OECD Environment Working Papers No. 86

Modelling of distributional impacts of energy subsidy reforms: an illustration with Indonesia

Olivier Durand-Lasserve, Lorenza Campagnolo, Jean Chateau, Rob Dellink

https://dx.doi.org/10.1787/5js4k0scrqq5-en

OECD

Unclassified **ENV/WKP(2015)7**

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development

27-Mar-2015

English - Or. English

ENVIRONMENT DIRECTORATE

ENV/WKP(2015)7
Unclassified

MODELLING OF DISTRIBUTIONAL IMPACTS OF ENERGY SUBSIDY REFORMS: AN ILLUSTRATION WITH INDONESIA - ENVIRONMENT WORKING PAPER No. 86

Olivier Durand-Lasserve(1), Lorenza Campagnolo (2), Jean Chateau (1), Rob Dellink (1)

(1) OECD Environment Directorate
(2) Ca' Foscari University of Venice & Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC) & Fondazione Eni Enrico Mattei (FEEM), Italy

Authorised for publication by Simon Upton, Director, Environment Directorate.

JEL classification: C68, H23, O53

Keywords: Computable general equilibrium model, households heterogeneity, fossil fuel subsidy reforms, distributional impacts, Indonesia

OECD Environment working papers are available at www.oecd.org/env/workingpapers.htm

JT03373236

Complete document available on OLIS in its original format

English - Or. English

OECD ENVIRONMENT WORKING PAPERS

OECD Working Papers should not be reported as representing the official views of the OECD or of its member countries. The opinions expressed and arguments employed are those of the author(s).

OECD Working Papers describe preliminary results or research in progress by the author(s) and are published to stimulate discussion on a broad range of issues on which the OECD works.

This series is designed to make available to a wider readership selected studies on environmental issues prepared for use within the OECD. Authorship is usually collective, but principal author(s) are named. The papers are generally available only in their original language -English or French- with a summary in the other language.

Comments on OECD Working Papers are welcomed, and may be sent to:

OECD Environment Directorate
2, rue André Pascal, 75775 PARIS CEDEX 16, France
or by e-mail to env.contact@oecd.org

OECD Environment Working Papers are published on
www.oecd.org/env/workingpapers.htm

ABSTRACT

This report develops an analytical framework that assesses the macroeconomic, environmental and distributional consequences of energy subsidy reforms. The framework is applied to the case of Indonesia to study the consequences in this country of a gradual phase out of all energy consumption subsidies between 2012 and 2020. The energy subsidy estimates used as inputs to this modelling analysis are those calculated by the International Energy Agency, using a synthetic indicator known as “price gaps”. The analysis relies on simulations made with an extended version of the OECD’s ENV-Linkages model. The phase out of energy consumption subsidies was simulated under three stylised redistribution schemes: direct payment on a per household basis, support to labour incomes, and subsidies on food products. The modelling results in this report indicate that if Indonesia were to remove its fossil fuel and electricity consumption subsidies, it would record real GDP gains of 0.4% to 0.7% in 2020, according to the redistribution scheme envisaged. The redistribution through direct payment on a per household basis performs best in terms of GDP gains. The aggregate gains for consumers in terms of welfare are higher, ranging from 0.8% to 1.6% in 2020. Both GDP and welfare gains arise from a more efficient allocation of resources across sectors resulting from phasing out energy subsidies. Meanwhile, a redistribution scheme through food subsidies tends to create other inefficiencies. The simulations show that the redistribution scheme ultimately matters in determining the overall distributional performance of the reform. Cash transfers, and to a lesser extent food subsidies, can make the reform more attractive for poorer households and reduce poverty. Mechanisms that compensate households via payments proportional to labour income are, on the contrary, more beneficial to higher income households and increase poverty. This is because households with informal labour earnings, which are not eligible for these payments, are more represented among the poor. The analysis also shows that phasing out energy subsidies is projected to reduce Indonesian CO2 emissions from fuel combustion by 10.8% to 12.6% and GHG emissions by 7.9% to 8.3%, in 2020 in the various scenarios, with respect to the baseline. These emission reductions exclude emissions from deforestation, which are large but highly uncertain and for which the model cannot make reliable projections.

Keywords: Computable general equilibrium model, households’ heterogeneity, fossil fuel subsidy reforms, distributional impacts, Indonesia

JEL classification: C68, H23, O53

RÉSUMÉ

Ce rapport élabore un cadre analytique qui évalue les effets macroéconomiques, environnementaux et redistributifs des réformes des subventions énergétiques. Il applique ce cadre au cas de l'Indonésie afin d'étudier les conséquences dans ce pays d'une suppression progressive de toutes les subventions à la consommation d'énergie entre 2012 et 2020. Les estimations des subventions à l'énergie sur lesquelles se base cette analyse par modélisation sont celles calculées par l'Agence internationale de l'énergie, à l'aide d'un indicateur synthétique appelé « différentiel de prix ». L'analyse repose sur des simulations réalisées avec une version enrichie du modèle ENV-Linkages de l'OCDE, modèle dynamique d'équilibre général calculable (EGC) mondial. La suppression des subventions à la consommation d'énergie a été simulée en retenant trois types de dispositifs de redistribution : un paiement direct au niveau des ménages, un soutien aux revenus du travail et des subventions aux produits alimentaires. Les résultats de la modélisation réalisée dans ce rapport indiquent que si l'Indonésie venait à supprimer ses subventions à la consommation des combustibles fossiles et d'électricité, elle enregistrerait des gains de PIB réel de 0.4 % à 0.7 % en 2020, selon le dispositif de redistribution retenu. La redistribution sous forme de paiements directs au niveau des ménages donne les meilleurs résultats en termes de gains de PIB. Le gain global pour les consommateurs en termes de bien-être est plus élevé, allant de 0.8 % à 1.6 % en 2020. Les gains en matière de PIB et de bien-être sont obtenus grâce à une répartition des ressources entre les secteurs de façon plus efficiente à la suite de l'élimination des subventions énergétiques. Dans l'intervalle, un dispositif de redistribution sous forme de subventions alimentaires tend à créer d'autres inefficacités, qui compensent en partie les avantages macroéconomiques de la suppression des subventions à la consommation d'énergie. Les simulations montrent aussi qu'à terme, le dispositif de redistribution joue un rôle en déterminant l'effet redistributif global de la réforme. Les transferts monétaires, et dans une moindre mesure les subventions alimentaires, peuvent rendre la réforme plus profitable pour les ménages pauvres et faire reculer la pauvreté. À l'inverse, les mécanismes qui compensent les ménages à l'aide de paiements proportionnels aux revenus du travail bénéficient davantage aux ménages à revenu élevé et accroissent la pauvreté. En effet, les ménages qui reçoivent des revenus du travail dans le secteur informel et qui ne peuvent prétendre à ces paiements, sont plus nombreux chez les pauvres. L'analyse montre aussi que d'après les prévisions, la suppression des subventions énergétiques en Indonésie devrait réduire les émissions de CO2 dues à la combustion des énergies fossiles de 10.8 % à 12.6 % et les émissions de GES de 7.9 % à 8.3 % en 2020 selon les différents scénarios, par rapport au scénario de référence. Ces réductions d'émissions ne tiennent pas compte des émissions dues à la déforestation, qui sont élevées mais restent très mal connues, et au sujet desquelles le modèle ne peut pas faire de projections fiables.

Mots clés : Modèle d'équilibre général calculable, hétérogénéité des ménages, réforme des subventions aux énergies fossiles, effets distributifs, Indonésie

Classification JEL: C68, H23, O53

FOREWORD

This report develops an analytical framework that assesses the macroeconomic, environmental and distributional consequences of energy subsidy reforms. The framework is applied to the case of Indonesia to study the consequences in this country of a gradual phase out of all energy consumption subsidies.

This paper has been authored by Olivier Durand-Lasserve, Jean Chateau, Rob Dellink (OECD Environment Directorate) and Lorenza Campagnolo (Ca' Foscari University of Venice, CMCC & FEEM). This report was reviewed by delegates to the Working Party on Climate, Investment and Development (WPCID) at their September -October 2014 meeting. The authors would like to thank Shardul Agrawala, Nils-Axel Braathen, Richard Dutu, Florian Egli, Florens Flues, Michael Förster, Nathalie Girouard, Ana Llena Nozal, Walid Oueslati, Mauro Pisu, Jehan Sauvage and Petar Vujanovic of the OECD, Florian Kitt of the IEA for helpful comments on earlier drafts of this paper; Teguh Dartanto (LPEM, University of Indonesia) and Arief Anshory Yusuf (CEDS, Universitas Padjadjaran) for their very constructive reviews. François Chantret, Marie-Jeanne Gaffard and Zoey Verdun are also thanked for their editorial assistance.

Note that the results presented in this paper largely reflect the context of the first part of 2014, during a period with high energy subsidies and high international oil prices. Since then there have been significant changes to the context. On 31 of December 2014, subsidies on gasoline were totally removed under the new government. This has been facilitated by a context of very low oil prices. However, the question of redistribution which is the most important issue addressed in this paper remains a crucial one as an increase in international oil price would greatly affect the population. In addition, methodological developments presented in this paper may be used to study energy subsidy reforms in other countries.

TABLE OF CONTENTS

List of Tables

List of Figures

Boxes

1. INTRODUCTION

In many emerging countries, governments subsidise fossil fuel consumption to keep domestic prices low so as to make energy more affordable for consumers and firms.[1] According to the International Energy Agency (IEA)'s measurement and definitions (see box 1), in 2012 worldwide fossil fuel consumption subsidies totalled USD 544 billion, including USD 135 billion for electricity (IEA, 2013).[2] The consumption subsidies are large in some non-OECD countries. In some cases, they represent a substantial share of a government's budget.

For years the OECD, but also the IMF and the World Bank, have recommended that governments "*rationalize and phase out over the medium term inefficient fossil fuel subsidies that encourage wasteful consumption*" (G20, 2009). The reason is that they can induce wasteful energy consumption, be a source of economic inefficiency, and contribute to greenhouse gas (GHG) emissions. They also often fail to tailor to the most vulnerable parts of the population since they massively leak to well-off household categories.

In several oil-importing countries that subsidize energy consumption, the high internal oil prices that prevailed until mid-2014 put pressure both on current accounts and government budgets, this context provided incentives to reform energy subsidies. However, fossil fuel subsidies reforms were particularly difficult to implement from a political perspective. This is not surprising since consumption subsidies are often one of the main instruments adopted to redistribute wealth, in the absence of full-fledged social security schemes. They are of crucial importance to support some categories of households, especially the poorest whose consumption is close to the minimum level for subsistence. This need is especially strong in periods of high international oil prices, as the subsidies dampen the vulnerability of households to oil price surges.

The recent decrease of international oil prices has created opportunities to reduce fossil fuel subsidies, which was achieved in several countries such as India and Indonesia in late 2014 and early 2015. But these reforms may still remain fragile as international oil price increases may renew the pressure to shelter households from strong increases in expenditures.

Redistribution schemes which reallocate the budget that was previously spent on energy subsidies can play a crucial role to make the subsidy reforms acceptable and equitable (World Bank 2014). Examples of redistribution schemes could include cash transfers to households, tax cuts on non-energy products expenditures, or improved public services.

Identifying which household groups win or lose from a fossil-fuel subsidies phase out is at the heart of the political acceptance of such a reform. Consequently, the analysis of macroeconomic and environmental impacts is insufficient when considering energy subsidy reforms. Such analysis should be complemented by a deeper look at their distributional consequences and the possibilities for designing compensatory measures to alleviate negative outcomes in terms of inequality and poverty.

The ability of policy to reduce inequalities will be characterized throughout the report by its progressivity. A policy is progressive if its net benefit as a proportion of wealth decreases with wealth[3].

---

[1] Meanwhile, many developed countries partly subsidise fossil fuel consumption, not directly by lowering final prices, but through tax concessions to consumers (OECD, 2013).

[2] Note that in this report, the terms fossil fuel consumption subsidies and energy consumption subsidies are used interchangeably. They embody all actions of governments to lower the final price of coal, oil, gas or fossil-fuel based electricity for both households and firms.

[3] In general, income or expenditures are used as a measure of wealth.

When considering income groups, progressivity is associated with higher benefits, as share of income, for lower than for higher quantiles. Progressivity is also associated with a lower dispersion of wealth across the population after the policy reform is conducted.

The circumstances which pertained in Indonesia in the period up to 2014[4] provide the basis for an interesting case study for investigating energy consumption subsidy reform. Firstly, Indonesia subsidises the consumption of electricity and oil products for both households and firms. It has kept its large energy subsidies inherited from its previous role as an important oil producer, while it has now become an oil-importing country. Secondly, for years subsidy reforms have featured prominently in Indonesian political discussions, and even more so in a context of high oil prices, which increases pressure on the government's budget and reinforces the incentive for a reform. Thirdly, the subsidy reform could help Indonesia to fulfil its commitment made in the 2009 Copenhagen Accord and 2010 Cancún. Fourthly, Indonesia was chosen because of the availability of public household budget survey data.

Box.1 Fossil fuel consumption subsidy : definition and measurement

The IEA (2000) has defined energy subsidies as "any government action that concerns primarily the energy sector and that lowers the cost of energy production, raises the price received by energy producers or lowers the price paid by energy consumers." Fossil-fuel consumer subsidies are actions of the government that lower the price of fossil-fuel-based energy paid by firms and households. Fossil-fuel-based energy sources include coal, oil and natural gas. It also includes electricity if it is produced from fossil fuels.

The IEA estimates fossil fuel subsidies using a price-gap approach, which compares end-user consumer prices with reference prices corresponding to the full cost of supply or, where available, the international market price, adjusted for the costs of transportation and distribution. This approach captures all subsidies that reduce consumer prices below those that would prevail in a competitive market. Such subsidies can take the form of direct financial interventions by government, such as grants, tax rebates or deductions and soft loans, and indirect interventions, such as price ceilings and free provision of energy infrastructure and services.

Simple as the approach may be conceptually, in practice calculating the size of subsidies requires a considerable effort in compiling price data for different fuels and consumer categories as well as computing reference prices. For traded forms of energy, such as refined petroleum products, the reference price corresponds to the export or import border price (depending on whether the country is an exporter or importer) plus internal distribution margins. For non-traded energy products, such as electricity, the reference price is the estimated long-run marginal cost of supply. Value-added Tax (VAT) is added to the reference price where the tax is levied on final energy sales. However, other taxes, including excise duties, are not included in the reference price. So, even if the pre-tax pump price of gasoline in a given country is set by the government below the reference level, there would be no net subsidy if an excise duty is levied that is large enough to make up the difference. The aggregated results are based on net subsidies only for each country, fuel and sector. Cases where the final price exceeds the reference price were not taken into account. In practice, part of the subsidy in one sector, or for one fuel, might be offset by net taxes in another. Subsidies were calculated only for end-user consumption, to avoid the risk of double counting: any subsidies on fuels used in power generation would normally be reflected at least partly in the final price of electricity. All the calculations for each country were carried out using local prices, and the results were converted to US dollars at market exchange rates.

Source : based on IEA (2000, 2006)

---

[4] The results presented in this paper largely reflect the context of the first part of 2014, during a period with high energy subsidies and high international oil prices. Since then there have been significant changes to the context. On 31 of December 2014, subsidies on gasoline were totally removed under the new government. This has been facilitated by a context of very low oil prices. However, the question of redistribution which is the most important issue addressed in this paper remains a crucial one as an increase in international oil price would greatly affect the population. In addition, methodological developments presented in this paper may be used to study energy subsidy reforms in other countries.

This report, based on a simulation approach, proposes an analysis of the distributional impact of energy subsidy phase out policies in Indonesia under various redistribution schemes. The aim of the report remains to help to understand the essential driving forces that determine the answer to the two following questions: What type of redistribution schemes can make the phasing out of such subsidies pro-poor and progressive?; and What are the trade-offs between the macroeconomic and environmental impacts of the reform and its distributional consequences? Such a perspective will allow us to draw conclusions that can extend, beyond the Indonesia case, to energy subsidy reforms in other countries.

To assess welfare impacts for each household group and to conduct distributional analysis, an augmented version of the ENV-linkages Model - the OECD multi-region, multi-sector and multi-period CGE model - has been elaborated. In the standard version of ENV-Linkages, regional economies feature a single representative household portrayed by a single demand system and earning the whole regional income (see Chateau et al., 2014a). This standard model can therefore only evaluate welfare impacts of policies at the country level. In the augmented version of the model, the representative Indonesian household is replaced by multiple household groups, each having its own income, expenditures and preferences. The improvement of the model for this study has been set up in such a way that multiple households can in principle also be characterized for other regions. This is possible once household survey data are collected and a procedure is available to reconcile this data with the national accounting data of the model.

In this modelling framework, the Indonesian household groups are influenced by the changes in both consumer prices and incomes induced by the phasing out of energy subsidies. The reforms directly affect the energy prices and indirectly the prices of other goods. These indirect price effects come from the increase in energy costs faced by firms. However, the reform also affects the disposable income of households. Firstly by changing wage and non-wage incomes, itself the result of changes in firm behaviour following the reform, and secondly by changing transfers and income taxation as part of the compensatory mechanism. To the extent that these changes in prices and incomes are different across households, the reform is expected to have distributional consequences.

The impacts of the phase out policies on different household groups depend on their characteristics, in particular on their expenditure structures, their sources of incomes and their ability to adjust their demand to changes in incomes and prices. For instance, the higher the budget share for energy products and the lower the reaction of energy demand to price is, the more a household may suffer from the effect of the phase out, unless their income is sufficiently raised by compensatory measures.

It is important to realise that the model used is stylised. Firstly, while substantial efforts have been made to produce a dataset that reflects the income and expenditure information available in the household budget survey, some extrapolations were necessary. Secondly, there is uncertainty about the behaviour of the households and consequently on the projected adjustments of their consumption patterns to price changes. Nonetheless, the modelling improvements overcome the major barrier to a fully integrated analysis, i.e. the specification of differentiated endogenous responses of households to policy shocks. This integrated approach is superior to the more limited ex-post analysis of distributional effects that is often carried out with microsimulation models.

This report is organised as follows. Section 2 puts forward the role of the energy subsidy system in Indonesia and the possible consequences of its reform. The methodology used for simulating energy subsidy reforms is presented in Section 3. The household data set constructed for the simulation analysis is described in Section 4. Then, Section 5 presents the phasing out policies that are simulated. The results of the policy simulations are presented in Section 6 and analysed in terms of economic, environmental and distributional performances. Section 7 concludes. Additional technical material is provided in the various appendices of this report.

2. OVERVIEW OF THE ENERGY CONSUMPTION SUBSIDIES IN INDONESIA

The Indonesian government subsidises the consumption of electricity and oil products for both households and firms. These subsidies, as measured using the price gap approach (see Box 1) are large given that the country is a net energy importer. In 2011, Indonesia was ranked the 10th country in the world in terms of total government expenditures on fossil fuel consumption subsidies (see Figure 1) following mostly big energy exporters (e.g. Iran, Saudi Arabia, Russia, Iraq, UEA and Venezuela) and larger economies (e.g. China and India). Figure 2 shows that Indonesia, was ranked 18th for the share of energy subsidies in terms of gross domestic product (2.5%). The only oil-importing countries with a higher share were Egypt, Ukraine, Pakistan and Bangladesh. However, in Indonesia the subsidies per capita, amounting to USD 88, were higher than in Bangladesh and Pakistan.

Energy subsidies absorb a considerable amount of budget resources. In recent years spending on subsidies became very high. For example, in 2011, energy subsidies rose to 29% of the Central government's expenditures (Dartanto, 2013). Furthermore, spending on energy subsidies was, in 2012, slightly higher than the government's investment in infrastructure (Diop, 2014). Finally, until 2010, the Indonesian government spent more on energy subsidies than on defence, education, health, and social security combined (Cheon et al., 2013).

Indonesia's trade and financial situation is very sensitive to changes in international oil prices and domestic energy demand. Recently, a combination of increasing oil prices and the stabilization of raw material prices, which traditionally represent a large share of Indonesian export, gave way to a significant worsening of the country's trade position. This situation led to a current account deficit in 2012, after almost 15 years of surplus, and to a small depreciation of the Rupiah.[5]

The energy subsidies, which are a burden and a source of unpredictability for the economy, also perform badly in terms of redistribution. Given that commercial energy consumption increases with income, the subsidies benefit wealthier households more (Mourougane, 2010). According to IEA (2012), in 2010 27% of Indonesians did not have access to electricity[6], mostly in rural areas (IEA, 2012). Agustina et al. (2008) mention a World Bank calculation which estimated that in 2007, 70% of fuel subsidies were received by the wealthiest 40% of households.

Fuel subsidies, by encouraging fossil-fuel burning, increase GHG emissions, as well as local air pollution. However, it is important to note that in Indonesia, energy related CO_2 emissions have a rather limited but increasing contribution to overall GHG emissions. In 2010, they represented about 20% of total GHG emissions while the contribution of CO_2 from tropical forest was around 61%. Energy related emissions of CO_2 from fuel combustion have increased rapidly over the recent period (4.1% annual growth rate from 2005 to 2010). Appendix A provides more detailed information on the links between energy consumption and GHG emissions.

