e.g. diesel and kerosene) and/or developed compensation schemes to mitigate adverse effects of the reform on the population (Clements et al., 2013; van Beers and Strand, 2013). Examples of countries that have phased in reforms for different fuels include Angola, India which started decontrolling gasoline prices and Peru, where subsidies were first removed on high-octane gasoline used in luxury cars, and ultimately on regular gasoline and LPG for industrial consumption (Ruggeri Laderchi, 2014). Although the importance of targeting of existing subsidies in mitigating the adverse impact on poverty is well recognized, this policy cannot however insulate the poorest population from the indirect effects of higher prices following subsidy reform, which, as discussed in section 4.2, can be significant.

This is why cash transfers to households are often used to sustain the extreme poor and to support needed adjustments. With this system, targeted households receive a level of cash that allows them to be compensated at least partially for the energy price increase and its indirect effects (Ruggeri Laderchi, 2014). However, if a targeted compensation approach indicates an even greater distributional adjustment in favor of the poor, it might have detrimental social consequences and foster resistance from those who are not receiving it. In Iran, for example the decision by the government to not target the compensatory cash transfer program associated to the subsidy reform undertaken in 2010 was to avoid triggering public discontent among the biggest energy users (Salehi-Isfahani et al., 2015). Poverty neutral cash transfers can moreover led to an unequal distribution of compensation benefits among regions. In particular, regions with higher energy consumption but lower pre-reform poverty rates will tend to receive a larger share of the overall compensation budget. A great example of this is given by the study of Rentschler (2016) on the impact of fuel subsidy reform in Nigeria. Finally, if the government is discovered to be incompetent in implementing programs based on

targeting the poor, the public may be against the subsidy reform, thereby blocking its adoption. Kyle (2018), using household survey data from Indonesia, show that corruption in the implementation of targeted transfer programs is associated with more resistance to reforming consumer fuel subsidies. But, even if the impact of targeted programs on poverty is complex, country experiences taken together suggest that well-functioning social protection systems help to use efficiently cash transfers as transitional measures during subsidy reforms (Ruggeri Laderchi, 2014).

Another influencing factor, highlighted by empirical studies examined in section 4.2, is the capacity of governments to support compensation schemes by long-run policies that reduce poverty. Vagliasindi (2012, 2013) concludes, from its review of concrete case studies, that targeted investments, such as infrastructure investments and extension services, are needed to improve productivity and to facilitate transition because cash transfers to compensate for losses are insufficient to induce supply response. The challenge is then to ensure an adequate balance among the complementary income support for transitions and core public programs to spur long-term growth and poverty reduction. For example, in some Sub-Saharan African countries, subsidy reforms have been associated with several additional measures as the elimination of fees for state primary and secondary schools, a ceiling on public transport fares, additional funding for health care in poor areas and a rise in the minimum wage, as experienced by Ghana during its 2005 reform, or investments related to the expansion of rural health services, electrification, and drinking water supply, as in Gabon when the government increased gasoline and diesel prices by 26 percent in March 2007 (Alleyne, 2013).

In conclusion, the most important lessons learned from experiences on subsidy reforms is that (i) the effectiveness and efficiency of a subsidy reform depends heavily on the specifics of implementation; (ii) while it is important to implement a well-designed subsidy reform which is more likely to succeed, this does not mean, however, that this reform will necessarily be more likely to be politically accepted and (iii) design of subsidy reforms must thus take into account a number of factors, such as political acceptability, leakage of benefits to households outside the target group, cost... To these different factors be considered, all available studies agree that a successful reform requires a consistent package of different measures that complement and reinforce each other such as an appropriate timing, a sound public communications strategy, and well-targeted compensating measures that facilitate public acceptance of reforms.

6. Conclusion

To conclude, the main issues and findings discussed in this paper are summarized. Findings from the empirical literature are dealt with first. Some research perspectives aimed at providing a better understanding of fossil fuel subsidies as well as their reforms

are then discussed.

6.1. Empirical lessons

Considerable light has already been shed on the impact of fossil fuel subsidies and their reform on income inequality and poverty in developing countries. With respect to income inequality, empirical evidence in the literature reveals a clear consensus among economists that fossil fuel subsidies are highly regressive. Due to their universal nature, they indeed accrue mostly to the richest households who are also the biggest energy consumers. As a consequence they have failed to protect the real incomes of the poorest households from high and rising energy prices and to encourage them to use hig-quality fuels. Since fossil fuel subsidies are also associated with deadweight and efficiency costs, opportunities exist for improving both efficiency and equity effects by reforming them. The stylized facts reveal that although significant changes to energy policies have occurred, many countries have nonetheless maintained fossil fuel subsidies over time. More specifically, country experiences show that although adjustments occur frequently, major reforms are difficult to achieve. Political-economy arguments have been advanced to explain how institutional factors and strategic interactions among various interests can represent important obstacles to reform decisions and their implementation. Another stylized fact related to subsidy reforms is that their distributional consequences often come at the expense of the poorest households, and this adverse effect may be particularly large. Although differentiating subsidies reforms within aggregate fossil fuel groups –for example, by eliminating first subsidies on fuels that are typically used by richer households– may help mitigate the impact on the real incomes of the poor, this is likely to be a very blunt second-best approach given the relatively high impact of prices increases on other goods. The introduction of a well-designed and well implemented social safety net offers a more effective way of protecting the poor and can generate substantial gains by allowing subsidies to be removed more efficiently.

