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Institutional Policy and Economic Impacts of Energy Subsidies Removal in East Asia

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Executive Summary

The Economic Research Institute for ASEAN and East Asia (ERIA) and the International Energy Agency (2013) estimate that fossil fuel subsidies amounted to US$51 billion in Southeast Asia in 2012. It is widely accepted that fossil fuel subsidies encourage wasteful energy use and burden government budgets. They also defer investment in energy infrastructure and efficient technology, and undermine renewable energy undertakings. While some ASEAN countries have acted to remove the subsidies, governments must take care in doing so as removing subsidies can often be politically sensitive. On the other hand, energy subsidies incentivise consumption and can result in increased energy demand. When the subsidies are inefficient, they can lead to fiscal pressure, harmful emissions, and potentially hamper sustainable green growth in East Asia Summit countries. Reducing subsidies should encourage more energy efficient consumption, have positive impacts on international energy prices and energy security, and make renewable energy and technologies more competitive. The environment and society should also benefit from reductions in local pollution and greenhouse gas emissions.

ERIA undertakes this study at a time when countries in ASEAN and East Asia, such as Malaysia, Indonesia, Thailand, China, and India, are embarking on energy reforms by removing their energy subsidies.

For leaders and policy-makers, energy subsidy reforms pose a challenging task as they involve positive impacts in the long term, but negative impacts on the economy and society in the short term.

The key findings suggest potential economic impacts of removing the energy subsidies:

For Malaysia's case, either a petroleum or gas subsidy removal or both would improve economic efficiency and increase real GDP by up to almost 1 percent in the short term. The immediate impact would be that the budget deficit would be greatly reduced after removing the government-funded petroleum subsidy.

For Thailand's case, the removal of fossil fuel subsidies, with reallocation to households and the government budget, is projected to have a negligent impact on the country's gross domestic product (GDP) in the short term. Accordingly, policy-makers do not need to be concerned when deciding whether to implement the reforms.

For India's case, the government wants to remove subsidies for liquefied petroleum gas (LPG) as LPG is used as the primary cooking fuel by urban and rural households, as well as commercial establishments. However, the LPG subsidy seems to benefit the rich more than the poor as most of the subsidy share goes to benefiting urban dwellers (69 percent share of the LPG subsidy). The study's findings suggest that removing the LPG subsidy would have little impact on the rate of economic growth. Thus, this supports the removal of the energy subsidy if the government wishes to pursue it.

For China's case, the country's total energy subsidies in 2010 accounted for 4.7 percent of GDP. The coal subsidy was the highest, accounting for 1.97 percent of total GDP, followed by the electricity subsidy, which accounted for 0.73 percent of total GDP. The study focuses on the removal of energy subsidies in China's iron and steel industry. The findings suggest that removing energy subsidies will induce costs, and thus require technological innovation for higher energy efficiency through aggressive policy support. The study also suggests that removing the energy subsidy could correct negative environmental externalities and improve social welfare in China.

The above studies, however, point out that removal of the energy subsidies will induce costs at all levels, and households will be worse off in the short term due to higher price levels. Therefore, careful, compensating policies are needed:

1. *Targeting*. While the reform of energy subsidies shows positive signs, energy subsidies will need to be targeted at population groups that need energy for their basic needs, such as cooking, lighting, and transportation.

2. *Transparency*. It is important that governments publicise their use of cash transfers to support the poor during the gradual removal of the energy subsidies. Transparency will help to garner public support during the reform process. Public campaigns and education outreach will be needed to clearly show how energy subsidies impact welfare, discourage investment, and reduce competition.

3. *Consistency*. Well-established programmes to monitor progress and mitigate any negative impacts will be needed. Reporting on, monitoring, and disseminating information on the reform process with clear timeframes, sector by sector, will allow all stakeholders to envisage the costs they and their businesses will incur in the future. This will ensure greater success for the reform programme. The reform process will benefit welfare, investment, and future growth, so government strategies need to build on these arguments and facts to show the public the benefits in a transparent and timely manner.

4. *Policy support*. Policy support and investment in efficient technologies, including environmental technologies, are key to promoting firm competitiveness due to lower energy consumption and savings.

Chapter 1

A Review of Energy Subsidy Removals and Other Energy Policy Reforms: The Case of Malaysia

Han Phoumin[1]

Abstract

Energy is heavily subsidized across the globe and energy subsidies exert an extensive economic burden on many countries, particularly on developing economies. The Government of Malaysia has a clear objective and rationale for removing inefficient fuel subsidies that do not reach the intended beneficiaries and benefit only richer groups. As such, the government has embarked in the right direction of energy reforms during the period of low oil prices since 2014. The phasing out of energy subsidies in Malaysia will have a positive effect as the country starts to see budget growth through the narrowing of government debt over time. It will also have multiple effects and benefits on the economy and welfare in Malaysia in the near future. To support the government carry out the fossil fuel reform effectively, this paper aims to provide policy recommendations to the government to ensure that the ongoing reform process will bring positive changes to the economy and the fossil fuel reform gains public support through a transparent process.

[1] Energy Economist, Economic Research Institute for ASEAN and East Asia

1. Introduction

In the past few decades, Malaysia has achieved great economic and social development by growing from a nation with an agricultural and commodity-based economy to becoming a prosperous middle-income nation. Robust economic growth, with a real gross domestic product (GDP) average growth rate of almost 6% per annum from 1991 to 2010, has helped improve the quality of life for Malaysians and has supported widespread advances in education, health, infrastructure, housing, and public amenities (The Tenth Malaysian Plan, 2011–2015).

However, in the current environment, Malaysia has faced new challenges at a critical juncture in its developmental journey of moving away from the middle-income trap. To propel itself away from the middle-income trap and reach the next level of high income, Malaysia will require urgent reforms through new, innovative approaches for implementing the Government Transformation Programme and the New Economic Model, which are premised on high income, inclusiveness, and sustainability. These approaches incorporate the 10 big ideas identified in the Tenth Malaysian Plan: being internally driven and externally aware; leveraging on diversity internationally; transforming to high income status through specialisation; unleashing productivity-led growth and innovation; nurturing, attracting, and retaining top talent; ensuring equality of opportunities and safeguarding the vulnerable; achieving concentrated growth and inclusive development; supporting effective and smart partnerships; valuing environmental endowments; and positioning the government as a competitive corporation (The Tenth Malaysia Plan 2011–2015).

Among the sectors targeted for Malaysia's economic transformation, reform of the energy sector and alleviation of its burden on the government budget is a top priority. Energy subsidies are important if they are well targeted for people who need energy to survive and to improve their well-beings. For example, fossil fuel subsidies are important as they improve the living conditions of the poor by making fuel for cooking and heating, such as kerosene, liquefied petroleum gas (LPG), and electricity, more affordable. In developing countries, where such subsidies are common, they can considerably raise the standard of living by enabling traditional fuels to be phased out. As a result, these communities experience less indoor pollution and a reduction in time spent gathering fuel, resulting in more time for education and other productive activities (United Nations Environment Programme, 2008).

However, energy subsidies, such as those in Malaysia, are rarely targeted specifically at the low-income groups that need them but are often "blanket subsidies," available to all consumers, regardless of their wealth. As a result, these subsidies benefit energy companies, suppliers, and wealthy households in urban areas comparatively more than they do poor households. Similar evidence has been found elsewhere. For example, energy subsidies in Peru for the Amazon region (through value-added tax exemptions) have led to wasteful and inefficient use of fossil fuels. Instead of increasing economic development in the Amazon region, the subsidies have induced smuggling and encouraged illegal activities, such as illegal logging and mining in the Amazon (APEC, 2015). Another energy subsidy study by the

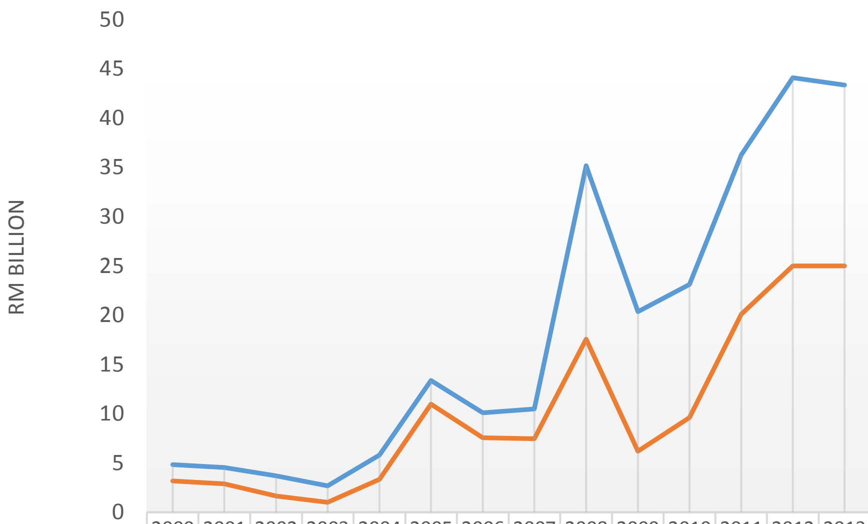
International Monetary Fund (2013) revealed that the bottom 20% of households received on average only 7% of the total subsidy, whereas the top 20% received 43%. Even kerosene subsidies, which are typically seen as being pro-poor, are not well targeted, with the top 60 % of households always receiving more than 57% of the subsidies (Baig et al., 2007).

Thus, there is a strong rationale for removing inefficient fuel subsidies that do not reach the intended beneficiaries and benefit only richer groups. Global energy prices have dropped since the end of 2014. As such, the Malaysian government has embarked in the right direction of energy reforms during the period of low oil prices. The phasing out of energy subsidies in Malaysia will have a positive effect as the country starts to see budget growth through the narrowing of government debt over time, and will have multiple effects and benefits on the economy and welfare in Malaysia in the near future.

2. The Motive for Subsidy Removals

Energy subsidies have been long existed in Malaysia, with the intention of keeping energy affordable for its citizens. Fuel subsidies have made goods and services cheaper by reducing input costs at the expense of increasing national debt. Overall subsidies were around only RM4–5 billion annually in the early 2000s, but rose exponentially to more than RM43 billion by 2013 (see Figure 1.1), at which time the government felt it was no longer possible to keep the subsidy price at the same level amid growing consumption.

Figure 1.1. Total Subsidies in Malaysia



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total subsidies (RM billion)	4.83	4.55	3.68	2.68	5.80	13.39	10.11	10.48	35.17	20.35	23.11	36.26	44.10	43.35
Total fuel subsidies (RM billion)	3.17	2.88	1.65	1.01	3.34	10.98	7.56	7.47	17.56	6.19	9.61	20.10	25.00	25.00

Source: Ministry of Finance Malaysia (2014).

Although subsidies lower the costs of production, they are also a burden on government expenditure. The large federal government debt was estimated at RM582.8 billion, or 54.5% of GDP, at the end of December 2014 (Ministry of Finance Malaysia, 2014). This burden prompted a serious move by the Malaysian government to carry out reforms on energy subsidies, among other measures. As of 2011, the subsidies represented 11.18% of Malaysia's government operating expenditure, equal to 2.3% of GDP in the same year (Ilias et. al., 2012). Among all subsidies, the fossil fuel (LPG, diesel, and petrol) and electricity subsidies represented 40% and 6% respectively, of total subsidies in the same year. The financial burden took a toll on economic growth and may have been a major hindrance to Malaysia's aspiration to achieving developed nation status by 2020.

Energy subsidies make up a large portion, about 5%, of government expenditure, and have grown exponentially from a few billion to around RM25 billion in 2014, as shown in Figure 1.1. In 2013, Malaysia's Prime Minister Najib initiated subsidies reforms in which fuel subsidies underwent a major reform, although they were not wholly abolished. The government realised that the blanket fuel subsidies and electricity tariff had aided the rich more than the poor. The fuel subsidies had also led to fuel smuggling to neighbouring economies at the expense of Malaysia's public funds, and this was considered to be wasteful expenditure (The Nation, 2014b).

The prices for RON 95, diesel, and LPG have been set by the Malaysian government since 1983 through what it calls an "automatic pricing mechanism". The way in which the pricing mechanism is set, or is called "automatic", suggests a pricing system that passes price fluctuations through to the consumer using a government predetermined formula. However, in practice, the prices of RON 95, diesel, and LPG have barely changed since 2009, and the price fluctuations have not been passed through to the consumer. In fact, the Malaysian government has used the automatic pricing mechanism to determine the subsidy needed to cover the difference between a fixed retail price and the market price (International Institute for Sustainable Development, 2013). Likewise, the electricity tariff rate has been set to increase by 4.99 sen/kilowatt hour (kWh) from 33.54 sen/kWh to 38.53 sen/kWh (almost 15%) for the 4-year period 2014–2017. This increase in tariff rate will cover the fuel component that needs to be passed through to end-users and consumers.

In general, energy subsidies bring with them many undesirable impacts, such as encouraging inefficient energy use, undermining returns on investments, and promoting reliance on outdated environmentally unfriendly technology that has negative environmental impacts. Thus, the energy subsidies reform will try to bring the subsidised prices of fuel products closer to their market clearing levels, while targeting remaining subsidies at the needy. The overriding goal of the subsidies is to address fiscal imbalances to improve not only the production system's efficiency but also efficiency in resource allocation. In this regard, the prime minister mentioned that fiscal reform including the energy subsidies reform was important to ensure that the targeted fiscal deficit remained at 3.5% of GDP in 2014, and 3% of GDP in 2015, and that a balanced budget would be achieved in 2020 (The Nation, 2014a).

3. Energy Subsidy Reform and its Economic Impacts

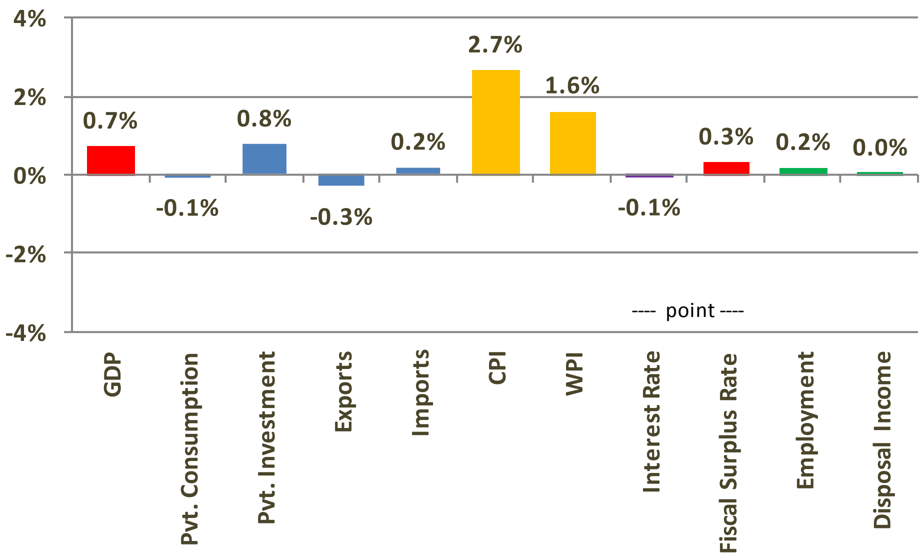
In July 2010, a subsidy reform programme was initiated by Prime Minister Najib to rationalise the 10th Malaysia Plan (2010–2015) and the New Economic Model (Economic Planning Unit, 2010), which set out the government's strategy for making Malaysia a high-income nation by 2020. The attempt to remove subsidies is a serious issue for the government as the prime minister has emphasised that more than RM40 billion alone was set aside for a price support scheme, and RM 49 billion for spending on development in 2014 (The Nation, 2014b).

About RM25 billion was allocated to fuel subsidies in 2013 and the subsidy reduction was to save at least RM 3.3 billion. However, the reform was only partial in 2013, and costly and significant price support for fuel still exists (Najib, 2013a).

The reform process gained momentum in 2014 and seemed to have a positive effect on the government budget. For instance, a government policy (the implementation of a managed float fuel pricing mechanism effective from 1 December 2014) to increase fuel prices through a 20-sen reduction in fuel subsidies for RON 95 petrol and diesel, and the increase of the electricity tariff from 33.54 sen/kWh to 38.53 sen/kWh, contributed to a decline in subsidy payments by 21.2% in fiscal year 2014 (Ministry of Finance Malaysia, 2014).

An empirical study by Rashid (2012) suggests that a subsidy reduction of 1 cent for the retail price of petrol could represent a reduction of government expenditure by as much as RM134 million. Another study by the Economic Research Institute for ASEAN and East Asia (ERIA) and the Institute for Energy Economics, Japan (IEEJ) in 2016 in a quantitative analysis of the economic impacts of an energy subsidy removal in Malaysia showed that the optimum positive economic effect could be observed if the Malaysian government uses all of its saved energy subsidy budget to reinvest into other sectors, such as investment in social infrastructure and expenditure for education, GDP would increase by 0.7 percentage points, the fiscal deficit would improve by 0.3 percentage points, and private investment would improve by 0.8 percentage points compared to the baseline case assuming no subsidy removal (see Figure 1.2).

Figure 1.2. Economic Impacts of Removing Energy Subsidies and Reinvesting in Other Social and Infrastructure Sectors (Changes from the Reference Case in 2020)

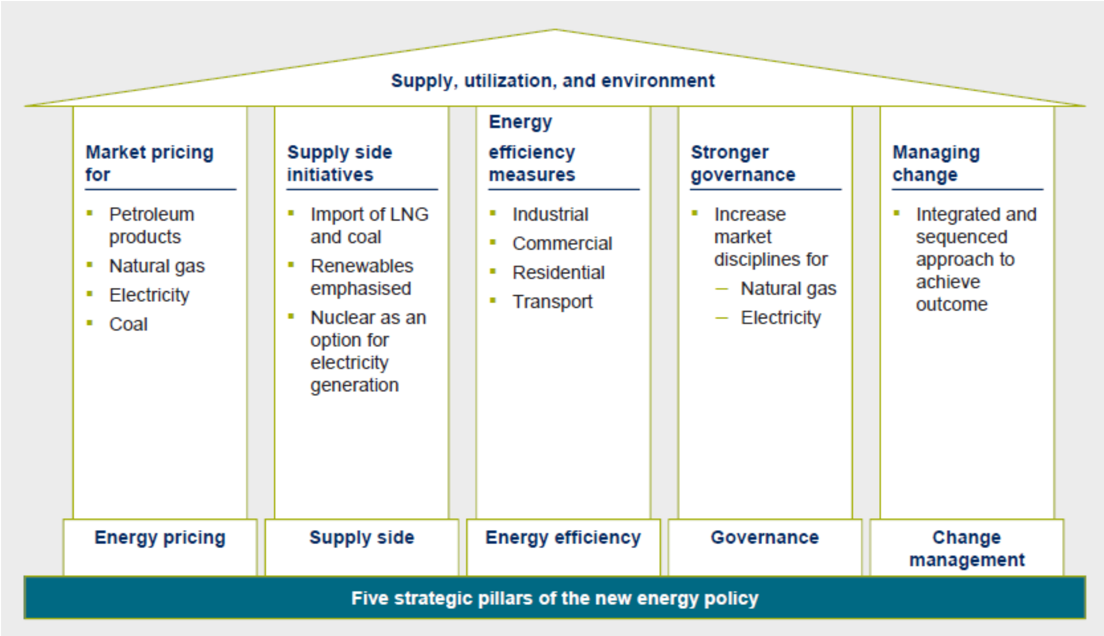


CPI = consumer price index, GDP = gross domestic product, WPI = wholesale price index.
Note: Changes are shown as percentage points.
Source: Quantitative Analysis for Economic Impacts by Removing Energy Subsidies in Malaysia. ERIA and IEEJ (2016).