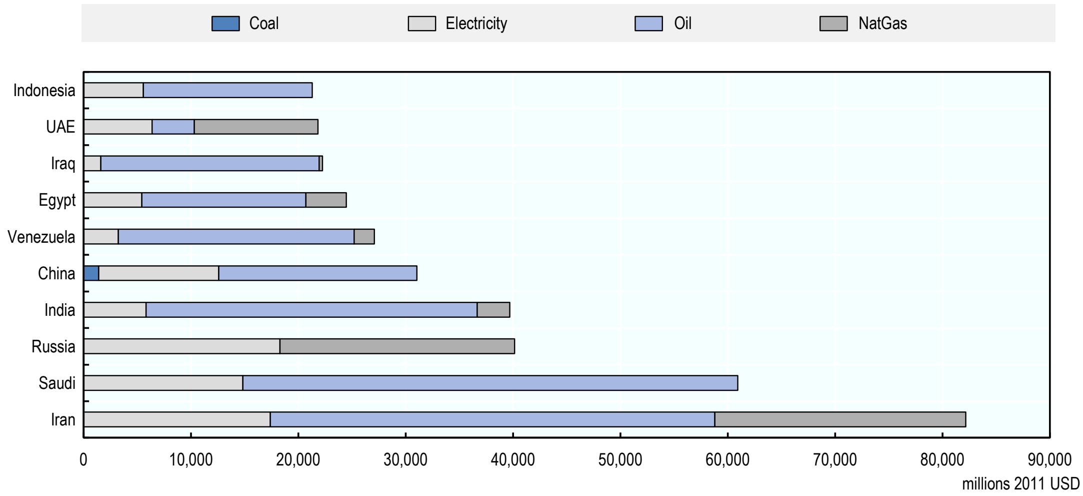
There has been a large increase in the CO_2 emissions from the power generation and transportation sectors (7% and 7.6%, respectively, in annual growth rate from 2005-2011). Driven by an expanding demand from households and industries, power generation has increased at a quick pace, while still relying largely on oil and coal technologies. Fuel consumption for transportation has also increased considerably (at 7.7% annual growth rate from 2005-2011), with a large contribution from trucks and buses.

---

[5] IMF World Economic Outlook data base, April 2014.

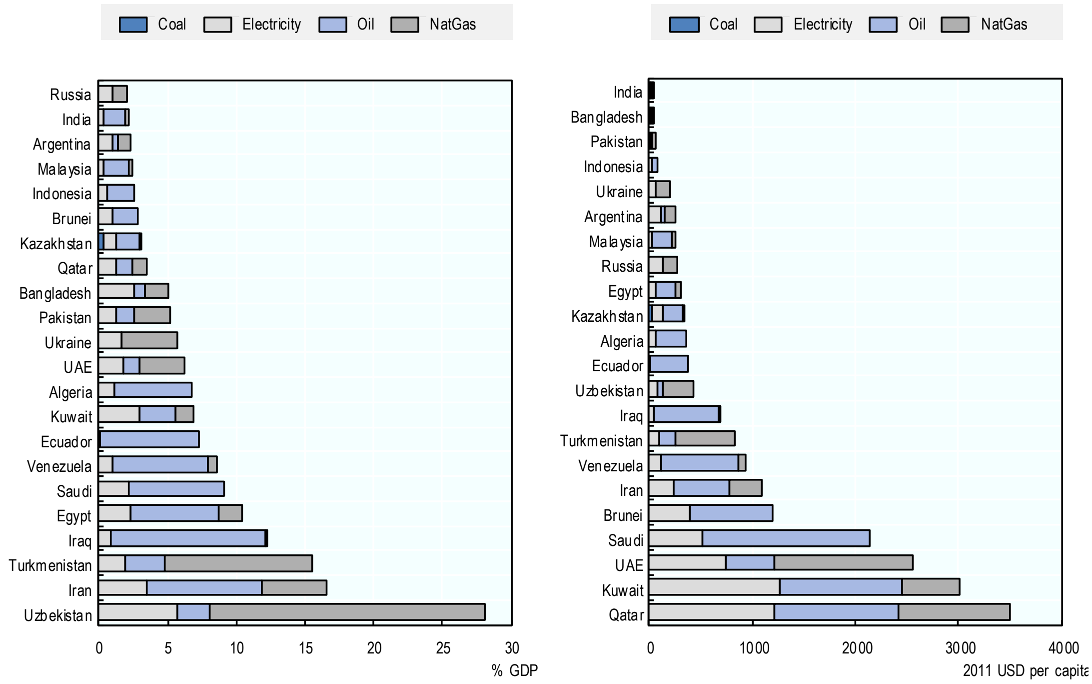
[6] See http://www.worldenergyoutlook.org/resources/energydevelopment/definingandmodellingenergyaccess/ for the IEA definition of access to electricity.

Figure 1. Top 10 countries for energy consumption subsidies in 2011



Source: IEA (2012)

Figure 2. Energy consumption subsidies per capita and as share of GDP in 2011 in selected countries



Source: IEA (2012)

In 2011, traditional biomass still represented almost 74% of final energy use in the residential and service sectors due to the high reliance on this fuel type by households. There is thus a concern that a reform of energy consumption subsidies might increase deforestation due to the substitution to wood from kerosene whose price would increase. Even if some (relatively old) empirical studies discard this effect (Dick, 1980; Pitt, 1983), its potential negative impact on overall GHG emissions should not be ignored even if they are beyond the scope of this paper.

Box 2 Fossil fuel subsidy reforms in Indonesia

Since the late 1990s, there have been substantial efforts in Indonesia to reduce energy consumption subsidies. Since the early 2000s, the fossil fuel subsidy mechanism has been progressively reformed. In 2001, fuel prices for industrial users were anchored to 50% of international prices (Dartanto, 2013). In 2004-2005, as a result of an increase in international prices there was a rise in fossil fuel subsidy expenditure (Dartanto, 2013; Mourougane, 2010).

In 2005, energy consumption subsidies were partially cut and energy prices for households and small businesses were very strongly increased (Dartanto, 2013; Mourougane, 2010). On the one hand, the higher consumer prices introduced in 2005 lifted temporarily the pressure on public finances. But on the other hand, the fact that the price setting mechanism was made independent of market price made the arrangement unsustainable in the context of surging international oil prices; and consequently successive readjustments were needed.

To limit the impact of the 2005 reform on the poorest households, the Bantuan Langsung Tunai (BLT) unconditional cash transfer programme was introduced (Mourougane, 2010; Miranti et al., 2013). This programme, working through the postal system, concerned more than 19 million households who received a monthly a payment equivalent to USD 10 during 12 months in 2005-2006.*

In 2008, electricity subsidies ceased for large industrial consumers and for households beyond a certain consumption threshold (Mourougane, 2010) in order to limit the pressure on public finances. During the same year, the Gasoline, Diesel and LPG prices were increased. As a compensation for households, a new wave of BLT was run over 9 months in 2008-2009. In addition, some existing anti-poverty programmes mechanisms were reinforced, including distribution of rice and control on rice prices, education and school support and to small businesses. In 2010, the average electricity price increased for most consumers, including households (IISD, 2012). In 2012, there was an attempt to prohibit government and four-wheeled vehicles from using subsidized gasoline. However, the attempt was abandoned due to strong public opposition. In the end, only government vehicles were excluded from the subsidies (IISD, 2012).

In May 2013, in a context of degradation of the current account, increasing government budget deficit and international credit rate downgrade, the revision of the budget of the Indonesian government introduced increases of diesel and gasoline prices by 22% and 44%, respectively (IEA, 2013). The increases were accompanied by a large compensation package of around USD 2.6 billion. As described by IISD (2014), it included USD 1.5 billion for temporary cash transfers to 15 million households, and extension of existing cash transfers programs, USD 0.7 million for poverty alleviation programs focused on infrastructure and USD 0.7 billion to support poor students and schooling.

*Note: * Statistics about the BLT programme can be found on the ILO website:*
http://www.ilo.org/dyn/ilossi/ssimain.viewScheme?p_lang=en&p_geoaid=360&p_scheme_id=3162

There have been several quantitative assessments of the macroeconomic, environmental and distributional impacts of a phase out of energy subsidies in Indonesia and selected references are presented in Table 1. Nevertheless, to our knowledge there has not been any study taking into account the three impacts simultaneously, or considering the reforms in a multi-period setting.

The results of the various studies are not fully comparable, as they correspond to different base years, energy subsidy reforms and modelling approaches. The studies do not agree whether the impact on GDP is positive or negative, but the effect can be substantial: ranging from +3.7% to -2.4%. The assessments based on a Social Accounting Matrix (SAM) analysis, which is essentially an Input Output (IO) approach, give negative effects on GDP, primarily because these models are not suited to account for the redistribution of the government budget that is no longer spent on subsidizing energy.[7] The CGE approaches (Magné *et al.* 2014;Yusuf et al., 2010), give positive impacts in the long run, as the termination of subsidies leads to a reallocation of inputs, consumption and government budget that increases economic efficiency (reducing the deadweight losses due to the subsidies). Nevertheless, CGE model analysis can show negative effects in the short run due to nominal wage rigidities[8]. When assessed, the impacts on CO_2 emissions are quite substantial ranging from -17.0% in (Magné *et al.*, 2014), to -6.7% in Yusuf et al. (2010).

[7] Furthermore, in the SAM approach, the households' expenditures are constant and the proportions of inputs used in the various production sectors are fixed. A drop in subsidies involves a negative shock a decrease in households demand and a contraction of output and GDP. In the CGE models, it is possible to operate substitutions between inputs and the subsidy reform can give way to a more efficient reallocation of the production factor which can be beneficial GDP and households' welfare.

[8] The reason is that in the short-run nominal wage rigidities can lead to a loss in aggregate employment.

Table 1. **Selected assessments of the impact of energy demand subsidy reforms in Indonesia**

Authors and method	Type of reform*	Macroeconomic impact**	Impact on CO2 from fuel combustion**	Distributional impact**
IEA (2000): Partial equilibrium model (feedback on GDP)	Phase out of all energy consumption subsidies (with 1995 as a base year)	GDP increases by 2.4%***	-10.97% in 2020	n/a
World Bank (2006): Household micro data	October 2005 package (fuel price adjustment and cash transfers)	n/a	n/a	Progressive largely through gasoline expenditures effects; progressivity improved by the cash transfers
Clements et al (2007): SAM Information on household group,	25% final consumer price increase	Real output reduction of 1.6% in the short run no reduction in the long run	n/a	Poverty increase but limited in the short run. And even more limited in the longer run. The urban households are more affected. The poverty
Yusuf and Resosudarmo (2008): CGE model with short-run nominal rigidities Information on several household groups	October 2005 package but with alternative recycling schemes	GDP decreases from 1.72% to 2.42% in the short run	n/a	Progressive and more detrimental to urban high-income households. Poverty effect can be offset by recycling schemes e.g. by cash transfers
Yusuf et al (2010) CGE model with short-run nominal rigidities	Phase out of all fossil fuel subsidies	GDP decreases by 0.5% in the short run; and increases by 0.43% in the long run	-6.7%	n/a
World Bank (2011) Descriptive statistics based on survey	n/a	n/a	n/a	Richer households receive more energy subsidies (in absolute terms) than poorer households, especially for gasoline subsidies.
Widodo et al (2012): SAM	Removal of fuel subsidies by IDR 1 billion	GDP decreases by IDR 88 million but support to some sectors of the economy can mitigate this effect	n/a	Rural households less affected. Recycling schemes that supports agriculture protect rural household through income and lower-class urban households through expenditures.
Dartanto (2013) CGE model combined in top down fashion with survey data	25% to 100% removal of fuel subsidies with alternative recycling schemes	n/a	n/a	25% removal of fuel subsidies increases poverty by 0.26 percentage points. But recycling with government development spending reduces poverty even if they are 50% less important than the subsidy removal.
Magné et al., (2014) CGE model	Multilateral phase out of all energy demand subsidies (gradual, achieved in 2020)	GDP increases by 3.7% in 2035	-17% in 2035	n/a

*Note that in some of the papers mentioned, various fossil fuel consumption subsidy reforms (in terms of product coverage and redistribution schemes) were envisaged. But not all the reforms are reported in this table.

** w.r.t. baseline. *** 10 years after the reform, based on the result of the IEA (2000) that estimates to 0.24% the annual additional GDP growth rate.

Source: Authors' review, inspired by Mourougane (2010)

The studies in Table 1 are generally in line in terms of their evaluation of distributional impacts. The direct effect of the subsidies phase-out reform, due to the increase in final consumer prices, will benefit more proportionally to low and middle income households. This progressivity is largely due to the decrease of subsidies on gasoline (World Bank, 2006, 2011). In the SAM-based models, mainly because of the negative effects on GDP, the reform increases poverty. In addition, the reform affects the urban more than the rural poor (Clements et al., 2007; Yusuf and Resosudarmo, 2008; Widodo et al., 2012). However, it also appears, from the various studies that redistribution schemes, for instance with cash transfers or subsidies on food products, can be efficient in alleviating poverty. For Dartanto (2013), investing in infrastructure and introducing cash transfers can contribute, using only 50% of the government's expenditures saved via the subsidy reform, to a significant reduction in poverty. It shows that the subsidy reform can both reduce poverty and consolidate the government's budget.

3. THE MODELLING APPROACH

The modelling approach developed for this report is designed to assess the impacts of phasing out the energy consumption subsidies on the welfare of households through their income and expenditure.

Because households are different, both in terms of their income structures and their expenditures pattern, they will be affected differently by the reform. At first sight, households that spend a relatively large fraction of their income on energy will be, *ceteris paribus*, more penalized by the subsidy phase out because of thee direct effect of higher energy prices. However, it is not straightforward to assess the total effect for these households, as all the indirect effects through changes in commodity prices and income have to be taken into account.

The "expenditure effect" is primarily due to the change in final consumption prices of the energy goods, consecutive to the subsidies phasing out reform. But other commodity prices, in particular those of energy intensive goods, are also influenced, to the extent the reform will modify energy cost faced by the firms. In turn, as consumers shift away from energy and energy-intensive goods, demands for other commodities are affected as well. In addition, the reform will lead to various adjustments throughout the economy, causing prices to change. For instance, final fuel prices will not only be influenced by the changes in the subsidies, but also as a result of a new equilibrium between supply and demand. Last, in a budget neutral setting, prices may be affected by a decrease in taxes and an increase of subsidies on specific goods. The magnitude of these tax and subsidy changes depends on the budget resources that were made available by the initial phasing out of energy subsidies.

Households will also be impacted through changes in their earnings, as the subsidy reduction may impact the rate of return on labour, land or capital.[9] The relationship depends on the structure of production, including the degree of substitutability between energy and other inputs, and on the ability of households to change their sources of income. In a budget-neutral setting the phasing out of the subsidies may also include additional transfers or changes in income tax, which further alter the disposable income of certain categories of households.

[9] The main reason is that the phasing out policy will decrease the quantity of energy used as input in the production sectors. It will change, in turn, the marginal productivity of the production factors, such as labour, capital and land, which are combined with energy in the production activities. Finally, the remuneration rate of the production factors, which is equal to their marginal productivity, is impacted by the policy reform.

To capture how the policies affect the sources of income of the various household groups and the affordability of the various goods they consume, it is necessary to combine a micro-level representation of households' incomes and consumption with a macroeconomic model that translates policy shocks into changes in final prices, and remuneration rates of production factors, taxes and subsidy rates. A simultaneous representation of the effects described above can only be obtained by fully integrating multiple households into a detailed multi-sectoral model (ENV/EPOC/WPCID(2013)20).

The macroeconomic model used in this paper is the OECD ENV-Linkages model (Chateau et al., 2014a). ENV-Linkages is a dynamic global and multi-sectoral computable general equilibrium (CGE) model, which focuses on the linkages between different sectors in different economies and is especially suited to assess the direct and indirect effects of policy shocks. For this study ENV-Linkages has been improved by directly integrating a module describing the behaviour of more than 10,000 representative household groups for Indonesia. In other regions, the final consumers are portrayed by a single representative household.

The characteristics of the representative household in terms of preferences and endowments are based on national accounting data. The multi-household representation for Indonesia is based on integrating this macroeconomic information from the social accounting matrices with data from the fourth edition of the "Indonesia Family Life Survey" (IFLS4) realised in 2007 (Strauss et al., 2009). [10]

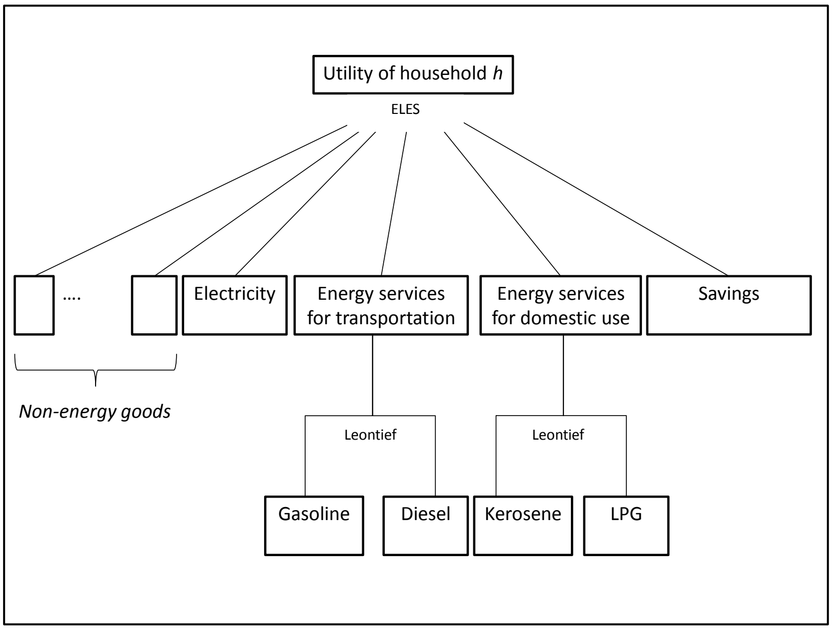
The household-level information from the survey data and the social accounting matrices from the model were reconciled to specify the parameters of the household module for Indonesia, ensuring that the sum of incomes and expenditures across the various household groups are consistent with country-level totals that are used in ENV-Linkages. Details about the reconciliation procedure are given in Appendix B.

For consistency, the household-specific demand systems are based on the preferences of the single households used in the standard version of the model. They are based on the same form of extended linear expenditure system (Chateau et al., 2014a) that represents demand for the various goods and services. The household-specific demand functions are calibrated using the survey data and the aggregate elasticity values of the CGE model that describe how consumers respond to changes in income or relative prices (see Appendix C for more details).

The structure of the individual Indonesian households' demand function is represented in Figure 3. In the standard version of the ENV-Linkages model, the representative Indonesian household consumes a single non-electric fuel aggregate. However, in the extended version of the model, taking advantage of additional information on fuel use provided in the survey, each household group can consume four types of non-electric energy goods: kerosene, liquefied petroleum gas (LPG), gasoline and diesel. Moreover, energy demands are aggregated into two categories: the first one represents energy use for transportation and the second one energy services for domestic use (lighting and cooking). The first aggregate combines gasoline and diesel; the second aggregate combines kerosene and LPG. The proportion of fuels within these aggregates are household-specific and calibrated on the reconciled survey data.

[10] For the fourth wave of the IFLS survey, 13,535 households were interviewed between late 2007 and early 2008. The survey which covers 13 out of 33 Indonesian provinces is representative of 83% of the Indonesian population (Strauss et al., 2009). The National Socioeconomic Survey (SUSENAS), which is representative of Indonesia and has a sample size over 300000 households, could have been used for a more in depth analysis. For more information about SUSENAS: http://www.rand.org/labor/bps/susenas.html.

Figure 3. Structure of the households' utility functions



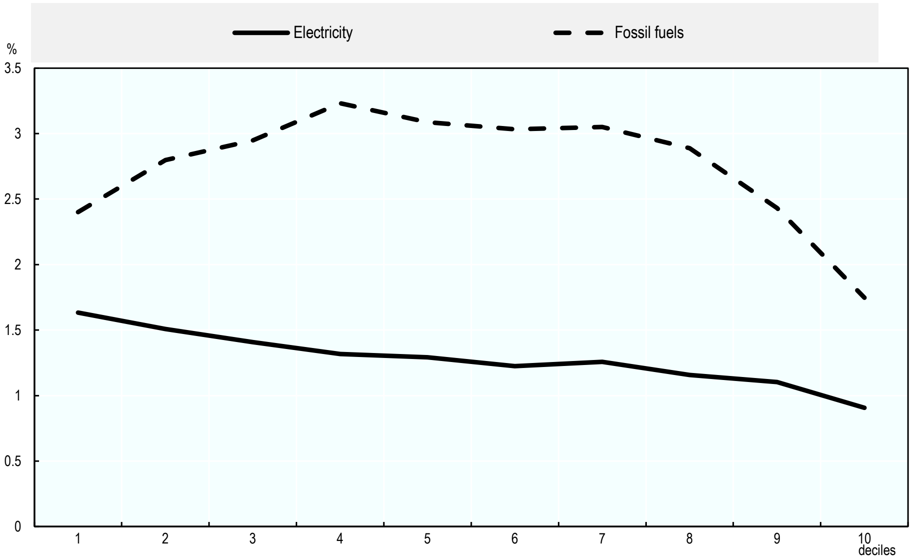
The households earn incomes from the remuneration of production factors they own. The endowments of labour, land and natural resources of each household group are assumed to be fixed, but the endowments in capital are endogenously determined as a result of households' savings decisions. The households also receive income from the government through transfers.

