Can government transfers make energy subsidy reform socially acceptable? A case study on Ecuador

Filip Schaffitzel[a*], Michael Jakob[b], Rafael Soria[c], Adrien Vogt-Schilb[d], Hauke Ward[b,e]

[a] Department Economics of Climate Change, Technische Universität Berlin, Str. d. 17. Juni 145, 10623 Berlin, Germany
[b] Mercator Research Institute on Global Commons and Climate Change, Torgauer Str. 12-15, 10829 Berlin, Germany
[c] Departamento de Ingeniería Mecánica, Escuela Politécnica Nacional, Ladrón de Guevara E11-253, 17-01-2759 Quito, Ecuador
[d] Inter-American Development Bank, 1300 New York Avenue, N.W., Washington, D.C. 20577, USA
[e] Potsdam Institute for Climate Impact Research, Postfach 60 12 03, 14412 Potsdam, Germany

Email addresses: filip.schaffitzel@alumni.tu-berlin.de; jakob@mcc-berlin.net; rafael.soria01@epn.edu.ec; avogtschilb@iadb.org; ward@mcc-berlin.net

* Corresponding author: 0049 177 27 123 53

Abstract

Energy subsidies account for about 7% of Ecuador's yearly public spending, or two thirds of the fiscal deficit. Removing these subsidies would yield clear economic and environmental benefits and help implement climate targets set in the Paris Agreement. However, expected adverse effects on vulnerable households can make reforms politically difficult. To inform policy design, we use household survey data from Ecuador in combination with augmented input-output data to assess the distributional impacts of energy subsidy reform. We find that in absolute terms energy subsidies benefit richer households more than poor ones. Relative to household income, subsidy removal without compensation would be regressive for diesel and LPG, progressive for gasoline, and approximately neutral for electricity. We then analyze how a fraction of financial resources freed up by subsidy reform could be used to mitigate income losses for poor households by means of in-kind and in-cash revenue recycling schemes. Our results indicate that removing all energy subsidies and increasing the existing social protection program, *Bono de Desarrollo Humano,* by nearly US$ 50 per month would confer net benefits of almost 10% of their current income to the poorest quintile. In addition, more than 1.3 billion US$ would still be available for the public budget after the reform. Finally, we conduct expert interviews to evaluate the political and institutional challenges related to energy subsidy reform. We identify two combinations of reform options and recycling schemes that would benefit the poorest 40% of households and are deemed to be feasible: eliminating subsidies on gasoline while increasing the amount transferred to vulnerable households through the *Bono de Desarrollo Humano* and replacing universal LPG subsidies with targeted LPG vouchers.

1 Introduction

In Ecuador, prices for gasoline, diesel, liquefied petroleum gas (LPG), and electricity have been subsidized since the 1970s by up to 85% (BCE, 2018a). In 2012, the country ranked fifth globally in energy subsidies when expressed as percentage share of GDP, only surpassed by Saudi Arabia, Iraq, Venezuela, and Algeria (Di Bella et al., 2015); in 2014, it was ranked third in Latin America (Marchan et al., 2017). Within the last ten years, Ecuador's officially reported fossil fuel subsidies caused a substantial strain on the public budget equivalent to on average US$ 2.3 billion per year, equivalent to roughly 7% of public spending or two thirds of public deficits. The Ecuadorian energy subsidies also benefit neighboring Colombia and Peru, where nearly 5% of subsidized LPG containers are smuggled to (Gould et al., 2018).

Revenues generated from removing fossil fuel subsidies could be used to mitigate deficits and sovereign debt, reduce distortionary taxes, and finance investments in education, health or infrastructure (Jakob et al., 2016; BCE, 2018c). In addition, removing subsidies would reduce the inefficient use of carbon-intensive fossil fuels, which increases local air pollution and counteracts climate change mitigation efforts. Coady et al. (2017) estimate that in 2015, the social cost of global warming, local air pollution, accidents and road damage caused by the over-utilization of subsidized energy in Ecuador is 1.6 times greater than the fiscal cost of energy subsidies[1]. Finally, subsidy reform would be a first step towards pricing energy and carbon emissions at a level consistent with the international climate objectives set out during the Paris Agreement, in which Ecuador is a party (Stiglitz and Stern, 2017; Jakob, 2017).

However, the international experience shows that energy subsidy removal can be politically difficult. Many countries have tried to remove subsidies or increase energy prices and failed. One reason is that even if economically inefficient, subsidies are a visible and effective means to transfer some income to poor and vulnerable households (Inchauste and Victor, 2017). Lessons learned from international experience suggest that successful energy reforms require policymakers to understand the impacts of the reforms on different groups before implementing them and to design and communicate compensation packages for negatively affected groups (Coady et al., 2018; Feltenstein, 2017; Gerasimchuk et al., 2017; Rentschler and Bazilian, 2017). The *gilets jaunes* protests in France provide a recent reminder of how politically sensitive the price of energy can be.

The process of building socially acceptable subsidy reform packages can be informed by assessing the impact of energy subsidy removal on different income groups. The international literature has found that energy subsidy removal may be regressive or progressive, that is it may cost poor households a larger fraction of their revenues when compared to wealthier households and vice versa, depending on the specific fuel and country context. But a few findings are robust across countries (Coady et al., 2018; Gerasimchuk et al., 2017; Rentschler and Bazilian, 2017). First, removing energy subsidies without compensation can harm consumers. Second, the *indirect* cost of subsidy removal, that is their effect on the price of goods and services is often a significant driver of total costs. Third, energy subsidies are a very expensive means to provide real income to poor and vulnerable households. This suggests that government could shield poor and vulnerable households from negative impacts by reinvesting just a small fraction of the financial proceeds from subsidy removal into more efficient social protection programs, such as direct cash transfers. And indeed, governments who have reinforced social protection as part of a policy package were more likely to succeed in increasing energy prices.

For Ecuador, the only quantification we are aware of is provided by Feng et al. (2018). Using a simple input-output model as part of a regional study on 11 countries, they find that it costs $13 to transfer $1 to bottom-quintile households in Ecuador using gasoline and diesel subsidies; $10 using electricity subsidies, and $7 using LPG subsidies. Based on these numbers, they conclude that governments could in principle compensate bottom-quintile households by recycling only a small fraction of the proceeds

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[1] The IMF provides per country data online at http://www.imf.org/external/np/fad/subsidies/data/codata.xlsx. We computed the fiscal cost as the sum of "pre-tax subsidies" and "forgone consumption tax revenue".

from energy subsidy removal into perfectly targeted lump-sum transfers (8%, 10%, and 14% respectively).

This paper builds on lessons learnt from the international literature and expands the quantitative and qualitative evidence base to inform possible energy subsidy reform packages in Ecuador. Recognizing that indirect effects are a crucial driver to consumer costs, we analyze the impact of subsidy removal by applying commodity specific input-output (IO) analysis in combination with household consumption data. Our method gives an upper-bound estimate of the short-term impact of subsidy reform on households, before firms adjust production processes and consumers adapt to new prices, a good indicator for public policy focused on the social acceptability of energy price hikes (Coady et al., 2018; Feng et al., 2018). Compared to Feng et al. (2018), we use finer IO data, narrower energy types categories (separating gasoline, diesel, and LPG), and more recent and official estimates of energy subsidies.

We find that it costs $20 to transfer $1 to the bottom income quintile using gasoline subsidies, with the impact dominated by the fact that gasoline is used mainly by richer households who own cars; $10 using electricity and $9 using diesel subsidies – this reflects the fact that electricity and diesel are used as inputs for most consumption goods– and $5 using LPG subsidies – reflecting that the direct utilization of LPG for cooking is roughly uniformly spread across the five income quintiles. Our results confirm Feng et al's previous result for the cost of electricity subsidies and highlight the value of separating by fuel type (diesel, gasoline and LPG) when computing the cost of energy subsidy removal.

We then model for the first time specific compensation schemes that could be financed by freed-up public revenues from subsidy reforms. Available quantitative studies globally have focused on assisting the incidence of recycling revenues with tax breaks or uniform per capita transfers (Coady et al., 2018; Rentschler and Bazilian, 2017). But in Ecuador, tax breaks won't benefit poor households who do not pay taxes, and universal transfers may not be feasible in practice. We thus model the impact of expanding existing cash transfers: we compare scaling up the amounts disbursed under the *Bono de Desarrollo Humano (BDH)*, increasing the number of beneficiaries of the BDH, enacting a minimum pension for senior citizens, and an ideal uniform lump-sum transfer to all citizens. We also assess the impact of in-kind transfers, that have played a role in other countries to make energy reforms successful (Coady et al., 2018; Gerasimchuk et al., 2017; Rentschler and Bazilian, 2017), but are seldom analyzed in the quantitative literature. We consider making health care free for poor households, and distributing vouchers to reduce food, LPG and transport expenditures by poor households. We show how a fraction of the revenue from subsidy reform typically suffices to compensate poor households, leaving most of the freed-up resources to fund the general budget of the state. For instance, our results suggest that if all energy subsidies are removed and the BDH is increased by US$ 46 per month, the net income of the bottom quintile would rise by 9% and the deficit could be reduced by US$1.3 billion.

In addition to quantitative impacts, local conditions and political structures can make reforms politically palatable or not (Inchauste and Victor, 2017). We thus conduct interviews with local and international experts to qualitatively elicitate the political appetite for different options for energy subsidy reforms. We find that two options which seem to be politically feasible include eliminating subsidies on gasoline while increasing cash transfers of the existing social protection program *Bono de Desarrollo Humano,* and replacing generalized LPG subsidies with targeted LPG vouchers.

Our analysis does not cover all aspects relevant to subsidy reform. For instance, we ignore the different ability of poor and rich households to adapt over time to price shocks. We ignore the impact of energy price hikes on firms and workers. Other papers have discussed how tax exemptions for energy-intensive firms (including taxi and bus compagnies), subsidies to help business transition to energy efficient equipment, and social protection and retraining programs to help workers transition to less energy-intensive sectors can help firms and workers cope (Coady et al., 2018; Hallegatte et al., 2013; ILO, 2018; Rentschler et al., 2017; Rozenberg et al., 2018). We do not assess the geographic incidence of energy price increases (Rentschler, 2016). We do not consider all possible compensation mechanisms, for instance we do not consider lifeline rates for electricity, or subsidies to help households switch to other energy sources (such as from LPG to electric cookstoves).

Despite its limitations, this paper provides critical intelligence that sheds light on some policy levers that seem politically-palatable and that the government of Ecuador could use to reform energy subsidies while shielding poor and vulnerable households from negative impacts, increasing the chances of success for the government. More generally, the approach and lessons learned can be applied to other developing countries. For instance, all countries in Latin America may benefit from increasing energy prices to fund development programs, reduce public deficits, and incentivize a transition to a low-carbon economy. The cash transfer programs of the region could be an instrument to reduce the impact of energy price hikes on poor consumers, therefore making price reforms more palatable.

The rest of the paper is organized as follows: Section 2 reviews relevant literature and puts our paper into context. Section 3 describes the current situation of Ecuador and provides background information. Section 4 presents the used data and the methodology. Section 5 reports the distributional impacts of energy subsidy reform, demonstrates how freed-up public revenues can be recycled, and evaluates the option space for policy makers. Section 6 concludes.

2 Contribution to the literature

This paper establishes a novel approach to assess the distributional impacts of subsidy reform in combination with a quantified analysis of different in-kind and cash transfer schemes that can be employed to prevent adverse outcomes for poor households. It is to our knowledge also the first paper combining quantitative and qualitative methods to gain a better understanding of the political economy of energy subsidy reforms.

To assess the distributional effects of climate policies, such as carbon or energy taxes, two major approaches are applied in the literature. These include dynamic CGE models (Abouleinein et al., 2009; Solaymani et al., 2013; van Heerden et al., 2005; Yusuf and Resosudarmo, 2015; Beck et al., 2015; Clements et al., 2007) and static, but more detailed models that use IO data in combination with household data (Dorband et al., 2019; da Silva Freitas et al., 2016; Datta, 2010; Feng et al., 2010a; Grainger and Kolstad, 2010; Kerkhof et al., 2008; Coady and Newhouse, 2006; Wier et al., 2005; Symons et al., 2002; Cornwell and Creedy, 1996). This study builds on the latter approach to quantify indirect impacts of energy price reforms (e.g. due to price changes of goods and services that consume energy). This allows us to identify the underlying drivers of distributional effects and inform the design of compensation schemes. The input-output model gives an upper-bound estimate of the short-term impact of energy price hikes on the price of other consumption goods, before firms had a chance to adjust production processes or prices and consumers had a chance to adapt. The International Monetary Fund (Coady et al., 2015) notes that the short-term estimate provided by input-output analysis may also be closer to the perceived impact of energy subsidy removal by the public, making it a good indicator for public policy focused on the social acceptability of energy price hikes.

The effect of energy subsidy reforms on household welfare has been analyzed for various countries, including Egypt (Abouleinein et al., 2009), Ghana (Coady and Newhouse, 2006), India (Gangopadhyay et al., 2005; Rao, 2012), Indonesia (Clements et al., 2007), Iran (Saboohi, 2001; Parvin and Banouei, 2009; Sharify, 2013), Malaysia (Solaymani et al., 2013) and Ukraine (Ogarenko and Hubacek, 2013). Arze del Granado et al. (2012) and Coady et al. (2015) review distributional impacts of fuel subsidy reforms for different developing countries and find significant welfare losses for households on average. If subsidies on all energy carriers were removed at the same time, welfare losses relative to household income are about equally distributed across income groups. However, in absolute terms, rich household benefit most of fuel subsidies.

In order to prevent adverse outcomes for low-income households, revenues from subsidy reform and fiscal environmental taxes can be recycled, for example to reduce income taxes in developed countries (Goulder, 1995a; Welsch, 1996; Dinan, 2015). This approach has been applied in practice in British Columbia, Canada, with progressive outcomes (Beck et al., 2015). Likewise, Lennox and van Nieuwkoop (2010) find that in New Zealand income or capital tax reductions would minimize the macroeconomic impact of the emission trading scheme slightly more than lump-sum transfers, which is in line with the "weak double-dividend notion" (Goulder, 1995b, p. 161). In developing countries such as Ecuador, however, poor household rarely pay income taxes, reducing the suitability of this solution. Another option assessed in the literature is the use of ex-post lump-sum transfers to recycle the revenues from energy taxes or subsidy removal. For Indonesia, Yusuf and Resosudarmo (2015) find that uniform transfers would reduce income inequality, whereas the modeled value added tax (VAT) reductions have no effect on income equality. This progressive distributional effect of lump-sum transfers has also been found in China (Brenner et al., 2007).

However, lump-sum transfers are in general not a feasible option for governments (Stiglitz, 2013). Clements et al. (2013) emphasize the importance for governments of using existing social safety nets to avoid poorly targeted compensatory payments. The detailed case study analysis with lessons from 20 developing countries by Vagliasindi (2013) highlights that successful energy price reforms have relied on both existing and newly developed social programs to compensate poor and vulnerable households. To our knowledge, the only ex-ante analysis of the impact of recycling revenues from energy price reforms into existing cash transfers is provided by Renner (2018), who quantifies how the *Oportunidades* cash transfer program can be expanded with a fraction of carbon tax revenues in Mexico to compensate poor households.

Apart from cash transfers, in-kind transfers have played an important role in making subsidy reforms successful. For instance, Adeoti et al. (2016) recommend a portfolio comprising various cash and in-kind transfers to compensate for distributional impacts of a fossil fuel subsidy reform in Nigeria. In the case of the Republic of Moldova, the study by OECD (2018) shows that a voucher system to compensate for the impact of energy subsidy removal is favorable over other cash transfer schemes.

3 Ecuador country background

This section provides an overview of the latest socio-economic developments in Ecuador and the country's energy supply. Further, we estimate energy subsidies for both fossil fuels and electricity. Finally, to understand through which mechanisms energy price increases could be compensated, we introduce the most important transfer schemes.

3.1 Socio-economic context

After the economic crisis in 1999, with GDP plummeting and inflation rates peaking at 96% in the subsequent year, Ecuador adopted the US-Dollar as its national currency (Jácome, 2004). Under Rafael Correa's presidency from 2007 to 2017, social spending quadrupled with major increases in education and health (Finance Ministry as cited in OPF, 2018). Apart from expanded social protection programs, rising employment and school enrollment rates may also have contributed to the decline in inequality, as shown by the reduced GINI index of 45.0 in 2016 (WB, 2018b; see also Table S8). In the same year, of the 16.4 million people in the upper-middle income country, 22.9% live under the national poverty line, a sharp decline compared to the poverty headcount of almost two thirds in 2000 (WB, 2018b). Burgos (2013) argues that this reduction is mainly due to economic growth and social policies improving income equality. However, since 2013 falling oil prices, the strengthening of the dollar, and the large deficit due high public spending triggered an economic recession. Public oil revenues decreased by about 50% exacerbating the annual budget deficit of 5.5% of GDP on average since 2013 (BCE, 2018d).

3.2 Energy supply and subsidies

The OPEC-member Ecuador possesses 0.2% of known global oil reserves and accounts for 0.6% of global oil production, or 7.3% of the oil originating in LAC (MH, 2018; BP, 2017). About one quarter of the produced oil is refined and almost entirely consumed domestically. 98% of Ecuador's oil products exports is crude oil due to the low national refinement capacity (BP, 2017; MICSE, 2016). To meet domestic demand, refined oil commodities are imported, because their consumption exceeds Ecuador's refinery throughput by a factor of 1.6 (BP, 2017). Larrea et al. (2017) argue that depleted reserves will convert Ecuador from a net exporter of oil to a net importer by 2030. Primary energy consumption stems largely from oil and hydro, whereas natural gas and other renewables only play a minor role (BP, 2017). Despite the high generation of hydro-electricity, CO_2 emissions per capita are relatively high in comparison to other upper middle-income LAC countries (ranking 6 out of 20) (WB, 2018a).

In 1974, when rising international oil prices and elevated oil extraction rates led to increased government revenues, fuels subsidies were introduced by the military regime to strengthen their power and support vulnerable households (Espinoza and Guayanlema, 2017). Since then, prices for gasoline, diesel, and

LPG have only changed on a few occasions and remained flat since 2003 (MCPEC, 2010). While low energy prices benefit consumers, subsidies encourage inefficient energy use. Moreover, the public budget is strained by US$ 2.3 billion per year on average in the past 10 years to finance fossil fuel subsidies (Figure 1). This represents almost 3% of GDP or 22% of oil export revenues on average. Of total fuel subsidies, diesel receives roughly half, gasoline about a third, and LPG a fifth. In times of high oil prices, official subsidies increase due to the rising gap between the world market price and the fixed domestic price of oil products, which are mostly imported (MICSE, 2016).

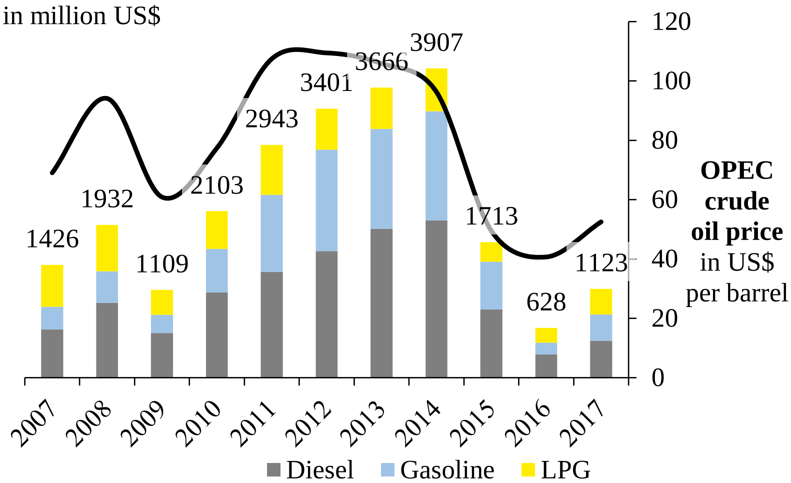

Figure 1: Official subsidies for diesel, gasoline, and LPG in million US$ and crude oil price from 2007 to 2017.

Source: BCE (2017, 2018a, 2018b), Statista (2018)

The Ecuadorian Central Bank calculates official subsidies by multiplying the price-gap between import and domestic sales prices with the volume of imported fuels. This approach disregards the volume of domestically produced and consumed fuels. Considering these additional opportunity costs, estimated total fossil fuel subsidies are 1.5 times higher than officially reported[2] and almost equivalent to government expenditures on education and health in 2012 (Table S14). Marchán et al. (2017) estimate that between 2008 and 2014, Ecuador had the third highest fuel subsidies relative to GDP in LAC countries, only surpassed by Bolivia and Venezuela.

In 2012 (when the augmented IO data was collected), more than half of the electricity was generated from renewable energies, essentially hydropower, while the other half stemmed from thermal power plants, using mainly fuel oil, natural gas, and diesel (ARCONEL, 2013). Today, the share of renewable electricity generation has increased to more than 80%, primarily due to the inauguration of new hydro power plants (CENACE, 2018; ARCONEL, 2017). Electricity began to be explicitly subsidized in 2007 by a reduced tariff (the so-called “dignity tariff”) of 4.0 USc/kWh for residential, low-consumption customers (Art. 1 f., Executive Decree No. 451-A of July 12, 2007). In 2015, about 2.1 million households received the “dignity tariff” (ARCONEL, 2015). It is designed as a cross-subsidy with consumers above the consumption threshold paying a markup to partly finance the subsidy (MCPEC, 2010). In addition, three further electricity subsidies are in place (Table S9) and in total nearly half of all electricity customers receive subsidies amounting to roughly US$ 75 million, or 4% of total sales (MEER, 2018; ARCONEL, 2018).