4. Making Energy Reform Meaningful with Other Necessary Energy Policies

The New Energy Policy within the Tenth Malaysian Plan (2011–2015) emphasises energy security and economic efficiency as well as environmental and social considerations. The policy focuses on five strategic pillars (see Figure 1.3): initiatives to secure and manage a reliable energy supply; measures to encourage energy efficiency; the adoption of market-based energy pricing; stronger governance; and managing change. Another key pillar in Malaysia's energy strategy is to become a regional oil and natural gas storage, trading, and development hub that will attract technical expertise and downstream services that can compete in Asia as well as promote energy efficiency measures and the use of alternative energy sources.

Figure 1.3. Five Strategic Pillars of the New Energy Policy



Source: *The Tenth Malaysia Plan 2011-2015*.

4.1. Renewable Policy and Initiatives

The National Renewable Energy Policy and Action Plan (2008) of Malaysia have set a national target to diversify the country's energy mix, including feeding 975 megawatts (MW), or 5.5%, of renewable energy into the grid by 2015 (see Table 1.1). By 2020, this is targeted to double to 2.065 MW, or 11%. Solar power is expected to contribute a minimum of 220 MW to the total capacity mix. The Ministry of Energy, Green Technology and Water's Green Technology Financing Scheme, worth RM1.5 billion (about US$500 million), offers incentives to green technologies.

The Small and Renewable Energy Programme, launched in May 2001, allows renewable projects with up to 10 MW of capacity to sell their electricity output to Tenaga Nasional Berhad (TNB) under 21-year license agreements. Any renewable energy plant, including biomass, biogas, municipal waste, solar, mini-hydropower, and wind energy plants, may apply to sell energy to the grid. The programme was limited to 219 MW in 2011 but increased to nearly 1 gigawatt in 2015. While participation has steadily increased and the results have been encouraging, the total volume of electricity generated is still small. With an attractive feed-in tariff rate (adopted in 2011) and abundant natural resources, Malaysia is ripe for foreign investment in renewable energy projects. For example, ABB – the leading power and automation technology group – has delivered and commissioned key components to integrate renewable energy from Amcorp Power Sdn Bhd's Gemas 10.25 MW solar power plant into Malaysia's electricity grid (ABB, 2014). Amcorp Power's solar plant located in Gemas, Negeri Sembilan, about 100 miles from the Malaysian capital, Kuala Lumpur, is the country's largest solar power plant and represents approximately 11% of its nearly 116 MW of grid-connected solar photovoltaic capacity.

Table 1.1. Renewable Energy Policy Planned Outcomes

Year Ending	Cumulative Total Renewable Energy(MW)	Share of Renewable Energy Capacity (%)	Annual Renewable Energy Generation (GWh)	Share of Renewable Energy Mix (%)	Annual CO_2 Avoidance (t)
2011	217	1%	1,228	1%	773,325
2015	975	6%	5,374	5%	3,385,406
2020	2,065	10%	11,227	9%	7,073,199
2030	3,484	13%	16,512	10%	10,402,484
2050	11,544	34%	25,579	13%	16,114,871

GWh = gigawatt hours, t = tonnes.
Source: The National Renewable Energy Policy and Action Plan (2008).

According to the renewable energy country profile of IRENA (2015), there are completed and ongoing renewable projects from the government and the private sector, including 36 MW of geothermal capacity addition by the end 2015 (1 project); 10 MW of solar photovoltaic capacity addition by mid-2013 (1 project); more than 20 MW announced (6 projects); around 1,100 million litres of biodiesel per year capacity addition announced (8 projects); more than 220 MW of biomass-fired capacity addition announced; and 45 MW of small hydro capacity addition announced (9 projects).

4.2. Energy Efficiency Policy and Initiatives

The National Energy Efficiency Master Plan (2010) has been a holistic implementation roadmap to drive efficiency measures across sectors with the target of achieving cumulative energy savings of 4,000 kilo tonnes of oil equivalent by 2015. Initiatives to drive energy efficiency efforts are shown in Table 1.2.

4.3. Power Generation Developments and Initiatives

Malaysia's electricity demand, mostly met by natural gas and to a lesser extent coal, continues to expand rapidly. In recent years, fuel availability to the power sector has been challenged by tightness in the supply of natural gas. Although gas shortages in Peninsular Malaysia and growing electricity demand in recent years have spurred the use of other fuels such as coal, diesel, and renewable sources, most of Malaysia's electricity generation capacity is natural gas fired.

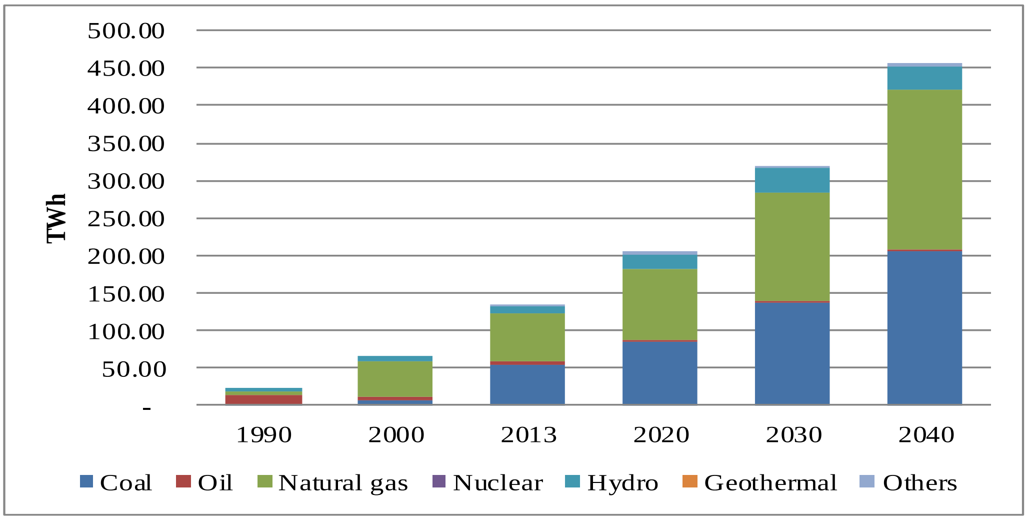
Table 1.2. Initiatives to Drive Energy Efficiency Efforts

Sector	Initiatives
Residential	- Phasing out of incandescent light bulbs by 2014 to reduce carbon dioxide emissions by an estimated 732,000 tonnes and reducing energy usage by 1,074 gigawatts a year - Increasing energy performance labelling from 4 (air conditioners, refrigerators, televisions, and fans) to 10 electrical appliances (six additional appliances: rice cookers, electric kettles, washing machines, microwaves, clothes dryers, and dishwashers) - Labelling appliances enables consumers to make informed decisions as they purchase energy efficient products.
Township	- Introduction of guidelines for green townships and rating scales based on a carbon footprint baseline and promoting such townships, starting with the towns of Putrajaya and Cyberjaya
Industrial	- Increasing the use of energy efficient machinery and equipment, such as high-efficiency motors, pumps, and variable speed drive controls - Introduction of minimum energy performance standards for selected appliances to restrict the manufacture, import, and sale of inefficient appliances to consumers
Building	- Revision of the Uniform Building By-Laws to incorporate the Malaysian Standard: Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings (MS1525). This allows for the integration of renewable energy systems and energy saving features in buildings. - Wider adoption of the Green Building Index to benchmark energy consumption in new and existing buildings - Increasing the use of thermal insulation for roofs in air-conditioned buildings to save energy

Source: The National Energy Efficiency Master Plan (2010)].

Kimura and Han (2016) conducted the study, *Energy Outlook and Energy Saving Potential in East Asia Region 2016*. The study's country estimates show that Malaysia's current total power generation is expected to grow by around 4.7% per year from 2013 until 2040, reaching 457 terawatt hours (TWh). Power generation from coal is projected to increase to almost 206.14 TWh in 2040 compared to 53.37 TWh in 2013. Power generation from natural gas will experience an annual growth rate of 4.6% per year from 2013 until 2040, from 63.32 TWh in 2013 to 211.93 TWh in 2040. Power generation from other sources (biomass and other renewable sources) will have the fastest growth at 6.6% per year from 2013 until 2040 (see Figure 1.4 and 1.5).

Figure 1.4. Power Generation by Fuel, Business-as-Usual Scenario



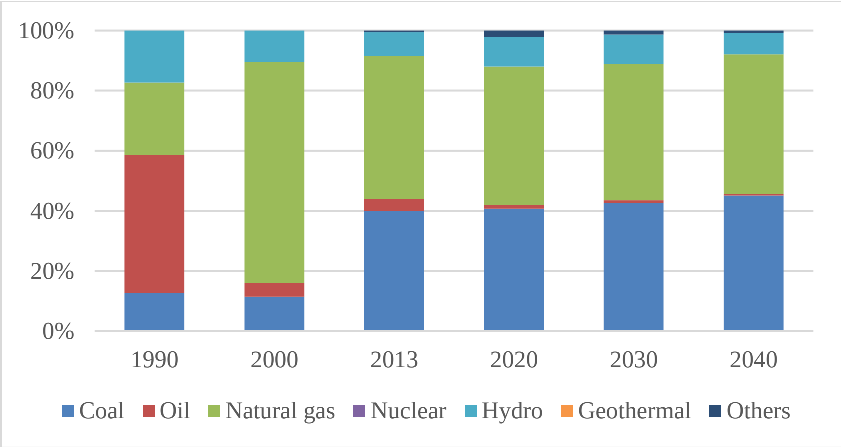
TWh = terawatt hours.
Source: Kimura and Han (2016).

In terms of share, the power generation mix will be dominated by natural gas and coal in 2040, with shares of 46.4% and 45.1%, respectively. Hydro follows with a share of 7.0% in 2040 compared to 7.9% in 2013. The share of others will be 0.9% of the total power generation in 2040. The oil share will be at 0.6% in 2040 compared to 3.9% share in 2013.

In the future energy mix, energy from nuclear power plants could be one of the sources that allows Malaysia to keep its options open as part of diversifying its energy mix strategy to support the country's economic growth. Considering this, a Nuclear Power Development Committee, headed by the Ministry of Energy, Green Technology and Water, was set up in June 2009 to plan and coordinate the preparatory efforts for a Nuclear Power Infrastructure Development Plan. A year later, the National Nuclear Policy was adopted by the Malaysian government on 16 July 2010 (The Malaysian Economic Transformation Programme, 2010).

The Malaysian Economic Transformation Programme in October 2010 considered nuclear energy to be important as a fuel option for electricity supply post-2020, especially for the Malaysian Peninsula. In 2011, the Malaysia Nuclear Power Corporation was registered under the Companies Act of Malaysia as a fully government-owned company, placed under the jurisdiction of the Prime Minister's Department as a new, fully dedicated Nuclear Energy Programme Implementation Organization. The Malaysia Nuclear Power Corporation focuses on critical enablers as identified in the Economic Transformation Programme, including public acceptance of the project and the readiness of the correct regulatory framework in Malaysia. Within the study plan conducted by the Nuclear Power Development Committee, Malaysia plans to have a total capacity of 2 gigawatts, with the 1st Unit of 1 gigawatt in operation by 2021. The plan under development lays out a development timeline of 11 to 12 years from pre-project to commissioning. However, this plan was delayed due to Japan's Fukushima nuclear disaster, and thus the expected construction of the first plant may be later than 2021.

Figure 1.5. Share of Power Generation by Fuel, Business-as-Usual Scenario



Source: Kimura and Han (2016).

5. Conclusions

While energy subsidy reforms have shown positive signs in the Malaysian political context, energy subsidies need to be well-targeted to those who need energy for their basic needs for cooking, lighting, and transportation. The removal of energy subsidies will affect the basket of consumption, especially the inflation of commodity prices that are related to the transportation of basket of commodities/ products, and the services that produce the products. In this regard, a well-designed programme to target and safeguard the poor will be needed, either through well-targeted fund transfers to the poor or through energy consumption rations for the poor. The Malaysian government has prepared to do so, but it needs to keep monitoring how the subsidies' funds reach the intended beneficiaries, and recommend any required corrective actions during the course of programme implementation.

It is important that the government publicises the cash transfers to support the poor during the gradual removal of the energy subsidies. Transparency will gather public support in the reform process. Public campaigns and education outreach on the energy subsidies removal will be needed to clearly show how energy subsidies impact welfare, discourage investment, reduce competition, and obstruct Malaysia's goal of achieving high-income status by 2020. The lessons learned from the past reform initiative – the Subsidy Rationalization Programme, which aimed to gradually adjust fuel prices, but was put on hold in March 2012 due to large public opposition to the fuel price increase – could offer an important lesson on how to move the energy subsidy reform in a more transparent direction to gain public support.

While the reform process gained positive momentum since 2014, a well-established monitoring programme on the reform's successes and impacts needs to be in place. Reporting, monitoring, and disseminating the reform process with a clear timeframe, sector by sector, will allow all stakeholders to envisage the costs incurred to individuals and businesses in the future. This will ensure larger success of the reform programme in Malaysia.

The reform process needs to be good for the welfare, investment, and future growth of Malaysia, so government strategy will need to be built around these arguments and facts to convince the public in a transparent and timely manner.

In addition to the energy subsidy policy reform, the Malaysian government has carried out other reforms, such as for the promotion of energy efficiency and energy security through increasing the renewable energy share, and the coordinating the right mix of power generation, including the option of nuclear energy in the future. Accordingly, meaningful reform will take a holistic view of the energy issues, and the Malaysian government has undertaken the right policy direction.

References

ABB (2014), ABB Inverters Help Connect Malaysia's Largest Solar Plant to Grid. Available at: http://www.abb.com/cawp/seitp202/d265daad340e4430c1257d410029f79e.aspx (accessed February 2015).

Asia-Pacific Economic Cooperation (2015), *Review on Fossil Fuels Reform in Peru*. Produced by Nathan Associates Inc. for the US-APEC Technical Assistance to Advance Regional Integration Project. USA.

Baig, T., et al. (2007), *Domestic Petroleum Product Prices and Subsidies: Recent Developments and Reform Strategies*. Washington, DC: International Monetary Fund.

Economic Planning Unit (2010), the New Economic Model. IRENA (2015). Renewable Energy Country Profile of Malaysia. Available at: http://www.irena.org/REmaps/countryprofiles/asia/Malaysia.pdf (accessed February 2015).

ERIA and IEEJ (2015), *Economic Impact of Removing Energy Subsidies in Malaysia.* ERIA Research Project Report 2015-13. Jakarta: ERIA. Available at: http://www.eria.org/publications/research_project_reports/FY2015/No.13.html

Ilias, S., et al. (2012), 'Low Inflation, but at a High Price', Malaysia CPI: Inflation and Subsidy. Malaysia: Maybank IB Research.

International Institute for Sustainable Development (IISD) (2013), *A Citizen's Guide to Energy Subsidies in Malaysia*.

International Monetary Fund (IMF) (2013), *Energy Subsidy Reform. Lessons and Implications*, Washington, DC: IMF.

Kimura, S. and P. Han (2016), *Energy Outlook and Energy Saving Potential in East Asia 2016*. Jakarta: ERIA. Available at: http://www.eria.org/publications/key_reports/FY2015/No.5.html

Ministry of Finance Malaysia (2014), Malaysian Economy: Fourth Quarter 2014.

Najib Tun Haji Abdul Razak. (2013). Fiscal Policy Committee (FPC) press statement. Prime Minister's Office.

Petroleum Incentives (2010), Oil, Gas and Energy. Available at: http://etp.pemandu.gov.my/30_November_2010-@-Petroleum_Incentives.aspx (accessed 14 June 2015).

Rashid, Z.A. (2012), 'Economic Impacts of Subsidy Rationalization Malaysia', *ERIA Project Report 2011*, pp. 207–252.

The Malaysian Economic Transformation Programme (2010).

The Nation (2014a), 'PM: Subsidies not Wholly Abolished', 2 April.

The Nation (2014b), 'Subsidies Taking Toll, Says Prime Minister', 22 January.

The National Renewable Energy Policy and Action Plan (2008).

The Tenth Malaysia Plan (2011-2015).

United Nations Environment Programme (2008), Reforming Energy Subsidies. Available at; http://www.unep.org/pdf/PressReleases/Reforming_Energy_Subsidies2.pdf (accessed March 2015).

Chapter 2

Economic, Social, and Environmental Impacts of Energy Subsidies:

Case Study of Malaysia

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Abstract

The Malaysian government has shown a strong intention to reduce energy subsidies in recent years. This study quantitatively investigates the potential impacts of removing energy subsidies on Malaysia's macroeconomic indicators, household welfare, and carbon emissions. A computable general equilibrium model with a breakdown of households by income level is constructed to perform the assessment. We show that either a petroleum or gas subsidy removal, or both, would improve economic efficiency and increase real gross domestic product by up to 0.97 %. The budget deficit would be largely reduced after removing the government-funded petroleum subsidies, especially as the saved subsidy costs could be entirely used to buy back government bonds. Households would be worse off in most scenarios due to higher price levels, but compensating policies through labour income tax rebates or direct transfer payments could make the poorest income group no worse than the baseline, with almost no extra impacts on the economy. The overall positive economic and environmental impact suggests that fossil fuel subsidies should be removed and the saved subsidy costs or increased tax revenue used to reduce fiscal deficits and compensate the most affected households and industries.

1. Introduction

Energy subsidies are economically unfavourable but prevail in the world due to social and political concerns. Generally, energy prices after a subsidy cannot reflect the true costs of energy supply and thus tend to induce energy waste in production and overconsumption by households. In addition, as differentiating consumers by income is costly in practice, energy subsidies are usually applied equally to all consumers, which is against the good intention of assisting disadvantaged groups. In the Association of Southeast Asian Nations (ASEAN), subsidies not only discourage the development of clean energy, fossil fuel exploration, and infrastructure investment and prevent the integration of energy markets as required by the ASEAN Economic Community, but they also limit the possibility to optimise the trade of low-carbon resources. Reform of fossil fuel subsidies, together with the promotion of renewables and energy efficiency, regional market integration, and connectivity, are key instruments to achieving a cleaner and more sustainable energy mix for ASEAN (Shi, 2016). Economists and global leaders have voted to remove energy subsidies for more than a decade, but progress in many countries is still limited. Major concerns are that disadvantaged groups would not be able to afford the higher market prices of fuels and electricity, and that the general public would not support such policies.