The direct integration of the full set of Indonesian households within the mathematical formulation of the ENV-Linkages model is impossible because of the high number of equations representing individual households exceeds the capacity of the modelling framework. For this reason, based on the decomposition algorithm of Rutherford et al. (2006), the CGE model and the household-level model have been formulated separately and adjusted iteratively until convergence (see Appendix D). The key advantage of this approach is that the model can endogenously represent the behaviour of many household groups, taking into account not only the effect of the macroeconomic reactions on individual households' income and expenditures, but also the feedback effect of their differentiated response on the macro economy. Such feedback effects are potentially significant, and missing in more traditional models that perform the distributional analysis ex-post through a stand-alone microsimulation model.

4. OVERVIEW OF THE RECONCILED HOUSEHOLD SURVEY DATA

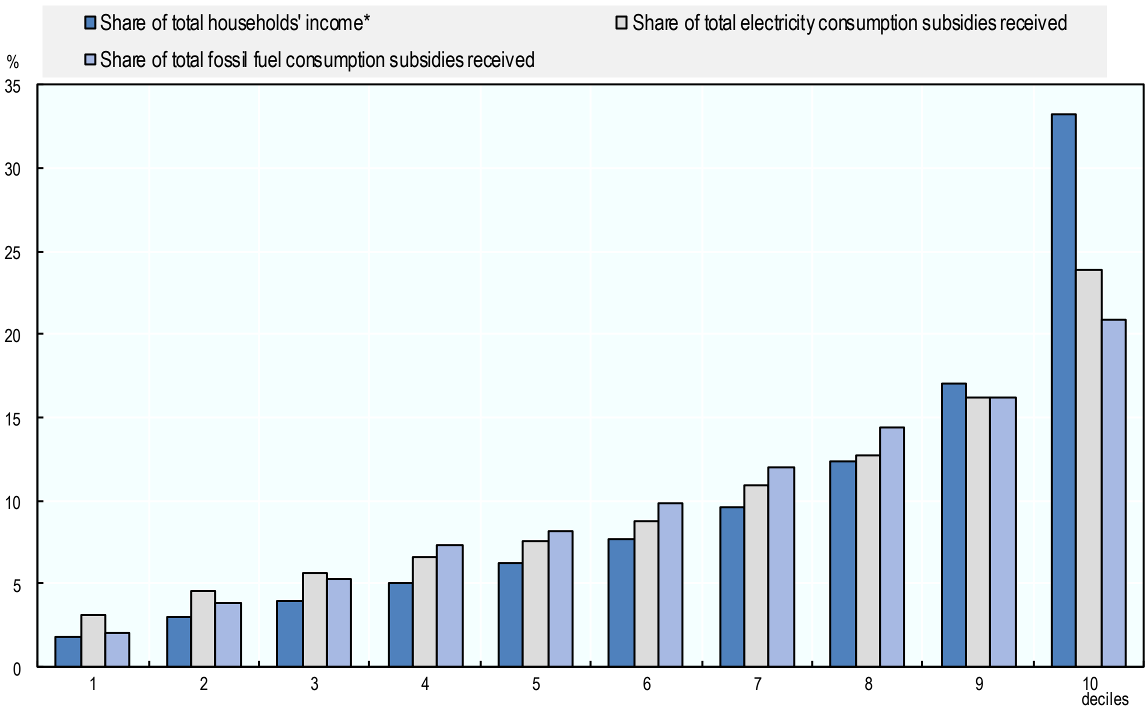
It is important to present the reconciled household data that are used as inputs in the model. Firstly, because this data set is a construction, elaborated from different sources, sufficient information must be provided to make comparisons possible with other data. Secondly, by considering the budget shares of energy in total consumption by household quantiles, it will be possible to evaluate whether, based on these data, the current subsidy scheme is progressive or regressive. Thirdly, a presentation of these data will help to understand which element of the household heterogeneity drives the distributional impact in the various scenarios.

Figure 4. Shares of energy in total expenditures by income decile group



Source: Authors' calculations based on IFLS4 and ENV-Linkages

Figure 5. Share of each income decile in total energy subsidies received and in total income



Note: * e.g. the incomes of the 10th decile households represent 33% of the total incomes of all the Indonesian households.
Source: Authors' calculations based on IFLS4 and ENV-Linkages

The reconciled household data are a key input for simulating the distributional impacts of the phasing out of the fossil-fuel consumption subsidies. In particular, the budget shares of energy consumption drive the effects on the household groups through expenditures. Three points need to be underlined concerning the reconciled household data.

First, the households who provided no information on any income or expenditure category or on housing (19% of the respondents) were dropped during the processing of the survey data[11]. If the poor households with no commercial energy consumption were overrepresented in these categories, the budget shares of energy for the poor might have been overestimated.

Secondly, the imputation of the IFLS4 survey data into social accounting categories can miss some important information. For instance, it was not possible to properly identify in IFLS4 data which households had access to electricity and whether electricity consumption corresponded to the payment of subsidized energy. Consequently, the simulations might overestimate the impact of an energy subsidy phase out, particularly for the rural poor households, which have often no access to electricity.

Lastly, during the reconciliation with social accounting data, the income and expenditure shares of each household in IFLS4 are adjusted[12].

Despite the attention paid to ensure the consistency of the reconciled survey data, the assessment regarding the distributional impacts of the current subsidy scheme remains illustrative, because survey data are always unsatisfactory to catch-up well the information concerning the two extremities of the households distribution (the poorest and the wealthiest). In addition, the robustness of the policy simulation results to the income and consumption structure of the various groups is subject to the quality of the reconciliation process.

Figure 4 shows that, the budget shares of fossil fuels (kerosene, LPG, gasoline, diesel) are below 3.3%, and that of electricity is below 1.6% for all the income deciles. These estimates are low, compared with other survey data (BPS, 2011). This is a direct consequence of the reconciliation process where the more robust macroeconomic information is inconsistent with the information of the survey, aggregated over all households. To overcome this problem, households' energy expenditure has been adjusted to match the aggregate energy expenditures of the social accounting data.

The budget share of fossil fuels increases with income until the 4th decile then stabilizes and decrease decreases significantly after the 8th decile to its lowest level in the last decile. World Bank (2006) also shows a decrease after the 8the decile but up to this decile the budget shares clearly increase with income. The budget share of electricity uniformly decreases with income, although one could expect to see, as in other survey data survey data (BPS, 2011), the smallest budget shares for the low income households, reflecting the lack of access to electricity for the poor, especially in rural areas. Thus, it seems that our reconciled data overestimate the electricity consumption of low income households.

As Figure 5 shows, until the 8th income decile, the share of the total subsidy payment received (the light grey bars for electricity and the light blue bars for fossil fuels) is higher than the total share of households' income (the dark blue bars). It means that the subsidies reduce inequalities between the lower 8 deciles and the top 2 deciles. In general, the lower the decile, the more the share of subsidy received exceeds the share of the group's income in total Indonesian households' income. Based on these considerations, even if in absolute terms the subsidies benefit the wealthiest households the most (since

[11] This was a modelling choice. The other alternative was a full reconstruction of the income, expenditure and housing data for some household categories.

[12] For instance, the shares were scaled down for energy consumption. Lower share for energy consumption will induce in the simulations less direct effect on the household groups through expenditures as a response to an energy subsidy phasing out compared with what could be expected from the original IFLS survey data.

energy consumption increases with income), the subsidy scheme can be labelled as progressive. However, the progressivity is not very strong, and insufficient to contribute substantially to the reduction of the income inequalities observed in Indonesia.

Table 2 gives the budget shares for urban and rural households by energy type and by income decile. Total energy expenditures are a higher fraction of consumption expenditures for urban than for rural households. The budget share of the fuels used in transportation (gasoline and diesel) tends to increase with income up to the 8th decile. Consequently, subsidies on these products can be regarded as regressive. The share of expenditures for domestic fuels (Kerosene and LPG) and for electricity decreases with income, showing that subsidies on these products are clearly progressive.

Table 2. Budget shares of energy products for urban and rural households

Decile		1	2	3	4	5	6	7	8	9	10
Urban and rural											
	Electricity	1.6	1.5	1.4	1.3	1.3	1.2	1.3	1.2	1.1	0.9
	Fossil fuels	2.4	2.8	2.9	3.2	3.1	3.0	3.1	2.9	2.4	1.7
	Gasoline and diesel	1.3	1.8	2.0	2.4	2.0	2.1	2.2	2.2	1.7	1.3
	Kerosene and LPG	1.1	0.9	0.9	0.8	1.1	0.9	0.8	0.7	0.7	0.5
	Total Energy	*4.0*	*4.3*	*4.4*	*4.5*	*4.4*	*4.3*	*4.3*	*4.0*	*3.5*	*2.7*
Urban											
	Electricity	2.0	1.6	1.5	1.4	1.5	1.4	1.3	1.4	1.2	0.9
	Fossil fuels	3.2	3.4	3.4	3.8	3.6	3.7	3.5	2.9	2.4	1.7
	Gasoline and Diesel	2.0	2.3	2.3	2.8	2.4	2.6	2.6	2.2	1.7	1.2
	Kerosene and LPG	1.2	1.1	1.2	1.0	1.2	1.1	0.9	0.8	0.7	0.5
	Total Energy	*5.2*	*4.9*	*4.9*	*5.2*	*5.1*	*5.1*	*4.8*	*4.3*	*3.6*	*2.6*
Rural											
	Electricity	1.5	1.5	1.4	1.3	1.2	1.1	1.2	0.9	0.9	0.9
	Fossil fuels	2.0	2.5	2.7	2.8	2.7	2.5	2.6	2.8	2.5	1.9
	Gasoline and Diesel	1.0	1.6	1.9	2.1	1.7	1.7	1.8	2.1	1.8	1.4
	Kerosene and LPG	1.0	0.9	0.8	0.8	0.9	0.7	0.7	0.7	0.7	0.5
	Total Energy	*3.5*	*3.9*	*4.0*	*4.1*	*3.8*	*3.6*	*3.7*	*3.7*	*3.4*	*2.8*

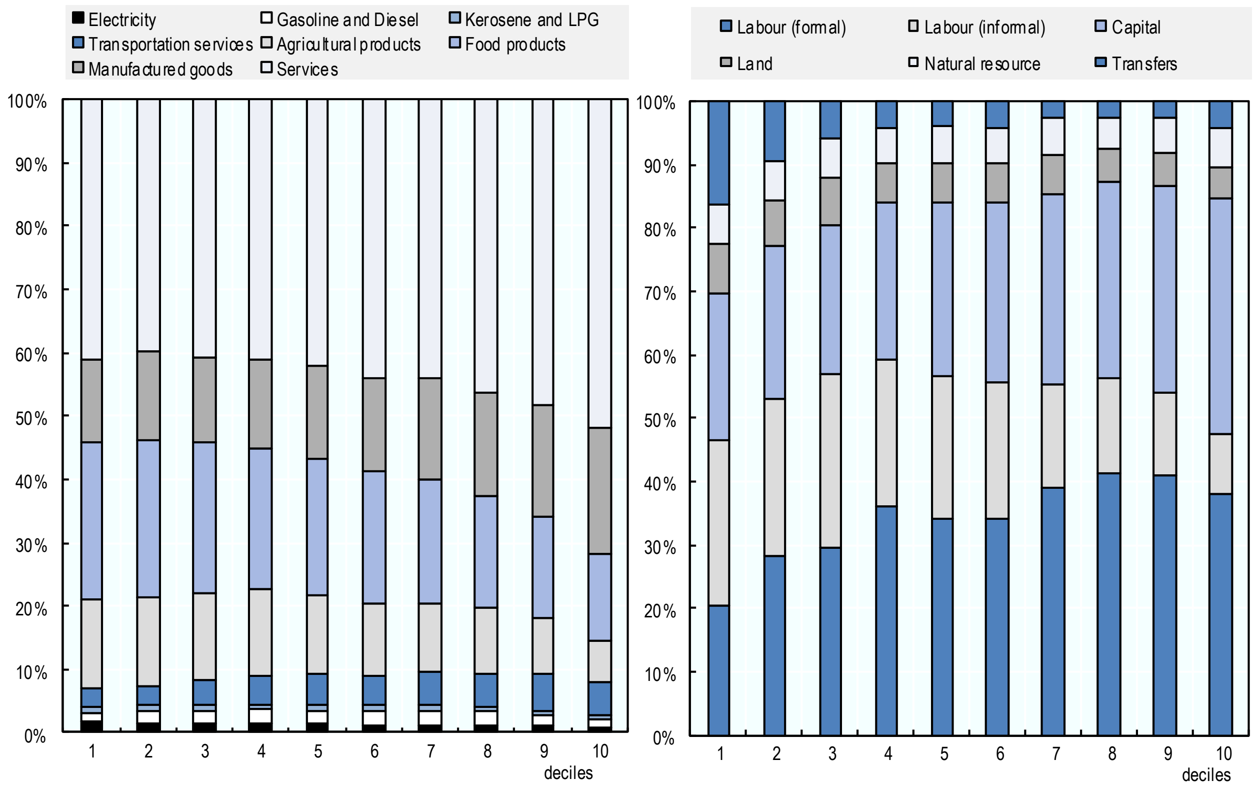
Source: Authors' calculations based on IFLS4 and ENV-Linkages

Figure 6 shows that the budget share of food consumption (food products and agricultural products) decreases with income. The low shares result from the reconciliation of the IFLS4 with social accounting data, where the aggregate shares of food and agricultural product consumption for Indonesia are relatively low. However, the reconciliation preserved the ratio of 2 between the shares of the first and last decile that was observed in the original IFLS4 survey data.

Figure 6 also shows how the structure of income varies between the decile groups. Firstly, the share of income coming from capital is higher for the top deciles. Secondly, even though the total share of labour income is relatively stable across deciles, the share of formal labour income increases with total income.[13]

[13] Following Miranti et al. (2013), we defined formal sector employees as regular employees and employers with permanent workers, while informal sector employees cover all employees with status of non-permanent, unpaid, casual and family workers.

Figure 6. Structure of expenditures (left) and incomes (right) by income decile



Source: Authors' calculations based on IFLS4 and ENV-Linkages

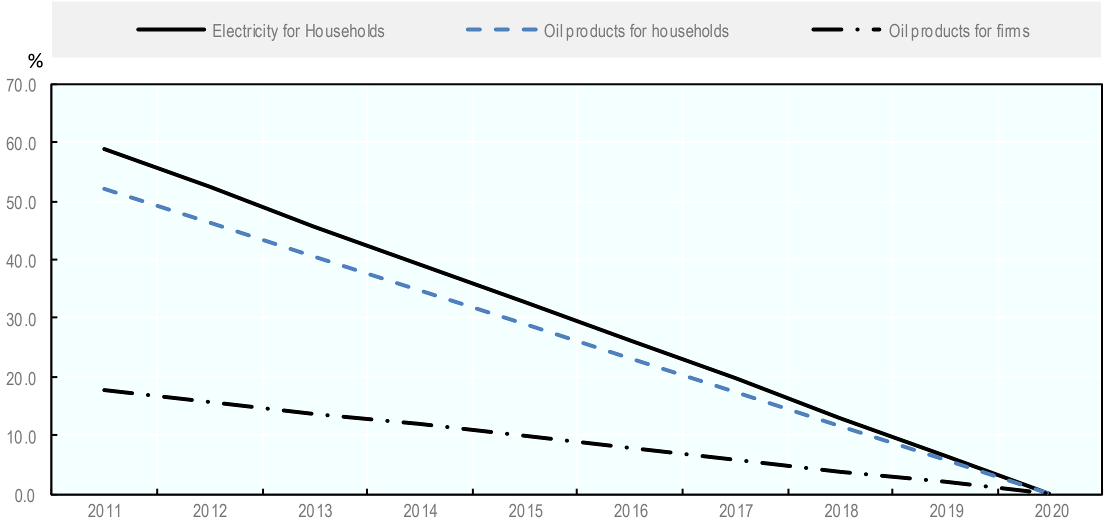
5. DESCRIPTION OF THE ILLUSTRATIVE SUBSIDIES PHASE-OUT POLICY SCENARIOS

The macroeconomic projections follow the OECD Economic Outlook and the corresponding long-term projections (Chateau et al., 2014a). The energy assumptions used in the *baseline* scenario are those of the current policy scenario (CPS) from the World Energy Outlook 2013 (IEA, 2013; Chateau et al., 2014b). For all the regions, all the energy policies, assumed after 2011 in the CPS scenario, are taken into account except the reforms to the consumers' energy subsidies.[14]

Following the illustrative scenario designed for the simulations contained in the joint report by IEA, OECD, OPEC & World Bank for the G20 (2010), and in line with Burniaux and Chateau (2014), the policy scenarios assume that, between 2012 and 2020, Indonesia implements a gradual (e.g. linear) phase out of all electricity and fossil fuel subsidies for households and firms (Figure 7). The reform applies to the existing electricity and other fuel subsidies for household's final energy demands and the intermediate oil product consumption subsidies for firms. The subsidies to firms for their intermediate consumption of oil products are lower than the subsidies on electricity and oil consumption received by households. Therefore, the phase out is expected to have much larger impacts on households than on firms.

[14] More detail on the calibration procedure can be found in Chateau et al. (2014b) who describe how the IEA scenarios are reproduced in ENV-Linkages.

Figure 7. Trajectories of energy consumption subsidy rates in the policy scenarios



Notes: (1)) For households the subsidy rate for oil products is an aggregate rate over the average oil product consumption basket, including Kerosene, LPG, Gasoline and Diesel. (2) The subsidy rates given here are gross (S) and not net (NS). To compute the net subsidy rate, tax rates (T) on energy products must be substracted (NS=S-T).

Source: Authors' calculations based on IFLS4 and ENV-Linkages

The scenarios differ by the compensating scheme for households they assume. Each of them is budget-neutral and financed by the decrease in subsidy expenditures. The compensating schemes include cash transfers, subsidies on food products, and a decrease in labour income taxation. Note that the scenarios are relatively stylised, since, for each of them, the compensation given to households is based on a single redistribution instrument although, in Indonesia, several were used in the same reform (see Box 2). For instance, cash transfers and food subsidies can be combined. Furthermore, other destinations of the avoided subsidy payments may also be considered, not least the reduction of government deficits or the expansion of public services, such as education and health care. Unfortunately, this wider set of compensating policy reforms could not be simulated in the model, which focuses purely on redistribution schemes that directly affect the income and private expenditures of households.[15] Nonetheless, the illustrative scenarios presented in this report give precious insights about the strengths and weakness of the components of potential fuel subsidy phase out policy reforms.

In the *cash transfer* scenario, the subsidy reform is compensated by unconditional cash payments on a per-household basis. Each household receives the same amount. Given the high level of existing income inequality, such a redistribution mechanism is a powerful instrument to reduce relative income inequalities, even if absolute income differences are unchanged. Another key attractiveness of this redistribution scheme is that cash transfers do not distort relative prices, as they are not linked to specific sources of income or expenditures. They are therefore economically efficient. However, in practice cash transfers may not be easy to implement. This scenario, albeit stylised, relates to the Bantuan Langsung Tunai unconditional cash transfer programmes, implemented in Indonesia in 2005-2006 and in 2008-2009 to compensate the decrease in energy subsidies (see Box 2).

[15] The reason for this is technical: the private welfare effects of changes in the provision of public services cannot be evaluated by the model. Hence, only redistribution schemes that directly affect private welfare and leave government expenditures unchanged can be consistently compared in the modelling framework.

In the *food subsidy* scenario, the phasing out is accompanied by an increase in the subsidies on food products. The rationale for this scenario is that if cash transfers are not an option, subsidies on energy can be replaced by support for other basic commodities that are less carbon-intensive. The downside of this option is that it artificially alters market prices. In addition, it is a less efficient, indirect way of supporting poor households. This reform is expected to benefit poorer households more than proportionately, given that the budget share of food decreases with income (see Figure 6). Even if it has larger food product coverage and targets all households in a non-discriminatory way, this scenario relates in certain aspects to the Rice Subsidy for the Poor programs, known as RASKIN, that were introduced in Indonesia on several occasions since the late 1990s[16] and also to the distribution of rice and support to rice price that were used following the 2008 energy price rise (see Box 2). Note that OECD (2012) stressed that such narrowly targeted programs have important negative side-effects and may be detrimental to food security.

In the *labour support* scenario, the households are compensated by receiving payments proportional to their labour income from the formal sector; this can take the form of reduced tax rates on labour, or if the compensation is larger than the existing tax rate, a subsidy on labour income. This stylised scenario assumes that such labour subsidies will be made available to the worker of the formal sector only, excluding those of the informal sector. The policy in this scenario is in line with the OECD *green growth strategy* (OECD, 2011) that recommends devoting extra fiscal resources from green taxation to lower labour income taxation. While the labour support scenario may be close to the cash transfers scenario in developed economies, in countries with a large informal sector and high unemployment rates such a policy reform may not reach the poorest households. The decrease in labour income taxation is regarded as levelling relative income inequalities in OECD countries, given that the share of rental income increases with total income. Consequently, the decrease in labour taxation can limit the potential regressive effect of a green tax reform. However, this type of scenario is expected to have very different implications in emerging countries like Indonesia where the informal sector is very important, and may not be effective as a support measure for the poorest households.