Besides the targeted explicit subsidies, in Ecuador implicit electricity subsidies are in place due to opaque electricity costs. For instance, public electricity companies exclude capital costs from energy cost calculation (Asamblea Nacional, 2015) and capital costs are frequently not included in cost accounting for transmission and distribution system operators (Marchán et al., 2017). Another example is the use of subsidized fuels in thermal power generation (Executive Decree No. 338 of August 8, 2005). Official electricity costs amounted only to 9.29 USc/kWh in 2016 (Table S10). In contrast, real

[2] Multiplying price-gap with total consumption of fossil fuels from MICSE (2016) yields about 3,700 million US$ of fuel subsidies per year on average between 2007 and 2015.

electricity costs are estimated to be between 14.0 to 16.0 USc/kWh based on the statements of several interviewees with extensive experience in the Ecuadorian energy sector. In 2016, nearly 18,900 GWh of electricity were delivered to final customers, which would result in total costs of electricity of approximately US$ 2,800 million. In the same year, overall electricity revenues reached US$ 1,863 million with sales prices averaging at 9.9 USc/kWh (ARCONEL, 2017). The difference between estimated costs and revenues yields the implicit electricity subsidy amounting to roughly US$ 950 million. For comparison, Marchán et al. (2017) estimate a similar average annual subsidy of US$ 800 million for the period 2008 to 2014.

3.3 Government transfer programs

An average household in Ecuador has a monthly monetary income of more than US$ 700 per month (INEC, 2012b). Government transfers are of special interest, as they can be used to compensate for adverse distributional effects. In 2012, Ecuadorian households received more than US$ 230 million of public transfers, of which almost 90% stemmed from monetary government transfers, mainly in form of pensions and the BDH (INEC, 2012a). Non-monetary transfers accounted for the remaining 10% of total transfers and include essentially educational transfers with food and health transfers only playing a minor role (Table S11).

The BDH is a conditional cash transfer that emerged in 2003 from the unconditional Solidarity Grant, which was established in 1998 to compensate for higher electricity and LPG prices due to subsidy reforms (Larrea, 2013; Schady, 2018). BDH beneficiaries are mothers with underage children up to a certain poverty line, senior citizens without pension and people with disabilities, who are living in "vulnerable conditions" (MIES, 2017). Nearly three quarters of the poorest 20% and half of the second income quintile received the BDH in 2011 (INEC, 2012a). Since 2009, the monthly payment amounted to US$ 35 and in 2013 it was raised to US$ 50 (Art. 2, Executive Decree No. 1838 of July 20, 2009; Art. 1, Executive Decree No. 1395 of January 2, 2013). Today, mothers receive an additional variable amount up to US$ 100 per month depending on the number and age of their children and eligible seniors obtain a total grant of US$ 100 per month (Art. 2, Executive Decree No. 253 of December 22, 2017). The grant is either transferred directly on bank accounts or can be obtained at a country-wide network of bank branches (Martínez et al., 2017). According to the vice minister of the responsible ministry (MIES), 411,000 people currently receive the grant.

4 Methods and data

The results of this study can be divided in three parts: distributional impacts of energy subsidy removal, revenue-recycling, and the feasible option-space for policy makers (Figure 2). First, three price increase scenarios for diesel, electricity, gasoline, and LPG subsidy reform are developed based on the past energy prices and an Ecuadorian Input-output table. Combining these scenarios with household expenditures allows us to assess the direct and indirect distributional impacts of energy subsidy reform. In the second part, we assess how the saved subsidy costs can be used to compensate for adverse distributional impacts by means of cash and in-kind transfers. In the final part, politically feasible options are evaluated qualitatively based on the findings from expert interviews.

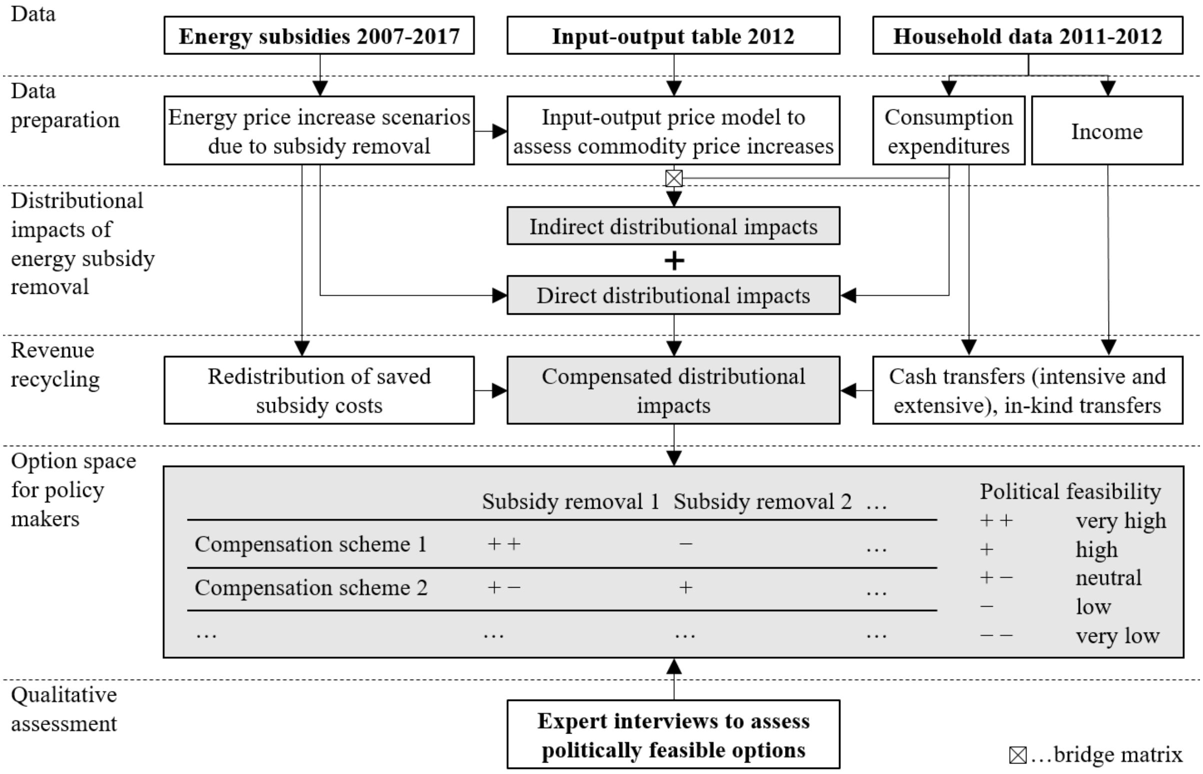

Figure 2: Research design of study. Note: grey shading: results; bold font: data and information sources.

Source: own illustration

4.1 Data

The underlying data and information sources are official and estimated energy subsidies for the period 2007 to 2017 (section 3.2), the augmented 245x245 commodity input-output table (IOT) from 2012 (BCE, 2012), household data from 2011 to 2012 (INEC, 2012a) and interviews with experts. The latter were conducted in 2018 before the results of the quantitative analysis were available (S3 and the Supplementary Information (SI) for details).

4.2 Method

This subsection first describes the development of the three energy price increase scenarios. Second, the underlying methodology to estimate distributional impacts is explained. Finally, the subsection shows how we selected and designed a set of compensation schemes. Please refer to the SI for details on mapping household with IO data.

4.2.1 Energy price increase scenarios due to subsidy removal

If subsidies for fossil fuels are removed, domestic sales prices can be expected to be equal to import prices. In the past ten years, the difference between import and domestic sales prices has varied substantially, mainly due to fluctuating import prices (Table S14). For the choice of the low, medium, and high scenario we use the minimum, median, and maximum price difference between import and domestic sales prices from BCE (2018a) between 2007 to 2017 (Figure 3). In the three scenarios LPG prices see the largest price increase as import prices have been up to 6 times higher than the domestic sales prices. To put the scenarios into today's context, in April 2018, diesel prices would have increased by almost 100%, gasoline prices by two thirds, and LPG by about 230% (BCE, 2018a).

Since electricity is not imported, comparing domestic and import prices is not an option. Hence, its price increases because of implicit subsidy removal are estimated based on an expert's estimation of electricity costs due to the lack of transparency (section 3.2). Real electricity costs are estimated at 0.15 US$/kWh, which is about two thirds higher than the official costs and represents the medium scenario. The low scenario is 50% less and the high scenario is 50% more.

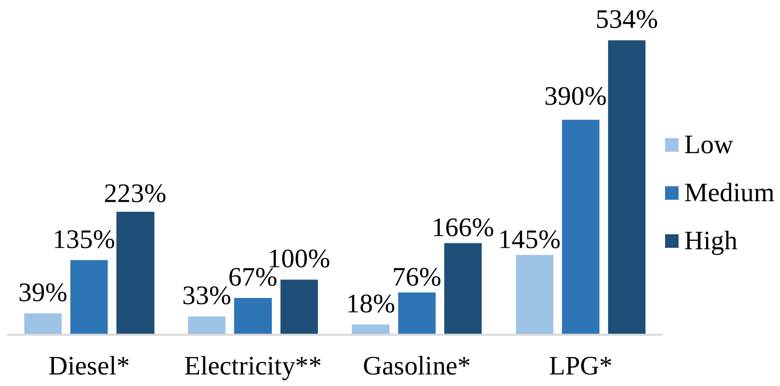

Figure 3: Domestic sales price increase scenarios for diesel, electricity, gasoline, and LPG if subsidies were removed

Source: own illustration based on *BCE (2018a), **expert interview

4.2.2 Input-output price-shifting model and estimation of distributional impacts

The analysis of our paper utilizes an IO framework (see Miller and Blair (2009) for an overview). It is based on the price-shifting model by Coady (2006)[3]. Hence, price changes in energy commodities propagate in accordance with elements of the Leontief inverse matrix L. One property of the Leontief matrix is that single elements (l_{ij}) account for all sectoral inputs (of sector i) that have eventually been used to produce one (normalized) unit of output (in sector j) (Schnabl and Holub, 1994). Consequently, l_{ij} can also be interpreted as the monetary value of inputs from sector i necessary to produce one US$ of output by sector j. If the corresponding Leontief element for diesel inflows into public transport is 0.3, this would imply that within the total supply chain 30 USc of diesel inputs are required to provide one US$ of public transportation. Hence, if diesel prices would double, while all other Leontief elements remain constant, assuming that producers pass the cost increase on to consumers, the consumer price of one unit of public transport service would increase by 30%.

To estimate direct distributional impacts, we calculate additional direct expenditures $c^{dir}_{k,s,h}$ required for household *h* to maintain its current energy consumption after subsidy removal of energy *k* in the scenario *s* as follows:

$$c^{dir}_{k,s,h} = p_{k,s} \cdot y_{k,h} \tag{1}$$

Here, $p_{k,s}$ is the price increase of energy *k* in the scenario *s* and $y_{k,h}$ are the total expenditures for direct consumption of energy *k* of household *h*.

The price increase $p_{kj,s}$ of IOT commodity *j* due to subsidy removal of energy *k* in scenario *s* is estimated as follows:

$$p_{kj,s} = l_{kj} \cdot p_{k,s} \tag{2}$$

where l_{kj} is the Leontief element in row *k* (energy) and column *j* (respective commodity). The commodity price increase is then used to assess the additional indirect expenditures $c^{indir}_{k,s,h}$ based on the consumption *y* of all other items *j* but energy *k*:

[3] To quantify how goods consumed by households become more expensive depending on the embodied carbon or energy, the majority of studies uses sectoral carbon- or energy intensities, e.g. Cornwell and Creedy (1996); da Silva Freitas et al. (2016); Dorband et al. (2017); Feng et al. (2010a); Grainger and Kolstad (2010); Kerkhof et al. (2008); Nijdam et al. (2005); Symons et al. (2002); Ogarenko and Hubacek (2013); Wier et al. (2005). As official sectoral energy intensities are not available for Ecuador and their assessment proved difficult due to methodological differences between the energy balance and the IOT, this study uses a simplified version of the price-shifting model of Coady (2006).

$$c_{k,s,h}^{indir} = \sum_{j} p_{kj,s} \cdot y_{j,h} \quad for\ j \neq k \tag{3}$$

Total additional expenditures $c_{k,s,h}^{tot}$ of household h due to subsidy removal of energy k in the scenario s is calculated by:

$$c_{k,s,h}^{tot} = c_{k,s,h}^{dir} + c_{k,s,h}^{indir} \tag{4}$$

Total distributional impacts DI are total additional household expenditures as percentage shares of household income I_h aggregated for each income quintile q, which is comprised of n_q households.

$$DI_{k,s,q}^{tot} = \frac{\sum_{h=1}^{n_q} \frac{c_{k,s,h}^{tot}}{I_h}}{n_q} \cdot 100\% \tag{5}$$

For further details on the input-output model, imported goods and price feedbacks, see section S2.

4.2.3 Selection of compensation mechanisms

The incidence of different compensation scheme (such as tax reforms, cash or in-kind transfers) depends on the ability to effectively target the desired income group (Adeoti et al., 2016). For instance, reducing the distortionary income tax or offering free education would be barely effective, as the two lowest income quintiles in Ecuador pay hardly any income taxes and have very low education expenditures (). Regarding cash transfers, we evaluate four different measures. Using the existing BDH has the advantage that well-established processes and infrastructure are already in place and can be used to build on and costs incur only due to higher monthly payments. The monthly grant from the BDH (US$ 35 in 2012) can be either (i) increased for current beneficiaries or (ii) expanded to new beneficiaries that fulfill certain eligibility criteria. Another possible cash transfer is (iii) the introduction of a minimum pension for all senior citizens. This measure would especially support poor households, because currently, the poorest 40% receive less than 10% of total pension payments. Although they might be difficult to implement in practice, (iv) uniform lump-sum transfers are also analyzed.

Selected in-kind transfers also comprise four different kinds. Free or reduced health care could be offered to the two lowest income quintiles (i). Expenditures on food not only account for large expenditures shares but are also highly indirectly affected by energy price increases. Hence, issuing food vouchers to vulnerable groups could alleviate these effects (ii). Eliminating diesel subsidies leads to increased public transportation expenditures, hence a public transportation voucher system for reduced fares is considered (iii). Similarly, LPG vouchers could be issued to low income groups to compensate for high direct LPG expenditures resulting from the respective subsidy reform (iv). Although this would imply that LPG subsidies would be still in place, they would be limited to vulnerable households. Further, this refund system could be designed as a cross-subsidy, adding a mark-up to unsubsidized prices to finance the voucher system (please refer to chapter S2e in the SI for the design of the compensation mechanisms).

4.3 Assumption and limitations

Our static IO approach assumes that producers directly pass on additional costs to consumers and that all economic sectors see the same relative price increase for their energy inputs. The latter assumption is favored over an absolute price increase, as price differences usually exist across sectors. In addition, due to the lack of price elasticities for detailed product groups, different sectors and household income quintiles in Ecuador, we disregard equilibrium effects and assume complete price inelasticity of producers and consumers. This seems reasonable from a short-term perspective as consumption patterns do not adjust immediately. For the long run, the resulting distributional impacts can be regarded as upper-bound estimates, before firms and household adjust. Moreover, how much a certain household would need to receive in order to keep up its current consumption has a direct interpretation as a welfare measure, namely compensated variation.

After removing energy subsidies, the resulting total additional household expenditures and official current Ecuadorian energy subsidies should be the same, as international prices are now paid directly by the consumers and not by the state. To calibrate our modelling, we compare these values. We find similar values for gasoline and LPG with a small relative difference ranging from 12% to 17% (Table S20). In the case of diesel and electricity subsidy removal however, additional expenditures are lower than official subsidies by about 60% on average. Presumably, this is because only final consumption by households is considered, leaving out other sectors, e.g. government and exports. However, it might also imply that price increases of goods, which lead to additional expenditures, are underestimated to some degree.

When considering the compensation mechanisms, transfers are modeled under the assumption that the two lowest income quintiles can be targeted with perfect precision. The distribution of the BDH shows that this is not always feasible in practice, since more than 10% of total BDH transfers benefit the richest 40% of the population (Table S11). In addition, the resulting compensated distributional impacts blur under- and overcompensated households, because they are aggregated by income quintiles. That is, an income quintile appears perfectly compensated (change of net income of 0%), although it contains net "winners" and "losers". This form of "fiscal impoverishment" is especially relevant for poor households becoming more poorer after such a reform (Higgins and Lustig, 2016). For a detailed design of compensation measures, it is advisable to evaluate these measures on disaggregated household levels.

5 Results

5.1 Direct and indirect distributional impacts of energy subsidy removal

We estimate that removing all energy subsidies would, in the medium price increase scenario, amount to additional monthly private expenditures of nearly US$ 190 million, i.e. almost US$ 50 per household (Table 1). The diesel subsidy results in highest additional expenditures for Ecuadorian households, totaling about US$ 53 million per month. Almost 95% of these additional expenditures stem from indirect effects, primarily due to additional electricity, food, and transportation costs. By contrast, LPG subsidy reform entails mainly additional direct expenditures. Electricity and gasoline subsidy reforms each imply about US$ 45 million of additional expenditures per month. In both cases, nearly three quarters of these expenditures come from direct energy consumption. Additional indirect expenditures originate mainly from increased food and transportation expenditures in case of electricity and gasoline subsidy reform, respectively.

Table 1: Direct and indirect additional monthly expenditures in medium scenario in 1,000 US$.

Note: blue shading indicates additional direct expenditures. For results by average households, see Table S7.

Expenditure category	Diesel	Electricity	Gasoline	LPG
Food	10,618.6	3,159.5	2,997.3	653.2
Apparel	1,987.5	1,287.0	470.2	275.3
Restaurants	1,900.0	1,316.4	885.7	79.4
Health care	1,977.6	655.8	681.5	28.5
Personal care	1,954.5	433.4	478.0	16.1
Other expenditures	1,885.1	686.6	864.1	41.2
Communication	2,118.4	2,288.4	386.8	82.6
Housing	1,859.1	378.9	414.2	14.9
Transportation services	7,183.0	559.7	3,788.4	34.4
Education	241.3	293.0	101.9	13.5
Energy consumption	17,744.3	34,676.9	33,071.0	40,191.3
Diesel	3,147.5	3.5	2.7	0.3
Electricity	13,144.8	34,579.1	455.8	1,194.7
Gasoline	492.7	61.2	32,583.2	5.3
LPG	959.4	33.2	29.3	38,991.1
Household supplies	688.0	177.9	155.4	6.5
Recreation and culture	1,453.8	721.1	383.0	75.4
Beverages	1,137.9	356.8	386.2	18.3
Durable goods	295.0	164.8	77.8	12.4

Total	53,044.0	47,156.3	45,141.7	41,542.9

Source: own calculations based on BCE (2012) and INEC (2012a)

Comparing the distribution of additional expenditures among income groups in absolute terms, additional expenditures increase as income increases (Table S17). However, the degree of increase varies significantly between energy types (Figure 4). Whereas the financial burden of LPG subsidy removal is almost equally distributed among income quintiles, removing diesel and electricity subsidies induces higher absolute expenditures for richer income groups. Additional expenditures due to gasoline subsidy reforms are unevenly distributed. Whereas the richest quintile bears more than half of total additional expenditures, the two poorest income quintiles together pay only about 14%.

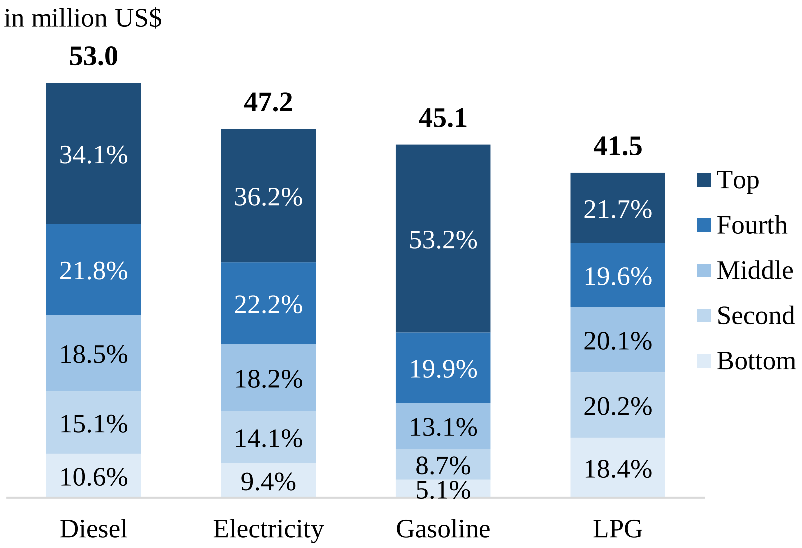

Figure 4: Total additional monthly expenditures in million US$ for medium scenario by income quintiles.