Malaysia is a good case for the subsidy study since energy subsidies have long been present in Malaysia at an unsustainable level and the government has taken steps to reduce them. If the proposed marketisation could be actualised, how and to what extent would the different sectors and income groups be affected? Is there any alternative financial assistance for disadvantaged groups to compensate their welfare loss arising from higher energy prices? Will the subsidy removal lead to a significant reduction in fossil fuel consumption and contribute to global efforts for climate change mitigation? To answer these questions, it is important to quantitatively evaluate the potential economic, social, and environmental impacts of energy subsidy reform in Malaysia. The evaluation can provide policymakers with better insights in improving the current policy configurations. The objectives of this study consist of (1) reviewing the evolution of energy subsidies in Malaysia and what the government has done or planned to do regarding the subsidy policy; and (2) quantitatively assessing the impacts of the fossil fuel subsidy removal, with and without other forms of financial assistance on issues such as gross domestic product (GDP), production at the sectoral level, government expenditure, household consumption and welfare, investment, and carbon emissions. A computable general equilibrium (CGE) model is constructed to perform the assessment.

Studies on energy subsidies relevant to Malaysia have appeared in the recent literature. By using a multiregional CGE approach, Kojima and Bhattacharya (2011) find that even a partial removal of energy subsidies in East Asia, including Malaysia, would result in an improvement of market efficiency. They estimate that a per annum subsidy reduction of approximately US$500 million in the East Asia region could improve regional GDP by around 0.05 %, while reducing emissions by about 0.5 %. Hamid, Rashid, and Mohammad (2011) use input-output

(I-O) analysis to evaluate the impacts of an exogenous increase in energy prices, with a specific focus on food industries. They find that resilient economies, especially developed East Asian economies have had consistent performance in terms of value added and imported inputs during periods of energy price surges. Recently, Solaymani and Kari (2014) used a CGE model to analyse the impacts of a petroleum subsidy removal and electricity rebate removal on the Malaysian economy, especially for the transportation sector. They show that the output of land transport, water transport, and air transport would decrease by 3.54 %, 1.15 %, and 2.14 %, respectively.

Compared with the existing literature, this study makes the following contributions. First, households are disaggregated into four income groups based on Malaysia's household income and expenditure survey. This allows us to compare imbalanced impacts of energy subsidy removal on different income groups and introduce compensating policies that can target disadvantaged groups. Although subsidies have been traditionally justified on the base of protecting poor people, numerous studies have shown that the rich can benefit more (Shi and Kimura, 2014). In the case of Malaysia, estimates show that higher-income groups received more than 70 % of the fuel subsidies (National Economic Advisory Council, 2009). Additionally, increased commodity prices due to higher energy prices after subsidy removal were expected to hurt the poor more than high-income groups (International Institute for Sustainable Development, 2013). Secondly, in addition to petroleum subsidies, which are often the subject of studies, this study also includes natural gas subsidies provided by state-owned gas supplier The two strands of subsidies have different funding mechanisms and thus are modelled separately. Lastly, this study uses the most recent Malaysian I-O table (2010), which can better capture recent economic structure changes than earlier versions used in the existing literature. With debates on further subsidy removal, this is a timely study for policymaking in Malaysia as it offers reference to the most vulnerable sectors and income groups. Accordingly, the government can formulate compensatory policy to minimise political opposition.

The study proceeds as follow. The next section briefly explains fuel subsidies in Malaysia and the existing literature. Section 3 introduces the CGE model. Section 4 reports the simulation results, followed by discussions and policy implications. The last section concludes.

2. Energy Subsidies and Recent Developments in Malaysia

Subsidies to fossil fuels are prevailing and serious in ASEAN. According to the International Energy Agency (2013), the total cost of fossil fuel subsidies in ASEAN amounted to US$51 billion in 2011. Malaysia is an outstanding example in the region. In 2011, the share of after-tax fossil fuel subsidies to GDP was roughly 7.21 % in Malaysia, only less than Brunei Darussalam's 8.41 %, but higher than 5.36 % in Indonesia and 4.72 % in Thailand, and much higher than the world average of 2.72 %. In terms of the ratio of energy subsidies to the overall government budget, Malaysia had the highest ratio in ASEAN at about 32.94 %, followed by 30.07 % in Indonesia and 20.85 % in Thailand, and significantly higher than the world average of 8.13 %.

As early as 1983, an automatic pricing mechanism was introduced in Malaysia to determine the retail prices of petrol, diesel, and liquefied petroleum gas based on factors such as the reference product cost (i.e. the Mean of Platts Singapore), operational costs, the margins of oil companies and station operators, sales tax, and subsidies. In reality, the automatic pricing mechanism has been used to determine the sales tax exemption and subsidy needed to cover the difference between a fixed retail price and the market price (IISD, 2013). The budget for petroleum subsidies has grown substantially overtime since the 1990s. According to Malaysia's own statistics, the budget was only RM27 million in 1990, but increased to RM3.2 billion in 2000 and 9.6 RM billion in 2010. The number reached an all-time high of RM17.6 billion in 2008 when oil prices reached a historically high level (Hamid and Rashid, 2012). International estimates are often significantly higher than Malaysia's own statistics, probably due to the adoption of different methodologies. For example, petroleum subsidies in 2009 are estimated to be RM13.95 billion by the International Energy Agency, more than twice the RM 6.19 billion estimated by Malaysia's own sources (IISD, 2013).

The end-user price of natural gas in Malaysia is ranked as the second lowest in ASEAN, only higher than that in Brunei, and more than half of Malaysia's electricity is generated by natural gas. Unlike petroleum products, natural gas is not directly subsidised by the government. Instead, Petronas, Malaysia's national oil and gas company, bears the cost. The company is required to sell natural gas to national power corporations and independent power producers at a controlled low price, which is around a quarter of the market price. Natural gas sold to non-power sectors, such as to industries and the commercial sector, are also heavily subsidised, although to a lesser extent than for power sectors. Based on data provided by Petronas, it is estimated that the company's foregone revenue in 2010 amounted to RM11.2 billion for supplying gas to power sectors and RM7.9 billion for supplying gas to non-power sectors (Ilias, Lankanathan, and Poh, 2012).

To reduce the budget deficit, the Malaysian government proposed to gradually rationalise price control on subsidised commodities and achieve market pricing by 2015 in the "2010-2015 Malaysia Plan". A follow-up subsidy rationalisation programme was launched in May 2010, which intended to increase the price of subsidised commodities by a pre-specified amount every 6 months until 2014. A poll conducted by the government showed that 61 % of the Malaysian public supported reducing subsidies (IISD, 2013). However, many price adjustments did not take place as scheduled, and the short-lived subsidy rationalisation programme was officially suspended in March 2012. The official explanation for the suspension was that rising commodity prices since 2011 shifted the government's focus to the cost of living (Teoh, 2012). On 3 September 2013, the Malaysian government decided to cut fuel subsidies for the first time since 2011, which raised the price of certain gasoline and diesel fuels by between 10.5 % and 11.1 % (Gangopadhyay, 2013).

The low oil price at the end of 2014 made it possible for Malaysia to overhaul fossil fuel subsidies to some extent (Bloomberg, 2014). In November 2014, Prime Minister Najib Razak announced that subsidies for gasoline and diesel would be removed from 1 December 2014. Since then, a managed float system that takes into account recent changes in production and markets has been used to price petroleum products. However, it is not clear whether the fossil fuel subsidies will come back if oil prices increase again since the fundamentals of the subsidy policy have not been changed (Shi, 2016). An incentive-based regulation framework for the natural gas sector was scheduled to be introduced in January 2016, but so far no further action has been announced.

3. Methodology and Data

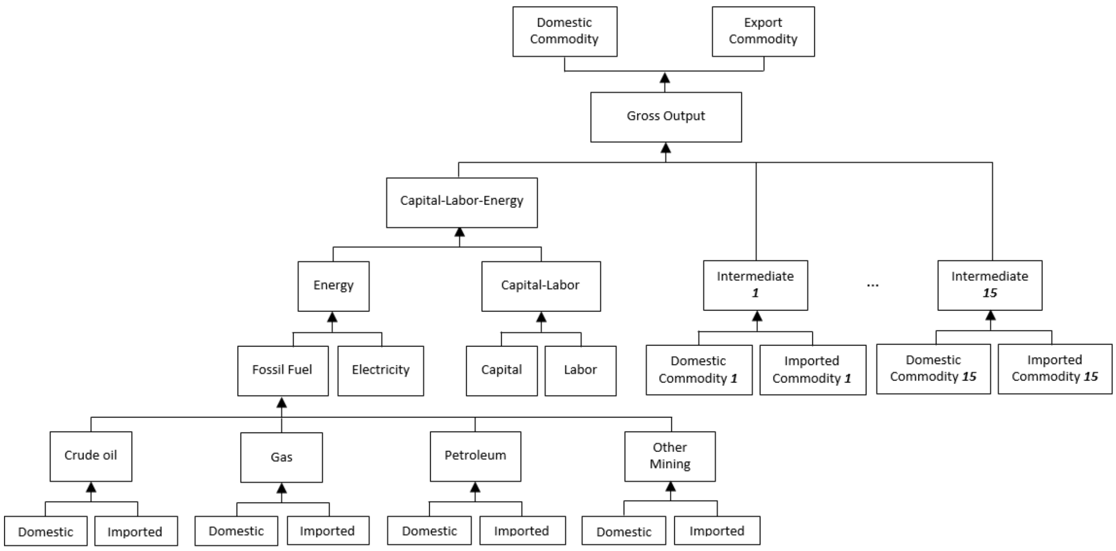
We build a Malaysian CGE model to quantitatively evaluate the potential impacts of energy subsidy reform. Generally, a CGE model is a top-down macroeconomic framework based on general equilibrium theory and actual data. The behaviour of each agent, such as households, firms, and the government, are described by a system of non-linear functions. An overall equilibrium can be obtained against a given external shock through the interactions of the agents. Comparing alternative equilibriums obtained under different scenarios provides policymakers with quantitative insight for long-run economic planning and policymaking. Therefore, CGE models have been widely used in analysis of government regulation, tax reform, trade liberation, regional cooperation, and environmental issues (e.g. Hudson and Jorgenson [1975]; Ballard et al. [1985]; Burniaux, Martin, and Oliveira-Martins [1992]; Harrison and Rutherford [1997]; Dixon [2006]; Hosoe [2007]; Perali, Pieroni, and Standardi [2012]; and Parrado and de Cian [2014]).

In this study, to be consistent with the classifications of the I-O table and household income and expenditure survey, the economy is divided into 15 non-energy sectors: agriculture (AR), food and wear (FW), wood and paper (WP), chemicals and metal (CM), machinery (MN), vehicles (VH), construction (CS), wholesale and retail trade (WR), hotels and restaurants (HR), transport (TP), communications and amusement (CA), housing (HS), education (ED), health (HE), and other services (OS); and 5 energy sectors: electricity (EC), crude oil (OL), natural gas (NG), other mining (OM), and petroleum (PL). In Malaysia's I-O table, coal is not separately listed but combined in the other mining sector, which is why the sector is considered as an energy sector in this study. The natural gas sector in this study is aggregated from the natural gas and gas sectors in the I-O table. Each sector is assumed to have one representative producer. The economy has four representative households, which represent the bottom 15 % (H1), lower-middle 40 % (H2), upper-middle 30 % (H3), and top 15 % (H4) of households by income.

3.1. The Model

Figure 1 describes the nested production structure for all sectors, which consists of three broad categories of inputs: factor inputs (i.e. labour and capital), energy inputs, and non-energy intermediate inputs. At each level of the production structure, the producer is assumed to choose a bundle of inputs that maximises profit subject to its production technology. Domestic inputs and imported input of the same variety are treated as imperfect substitutes in production and aggregated using a constant elasticity of substitution function. The fossil fuel bundle, energy bundle, capital-labour bundle, and capital-labour-energy bundle are all constant elasticity of substitution aggregations. Following a Leontief function, the capital-labour-energy input and non-energy intermediate inputs are then aggregated into the gross output, which is either supplied to the domestic market or exported. For crude oil, natural gas, other mining, and petroleum, the domestic supply and exports are not differentiated. For the remaining sectors, the gross output is further transformed into domestic and export commodities using a constant elasticity of transformation function. The representative households receive factor income by supplying capital and labour and receive transfer payments from the government and the rest of the world. After paying income taxes and making non-tax payments to the government, the households consume and save. As the Malaysian government has a budget deficit, one form of household saving is to purchase government bonds. The total consumption of each representative household is subject to its budget constraint, and the consumption of each commodity *j*, as well as the share of domestic commodity *j* and imported commodity *j*, are determined following a nested constant elasticity of substitution structure.

Figure 2.1. Nested Production Structure



Source: Authors.

Government revenue comes mainly from tax collection. According to the data, taxes in the model include (1) labour income tax, (2) capital income tax, (3) production tax on gross output, (4) sales tax on final consumption and investment, and (5) sales tax on exports. Tax revenue and non-tax payments allow the government to spend on goods and services, such as education, healthcare, and national defence, provide subsidies, save for investment, and also make transfer payments to households and the rest of the world. In this study, government subsidies are provided for products in the agriculture, food and wear, chemical and metal, and petroleum sectors. On top of the constant elasticity of substitution combination of domestic and imported commodities, the total government consumption is a composition of commodities based on a Cobb-Douglas function. That is, the government is assumed to consume each commodity in a fixed proportion of the total government consumption.

Domestic savings by the government and households, as well as foreign savings arising from the trade balance, are assumed to be entirely used on investment. Like government consumption, the total investment on commodities is also based on a Cobb-Douglas function, and substitution between domestic and imported products follows a constant elasticity of substitution function. In addition to the market-clearing conditions for commodities, labour, and capital, several other assumptions are made to complete the model: (a) household saving rates are exogenous, (b) prices of exports and imports are exogenous, and (c) foreign savings are fixed while the exchange rate is floating.

3.2. Data

We construct a social accounting matrix according to the framework presented in Section 3.1. Most data used are from Malaysia's I-O Table 2010. Other non-energy data, such as factor income taxes, non-tax payments, and government transfer payments, are collected from Malaysia's Statistical Handbook and Yearbook of Statistics. The household disaggregation is based on information from the Malaysia Household Income and Basic Amenities Survey Report 2009 and Malaysia Report on Household Expenditure Survey 2009. The figures show that income inequality is quite serious in Malaysia. Energy-related data, such as the energy supply, sectoral consumption of fossil fuels, and retail fuel prices in Malaysia, are obtained from the Malaysia National Energy Balance and Malaysia Energy Statistics Handbook. These data are utilised to disaggregate the crude oil and natural gas sector and the electricity and gas sector in the I-O table and calculate the CO_2 emissions from fossil fuel combustion.[1] Emission factors used in the calculation are set following the IPCC (2006). Most parameter values used in the simulation, such as tax rates and saving rates, are calibrated on a basis of the social accounting matrix, but the elasticities of substitution/transformation in production and the consumption and investment functions are set in line with those used in the Massachusetts Institute of Technology Emissions Prediction and Policy Analysis model (e.g. Paltsev et al., 2005), the Global Trade Analysis Project (GTAP) model (e.g. Huff et al., 1997), and Solaymani and Kari (2014).

[1] Emissions from gas flaring reinjection and use (specified in the National Energy Balance table) are not considered in this study.

4. Simulation and Results

The aim of this study is to assess how the Malaysian economy, different income groups, and carbon emissions will be affected by a reform of energy subsidies – more specifically, government-funded petroleum subsidies and a producer-funded gas subsidy. Accordingly, three broad categories of scenarios are designed for the simulation: (1) no petroleum subsidies, (2) no gas subsidy, and (3) no petroleum subsidies and no gas subsidy. A gas subsidy removal in power generation only, and a removal in power generation as well as industries and commercial sectors, are simulated separately as sub-scenarios. A petroleum subsidy removal would directly reduce fiscal expenditure, and a gas subsidy removal is expected to improve economy efficiency and overall increase government revenue. How should the extra money be used? Two additional sub-scenarios are specified for government behaviour: (a) use the increased revenue to cut the budget deficit (i.e. fixed fiscal expenditure setting), which is the primary incentive for the government to abandon the subsidy policy; or (b) spend the extra money following the expenditure pattern in 2010 (i.e. flexible fiscal expenditure setting). Regarding the compensating policy for the disadvantaged group, two options are simulated, labour income tax rebates and direct government transfer payments. The compensation is provided up to the point where the bottom 15 % of households (H1) are no worse than the baseline status. Table 2.1 summarises the major scenario assumptions and additional scenarios for the compensating policy. In all the simulations, the gross outputs of the crude oil, natural gas, other mining, and petroleum sectors are fixed at their 2010 capacities based on the sectors' production features in the short run. Outputs that cannot be absorbed in domestic markets are assumed to be entirely exported.

Table 2.1. Scenario Assumptions

Major Scenarios			*a.* Fixed fiscal expenditure	*b.* Flexible fiscal expenditure
1.	No petroleum subsidies		*1a*	*1b*
2.	No gas subsidy	Power generation only (*P*)	*2a_P*	*2b_P*
		Power generation, industries, and commercial sector (*PIC*)	*2a_PIC*	*2b_PIC*
3.	No petroleum subsidies and no gas subsidy	Power generation only (*P*)	*3a_P*	*3b_P*
		Power generation, industries, and commercial sector (*PIC*)	*3a_PIC*	*3b_PIC*
Compensation Scenarios				
I.	Income tax rebate to *H1*			
II.	Transfer payment to *H1*			

Source: Authors.

4.1. Impacts of Subsidy Removal

Table 2.2 shows the simulation results for 10 scenarios or sub-scenarios when there is no compensating policy for the disadvantaged groups. When petroleum subsidies are completely removed, economic efficiency improves and real GDP increases by 0.38 % when the saved subsidy is used to reduce the budget deficit (i.e. Scenario 1a), and by 0.34 % when the save subsidy is spent on government consumption and infrastructure investment (i.e. Scenario 1b). The budget deficit declines significantly, by 27.92 %, under the former setting and negligibly, by 0.80 %, under the latter setting. Generally, lower-income groups are less affected than higher-income groups, which is mainly because petroleum products account for a larger proportion in the consumption baskets of higher income groups. Investment increases in Scenario 1a as the private savings previously used to purchase government bonds are now channelled to investment, which dominates other factors such as inflation and reduced government tax revenue. In Malaysia, government tax revenue is not linearly related to the economy's overall performance. This is because capital income tax and production tax on gross output, which account for more than two-thirds of Malaysian government tax revenue, have quite different tax rates across sectors. However, exports and imports increase along with the overall economy in this scenario. Investment, exports, and imports all decrease in Scenario 1b as the saved subsidy cost is spent on domestic services, such as education, health, and other public services. In both Scenarios 1a and 1b, a higher petroleum price lowers the country's consumption of petroleum and consequently reduces the total carbon emissions. As government consumption is service dominated and less energy intensive than investment and household consumption, the carbon emission reduction is larger in Scenario 1b.