The *cash transfer multilateral* scenario corresponds to the *cash transfer* scenario, but in a context of a global multilateral subsidy phase out. This scenario aims at showing that the outcomes of the reform in Indonesia depend on whether other countries also decide to phase out subsidies. If the phase out is multilateral, the global energy demand will decrease and so are the world energy prices, these import price reductions can in turn partially offset the inflationary impact of the subsidy reform on final energy prices, thus limiting the detrimental effect of the decrease in energy subsidies for households. Note that the regional impacts of the *cash transfer multilateral* scenario in terms of changes in real income and GHG emissions are summarised in Appendix E.

6. SIMULATION RESULTS

For each phase out scenario, the outcomes of the models are compared to the *baseline scenario*, where the subsidies remain at their 2011 levels. Besides the distributional impacts, the economic efficiency and environmental impacts of the policy reform will also be considered. The efficiency of the reforms will be assessed by looking at both the variations in GDP and the variations in the aggregate consumers' real

[16] Statistics about the RASKIN programme can be found on the ILO website:
http://www.ilo.org/dyn/ilossi/ssimain.viewScheme?p_lang=en&p_geoaid=360&p_scheme_id=3153

income equivalent (as a welfare indicator). Climate benefits are measured by the changes in GHG emissions. Other environmental benefits, such as improved local air quality, can unfortunately not be assessed within the current framework.

6.1 Overview of the size of the redistribution of the avoided subsidies

Table 3 shows the magnitude of the impact of the phase-out policies, including the redistribution of the avoided subsidy payments, on transfers, subsidies for food products, and labour incomes in the various scenarios. In the *cash transfer* and *cash transfer multilateral* scenarios, the budget resources redistributed through the cash transfers for households is projected to increase from 0.5% to 2.5% of GDP between 2012 and 2020. In the short and medium run, the volume of redistribution under these scenarios are of a similar magnitude as the two waves of the BLT cash transfers programmes that were introduced in 2005-2006 and 2008-2009 in Indonesia, which represented approximately 0.8% and 0.3% of GDP, respectively. However, as progressively all subsidies are phased out, by 2020 a large amount of budget resources that were previously used to subsidise energy is available for redistribution. The long-run budget redistribution would be very large in comparison to most of the major cash transfers programs that have been introduced in other countries so far (ILO, 2013). In the *food subsidy* scenario, the redistribution implies an increase in subsidies for the consumption of food and agricultural products that will reach an average rate of 16% in 2020. In the *labour support* scenario, the subsidy on labour earnings reaches and average rate of 4.8% in 2020.

Table 3. Effect of the phasing out on transfers and subsidies in the various scenarios

	2011	2012	2014	2016	2018	2020
Cash transfer & Cash Transfer multilateral scenarios						
Cash Transfers to households (as % of baseline GDP)	0.0	0.5	1.2	1.7	2.1	2.5
Subsidy rate on food and agricultural products*	-	-	-	-	-	-
Subsidy rate on labour income**	-	-	-	-	-	-
Food subsidies scenario						
Cash Transfers to households (as % of baseline GDP)	-	-	-	-	-	-
Subsidy rate on food and agricultural products*	0	3.2	8.3	12.0	14.9	16.2
Subsidy rate on labour income**	-	-	-	-	-	-
Labour support scenario						
Cash Transfers to households (as % of baseline GDP)	-	-	-	-	-	-
Subsidy rate on food and agricultural products*	-	-	-	-	-	-
Subsidy rate on labour income**	0	0.9	2.5	3.4	4.2	4.8

Notes: * Aggregate rate over the average agriculture and food product basket in addition. In addition, this rate is gross (S) and not net (NS). To compute the net subsidy rate, an average tax rate of 5.7% on agriclture and food products must be substracted. ** Average rate, over both formal and informal labour income.

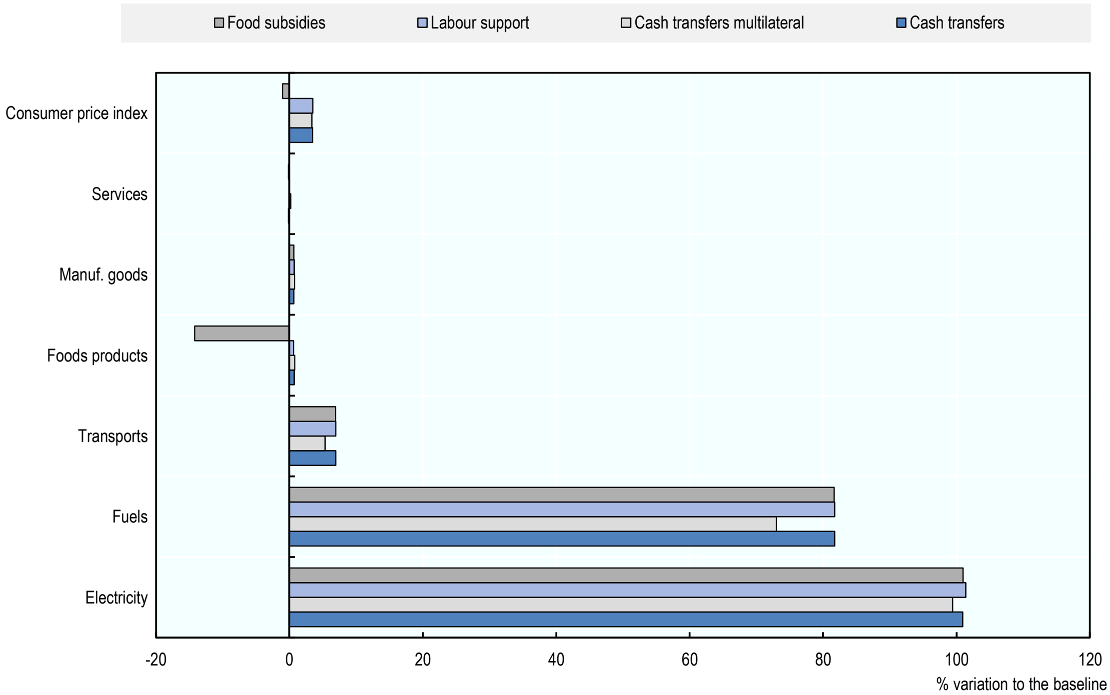
Source: Authors' calculations based on IFLS4 and ENV-Linkages

6.2 Macroeconomic impacts

The direct effect of the energy subsidies reform, regardless of the redistribution mechanism scenario, is that energy prices for all consumers (firms and households) are raised. The consumer prices of other goods are also indirectly affected through changes in producer costs, which reflect changes in energy costs, and adjustments of all relative prices to ensure that general equilibrium is maintained. The second set of channels through which the reform impacts households is through changes in income. The third set of channels is through the redistribution of the government budget that is no longer spent on subsidizing fossil fuels, which characterize each of the scenarios considered here. By considering the entire chain of impacts on demand and supply for each good and service, the model projects the quantitative impact of the reforms on GDP.

Figure 8 shows the changes in final consumer price indexes for various groups of commodities in 2020, as deviations from the baseline. The *cash transfer*, the *cash transfer multilateral* and the *labour support* scenarios give way to a significant increase (close to 3.5%) in the real consumer price index (CPI), which represents a basket of all consumed commodities.[17] In contrast, the *food subsidy* scenario leads to a decrease in consumer prices, as the reduced consumer price of subsidised food products dominates the increase in the price of the other products.

Figure 8. Effect of the energy subsidies' phasing out on final consumer prices in 2020



Source: Authors' calculations based on IFLS4 and ENV-Linkages

Unsurprisingly, as the final energy commodity prices are directly targeted by the subsidy phase out, they are most impacted. In 2020, in all scenarios, fuel and electricity prices are respectively about 80% and 100% higher than in the *baseline*. The increase in fuel prices is slightly more limited in the *cash transfer multilateral* scenario because of an indirect effect through global energy markets. In this scenario, the phasing out of energy subsidies in other regions negatively affects global oil demand and consequently lowers international oil prices. This reduction in price partly compensates the domestic impacts of the subsidy phase out on final energy prices. However, the small difference in fuel prices with the other scenarios shows that this effect remains limited.

The prices of non-energy commodities are affected indirectly by the phase out. Firstly, through change in production costs, which in turn reflect mainly the changes in energy costs. Secondly, as

[17] The model only calculates real prices and does not reflect monetary information such as inflation. Nominal prices would be increasing by the sum of the CPI change plus the inflation rate. Furthermore, please note that all prices are relative to a *numéraire*, which is a basket of export prices of OECD countries.

households and firms substitute away from energy they will increase their use of other goods and services. The price of transportation services is the most affected because of the high dependence of the sector on motor fuels, though the price increase remains limited to 7% with respect to the baseline. For the other non-energy goods, the increase is lower than 1%. These relatively modest indirect impacts on non-energy commodity prices are largely due to our assumption that the base-year energy subsidies rates were significantly lower for firms than for households. Because of this assumption, the phase out corresponds to a much bigger energy price shock for households than for firms.

The negative impact on food prices in the *food subsidy* scenario, observed in Figure 8, stems from the indirect effects of the tax and subsidy system through the redistribution scheme. In this scenario, the phasing out of energy subsidies is compensated by fiscal support on food prices. Under the assumption that government resources are identical to those of the *baseline* scenario, this subsidy, which reaches an aggregate rate close to 16% over the food product basket (see Table 3), significantly lowers final food prices.

As a result of higher energy prices, demand for energy goods will decrease for final consumers, as shown in Table 4. The large decreases observed are directly related to the values of the own price elasticities of demand, which follow Chateau et al. (2014a), and are close to -1 (see section 6.5 for a sensitivity analysis on this parameter). However, changes in the demand for other goods and services are *a priori* indeterminate because they result from a mix of an income effect (through changes in transfer payments and earnings from production factors) and a substitution effect (through changes in relative prices).

Table 4. Total households' demand variations for aggregated good categories in 2020 by scenario

	Cash transfers	Cash transfers multilateral	Labour support	Food subsidies
Electricity	-47.8	-47.3	-48.2	-49.3
Fuels	-42.7	-39.7	-42.8	-44.2
Transports	-3.7	-2.0	-3.1	-5.6
Foods products	2.0	2.1	1.6	12.1
Manuf. goods	2.3	2.4	3.1	0.1
Services	3.5	3.4	4.4	1.1
Note: % deviations, w.r.t. the baseline				

Source: Authors' calculations based on IFLS4 and ENV-Linkages

The phase out also affects the real return on production factors net of the factor tax rates as shown in Figure 9. The changes in net return reflect variations in the relative marginal productivities of the factors induced by the policy. In the case of labour productivity in the *labour support* scenario it also reflects changes in the subsidies on formal labour.

The lower real return on capital induced by the phase out policy, which appears in the longer run, is related to higher household savings created by the subsidy reform[18]: as will be explained later in this section, the policies are projected to increase the savings of households. The higher savings increase the capital stock and thus decrease its marginal productivity.

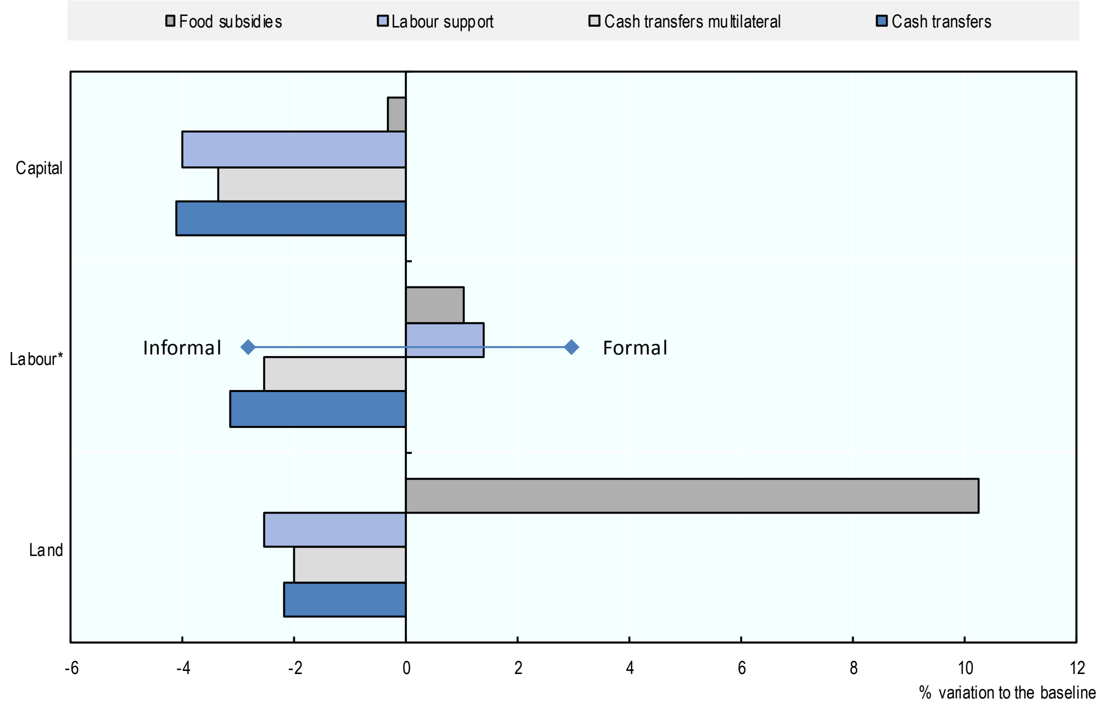
The net return on labour is negatively impacted in the *cash transfer* and *cash transfer multilateral* scenarios. A decrease in net return, which, as in the case of capital can be explained by complementarities

[18] Except in the *food subsidy* scenario where savings decrease.

between energy and labour, leads to a decrease in the marginal productivity of labour. In the *labour support* scenario the subsidy to labour will increase the net return on labour, but the situations are different for the formal and informal sectors. Informal labour is not part of the official tax system, and hence does not receive the labour support subsidies and its rate of return decreases, reflecting the lower marginal labour productivity. Formal labour is subsidised at a rate close 6.8%, which dominates the decrease in labour marginal productivity and hence yields a higher net return. These differentiated effects on different segments of the labour market are illustrated in Figure 9, together with the effect on the whole labour market. In the *food subsidy* scenario, the subsidies on food products are beneficial to the agricultural sector and to its workers, positively affecting real labour remuneration at the national level.

The relative decrease in the return on land in all the scenarios except *food subsidy* is due, as for labour and capital, to the complementarity with energy in the production process. But as expected, in the *food subsidy* scenario, the food subsidies that compensate for the energy subsidy phase out support the demand for food products and thereby increase the return on land.

Figure 9. Net real return rates by income sources in the various scenarios in 2020



* In the labour support scenarios, in addition to the avrage remuneration rate of labour; the remuneration rates of formal and informal labour are distinguished.

Source: Authors' calculations based on IFLS4 and ENV-Linkages

Figure 10 shows that the impact of the energy subsidy reforms on GDP is positive in all the scenarios. However, the gains remain very limited, until 2020 they are not higher than 0.7% above the baseline. These limited gains are explained by the modest share of energy consumption in total household consumption, which limits the potential impacts of the subsidy reform on the overall economy. The best scenarios in terms of GDP couple the subsidy reform with cash transfers redistribution schemes. As the subsidy phase out improves the efficiency of the economy and increase the growth rate of the economy, they lead to GDP gains, whereas the *food subsidy* and the *labour support* scenarios have smaller GDP gains, which eventually start to fade away.

To explain the macroeconomic performance of the policy in the inter-temporal modelling framework, it is necessary to make the distinction between “static” and “dynamic” mechanisms. The static mechanisms relate to reform-induced changes in the efficiency of production factors and consumption goods allocation for a given stock of capital. Typically, subsidies create inefficiencies (deadweight loss) in the allocation of consumption goods and factors, and removing them tends to have a positive direct effect. In addition, the redistribution schemes influence the efficiency of the policy, when they affect other existing taxes. The dynamic mechanisms come from the impact of the policy on households’ savings. A reform, whose consequence is an increase in aggregate savings, and consequently capital accumulation in the economy, will have better long-term GDP growth performances.[19]

The subsidy removal has a positive direct impact on the economy, since it reduces allocation inefficiencies. However, depending on the scenario, the recycling schemes adopted may create new inefficiencies in the economy. The lump-sum transfers used in the *cash transfer* and *cash transfer multilateral* scenarios do not create inefficiencies because they do not influence production factor allocation. Similarly, given that total labour supply is exogenous, the redistribution through changing the net sum of taxes and subsidies on labour in the *labour support* scenario does not affect the supply of labour from households and is in that sense equivalent to a lump-sum transfer. However, in the *food subsidies* scenario, the redistribution consists of reducing existing food taxes during the first years and then introducing subsidies on food products as the avoided energy consumption subsidy payments become larger than the baseline tax revenues on food products. The reduction of food taxes tends to have an immediate positive impact on the economy, as an existing price distortion is reduced. This explains the slight better growth performance in this scenario than in the other scenarios during the first year of the model horizon. However, the subsidies on food products appear after a few years and create inefficiencies that partially offset the positive impact of removing energy consumption subsidies.

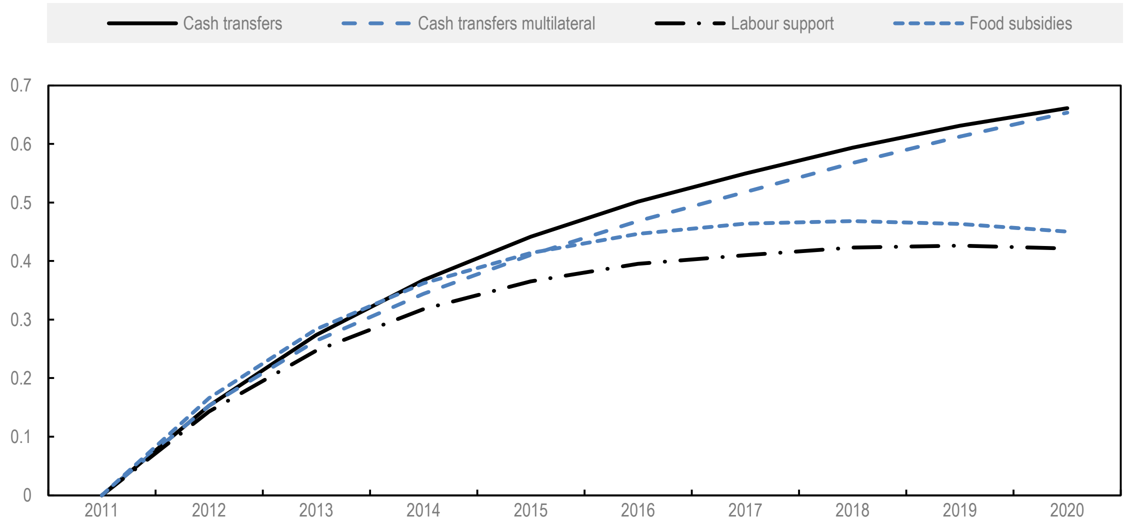
Figure11 shows that the policies have a significant impact on the capital stock by presenting the ratio between the two most important production factors, capital and labour (in efficiency units, i.e. including human capital). The *cash transfer*, the *cash transfer multilateral* and the *labour support* scenarios induce more capital accumulation. In these scenarios, households receive additional income and part of it is saved. However, the impacts on capital accumulation are more pronounced with cash transfers than with labour support. This difference stems from the heterogeneity of households. The budget redistribution schemes target different parts of the population (all households in the cash transfer scenarios, and households with formal labour income in the labour support scenario) which have different marginal propensities to save. Consequently, the choice of the redistribution scheme affects total savings: for the same amount redistributed, the *cash transfer* mechanism will give way to higher aggregated savings.[20]

Savings rates, and hence capital accumulation, are also influenced by the changes in consumption prices. As seen in Figure 8, the consumer price index increases in all scenarios except the *food subsidy* scenario. Hence, consumers are induced to substitute away from consumption toward saving. The food subsidies, in contrast, make consumption more attractive, thereby pushing savings rates down.

[19] In particular if, as in this study the current account is fixed.

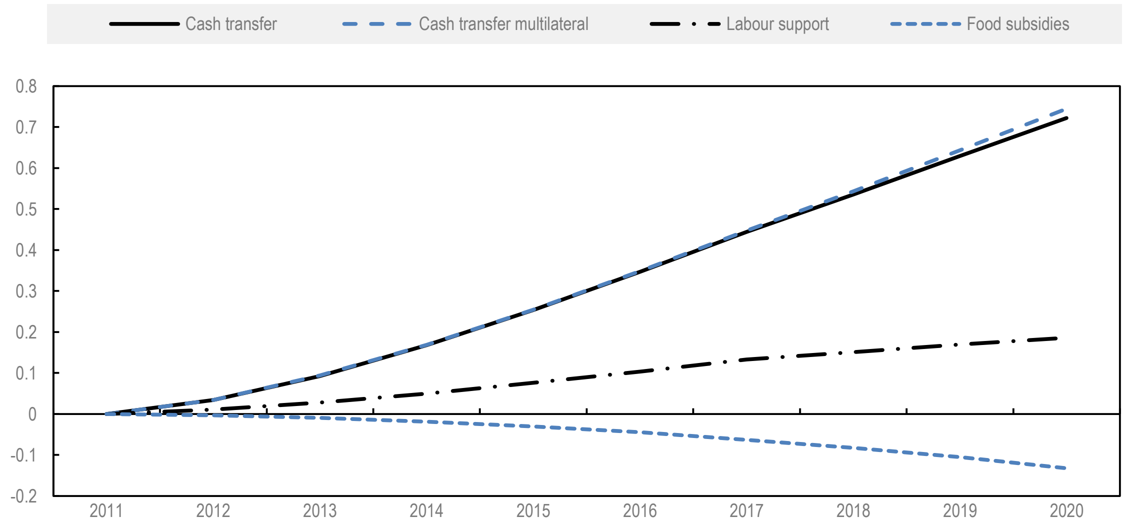
[20] For instance, in the base-year, a labour support mechanism that accrues the formal labour income revenue by 1% gives way to 0.16% increase in aggregate savings. If an equivalent amount is redistributed with cash transfers, the aggregate savings increase by 0.33%.