Source: own calculations based on BCE (2012) and INEC (2012a)

Total additional expenditures, in absolute terms, can be interpreted as the amount of subsidies currently paid by public revenues. The cost inefficiencies of using energy subsidies to redistribute income to the poor become apparent when comparing the public spending for energy subsidies with the actual benefits of the lowest income group. On average, it costs US$ 11.3 to transfer US$ 1 to the bottom income quintile using energy subsidies. Since in absolute terms LPG subsidies benefit different income groups almost equally, the cost to move additional income to the poorest quintile amount to only US$ 5.4[4]. Gasoline subsidies are a very inefficient measure to decrease inequality, as it costs almost US$ 20 to provide the bottom quintile with an additional income of US$ 1. In absolute terms, the top quintile benefits the most from all energy subsidies especially from gasoline subsidies, of which more than half are captured by the richest income group.

To clearly demonstrate direct and indirect distributional impacts, the additional household expenditures are set in proportion to the respective household income (Figure 5 and Table S19). Total distributional impacts are progressive for gasoline subsidy reform, essentially neutral for electricity subsidy reform, slightly regressive for diesel, and highly regressive for LPG. In the high LPG subsidy removal scenario, additional expenditures of the bottom quintile range up to 4.2% of income; that is, households have additional expenditures of almost US$ 12 per month (Table S18).

Direct distributional impacts of diesel subsidy reform (blue bars) play a negligible role due to low direct consumption (see also Table A1 in the Appendix). In contrast, LPG is almost exclusively consumed directly, resulting in more than 90% direct distributional impacts across all income groups. Removing subsidies for electricity leads to direct distributional impacts that account for about three quarters of total impacts for each income quintile. When the gasoline subsidy is removed, the share of direct

[4] Total costs of LPG subsidies US$ 41.5 million divided by financial benefit of Q1 US$ 7.7 million.

distributional impact increases with increasing income, accounting for less than 40% in the bottom quintile and almost 80% in the top quintile.

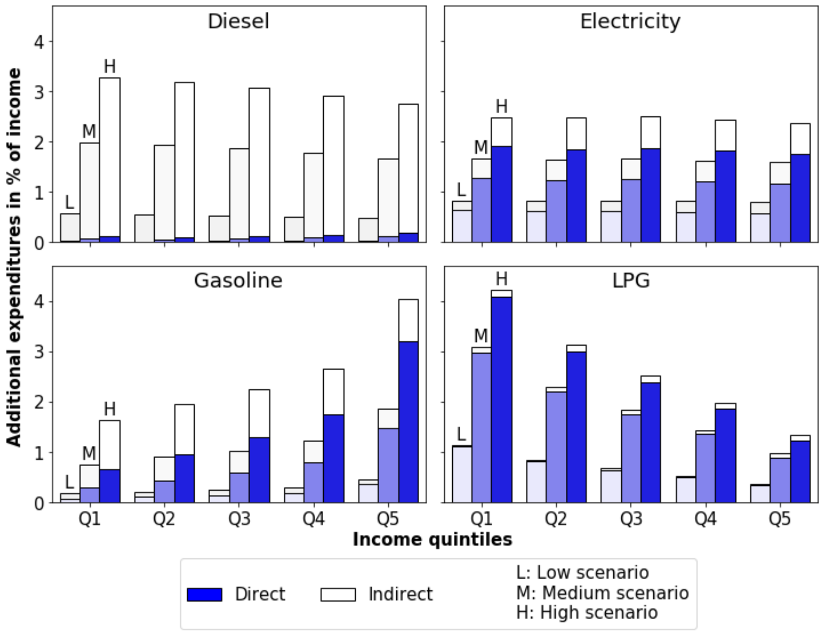

Figure 5: Direct and indirect distributional impacts due to energy subsidy removal for three scenarios by income quintiles in % of income. Note: Inter-quintile proportions and direct shares are linear, only the total amount of additional expenditures changes between scenarios.

Source: own illustration and calculations based on BCE (2012) and INEC (2012a)

5.2 Compensating adverse distributional impacts

Additional household expenditures turn into revenues for the government, which can be recycled to compensate for adverse distributional effects. Depending on the energy type and the assumed scenario, the amount of freed-up revenues ranges between US$ 130 million and US$ 1,178 million per year (Figure 6).

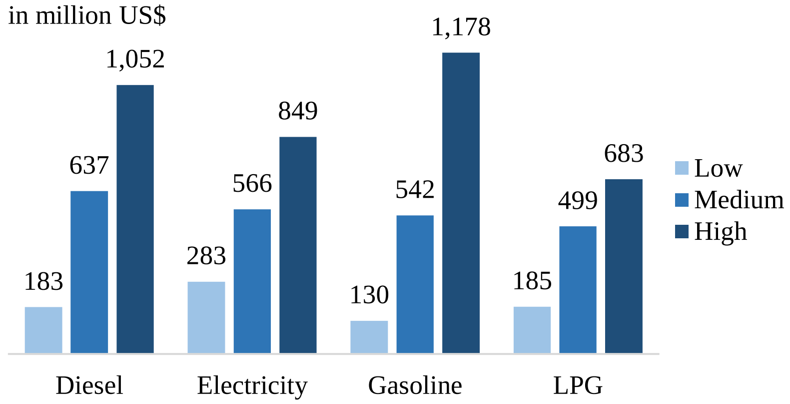

Figure 6: Estimated freed-up revenues in million US$ per year by energy type and scenarios.

Source: own calculations based on BCE (2012) and INEC (2012a)

Recycling the freed-up revenues to reduce the financial burden of poor households is modeled for the various compensation schemes. Table S21, Table S22, and section S5 provide detailed tables and graphs of each compensation scheme and energy subsidy removal scenarios. In the following, the design and distributional effects of cash and in-kind transfers are presented based on the medium scenario.

The first type of cash transfers involves increasing the BDH to the extent that the lowest two quintiles are compensated for additional expenditures due to energy subsidy removal. The required absolute increase of the BDH is similar for diesel, electricity, and LPG subsidy reforms and amounts to between US$ 11.2 and US$ 15.6 for current beneficiaries (Table S21). Gasoline subsidy reform does not drastically affect 40% of the poorest population, therefore the necessary additional cash transfer amounts only to about US$ 6. Costs for this measure do not exceed the available revenues, hence substantial sums remain for the public budget, e.g. nearly US$ 420 million per year in the case of gasoline subsidy removal, and about US$ 185 million for LPG. If all energy subsidies are removed and the BDH is increased by US$ 46 per month, the net income of the lowest quintile would rise by 9%. In addition, more than 1.3 billion US$ would still be available for the public budget after the reform. The resulting distributional effects are highly progressive, yielding the bottom quintile an additional net income of up to 2.7% of total income (Figure 7). By design, households belonging to the poorest income quintiles are net "winners", those in the second quintile are neither "winners" nor "losers", and the remaining households are net "losers".

Second, by using freed-up revenues, the BDH (US$ 50/month) could be expanded to more than 900,000 additional households earning less than US$ 180 per capita and month on average. The line plot representing the additional net income indicates that the two richest quintiles would be net "losers". The second quintile would benefit the most, receiving up to 4.7% of additional net income. This is because the share of current BDH non-beneficiaries, which would benefit from the BDH expansion, is higher (by one third) compared to the bottom quintile.

Third, introducing a minimum pension for senior citizens who currently receive monthly pension payments below US$ 53 on average, yields the highest relative net income gains (up to nearly 8%) for the bottom quintile of all modeled compensation schemes. The top quintile is the only quintile in which additional income is not sufficient to compensate for subsidy-induced expenditures, resulting in an average net income loss of 0.7%. Overall, a minimum pension would turn adverse distributional impacts into highly progressive ones. This is due to the uniform additional payment, which is relatively higher for lower income households, and the unequal distribution of existing pension payments. 80% of pensions already benefit the richest 40% of the households, hence only a small share of these households would be eligible for a minimum pension.

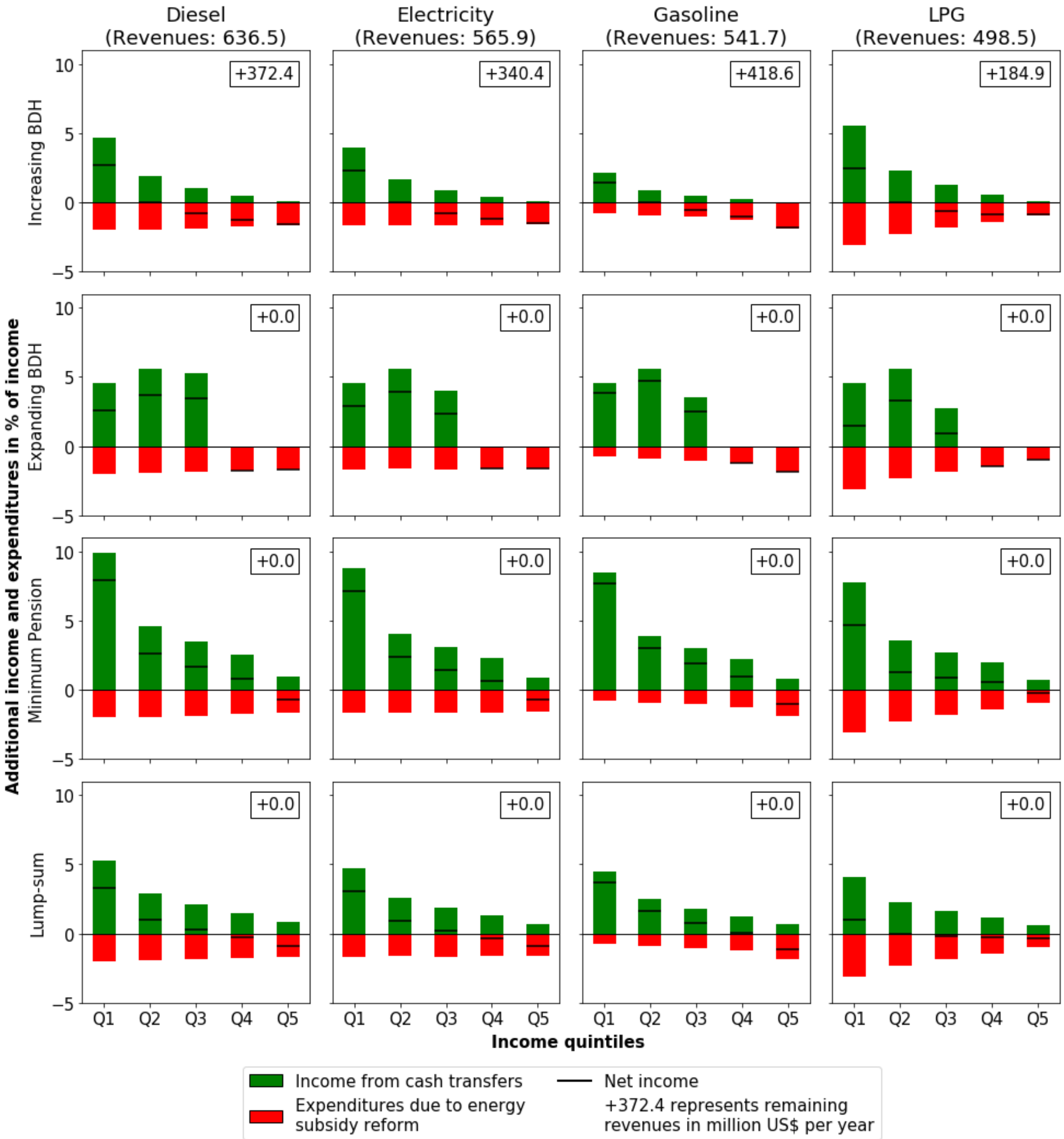

Figure 7: Distributional impacts of cash transfers and energy subsidy reform for the medium scenario by income quintiles in % of income. Note: for all scenarios see Figure S1 to Figure S6 in the SI.

Source: own illustration and calculations based on BCE (2012) and INEC (2012a)

Finally, recycling the revenues via lump-sum transfers also exhibits progressivity, mainly because a uniform cash transfer is of higher relative value for lower income quintiles. Net income changes range from 1.0% to 3.3% of income for the lowest quintile and from -1.2% to -0.3% for the top income quintile. In-kind transfer schemes are modeled to benefit the poorest 40% of households. Therefore, compensated distributional impacts tend to be progressive for almost all in-kind transfers and the three richest income quintiles are always net "losers" (Figure 8).

First, in the medium scenario, generated revenues suffice to ensure free health care to the lowest two quintiles and on average, almost US$ 200 million are left that can be used to finance other public investments. The second income quintile benefits more than the first, because its higher health care expenditures are now paid by freed-up revenues and consequentially more additional income is available to them. This quintile also benefits from the highest relative change in additional net income, amounting to a gain of about 3% on average.

Second, the monthly value of food vouchers to compensate for additional expenditures of the second quintile ranges between US$ 2.7 per person for LPG subsidy reform and to US$ 1.1 per person for gasoline subsidy reform (Table S21). Costs for this compensation measure are rather low, between US$

100 million for gasoline and US$ 245 million for LPG subsidy reform, respectively. Thus, remaining revenues are high, ranging between US$ 256 million and US$ 430 million per year. Net income gains amount up to 1.6% captured by the first income quintile in the diesel scenario.

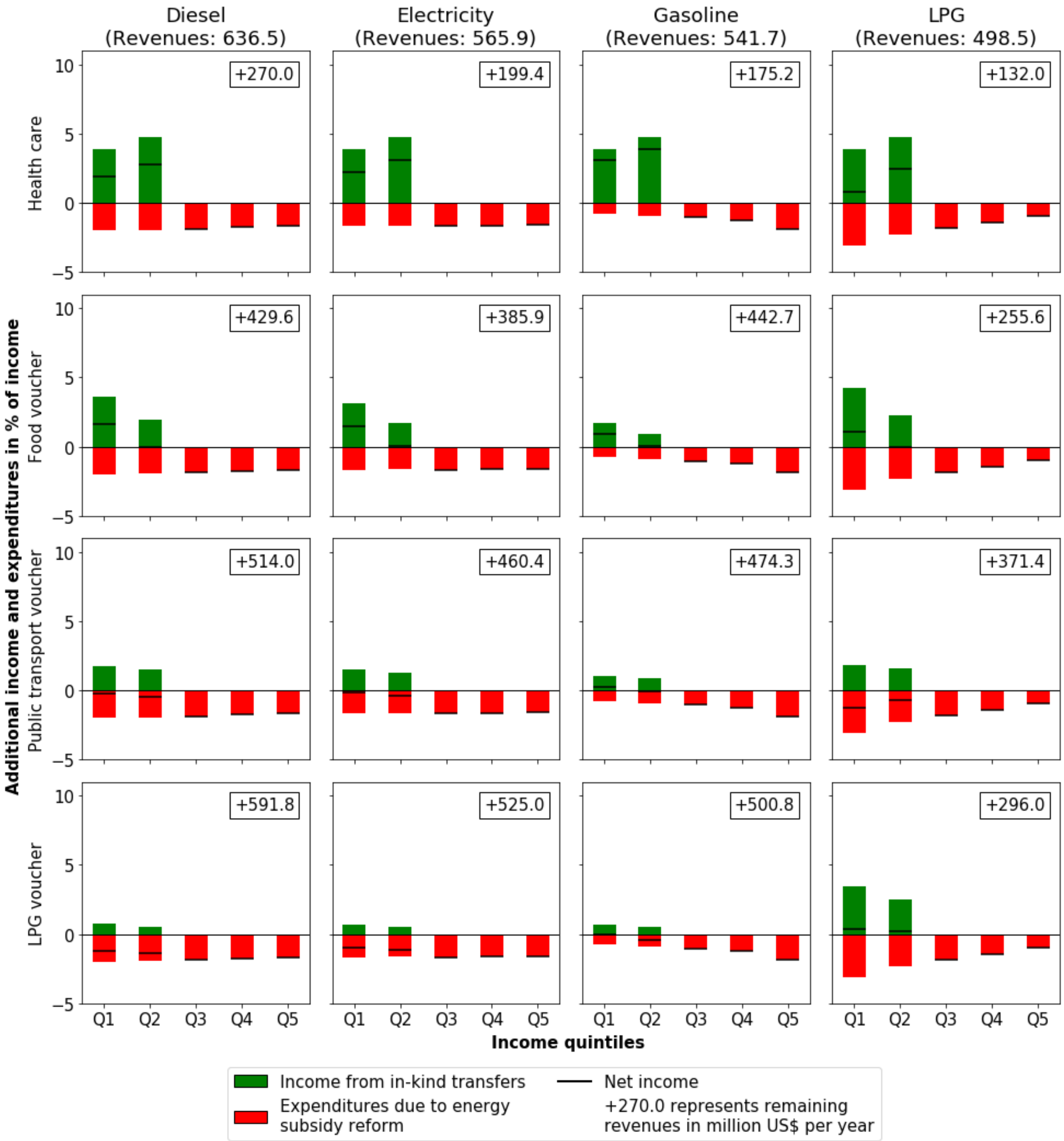

Figure 8: Distributional impacts of in-kind transfers and energy subsidy reform for the medium scenario by income quintiles in % of income. Note: for all scenarios see Figure S7 to Figure S10 in the SI.

Source: own illustration and calculations based on BCE (2012) and INEC (2012a)

Third, although vouchers for public transport by bus were modeled for all energy subsidy removals, it is presumably most adequate for diesel subsidy removal, because it directly tackles increased indirect expenditure for transportation services. In case of eliminating diesel subsidies, the maximum issued voucher value amounts to US$ 10.2 per month and average-sized households. Not all households can make use of the entire voucher value due to lower transportation expenditures. Therefore, in a static model, the additional benefit from this measure is limited and results in net income losses for all income quintiles.

Finally, giving the poorest 40% of the population one free LPG cylinder per month and average household is a way of targeting energy subsidies to the poor. It is relatively low in costs and perfectly compensates for additional expenditures of the lowest two income quintiles. Further, households who do not consume LPG would also benefit from LPG vouchers, as they could sell their vouchers on the market. In addition, this measure has the advantage that additional LPG expenditures can be addressed directly with the corresponding in-kind transfer, which presumably makes the benefits more salient.

5.3 Political feasibility of phasing out energy subsidies and compensation schemes

In this subsection we draw on interviews with local experts to qualitatively evaluate the political feasibility of energy subsidy reform scenarios and compensation schemes (see section S1c for methodology).

Regarding energy subsidies, most interviewees stated that eliminating subsidies for gasoline, is the politically most feasible option in the short term. This is because mainly higher-income groups, whose members usually own a private car, benefit from gasoline subsidies. One expert also mentioned, that this group is not well organized and only "vote but don't paralyze" the country. Additionally, it was stated that a price increase for high-quality gasoline in 2016, introduced to finance the reconstruction of earthquake regions, did not lead to protests[5]. Two interviewees even proposed introducing a cross-subsidy, which taxes gasoline consumption to finance diesel subsidies. To avoid possible protests against high gasoline prices by politically-powerful taxi drivers, an interviewee recommended giving them a chip card with a monthly gasoline quota. In late December 2018, several months after we conducted this interview, the government indeed increased gasoline prices while offering taxi drivers pre-paid cards to buy gasoline at a lower cost.

Removing electricity subsidies would require two steps. First, the implicit subsidies would need to be made transparent by including capital costs and unsubsidized fuel prices in the official electricity cost calculations. Second, the explicit subsidies could then be reduced by increasing electricity tariffs. The political feasibility of the first step is perceived as rather difficult by some experts, as it would entail a rigorous reform of the electricity market. At the same time, it might be an opportunity for liberalization that allows for the participation of private operators. As to the second step, raising electricity tariffs is viewed by some experts as a politically viable option, because the current "dignity tariff" block-pricing scheme would protect low-income groups from large price increases. However, others argue that electricity prices should stay low to incentivize the replacement of LPG stoves with electric induction ones.

Diesel subsidy reform is viewed by all experts as rather contentious, mainly due to the influence of the well-organized transport sector that highly depends on low diesel prices. The power of the transport sector is mainly based on the ability to paralyze the country by means of strikes. Fisheries would also be affected by diesel price increases, but their political influence is lower, as mentioned by several interviewees.

Finally, many interviewees stated that LPG subsidy reduction would also entail high political risks. This is best represented by the following statement, independently brought forth by several experts: "if LPG [subsidy] is touched, the government will fall". One interviewee used even more drastic words, claiming that "removing LPG subsidies is [political] suicide". Especially low-income households who rely on cheap LPG prices have a relatively low threshold to actively protest on the streets, according to some interview partners. In addition, one expert warned that eliminating LPG subsidies might lead to increased deforestation in rural areas, because people could return to using firewood for cooking.[6]

In general, cultural barriers undermining the political feasibility of fossil fuel subsidy reforms were also mentioned. For instance, as people have been used to fixed fuel prices for almost twenty years, the tolerance to accept varying fuel prices is very low. Therefore, many interview partners emphasize the

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[5] In 2016, the price of high-quality "super" gasoline increased, but the price of lower-quality "extra" gasoline was maintained at the same, subsidized level. Most consumers of super gasoline switched to "extra", diminishing the fiscal benefit of reducing subsidies on "super". In August 2018, the government eliminated the subsidy on super gasoline and in December 2018, the price of "extra" was increased. This happened several months after we conducted the interviews reported here.