Table 2.2 Macro Impacts (%)

	Scenario									
	1a	***1b***	***2a***		***2b***		***3a***		***3b***	
			P	***PIC***	***P***	***PIC***	***P***	***PIC***	***P***	***PIC***
GDP	0.38	0.34	0.28	0.54	0.28	0.53	0.69	0.97	0.66	0.93
Budget deficit	-27.92	-0.80	-3.45	-7.02	0.14	0.30	-30.79	-33.70	-0.59	-0.38
H1 consumption	-1.12	-0.97	-0.21	0.06	-0.20	0.09	-1.26	-0.94	-1.11	-0.78
H2 consumption	-1.24	-1.10	-0.07	0.24	-0.06	0.27	-1.24	-0.88	-1.08	-0.72
H3 consumption	-1.42	-1.33	0.09	0.50	0.10	0.51	-1.24	-0.77	-1.14	-0.68
H4 consumption	-1.61	-1.70	0.24	0.74	0.23	0.72	-1.27	-0.70	-1.36	-0.81
Government consumption		8.16			0.77	1.65			8.73	9.40
Investment	3.32	-1.31	0.92	1.10	0.48	0.16	4.20	4.33	-0.75	-1.00
Exports	1.01	-0.27	-0.54	-0.73	-0.64	-0.99	0.42	0.20	-0.93	-1.28
Imports	1.20	-0.33	-0.64	-0.87	-0.76	-1.18	0.50	0.24	-1.10	-1.52
CO_2 emissions	-1.84	-2.09	-4.64	-4.22	-4.66	-4.27	-6.37	-5.89	-6.63	-6.17

GDP = gross domestic product, P = power generation only, PIC = power generation, industries, and commercial sectors.
Source: Authors.

For gas subsidy reform, real GDP increases more when the removal is across all sectors, as in Scenarios 2b and 2d, rather than only in power generation, as in Scenarios 2a and 2c. As the saved gas subsidy does not go to the government, budget deficit reduction in the fixed expenditure scenarios thus mainly arises from higher tax revenue, and is much smaller than in Scenario 1a. The budget deficit increases slightly in the flexible expenditure scenarios due to increased demand for government bonds from the households. This is set to be proportionally related to household savings in these scenarios. Lower-income households are only moderately affected by the gas subsidy removal or higher-income households are even better off. The explanation is that: first, the natural gas used by households is not initially subsidised, so they are only indirectly affected by the increase in the electricity price; second, the previously forgone revenue turns into capital income (essentially, operating surplus), which is then distributed to households proportionally. According to the household income survey, higher-income groups receive much more than lower-income groups. Investment increases in all four sub-scenarios, but is lower under the flexible expenditure setting. Exports and imports generally decrease, mainly because exports of (electricity-intensive) machinery and petroleum products decrease. Producers and households mostly switch from more expensive natural gas and electricity towards domestic petroleum products, which thus affects exports. The carbon emission reductions in the gas subsidy removal scenarios are more than doubled in the petroleum subsidy removal scenarios. After all, more than 50 % of electricity is generated by natural gas, while less than 5 % is generated by petroleum products. The emission reduction is relatively smaller in complete removal scenarios as energy demand arising from higher productions partially offsets the decrease in energy consumption due to the increased energy price.

When the reform extends to both the petroleum and gas subsidies, the macro impacts are close to, but not equal to, the accumulated impacts of the individual cases. The figures show that when both subsidies are removed, real GDP can increase by almost 1 %, which is a significant change in any country. By comparison, the growth rate is relatively higher under the fixed government consumption and infrastructure investment setting than under the flexible setting. As in previous simulations, households are overall less affected when the government decides to spend the saved subsidy costs rather than cutting the budget deficit, and are also less affected when the gas subsidy is removed in all sectors. The carbon emission reduction is around 6 % in all four sub-scenarios, which implies that energy subsidy reform could be an important policy instrument for Malaysia to mitigate climate change and achieve its intended nationally determined contribution target.

Table 2.3 shows how the sectoral outputs are affected by the energy subsidy reform. The general principle is that petroleum-intensive sectors are more affected by the petroleum subsidy removal and electricity-intensive sectors are more affected by the gas subsidy removal. For example, the agriculture sector and transport sector are petroleum intensive, so their outputs decrease due to higher production costs when petroleum subsidies are removed, but increase due to the relocation of labour and capital from more affected sectors when the gas subsidy is removed. On the contrary, the machinery sector is electricity intensive, so its output increases in the petroleum subsidy removal scenario, but decreases in the gas subsidy removal scenario.

Table 2.3. Impacts on Output at the Sectoral Level (%)

Sector	Scenario									
	1a	*1b*	*2a*		*2b*		*3a*		*3b*	
			P	***PIC***	***P***	***PIC***	***P***	***PIC***	***P***	***PIC***
AR	-1.36	-1.95	0.90	0.62	0.84	0.49	-0.37	-0.58	-1.01	-1.28
FW	-1.76	-2.21	1.14	-0.14	1.10	-0.24	-0.52	-1.70	-1.01	-2.24
WP	-0.45	-1.58	-0.75	-0.44	-0.86	-0.67	-1.10	-0.78	-2.31	-2.09
CM	-2.49	-4.29	-0.72	-6.29	-0.88	-6.65	-2.98	-8.10	-4.88	-10.06
MN	3.76	1.57	-2.83	-1.90	-2.99	-2.34	0.61	1.22	-1.67	-1.31
VH	1.05	-1.88	0.27	-0.23	0.00	-0.82	1.35	0.84	-1.77	-2.50
CS	1.98	-1.40	0.70	0.82	0.38	0.13	2.69	2.78	-0.94	-1.12
WR	-0.90	-1.92	0.56	0.86	0.46	0.64	-0.28	0.07	-1.38	-1.13
HR	-1.07	-0.82	-0.19	0.17	-0.17	0.22	-1.20	-0.80	-0.94	-0.52
TP	-4.57	-4.91	1.30	2.59	1.26	2.51	-3.20	-1.90	-3.56	-2.30
CA	-0.49	-0.17	-0.25	0.55	-0.22	0.62	-0.72	0.10	-0.37	0.47
HS	-0.61	-0.24	0.08	0.51	0.11	0.59	-0.50	-0.04	-0.11	0.39
ED	-0.46	3.88	0.06	0.24	0.57	1.21	-0.37	-0.17	4.37	4.92
HE	-0.60	2.68	0.04	0.15	0.46	0.72	-0.52	-0.38	3.11	3.29
OS	-0.15	2.30	-0.32	0.04	-0.13	0.53	-0.45	-0.09	2.11	2.73
EC	-0.72	-0.58	-10.08	-8.97	-10.07	-8.94	-10.67	-9.53	-10.50	-9.35

P = power generation only, PIC = power generation, industries, and commercial sectors.
Source: Authors.

4.2. Impacts of the Compensating Policy

In addition to household consumption in volume, compensating variation and equivalent variation are also considered in this study to discuss the loss of welfare arising from the energy subsidies removal. Intuitively, compensating variation refers to the amount of money a household must be compensated for when the price changes, and equivalent variation refers to the amount of money a household would accept in lieu of the price changes. A negative sign implies that the price changes would make the household worse off. Table 2.4 lists the simulated compensating variation and equivalent variation values for each income group, the signs of which are consistent with household consumption in volume. Since the energy subsidies removal makes disadvantaged groups even worse in most situations, the labour income tax rebate and direct government transfer to the bottom 15 % households (H1) based on compensating variation and equivalent variation values are simulated in this study. Table 2.5 shows that compensating the poorest people would hardly affect macroeconomic performance or total carbon emissions, so the two compensating instruments are almost identical in terms of their economic impacts.

Table 2.4. Compensating Variation and Equivalent Variation (RM billion)

Scenario		Income group			
		H1	**H2**	**H3**	**H4**
1a	CV	-0.22	-1.26	-2.05	-2.56
	EV	-0.22	-1.24	-2.02	-2.52
1b	CV	-0.19	-1.11	-1.92	-2.69
	EV	-0.19	-1.10	-1.90	-2.67
2a_P	CV	-0.04	-0.07	0.13	0.38
	EV	-0.04	-0.07	0.13	0.37
2a_PIC	CV	0.01	0.24	0.71	1.17
	EV	0.01	0.24	0.71	1.17
2b_P	CV	-0.04	-0.06	0.15	0.36
	EV	-0.04	-0.06	0.14	0.36
2b_PIC	CV	0.02	0.27	0.73	1.13
	EV	0.02	0.27	0.73	1.13
3a_P	CV	-0.25	-1.26	-1.79	-2.04
	EV	-0.25	-1.24	-1.76	-2.00
3a_PIC	CV	-0.19	-0.89	-1.11	-1.11
	EV	-0.18	-0.87	-1.10	-1.10
3b_P	CV	-0.22	-1.09	-1.65	-2.17
	EV	-0.22	-1.08	-1.63	-2.14
3b_PIC	CV	-0.15	-0.72	-0.98	-1.28
	EV	-0.15	-0.71	-0.97	-1.27

CV = compensating variation, EV = equivalent variation, P = power generation only, PIC = power generation, industries, and commercial sectors.

Source: Authors.

Table 2.5. Impacts of the Compensating Policy (%)

		Scenario							
		1a	***1b***	***2a***	***2b***	***3a***		**3b**	
				P	**PIC**	**P**	**PIC**	**P**	**PIC**
GDP	*I*	0.38	0.34	0.28	0.28	0.69	0.97	0.66	0.93
	II	0.38	0.34	0.28	0.28	0.69	0.97	0.66	0.93
Budget deficit	*I*	-26.81	-0.76	-3.21	0.15	-29.48	-32.75	-0.54	-0.35
	II	-27.24	-0.80	-3.32	0.14	-30.01	-33.13	-0.59	-0.39
H1	*I*	0.00	0.02	0.02	0.00	0.04	0.01	0.01	0.01
consumption	*II*	0.01	0.04	0.00	0.00	0.01	0.00	0.00	0.01
H2	*I*	-1.24	-1.11	-0.07	-0.06	-1.24	-0.88	-1.09	-0.72
consumption	*II*	-1.24	-1.11	-0.07	-0.06	-1.24	-0.88	-1.09	-0.72
H3	*I*	-1.42	-1.34	0.09	0.10	-1.24	-0.77	-1.15	-0.68
consumption	*II*	-1.42	-1.34	0.09	0.10	-1.24	-0.77	-1.15	-0.68
H4	*I*	-1.61	-1.70	0.24	0.23	-1.27	-0.70	-1.36	-0.81
consumption	*II*	-1.61	-1.70	0.24	0.23	-1.27	-0.70	-1.36	-0.81
Government	*I*		7.96		0.73			8.50	9.24
consumption	*II*		7.98		0.73			8.53	9.26
Investment	*I*	3.21	-1.29	0.89	0.49	4.08	4.24	-0.73	-0.99
	II	3.20	-1.31	0.90	0.48	4.08	4.24	-0.75	-1.00
Exports	*I*	0.99	-0.26	-0.54	-0.64	0.40	0.18	-0.92	-1.27
	II	0.99	-0.27	-0.54	-0.64	0.40	0.18	-0.92	-1.27
Imports	*I*	1.17	-0.31	-0.64	-0.76	0.47	0.21	-1.09	-1.51
	II	1.17	-0.32	-0.64	-0.76	0.47	0.21	-1.09	-1.51
CO_2 emissions	*I*	-1.84	-2.08	-4.64	-4.66	-6.37	-5.89	-6.62	-6.16
	II	-1.84	-2.08	-4.64	-4.66	-6.37	-5.89	-6.62	-6.17

GDP = gross domestic product, P = power generation only, PIC = power generation, industries, and commercial sectors.

Source: Authors.

5. Discussion and Policy Implications

Subsidies removal can produce both economic and environmental benefits. We have shown that either a petroleum or gas subsidy removal, or both, would improve economic efficiency and increase real GDP. In the interest of economic growth and climate change mitigation, both the petroleum and gas subsidies should be removed, rather than only one of them. Removing the government-funded petroleum subsidies would largely reduce the budget deficit , especially if the saved subsidy costs are entirely used to reduce the budget deficit. At the sectoral level, changes in outputs are different across sectors. Generally, petroleum intensive sectors are more affected by the petroleum subsidy removal, while electricity intensive sectors are more affected by the gas subsidy removal. Compared to the flexible expenditure setting, the fixed expenditure setting performs slightly better in terms of economic benefits, but worse in terms of the CO_2 emissions reduction. While there is a trade-off between the fixed expenditure and flexible expenditure settings, the sustainability of the fiscal system discourages the flexible expenditure setting. Whether to use the extra money to reduce the budget deficit, or for education, healthcare, or other public services, or a combination of these, is subject to the government's preference.

Households at all income levels would be worse off in most scenarios. Low-income groups tend to suffer less than their high-income peers in the petroleum subsidy scenarios, but are worse off in other scenarios, especially when their high-income peers benefit from the gas subsidy removal due to disproportionate the employment of high income households in the gas sector. Given their low average income, it would be difficult to offset the impact for low income households. From the public policy perspective, the projection for disadvantaged groups is one of the key tasks for the government. Simulation results show that the compensating policy through labour income tax rebates or direct transfer payments could make the poorest income group no worse off than the baseline while having almost no extra impacts on GDP growth or emissions reductions. Given the significant net economic benefits, it is also possible to compensate other households and industries, which could reduce public opposition and also lead to a Pareto improvement.

Although the simulation results support phasing out of fossil fuel subsidies, the political sensitivity demands a holistic approach, strategic planning, and actions (Shi, 2016). A subsidy removal could induce unrest and possibly even riots, and fuel subsidy removal is also often used as a weapon in domestic politics (Shi and Kimura, 2014). Therefore, compensating policy for the disadvantaged groups should be carefully considered. While preparation of subsidy removals will take time, there is no excuse to delay initial actions, such as public education and campaigns (Shi, 2016). Delaying the removal of subsidies will primarily increase costs for the government and leave little room for policy space when energy prices are higher than expected (Wu, Shi, and Kimura, 2012).

6. Conclusion

This study quantitatively investigates the impacts of removing energy subsidies on Malaysia's macroeconomic indicators, household welfare, and carbon emissions. A dedicated Malaysia CGE model was built to incorporate a breakdown of households by income to allow estimations of the impact on households. The results show significant economic and environmental benefits for removing the petroleum and gas subsidies. However, the impacts on industrial sectors and on households are mixed. The results suggest that Malaysia should proceed to remove the subsidies, but with a comprehensive policy scheme to minimise resistance. The results also imply that a proper compensation approach to households, at least to the most disadvantaged group, is needed. Further compensation for other households and industries is also possible, given the positive overall economic benefits. With a significant budget deficit reduction and economic benefits, it is recommended to use the saved subsidy costs or increased tax revenue to reduce fiscal deficits as well as compensate the most affected households and industries.

References

Ballard, C.L., D. Fullerton, J.B. Shoven, and J. Whalley (1985), *A General Equilibrium Model for Tax Policy Evaluation*. Chicago: University of Chicago Press for the National Bureau of Economic Research.

Bloomberg (2014), 'Malaysia Scraps Fuel Subsidies as Najib Ends Decades-Old Policy'. Available at: https://www.bloomberg.com/news/articles/2014-11-21/malaysia-scraps-fuel-subsidies-as-najib-ends-decades-old-policy Accessed on 15 May 2016

Burniaux, J.-M., J.P. Martin, and J. Oliveira-Martins (1992), 'GREEN: A Global Model for Quantifying the Cost of Policies to Curb CO2 Emissions', *OECD Economic Studies* 19, pp. 49–92.

Department of Statistics (2011b), *Report on Household Expenditure Survey, Malaysia 2009/10*. Department of Statistics, Malaysia.

Department of Statistics (2012), *Household Income and Basic Amenities Survey Report 2009*. Department of Statistics, Malaysia.

Department of Statistics (2014), *Input-Output Tables, Malaysia 2010*. Department of Statistics, Malaysia.

Dixon, P.B. (2006), 'Evidence-based Trade Policy Decision Making in Australia and the Development of Computable General Equilibrium Modelling'. *Working Paper No. G-163*. Centre of Policy Studies and IMPACT Centre,

Gangopadhyay, A. (2013), 'Malaysia's Move on Subsidies Fans Rate Hike Expectations', *The Wall Street Journal*. 15 May 2016

Hamid, K.A. and Z.A. Rashid (2012), 'Economic Impacts of Subsidy Rationalization in Malaysia', in Y. Wu, X. Shi, and F. Kimura (eds.), *Energy Market Integration in East Asia: Theories,* *Electricity Sector and Subsidies*. Jakarta: Economic Research Institute for ASEAN and East Asia.

Hamid, K.A., Z.A. Rashid, and R.Z.R. Mohammad (2011), 'Effect of Energy Price Increase on East Asian Region's Food Industries' Interconnectedness and Integration', in F. Kimura and X. Shi (eds.), *Deepen Understanding and Move Forward: Energy Market Integration in East Asia*. Jakarta: Economic Research Institute for ASEAN and East Asia.

Harrison, G.W. and T.F. Rutherford (1997), 'Burden Sharing, Joint Implementation and Carbon Coalitions', in C. Carraro (ed.), *International Environmental Agreements on Climate Change*. Amsterdam: Kluwer Academic.

Hosoe, N. (2006), 'The Deregulation of Japan's Electricity Industry', *Japan and the World Economy*, 18, pp. 230–246.

Hudson, E.A. and D.W., Jorgenson (1975), 'U.S. Energy Policy and Economic Growth 1975–2000', *Bell Journal of Economics and Management Science*, 5(2), pp. 461–514.

Huff, K.M., K. Hanslow, T.W. Hertel, and M.E. Tsigas (1997), 'GTAP Behavioral Parameters', in T.W. Hertel (ed.), *Global Trade Analysis: Modeling and Applications*. Cambridge University Press.

Ilias, S., R. Lankanathan, and W. Poh (2012), 'Low Inflation, but at a High Price', Malaysia CPI: Inflation and Subsidy. Maybank IB Research, Malaysia.

Intergovernmental Panel on Climate Change (IPCC) (2006), IPCC Guidelines for National Greenhouse Gas Inventories. Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/. Accessed on 15 May 2016.

International Energy Agency (IEA) (2013), *Southeast Asia Energy Outlook*. Paris: International Energy Agency.

International Institute for Sustainable Development (IISD) (2013), *A Citizens' Guide to Energy Subsidies in Malaysia*. Manitoba, Canada: IISD.

International Monetary Fund (IMF) (2013), *Energy Subsidy Reform: Lessons and Implications*. Washington, D.C: IMF.

Kojima, S. and A. Bhattacharya (2011), 'Pricing Reform and Enhanced Investment in the Energy Sector: A Way Towards East Asian Economic Development', in F. Kimura and X. Shi (eds.), *Deepen Understanding and Move Forward: Energy Market Integration in East Asia*. Jakarta: ERIA.

National Economic Advisory Council (2009), *New Economic Model for Malaysia, Part 1*. Putrajaya, Malaysia.