Figure 10. Real GDP as percent deviation to the baseline in the various scenarios



Source: Authors' calculations based on IFLS4 and ENV-Linkages

Figure 11. Capital to efficient labour ratio, as % variation from the baseline



Source: Authors' calculations based on IFLS4 and ENV-Linkages

6.3 Distributional impacts

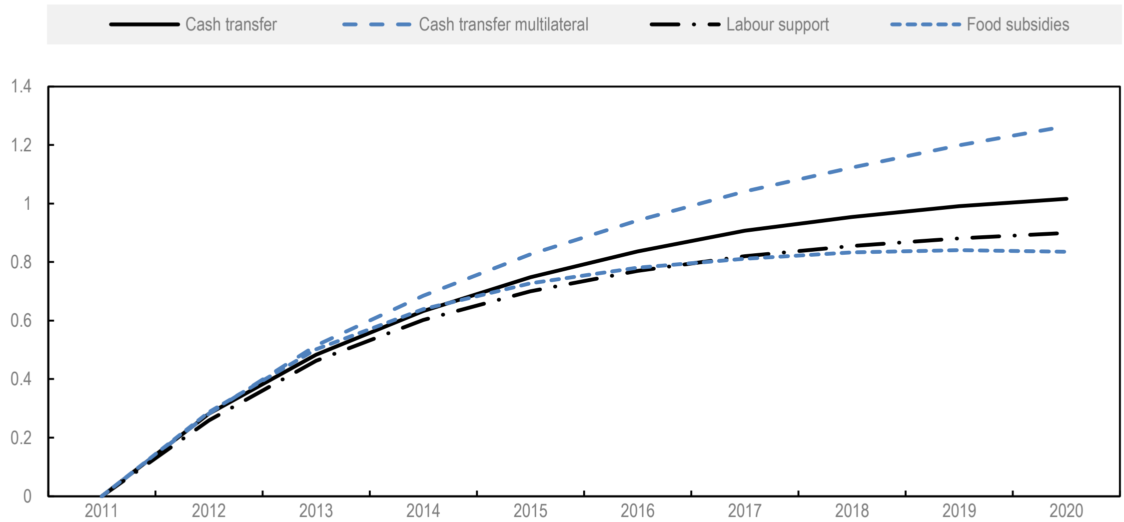
The measure of welfare used to assess the distributional impacts of the phase out of fossil fuel subsidies is the equivalent income[21] (EI) which translates the welfare reached by a household group in a policy scenario into the level of income that would have been necessary to reach the same level of utility in the baseline scenario. The variation of the EI between a policy scenario and the baseline is called

[21] This welfare measure excludes the welfare derived from the provision of public goods, as this cannot be measured properly. As long as the provision of public goods is constant across scenarios, as is the case in the scenarios investigated in this paper, the change in welfare from private consumption equals the change in total welfare.

equivalent variation in income (EV), it represents the additional income that would have been necessary to reach the same level of welfare in the baseline scenario. A first criterion used in this report to regard a policy as progressive is that the EI are more evenly distributed than the baseline incomes[22]. A second criterion if that the EV, as a percent of the baseline income, decreases with income.

The total welfare changes for all households together are displayed in Figure 12. The gains are more important than the effect on GDP shown in Figure 10. They range between 0.8% and 1.4% in 2020, while the corresponding range for GDP gains is from 0.4% to 0.7%. The difference between the two indicators is that the welfare measure fully takes into account the terms of trade improvements consecutive to the reform. This effect is stronger in the *cash transfer multilateral* scenario, since lower international oil prices reinforce the decreased value of energy imports. Consequently, this scenario outperforms all the others in terms of welfare improvements.

Figure 12. Total households' equivalent income variations in the various policy scenarios



Source: Authors' calculations based on IFLS4 and ENV-Linkages

Table 5 shows statistics of the distribution of equivalent incomes for the year 2020 under the various scenarios. Two dispersion statistics, the Gini and the Theil indexes, provide insight on whether the policies give way to higher or lower overall inequalities than in the *baseline*, and can, in this sense, be regarded as progressive or regressive. In the *cash transfer* and *cash transfer multilateral* scenarios, the Gini and the Theil indexes significantly decrease; therefore with regards to these criterions these scenarios can be regarded as progressive, in the sense that poorer households benefit more than richer households from the reforms. The dispersion statistics hardly change in the *food subsidy* scenario, which therefore can be regarded as distribution neutral, but they increase in the *labour support* scenario which appears to be regressive.

The inter-quantile ratios show that the progressivity of the *cash transfer* and *cash transfer multilateral* scenarios comes from the fact that they are relatively beneficial to the poorest decile. First, in these two scenarios, the gap between the highest and the lowest quantiles decreases. The ratio between the 99th centile and the 1st centile shrinks from 45 to about 39, and the ratio between the 95th and the 5th centile decreases from 14.2 to 12.7 as the lump sum payment is a relatively large part of their total income. In

[22] Note that by construction, in the baseline scenario, the EI is equal to income.

addition, in these scenarios, the households in the 5th centile have a welfare increase of more than 9%. The increase in welfare is also very important in the 10th centile. This means that these policies are primarily beneficial to the very poor. A diminishing ratio between the highest and lowest quantiles and a significant welfare increase are also observed, but to a lower extent, in the *food policy* scenario. However, the *labour support* scenario sees an increase in the ratios between higher and lower quantiles.

Table 5. Equivalent income dispersion statistics across households in 2020 by scenario

Scenario		Baseline	Cash transfers	Cash transfers multilateral	Labour tax	Food subsidies
Inequality indexes*						
	Gini coefficient*	0.445	0.436	0.436	0.450	0.443
	Theil Index	0.348	0.336	0.336	0.357	0.346
Inter-quantile ratios						
	Decile 8/Decile3	2.4	2.3	2.3	2.4	2.3
	Decile 10/Decile 1	8.2	7.6	7.6	8.4	8.1
	Centile 95/Centile 5	14.2	12.7	12.7	14.6	14.0
	Centile 100/Centile1	45.2	39.0	38.9	46.4	43.8
Average equivalent income variations (in %) per quantile groups						
	Centile 5	-	9.1	9.2	-1.2	2.1
	Centile 10	-	6.8	6.9	-0.9	2.5
	Centile 90	-	-0.1	0.2	1.5	0.0
	Centile 95	-	-0.2	0.0	2.0	0.2

Note: *The inequality indexes are computed on the per capita and not on the per household distribution of equivalent incomes

Source: Authors' calculations based on IFLS4 and ENV-Linkages

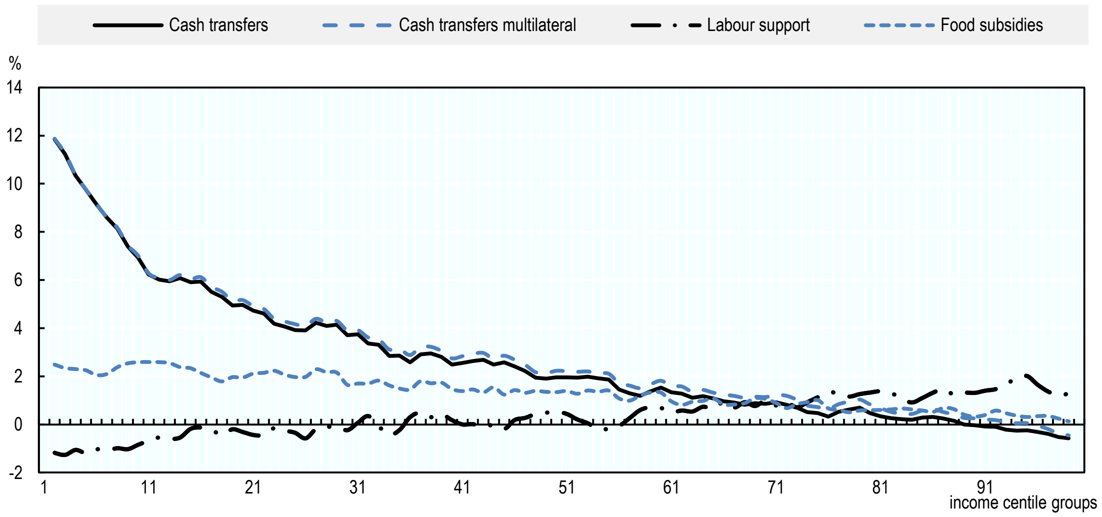
Figure 13 shows for the various scenarios the EV by income centile groups in 2020 and thus provides more details about the distribution of the gains and losses due to the policies. As the EV are expressed as percent deviation from the baseline, a scenario where EV decreases with income quantile can be interpreted as progressive as it denotes that the lower the initial income, the higher the proportion of income-equivalent gained from the policy.

All the scenarios yield positive welfare impacts (the EV is positive) for the majority of the household centile groups, showing that most of the households gain from the reform. This reflects, at the household group level, the positive macroeconomic impacts of the scenarios. In addition, except for *the labour support* scenario, the EV is higher for the lowest centile groups, confirming that these scenarios are progressive.

The *cash transfer* and *cash transfer multilateral* scenarios have very similar impacts across the household groups. They are the most progressive and they benefit all household groups except the very rich. This result is largely due to the natural progressivity of unconditional cash transfer schemes (the payments received by the households are identical and therefore represent a much higher share of income for poorer households than for richer ones) reinforced by the fact that in Indonesia, the initial level of inequality is high.

The *food subsidy* scenario is the only scenario investigated that is beneficial to all income centiles. The relative benefit of the reform is higher for the lowest centiles, due to their larger share of income going toward food and agricultural product consumption (see Figure 6). The *labour support* scenario is regressive, and detrimental to lower income household groups.

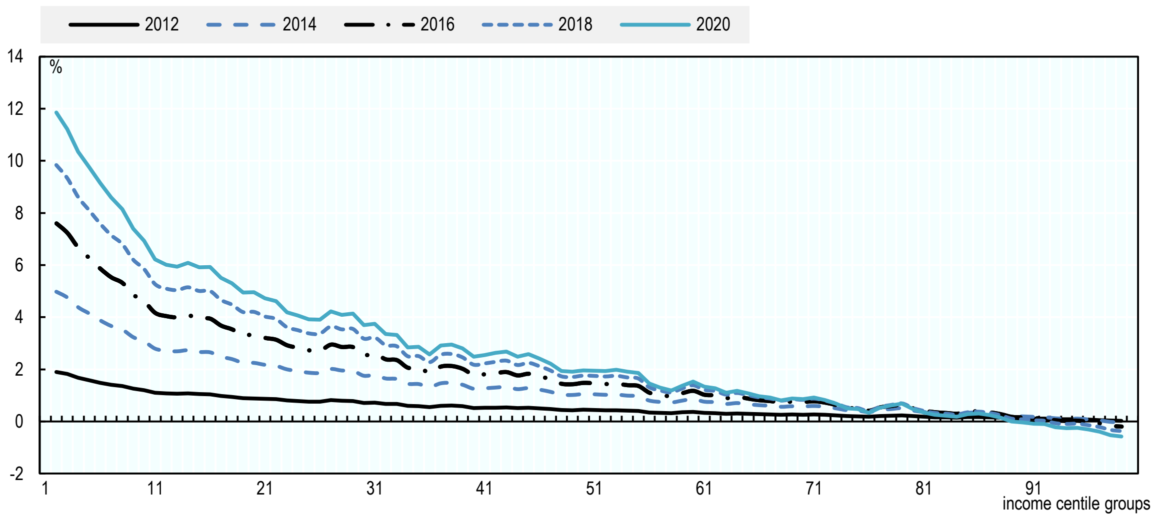
Figure 13. Welfare variations by income centiles in 2020 in the various policy scenarios



Source: Authors' calculations based on IFLS4 and ENV-Linkages

The evolution of the EV by income centiles through time in the *cash transfer* scenario is displayed in Figure 14. The distributional pattern is more or less constant throughout the years, and the effects amplify over time, in line with the larger policy shock. In addition, for low-income households, the policy has a significant positive impact in the short run, as welfare improvement is more rapid during the first years after the reform. In addition, these figures show that even a partial phase out of energy consumption subsidies complemented by cash transfers can be progressive.

Figure 14. Dynamic of welfare variations by income centiles in the cash transfer scenario



Source: Authors' calculations based on IFLS4 and ENV-Linkages

To identify the main drivers of the distributional impacts of each reform the welfare changes of the household groups is decomposed into the following effects:

1. The direct effect of the *final price* changes, i.e. the change in expenditures that would have occurred in the absence of household demand response.

2. The effect through change in *labour income*: the change in income that comes from the variation in the return on labour. This latter reflects not only the change in labour marginal productivity, but also, in the case of the *labour support* scenario, the introduction of the subsidies on labour.

3. The effect of the change in *non-labour incomes* (i.e. incomes from capital, land and natural resources).

4. The effect through higher *transfers* that increase households' disposable income. The indirect component of this change is provided by the fact that as government tax revenues change, the government budget is balanced by endogenously adjusting the transfers to households. In the cash transfers and cash transfers multilateral scenarios, this also includes the direct effect of the redistribution scheme.

5. The effect through *demand adjustment*, which takes into account the impact on of the adjustment of consumption and savings made by the households as a response to the changes in incomes and relative prices.

These components are shown in Figure 15 for the *cash transfer* scenario. The model simulation projects that the direct effect of the policy through changes in final prices is regressive. The effect is equivalent to a 5% decrease in income for the lowest centile groups, but to less than 3% for the wealthiest groups. The effects through labour and non-labour incomes are quite small and more or less distribution neutral. The effect of demand adjustment is positive and distribution neutral.[23] Note that the large predominance of the transfer effect makes the assessment about the progressivity of the cash transfer reform very robust to the statement, made in section 2, that the initial energy consumption subsidy scheme is progressive. The overall progressivity of the cash transfer scenarios is hence almost entirely due to the changes in transfers.

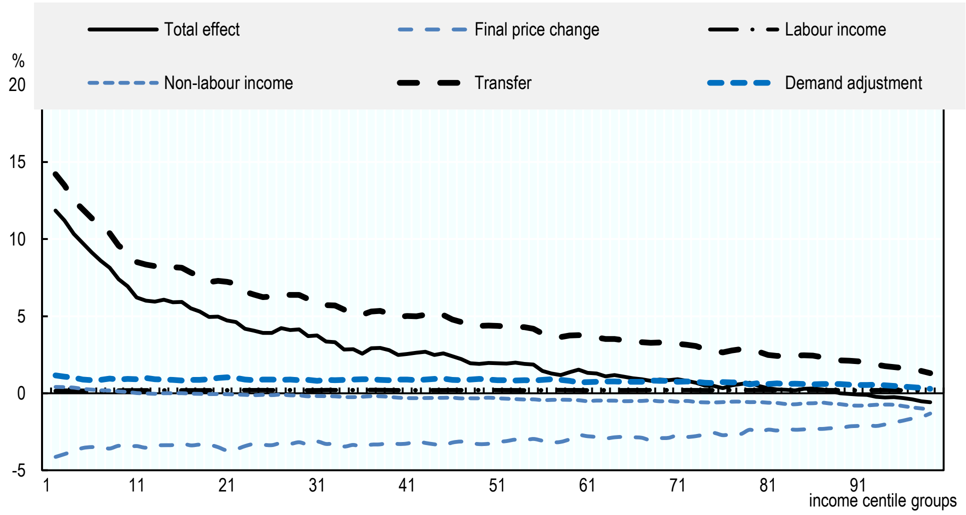
When considering the effects under the *labour support* scenario, in Figure 16, it appears that the regressive impacts through changes in net labour incomes reinforce the regressivity of the final price effect. This result is counter-intuitive given that the effect of labour income was distribution-neutral under the *cash transfer* scenario, translating relatively homogenous shares of labour incomes across the household centiles. However, the explanation comes from the very nature of the budget redistribution scheme. Transfers proportional to labour income, as used in the *labour support* scenario are regressive, as the incomes from formal labour are a higher proportion of total incomes for higher-income households than for lower-income households (see figure 6).

Figure 17 shows that under the *food subsidy* scenario, the final price effect changes sign. In this scenario, the subsidies on food products are sufficiently progressive to offset the regressive impacts of the increase in final energy prices. The progressivity of the food subsidies is due to the higher budget shares of

[23] This neutrality comes from the fact that the income and price elasticities of demand of the various household groups were calibrated to the same value (the value used in the single household version of ENV-Linkages). If sufficient data can be found, follow-up analysis could investigate the impacts of the policy reform in a setting where households have different elasticities.

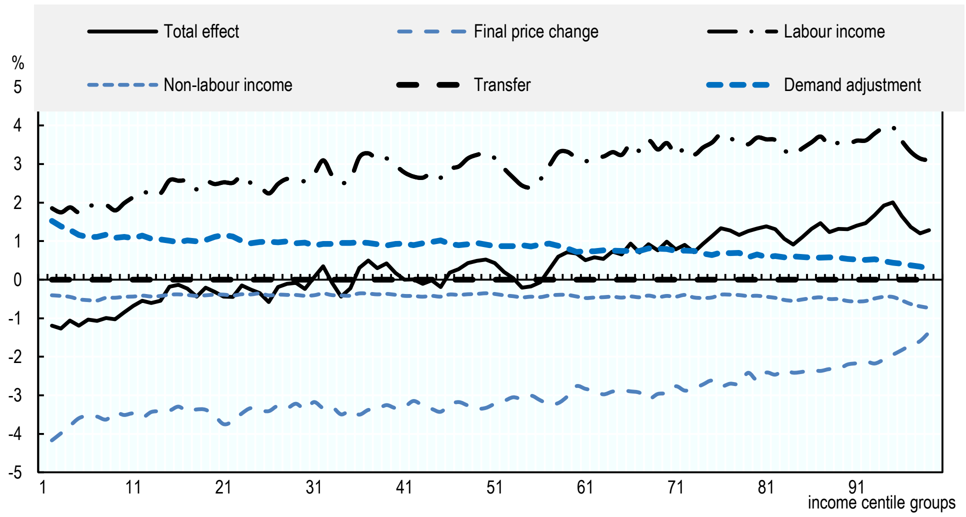
food for poor households relative to rich households (see Figure 6). In addition, in this scenario, the non-labour income effect is relatively progressive, due to the positive impacts of the food subsidies on land returns (see Figure 9) and to the relatively high proportion of revenue from land in low-income households' incomes[24] (see Figure 6).

Figure 15. Decomposition of welfare effects across income centiles in the cash transfer scenario



Source: Authors' calculations based on IFLS4 and ENV-Linkages

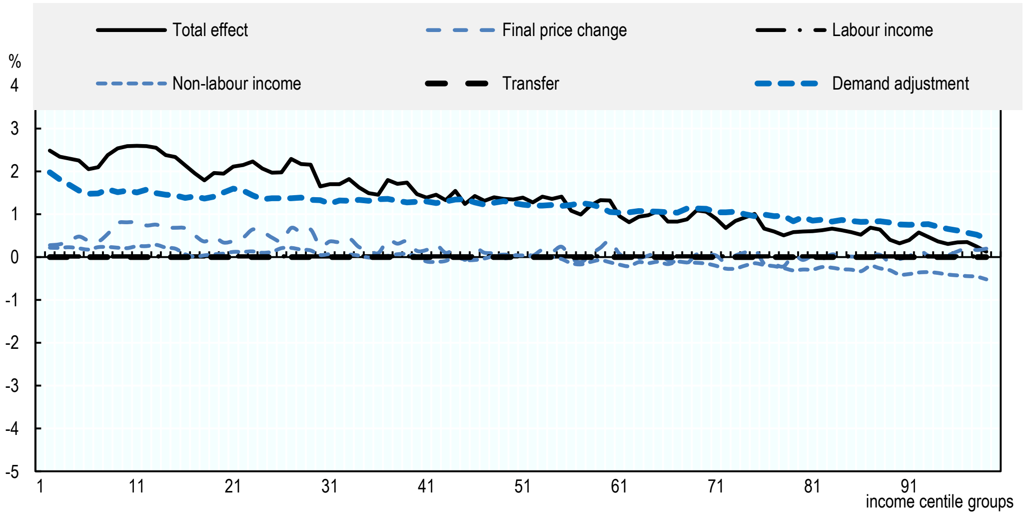
Figure 16. Decomposition of welfare effects across income centiles in the labour support scenario



Source: Authors' calculations based on IFLS4 and ENV-Linkages

[24] However, this result is not necessarily robust, as the land incomes of low income rural households may be overestimated in the reconciled household survey data. It is likely that the land incomes of urban high-income landowners are underestimated.