[6] The interviewees did not mention the fact that the government of Ecuador is aiming at replacing LPG cookstoves with electric induction ones nationally to leverage domestically-produced low-carbon electricity (Carrillo Maldonado et al., 2018). If this program is successful, the role of LPG as a basic consumption item required for cooking might be drastically reduced.

need to eliminate energy subsides gradually. Besides, most interviewees agreed that low oil prices represent an opportunity for fossil fuel subsidy reform, as the pressure to consolidate the public budget is highest. However, in times of rising oil prices, this window of opportunity is slowly closing. In addition, multiple experts claimed that the current president is showing less willingness to reform energy subsidies than his predecessor and since the former popular president "Rafael Correa did not reform energy subsidies, no one will". (After we conducted this interview, the government led by Lenin Moreno did in fact reduce gasoline subsidies substantially).

Concerning possible compensation mechanisms, increasing or expanding the existing cash transfer system BDH is regarded as institutionally and politically feasible by most interviewees. Two interviewees expressed concerns about combining energy and social policy because "it confuses people", while another interviewee proposed introducing an "Energy Grant" based on the BDH system to underline the connection between both policies. One interviewee claimed that the current BDH system would not be an adequate mechanism, because transfers are poorly targeted.

Providing free health care for vulnerable households is also seen as politically feasible by various interviewees. Further, it was suggested to use freed-up public revenues for investments in public transport and education or for financial support of marginalized industries and agriculture.

Some experts perceive introducing vouchers as politically feasible. Others, however, argue that the threat of possible corruption and fraud is high. According to two experts, latest experiences with food vouchers issued to people affected by the earthquake showed that it is essential that vouchers can be redeemed at any store and for a sufficient variety of food items.

Public transportation vouchers were not mentioned by our interview partners when asked for possible compensation schemes, presumably because public transport is already relatively cheap[7], of low quality and only accounts for about 5% of total expenditures across income groups on average (Table A1 in the Appendix).

In contrast, LPG vouchers were regarded as a politically feasible instrument by most interviewees, as these would directly ease the financial burden caused by increased LPG prices. According to one expert, introducing LPG vouchers was planned in the past, but failed due to problems in the implementation. To that effect, another interviewee recommended issuing the vouchers using the customer base of the electricity sector. That way the number of vouchers would be limited to one per household and avoid fraud. On the other hand, it would limit the distribution of LPG vouchers to those households connected to the electricity grid (97,4% of population). Issuing LPG vouchers to current BDH beneficiaries, as proposed by two other interviewees, would avoid this problem. One of them further suggested designing the LPG voucher system as a cross-subsidy. This would add a mark-up to the unsubsidized LPG prices to finance the vouchers.

6 Conclusion

This paper analyzes the distributional impacts of energy subsidy reforms in Ecuador. We find that the uncompensated distributional effects vary by energy types. Removing electricity subsidies leads to additional household expenditures that are nearly equally distributed among income groups with respect to their income. Diesel and LPG subsidy reforms exhibit slightly and highly regressive distributional effects, respectively. In contrast, a gasoline subsidy reform would be highly progressive.

At the time of writing, removing energy subsidies would closely approximate the underlying assumptions of the medium scenario. Hence, subsidy removal would free up public revenues equal to more than US$ 2.3 billion per year. Our analysis of compensation schemes shows that for compensating the poorest 40% of households for the adverse distributional effects an increase of the existing cash transfer BDH for current recipients by about US$ 13.1 for diesel, US$ 11.2 for electricity, and US$ 15.6 for LPG subsidy removal would suffice. To compensate for increased gasoline prices, only about US$ 6.1 of additional cash transfer is required. More than 75% (gasoline), nearly 60% (electricity and diesel),

[7] E.g. in Qutio, a one-way ticket by bus currently costs US$ 0.25

or 37% (LPG) of the freed-up revenues would be available for other public spending or reduction of the public deficit. We also show that additional revenues could also be employed in an even more progressive manner by expanding the BDH to non-beneficiaries or by introducing a minimum pension. Regarding in-kind transfers, energy subsidy reforms could provide the poorest 40% of the population with free health care. Issuing food stamps to the lowest two quintiles yields similar results. The compensating effect of public transportation vouchers, however, is limited. In case of LPG subsidy reform, it is sufficient to provide the lowest two income groups with one free LPG cylinder per month to alleviate the regressive distributional impacts of energy subsidy reforms.

Drawing on expert interviews suggests that gasoline subsidy reforms in combination with an increase of the BDH might be the most viable option with respect to distributional as well as political aspects. The second politically viable option is LPG subsidy reforms along with LPG vouchers for vulnerable households. However, this requires implementing a fraud-resistant system that maintains accessibility for beneficiaries. Both options exhaust the available budget to about 25% and 40% respectively.

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Acknowledgments

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Appendix A. Supplementary information

Supplementary information to this article can be found online at URL.

The quantitative analysis was perfomed with Python. The code is publically available at: https://github.com/filscha/political-economy_subsidy-reform_ecuador

Supplementary Information

S1 Supplementary Data

a. Input-output data

Ecuador's central bank provides 71x71 input-output tables (IOT) on a yearly basis and for 2012 an augmented 245x245 commodity IOT is available, which is chosen for this study. The highly disaggregated IOT allows for detailed mapping to household expenditures and has the advantage of the refined oil products being split into five fuel types, including gasoline, diesel, and LPG. As illustrated in Table S1, the IOT consists of the 245x245 square matrix **Z** of intersectoral flows in 1,000 US$. Total output **x** is a column vector equal to the row sums of **Z** (intermediate demand) and final demand **y**. The latter is divided into final demand by households, government, non-profit organizations, gross fixed capital formation, change in stocks, and exports. Total outlays are equal to total output and include the column sum of **Z** (intermediate inputs), production taxes, imports, and value added.

Table S1: Simplified structure of Ecuador's 245x245 commodity IOT 2012.

Selling sectors	Buying sectors $1 \cdots j \cdots 245$	Final demand	Total output
1			
⋮			
i	**Z**	**y**	**x**
⋮			
n			
Taxes	**t'**		
Imports	**i'**		
Value added	**v'**		
Total outlays	**x'**		

Source: Ogarenko and Hubacek (2013, p. 13), BCE (2012)

Values of **Z** are expressed in basic prices, which according to the System of National Accounts on which the IOT is based, implies that subsidies are included, but taxes excluded (EC et al., 2009). As a result, commodities are valued based on subsidized prices, as well as final demand and total output. The total subsidy itself is not reflected explicitly in the IOT, but implicitly in the value added, consisting of wages and profits less subsidies (EC et al., 2009). Gasoline, diesel, and LPG are the only three commodities that exhibit a negative value added, indicating the presence of a subsidy. Ecuador's supply table in 2012 lists the subsidies for these commodities and for electricity explicitly and the relevant subsidized IOT commodities can therefore be identified (Table S2).

Table S2: Subsidized IOT energy commodities in 2012.

IOT no.	IOT name (original)	Subsidized energy type	Subsidy acc. supply table 2012 in US$
130	Gasolinas, nafta y gasolina natural	Gasoline	480,123,000
131	Diesel	Diesel	1,991,793,000
134	Gases de hidrocarburos	LPG	633,195,000
176	Servicios de transmisión y distribución eléctrica	Electricity	100,000,000

Source: BCE (2012, 2013, 2018e)

The construction of the IOT is derived from supply and use tables, which themselves are based on various data sources, such as surveys, studies, and statistical data (Schnabl and Holub, 1994). During this complex process of data preparation, aggregation, and standardization, errors can occur. Therefore, IOT data should be handled with care. Regarding the Ecuadorian IOT, it should be noted that the outputs of diesel, fuel oil, and other fuels appear to be flawed. For instance, fuel oil inputs for electricity generation exceed diesel inputs by several orders of magnitude (Table S3). This is in stark contrast to direct physical fuel oil usage for electricity generation, which is only about twice as high as diesel consumption (ARCONEL, 2013). Even when taking into account that the Leontief inverse matrix also considers higher-order interconnections among sectors, this order of magnitude seems implausible. Similarly, the road transport sector uses significantly higher monetary inputs from unspecified fuels and fuel oil compared to diesel, although in physical units the transport sector used more than four times more diesel than fuel oil in 2012 (MICSE, 2016). Thus, the inputs from the diesel sector seem to be considerably understated in the IOT, presumably due to accounting issues, fuel oil and other fuels are aggregated to the diesel commodity.

Table S3: Input shares of diesel, fuel oil, and other fuels for electricity generation and road transport.

IOT commodity	Electricity generation	Passenger road transport	Cargo road transport
Diesel	0.00137	0.00786	0.00804
Fuel oil	0.37866	0.00605	0.10492
Other fuels	0.06370	0.03168	0.03313

Source: BCE (2012)

b. Household data

The datasets on Ecuadorian household expenditures and income are retrieved from the National Survey of Income and Expenditures for Urban and Rural Households 2011-2012 (ENIGHUR) with a sample size of 153,444 persons, or 39,617 households respectively. The later Survey on Living Conditions (ECV) from 2013/2014 is available as well, but is not included, due to the expenditure items of ENIGHUR being available in more detail.

The current household expenditures can be divided in non-monetary and monetary expenditures (Table S4 and detailed Table S13

Table S12: Selected income and expenditures in US$ per month and capita and possible compensation schemes.

Note: +further analyzed.

Income/expenditures	Total	Q1	Q2	Q3	Q4	Q5	Compensation schemes
Income							
BDH	3.86	6.31	4.78	3.39	1.97	0.62	Increasing/Expanding+
Pensions	9.38	1.02	2.87	5.38	12.56	38.27	Minimum pension+
Expenditures							
Social security	7.24	0.80	2.70	5.17	9.68	27.24	Minimum pension+
Income tax	0.93	0.00	0.02	0.11	0.36	6.16	Progressive income tax
Education	6.86	0.38	1.46	3.72	8.77	30.56	Free education
Health care	11.76	2.71	5.70	9.37	15.20	38.64	Free/reduced health care+
Food	34.39	20.30	31.22	36.88	42.97	52.81	Vouchers+
Public transport (bus)	5.06	2.66	4.68	5.92	6.97	6.72	Vouchers+
LPG	0.66	0.47	0.60	0.66	0.76	1.00	Vouchers+

Source: own calculations based on INEC (2012a)

Table S13). Non-monetary expenditures are derived from non-monetary income, which seems reasonable, as these goods are consumed and do not need to be bought later. The effect of increased energy prices on non-monetary expenditures is neglected, as non-monetary expenditures and income would rise by the same absolute amount. Considering additional expenditures as percentage shares of income, there might be a slight increase if total income exceeds expenditures, but this effect is also negligible. In addition, some non-monetary expenditures lack detailed product groups (e.g. income from received gifts) or represent abstract imputed values (e.g. for dwellings). Monetary current consumption expenditures represent three quarters of total current expenditures, whereas monetary non-consumption expenditures are relatively small.

Table S4: Official monthly expenditure aggregates of all households. Note: *: used to model additional expenditures. §: sum used as proxy for income.

Aggregates	Monthly expenditures in US$	Monthly expenditures in %
Total current expenditures	3,176,344,301	100.0%
Non-monetary current expenditures/income§	723,715,752	22.8%
Salary in kind	111,444,729	3.5%
Self-consumption	66,778,956	2.1%
Income in form of received gifts	214,215,387	6.7%
Imputed value of dwellings	331,276,680	10.4%
Monetary current expenditures	2,452,628,550	77.2%
Adjusted current consumption expenditures*,§	2,152,134,280	67.8%
Current consumption expenditures	2,393,571,816	75.4%
− Discounted durable goods	-241,437,535	-7.6%
Non-consumption expenditures (e.g. taxes) §	59,056,734	1.9%

Source: own calculations based on INEC (2012a, 2012b)

Current consumption expenditures represent the most important expenditure figure. This is due to their high share and their visible price increases in everyday life. Monetary consumption items also contain annual expenditures for durable goods, such as furniture, electric household appliances (fridge, washing machine, etc.), vehicles, and electronic devices (TV, computer, etc.). These long-lasting items purchased in the year of the survey inflate the actual consumption expenditures. Those households purchasing durable goods appear richer than others that happen not to buy durables within the year of the survey. For this reason, expenditures for durable items are discounted linearly over a period of ten years, during which households are presumed to benefit from the investment. Additional expenditures due to higher energy prices are estimated based on adjusted current consumption expenditures.

Because stated income in household surveys in emerging economics can be misleading due to narrow definitions of income, a proxy is used for income. It is based on the sum of adjusted current consumption expenditures, monetary non-consumption expenditures, and non-monetary current expenditures. The proxy might underestimate the income for rich households, because their real income and assets probably exceed their expenditures. However, their reported income is likely to be understated, since rich households might not disclose all income sources during a household survey.

c. Expert elicitation interviews

As stated by Morgan (2014, p. 7176), expert elicitation interviews are regarded as "a valuable addition to other forms of evidence in support of public policy decision making". Consequently, we consider this qualitative assessment as a complementary tool to evaluate the quantitative option space and to identify politically feasible options. For this purpose, 13 semi-structured interviews were conducted in Spanish with 17 interview partners. Nine interviews were carried out face-to-face in Quito, the remaining four via videoconferencing. To obtain various perspectives, the interviewees came from different backgrounds comprising academia, civil society, public sector, and international organizations (Table S16). During the average interview duration of 60 minutes, an identical set of eight questions was used to guide each interview (Table S15 in section S4). These questions covered the three main topics: latest challenges of Ecuador, assessment of current government, and energy subsidies (e.g. timing, barriers, and policy sequencing). Depending on the competence and professional background of the expert, certain topics were explored more in depth, these individual interview questions complemented the aforementioned question set. Therefore, quantitative comparability between the interviews is limited and interviews are regarded as a qualitative contribution. The gained first-hand expert information is used to assess different subsidy removal scenarios and compensation schemes.

S2 Supplementary Methods

a. Input-output model

According to Leontief (1986, p. 19), "input-output analysis is a method of systematically quantifying the mutual interrelationships among various sectors of a complex economic system." This method is based on empirical Input-Output tables (IOTs) that describe the intersectoral flow of goods and services within a national economy usually over a year and expressed in terms of monetary value. Depending on the level of aggregation the tables can represent 50 "or even 1000 different sectors" (Leontief, 1986, p. 20) of an economy. The horizontal rows of the table contain information on the usage of a sector's output, whereas the column entries give insights where inputs for a sector stem from. Therefore, as the name "input-output" suggests, one element of the IOT is both, input and output, depending on the perspective.

For *n* numbers of producing sectors, also called industries, the symmetric matrix **Z** consists of n rows of selling sectors and *n* columns of buying sectors. The resulting structure contains *n* linear equations with intersectoral transaction *z* and final demand *y* (Feng et al., 2010b), as shown in equation (6).

$$\begin{array}{ccccccccccc} x_1 & = & z_{11} & + & z_{12} & + \cdots + & z_{1n} & + & y_1 \\ x_2 & = & z_{21} & + & z_{22} & + \cdots + & z_{2n} & + & y_2 \\ \vdots & & \vdots & & \vdots & & \vdots & & \vdots \\ x_n & = & z_{n1} & + & z_{n2} & + \cdots + & z_{nn} & + & y_n \end{array} \tag{6}$$

The row of sector *i* contains *n* intersectoral transactions z_{ij} that represent the value of goods or services sold by sector *i* to a buying sector *j*. Summing up all intersectoral transaction of sector *i*'s row results in total intermediate demand of sector *i*'s production output, z_i:

$$z_i = \sum_{j=1}^{n} z_{ij} \tag{7}$$

To account for total output *x*, final demand is also to be considered, namely by foreign countries (exports), government, households, additions to inventory, and private capital formation. The value of goods and services that were produced for final consumption is represented by the additional exogenous final demand sector *y*. Hence, total output *x* of sector *i* is

$$x_i = z_i + y_i \tag{8}$$

The vertical column of a buying sector *j* states the value of inputs that were purchased by sector *j* from sector *i* to produce *j*'s goods or services. The sum of the *n* figures of sector *j*'s column is equal to the total intermediate input z_j absorbed by sector *j* during the production year:

$$z_j = \sum_{i=1}^{n} z_{ji} \tag{9}$$

Total outlays of a sector comprise not only these outlays due to purchased inputs from endogenous sectors, but also the inputs of foreign countries (imports), depletions of inventory and value added, which represents inputs from government (paid in the form of taxes), households (in the form of wages, salaries, and dividends), and depreciation of private capital. Total outlays of a productive sector are equal to its total output and represent the national production. (Leontief, 1986)

To determine the ratio of how much a buying sector *j* consumes from selling sector *i* per unit of the buying sector's output, Leontief (1986, p. 22) introduces the "input coefficient of product of sector *i* into sector *j*", also referred to as technical coefficients a_{ij}. They are defined by dividing the intersectoral transaction from selling sector *i* to buying sector *j* z_{ij} with total output of sector *j* x_j:

$$a_{ij} = \frac{z_{ij}}{x_j} \tag{10}$$

The sum of the technical coefficients of a sector's column can be interpreted as "the total material cost of one unit, hence 1$" (Raa, 2005, p. 18), of the sector and these are usually below 1 unless a strong price jump of inputs occurs.

Combining equation (7), (8), and (10) results in equation (11) for total economic output:

$$x_i = z_i + y_i = \sum_{j=1}^{n} z_{ij} + y_i = \sum_{j=1}^{n} a_{ij}x_j + y_i = a_{i1}x_1 + a_{i2}x_2 + \cdots + a_{in}x_n + y_i \tag{11}$$

Rewriting equation (11) for the entire economy and in matrix notation with the technical coefficient matrix **A** gives:

$$X = AX + Y \tag{12}$$

And rewriting (11) as a set of *n* linear equations yields:

$$\begin{array}{llll} (1-a_{11})x_1 & -a_{12}x_2 - \cdots & -a_{1n}x_n & = y_1 \\ -a_{21}x_1 & +(1-a_{32})x_2 - \cdots & -a_{2n}x_n & = y_2 \\ \vdots & \vdots & \vdots & \vdots \\ -a_{n1}x_1 & -a_{n2}x_2 - \cdots & +(1-a_{nn})x_n & = y_n \end{array} \tag{13}$$

Expressed in matrix notation:

$$\begin{bmatrix} (1-a_{11}) & \cdots & -a_{1n} \\ \vdots & \ddots & \vdots \\ -a_{n1} & \cdots & (1-a_{nn}) \end{bmatrix} \times X = Y \tag{14}$$

Where **X** is a column vector of total output and **Y** a column vector of final demand. Or even shorter with the technical coefficient matrix **A** and the identity matrix **I**:

$$(I - A) \cdot X = Y \tag{15}$$

For a given final demand *y* for each sector the system of linear equations can be solved for total production, which includes intermediate consumption.

$$\begin{array}{l} x_1 = A_{11}y_1 + A_{12}y_2 + \cdots + A_{1n}y_n \\ x_2 = A_{21}y_1 + A_{22}y_2 + \cdots + A_{2n}y_n \\ \vdots \quad\; \vdots \qquad \vdots \qquad\quad \vdots \quad \vdots \\ x_n = A_{n1}y_1 + A_{n2}y_2 + \cdots + A_{nn}y_n \end{array} \tag{16}$$

Where A_{ij} "indicates by how much the output x_i […] would increase if y_j, that is, the quantity of good *j* absorbed by […] final users, had been increased by one unit." (Leontief, 1986, p. 24) The matrix of these constants is calculated as the inverse of the matrix on the left-hand side of equation (14):

$$X = \begin{bmatrix} (1-a_{11}) & \cdots & -a_{1n} \\ \vdots & \ddots & \vdots \\ -a_{n1} & \cdots & (1-a_{nn}) \end{bmatrix}^{-1} \times Y = \begin{bmatrix} l_{11} & \cdots & l_{1n} \\ \vdots & \ddots & \vdots \\ l_{n1} & \cdots & l_{nn} \end{bmatrix} \times Y \tag{17}$$

Using the technical coefficient matrix **A** yields the solution

$$X = (I - A)^{-1} \cdot Y = LY \tag{18}$$

Where $(\boldsymbol{I} - \boldsymbol{A})^{-1}$ is called the Leontief inverse Matrix **L** and allows for calculating the total production of each sector for any final demand that is to be satisfied (Leontief, 1986, Ch. 2).

b. Imported goods

Imported goods that were manufactured abroad are not affected by domestic energy price increases. This fact is implicitly considered by the price shifting model, as the Leontief elements are based on the technical coefficient matrix A, which in turn is derived from the intersectoral flows of the domestic economy divided by total intermediate input and, among others, imports. Hence, the share of energy inputs (for domestic production) decreases with rising import shares and represents an implicitly adjusted figure of an average good produced domestically and abroad.

c. Price feedbacks

The applied method considers price feedbacks on energy products, which leads to slightly higher energy price increase scenarios (Table S5). These feedbacks are most relevant in electricity generation, because power plants consume electricity for their own use.

Table S5: Price increase scenarios considering feedbacks.