Paltsev, S., J.M. Reilly, H.D. Jacoby, R.S. Eckaus, J. McFarland, M. Sarofim, M. Asadoorian, and M. Babiker (2005), The MIT Emissions Prediction and Policy Analysis (EPPA) Model: Version 4. MIT Joint Program on the Science and Policy of Global Change.

Parrado, R. and E. de Cian (2014), 'Technology Spillovers Embodied in International Trade: Intertemporal, Regional and Sectoral Effects in a Global CGE Framework', *Energy Economics* 41, pp. 76–89.

Perali, F., L. Pieroni, and G. Standardi (2012), 'World Tariff Liberalization in Agriculture: An Assessment Using a Global CGE Trade Model for EU15 Regions, *Journal of Policy Modeling*, 34, pp. 155–180.

Shi, X. (2016), 'The Future of ASEAN Energy Mix: A SWOT Analysis', *Renewable and Sustainable Energy Reviews*, 53, pp. 672–680.

Shi, X. and F. Kimura (2014), 'The Status and Prospects of Energy Market Integration in East Asia', in Y. Wu, Y., F. Kimura, and X. Shi (eds.), *Energy Market Integration in East Asia: Deepen Understanding and Move Forward*. New York: Routledge, pp. 9–24.

Solaymani, S. and F. Kari (2014), 'Impacts of Energy Subsidy Reform on the Malaysian Economy and Transportation Sector', *Energy Policy*, 70, pp. 115–125.

Teoh, S. (2012), 'Subsidy Cuts Frozen, says Pemandu' *The Malaysian Insider*. Available at: http://www.malaysia-today.net/subsidy-cuts-frozen-says-pemandu/Accessed on 15 May 2016.

Wu, Y., X. Shi, and F. Kimura (eds.) (2012), *Energy Market Integration in East Asia: Theories, Electricity Sector and Subsidies*. Jakarta: ERIA.

Chapter 3
Impact Analysis of Removing Petroleum Product Subsidies in Thailand

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Abstract

The objective of this study is to collect the related information on the mechanism of the major petroleum product subsidies and examine the impact of the subsidy removals in Thailand. The price-gap approach is used to estimate the past magnitude of the petroleum product subsidies. The impacts of the subsidy removals at the macroeconomic level are estimated using computable general equilibrium models. Since the Thai government has already started to reform the fuel price subsidies, a review of current policy and the implications for Thailand are also discussed.

1. Introduction

Thailand is a net energy importer, with over 60 % of its energy consumption coming from imported sources (Energy Policy and Planning Office, 2013). Although there has been a continuous discovery of oil and gas in Thailand, domestic demand for energy has also grown steadily since the early 1980s, with the exception of the period following the 1997 and 2008 financial crises. As a result, there has been little overall change in Thailand's import dependency. Petroleum products comprise the largest share of total consumption in Thailand, thus making them the main focus in this study. Given that the large majority of its petroleum is imported, Thailand is highly exposed to changes in prices in international markets.

Amid high petroleum prices during the past decade, many countries, including Thailand, are subsidising petroleum product prices. As with all public policies, governments began subsidising energy fuels with the best of intentions: to provide energy access for all citizens, especially the poor; to provide economic assistance to businesses; to protect domestic markets from international price volatility; and to curb inflation.

Thailand has stabilised and subsidised fuel prices for many years to shield consumers from volatile petroleum prices and improve access to energy. Fuel and electricity subsidies are clearly benefiting some consumers, including the poor, who rely on subsidised liquefied petroleum gas (LPG) for cooking and free electricity. However, a report from the World Bank (2010) shows that energy subsidies can have unintended consequences for the economy by encouraging overconsumption and benefitting wealthier citizens far more than the poor.

In addition, Thailand's determination to promote energy efficiency, a stand that put it at the forefront of many countries in the 1970s, has long been dimmed because of price distortions created by the petroleum products' price subsidy regimes. Thailand has an energy conservation law and energy conservation funds, but serious implementation is lacking. Currently, the transport sector is the largest energy consumer at 36 %, followed by the industrial and commercial sectors. Transport operators enjoy diesel that is priced below real market levels. Natural gas used as a vehicle fuel is also heavily subsidised. According to the World Bank (2010, most countries have improved their energy efficiency since the oil crisis in the 1970s, but a study from the Ministry of Energy in Thailand has stated that Thailand is among the countries with the highest energy intensity per unit of output due to the price distortions.

Clearly, someone must pay for these subsidies, which most often is the government. Whatever the good intentions may be, many previous studies have pointed out that there are unintended consequences of energy subsidies on energy fuels. An International Monetary Fund (IMF) report (IMF, 2008) points out several consequences. First, the main beneficiaries of fossil fuel subsidies are, in most cases, the rich and middle class rather than the poor. IMF research shows that the richest households (top 20 %) benefit 42 % from energy subsidy programmes, while the poorest households (bottom 20 %) benefit by only 8.9 %. The IMF also explains that since the fuel subsidies are usually provided per unit of energy, such as per litre of gasoline or diesel, those who consume the most energy receive the largest share of the subsidy, with the largest consumers of energy and recipients of subsidies, therefore, being the wealthiest households and those in urban areas.

Second, maintaining energy prices at a low level on the domestic market makes the energy sector unattractive for investors. This restricts countries' capacity to provide better energy services to citizens. For instance, underinvestment means that countries cannot produce quality, refined petroleum products within their national borders, or extend and maintain their electricity infrastructure.

Third, by stimulating energy demand, energy subsidies encourage faster depletion of fossil fuel reserves. Thailand's energy reserves are now estimated to last only for another 20 years. Looking to the future, energy subsidies will lead to growing imports of fossil fuels from the current high level of 20 % of the total annual import value, thus affecting energy security for Thailand. Fossil fuel subsidies promote wasteful practices of energy consumption and make green energy technologies less competitive compared to conventional energy sources.

Fourth, subsidies result in a growing retail price disparity between different fuels or for the same fuel across national borders. This leads to fuel smuggling, the emergence of black markets, and the non-authorised use of subsidised fuels. Such practices as, for example, the installation of cooking LPG cylinders on cars, may not only be illegal but also dangerous. Last but not least, all the above-mentioned unintended outcomes of energy subsidies lead to increased air pollution and emissions of greenhouse gases.

Eliminating these subsidies poses considerable challenges. Energy access and affordability are critical factors for development. Thailand is in the midst of facing these challenges as the government phases out several energy subsidies, particularly the removal of petroleum product subsidies.

This leads to the objectives of this chapter. The first objective is to review the policy implications and mechanism of the petroleum product price subsidies in Thailand. Since diesel and LPG are the two main petroleum products that were subsidised by the Thai government, the study focuses on the subsidies for these products. The second objective is to analyse the impacts of the subsidy removal on the country's economy by observing the size of the subsidies in the past and examining the extent to which the subsidies removal may theoretically impact gross domestic product (GDP). Most the data and price information for the study are from the Energy Policy and Planning Office (EPPO) under the Ministry of Energy. The concepts of the study are drawn from previous studies by the International Institute for Sustainable Development (Leangcharoen, Thampanishvong, and Laan,2013), and the Asian Development Bank (2015).

The chapter is arranged in three parts. The first part provides an overview of petroleum product consumption in Thailand, including the price structures and the forms of the selected product subsidies, which are mainly for diesel and LPG. The second reports the magnitude using the price-gap approach and the impact of the subsidy removal using a computable general equilibrium (CGE) model with the basic assumptions. The final part summarises the results and policy recommendations for the government to continue the petroleum product price reforms that have been already started.

2. Price Structure and Form of Petroleum Product Subsidies

This section reviews the information regarding the consumption of petroleum products and their price structure to analyse the impact of the subsidy removals in Thailand.

2.1. Overview of Petroleum Product Consumption in Thailand

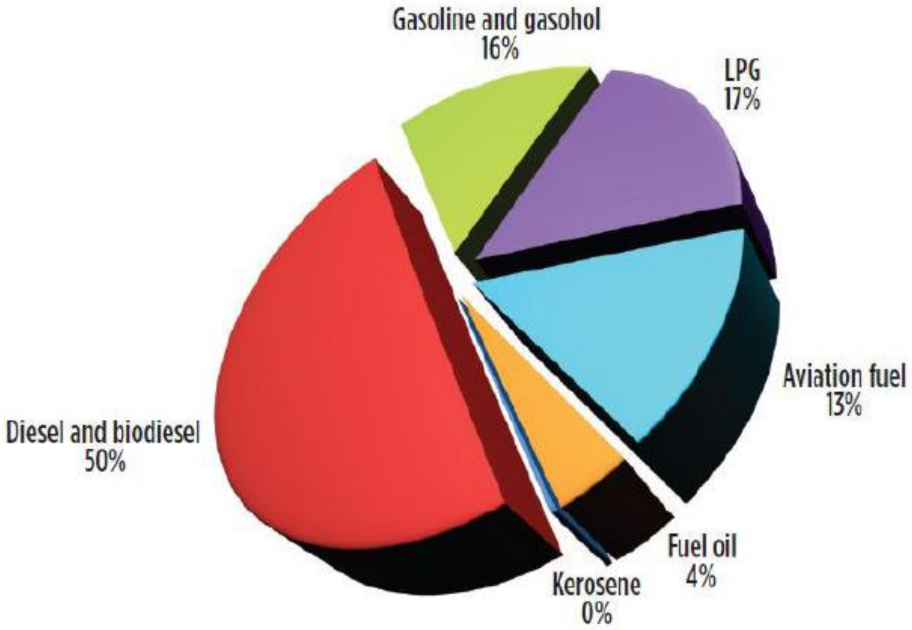
The transportation sector is the largest consumer of petroleum products in Thailand. Before 2005, gasoline and diesel were the two major petroleum products consumed in this sector. Gasoline is sold as gasoline 91 (gasoline with octane 91) and gasoline 95 (gasoline with octane 95).

The main types of diesel used in Thailand are high-speed diesel (HSD) with a 0.05 % sulphur content and low-speed diesel (LSD). Diesel is sold almost entirely as HSD, with a small amount as LSD. HSD is the dominant fuel in the transportation sector as its consumption is more than twice the consumption of gasoline (see Figure 3.1). The dependence on these two products led to a cabinet resolution on 9 December 2003 to eventually replace gasoline 95 with gasohol, a mixture of gasoline and ethanol (NEPO, 2006). The available options for gasohol consumers are a mixture containing 10 % ethanol and 90 % gasoline (E10), a mixture containing 20 % ethanol and 80 % gasoline (E20), and a mixture containing 85 % ethanol and 15 % gasoline (E85).

Following the gasohol plan, the cabinet also approved the National Energy Council Committee's energy policy on 21 November 2006 to promote the consumption of biodiesel as a substitute for HSD by expanding the acreage and distribution channels of palm oil. Initially, the biodiesel proportion was set at 5 % biodiesel and 95 % HSD (B5). From February 2008, the government mandated that the remaining HSD be blended with 2 % biodiesel (B2). The proportion of biodiesel in HSD was then increased to 3 % on 10 June 2010 (B3). After the emergence of biodiesel, the consumption of pure HSD became insignificant after June 2010. Accordingly, the term diesel in this chapter refers to a biodiesel mixture.

Diesel is an important input in the transport and agricultural sectors, which account for over 40 % of final energy consumption. Diesel is the most widely used petroleum product in Thailand, followed by LPG, gasoline, and aviation fuel. Fuel oil and kerosene comprise less than 5 % of total consumption as shown in Figure 3.1. According to the Department of Energy Business, Ministry of Energy , biodiesel (B2, B3, and B5) consumption in Thailand is around 52 million litres per day, comprising about 97 % of the total diesel consumption and insignificant HSD. LPG is used in the industry, transport, and residential sectors, as well as by small businesses, such as street vendors. The consumption of gasohol exceeds the consumption of gasoline, with E10 constituting about 90 % of the total gasohol consumption of around 12 million litres per day. Gasoline 91 is now the major product, with about a 99 % share of the total gasoline consumption of around 8 million litres per day.

Figure 3.1. Decomposition of Petroleum Product Consumption in Thailand



Source: EPPO (2013).

2.2. Petroleum Product Price Structure

Thai current petroleum product prices can be divided into the ex-refinery price, wholesale price, and retail price, as shown in Figure 3.2. The wholesale and retail prices of the petroleum products are published daily by the National Energy Policy Office.

Figure 3.2 Petroleum Product Pricing Structure in Thailand

Source: EPPO (2013).

The wholesale price comprises the ex-refinery price plus the excise tax, municipal tax, contribution to the Oil Fund, contribution to the Energy Conservation Promotion Fund, and value-added tax (VAT). The retail price comprises the wholesale price plus the marketing margin and VAT. The structures were initially set up and controlled by the government for a long time. In 1991, the government started to deregulate these price structures by allowing the ex-refinery price and marketing margins to be determined by a market mechanism. However, the government still controllsretail prices via oil funds, tax rates, and energy conservation funds. Since the energy conservation funds have been almost unchanged for many years, the government can mostly achieve its desired retail prices by manipulating the oil funds and tax rates.

The ex-refinery price and the marketing margin are the only two components in the price structure that are determined by market forces and reflect the production and distribution costs of a given petroleum product. The Singapore market, Means-of-Platts (MOPs), is used as the reference market in determining the prices of petroleum products because it is the largest export market in the Asian region that is nearest to Thailand, and hence has the lowest import costs; moreover, the trading volume in the market is enormous, making it difficult to speculate oil prices, and thus price volatility is less than other markets. In addition, the changes in prices in the Singapore market are in line with other markets worldwide.

The remaining price components in the price structure, including the oil fund, are transfer payment items that are controlled by the government. The municipal tax rate is directly related to the excise duty and its rate is set at 10 % of the excise duty. The energy conservation fund contribution is collected at a designated rate and is used to finance energy conservation projects under the jurisdiction of the energy ministry.

There are two collections for VAT. The first collection is on the wholesale price and its rate is set at 7 % of the wholesale price. The rate for the second collection is also 7 %, collected on the marketing margin. Figure 3.2 shows the overall components of the daily price structure of Thai petroleum products.

2.3. Forms of Petroleum Product Subsidy

Thailand subsidises the consumption of petroleum products in three forms: through the *Oil Stabilization Fund* (an oil price fund), *tax exemptions*, and *caps* on ex-refinery and retail prices. It caps retail prices for diesel, LPG, and natural gas for vehicles (NGV), and subsidises biofuel blends. For diesel and NGV, price subsidies are universal in that wealthy and poor consumers alike can access them. LPG prices vary depending on the consuming sector, and are subsidised for low-consuming households.

2.3.1. Role of the Oil Stabilization Fund

The first energy crisis in 1973 caused unprecedented increases in international oil prices. Thailand is one of the oil importing countries that was affected by the first energy crisis. The first energy crisis was a significant factor that led to the Oil Shortage Prevention Act in 1973 that empowers the prime minister to issue measures to prevent an oil shortage. This led to the establishment of the Oil Stabilization Fund in the same year, which requires oil traders to make contributions to the fund at designated rates. Compensation to fuel oil traders during certain periods is then drawn from the Oil Stabilization Fund.

Another version of the Oil Stabilization Fund (foreign exchange) was set up in 1978 with the objective of collecting the windfall profits of the oil traders from the baht appreciation. Later, the government decided to integrate the 1973 Oil Stabilization Fund with the 1978 Oil Fund Stabilization (foreign exchange) in 1979, when there were sharp increases in international oil prices. This fund was set up because the government did not want to change domestic prices according to changes in world oil prices. The new oil fund has been managed by the Energy Fund Administration Institute, which is responsible for the procurement of funds to stabilise domestic retail oil prices and for other tasks in compliance with the government policies relevant to the Energy Fund Administration.

The oil fund has been utilised as a tax instrument for gasoline and HSD, the two major petroleum products before the emergence of gasohol and biodiesel in 2007. Its utilisation has been found to increase fluctuations in the costs and retail prices of gasoline and HSD during 2007this period.

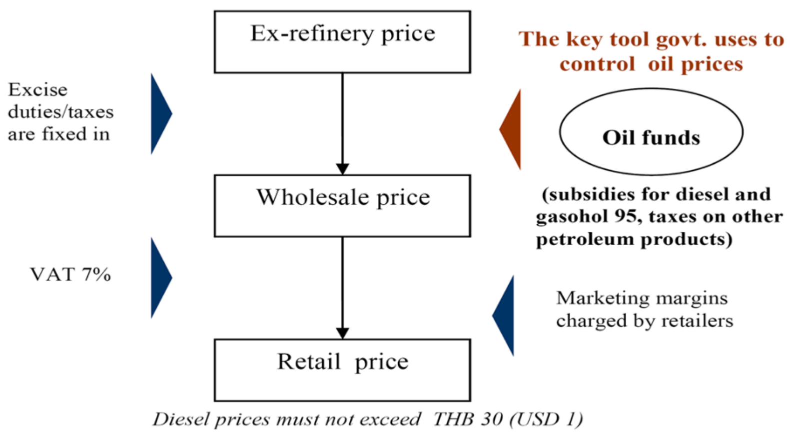
After the emergence of gasohol and biodiesel in 2007, the oil fund became a price stabilising instrument for reducing the fluctuations in the costs and retail prices of gasohol, biodiesel, gasoline, and HSD. The utilisation of the oil fund after 2007 has also had a cross price subsidy feature, where the gasoline 91 consumers are the major contributors to the oil fund and the E85 consumers are the major recipients of the subsidies. The oil fund account can be either in surplus or in deficit in a given period depending on the degree of the cross-price subsidies.

The fund is a monetary reserve that acts as a means of reducing price volatility and allowing cross subsidisation. It has been used both to smooth price swings on the world market and to cross-subsidise socially sensitive fuels. Levies are imposed on fuels. Subsidies may be provided on a per-litre basis or as a lump sum to fuel producers or distributors. As such, over the years, the oil fund has been used to (i) reduce price spikes; (ii) cross-subsidise fuels for economic, political, or social reasons; and (iii) encourage greater use of domestically produced energy resources.

2.3.2. Diesel Subsidy: Cross Subsidy and Tax Reductions for Price Caps

The price subsidies for petroleum products are different for each product. Some are charged and some are subsidised. Gasoline, kerosene, and fuel oil are the petroleum products that most often face oil fund levies. The fuels that are most often subsidised are diesel and LPG, using the mechanism shown in Figure 3.3.

Figure 3.3. Thailand's Diesel Subsidy Scheme Using Oil Funds



Source: EPPO (2013).

Oil fund levies and subsidies are adjusted weekly, and it is not unusual for a levy to be applied one week and a subsidy the next to keep retail prices stable. For instance, diesel was subsidised in 11 out of 12 months in 2004, and diesel, but not gasoline, continued to be subsidised by the fund in 2005 until August. Diesel was again subsidised in 2008, in June 2009, in the first 4 months of 2011 leading up to a closely contested national election in July 2011, and again in August and September 2012. In addition, the oil fund levy was eliminated for both gasoline and diesel in the last 4 months of 2011. By April 2011, the oil fund reserves had been depleted. Aside from periodic subsidisation of gasoline and diesel, the oil fund has been used mainly to subsidise bioethanol and biodiesel. The government has committed to maintaining the diesel price at about B30/litre since late 2010. In theory, the oil fund is revenue neutral. In practice, it has required injections of government funds during periods of prolonged deficits (most recently in 2004) and borrowings from commercial banks to allow ongoing deficits (most recently in 2012). The oil fund had a deficit of B22 billion in June 2012.