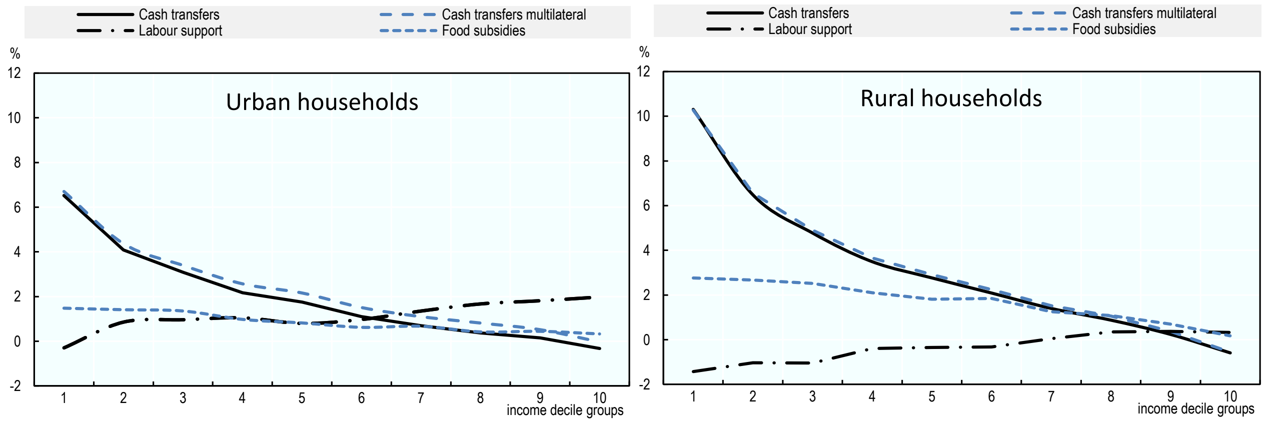
Figure 17. Decomposition of welfare effects, by income centiles in the food subsidy scenario



Source: Authors' calculations based on IFLS4 and ENV-linkages

The phasing out of fossil-fuel subsidies has different impacts in urban and rural areas, as shown by Figure 18. Until the 9th decile, the *cash transfer* and the *food subsidy* scenarios are more beneficial to rural than to urban households. The main reason is that, according to our data[25], the rural households have a lower share of their initial budget for energy expenditures and therefore they are less affected by the impact of the reform on final energy prices. The *labour support* scenario, in contrast, is less beneficial to the rural households, because of the greater importance of the informal sector in these areas. Due to the higher share of food product consumption in rural than in urban areas, and to an increase in land returns, the *food subsidy* scenario is more beneficial to rural than to urban households[26].

Figure 18. Welfare impacts for the urban and rural household by income decile in 2020



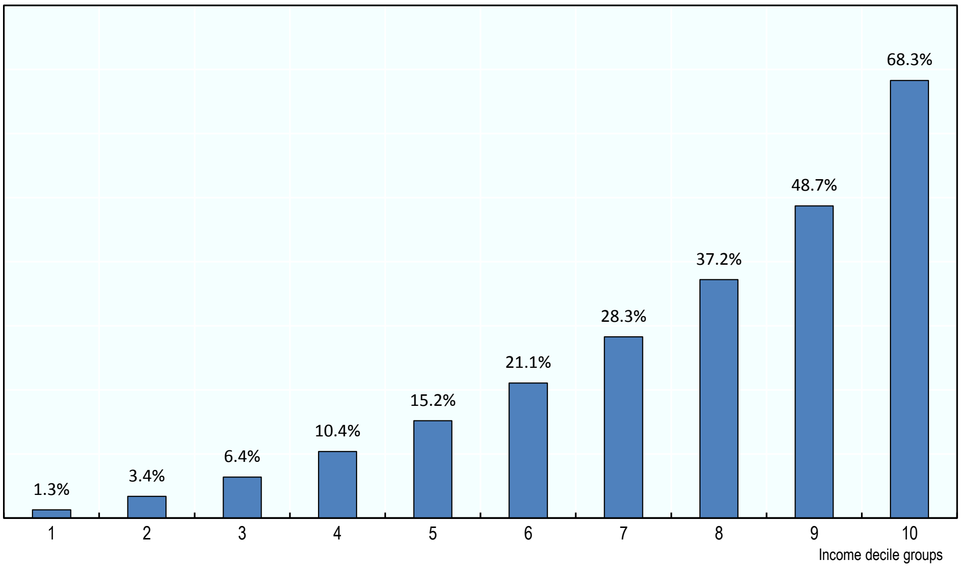
Source: Authors' calculations based on IFLS4 and ENV-Linkages

[25] BPS (2011) also found higher value shares for food and agricultural products in rural than in urban areas.

[26] Note that this result might be influenced by a potential underestimation of the role of self-consumption and in-kind private transfers for rural households.

The *cash transfers* scenarios are the most progressive, but they are very stylised. They assume a redistribution of the expenditures that are no longer spent on subsidies to all households, who receive the same payment, whether they are poor or better off. In practice, cash transfers may be only a part of the distribution schemes and also be better targeted to a specific part of the population. A natural question concerning the cash transfer is what percentage of the money saved by the subsidy reform needs to be redistributed to mitigate the effect of the policy for some parts of the population.[27] Figure 19 shows that to avoid losses in the real income of all the household decile groups, including the wealthiest, almost 70% of the government's expenditures avoided by the energy subsidy reform has to be redistributed with cash transfers. This relatively high percentage is largely explained by the amount that would be used to support the high income household groups. If one focuses on maintaining the real income of the population that is e.g. below the 4th decile, the percentage drops to 10%.

Figure 19. Rate of redistribution needed to preserve real income up to a given income decile group



Source: Authors' calculations based on IFLS4 and ENV-linkages

6.4 Environmental impacts

Table 6 shows that the policy reform is projected to lead to a 7.9% to 8.3% reduction in GHG emissions at the 2020 horizon when compared with the baseline. The reduction of GHG is mainly due to a 10.8% to 12.6% decrease in energy-related CO_2 emissions, in line with the decrease in energy consumption (ranging from 10.9% to 12.7%). However, the emission reductions exclude emissions from deforestation, which are large but highly uncertain and for which the model cannot make reliable projections. The IEA estimates that in 2010, CO_2 from forest fires were about 60% of total GHG emissions (Appendix A). Hence, the emission reductions achieved by the energy subsidy policy phase out are substantially lower when including deforestation emissions.

Largely, the emission-reduction efforts are achieved by energy conservation and not by a reduction of the CO_2 intensity of energy. The mitigation effort is borne by households, who reduce their energy consumption by 42% to 46%, whereas energy consumption by firms declines by only 4.9% to 6.2%. This effect is mainly due to the much lower energy consumption subsidy rates for firms than for households in the baseline.

[27] This calculation assumes non-negative income effects at the decile level. Within decile, individual households with a-typical characteristics may still be worse off from the policy reform.

Table 6. GHG emission and energy consumption reduction in 2020 w.r.t. the baseline by scenario

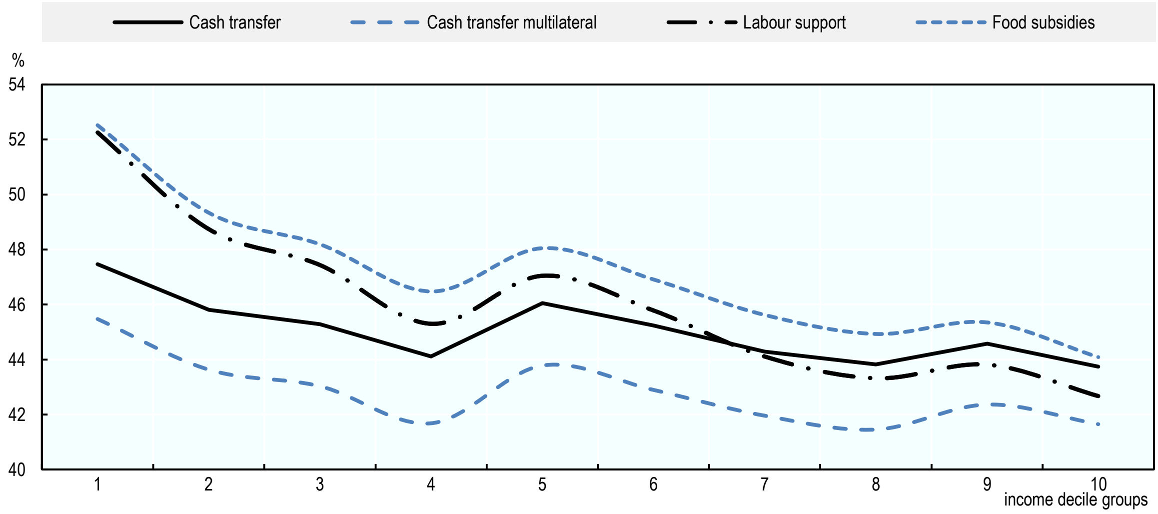
Scenario	Cash transfers	Cash transfers multilateral	Labour support	Food subsidies
All GHG*	7.9	7.3	8.3	7.9
CO2 emissions*	11.8	10.7	12.3	12.6
Total energy consumption	12.1	10.8	12.5	12.7
Households	44.6	42.3	44.8	46.0
Firms	5.8	4.7	6.2	6.2

* Not including the emissions from tropical forest fires and the 10% of biofuel combustion emissions, which is the fraction assumed to be produced unsustainably

Source: Authors' calculations based on IFLS4 and ENV-linkages

The achieved reduction of energy consumption varies across household deciles, as shown in Figure 20. The *cash transfer* scenarios lead to a lower energy consumption reduction for the lowest income quantiles. This sort of rebound effect is due to the increase of income, which stimulates all demands including energy consumption. On the one hand, the low income households have a direct incentive to consume less energy due to increased final prices. On the other hand, their income increases significantly thanks to the cash transfers they receive, which tends to stimulate their energy consumption and to offset part of the energy consumption reduction that was due to the direct effect through energy prices.

Figure 20. Rate of reduction of energy consumption by household decile in the various scenarios



Source: Authors' calculations based on IFLS4 and ENV-linkages

6.5 Sensitivity of the results to the households' demand elasticities

The simulation results may be largely driven by the assumptions about the households' income and price elasticities of energy demand. In particular, the large amount of emissions reduction realised by households in the various scenarios is largely related to the calibration of the price elasticities of households' electricity and fuels demands close to -1 (cf. Chateau et al., 2014a)[28].

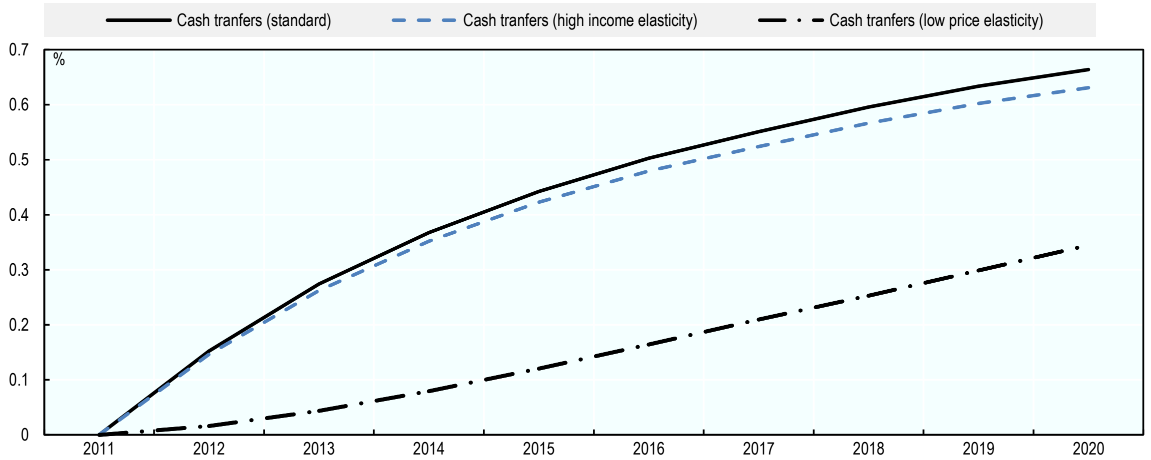
[28] This value is used in many CGE models like ENV-Linkages, while partial models for the energy sector often use values closer to -0.5 (Webster *et al.*, 2008).

To assess the robustness of the results to the values taken by households' income and price elasticities of energy demand, a sensitivity analysis is conducted on these parameters. This sensitivity analysis is done for the *cash transfer* scenario. The simulation results already presented will be regarded as the "standard" case and compared to two other values of the incomes and price elasticities of demand, each corresponding to a case.

- A "high income elasticity" case, where the households' income elasticities of electricity and fuel demand that are close to 1 in the standard case are doubled.
- A "low price elasticity" case, where the households' own price elasticities of electricity and fuel demand that are close to -1 in the standard case are halved.

The GDP trajectories obtained for the *cash transfer* scenario under the various elasticity values is displayed in Figure 21. The GDP changes remain positive. They are rather robust against the income elasticity of energy demand. However, the price elasticity of demand plays a greater part. A lower price elasticity of energy demand implies significantly lower GDP gains. Two reasons can be invoked. First, a lower elasticity of demand decreases the initial deadweight losses due to the energy consumption subsidies, which limits the efficiency gains obtained with the phase out. Second, as the consumers are less responsive in their energy consumption, they have more difficulties to adjust their behaviour. In particular, they increase their savings less and thus contribute less to the growth of the capital stock.

Figure 21. Real GDP sensitivity to demand elasticities in the cash transfer scenario



Source: Authors' calculations based on IFLS4 and ENV-linkages

Table 7 shows that the price elasticity strongly influences households' energy consumption, as could be expected, and consequently their CO_2 emissions. With the price elasticity of households being divided by two, their energy consumption reduction is half as strong as the in standard case. Consequently, the impact on total CO_2 emissions and total GHG emission is less pronounced. In contrast, the income elasticity does not influence the results much.

Table 7. GHG emission and energy consumption reduction in 2020 w.r.t. the baseline in the sensitivity analysis

Scenario	Cash transfers (standard)	cash transfer (high income elasticity)	cash transfers (low price elasticity)
All GHG*	7.9	7.6	6.8
CO2 emissions	11.8	11.4	4.5
Total energy consumption	12.1	11.6	7.2
Households	44.6	42.9	23.5
Firms	5.8	5.5	4.0

* Not including the emissions from tropical forest fires and the 10% of biofuel combustion emissions, which is the fraction assumed to be produced unsustainably

Source: Authors' calculations based on IFLS4 and ENV-linkages

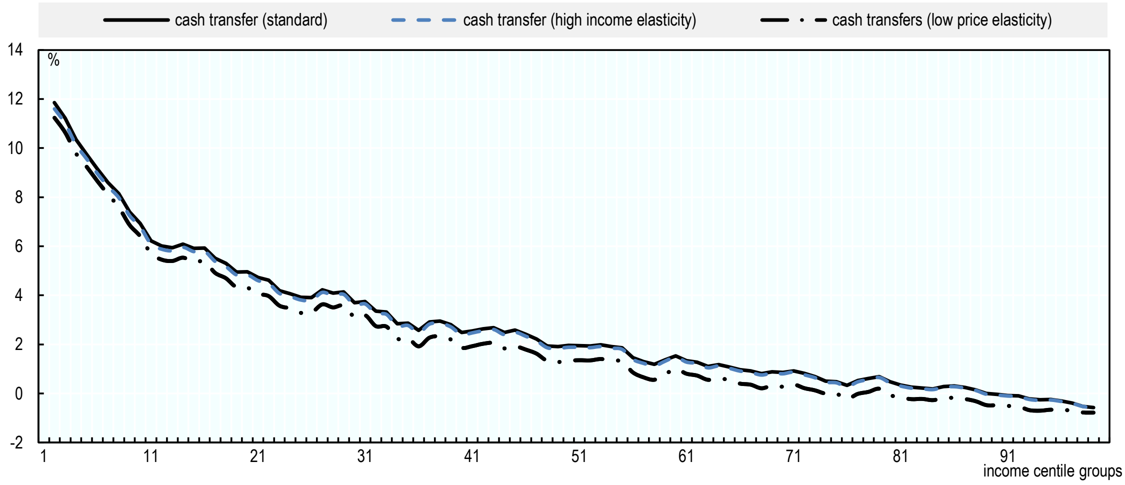
Even if the price elasticity of demand largely influences the environmental and economic performance of the cash transfer policy, it has very limited effect on its distributional performances. Table 8 shows that the dispersion statistics of the equivalent incomes of households are robust to the price elasticity. The overall distributive pattern is also robust, as shown in Figure 22. Of course, this result does not extend to the situation where different income and price elasticities are assumed for different household groups. There is unfortunately insufficient information to investigate such a situation.

Table 8. Sensitivity of welfare dispersion statistics in 2020 to demand elasticity values

Scenario	Baseline	Cash transfers (standard)	cash transfer (high income elasticity)	cash transfers (low price elasticity)
Inequality index				
Gini coefficient	0.445	0.436	0.436	0.437
Theil Index	0.348	0.336	0.336	0.337
Inter-quintile ratios				
Dec8/Dec3	2.4	2.3	2.3	2.3
Dec10/Dec1	8.2	7.6	7.6	7.6
Cent95/Cent5	14.2	12.7	12.7	12.7
Cent100/Cent1	45.2	39.0	39.0	38.9

Source: Authors' calculations based on IFLS4 and ENV-linkages

Figure 22. Welfare gains by centile in 2020 for alternative demand elasticities in the cash transfer scenario



Source: Authors' calculations based on IFLS4 and ENV-linkages

7. CONCLUSIONS

This paper provided a quantitative assessment of fossil-fuel subsidy reforms in Indonesia. It introduced an enhanced modelling framework, by combining the OECD's dynamic general equilibrium model ENV-Linkages with a dedicated module for assessing the distributional consequences of reform for specific household groups in Indonesia.

The illustrative simulations investigated in this report suggest that it is possible to reconcile the economic environmental and distributional performances of the policy reform. The phase out of energy consumption subsidies contributes to a 10% to 12% decrease in energy-related CO_2 emissions and to a 7.3% to 8.3% decrease in GHG emissions at the 2020 horizon compared with the baseline. These emission reductions exclude emissions from deforestation, which are large but highly uncertain and for which the model cannot make reliable projections. The IEA estimates that in 2010, CO_2 from forest fires were about 60% of total GHG emissions. Hence, the emission reductions achieved by the energy subsidy policy phase out are substantially lower when including deforestation emissions. Since most of the initial subsidy rates for energy consumption were relatively low for industries and high for households, the emissions-reduction effort is mainly driven by households who decrease their energy consumption by 42% to 46%. All the scenarios give way to positive impacts on GDP at the 2020 horizon (+0.4% to +0.7% in 2020 with respect to the baseline), due to a decrease in the deadweight loss associated with the subsidies and also, in some scenarios, to higher savings and investment. The good economic performance of the *cash transfer* scenarios does imply a somewhat smaller improvement in environmental performance, as the general level of economic activity is larger. The food subsidies recycling scheme is the best option in terms of emissions reduction, though this is largely due to the less positive impacts on GDP.

Concerning the distributional impacts, the scenario projections suggest that for households the direct effect of the subsidy reform, arising from higher energy prices, is regressive, especially in urban areas, and that the effect through incomes is distribution neutral. However, the redistribution schemes can make the total effect of the reform progressive and pro-poor. The *cash transfer* scenario is the most progressive among the scenarios investigated here. As cash transfers increase the incomes in the lowest income quantiles, they lead to a lower decrease in energy consumption and associated CO_2 emissions for these household categories. The budget redistribution using food subsidies is less progressive than with cash transfers, and the effect on GDP is less positive, as the food subsidies generate new inefficiencies and induce less savings and investment. Transfers proportional to labour income, as used in the *labour support* scenario are regressive, as income earned from formal labour represents a higher proportion of total income for higher-income than for lower-income households. This poor distributional performance comes along with less positive impacts on GDP than in the case of food subsidies, but gives way to very similar levels of emission reduction.

However, it is necessary to consider the feasibility of such mechanisms and their performance with respect to other mechanisms that were not included in this paper's policy scenarios. Cash transfers, if used as the sole way to compensate households for the phasing out of the energy subsidy, would reallocate a fraction of domestic wealth almost equivalent to the one previously managed by energy subsidies: more than 2.5 % of GDP. The feasibility and the transparent implementation of such massive cash transfer programmes over long periods of time can be questioned. Alternatively, cash transfers might be limited and targeted to more specific household groups. However, over time the mechanism is not without problem, as entitlement to the cash transfers can create dependence to these and interplay with the activity choices of households at the expense of their contribution to economic growth. In addition, the implementation of large-scale and long-lasting cash transfer systems represents, for the public authorities, a challenge comparable to the implementation of a full-scale social-security system. For these reasons, cash transfers can be also considered as a transitional response to the decrease in energy subsidies. In this case, their role is to limit the detrimental effects on poor households in the short and medium term, while they would be replaced in the longer run, by alternative destinations for the avoided subsidy expenditures.

This report represents an advance in the work of the OECD on the distributional impacts of environmental policies. The methodology developed, integrating detailed information on household behaviour in a full-scale socioeconomic model, is set up such that the analysis can be expanded to other countries. Countries like China, Egypt, India, Ukraine or Thailand also rely on energy subsidies to households. However, differences in local circumstances will influence the numerical results and warrant separate studies. But more generally, the modelling framework lends itself well to the analysis of the trade-offs associated with environmental policies between economic efficiency, environmental effectiveness and equity in both OECD and non-OECD countries. However, some limitations of the approach used in this report need to be underlined in order to better interpret the main outcomes and identify possible direction for future work.