Energy	Price feedback	Low	Medium	High
Diesel	1.56%	39.4%	137.1%	226.6%
Electricity	6.34%	35.4%	70.9%	106.3%
Gasoline	0.15%	18.4%	76.6%	166.4%
LPG	0.01%	144.5%	389.7%	533.7%

Source: own calculations based on Figure 3 and BCE (2012)

d. Mapping consumption expenditure items to IOT commodities

Increased energy prices will lead to production cost increases of consumption items. To estimate the resulting additional indirect expenditures for households, their consumed goods are mapped to the commodities of the IOT, from which price increases are derived (section 4.2.2). The product classifications from BCE (2013) indicate which products are included in the 245 IOT commodities. Expenditure items are also available on a highly disaggregated level with nearly 3,400 possible items (INEC, 2012a). For this reason, household expenditure items are mapped to IOT commodities in high detail. The level of detail varies depending on the aggregation level of IOT commodities and expenditure items. In total, more than 550 items were matched to 130 different IOT commodities (**Error! Reference source not found.** in section S4).

e. Design of compensation schemes

The first modeled cash transfer involves increasing the amount of the BDH. We determine by how much the BDH, at the time amounting to US$ 35 per month, should be increased in two different ways. A straightforward approach uses 100% of freed-up revenues $R_{k,s}$, freed-up by removing the subsidy for energy k in scenario s, and distributes them equally among all beneficiaries B receiving a personal income from the BDH amounting to $I_{BDH,i}$:

$$\Delta BDH_{k,s}^{100\%} = \frac{R_{k,s}}{\sum_i^B I_{BDH,i}} \tag{19}$$

The absolute increase of the monthly BDH in US$ is the product of $\Delta BDH_{k,s}^{100\%}$ with the former amount of the BDH, namely US$ 35 per beneficiary.

The other approach takes into account that the BDH does not exclusively benefit the lower income quintile groups, but also higher income quintiles. Thus, it seems reasonable to increase the BDH only up to an amount that is sufficient to compensate the second income quintile. The corresponding increase of the BDH is calculated by dividing total distributional impacts of the second quintile $DI_{k,s,Q2}^{tot}$ with its relative income from the BDH $i_{BDH,Q2}$:

$$\Delta BDH_{k,s}^{Q2} = \frac{DI_{k,s,Q2}^{tot}}{i_{BDH,Q2}} \quad with\ i_{BDH,Q2} = \frac{\sum_h^{size_{Q2}} \frac{I_{BDH,h,Q2}}{I_h}}{size_{Q2}} \tag{20}$$

where $size_{Q2}$ represents the number of households in the second quintile and $I_{BDH,h,Q2}$ represents the income from the BDH for household h from the second quintile.

This approach does not exhaust the entire available budget and the remaining revenues can be used, for example, to repay expensive loans, to invest in public schools or in basic infrastructure, such as sanitation, electricity or telecommunications (Jakob et al., 2016). The remaining revenues are calculated by subtracting the total cost of increasing the BDH from the initially available revenues:

$$RR_{k,s}^{BDHQ2} = R_{k,s} - C_{k,s}^{\Delta BDH,Q2} \quad with\ C_{k,s}^{\Delta BDH,Q2} = \Delta BDH_{k,s}^{Q2} \cdot \sum_h I_{BDH,h} \tag{21}$$

As a second possible compensation scheme, we consider expanding the BDH, currently amounting to US$ 50 per month, only to non-beneficiaries using the entire revenues. To estimate the number of additional households, the available revenues are distributed among those households with the least income per capita. The criteria to be eligible for the BDH is derived from the maximum income per capita of those households receiving the BDH.

Third, we consider introducing a minimum pension for everyone older than 64 years of age. Senior citizens who already receive a monthly pension below the minimum pension, receive the corresponding difference. Retirees with a pension above the minimum pension are excluded from additional pension payments. Minimum pension levels are estimated by calculating the costs of different minimum pension levels (increasing up to a certain maximum in US$ 0.5 steps) and identifying affordable options based on the revenues that are available for each energy subsidy removal scenario.

As a final cash transfer scheme, we model how revenues can be recycled via lump-sum transfers to everyone. To account for the reduced costs of children in comparison to adults, we use adult equivalents *AE* as calculation basis:

$$LS_{k,s} = \frac{R_{k,s}}{AE} = \frac{R_{k,s}}{A + \alpha K} \quad with\ \alpha = 0.7 \tag{22}$$

where $LS_{k,s}$ is the amount of lump-sum transfer in energy subsidy removal scenario k,s, A and K stand for the total number of adults and children, respectively, and α represents the parameter to account for the reduced costs of children. Deaton (2003) suggests setting α between 0.3 (poor countries) and 1 (rich countries). For the upper middle-income country Ecuador, we use an α equal to 0.7.

Regarding in-kind transfers, we first quantify by how much health care expenditures for the two lowest income quintiles can be reduced by revenue-recycling:

$$\Delta c_{Q12}^{health} = \frac{R_{k,s}}{c_{health,Q12}} \cdot 100\% \quad with\ c_{Q12}^{health} = c_{Q1}^{health} + c_{Q2}^{health} \tag{23}$$

where c_{Q1}^{health} and c_{Q2}^{health} represent total health care expenditures of the bottom and second quintile, respectively. Health care expenditure reductions Δc_{Q12}^{health} are limited to 100% and the remaining revenues are calculated as follows:

$$RR_{k,s}^{health} = R_{k,s} - c_{Q12}^{health} \quad for\ \Delta c_{Q12}^{health} > 100\% \tag{24}$$

Second, we estimate the value of food vouchers issued to the two lowest income groups. For this purpose, we reuse equation (20), replacing the variables with those describing the second income quintile and substituting household income from the BDH with a personal unit income of US$ 1. The resulting increase of the unit income can be interpreted as the absolute value of food vouchers necessary to compensate for total additional expenditures of the second income quintile on average. The remaining budget is derived as follows:

$$RR_{k,s}^{food} = R_{k,s} - C_{k,s}^{food} \quad with\ C_{k,s}^{food} = \sum_{i} I_{i,Q12}^{food} \tag{25}$$

where the total cost of the designed food vouchers system $C_{k,s}^{food}$ is the sum of income from food vouchers of all individual beneficiaries from the first and second quintile $I_{i,Q12}^{food}$.

Further, we evaluate a voucher system for public transportation by bus to compensate for additional expenditures of the lowest two income groups. A plausible basis for the calculation of the voucher value would be the additional indirect expenditures for public transportation due to diesel subsidy removal. However, those households using public transportation by bus only have very little additional transportation expenditure increases on average, amounting to US$ 0.15, US$ 0.54, and US$ 0.89 per month for the low, medium, and high scenario, respectively. Therefore, a maximum value of public transport vouchers is calculated based on the absolute additional expenditures of the second quintile. The actual value of the issued vouchers is, however, limited to the already existing expenditures for public transportation by bus, assuming that these expenditures represent the basic need.

Finally, we model the introduction of LPG vouchers to the two lowest income quintiles. There are three forms of LPG consumption, namely as domestic consumption, centralized domestic consumption, and as vehicle fuel. The household data for domestic LPG consumption also contains the physical quantity in kilograms. Since the LPG quantities for centralized domestic consumption and for vehicle fuel are rarely reported and due their small share of total consumption (0.33% and 0.01% respectively), these two consumption forms are neglected. In 2012, households consumed monthly about 17.5 kg of LPG on average, or almost 1.2 cylinders containing 15 kg of LPG (Table S6). Consumption is rather equally distributed across the first four income groups and averages at about 1.1 cylinders a month, whereas the richest income quintile consumes 1.3 cylinders monthly. In 2012, consumers paid on average US$ 2.42 per cylinder, which is in line with domestic sales prices (El Comercio, 2014).

Table S6: Domestic LPG consumption per month and household.

	Total	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Consumption in kg	17.57	16.78	17.11	17.10	17.63	19.44
Consumption in cylinders	1.17	1.12	1.14	1.14	1.18	1.30
Expenditures in US$	2.83	2.79	2.75	2.72	2.79	3.14
Price in US$/cylinder	2.42	2.49	2.41	2.39	2.38	2.43

Source: own calculations based on INEC (2012a) and (ARCH, 2016)

We assume that the basic need for LPG is one cylinder per month and average-sized household. This is below the observed consumption, but can be justified, given that the low LPG prices might lead to increased demand due to inefficient or even wasteful consumption. Based on this assumption we establish a voucher system that gives the poorest 40% of households one free cylinder, or 15 kg of LPG, per month. The resulting additional available income I_h^{LPG} for each LPG-consuming household *h* in the first and second quintile is calculated as follows:

$$
\begin{gathered}
I_h^{LPG} = \frac{v^{LPG}}{q_h^{LPG}} \cdot \left(c_h^{LPG} + \Delta c_{h,s}^{LPG}\right) \\
with\, v^{LPG} = 15kg \quad for\, q_h^{LPG} > 0
\end{gathered}
\tag{26}
$$

where v^{LPG} is the quantity of LPG in kg that can be acquired for free, q_h^{LPG} is the quantitative LPG consumption in kg of household h, c_h^{LPG} is the current monetary LPG expenditure, and $\Delta c_{h,s}^{LPG}$ are the additional expenditures for LPG depending on scenario s. It is assumed that households consuming no LPG or less than one cylinder per month can sell the vouchers and therefore receive additional income above their LPG expenditures.

S3 Supplementary Results

a. Household consumption categories

After adjusting income and expenditures items, the resulting income statistics reveal that mean income per capita (not adjusted for household size) is about US$ 230 per month (Table A1). While the poorest income group earns US$ 71.26, the richest 20% of the population receive US$ 544.52, more than twice as much as the preceding income quintile. Monthly household income averages at roughly US$ 750 and total monthly income of all Ecuadorian households combined reaches almost US$ 3 billion. Mean household size is 3.9 and decreases as income increases. On average, more than 5 people live in households of the bottom quintile, which are almost twice as many people as in the top income quintile.

Table A1: Income statistics and expenditure categories by income quintiles.

	Total	Q1	Q2	Q3	Q4	Q5
Monthly per capita income in US$ - Range	7.87 - 9229.65	7.87 - 98.17	98.18 - 143.04	143.05 - 202.12	202.13 - 313.02	313.03 - 9229.65
Monthly per capita income in US$ - Mean	231.39	71.26	120.35	170.70	250.13	544.52
Monthly household income in US$ - Mean	748.10	361.39	524.30	663.46	816.54	1,374.83
Mean household size	3.88	5.19	4.37	3.90	3.28	2.66
Total monthly income in million US$	2,935	284	411	521	641	1,079
Total monthly expenditures in million US$	2,152	205	302	379	467	798
Average consumption expenditures as % of total						
Food	24.3%	40.3%	35.4%	29.8%	23.7%	13.8%
Apparel	8.8%	8.9%	8.7%	8.6%	9.0%	8.9%
Restaurants	8.4%	5.4%	6.7%	8.2%	9.7%	9.1%
Health care	8.3%	5.4%	6.5%	7.6%	8.4%	10.1%
Personal care	6.5%	7.4%	7.1%	6.9%	6.5%	6.0%
Other expenditures	5.6%	4.1%	3.8%	4.1%	4.9%	7.8%
Communication	5.5%	2.8%	4.1%	5.2%	6.1%	6.6%
Housing	5.5%	3.3%	4.8%	5.4%	5.8%	6.1%
Transportation services	5.4%	6.6%	6.6%	6.5%	5.8%	4.0%
Education	4.9%	0.8%	1.7%	3.0%	4.8%	8.0%
Direct energy consumption	4.7%	3.8%	3.8%	4.1%	4.5%	5.7%
Electricity	2.3%	2.2%	2.3%	2.4%	2.3%	2.2%
Gasoline	2.0%	0.6%	0.9%	1.2%	1.7%	3.3%
LPG	0.5%	0.9%	0.7%	0.5%	0.4%	0.3%
Diesel	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Household supplies	3.8%	3.9%	3.1%	2.9%	2.8%	5.1%
Recreation and culture	3.4%	3.0%	2.7%	2.7%	3.0%	4.4%
Beverages	3.4%	3.9%	4.1%	4.0%	3.7%	2.6%
Durable goods	1.2%	0.6%	0.7%	0.9%	1.3%	1.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: own calculations based on INEC (2012a), for mapping of expenditure items to categories, see **Error! Reference source not found.** and **Error! Reference source not found.**.

Expenditure items are grouped into 22 product categories (**Error! Reference source not found.** and **Error! Reference source not found.** provide mapping details) to shed some light on current consumption patterns of the five income quintile groups (Table A1). On average, food accounts for almost one quarter of overall consumption expenditures with significant variation across income groups. While the richest quintile spent less than 14% on food, for the poorest quintile food items account for more than 40% of their total expenditure. The financial priority of health care also varies widely between income quintiles. For the highest income quintile health care ranks second after food, while the lowest income quintile spends more on food, apparel, personal care, and transportation services than on health. Direct energy expenditures make up almost 5% of total expenditures with electricity and gasoline accounting for 48% and 42% of direct energy expenditures respectively. LPG constitutes only a minor part of direct energy expenditures, presumably due to low LPG prices. Diesel expenditures play a negligible role, as this fuel is almost exclusively used in public transportation, thermal power plants, and industry (MICSE, 2016). Electricity spending is equally distributed across income groups as opposed to gasoline and LPG expenditures, which increase and decrease respectively with higher income. Expenditures for gasoline across income groups correlate extremely closely with expenditures for vehicles (correlation coefficient 0.99), thus higher income groups spend relatively more on gasoline because they own cars. In physical units, LPG consumption is almost equally distributed across income groups (section S2e), which is probably due to the basic need for cooking using LPG stoves, but in relation to income poor households spend considerably more than high-income households.

b. Price increases by categories

Applying the IO price-shifting model, we estimate the price increases of IO commodities caused by elevated costs for energy inputs (Table S7). In the following, price increases of expenditure categories are presented based on the medium scenario. Regarding diesel, a price jump by 137% has major indirect effects on prices of electricity (+27.0%), LPG (+9.6%), ceramic products (+7.4%), and transportation services (+6.1%). The median price increase of the remaining expenditure categories ranges from 0.2% (education) to 1.8% (communication). Removing electricity subsides increases its price by 71% and leads to lower and more evenly distributed price increases across expenditure categories. The median increases in prices of expenditure categories are between 0.1% and 0.9%. Increasing gasoline prices by 77% has similar indirect price increase effects, only prices for transportation services, more specifically, taxi services, stand out with a resulting price increase of 3.2%. The price impact of LPG subsidy reform on other commodities is negligible.

Table S7: Price increases and additional expenditures by categories in medium scenario. Note: blue shading indicates direct effects, *: only indirect price increases are considered

Expenditures categories	Price increase range in % (median)				Total additional monthly expenditures in US$ per average household				Total additional expenditures as % of total			
	Diesel	Electricity	Gasoline	LPG	Diesel	Electricity	Gasoline	LPG	Diesel	Electricity	Gasoline	LPG
Food	0.7-4.6 (1.56)	0.2-1.5 (0.26)	0.1-1.2 (0.72)	0.0-1.3 (0.01)	2.71	0.81	0.76	0.17	20.0%	6.7%	6.6%	1.6%
Apparel	1.0-1.8 (1.37)	0.4-1.4 (0.68)	0.2-0.5 (0.29)	0.0-0.7 (0.12)	0.51	0.33	0.12	0.07	3.7%	2.7%	1.0%	0.7%
Restaurants	1.1-1.1 (1.05)	0.7-0.7 (0.73)	0.5-0.5 (0.49)	0.0-0.0 (0.04)	0.48	0.34	0.23	0.02	3.6%	2.8%	2.0%	0.2%
Health care	0.5-1.6 (1.02)	0.3-0.4 (0.38)	0.4-0.4 (0.38)	0.0-0.0 (0.02)	0.50	0.17	0.17	0.01	3.7%	1.4%	1.5%	0.1%
Personal care	1.3-1.8 (1.62)	0.3-0.6 (0.39)	0.3-0.5 (0.47)	0.0-0.0 (0.02)	0.50	0.11	0.12	0.00	3.7%	0.9%	1.1%	0.0%
Other expenditures	0.2-6.2 (1.43)	0.1-2.0 (0.47)	0.0-3.2 (0.37)	0.0-0.3 (0.02)	0.48	0.18	0.22	0.01	3.6%	1.5%	1.9%	0.1%
Communication	1.4-1.8 (1.78)	0.4-2.0 (0.62)	0.3-1.2 (0.48)	0.0-0.1 (0.02)	0.54	0.58	0.10	0.02	4.0%	4.9%	0.9%	0.2%
Housing	0.0-3.4 (1.62)	0.0-0.5 (0.39)	0.0-0.5 (0.33)	0.0-0.0 (0.02)	0.47	0.10	0.11	0.00	3.5%	0.8%	0.9%	0.0%
Transportation services	6.1-6.1 (6.14)	0.5-0.5 (0.48)	3.2-3.2 (3.24)	0.0-0.0 (0.03)	1.83	0.14	0.97	0.01	13.5%	1.2%	8.4%	0.1%
Education	0.2-0.4 (0.21)	0.2-0.3 (0.29)	0.1-0.1 (0.09)	0.0-0.0 (0.01)	0.06	0.07	0.03	0.00	0.5%	0.6%	0.2%	0.0%
Energy consumption	1.2-137.1 (18.27)	0.1-70.9 (0.24)	0.1-76.6 (0.61)	0.0-389.7 (1.23)	4.52	8.84	8.43	10.24	33.5%	73.5%	73.3%	96.7%
Diesel	137.1-137.1	0.2-0.2 (0.15)	0.1-0.1 (0.12)	0.0-0.0 (0.01)	0.80	0.00	0.00	0.00	5.9%	0.0%	0.0%	0.0%
Electricity	27.0-27.0 (26.95)	70.9-70.9	0.9-0.9 (0.93)	2.4-2.4 (2.45)	3.35	8.81	0.12	0.30	24.8%	73.3%	1.0%	2.9%
Gasoline	1.2-1.2 (1.16)	0.1-0.1 (0.14)	76.6-76.6	0.0-0.0 (0.01)	0.13	0.02	8.31	0.00	0.9%	0.1%	72.2%	0.0%
LPG	9.6-9.6 (9.59)	0.3-0.3 (0.33)	0.3-0.3 (0.29)	389.7-389.7	0.24	0.01	0.01	9.94	1.8%	0.1%	0.1%	93.9%
Household supplies	0.0-2.4 (1.50)	0.0-1.5 (0.74)	0.0-0.3 (0.29)	0.0-0.6 (0.03)	0.18	0.05	0.04	0.00	1.3%	0.4%	0.3%	0.0%
Recreation and culture	0.6-2.6 (1.62)	0.4-2.0 (0.88)	0.1-1.0 (0.51)	0.0-0.3 (0.03)	0.37	0.18	0.10	0.02	2.7%	1.5%	0.8%	0.2%
Beverages	1.5-2.0 (1.51)	0.5-0.8 (0.47)	0.4-0.6 (0.40)	0.0-0.0 (0.03)	0.29	0.09	0.10	0.00	2.1%	0.8%	0.9%	0.0%
Durable goods	0.3-7.4 (1.62)	0.1-1.6 (0.60)	0.1-6.7 (0.26)	0.0-0.7 (0.02)	0.08	0.04	0.02	0.00	0.6%	0.3%	0.2%	0.0%
Total	0.0-27.0 (1.62)*	0.0-2.0 (0.47)*	0.0-6.7 (0.40)*	0.0-2.4 (0.02)*	13.52	12.02	11.51	10.59	100.0%	100.0%	100.0%	100.0%

Source: own calculations based on INEC (2012a) and BCE (2012)

S4 Supplementary Tables

Table S8: Socio-economic indicators for Ecuador from 1996 to 2016. Note: *: previous year; **: subsequent year.

	1996	2000	2004	2008	2012	2016
Population	11,683,479	12,628,596	13,509,647	14,447,562	15,419,666	16,385,068
GDP/cap, PPP (const. 2011 intern. US$)	7,696.6	7,387.6	8,311.7	9,285.9	10,322.2	10,424.3
GDP (current million US$)	25,226.4	18,327.8	36,591.7	61,762.6	87,924.5	98,614.0
GDP growth (%)	1.7	1.1	8.2	6.4	5.6	-1.6
Unemployment (%)	10.4	9.0	8.6	7.3	3.2	4.6
Inflation, consumer prices (%)	24.4	96.1	2.7	8.4	5.1	1.7
Poverty headcount (national poverty lines) (%)	n/a	64.4	44.6	35.1	27.3	22.9
GINI index	53.4*	56.4	53.9	49.7	46.1	45.0
School enrollment, second. (% net)	46.4**	47.9	50.6	56.1*	79.0	87.2
Life expectancy (years)	71.6	72.9	73.9	74.7	75.4	76.3
Government expenditure on						
Education (% of GDP)	NA	1.5	2.3	3.1	4.6	4.5
Health (% of GDP)	NA	0.6	1.1	1.4	2.0	2.5

Source: WB (2018b), Finance Ministry (as cited in OPF, 2018)

Table S9: Explicit electricity subsidies in Ecuador.

Subsidy	Legislation	Recipients	US$/year
Dignity tariff	Executive decree no. 451-A. July 12, 2007	2,083,705	52,348,458
Senior citizens	Law of senior citizens no. 376. October 13, 2006	267,000	13,200,000
Volcanic eruption of Tungurahua	Law of Tungurahua volcano	2,200	226,000
Consumers with disabilities	Organic law of disabilities	69,000	8,800,000
Total		2,421,905	74,574,458

Source: ARCONEL (2015), MEER (2018)

Table S10: Official and estimated electricity costs in USc/kWh.