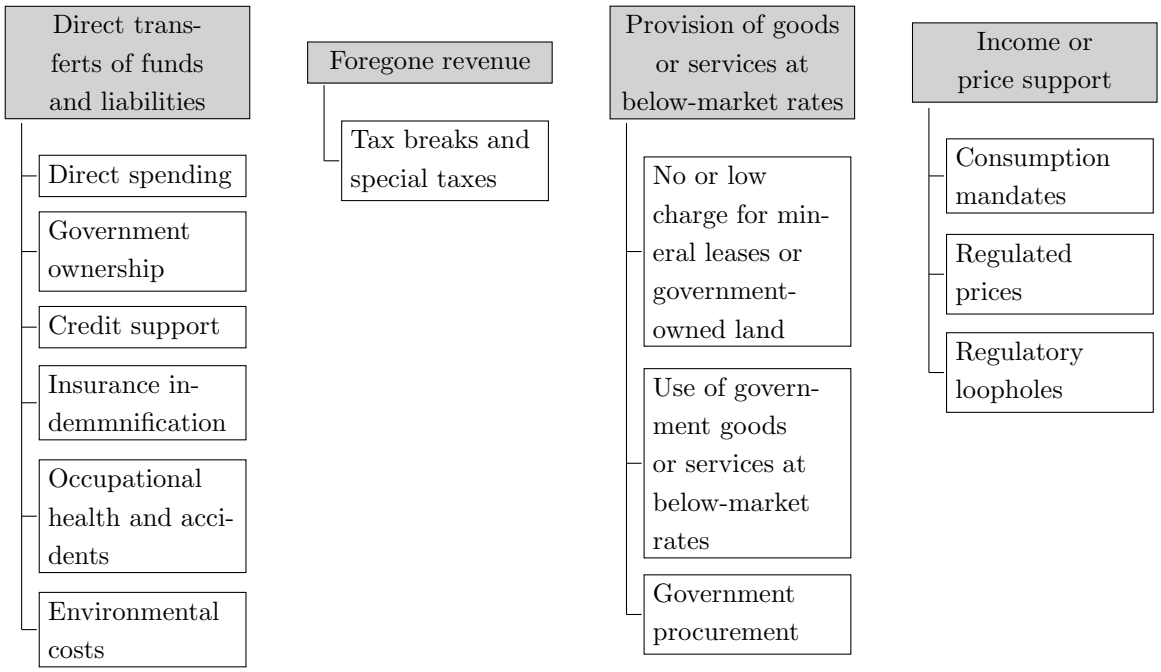
6.2. Methodological lessons

If much progress has occurred in the past decade in improving our understanding of why governments have implemented fossil fuel subsidies and why they are incited to engage in reform process, it must however be noted that adequate assessments of these political actions are often hampered by the lack of available and reliable statistical data for many countries. From our review, it appears that there is no comprehensive dataset including all support measures that fall within the definition of a subsidy such as the one used by the World Trade Organizations Agreement on Subsidies and Countervailing Measures. It is important to bear in mind that fossil fuel subsidies encompass a broad array of instruments and a detailed assessment of these instruments, by improving our understanding of subsidy mechanisms, could inform country-level decisions on the choice

of the most optimal combination among multiple potential measures to ensure successful reforms. When more data is made available such as those relating to consumer subsidies, the coverage of countries, products, and year remains limited. Such database could offer the possibility of performing econometric analyses and generating a reliable picture of long-term trends in fossil fuel subsidies for individual countries and fuel products, as well as for country-groups, regions, and the world as a whole. It could also help to a better understanding of subsidy reforms as well as their impacts. While the first subject has received considerable attention, key factors affecting subsidy reforms have however been identified mainly through case studies and theoretical models. In particular, if the role played by exogenous changes, institutional factors, energy's dependence and structural changes has been recognized, insights concerning their respective role have not yet been integrated into econometric studies. Much remains also to be learned about the incidence of subsidy reforms. Their impacts are inherently complex, as subsidy reforms are usually one component of broader reform packages and are furthermore phased out progressively. They have often been analyzed through partial equilibrium analyses and computable general equilibrium models which mainly provide *ex-ante* evaluations. In contrast, relatively little econometric work has quantified the *ex-post* effects of such reforms on income inequality and poverty. Improving our understanding in this area could also help in designing sustainable subsidy reforms that would be explicitly related to poverty reduction and the improvement of living standards in developing countries.

Appendix

Figure A.1: *Scope of estimated subsidies*



Source: (ADB, 2016)

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