In addition to the cross-subsidy by the oil fund, the government also imposed tax breaks for diesel. In April 2011, the cabinet approved a cut in the excise tax for diesel from B5.31/litre to B0.005/litre, effective from 21 April until 30 September to keep the diesel price at or below B30/litre, a move widely criticised for being political even by the Federation of Thai Industries. Although launched initially as a temporary measure, this excise tax reduction has remained in effect to this day. In July 2011, the Excise Department said the decision had led to higher diesel consumption and the government had lost B9 billion a month. Table 3.1 shows the differences in the price structures for gasoline and diesel. The total subsidies for diesel from the lower oil fund levy and tax breaks relative to gasoline are about B16.17/litre in order to keep the retail price of diesel below B30/litre.

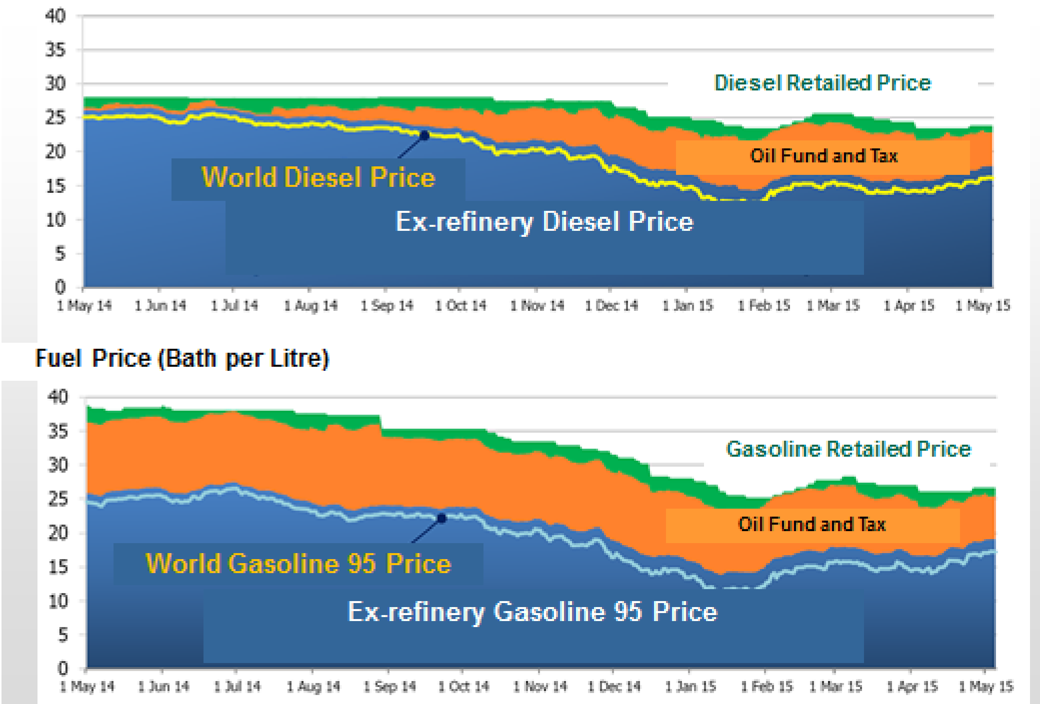
Table 3.1. Subsidies for Diesel Relative to Gasoline

Unit: THB/litre	Gasoline (ULG 91R)	Diesel (HSD 0.035%S)	Tax reductions for diesel compared with gasoline
Ex-refinery price	25.20	25.49	
Excise tax	7.00	0.01	7.00
Municipality tax	0.70	0.00	0.70
Oil fund levy	7.70	0.30	7.40
Conservation fund levy	0.25	0.25	0.00
VAT on wholesale price	2.86	1.82	1.04
VAT on retail price	0.18	0.14	0.04
Retail	46.45	29.99	
(Total tax reductions for diesel compared with gasoline)			**16.175**

VAT = value-added tax.
Source: EPPO (2013).

Diesel consumption has risen steadily after its price was capped at B30/litre in 2011. The army seized power on 22 May 2014 in a bid to restore order and get the economy back on track after months of political unrest that had hurt economic activity. The energy price reform is among the military government's priorities. Under the current subsidies through the oil fund, diesel users pay lower prices at the expense of costly gasoline prices. However, with the decrease in the world oil price, the impact of the subsidy removal on the retail price is insignificant. This is the first time since April 2011 that Thailand has raised the levy on diesel as shown in Figure 3.4. The country's retail fuel prices have been distorted by various populist policies introduced by previous governments through the oil fund. As a result, retail prices of gasoline will fall by B1.0–B3.89/litre, while diesel prices will rise by B0.14/litre but still below B30/litre. The oil fund and tax for diesel increase since mid-2014 is comparable to the stable gasoline are shown in Figure 3.4. This provides a good signal for the subsidy reform for diesel in Thailand, which needs to continue in the future even amid an environment of increasing world oil prices.

Figure 3.4. Removal of Diesel Subsidies by Increasing the Oil Fund and Tax Relative to Gasoline



Source: EPPO(2015).

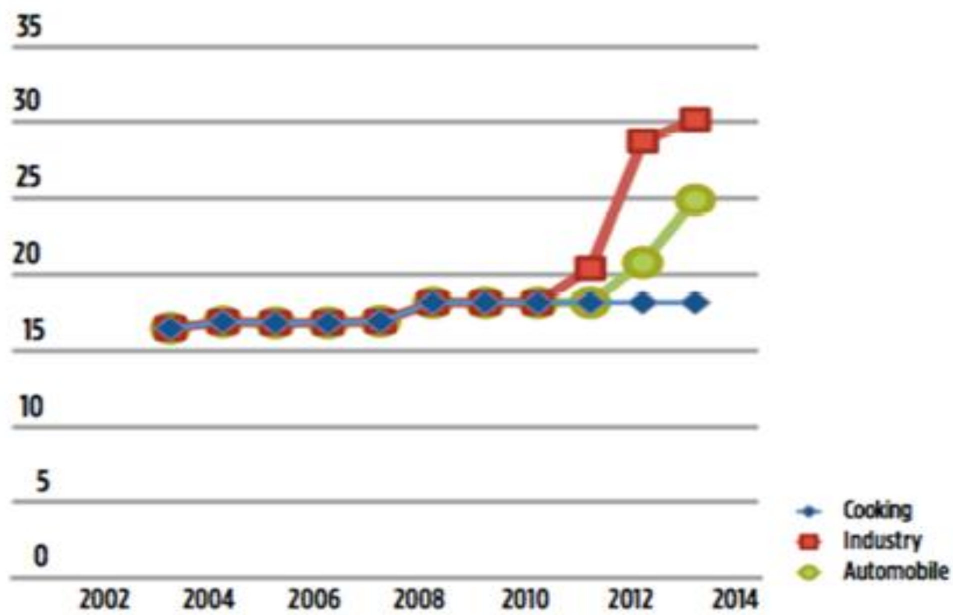
2.3.3. LPG Subsidy: Cross-Subsidy and Price Caps

The major source of the subsidy for LPG is not the oil fund, but the subsidy applied at the refinery gate using the price caps. The ex-refinery price has been capped at US$333/tonne for more than 2 decades under a programme intended originally to help relieve the burden of households and food vendors. Retail prices are also capped for all sectors, except the petrochemicals industry. Oil fund levies are applied to the cooking, transport (automobile), and industry sectors. Lump-sum transfers are made from the oil fund to LPG producers and importers to compensate for the capped ex-refinery price. Domestic producers of LPG are only compensated for the difference between the cost of production and the ex-refinery price. They are not compensated for the opportunity cost of selling LPG domestically rather than at the higher international price.

The Saudi Aramco Contract Price for LPG is widely used as a reference price upon which producers and wholesalers base their negotiations. This benchmark price for LPG has been consistently above US$333 since August 2004, rising to an average of US$850 a tonne in 2011 and US$920 in 2012. The government's plan to float the price of LPG for industries in 2008 faced strong opposition and was delayed until July 2011, when the government began to raise the price by B3/kg every 3 months until it reached B30.13/kg; price increases above B30.13/kg were to require the approval of the National Energy Policy Council, chaired by the prime minister. Many companies switched to 48-kg cylinders, normally reserved for household use. The government began to raise the price of automotive LPG in 2012. The LPG subsidy is borne by the government and the compressed natural gas subsidy by PTT (formerly known as Petroleum Authority of Thailand), and hence the government has used the oil fund to finance the conversion of taxis from LPG to compressed natural gas. PTT is eventually reimbursed for the LPG subsidy, but with a long delay.

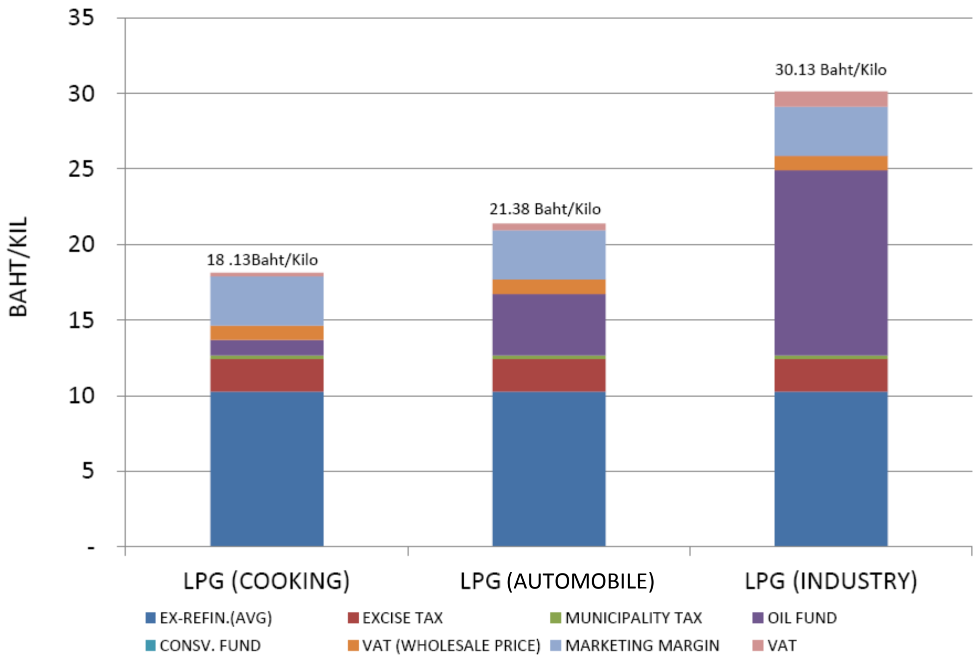
The price of LPG from 2003 to 2013 is shown in Figure 3.5. The LPG price for industry started to float in response to the world market in 2011, followed by the automobile sector in 2012. As shown in Figure 3.6, as of December 2012, LPG was sold at B18.13/kg to households, B30.13/kg to industrial consumers, and B21.38/kg as an automotive fuel, and these prices were maintained through early 2013. In November 2012, the government announced a plan to raise LPG prices for all consumers over time to B36/kg, based on an assumed benchmark price of US$0.90/kg in 2013–2014. The retail price was raised by B0.5/kg every month for residential and automotive consumers and by B1/kg a month for industrial users until B36 was reached.

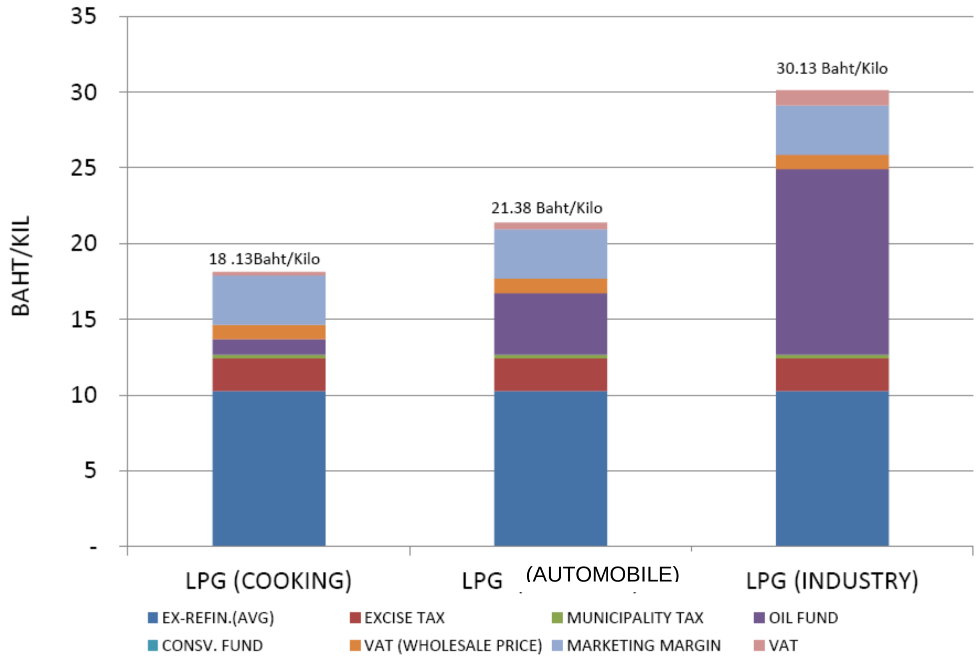
Figure 3.5. Retail Price of LPG by Sector
(baht per kilogram)



Source: EPPO (2013).

Figure 3.6. LPG Price Structures for Different Sectors (as of December 2012)

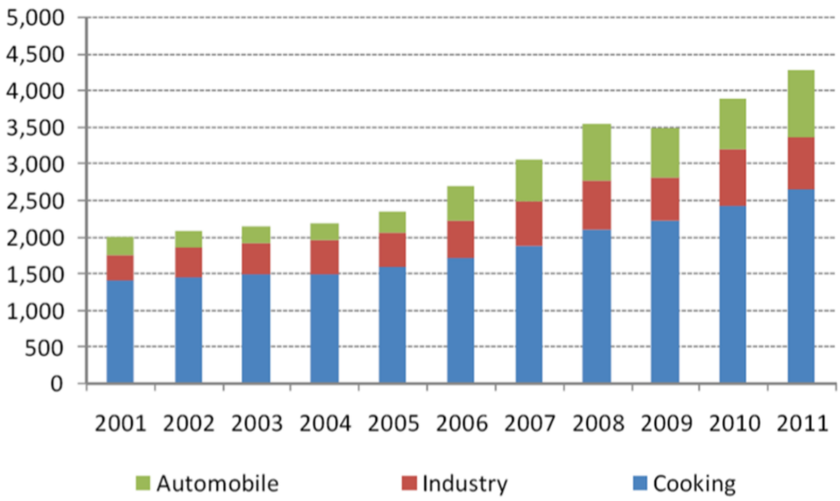




LPG = liquefied petroleum gas, VAT = value-added tax.
Source: EPPO (2013).

The impact of the different LPG price structures for the different sectors creates market distortions and encourages demand to increase in the low-LPG price sector, which comprises mainly use by households for cooking. Figure 3.7 shows the stagnating consumption of LPG by industrial users and the sharply rising consumption of LPG by households, supporting reports that some industrial users may have switched to residential LPG for cost savings.

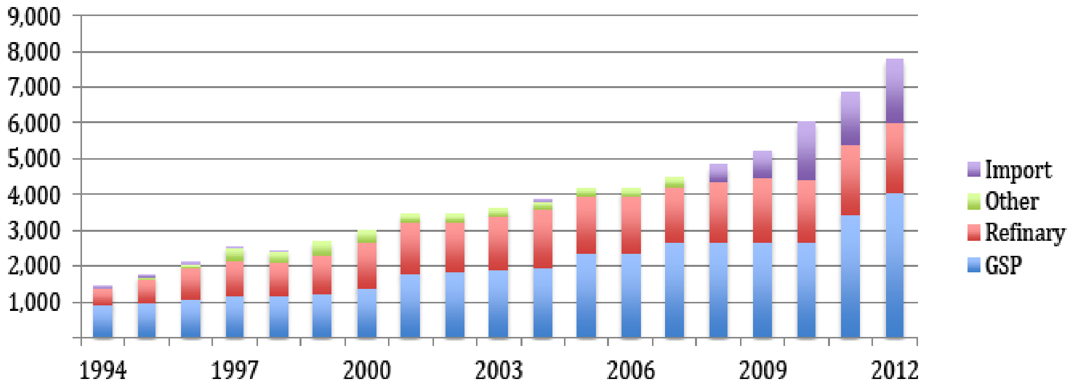
Figure 3.7. Consumption Growth of LPG in the Residential Sector
(kg million)



Source: EPPO (2013).

The supply of LPG comes from three mains sources, as shown in Figure 3.8. The first source are the gas separating plants, which uses natural gas in the Gulf of Thailand as raw material. This accounts for around 50 % of the total supply. The second source of LPG comes from refineries that use crude oil as the raw material. The last source of LPG is direct imports. Thailand has imported LPG since 2008 at three times the domestic price, with the import amount increasing by 47 % per year on average. Since the gas separating plant uses domestic resources, it can produce LPG at the lowest cost, while refineries have higher costs because the crude oil is imported and the price is more expensive and fluctuates more than the price of domestic natural gas.

Figure 3.8. Sources of LPG in Thailand



Source: EPPO (2013).

2.4. Impacts of the Petroleum Product Subsidy Reform

In Thailand, it is estimated that the approximate cost of energy subsidies in 2011 was about B168.8 billion in energy tax reduction and subsidies. In particular, the diesel excise tax reduction costs the government about B106.5 billion annually, while the LPG subsidy adds another B45 billion per year, and the NGV policy another B17 billion. It is indeed a huge cost to society that also creates economic distortions. Keeping retail diesel prices below gasoline prices will only lead to more consumers shifting to diesel vehicles. According to the Nation, Thailand's former Energy Minister Piyasvasti Amranand said in June 2014: "*Energy prices reform must be carefully considered. The previous governments have turned energy policies into populist policies. Subsidizing diesel and LPG with the Oil Fund finances does not save the country's expenses, but raise the country's burden. Diesel subsidies have led to a loss of over 100 billion baht in annual revenue. In three years, the amount has risen to 300 billion baht. Combined with LPG subsidies, that ran up to 500 billion baht. Some parties will need to shoulder the cost if the subsidies continue.*"

The impact of the subsidy reforms will vary depending on their nature. Sudden price changes tend to have the greatest impact on vulnerable consumer groups. Price hikes will also translate into higher input costs for businesses, affecting their profits and sales. Due to the indirect impact on other goods and services, energy subsidy reforms will affect the inflation rate. A policy framework for sustainable energy subsidy reforms is needed in Thailand. Looking ahead, policymakers will need come up with a sustainable energy reform plan. Challenges lie ahead in decontrolling energy prices, assessing and managing the negative impacts of the reforms, and finding ways to build public acceptance of the reform plans. Thailand should continue to remove the price subsidies and directly provide other social programmes to help low-income groups.