Firstly, even though the report uses an advanced modelling framework that combines a micro and a macro approach, the policies investigated are defined at a macroeconomic level, in terms of a stylised reallocation of monetary flows from the government to households. This approach tends to abstract from the institutional context of Indonesia. This context is an essential bottleneck which restraint the possibility of efficiently compensating poor households and therefore the political feasibility of the subsidy reforms. For instance, as mentioned by World Bank (2014), "the implementation of cash transfers raises concerns on the amount of time and human and institutional capacity that may be needed for their effective implementation". To represent the institutional bottlenecks and the role of social security systems, the modelling approach would need several refinements; in particular it should be based on much more detailed data and an extended representation of existing policies. This would be indeed a full research program and would require collaboration with Indonesian counterparts.

Secondly, the current modelling framework is limited in terms of the redistribution mechanisms that could be analysed. It cannot represent in-kind transfers, supports to energy efficiency (for instance by the distribution energy-saving light bulbs), provision of public services and investment in infrastructure that would be made possible by an energy subsidy reform. Development of infrastructure for water or energy, and the provision of public services in particular for health and education might be very beneficial to the livelihood of the poor, reduce inequality and become a source of long term growth. However, simulating such policies, as well as their economic, environmental and distributional impacts, remains a challenge and is beyond the current capabilities of the modelling framework.

Thirdly, it is important to underline the necessary limitations of a welfare analysis based on household surveys. The underlying assumption is that all the households face the same prices and that they have access to all the commodities. But in practice, different households can face different prices, depending on their location, on access to commodities. Further work would be needed in order to better take into account the differences in local prices and accessibility in households' welfare measurement.

Fourthly, the representation of households' sources of revenue remains very simplified. The choice of activities by the households is not represented. Their labour supply is given and not influenced by changes in wages or by policies that favour the formal sector. Moreover the workers are assumed to be fully mobile across the production sectors and therefore it is not possible to address the bottlenecks associated with the change in the structure of activities or the some potential benefits of mechanisms that encourage accession to the formal sector. In addition, differences in saving behaviour of households between different income groups and the implied responsiveness to the policy reform should be investigated in more detail, since it presents a major feedback to the macro economy.

Lastly, an extension of the modelling framework to other countries can be severely limited by the availability of suitable data (see Appendix F) and by the fact that reconciling detailed budget survey data into the macroeconomic model is very time consuming. Hence, future research could be oriented towards less data intensive approaches by focusing on fundamental mechanisms at play in the trade-offs between economic, environmental and social performance of green growth policies. Such stylised analysis could for example focus on looking at different portions of the labour markets (e.g. through differentiating skill categories) or use synthetic indicators of household heterogeneity to mimic distributional consequences. Finally, distributional consequences of green growth policies extend beyond households, and it may also be worthwhile to study the differences in regional and sectoral impacts of green growth policies, thereby creating a link to competitiveness issues.

REFERENCES

Agustina, C. D., J. Arze del Granado, T. Bulman, W. Fengler,M. Ikhsan (2008), “Black Hole or Black Gold? The Impact of Oil and Gas Prices on Indonesia’s Public Finances” Policy Research Working Paper 4718, The World Bank East Asia and Pacific Region Pacific Poverty Reduction and Economic Management Unit, September 2008.

BPS (2011), Expenditure for consumption of Indonesia, based on SUSENAS 2011 first Quarter, BPS-Statistics Indonesia, http://www.bps.go.id/eng/hasil_publikasi/flip_2011/3201004/index.html?pageNumber=34

Burniaux, J. and J. Chateau (2014),“ Greenhouse gases mitigation potential and economic efficiency of phasing-out fossil fuel subsidies”, International Economics, Vol. 140, pp. 71-98.

Chateau, J., R. Dellink and E. Lanzi (2014a), "An Overview of the OECD ENV-Linkages Model: Version 3", *OECD Environment Working Papers*, No. 65, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5jz2qck2b2vd-en.

Chateau, J., B. Magné and L. Cozzi (2014), "Economic Implications of the IEA Efficient World Scenario", *OECD Environment Working Papers*, No. 64, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5jz2qcn29lbw-en.

Cheon, A., J. Uperlainen and M. Lackner (2013), “Why do governments subsidize gasoline consumption? An empirical analysis of global gasoline prices, 2002-2009”, *Energy Policy* Vol. 56, pp. 382-386.

Clements, B., H.-S. Jung and S. Gupta (2007), “Real and Distributive Effects of Petroleum Price Liberalization: The Case of Indonesia,” *Developing Economies*, Vol. 45(2), pp. 220-237.

Dartanto T. (2013), “Reducing fuel subsidies and the implication on fiscal balance and poverty in Indonesia: A simulation analysis”, *Energy Policy*, Vol. 58,pp. 117–134.

Dick, H. (1980), “The Oil Price Subsidy, Deforestation and Equity”, *Bulletin of Indonesian Economic Studies*, Vol. 16(3), pp. 32-60, DOI: 10.1080/00074918012331333829.

Diop, N. (2014), “Why is reducing Energy Subsidies a Prudent, Fair and Transformative policy for Indonesia?”, *World Bank Economic Premise*, No. 136.

EC (2010), “The distributional impact of imputed rent in EU-SILC”, Eurostat Methodologies and Working Papers.

Flues F., and Thomas A., forthcoming, The distributional effects of energy taxes, Tax Policy Working Paper, OECD.

Golan, A. and G. Judge (1996), “Recovering information in the case of underdetermined problems and incomplete economic data”, *Journal of Statistical Planning and Inference*, Vol. 49(1), pp. 127-136, doi: http://dx.doi.org/10.1016/0378-3758(95)00033-X.

G20 (2009), *G20 Leaders’ Statement: The Pittsburgh Summit*, September 24 – 25, 2009.

IEA (2000), *World Energy Outlook 1999: Looking at Energy Subsidies: Getting the Prices Right*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/weo-1999-en.

IEA (2006), *World Energy Outlook 2006*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/weo-2006-en.

IEA (2010), *World Energy Outlook 2010*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/weo-2010-en.

IEA (2011), *World Energy Outlook 2011*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/weo-2011-en.

IEA (2012), *World Energy Outlook 2012*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/weo-2012-en.

IEA (2013), *World Energy Outlook 2013*, IEA, Paris. DOI: http://dx.doi.org/10.1787/weo-2013-en

IEA, OECD, OPEC & World Bank (2010), Analysis of the scope of Energy Subsidies and Suggestions for the G-20 initiative, IEA, OPEC, OECD, World Bank Joint Report, Prepared for submission to the G-20 meeting, Toronto (Canada).

IISD (2012), "A citizen's guide to energy subsidies in Indonesia, 2012 update", International Institute for Sustainable Development, Global Subsidy Initiative, Report, http://www.iisd.org/gsi/sites/default/files/indonesia_czguide_eng_update_2012.pdf.

IISD (2014), "Indonesia Energy Subsidy Review, Biannual Survey of energy subsidy policies", International Institute for Sustainable Development, Global Subsidy Initiative, Report, March 2014 http://www.iisd.org/gsi/sites/default/files/ffs_indonesia_review_i1v1.pdf.

ILO (2013), Cash transfer programmes, poverty reduction and empowerment of women: A comparative analysis, International Labour Office, Working paper 4/2013.

Ivanic, M. (2004), Reconciliation of the GTAP and Household Survey Data, GTAP Technical paper 31.

Magné, B., J. Chateau, R. Dellink (2014), "Global implications of joint fossil fuel subsidy reform and nuclear phase-out: an economic analysis", (supplementary material), Climatic Change, Vol 123(3-4), pp 677-690.

Miranti, R., et al. (2013), "Trends in Poverty and Inequality in Decentralising Indonesia", *OECD Social, Employment and Migration Working Papers*, No. 148, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5k43bvt2dwjk-en.

Mourougane, A. (2010), "Phasing Out Energy Subsidies in Indonesia", *OECD Economics Department Working Papers*, No. 808, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5km5xvc9c46k-en.

OECD (2011), *Towards Green Growth*, OECD Green Growth Studies, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264111318-en.

OECD (2012), *OECD Review of Agricultural Policies: Indonesia 2012*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264179011-en

OECD (2013), *Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels 2013*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264187610-en.

Pitt, M. (1983), “Equity, Externality and Energy Subsidies, The case of Kerosene in Indonesia”, *Journal of Development Economics* Vol. 17(3), pp. 201-217.

Reimer, J. and T. Hertel (2003), International Cross Section Estimates of Demand for Use in the GTAP Model, GTAP Working Papers 1190, Center for Global Trade Analysis, Department of Agricultural Economics, Purdue University.

Rutherford, T., Tarr, D., and O. Shepotylo (2006), “The Impact on Russia of WTO Accession and The Doha Agenda: The importance of liberalization of barriers against foreign direct investment in services for growth and poverty reduction” in, Hertel, T. W. and L. A. Winters, (eds.) (2006).

Strauss, J., F. Witoelar, B. Sikoki and A. M. Wattie (2009), The Fourth Wave of the Indonesian Family Life Survey (IFLS4): Overview and Field Report. April 2009. WR-675/1-NIA/NICHD.

UNECE (2011), *Canberra Group Handbook on Household Income Statistics*, United Nations Economic Commission for Europe, Geneva.

Webster, M., S. Paltsev and J. Reilly (2008), "Autonomous efficiency improvement or income elasticity of energy demand: Does it matter?", Energy Economics, Vol 30(6), pp 2785-2798.

Widodo, T., G. A. Sahadewo, S. U, Setiastuti and M. Chaerriyah (2012), “Cambodia’s Electricity Sector in the Context of Regional Electricity Market Integration” in Wu, Y., X. Shi, and F. Kimura (eds.), *Energy Market Integration in East Asia: Theories, Electricity Sector and Subsidies*, ERIA Research Project Report 2011-17, Jakarta: ERIA, pp.173-206.

World Bank (2006), *Making the new Indonesia work for the poor*, The World Bank Washington D.C.

World Bank (2011), Indonesia Economic Quarterly, March 2011.

World Bank (2014), “Transitional policies to assist the poor while phasing out inefficient fossil fuel subsidies that encourage wasteful consumption”, unpublished technical paper, August 2014.

Yusuf, A. A., Komarulzaman, A., Hermawan W. Hortono, D. and K. R. Sjahrir (2010), Scenarios for Climate Change Mitigation from the Energy Sector in Indonesia: the Role of Fiscal Instruments, Working Paper in Economics and development Studies, No. 201005, Department of Economics, Padjadjaran University .

Yusuf, A. A. and B. P. Resosudarmo (2008), “Mitigating Distributional Impact of Fuel ¨Pricing Reform, The Indonesian experience”, ASEAN Economic Bulletin, Vol. 25(1), pp. 32-47.

APPENDIX

A. GHG emissions and energy consumption in Indonesia

Table 9. Historical GHG emissions by source in Indonesia

	1990	2000	2005	2010	As % of GHG emissions in 2010	CAAGR* (%) 2000-2005	CAAGR* (%) 2005-2010
Total GHG	1101	1444	2829	1926	100	14	-7
CO2 emissions	858	1185	2412	1615	84	15.27	-7.71
Fuel Combustion	146	273	336	410	21	4.23	4.09
Fugitive	10	8	6	4	0	-7.92	-5.88
Industrial processes	8	13	15	18	1	3.62	2.94
Others**	694	891	2055	1183	61	18.20	-10.46
CH4 emissions	152	168	260	219	11	9.12	-3.36
Energy	37	46	49	68	4	1.44	6.83
Agriculture	82	79	98	94	5	4.51	-0.82
Waste	26	40	51	56	3	4.94	2.03
Others***	7	3	62	0	0	78.03	-66.20
N2O emissions	89	91	157	91	5	11.55	-10.23
Agriculture	55	60	81	66	3	6.17	-4.09
Energy and ind. processes	4	4	5	4	0	1.22	-1.81
Others****	30	26	71	21	1	21.98	-21.32
Other GHG (HFC, PFC, SF6)	2	1	1	1	0	0.46	3.99

* Compounded Average Annual Growth Rate

**Sum of direct emissions from tropical forest fires and of 10% of biofuel combustion emissions, which is the fraction assumed to be produced unsustainably (IPCC Source/Sink Category 5).

***Includes industrial process emissions and tropical and temperate forest fires and other vegetation fires (IPCC Source/Sink Categories 2 and 5).

**** Others include N2O usage, tropical and temperate forest fires, and human sewage discharge and waste incineration (nonenergy) (IPCC Source/Sink Categories 3, 5 and 6).

Source: IEA CO2 Emissions from Fuel Combustion Statistics

Table 10. Historical energy-related CO2 emissions by sector in Indonesia

	1990	2000	2005	2011	% of CO2 emissions in 2011	CAAGR* (%) 2000-2005	CAAGR* (%) 2005-2011
CO2 emissions	146	273	336	426	100	4.23	4.04
Power generation	22	61	92	138	32	8.43	7.04
Other enrgy use	25	28	31	28	6	2.55	-2.10
Industry	44	76	98	118	28	5.19	3.14
Transport	32	65	74	115	27	2.61	7.60
Other	23	43	41	28	7	-1.02	-6.18

* Compounded Average Annual Growth Rate

Source: IEA CO2 Emissions from Fuel Combustion Statistics

Table 11. Historical final energy demand and fuels for power generation in Indonesia

	1990	2000	2005	2011	Share in 2011 (%)	CAAGR (%) 2000-2005	CAAGR (%) 2005-2011
Power generation (Mtoe)	8.9	28.0	39.2	57.7	100.0	6.9	6.7
Coal	2.3	8.4	13.4	21.9	37.9	9.8	8.5
Oil	4.0	4.6	9.3	10.4	17.9	15.1	1.7
Gas	0.2	5.8	4.1	8.3	14.3	-6.6	12.3
Hydro	0.5	0.9	0.9	1.1	1.8	1.4	2.5
Biomass & Waste	0.0	0.0	0.0	0.1	0.1	29.7	44.2
Other renewables	1.9	8.4	11.4	16.1	27.9	6.3	6.0
Final consumption (Mtoe)	79.8	120.3	134.2	158.3	100.0	2.2	2.8
Coal	2.1	4.7	8.3	11.2	7.1	12.4	5.1
Oil	27.2	49.0	53.4	64.4	40.7	1.7	3.2
Gas	6.0	11.5	13.6	16.6	10.5	3.4	3.4
Electricity	2.4	6.8	9.3	13.7	8.7	6.4	6.8
Biomass & Waste	42.0	48.3	49.6	52.3	33.0	0.5	0.9
Industry (Mtoe)	18.1	30.6	35.5	44.9	100.0	3.0	4.0
Coal	2.1	4.6	8.3	11.2	25.0	12	5
Oil	5.5	9.3	10.1	10.0	22.2	2	0
Gas	1.9	5.2	7.1	12.5	27.9	6	10
Electricity	1.3	2.9	3.7	4.8	10.6	5	4
Biomass & Waste	7.2	8.6	6.3	6.4	14.2	-6	0
Residential and services (Mtoe)	42.4	54.6	59.1	61.7	100.0	1.6	0.7
Oil	6.5	11.0	10.2	7.0	11.3	-1.6	-6.1
Gas	0.0	0.0	0.0	0.2	0.3	3.0	27.2
Electricity	1.2	3.9	5.6	9.0	14.6	7.6	8.2
Biomass & Waste	34.7	39.7	43.3	45.6	73.9	1.8	0.9
Transportation (Mtoe)	10.7	21.9	25.1	39.2	100.0	2.8	7.7
Oil	10.7	21.9	25.1	38.9	99.2	2.8	7.6
Gas	0.0	0.0	0.0	0.0	0.1	-23.1	30.3
Other	8.6	13.2	14.5	12.5	100.0	2.0	-2.5
Oil	4.5	6.9	8.1	8.6	68.9	3.3	1.1
Gas	4.1	6.3	6.5	3.9	31.1	0.5	-8.1

Source: IEA World Energy Statistics and Balances

B. Reconciliation of the budget survey and CGE data

The household-level information from the IFLS4 survey data and the national accounting data from the CGE model (based on the GTAP 8.1 database) are reconciled in order to produce, for the base-year (2011), a data set where individual incomes and expenditures are consistent with country-level totals. First, the incomes and expenditure categories from the survey data are assigned to social accounting input-output categories. This step involves matching the micro accounting categories of expenditures by function used in the survey to the macro accounting categories of expenditures by commodities of the CGE model (Ivanic, 2004). For instance, categories of goods whose consumption was reported in the survey have to be mapped into the goods categories used in the CGE model. In a second step, the household survey data are adjusted so as to ensure that, for each expenditure and incomes category, the sum over household is equal to the country-level total. This procedure is based on two successive cross-entropy minimization problems[29]: one for the incomes, one for the expenditures. As a result of these reconciliation processes, the

[29] See Golan and Judge (1996) for details about cross-entropy minimization problems.

household-level data are adjusted, but the weights of each household in total consumption from the survey data are preserved. Additional adjustments have also been necessary in order to ensure that, at the household level, the saving rates are consistent with the capital incomes.

B.1 Imputation of the survey incomes and expenditure to the social accounting categories

The expenditure part of the IFLS4 budget survey collects information on food, non-food goods and services on a weekly base, household items monthly and durable goods bought in the analysed year. For the sake of comparability with the national accounting data, the value of self-produced or not purchased goods was not considered as part of total expenditures as well as gifts given outside the household (Reimer and Hertel, 2003).

To map the survey's categories into the detailed (25 items) product categories used in ENV-Linkages, the approach used depended on the type of good considered. Special attention was paid to the imputation of energy product consumptions and to housing service category.

On the energy goods part, the kerosene and the electricity expenditures could be obtained by a direct mapping with the corresponding survey category. Given that the IFLS4 survey does not isolate expenditures for gasoline, diesel and LPG, the expenditures for these products had to be extracted from broader consumption categories using additional information included in the survey. For example, the households owing a Liquefied Petroleum Gas (LPG) stove, the LPG expenditure was approximated by total fuel expenditures. The gasoline and diesel consumptions were derived from the transportation expenditure categories of the survey (since the latter include the expenditures for "gasoline and the like") and from information about the vehicle ownership.

A specific imputation method is also used for housing service category. The survey provides a detailed breakdown of expenditure components including actual housing rents and estimated ones for self-owned or occupied dwellings. Special attention is devoted to the latter category that usually is not considered for the income and expenditure computations in a micro framework. When rent is clearly a cost for tenants and it contributes to income of housing owners, the macro framework, classifies the ownership of the dwellings as an industry that sells housing services to tenants and receives a gross-rent at competitive prices (UNECE, 2011). This value, net of current expenses, also enters in the income computation of housing owners. In addition to the reconciliation of housing services with the classification of the national accounting data, we built an imputation model to integrate few missing data (around 6% of the sample). We followed the literature on the estimation of dwelling services (EC, 2010) that considers location and household characteristics (rural/urban area, household size, availability of electric equipment and other facilities) as main explanatory variables, and expresses the rent in a logarithmic scale to better capture the non-linearity in the relation. Subsequently, we replaced the missing data with the average of generated values across imputations.

For the other goods and services, a simplified imputation method, using two-steps was used. First, the survey's expenditures were mapped into 5 broad categories (agricultural products, food products, manufactured goods, transportation and services). Then, the breakdown of these broad categories into the more detailed ENV-linkages categories was done with a proportional allocation based on the aggregate consumption structure in the ENV-linkages base year (2011) consumption expenditure for Indonesia.

The IFLS4 also collects information on total income received by all household's members, surveying the five main components of income: flows connected to economic activities (cash and in-kind), remuneration due to assets ownership, value of services produced for own consumption, transfers and inter-household flows (e.g. gifts). Expected, but not materialized earnings are excluded from income computation as well as holding gains/losses and irregular gains: e.g. lottery winning and lump sum pensions (UNECE, 2011).

The labour market section of IFLS4describes the occupation status of individuals (employed and self-employed), the sector of occupation and the remuneration (wages and net-profits, respectively). For the sake of micro-macro harmonization, the considered sectoral aggregation is: agriculture, electricity, manufacturing, transportation, construction and services. When the information about occupation was completely missing, we dropped the observation; instead, the missing yearly salary was integrated using the monthly data multiplied by the number of working months in the year. Sectoral information, in addition to province and urban/rural locations, was used for replacing the few left missing data using the conditioned mean technique. The year-end bonuses were included in the computation of yearly wage.

The salary section of IFLS4 was merged with more specific information on net-profits of household businesses (farm and non-farm). Regarding the farm activity, the difference between incomes and total production costs was used to fill the numerous missing data gaps on net-profits. For firm businesses, incomes used for household consumption were considered a more reliable estimate of net-profits; they were elicited as the sum of "the value of production used for household consumption, the value of business net income used on household expenditures and the amount of cash left over" (Strauss et al., 2009); when missing, we used the net-profit data. Moreover, net-profits both for farm and non-farm businesses were complemented taking into account yield loss experienced and income generated from other production assets (purchases, sales and rent of land, livestock, buildings, etc.) in order to obtain the total income from production.

The property income consists of the incomes generated by household financial and non-financial assets not used in the production process. The imputed rent (net of housing costs) from owned/occupied dwellings is an important component of income and is considered as the remuneration received for self-produced services.