Electricity costs	Official	Estimated
Generation	4.32	8.0-1.0
Hydropower	-	6.0
Thermal power	-	2.0-4.0
Transmission and distribution	4.97	6.0
Total	9.29	14.0-16.0

Source: ARCONEL (2017), expert interview

Table S11: Monthly income from government transfers in 2012 by income quintiles in 1,000 US$.

Government transfers	Total	Q1	Q2	Q3	Q4	Q5
Total non-monetary	**25,617**	**11,175**	**6,309**	**3,950**	**2,349**	**1,833**
Kindergarten program	3,359	1,219	1,022	614	332	171
Free school textbooks and uniforms	9,377	4,073	2,459	1,629	901	315
Free school breakfast and lunch	9,790	5,343	2,348	1,303	628	168
Student grants	1,882	113	161	165	342	1,101
Food programs	710	299	198	125	64	24
Medical visits	499	127	121	113	84	55
Total monetary	**206,688**	**31,053**	**27,137**	**28,367**	**38,485**	**81,645**
Pension	142,739	4,151	9,835	16,493	32,335	79,925
Bono de Desarrollo Humano	58,798	25,656	16,390	10,381	5,067	1,304
(as share of total income)	(4.4%)	(12.5%)	(5.2%)	(2.8%)	(1.3%)	(0.3%)
Housing Grant	3,169	728	588	793	748	313
Disability Grant	1,982	518	325	701	335	104
Total	**232,305**	**42,227**	**33,446**	**32,318**	**40,834**	**83,479**

Source: own calculations based on INEC (2012a)

Table S12: Selected income and expenditures in US$ per month and capita and possible compensation schemes.

Note: +further analyzed.

Income/expenditures	Total	Q1	Q2	Q3	Q4	Q5	Compensation schemes
Income							
BDH	3.86	6.31	4.78	3.39	1.97	0.62	Increasing/Expanding+
Pensions	9.38	1.02	2.87	5.38	12.56	38.27	Minimum pension+
Expenditures							
Social security	7.24	0.80	2.70	5.17	9.68	27.24	Minimum pension+
Income tax	0.93	0.00	0.02	0.11	0.36	6.16	Progressive income tax
Education	6.86	0.38	1.46	3.72	8.77	30.56	Free education
Health care	11.76	2.71	5.70	9.37	15.20	38.64	Free/reduced health care+
Food	34.39	20.30	31.22	36.88	42.97	52.81	Vouchers+
Public transport (bus)	5.06	2.66	4.68	5.92	6.97	6.72	Vouchers+
LPG	0.66	0.47	0.60	0.66	0.76	1.00	Vouchers+

Source: own calculations based on INEC (2012a)

Table S13: Detailed official monthly expenditure aggregates of all households and source dataset.

Aggregates	Monthly expenditures in US$	in %	Source dataset
Total current expenditures	3,176,344,301	100.0%	Hogares_Agregados
Non-monetary current expenditures/income	723,715,752	22.8%	Hogares_Agregados
Salary in kind	111,444,729	3.5%	Hogares_Agregados
Housing	10,518,295	0.3%	Personas_Ingresos
Food	71,263,120	2.2%	Personas_Ingresos
Apparel	8,042,890	0.3%	Personas_Ingresos
Transport	11,374,212	0.4%	Personas_Ingresos
Childcare	138,581	0.0%	Personas_Ingresos
Education for children	124,685	0.0%	Personas_Ingresos
Others	9,982,946	0.3%	Personas_Ingresos
Self-consumption	66,778,956	2.1%	Hogares_Agregados
Non-agriculture	40,096,681	1.3%	Hogares_Agregados
Agriculture	26,682,275	0.8%	Hogares_Agregados
Income in form of received gifts	214,215,387	6.7%	Hogares_Agregados
Total expenditures gifts	214,215,387	6.7%	Gastos_Hregalos
Imputed value of dwellings	331,276,680	10.4%	Hogares_Agregados
Estimated rent of owned dwellings	257,435,222	8.1%	Gastos_V
Estimated rent of transferred dwellings	55,125,861	1.7%	Gastos_V
Amortization of owned loan-financed dwellings	18,715,598	0.6%	Gastos_V
Monetary current expenditures	2,452,628,550	77.2%	Hogares_Agregados
Current consumption expenditures	2,393,571,816	75.4%	Hogares_Agregados
Sum of all consumption expenditure items	2,393,571,816	75.4%	Gastos_V
Non-consumption expenditures	59,056,734	1.9%	Hogares_Agregados
Property tax	4,766,470	0.2%	Personas_Ingresos
Sales tax	525,870	0.0%	Personas_Ingresos
Vehicle purchase tax	418,720	0.0%	Personas_Ingresos
Inheritance or lottery tax	1,199,073	0.0%	Personas_Ingresos
Financial support to other households	41,213,482	1.3%	Personas_Ingresos
Alimony	4,233,369	0.1%	Personas_Ingresos
Vehicle expenditures	6,699,749	0.2%	Personas_Ingresos

Source: own calculations based on INEC (2012a)

Table S14: Official and estimated fossil fuel subsidies from 2007 to 2017.

	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	10Y average
Total fossil fuel subsidies	**million US$**	**1,426.0**	**1,931.7**	**1,108.8**	**2,102.9**	**2,942.9**	**3,400.9**	**3,666.4**	**3,907.4**	**1,713.1**	**627.7**	**1,122.7**	**2,252.5**
	% of GDP	2.8%	3.1%	1.8%	3.0%	3.7%	3.9%	3.9%	3.8%	1.7%	0.6%	1.1%	2.7%
Total estimated (price-gap)	million US$	2,259.1	3,444.6	1,759.2	2,837.0	4,875.5	5,465.2	5,360.5	5,202.9	2,240.7			3,898.2
	% of GDP	4.4%	5.6%	2.8%	4.1%	6.1%	6.2%	5.6%	5.1%	2.3%			4.7%
Difference relative	%	1.58	1.78	1.59	1.35	1.66	1.61	1.46	1.33	1.31			1.51
Gasoline	**million US$**	**288.4**	**404.2**	**231.1**	**547.8**	**975.3**	**1,280.2**	**1,261.7**	**1,381.4**	**599.1**	**147.4**	**329.9**	**715.8**
Share	in % of total	20.2%	20.9%	20.8%	26.0%	33.1%	37.6%	34.4%	35.4%	35.0%	23.5%	29.4%	29.6%
Import volume	million bbl	7.8	7.4	9.4	12.9	12.6	14.2	16.0	20.1	19.4	15.9	16.4	14.4
Import price	US$/barrel	90.4	108.5	80.4	97.0	131.5	143.6	131.7	121.7	82.2	61.1	72.4	103.0
Domestic sales price	US$/barrel	55.1	55.2	55.1	55.0	54.5	54.0	52.8	51.9	51.6	51.6	52.3	53.4
Ratio import/sales price	%	164.0%	196.7%	145.9%	176.4%	241.1%	266.2%	249.3%	234.4%	159.3%	118.4%	138.5%	192.6%
Price-gap approach	-												
Total consumption	million bbl	17.1	17.3	19.6	22.6	23.8	24.8	25.7	28.4	28.3			23.8
Estimated subsidy	million US$	602.1	921.7	495.3	952.0	1,829.9	2,221.1	2,026.9	1,982.5	867.0			1,412.1
Difference absolute	million US$	313.63	517.56	264.16	404.22	854.65	940.91	765.21	601.12	267.92			577.0
Diesel	**million US$**	**607.0**	**942.1**	**564.6**	**1,078.3**	**1,335.6**	**1,599.3**	**1,882.2**	**1,985.9**	**864.9**	**294.3**	**468.8**	**1,101.6**
Share	in % of total	42.6%	48.8%	50.9%	51.3%	45.4%	47.0%	51.3%	50.8%	50.5%	46.9%	41.8%	48.5%
Import volume	million bbl	11.8	10.9	13.7	19.9	15.1	17.0	20.8	25.0	23.7	18.1	17.9	18.2
Import price	US$/barrel	90.5	127.1	77.9	93.6	130.0	136.5	131.9	120.9	75.9	57.5	69.0	102.0
Domestic sales price	US$/barrel	40.1	41.8	39.3	39.8	42.4	42.3	41.5	40.3	39.1	41.4	42.8	41.1
Ratio import/sales price	%	225.7%	304.1%	198.3%	235.0%	307.0%	323.1%	318.2%	299.8%	194.4%	138.8%	161.1%	248.0%
Price-gap approach	-												
Total consumption	million bbl	20.6	21.1	22.6	24.2	25.6	27.1	29.4	31.9	29.5			26.4
Estimated subsidy	million US$	1,039.9	1,803.4	872.3	1,299.2	2,241.3	2,550.8	2,659.1	2,566.1	1,088.9			1,885.1
Difference absolute	million US$	432.94	861.34	307.72	220.90	905.67	951.50	776.94	580.13	223.96			603.5
LPG	**million US$**	**530.6**	**585.5**	**313.1**	**476.8**	**631.9**	**521.4**	**522.6**	**540.1**	**249.1**	**186.1**	**324.0**	**435.1**
Share	in % of total	37.2%	30.3%	28.2%	22.7%	21.5%	15.3%	14.3%	13.8%	14.5%	29.6%	28.9%	21.9%
Import volume	million bbl	9.7	9.3	9.1	9.4	9.8	9.0	9.6	10.7	10.8	9.8	10.4	9.8
Import price	US$/barrel	65.3	74.6	45.5	63.1	77.8	71.8	69.0	65.9	36.4	31.7	44.9	58.1
Domestic sales price	US$/barrel	10.7	11.8	11.2	12.5	13.8	13.6	14.1	14.7	13.4	13.0	13.9	13.2
Ratio import/sales price	%	609.5%	633.7%	407.5%	505.4%	562.6%	529.9%	489.6%	448.1%	272.0%	244.5%	322.8%	441.6%
Price-gap approach	-												
Total consumption	million bbl	11.3	11.4	11.4	11.6	12.6	11.9	12.3	12.8	12.4			12.0
Estimated subsidy	million US$	617.2	719.4	391.6	585.8	804.3	693.4	674.5	654.3	284.8			601.0
Difference absolute	million US$	86.53	133.97	78.55	108.99	172.34	171.91	151.90	114.20	35.73			120.9

Source: BCE (2018a), MICSE (2016)

Table S15: Set of interview questions.

	Original	English
1.	¿Cuáles son los grandes retos a los que se enfrenta Ecuador?	What are the major challenges facing Ecuador?
2.	¿Qué está haciendo el gobierno actual para solucionar estos desafíos?	What is the current government doing to address these challenges?
3.	¿Existe un buen momento para bajar los subsidios energéticos? ¿En caso positivo, cuando sería?	Is there a good moment to reduce energy subsidies? If so, when would it be?
4.	¿Qué subsidio energético bajaría primero y por qué? ¿Electricidad, GLP, gasolina, diesel?	Which energy subsidy would you reduce first and why? Electricity, LPG, gasoline, diesel?
5.	¿Cuáles son las barreras que impiden la bajada de los subsidios de …? ¿Electricidad, GLP, gasolina, diesel?	What are the barriers to reducing subsidies for...? Electricity, LPG, gasoline, diesel?
6.	¿Cuáles serían medidas adecuadas antes de una reforma de subsidios para que la subida de precios de energía tenga menos impacto negativo a los presupuestos de hogares? ¿Electricidad, GLP, gasolina, diesel?	What could be appropriate measures before reforming subsidies to reduce the negative impact on household budgets due to higher energy prices? Electricity, LPG, gasoline, diesel?
7.	Aún no tenemos los resultados cuantitativos, pero que piensa usted, ¿quiénes se benefician más de los subsidios energéticos? ¿Los hogares pobres/ricos? ¿Los hogares urbanos/rurales? ¿Electricidad, GLP, gasolina, diesel?	We do not yet have the quantitative results, but what do you think, who benefits most from energy subsidies? Poor/rich households? Urban/rural households? Electricity, LPG, gasoline, diesel?
8.	Si se bajan los subsidios, los gastos de los hogares van a subir, lo que puede aumentar el riesgo de pobreza de los hogares ya más pobres. ¿Qué medidas serían posibles para recompensar este efecto de los hogares vulnerables?	If subsidies are cut, household expenditures will rise, which can increase the risk of poverty. What measures would be possible to compensate for this impact on vulnerable households?

Table S16: Interview partners, their organization and position at time of interview, and date of interview. Note: *Interview carried out via videoconferencing

Interviewee	Organization	Position	Date
Eduardo Noboa*	Leuphana University of Lüneburg	PhD researcher with working experience in public sector, former undersecretary of Climate Change at MAE	Feb 14, 2018
Gonzalo Sánchez*	Escuela Superior Politécnica del Litoral (ESPOL)	PhD, researcher and lecturer for Economics	Feb 19, 2018
Martín Cordovez	Instituto Nacional de Eficiencia Energética y Energías Renovables (INER)	Executive director	Feb 19, 2018
Sebastián Espinoza	INER	Director for information management, PhD researcher	Feb 19, 2018
Carlos Larrea	Universidad Andina Simón Bolivar (UASB)	PhD, professor in Social and Global Sciences	Feb 20, 2018
Esteban Albornoz	National Assembly	Assemblyman, former minister at MEER	Feb 22, 2018
Alfredo Samaniego	National Assembly	Adviser from ARCONEL, former vice minister at MEER	Feb 22, 2018
Elsy Parodi	Ministerio de Electricidad y Energía Renovable (MEER)	Minister	Feb 22, 2018
Victor Orejuela	MEER	Adviser to the minister	Feb 22, 2018
José Hidalgo Pallares	Corporación de Estudios para el Desarrollo (CORDES)	Director	Feb 23, 2018
Volker Frank	Fundación Futuro Latinoamericano (FFLA)	Director of technical management	Feb 23, 2018
María Victoria Chiriboga	Ministerio del Ambiente (MAE)	Undersecretary of Climate Change	Feb 23, 2018

Marco Cazco	Ministerio de Inclusión Económica y Social (MIES)	Vice minister	Feb 23, 2018
Sebastián Burgos	MIES	Advisor	Feb 23, 2018
Ana María Núñez	United Nations Development Program (UNDP)	Program Officer Ecuador Energy and Environment Unit	Feb 23, 2018
Alfredo Mena*	Corporación para la Investigación Energética (CIE)	Executive director	Mar 20, 2018
Pablo Carvajal*	University College London (UCL)	PhD researcher, former minister advisor at MEER and MICSE	Apr 5, 2018

Table S17: Additional monthly consumption expenditures by income quintiles in million US$.

	Diesel			Electricity			Gasoline			LPG		
	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
Total												
Q1	1.61	5.62	9.28	2.21	4.42	6.63	0.55	2.30	5.00	2.84	7.66	10.49
Q2	2.29	7.99	13.19	3.31	6.63	9.94	0.95	3.94	8.55	3.11	8.37	11.47
Q3	2.81	9.79	16.18	4.29	8.58	12.88	1.42	5.89	12.81	3.10	8.34	11.43
Q4	3.32	11.57	19.12	5.23	10.46	15.69	2.16	9.00	19.56	3.03	8.16	11.18
Q5	5.19	18.07	29.86	8.53	17.06	25.59	5.77	24.02	52.21	3.34	9.00	12.33
Total	15.24	53.04	87.64	23.58	47.16	70.73	10.85	45.14	98.13	15.41	41.54	56.91
Direct												
Q1	0.06	0.19	0.32	1.63	3.26	4.89	0.23	0.95	2.07	2.74	7.38	10.11
Q2	0.08	0.28	0.46	2.43	4.87	7.30	0.48	1.99	4.33	2.96	7.98	10.94
Q3	0.12	0.41	0.68	3.17	6.34	9.51	0.85	3.52	7.66	2.92	7.87	10.78
Q4	0.19	0.67	1.11	3.84	7.67	11.51	1.50	6.25	13.58	2.82	7.61	10.42
Q5	0.46	1.59	2.63	6.22	12.44	18.66	4.77	19.87	43.19	3.02	8.15	11.16
Total	0.90	3.15	5.20	17.29	34.58	51.87	7.83	32.58	70.83	14.47	38.99	53.41
Indirect												
Q1	1.56	5.43	8.97	0.58	1.16	1.74	0.32	1.35	2.93	0.10	0.28	0.39
Q2	2.21	7.71	12.73	0.88	1.76	2.64	0.47	1.94	4.23	0.15	0.39	0.54
Q3	2.69	9.38	15.49	1.12	2.25	3.37	0.57	2.37	5.15	0.18	0.47	0.65
Q4	3.13	10.90	18.02	1.40	2.79	4.19	0.66	2.75	5.98	0.21	0.55	0.76
Q5	4.73	16.48	27.23	2.31	4.62	6.92	1.00	4.15	9.02	0.32	0.85	1.17
Total	14.33	49.90	82.44	6.29	12.58	18.87	3.02	12.56	27.30	0.95	2.55	3.50

Source: own calculations based on INEC (2012a) and BCE (2012)

Table S18: Additional monthly consumption expenditures by income quintiles in US$/household.

	Diesel			Electricity			Gasoline			LPG		
	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
Total												
Q1	2.06	7.16	11.83	2.82	5.63	8.45	0.70	2.93	6.37	3.62	9.76	13.37
Q2	2.92	10.18	16.82	4.22	8.45	12.67	1.21	5.02	10.90	3.96	10.67	14.62
Q3	3.58	12.48	20.61	5.47	10.94	16.41	1.80	7.51	16.32	3.94	10.63	14.56
Q4	4.24	14.75	24.37	6.67	13.34	20.00	2.76	11.47	24.93	3.86	10.40	14.25
Q5	6.62	23.03	38.06	10.87	21.74	32.61	7.36	30.61	66.54	4.26	11.47	15.72
Mean	3.88	13.52	22.34	6.01	12.02	18.03	2.76	11.51	25.01	3.93	10.59	14.51
Direct												
Q1	0.07	0.24	0.40	2.08	4.15	6.23	0.29	1.21	2.64	3.49	9.40	12.88
Q2	0.10	0.36	0.59	3.10	6.20	9.30	0.61	2.54	5.52	3.78	10.18	13.94
Q3	0.15	0.53	0.87	4.04	8.08	12.12	1.08	4.49	9.76	3.72	10.03	13.74
Q4	0.25	0.85	1.41	4.89	9.78	14.67	1.91	7.96	17.31	3.60	9.70	13.29
Q5	0.58	2.03	3.35	7.93	15.86	23.79	6.08	25.32	55.04	3.85	10.39	14.23
Mean	0.23	0.80	1.33	4.41	8.81	13.22	2.00	8.31	18.05	3.69	9.94	13.61
Indirect												
Q1	1.99	6.92	11.43	0.74	1.48	2.22	0.41	1.72	3.73	0.13	0.36	0.49
Q2	2.82	9.82	16.23	1.12	2.25	3.37	0.60	2.48	5.39	0.18	0.50	0.68
Q3	3.43	11.95	19.74	1.43	2.86	4.29	0.73	3.02	6.56	0.22	0.60	0.83
Q4	3.99	13.90	22.96	1.78	3.56	5.34	0.84	3.50	7.62	0.26	0.71	0.97
Q5	6.03	21.00	34.70	2.94	5.88	8.83	1.27	5.29	11.50	0.40	1.09	1.49
Mean	3.65	12.72	21.01	1.60	3.21	4.81	0.77	3.20	6.96	0.24	0.65	0.89

Source: own calculations based on INEC (2012a) and BCE (2012)

Table S19: Additional monthly consumption expenditures by income quintiles in % of income.

	Diesel			Electricity			Gasoline			LPG		
	Low	**Medium**	**High**	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
Total												
Q1	0.57%	1.98%	3.27%	0.83%	1.66%	2.49%	0.18%	0.76%	1.64%	1.15%	3.09%	4.23%
Q2	0.55%	1.93%	3.19%	0.82%	1.65%	2.47%	0.22%	0.90%	1.96%	0.85%	2.29%	3.14%
Q3	0.53%	1.86%	3.07%	0.83%	1.66%	2.49%	0.25%	1.03%	2.25%	0.68%	1.83%	2.51%
Q4	0.51%	1.77%	2.92%	0.81%	1.63%	2.44%	0.29%	1.22%	2.66%	0.53%	1.44%	1.97%
Q5	0.48%	1.67%	2.76%	0.79%	1.59%	2.38%	0.45%	1.86%	4.05%	0.36%	0.97%	1.34%
Mean	0.53%	1.84%	3.04%	0.82%	1.64%	2.46%	0.28%	1.15%	2.51%	0.71%	1.93%	2.64%
Direct												
Q1	0.02%	0.07%	0.11%	0.64%	1.27%	1.91%	0.07%	0.30%	0.65%	1.11%	2.99%	4.09%
Q2	0.02%	0.06%	0.10%	0.62%	1.24%	1.85%	0.11%	0.44%	0.95%	0.81%	2.20%	3.01%
Q3	0.02%	0.07%	0.12%	0.62%	1.25%	1.87%	0.14%	0.59%	1.29%	0.65%	1.74%	2.39%
Q4	0.03%	0.09%	0.15%	0.61%	1.21%	1.82%	0.19%	0.80%	1.75%	0.50%	1.35%	1.85%
Q5	0.03%	0.12%	0.20%	0.58%	1.17%	1.75%	0.35%	1.47%	3.21%	0.33%	0.90%	1.23%
Mean	0.02%	0.08%	0.14%	0.61%	1.23%	1.84%	0.17%	0.72%	1.57%	0.68%	1.83%	2.51%
Indirect												
Q1	0.55%	1.91%	3.16%	0.19%	0.39%	0.58%	0.11%	0.46%	0.99%	0.04%	0.10%	0.14%
Q2	0.54%	1.87%	3.09%	0.21%	0.41%	0.62%	0.11%	0.46%	1.00%	0.04%	0.10%	0.13%
Q3	0.51%	1.78%	2.95%	0.21%	0.41%	0.62%	0.11%	0.44%	0.96%	0.03%	0.09%	0.12%
Q4	0.48%	1.68%	2.77%	0.21%	0.41%	0.62%	0.10%	0.42%	0.91%	0.03%	0.09%	0.12%
Q5	0.45%	1.55%	2.57%	0.21%	0.42%	0.63%	0.09%	0.39%	0.85%	0.03%	0.08%	0.11%
Mean	0.51%	1.76%	2.91%	0.20%	0.41%	0.61%	0.10%	0.43%	0.94%	0.03%	0.09%	0.12%

Source: own calculations based on INEC (2012a) and BCE (2012)

Table S20: Total additional household expenditures compared to official energy subsidies.
Note: Official energy subsidies vary due to the subsidy level that corresponds to the scenario, e.g. in the low scenario fossil fuel subsidies are equivalent to the official numbers in 2016; Modeled subsidies only consider additional expenditures from households, other sectors, such as industry, public sector are excluded; *: estimated based on expert interviews (section 3.2).