3. Impact Analysis of Petroleum Product Subsidy Removals

There are two sets of methodologies used in this study. The first is to measure the magnitude of petroleum product subsidies using a price-gap approach, and the second is to quantify the impacts of subsidy reform using a basic CGE model.

3.1. Estimating the Size of the Petroleum Product Subsidies

Assessing the magnitude of the petroleum product subsidies is a task challenged by poor data quality, limited data availability, and lack of data comparability, as there is no harmonised or consistent reporting structure for such subsidies. Direct financial transfers are generally the easiest to quantify, as they are usually included in government budgets. In addition, some market transfers to consumers through lowered prices and tax credits are also straightforward to estimate. Different approaches are applied to estimate energy subsidies. The *effective rate of assistance* covers any direct and indirect action that affects the price of a good. The *producer subsidy equivalent*, developed by the Organisation for Economic Co-operation and Development, looks at the value of subsidies to their recipients as a measure of their impact. The price-gap approach focuses on end-use energy consumption subsidies and quantifies the gap between world energy prices and domestic (subsidised) end-user prices. While the effective rate of assistance has the virtue of capturing the full extent of the subsidy, in theory, such a measure is difficult to use in practice because it requires a wealth of reliable information and data, which in many cases are difficult to obtain. The producer subsidy equivalent offers a feasible way to pursue the magnitude of impacts over time but provides no information about the effects on economic efficiency.

The price-gap approach is a widely used method that focuses on consumer-side subsidies and quantifies the gap between the reference price and the subsidised end-user price (Koplow, 2009). This study applies the price-gap approach to estimate the scale of the petroleum product subsidies in Thailand over the past period. The price-gap approach has the advantage of conceptual and analytical simplicity. It is the most pervasive approach in analysing energy subsidies and the majority of Thai energy subsidies are in the form of end-use subsidies. The theoretical foundation of the price-gap approach was proposed by Corden (1957). It is based on the idea that subsidies to consumers of energy lower the end-user prices of energy products and thus lead to more consumption than would occur in their absence. IEA (1999, 2008) and Coady et al. (2010) used this method to estimate the magnitude of energy subsidies in other countries.

However, the price-gap approach also has limitations. Firstly, it only captures the subsidies on end use. Secondly, it requires accurate data on world reference prices, domestic taxes, and transport costs, all of which can only be collected from the historical data that may or may not be possible to obtain. Thirdly, and in the context of this study, it identifies only the static effects. It compares the given situations with and without subsidies, holding all other things equal. The dynamic effects of the removal of energy subsidies may well bring larger benefits than the static results. This suggests that the estimate itself may underestimate rather than overestimate the impact of energy subsidies (IEA, 1999). The results should, therefore, be seen as a lower bound of the true costs of the energy subsidies.

For its simplicity and the data availability, we first utilise the price-gap approach to estimate the energy subsidies. We determine the consumer price and reference price, and then compute the price gap:

Price gap = Reference price − Consumer price

Subsidies = Price gap x Quantity of subsidised products

However, from the background information provided in the previous section, the petroleum product price subsidies in Thailand use the oil fund and taxes as a means for the subsidy policy implementation. Therefore, the negative oil fund levies represent the amount of subsidy imposed for each petroleum product from the fund. Table 3.2 shows the past annual average oil fund levels for each petroleum product based on the government policy in that period. The annual consumption in litres for each petroleum product multiplied by the average subsidy for the product relative to the other products can be estimated as a part of the annual subsidy amount.

Table 3.2. Annual Average Oil Fund Tax Levels Levied on Petroleum Products
(baht per litre)

	Gasoline		Gasohol					Diesel			LPG
				ULG95		ULG91		HSD		Fuel	cooking
	ULG95	ULG91	E10	E20	E85	E10	Kerosene	0.035%S	LSD	Oil	(THB/kg)
1996	0.11	0.11					0.03		0.12	0.03	-0.64
1997	0.08	0.08					0.06		0.04	0.03	-1.89
1998	0.16	0.16					0.10		0.13	0.06	0.40
1999	0.09	0.09					0.10		0.08	0.06	-2.94
2000	0.34	0.22					0.10		0.11	0.06	-7.31
2001	0.50	0.30					0.10		0.50	0.06	-5.55
2002	0.50	0.30	0.27			0.27	0.10		0.50	0.06	-2.45
2003	0.49	0.30	0.27			0.27	0.10		0.50	0.06	-3.05
2004	-0.34	-0.59	0.24			0.27	0.10		-2.27	0.06	-2.55
2005	1.28	1.03	0.13			0.16	0.10	-0.92	-1.02	0.06	-2.54
2006	2.70	2.50	0.84			0.84	0.10	1.47	1.47	0.06	-1.93
2007	3.67	3.37	0.85			0.62	0.10	1.39	1.39	0.06	-1.02
2008	3.78	3.31	0.77	-0.21		0.28	0.10	0.40	0.31	0.06	0.30
2009	6.94	5.31	1.78	-0.80	-7.88	1.17	0.10	0.78	1.20	0.06	0.22
2010	7.50	6.65	2.74	-0.41	-10.93	1.43	0.10	0.66	1.20	0.06	0.61
2011	4.90	4.38	1.87	-1.80	-13.50	-0.40	0.10	-0.60	1.20	0.06	1.14
2012	5.23	4.73	2.03	-1.30	-12.40	-0.16	0.10	0.69	1.20	0.06	0.89*

* Different oil fund levies were applied to LPG for different sectors in 2012. The average levy for industry was THB 10.55 per kilogram and for automotive use THB 3.34.

LPG = liquefied petroleum gas.
Source: EPPO (2013).

3.1.1. Estimation of Diesel Subsidies

Two successive Thai national governments have capped the retail price of HSD diesel in the Bangkok metropolitan region to below B30/litre. The policy first emerged in December 2010 when the public and industry expressed concerns after the diesel price rose above B30/litre. The government initially applied a subsidy from the oil fund to reduce diesel prices. The oil fund became depleted and in April 2011 the decision was taken to temporarily reduce the diesel excise tax from B5.30/litre to B0.005/litre. The VAT of B0.40 was also removed, leading to a total tax exemption of B5.70/litre. Since that time, the excise tax exemption has been repeatedly extended and an oil fund levy or subsidy has been applied to maintain the price close to B30/litre. The cost of the excise tax exemption was over B100 billion in foregone revenue in 2012 alone, as shown in Table 3.3. The policy to reduce the excise tax reduced the price paid by consumers and hence is classified as a subsidy.

Table 3.3. Excise Tax Forgone for Diesel due to Tax Reduction

(B billion)

	2005	2006	2008	2009	2011	2012
Diesel	10.74	4.77	10.99	2.74	74.97	108.23

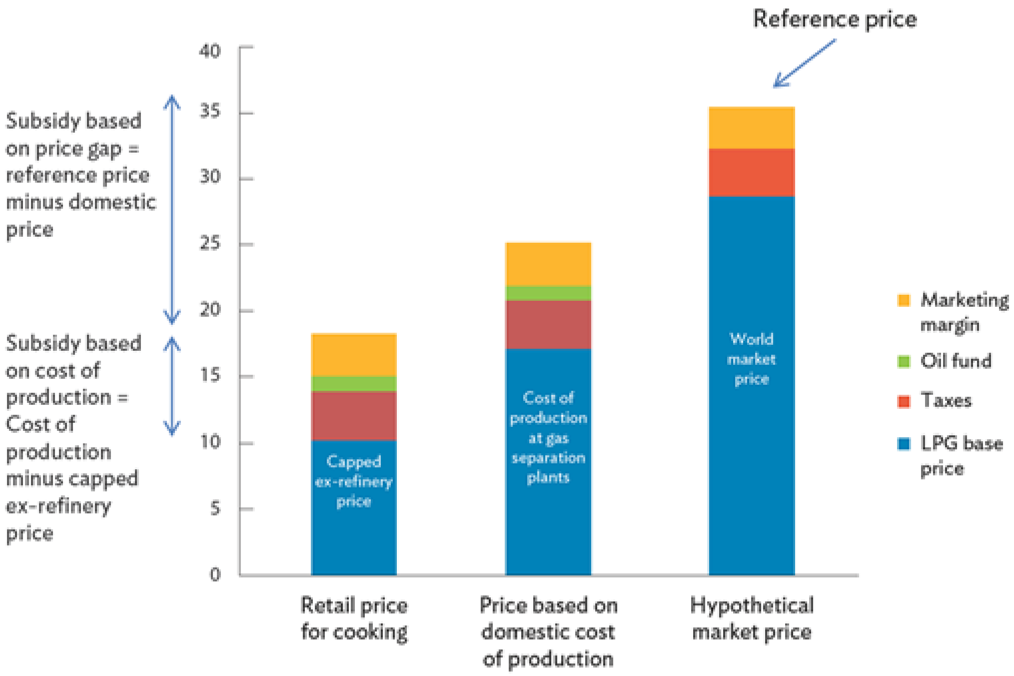
Source: Excise Tax Department (2013).

A tax reduction is distorting if taxes remain unchanged (or are higher) for other fuels. Compared with gasoline, diesel benefits from multiple tax and levy reductions. This distorts the market in favour of diesel, despite having a similar ex-refinery price as shown earlier in Table 3.1. The policy also creates a major hole in the government's budget compared with a scenario where the policy is not implemented. Capping the price at B30/litre has also reduced margins for fuel retailers. PTT (2012) reported in late 2012 that the diesel marketing margin for that year will likely settle at an average of B1/litre, lower than the B1.50 retailers expect to gain. PTT said that retailers were losing a total of around B30 million per day and that the marketing margin for gasoline (B3.2 for octane 95 and B2.5 for octane 91 on 27 February 2013) was not sufficient to compensate for this loss, given the relatively low amounts of gasoline sold compared with diesel.

3.1.2. Estimation of the LPG Subsidies

The subsidies for LPG are complex. The government sets prices for four different consumer categories and free-market prices prevail for the petrochemicals industry. The price structure of subsidised LPG is made up of the capped ex-refinery price, oil fund levies (which are used to partly compensate LPG suppliers for the capped ex-refinery price), and some taxes and margins. In addition, there is the opportunity cost of selling LPG at below-world-market prices. A price-gap analysis can be used to cut through some of these complexities and provide a total figure for the full cost of LPG subsidies. The conceptual price gap estimation is shown in Figure 3.9.

Figure 3.9. LPG Subsidies Estimation on Price Caps



LPG = liquefied petroleum gas.

Note: An oil-fund levy was not included in the reference price because the government, to keep prices down, is unlikely to apply a levy to market-priced LPG.

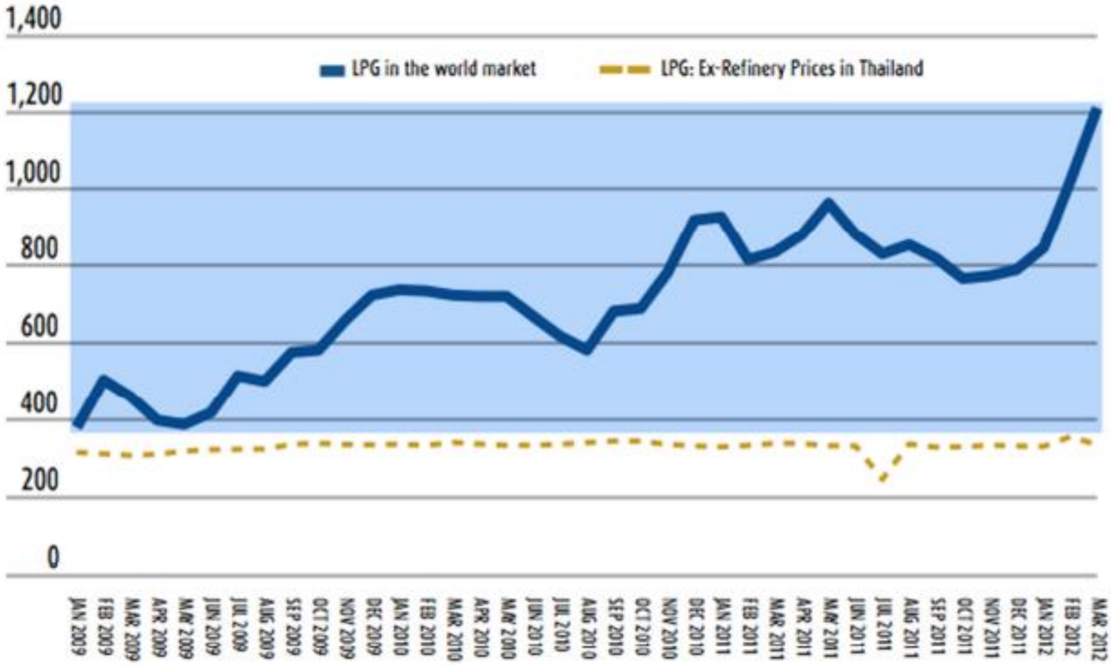
* Based on 2012 average prices.

Source: ADB (2015).

The Saudi Aramco Contract Price for LPG generally moves in line with the crude oil price. However, to manage domestic LPG prices, the Thai government has determined marketing margins for retailers in the cooking segment and has subsidised LPG wholesale prices at PTT's storage terminals.

The domestic retail prices of LPG comprise four main elements. Firstly, the ex-refinery price normally refers to the average cost of production, but the LPG price is an exceptional case. The ex-refinery price of LPG is directly regulated by the government, and the price is in fact much lower than the actual cost of production. The real LPG ex-refinery price has decreased over time compared with other petroleum prices, which have fluctuated and increased, as shown in Figure 3.10. Secondly, taxes and VAT are kept in the same as for other products, except for the municipal tax, which varies slightly among provinces. Thirdly, the oil fund is a form of tax that the government takes from every petroleum product in order to subsidise and stabilise the domestic petroleum price during fluctuating periods. While LPG also pays into the oil fund, it is a main expense for the fund. Lastly, the marketing margin is the difference between the wholesale price and the retail price. In other words, it is that profit that retailers or gas stations receive from selling the gas. Therefore, if the marketing margin is low, a gas station has a low incentive to provide good services to its customers, which may lead to security problems.

Figure 3.10. LPG Ex-Refinery Price Gap to the World LPG Market Price



LPG = liquefied petroleum gas.
Note: The LPG world price is taken to be the Saudi Aramco Contract Price, a major international price benchmark.
Sources: EPPO (2013).

As mentioned, there are three sources of LPG in Thailand with different costs of production. Subsidised LPG by source in 2012 is shown in Table 3.4. The subsidy for imported LPG (which started in 2008) is the highest at around B36 billion, followed by LPG from the refineries, which was subsidised by around B14 billion. The lowest subsidy is for LPG from the gas separation plant, which uses domestic natural gas as a raw material, at around B7 billion. The total subsidy for 2012 was around B57 billion.

Table 3.4. Estimated LPG Subsidies by Source, 2012

(B billion)

Source of LPG	LPG production for subsidized markets (million tonnes)	Benchmark price (production or import cost) (US$ per tonne)	Subsidy rate (THB per kg)	Subsidies (THB billion)
Refineries	1.00	779	13.85	13.86
Import	1.68	1024	21.48	36.02
Gas separation plant	2.04	450	3.64	7.43
Total				57.32

LPG = liquefied natural gas.
Source: EPPO (2013).

The oil fund has not provided a per litre subsidy for LPG since 2007, with the exception of 2 months in 2008. However, the oil fund has continued to fund the LPG subsidy, reaching B47.21 billion in 2012. These funds are used to partially compensate producers and importers for losses incurred from the capped LPG ex-refinery price (Energy Policy and Planning Office, 2013).

The retail price of LPG for all users was constant at B18.13 from March 2008 until July 2011. To stem mounting subsidies, the government decided in 2011 to raise the price of LPG for industrial and automotive users. The price for industries was to increase by B3/kg per quarter starting in July 2011 until the price reached B30.13/kg (achieved in March 2012). Increases above B30.13/kg required the approval of the National Energy Policy Council, chaired by the prime minister.

The price for automotive LPG was to increase by B0.75/kg per month starting in January 2012. Between January 2012 and January 2013, the price of automotive LPG was raised seven times. On only three of those occasions was the full B0.75 added to the price (Energy Policy and Planning office, 2013). LPG price increases are primarily achieved through higher oil fund levies (see Table 3.5). The retail price of LPG for cooking continues to be capped at B18.13/kg.

Table 3.5. LPG Price Structure, 2013

LPG Price Quoted on 2 November 2013				
Unit:Baht/ kilogram	Low income	Cooking	Automobile	Industry
Ex-Refinery	10.4330	10.4330	10.4330	10.4330
Tax	2.1700	2.1700	2.1700	2.1700
Municipal Tax	0.2170	0.2170	0.2170	0.2170
Oil Fund1	0.8663	0.8663	0.8663	0.8663
Conservative Fund	0.0000	0.0000	0.0000	0.0000
Wholesale Price	13.6863	13.6863	13.6863	13.6863
VAT	0.9580	0.9580	0.9580	0.9580
Oil Fund 2	-	1.4019	3.0374	11.2200
Marketing Margin	3.2566	3.2566	3.2566	3.2566
VAT	0.2280	0.3261	0.4406	1.0134
Retail Price	**18.13**	**19.63**	**21.38**	**30.13**

VAT = value-added tax.
Source: EPPO (2013).

The Thai government plans to reform LPG subsidies by increasing the retail price to reflect the cost of production and providing direct subsidies to the poor. The Energy Policy and Planning Office (EPPO) indicated that prices for LPG for households and transport sectors will rise to B24.82. This new price reflects the cost of production for LPG from gas separation plants, but is still lower than for LPG purchased on the international market, which is around B36/kg. A government study (Pusayanawin, 2012) found that if the price of LPG rises by B6/kg, each household would pay B20 more each month. For food vendors, the cost would rise by B0.35 per dish. The Committee on Energy Policy Administration indicated that assistance would be provided to street vendors and poor households (identified as those using less than 90 kilowatt hours of electricity per month) (Pusayanawin, 2012. The committee approved the use of B50 million from the oil fund to develop a database of street vendors, of which there are about 500,000. Approximately 9 million eligible households would be subsidised at a rate of 6 kg per household per month via a system of planned credit cards, while street vendors would receive help not exceeding 150 kg per month per shop (Pusayanawin, 2012).

3.2. Economics Impacts of Subsidy Removals

Petroleum products subsidies have an economic impact by distorting prices and therefore affecting production and consumption decisions. Increases in oil and natural gas prices would ripple throughout other sectors of the economy, affecting the costs of production, and therefore the prices of other goods, particularly energy-intensive ones. In turn, this may affect the competitiveness of goods from certain sectors and countries in the global economy and could result in changes in trade flows. All these changes have effects on global emissions from fuel combustion. Many of the environmental and social impacts of petroleum products subsidies stem from this economic distortion – both through increased consumption in countries where energy prices are kept artificially low, and through the continued operation of less efficient, and often less clean fuel producers in countries where prices are kept artificially high to support domestic producers. Subsidies also affect government budgets by imposing fiscal burdens, which in turn reduce the amount of money available to spend on social programmes.