The incomes are more difficult to be matched with the Social Accounting Matrix (SAM) categories. The main problems come from the choice of mapping procedure of business profits and wages from the survey to capital, labour, natural resources and land remunerations in the SAM. Following Ivanic (2004), we consider wages directly as labour remuneration as well as a portion of profits in farm and non-farm business computed using the average wage, sector and region specific. The left over profits from business and self-employed activities, in addition to property rents and dividends are accounted as generalised capital factor remuneration (capital, land and natural resources). The repartition of this aggregate is operated using the sector specific ratio of capital, land and natural resources coming from the CGE model.

The transfer aggregate includes monetary flows from government and non-profit institutions in the form of conditional and non-conditional support programs. Only 300 households report positive transfers, therefore for the other observations we imputed an average transfer depending on household size and income decile. We excluded from the computation inter-household flows.

B.2 Reconciliation procedure

After the imputation process, the discrepancies between the aggregate numbers in the CGE model and the total over households in the survey data have to be eliminated by reconciliation. A reconciliation procedure was designed to fulfil the following requirements:

1. The weight of each household in total consumption must be the same as in the household survey.

2. For each good category, the total expenditure across households must add-up to the CGE base-year representative household expenditure.

3. For each income category (labour, capital, etc.), the total across the households must add-up to the CGE base-year value.

4. At the household level, the total disposable income must be equal to the sum of expenditures and savings.

5. For all the households, the ratio between savings and capital incomes must be the same.

Condition (1) ensures that the distribution of total consumption between household in the household survey will be preserved after reconciliation. Requirements (2) and (3) are standard accounting conditions for the micro macro data reconciliation. But (4) was specified due to the inconsistencies observed at the household level between declared incomes and expenditures. Last, (5) was imposed, for the sake of the multi-period modelling exercise, in order to avoid in the baseline big reallocations of capital ownership between the households. Such reallocation would have significantly affected the dynamic of inequalities in the baseline and blurred the distributional analysis. A low savings rate is translated into a low marginal propensity to save (see Appendix C) and consequently into low capital accumulation in the baseline scenario. Identical savings to capital incomes ratios across households are used to avoid massive reallocation of capital incomes from households with low initial saving rates and high contribution of capital in their income to households with high saving rates with low initial contribution of capital in their income. One side consequence of this assumption is that there are no households with negative savings after the reconciliation.

The reconciliation procedure used to meet the five requirements was based on cross-entropy minimization problems (Golan and Judge, 1996) and can be summarized as follows. First, the expenditures are reconciled using cross entropy. Then, the household-level capital incomes and savings are computed by allocating the CGE model aggregate saving proportionally to the share of each household in total capital incomes as observed in the survey. Last, the non-capital incomes of households are reconciled with the survey using cross entropy minimization.

C. Calibration of the household's preferences parameters based on the survey

Each household group *h* containing population pop_h has the following type of utility function[30]:

$$u_h = \sum_i \left\{ mpc_{h,i} \cdot \ln(c_{h,i} - pop_h \cdot \theta_{h,i}) + mps_h \cdot \ln(s_h - pop_h \theta_{h,s}) \right\}$$

with $c_{h,i}$ the consumption of good *i*, and s_h the savings. The preference parameters are the marginal propensities to consume $mpc_{h,i}$, the marginal propensity to save $mpc_{h,i}$ and adjustment parameters $\theta_{h,i}$, and $\theta_{h,s}$.

The household's demand for consumption good and the saving behaviour results from the utility maximization under budget constraint:

[30] This form is very close to the utility function used for ELES demand system. The main difference is the adjustment term $\theta_{h,s}$ for savings. This term is used here to make possible the survey replication for alternative Frisch parameters. This property would allow us to do sensitivity analysis on the price elasticities by changing the Frisch parameters.

$$(c_h, s_h) = argmax\left\{u(c_h, s_h) \mid \sum_i p_i c_{h,i} + s_h \leq yd_h\right\}$$

The optimal demand for good *i* and the savings are given by:

$$c_{h,i} = pop_h \cdot \theta_{h,i} + \frac{mpc_{h,i}}{p_i}(yd_h - \sum_{i'} p_{i'}\theta_{h,i'} + \theta_{h,s})$$
$$s_h = pop_h \cdot \theta_{h,s} + mps_h(yd_h - \sum_{i'} p_{i'}\theta_{h,i'} + \theta_{h,s})$$

The household-group utility functions are calibrated on the consumption in volume ($\bar{c}_{h,i}$), consumption good prices[31], ($\bar{p}_i$) and savings ($\bar{s}_h$) taken from the reconciled survey; and also based on assumptions about the income elasticities of demand ($\eta_{h,i}$) and income elasticity of savings ($\eta_{h,s}$) and for the Frisch parameter (fr_h). By default, the Frisch parameters are equal for all the households, and the income elasticity parameters are based on the value used for the representative household in the standard version of the model.

First, the marginal propensities to consume and to save are:

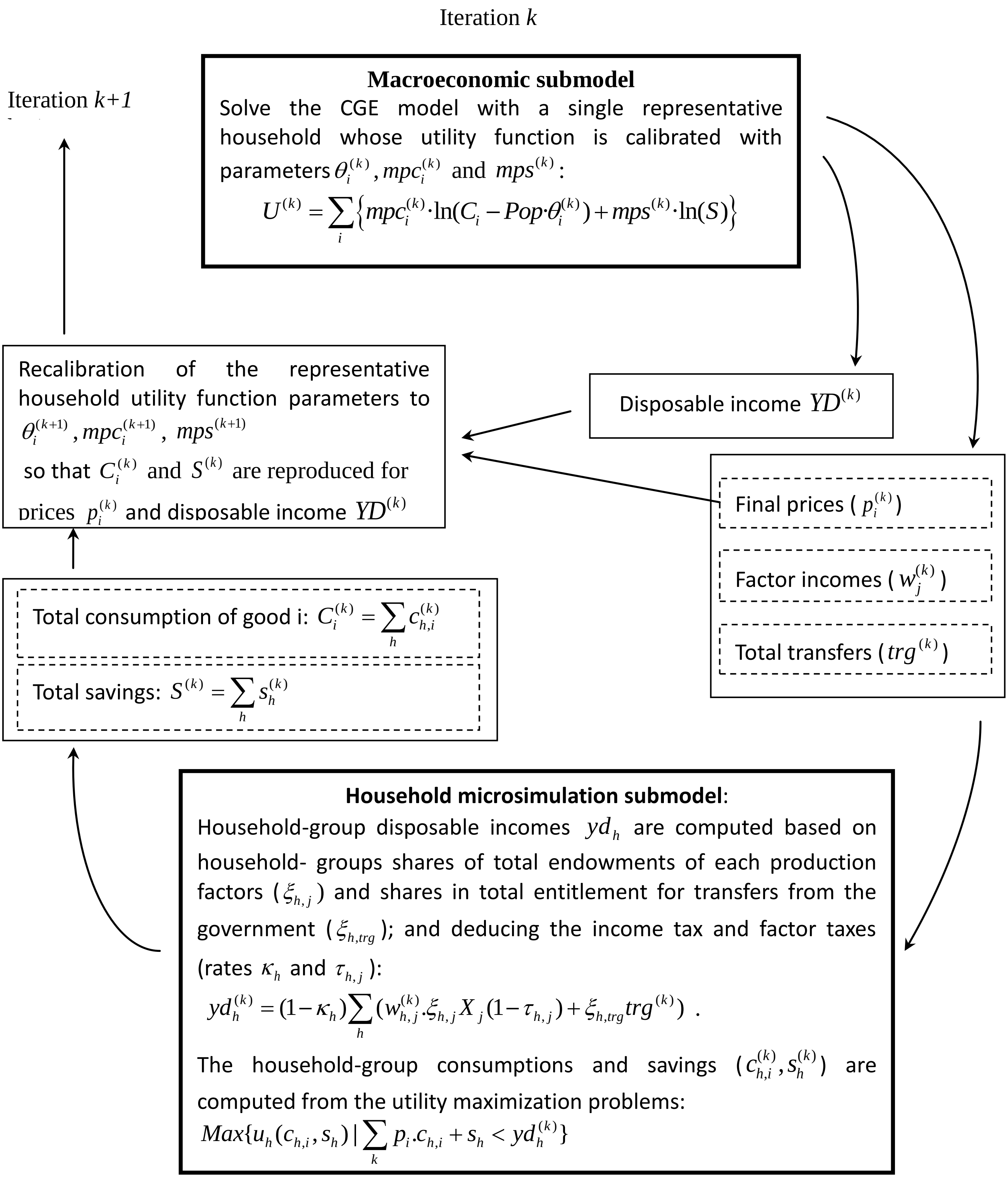
$$mpc_{h,i} = \eta_{h,i} \cdot \frac{\bar{p}_i \bar{c}_{h,i}}{\overline{yd}_{h,i}},$$
$$mps_h = \eta_{h,s} \cdot \frac{\bar{s}_h}{\overline{yd}_h}$$

Then, based on the Frisch parameter, the θ parameters are calibrated with formulas

$$\theta_{h,i} = (\bar{c}_{h,i} - mpc_i \frac{\overline{yd}_h}{\bar{p}_i \cdot (-fr_h)}) / pop_h$$
$$\theta_{h,s} = (\bar{s}_h - mps \frac{\overline{yd}_h}{\bar{p}_i \cdot (-fr_h)}) / pop_h$$

[31] The consumptions in volume are retrieved from the households expenditures using the CGE price base year price.

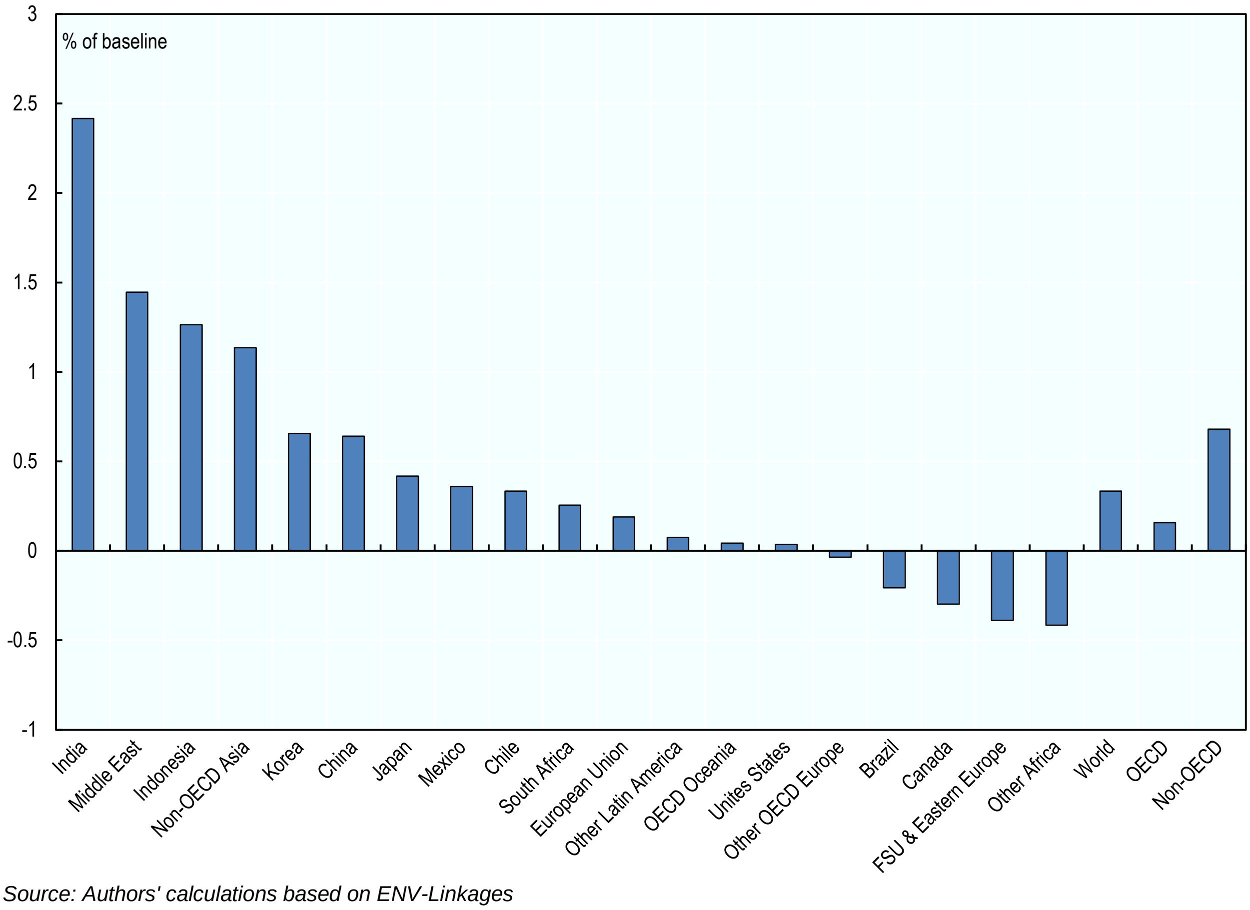
D. The model's decomposition algorithm



E. Regional effects of a multilateral phase out of energy consumption subsidies

Figure 23 displays impacts of the multilateral phase out of energy consumption subsidies on regional real incomes at horizon 2020. The gains at the world level reach 0.33% with respect to the baseline. Many of the regions that benefit most from the subsidy reform are in Asia, because of a their high initial level of energy consumption subsidies, the high energy intensity of their industry, their dependence on energy imports and their openness to trade. The Middle East, which is the main energy exporter, also benefits from the policy. On the one hand, it is the region where the energy subsidies are substantially larger than in other regions, implying a large positive efficiency effect from their removal. But this is mitigated by a negative effect through oil markets as the multilateral energy consumption subsidy reform tends to depress on global oil prices. However, the latter effect is rather limited in 2020 and the efficiency effect dominates. The regions that are negatively affected by the reform are energy exporters. These results are largely in line with those commented more deeply in Magné *et al.* (2014). The magnitude of the impacts appears different in both studies, as the results presented here are for the year 2020, while Magné *et al.* (2014) highlighted consequences in 2035.

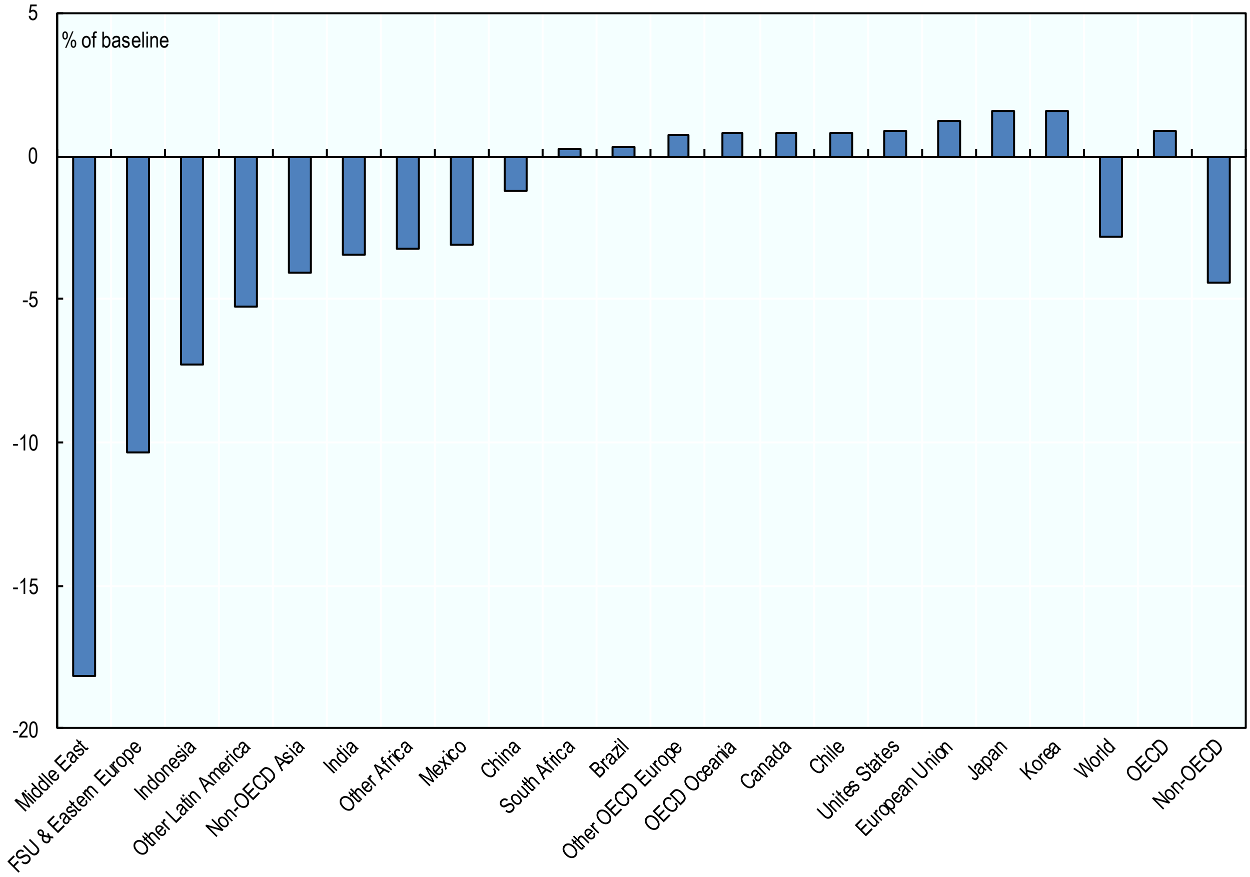
Figure 23. Impact of a multilateral energy consumption subsidy phase out on regional real income in 2020



Source: Authors' calculations based on ENV-Linkages

Figure 24 shows that the multilateral phase out of energy consumption subsidies leads to 3% global GHG emission reduction at horizon 2020 relative to the baseline. The reduction is driven mostly by non-OECD countries (-4.5%). Emissions in the OECD countries slightly increase (0.9%) as a result of lower international energy prices. The regions whose emissions decrease most are those with the highest initial energy consumption subsidies as a proportion of GDP (see Figure 2), specifically Middle-East, FSU and Eastern Europe, Indonesia and non-OECD Latin America.

Figure 24. Impact of a multilateral energy consumption subsidy phase out on regional GHG emissions in 2020



Note: these GHG emissions do not include the emissions from tropical forest fires and the 10% of biofuel combustion emissions, which is the fraction assumed to be produced unsustainably

Source: Authors' calculations based on ENV-Linkages

F. Data availability issue for extending the distributional analysis to other countries

In theory the type of analysis presented in this paper can be generalized to other countries and to various topics related to environmental tax reform. But such analysis is made difficult by the lack of availability of suitable international harmonized micro data on households' incomes and expenditures that is publicly available (see Table 12). The OECD Center for Tax policy and Administration (CTP) has an elaborated and harmonized data set (Flues and Thomas, Forthcoming), mostly based on confidential micro data provided by Eurosat. The publicly available Eurostat data and other cross country sources lack of detail in terms of number household quantile groups and give very partial or no information on energy expenditures.

Table 12. Main sources of cross country households income and expenditure data

	OECD Center for tax policy and administration (OECD/CTP)	Cross-national data center in Luxembourg (LIS)*	Eurostat website*	ILO Laborstat*
Type of data	Micro data including income and expenditure	Micro data on incomes and expenditures	data on expenditures per quintiles and mostly per quintile	data on income and expenditure per, the number of quantiles is in bracket
Energy consumption categories	several	no	a single category including electricity, gas and other fuels	single category including fuel and lighting
Accessibility	Confidential	On request. Only aggregated indicators can be loaded	Publicly available	Publicly available
Country coverage**				
Australia		2003		1998-1998 (10)
Austria	2009	2004	2005	
Belgium	2010	2000	2005	2001 (10)
Brazil		2011		
Bulgaria			2005	2004 (10)
Canada		2010		
Chile	2012			
China		2002		
Columbia		2010		
Czech Rep	2010	2004	2005	2003 (10)
Denmark		2010	2005	2001-2003 (10)
Estonia	2010	2010	2005	2004 (5)
Finland	2012	2010	2005	2001 (10)
France	2011	2005	2005	2001 (10)
Germany	2008	2010	2005	
Greece	2010	2010	2005	
Hungary	2010	2005	2005	2003 (10)
Iceland		2010		2001-2003 (4)
India		2004		2003.0
Ireland	2004	2010	2005	
Israel		2010		
Italy	2010	2008	1999	
Japan		2008		
Luxembourg	2010	2010	2005	
Mexico		2010		2002 (10)
Netherland	2004	2010	2005	2000 (10)
Norway		2010	2005	2002 (6)
New Zealand				
Poland	2010	2004	2005	2003 (5)
Portugal			2005	
Russia		2010		
Slovak Republic	2010	2010	2005	
Slovenia	2010	2010	2005	
South Africa		2010		
South Korea		2010		2004 (10)
Spain	2010	2010	2005	2002 (10)
Switzerland	2011	2004		2003 (10)
Sweden		2005	2005	
Chinese Taipei		2010		
Turkey	2010		2005	2003 (10)
UK	2010	2010	2005	2003-2004 (10)
Turkey		2010		2003 (10)
USA		2004		
Sources	see Flues and Thomas. (Forthcoming)	http://www.lisdatacenter.org/	ec.europa.eu/eurostat	http://laborsta.ilo.org/STP/guest

Notes * The description correspond to the data as they where in July 1014. ** The year corresponds to the year of the survey. For ILO data, the figures in brackets correspond to the number of quantile for which income of expenditures data are available

Source: Authors' review