Energy	**Modeled subsidies (official subsidies) in million US$/year**			**Ratio of model to official**		
	Low	Medium	High	Low	Medium	High
Diesel	182.8 (294.3)	636.5 (1078.3)	1051.7 (1599.3)	62.1%	59.0%	65.8%
Electricity	282.9 (475.0*)	565.9 (950.0*)	848.8 (1425.0*)	59.6%	59.6%	59.6%
Gasoline	130.2 (147.4)	541.7 (547.8)	1177.5 (1280.2)	88.3%	98.9%	92.0%
LPG	184.9 (186.1)	498.5 (522.6)	682.9 (585.5)	99.4%	95.4%	116.6%

Source: own calculations based on BCE (2012), INEC (2012a), and Table S14

Table S21: Design of compensation mechanisms and remaining revenues. Note: *: 100% of freed-up revenues are spent, thus no remainder; #: to be adjusted for household size in practice

	Diesel			**Electricity**			**Gasoline**			**LPG**		
	min	**med**	**max**	**min**	**med**	**max**	**min**	**med**	**max**	**min**	**med**	**max**
Freed-up revenues in million US$/year	182.82	636.53	1051.68	282.94	565.88	848.81	130.16	541.70	1177.52	184.95	498.51	682.86
Cash transfers												
Increase BDH*												
Increase in US$	9.07	31.58	52.17	14.04	28.07	42.11	6.46	26.87	58.41	9.17	24.73	33.87
Increase BDH up to Q2												
Increase in US$	3.76	13.10	21.64	5.59	11.19	16.78	1.47	6.11	13.27	5.77	15.56	21.31
Remainder in million US$/year	106.97	372.43	615.34	170.18	340.35	510.53	100.58	418.62	909.97	68.59	184.89	253.26
Expand BDH ($50/month) to non-beneficiaries*												
Up to monthly income/cap in US$	111.65	193.99	305.91	130.99	180.44	241.71	100.10	176.07	363.80	112.22	168.08	203.07
Number of additional households	304,707	1,060,880	1,752,799	471,563	943,125	1,414,688	216,929	902,833	1,962,531	308,243	830,858	1,138,101
Minimum pension for everyone ≥ 65 years*												
in US$/month	17.5	60	98	27	53.5	79.5	12.5	51.5	109.5	17.5	47.5	64.5
Lump-sum transfer*												
in US$ per month and adult	1.13	3.93	6.50	1.75	3.50	5.25	0.80	3.35	7.28	1.14	3.08	4.22
In-kind transfers												
Reduced health care for Q1 and Q2												
Reduction in %	49.9%	100.0%	100.0%	77.2%	100.0%	100.0%	35.5%	100.0%	100.0%	50.5%	100.0%	100.0%
Remainder in million US$/year	0.0	270.0	685.2	0.0	199.4	482.3	0.0	175.2	811.0	0.0	132.0	316.3
Food vouchers for Q1 and Q2												
in US$ per month and person	0.7	2.3	3.8	1.0	2.0	2.9	0.3	1.1	2.3	1.0	2.7	3.7
Remainder in million US$/year	119.8	429.6	709.8	193.0	385.9	587.9	103.2	442.7	970.6	95.0	255.6	349.9
Public transport vouchers for Q1 and Q2												
in US$ per month and average household#	2.92	10.18	16.82	4.22	8.45	12.67	1.21	5.02	10.9	3.96	10.67	14.6
Remainder in million US$/year	142.0	514.0	875.1	225.2	460.4	704.0	112.8	474.3	1048.3	130.5	371.4	522.5
LPG vouchers for Q1 and Q2												
# cylinders per month and average household#	1	1	1	1	1	1	1	1	1	1	1	1
Remainder in million US$/a	182.8	636.5	1,051.7	282.9	565.9	848.8	130.2	541.7	1,177.5	83.6	295.5	420.0

Source: own calculations based on INEC (2012a) and BCE (2012)

Table S22: Additional net income due to energy subsidy reform and compensation schemes by income quintile in % of income.

	Diesel			Electricity			Gasoline			LPG		
	min	med	max	min	med	max	min	med	max	min	med	max
Cash transfers												
Increase BDH using 100% revenues												
Q1	2.7%	9.3%	15.4%	4.2%	8.4%	12.6%	2.1%	8.9%	19.2%	2.1%	5.8%	7.9%
Q2	0.8%	2.7%	4.5%	1.2%	2.5%	3.7%	0.7%	3.1%	6.7%	0.5%	1.4%	1.9%
Q3	0.2%	0.7%	1.1%	0.3%	0.6%	0.9%	0.3%	1.1%	2.4%	0.1%	0.2%	0.2%
Q4	-0.2%	-0.6%	-0.9%	-0.3%	-0.6%	-0.8%	0.0%	-0.2%	-0.4%	-0.2%	-0.5%	-0.7%
Q5	-0.4%	-1.4%	-2.3%	-0.7%	-1.4%	-2.0%	-0.4%	-1.6%	-3.6%	-0.3%	-0.8%	-1.1%
Increase BDH up to Q2												
Q1	0.8%	2.7%	4.5%	1.2%	2.3%	3.5%	0.3%	1.4%	3.1%	0.9%	2.5%	3.4%
Q2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Q3	-0.2%	-0.8%	-1.3%	-0.4%	-0.8%	-1.1%	-0.1%	-0.5%	-1.2%	-0.2%	-0.6%	-0.8%
Q4	-0.4%	-1.3%	-2.1%	-0.6%	-1.2%	-1.8%	-0.2%	-1.0%	-2.2%	-0.3%	-0.8%	-1.2%
Q5	-0.5%	-1.6%	-2.6%	-0.7%	-1.5%	-2.2%	-0.4%	-1.8%	-3.9%	-0.3%	-0.9%	-1.2%
Expand BDH ($50/month) to current non-beneficiaries												
Q1	4.0%	2.6%	1.3%	3.8%	2.9%	2.1%	4.4%	3.8%	2.9%	3.4%	1.5%	0.4%
Q2	1.0%	3.7%	2.4%	3.2%	4.0%	3.1%	0.0%	4.7%	3.7%	0.8%	3.3%	2.5%
Q3	-0.5%	3.4%	3.0%	-0.8%	2.3%	3.6%	-0.2%	2.5%	3.8%	-0.7%	0.9%	3.5%
Q4	-0.5%	-1.8%	3.2%	-0.8%	-1.6%	0.5%	-0.3%	-1.2%	3.7%	-0.5%	-1.4%	-1.9%
Q5	-0.5%	-1.7%	-2.8%	-0.8%	-1.6%	-2.4%	-0.4%	-1.9%	-2.5%	-0.4%	-1.0%	-1.3%
Expand BDH to all households												
Q1	8.9%	16.9%	15.6%	12.2%	17.2%	16.4%	7.2%	18.1%	17.2%	8.4%	15.8%	14.7%
Q2	-0.6%	2.6%	8.7%	-0.8%	1.0%	7.3%	-0.2%	1.1%	9.9%	-0.9%	-1.5%	2.6%
Q3	-0.5%	-1.9%	-0.7%	-0.8%	-1.7%	-2.5%	-0.2%	-1.0%	2.7%	-0.7%	-1.8%	-2.5%
Q4	-0.5%	-1.8%	-2.9%	-0.8%	-1.6%	-2.4%	-0.3%	-1.2%	-2.7%	-0.5%	-1.4%	-2.0%
Q5	-0.5%	-1.7%	-2.8%	-0.8%	-1.6%	-2.4%	-0.4%	-1.9%	-4.1%	-0.4%	-1.0%	-1.3%
Minimum pension for senior citizens												
Q1	2.3%	7.9%	13.1%	3.6%	7.1%	10.7%	1.8%	7.7%	16.7%	1.7%	4.7%	6.4%
Q2	0.7%	2.6%	4.4%	1.2%	2.4%	3.6%	0.7%	3.0%	6.6%	0.5%	1.3%	1.8%
Q3	0.5%	1.6%	2.7%	0.7%	1.4%	2.2%	0.5%	1.9%	4.2%	0.3%	0.9%	1.2%
Q4	0.2%	0.8%	1.3%	0.3%	0.6%	1.0%	0.2%	1.0%	2.1%	0.2%	0.6%	0.8%
Q5	-0.2%	-0.7%	-1.2%	-0.4%	-0.7%	-1.1%	-0.2%	-1.0%	-2.3%	-0.1%	-0.2%	-0.3%
Lump-sum transfer												
Q1	0.9%	3.3%	5.4%	1.5%	3.0%	4.5%	0.9%	3.7%	8.1%	0.4%	1.0%	1.4%
Q2	0.3%	1.0%	1.6%	0.5%	1.0%	1.4%	0.4%	1.6%	3.5%	0.0%	0.0%	0.0%
Q3	0.1%	0.2%	0.4%	0.1%	0.2%	0.3%	0.2%	0.8%	1.6%	-0.1%	-0.2%	-0.3%
Q4	-0.1%	-0.3%	-0.5%	-0.2%	-0.3%	-0.5%	0.0%	0.0%	0.1%	-0.1%	-0.3%	-0.4%
Q5	-0.2%	-0.9%	-1.4%	-0.4%	-0.9%	-1.3%	-0.3%	-1.2%	-2.6%	-0.1%	-0.3%	-0.5%
In-kind transfers												
Free/Reduced health care for Q1 and Q2												
Q1	1.4%	1.9%	0.6%	2.2%	2.2%	1.4%	1.2%	3.1%	2.2%	0.8%	0.8%	-0.3%
Q2	1.8%	2.8%	1.6%	2.8%	3.1%	2.3%	1.5%	3.8%	2.8%	1.5%	2.5%	1.6%
Q3	-0.5%	-1.9%	-3.1%	-0.8%	-1.7%	-2.5%	-0.2%	-1.0%	-2.2%	-0.7%	-1.8%	-2.5%
Q4	-0.5%	-1.8%	-2.9%	-0.8%	-1.6%	-2.4%	-0.3%	-1.2%	-2.7%	-0.5%	-1.4%	-2.0%
Q5	-0.5%	-1.7%	-2.8%	-0.8%	-1.6%	-2.4%	-0.4%	-1.9%	-4.1%	-0.4%	-1.0%	-1.3%
Food vouchers for Q1 and Q2												
Q1	0.5%	1.6%	2.6%	0.7%	1.5%	2.0%	0.3%	1.0%	1.9%	0.4%	1.1%	1.5%
Q2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Q3	-0.5%	-1.9%	-3.1%	-0.8%	-1.7%	-2.5%	-0.2%	-1.0%	-2.2%	-0.7%	-1.8%	-2.5%
Q4	-0.5%	-1.8%	-2.9%	-0.8%	-1.6%	-2.4%	-0.3%	-1.2%	-2.7%	-0.5%	-1.4%	-2.0%
Q5	-0.5%	-1.7%	-2.8%	-0.8%	-1.6%	-2.4%	-0.4%	-1.9%	-4.1%	-0.4%	-1.0%	-1.3%
Public transport vouchers for Q1 and Q2												
Q1	0.1%	-0.2%	-0.9%	0.1%	-0.1%	-0.5%	0.1%	0.3%	0.2%	-0.3%	-1.3%	-2.0%
Q2	0.0%	-0.4%	-1.1%	-0.1%	-0.3%	-0.7%	0.0%	-0.1%	-0.4%	-0.2%	-0.7%	-1.2%
Q3	-0.5%	-1.9%	-3.1%	-0.8%	-1.7%	-2.5%	-0.2%	-1.0%	-2.2%	-0.7%	-1.8%	-2.5%
Q4	-0.5%	-1.8%	-2.9%	-0.8%	-1.6%	-2.4%	-0.3%	-1.2%	-2.7%	-0.5%	-1.4%	-2.0%
Q5	-0.5%	-1.7%	-2.8%	-0.8%	-1.6%	-2.4%	-0.4%	-1.9%	-4.1%	-0.4%	-1.0%	-1.3%
LPG vouchers for Q1 and Q2												
Q1	-0.6%	-2.0%	-3.3%	-0.8%	-1.7%	-2.5%	-0.2%	-0.8%	-1.6%	0.6%	0.3%	0.2%
Q2	-0.6%	-1.9%	-3.2%	-0.8%	-1.6%	-2.5%	-0.2%	-0.9%	-2.0%	0.4%	0.2%	0.1%
Q3	-0.5%	-1.9%	-3.1%	-0.8%	-1.7%	-2.5%	-0.2%	-1.0%	-2.2%	-0.7%	-1.8%	-2.5%
Q4	-0.5%	-1.8%	-2.9%	-0.8%	-1.6%	-2.4%	-0.3%	-1.2%	-2.7%	-0.5%	-1.4%	-2.0%
Q5	-0.5%	-1.7%	-2.8%	-0.8%	-1.6%	-2.4%	-0.4%	-1.9%	-4.1%	-0.4%	-1.0%	-1.3%

Source: own calculations based on INEC (2012a) and BCE (2012)

S5 Supplementary Figures

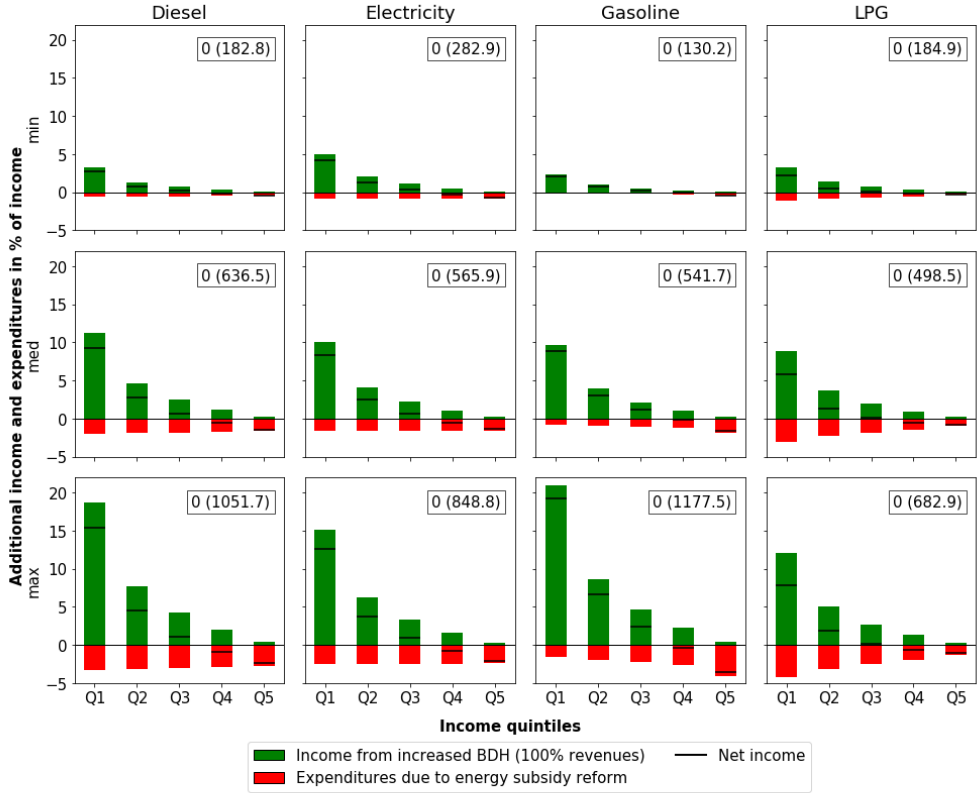

Figure S1: Distributional impacts of increased BDH (100%) and energy subsidy reform by income quintiles in % of income.

Source: own illustration based on INEC (2012a) and BCE (2012)

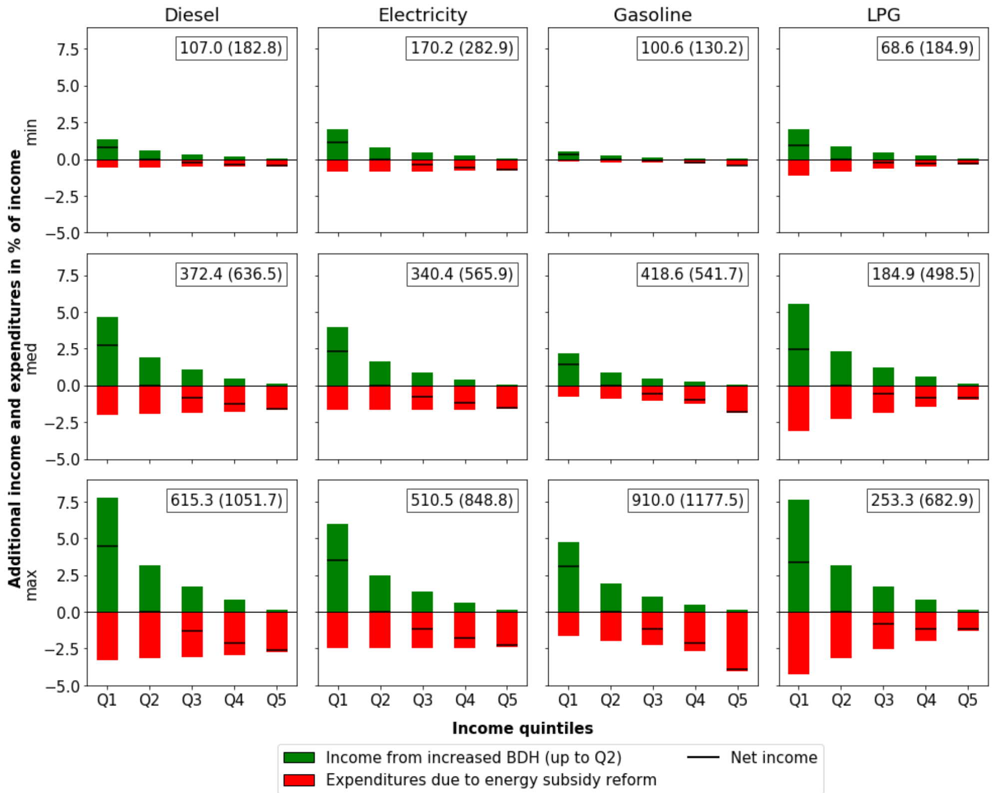

Figure S2: Distributional impacts of increased BDH (up to Q2) and energy subsidy reform by income quintiles in % of income.

Source: own illustration based on INEC (2012a) and BCE (2012)

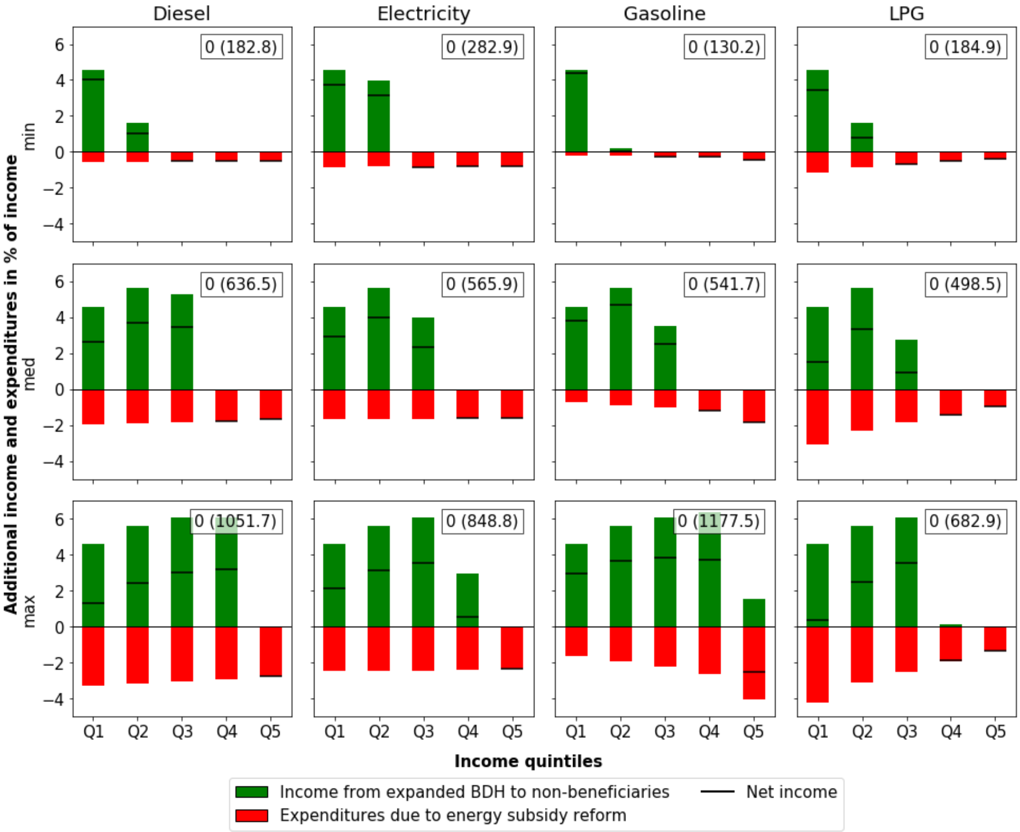

Figure S3: Distributional impacts of expanded BDH ($50/month) to non-beneficiaries and energy subsidy reform by income quintiles in % of income.

Source: own illustration based on INEC (2012a) and BCE (2012)

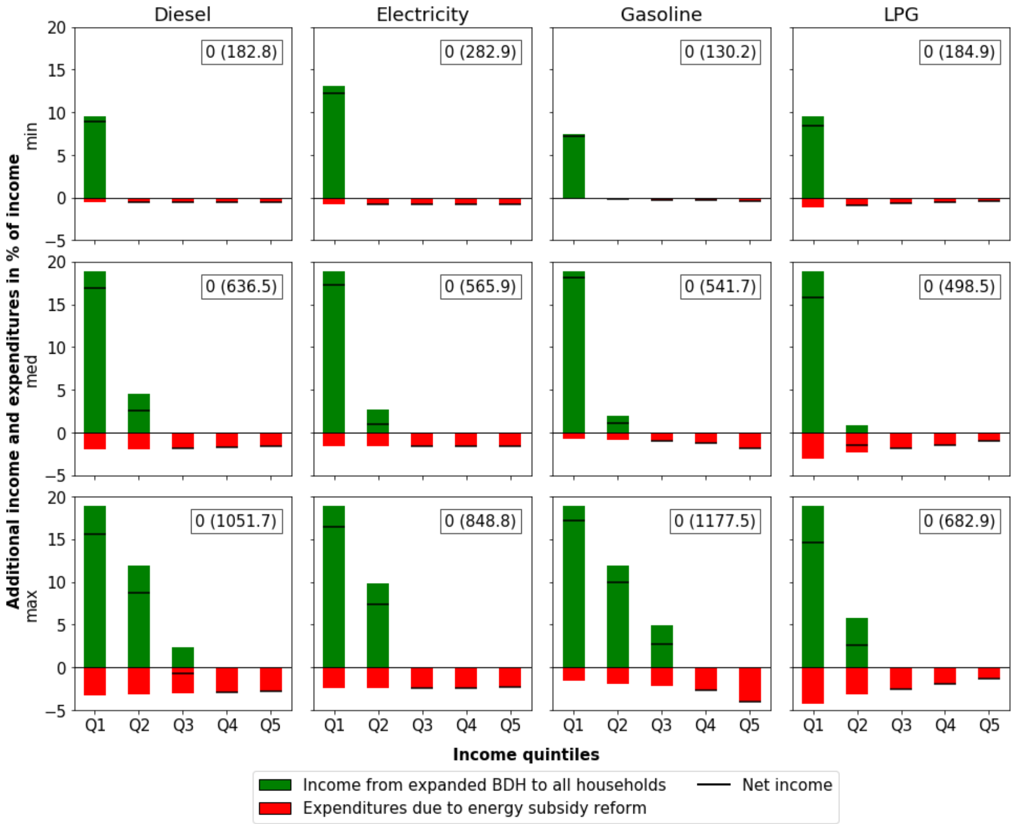

Figure S4: Distributional impacts of expanded BDH ($50/month) to all households and energy subsidy reform by income quintiles in % of income.

Source: own illustration based on INEC (2012a) and BCE (2012)

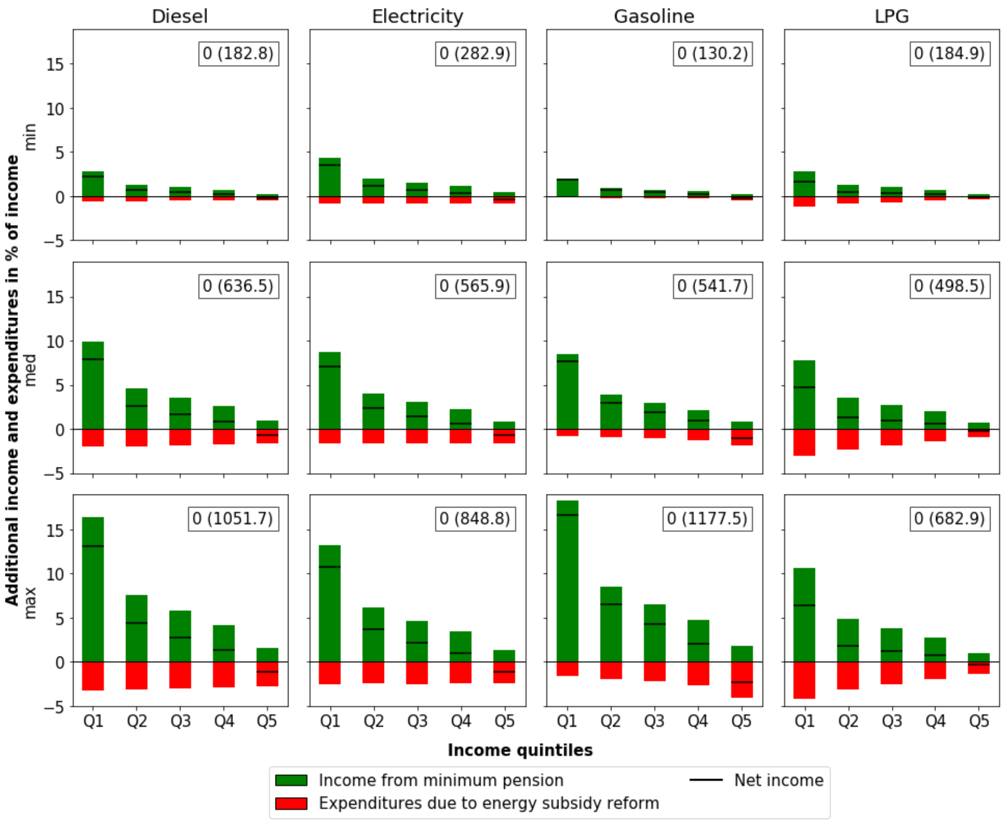

Figure S5: Distributional impacts of minimum pension for senior citizens and energy subsidy reform by income quintiles in % of income.

Source: own illustration based on INEC (2012a) and BCE (2012)

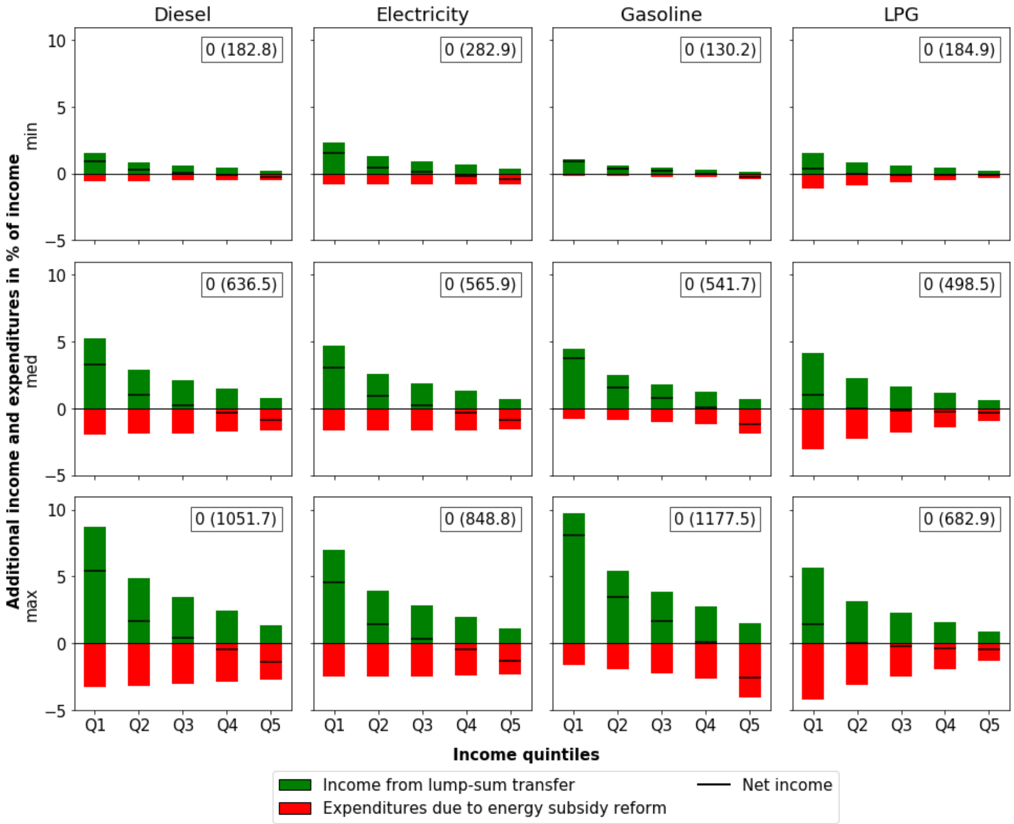

Figure S6: Distributional impacts of lump-sum transfer and energy subsidy reform by income quintiles in % of income.

Source: own illustration based on INEC (2012a) and BCE (2012)

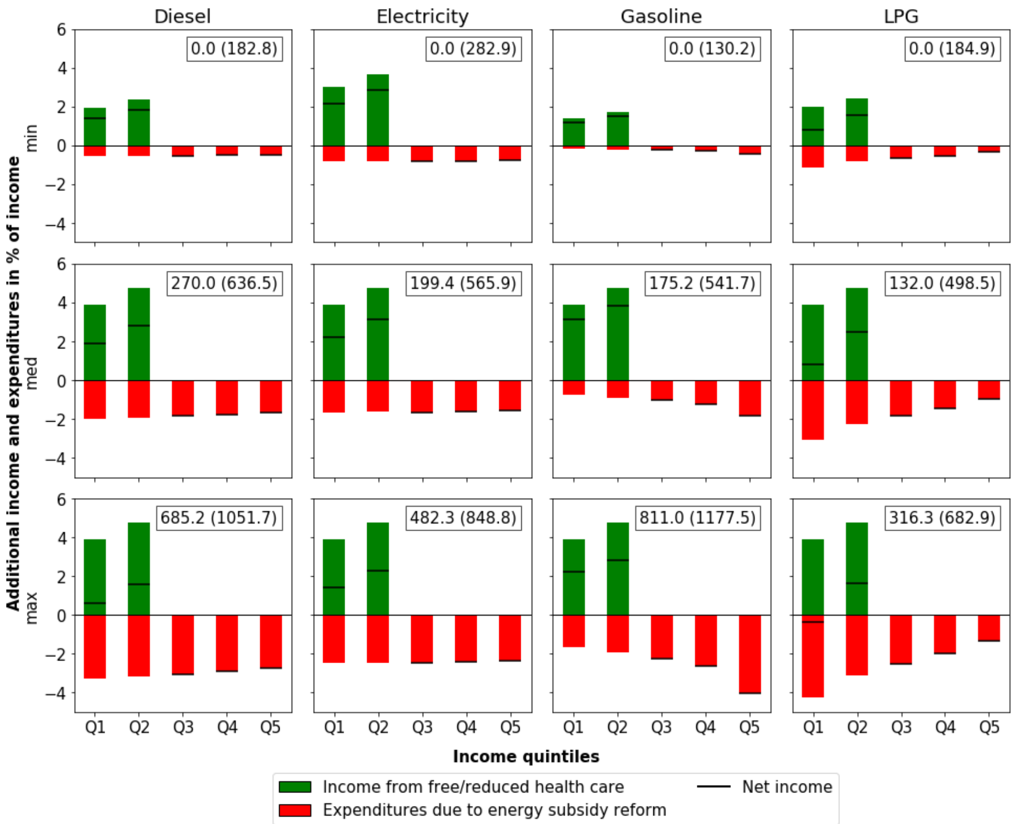

Figure S7: Distributional impacts of free/reduced health care for Q1 and Q2 and energy subsidy reform by income quintiles in % of income.

Source: own illustration based on INEC (2012a) and BCE (2012)

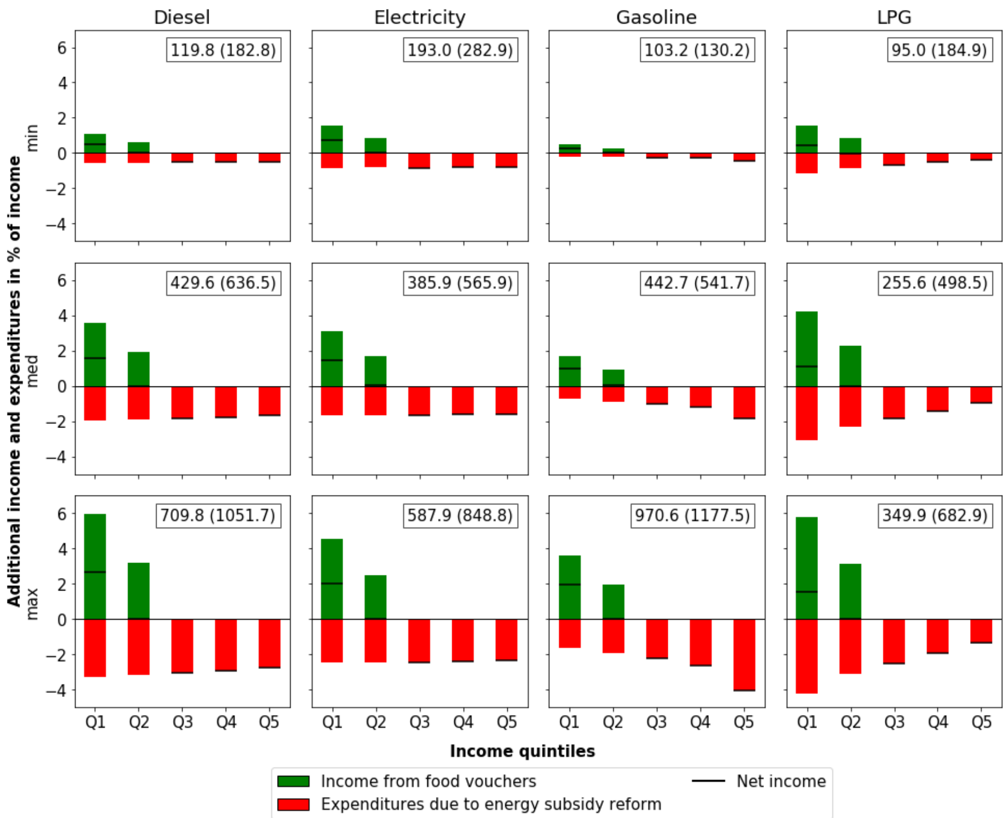

Figure S8: Distributional impacts of food vouchers for Q1 and Q2 and energy subsidy reform by income quintiles in % of income.

Source: own illustration based on INEC (2012a) and BCE (2012)

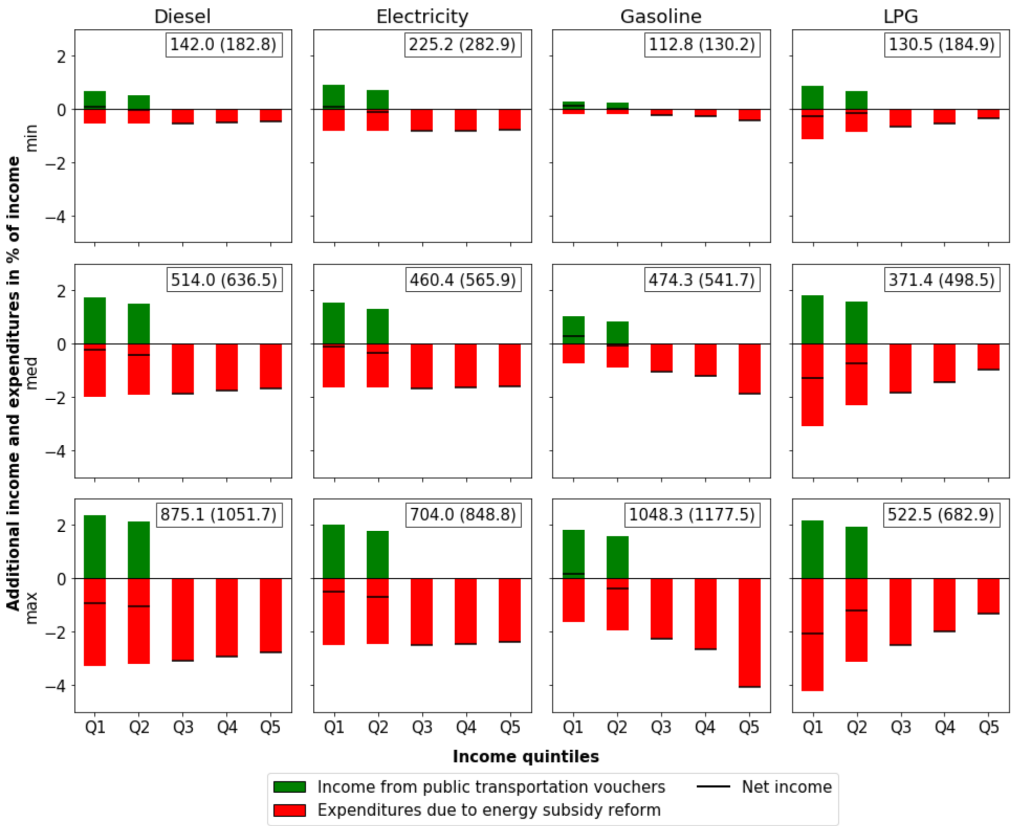

Figure S9: Distributional impacts of public transportation vouchers for Q1 and Q2 and energy subsidy reform by income quintiles in % of income.

Source: own illustration based on INEC (2012a) and BCE (2012)

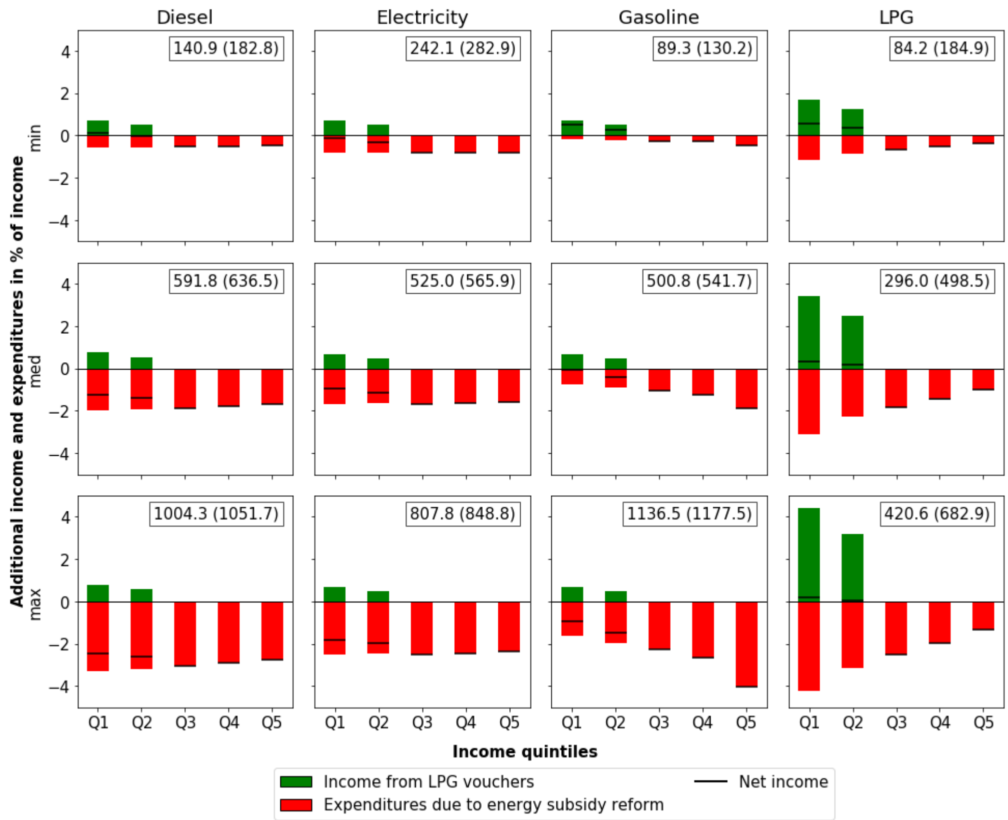

Figure S10: Distributional impacts of LPG vouchers for Q1 and Q2 and energy subsidy reform by income quintiles in % of income.

Source: own illustration based on INEC (2012a) and BCE (2012)