It should not be assumed that removing all petroleum product subsidies will necessarily have positive economic, environmental, and social effects across the board. The results of removing such subsidies are highly complex and some groups within certain countries may be negatively affected. Removing the subsidies could also have negative terms of trade effects for some countries. This study performs economic modelling approaches for quantifying the impacts of fossil fuel subsidy reform.

Computable general equilibrium (CGE) models simulate markets for production factors and goods using sets of equations that specify supply and demand behaviour across a multitude of markets. In theory, a general equilibrium analysis is supposed to look at the economy as a whole and therefore take account of linkages between all markets, including labour markets and markets for all goods that require energy as an input. Numerous CGE models are currently in use, each containing a set of complex non-linear equations that must be solved, based on assumptions regarding economic behaviour, including the price elasticities of supply and demand. The models are first run using values with the subsidy in place, and then again with the subsidy removed to estimate the overall net benefits and costs associated with the subsidy removal.

The data requirements for the general equilibrium model are massive, so the accuracy of the results is dependent on the accuracy of the assumptions and data. Energy is a fairly ubiquitous input to the production of most goods in the market, and changes in energy prices will affect almost all goods. Some key industries, particularly energy-intensive ones, should be included in the model in a disaggregated manner. However, in practice, most of the CGE models that have been used to simulate petroleum product subsidy reforms require choices as to what is modelled in detail and what is left in aggregated form, and the disaggregation of markets is not always undertaken.

Based on the data set and the developed CGE model available, this study will apply the CGE model, which is developed from the standard model by the Partnership for Economic Policy. The model will be modified for one region, 40 activity sectors, and 49 commodities. The database used in this study is based on the social accounting matrix, which was developed based on the input-output table for 2005 by the office of the National Economic and Social Development Board (NESDB, 2010). The CGE model used in this study was developed by Prinyarat Leangcharoen of the Thailand Development Research Institute and Kridtiyaporn Wongsa of Chiang Mai University.

For all these models, two main scenarios were explored: *business as usual*, where no policy change takes place; and *subsidy removal*, where all quantified subsidies are eliminated. The analysis assumes that subsidies are removed and the saved expenditure is entirely withdrawn from the economic system. This is clearly an unrealistic scenario, but it isolates which groups of households and businesses are most likely to be affected in the short term by a price shock before the impacts of reallocated savings are felt.

The future baseline growth of GDP was based on projections in the IMF's World Economic Outlook, National Development Plans, and economic growth expectations. Population projections are based on the United Nations Department of Economic and Social Affairs using medium-variant estimates. Assumptions on the projected growth of fossil fuel prices are based on the IEA's *World Energy Outlook 2012* and current policies scenario. For Thailand, assumptions used in the projections include GDP growth (4.6 %), population growth (0.086 % average), and fossil fuel growth (2.2 % average).

Assumptions are also made about the nature of subsidies to simplify the analysis. All subsidies are taken to be "on budget" and, as such, subsidy reform is assumed to increase government budgets by the amount of the quantified subsidies. It is also assumed that consumers paid the official prices before the reforms took place. In reality, however, some consumers may pay higher prices, because the diversion of subsidised fuels constrains supply. This kind of complex relationship is not captured in the models. Changes to the supply of energy after reform are also not considered in the macroeconomic projections.

All impacts are measured as a percentage change from Scenario 1 (business as usual). Generally, the removal of large consumer subsidies for widely used energy sources can be expected to have a significant impact across areas as varied as government finances, the economy, consuming sectors (households, businesses, and industry), energy supply, the environment, and governance.

The results are highly dependent on the model assumptions and methodologies. Both the social accounting matrix and macroeconomic models conclude that reallocating a greater proportion of savings to households would deliver more positive results than allocating a greater proportion to government budgets. These results are due to structural assumptions in the models on the important role played by wealthier households in stimulating economic demand, and the relative effectiveness of household expenditure in stimulating economic growth, compared to government expenditure or debt reduction. In particular, the structure of the macroeconomic model includes no relationship between increasing government expenditure or reducing debt, and the impacts on GDP or welfare.

The removal of fossil fuel subsidies in Thailand, with reallocation to households and the government budget, is projected to have very low impacts (some positive, some negative) under the CGE model. Under the subsidy reallocation option, the CGE model projects impacts that are slightly negative: a fall in GDP against the business-as-usual scenario of 0.048 % and 0.042 %, respectively, in the scenarios that reallocated a share of savings to all households and all savings to all households. However, these impacts are not considered to represent an accurate outcome of the scenario being tested, as the structure of the CGE model is only capable of projecting GDP impacts in response to an increase in the factors of production, and not from transfers that stimulate household consumption and reduce government debt. The results do, however, indicate that in the non-realistic scenario, if subsidy savings are not reinjected into the economy at all, the reform will have fairly minimal impacts on GDP growth.

The CGE analysis projects small, negative impacts on household consumption under the “all reallocation” scenarios, including when all savings are allocated to households. In the case of the compensation scenarios, it is likely that these net negative impacts are projected because only direct effects are compensated. Direct increases in household expenditures from higher fossil fuel prices are only one part of the increase in household costs. Reallocation of all savings to households is still insufficient to reduce the negative impact of the subsidy removal.

Among other literature on the social impacts of subsidy removal, Tangkitvanich and Kansuntisukmongkol (2007) conclude that oil price control mainly benefited high-income households in rural areas and low-income households in urban areas. Although low tax rates on diesel generally contribute to social well-being, less-than-optimal tax rates led to a social burden of B74.65 million per quarter on average between 1995 and 2009 (Muangkum, 2011).

Using the basic CGE model created by Prinyarat Leangcharoen and Kridtiyaporn Wongsa, the sectors projected to be most affected by the removal of petroleum subsidies are related to motor vehicles and to petroleum. This indicates that the energy sector is typically the most vulnerable to reforms. Impacts on the energy-intensive rubber industry make up the next-largest negative impacts, but these are small, at about 0.3 % of output. The sensitivity of the analysis, however, is limited because the CGE model distributes subsidies across the entire petroleum sector, without further disaggregation by fuel type. Given that the majority of Thailand’s subsidies are related to diesel, LPG, and NGV, this suggests that some of the impacts indicated by the CGE analysis may relate to sectors more reliant on gasoline than other fuels.

At the sector level, the greatest decrease in energy consumption is projected for the transportation sector. This is because the removal of subsidies is projected to result in the substitution of LPG boilers with advanced natural gas boilers and coal boilers in 2015 and 2020. On the other hand, the removal of subsidies makes natural gas boilers more expensive than coal boilers in the short term. As a result, less efficient coal boilers are adopted, leading to a small increase in energy consumption in 2030.

The government has implemented policies to reduce the fiscal burden of fuel subsidies by gradually increasing the LPG price while protecting the poor. In their current form, however, these policies have only a limited impact on helping the poor and reducing the budgetary impacts of fossil fuel subsidies. Of the 7.7 million eligible recipients, only 2 % have registered to access the cheapest LPG. This may be because retail prices for all household consumers are still only marginally above the rate for poor consumers. If the price disparity grows, more may register for the cheapest gas. But it may also be because the process for registering and accessing subsidised LPG is difficult or cumbersome. Raising the LPG price to B24/kg, equivalent to the domestic cost of production, for other consumers of cooking and transport fuels will still provide significant subsidies. Moreover, the price is significantly lower than the price PTT pays for imported LPG – and it is exempt from the usual fuel taxes.

4. Discussion and Recommendations

Product price subsidies do not reduce the cost of the product, they just change the proportion paid by consumers or producers and move the rest of the costs onto other parts of the population. Someone still pays, but through taxes, higher prices, reduced government revenue, expenditure on other priorities, or lack of investment in energy infrastructure. Indeed, the inefficiency of subsidies can actually increase the overall cost burden on society.

Policymakers often justify energy subsidies with the argument that they contribute to economic growth, poverty reduction, and security of supply (World Bank, 2010). However, subsidies are rarely the most efficient tool for promoting these objectives. In reality, the main motivation behind energy subsidies is typically political, as seen in Thailand over the past years. Subsidies are a tangible way for governments to show that they are supporting their people. This is particularly important in countries that lack the administrative capacity to offer social and economic support through other policy mechanisms.

Since partial deregulation of the energy market in Thailand in 1991, subsidies were initially used to reduce price peaks for gasoline and diesel during times of high oil prices. Since the mid-2000s, subsidies have become more widely used to encourage the use of domestically produced resources, such as natural gas and biofuels, and to reduce the price of socially important fuels, such as LPG for cooking and diesel for transport and agriculture.

Raising the cost of different fuels will affect the economy in different ways. Cheap diesel primarily provides benefits by reducing the costs of personal transport and of energy-consuming economic sectors, like agriculture and fisheries. Even where people do not own vehicles, it still provides indirect benefits by reducing the cost of public transport, like buses. Cheap diesel can also provide indirect benefits by reducing the cost of goods that require transportation, such as food. Low prices of LPG for vehicles decrease the fuel costs for minibuses, taxis, and tuk-tuks (three-wheeled motorcycle taxis). This creates economic opportunities by enabling travel and sustaining jobs for drivers.

The majority of the benefits, however, are likely to accrue to the better-off, who can afford to purchase these fuels at quantity. Subsidised fuel may also “leak” to be used for unintended purposes (such as in the case of cooking LPG, being used illegally in the automotive or industrial sectors). Indeed, some benefits are not even enjoyed by Thais – LPG is smuggled across Thailand’s borders and sold for a profit in neighbouring countries.

The net benefits of energy subsidies must also consider the opportunity costs of subsidisation. Money spent on making energy cheap cannot be spent on other priorities. This is a far more complex consideration, but one consumer’s gain comes at a loss to others. Additionally, low energy prices cause inefficient economic allocation, reducing the size of the economy.

As people get used to low prices, subsidy reform becomes difficult. Powerful beneficiaries oppose it and governments fear social unrest when prices rise due to reforms. But this mindset must change, as the benefits of subsidy reform are potentially immense. The substantial drop in oil prices over the past years has opened a new window of opportunity to put an end to these harmful subsidies.

The largest quantifiable subsidies in Thailand were tax breaks for diesel and market-price support for LPG, as mentioned earlier, resulting from caps on retail prices. Market-price support is provided through cross-subsidies from the oil fund and PTT's under-recoveries by the majority state-owned oil company.

The single largest subsidy, a diesel tax exemption, arises from a government policy to keep diesel prices below B30 per litre. Initially intended as a temporary measure, the excise exemption has been rolled over each month since 2011. Significant decline and variations in world oil prices may lead to lower subsidy estimates since 2015 until present with lower world oil prices, but without policy change this would be expected to simply rise again when world oil prices rise.

Based on analysis of the complex interactions between the economic, social, energy, and environmental issues, the study shows that the initial rise in energy prices due to subsidy reforms will nudge households and businesses to shift to alternative fuels and to adopt energy-efficient appliances. Using the money freed up from subsidies to compensate poorer households and to increase government budgets will cancel out the negative effects of the initial price rise. These changes should allay the fears of reform.

The study measures the actual subsidies, such as the direct transfers, tax exemptions, subsidised credit, and losses of state enterprises by different fuel types. For example, the excise tax forgone for diesel due to tax reduction was around B108 billion in 2012 (as shown in Table 3.3) and the LPG subsidy around B57 billion in 2012 (as shown in Table 3.4). This information should help countries better sequence and prioritise reforms. The study contributes to international and national efforts to develop knowledge to ensure reforms are well-planned, sustainable, and politically acceptable. We hope the findings of this study will promote further discussion and sharing of knowledge on the best ways to anticipate the impacts of fossil fuel subsidy reforms. This can help ensure that subsidies are not simply removed, but that the funds they release are put to best use in helping the poor cope with the changes.

Energy price reforms are currently an ongoing process. In response to rising subsidy costs and the leakage of subsidies to unintended recipients, Thailand has attempted to reduce some subsidies, but progress has been erratic. Gasoline has been largely unsubsidised since 2005 and eligibility for free electricity was further restricted in 2012. Diesel, meanwhile, has since 2005 been unsubsidised at some times and subsidised at others. Since December 2010, an excise tax exemption on diesel has resulted in significant foregone revenue.

LPG use illustrates the pattern of household energy consumption and the impact on disposable income, with consumption following a general pattern of increasing with income. But although poorer, lower-income households consume less fuel, this constitutes a larger proportion of their income. The CGE model found that impacts on households would be small, but only the reallocation of all subsidy savings to households would reduce the incidence of poverty.

This study agrees with the previous study by ADB (2015) that provides some recommendations to improve social assistance programmes for the poor, including the following:

- Phase out subsidies for diesel and LPG, and replace them with targeted cash transfers for the poor that compensate for the direct and indirect impacts of subsidy removal. This can be achieved using the funding liberated from the reforms. Imposing the excise on diesel would generate over B110 billion per year in government revenue, almost double the annual cost of the old-age allowance. This would provide a survival pension to over 7 million people (more than 10 % of the population). Funds from imposing taxes on diesel would be sufficient to fund a similar scheme for the poor who need a social assistance regime. The poor who earn income below the poverty line comprise 13 % of the population, but there is likely to be an overlap between this group and those already receiving the old-age allowance.

- Utilise pro-poor programmes. Thailand has numerous pro-poor programmes that could be used to help develop a unified registry of the poor as well as proxy means testing. As an upper-middle income country, identification of poor households should be readily achievable.

- Use subsidy savings to increase funding for education and health services in poor areas. The key structural issues facing Thailand are the need to extend access to quality education and health care to the underprivileged, and reducing the environmental impacts of growth. Fossil fuel subsidy reform can address both of these by liberating funds for social spending and reducing emissions by eliminating distortions in fuel pricing. Allocating some subsidy savings to new social insurance schemes could also help to increase support for subsidy reform among the non-poor.

References

Asian Development Bank (2015), *Fossil Fuel Subsidies in Thailand: Trends, Impacts and Reforms*. Manila: Asian Development Bank.

Coady, D., R. Gillingham, R. Ossowski, J. Piotriwski, S. Tareq and J. Tayson (2010), *Petroleum Product Subsidies: Costly, Inequitable, and Rising*. IMF Staff Position Note, SPN/10/05,Washington, DC: IMF

Corden, M. (1957), "The Calculation of the Cost of Protection", *Economic Record* 33, pp. 29-51.

Department of Energy Business (DOEB) (2012), *Oil Plan* (in Thai)

Energy Policy and Planning Office (2013), Energy Statistics: Petroleum. http://www.eppo.go.th/info/2petroleum_stat.htm (accessed May 20, 2016).

Energy Policy and Planning Office (2015), *Thailand Energy Report* (in Thai).

Excise Tax Department, Ministry of Finance. (2013). *Data provided in response to a formal request by K. Thampanishvong, Interviewer*. Bangkok: Thailand Development and Research Institute.

International Energy Agency (IEA) (1999), *Energy Balances of Non-OECD Countries, 1996-1997*, Paris: IEA

International Energy Agency (IEA) (2012), *World Energy Outlook 2012*. Paris: IEA.

International Monetary Fund (IMF) (2008), *Food and Fuel Prices—Recent Developments, Macroeconomic Impact, and Policy Responses*. Washington, DC: IMF.

National Economic and Social Development Board. http://eng.nesdb.go.th/ (accessed June 12, 2016).

National Energy Policy Office (NEPO) (2006), *Report of Energy Development inThailand*, Bangkok: NEPO

Koplow, D. (2009), *Measuring Energy Subsidies Using the Price-Gap Approach: What does it leave out?* Manitoba: International Institute for Sustainable Development (IISD).

Leangcharoen, P., K. Thampanishvong, and T. Laan (2013), *A Citizens' Guide to Energy Subsidies in Thailand*. Geneva: Global Subsidies Initiative of the International Institute for Sustainable Development.

Ministry of Energy (2013), *LPG Frequently Asked Questions* (in Thai). http://www1.lpg4u.net/FAQ.aspx (accessed May 21, 2016).

Muangkum, L. (2011), *The Optimal Diesel Tax Rate in Thailand* (in Thai). Bangkok: Kasetsart University Press.

PTT Public Company (2012), *Annual Report 2012*. Bangkok: PTT.

Pusayanawin, W. (2012, December 20), Bid to Ease LPG Price Fears. The Nation.

The Nation (2014, June 24), Fuel subsidies must be short-term. Available at: http://www.nationmultimedia.com/news/business/aec/30237034 (accessed May 25, 2016)

Tangkitvanich, S., and C. Kansuntisukmongkol (2007), *Impacts from Oil Price Intervention Policy* (in Thai), Bangkok: Thailand Development Research Institute.

World Bank (2010), *Subsidies in the Energy Sector: An Overview*. Washington, DC: World Bank.

Chapter 4

An Intersectoral Assessment of the Impact of Removing Energy Subsidies in China

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Abstract

Energy subsidies are used in many countries, but their negative impacts are gradually being recognised. At the same time, energy price fluctuations may also have a negative influence on different sectors in China. In this study, we estimate the value of the energy subsidies and show that China's total energy subsidy in 2010 was around CNY1,929.65 billion, accounting for 4.7 % of the country's gross domestic product. Taking the iron and steel industry as an example, we analyse the impacts of removing the energy subsidy on industry competitiveness, emissions, welfare, and technology diffusion. We also analyse the joint impacts of removing the energy subsidy and implementing an emissions trading system. The results show that removing the energy subsidy would reduce CO_2 emissions and increase social welfare. However, when combined with an emissions trading system, not all sectors would profit from the policy combination. Removing the energy subsidy would at the same time reduce the equilibrium CO_2 price.

1. Introduction

Energy in an important input for economies and many human activities. Subsidies for energy production and utilisation are one of the most common forms of policy intervention, both in industrialised countries and developing countries. Government intervention in energy policies affects the supply and demand of energy, as well as final energy prices, and has an important influence on economic growth and development. Energy subsidies can be divided into producer subsidies and consumer subsidies. Producer subsidies appear when the producer price is higher than the price with no subsidy; consumer subsidies appear when the consumer price is lower than the free market price. Consumer subsidies can be divided into two types. The first is pre-tax consumer subsidies, which arise when the energy subsidy paid by consumers, for example, firms and households. The second is post-tax consumer subsidies, which arise when the price paid by consumers is below the supply cost of energy plus an appropriate Pigouvian tax, which reflects the environmental damage associated with energy consumption (Coady et.al, 2015). Generally speaking, developing countries subsidise consumers, and industrialised countries subsidise producers. However, no matter the form of the energy subsidy, both result in energy prices not reflecting the true cost of supply or consumption. A low consumer price results in overuse, inefficient use, and wasting of energy. A higher producer price encourages excessive production, high-cost operations, and discourages competition. Energy subsidies lead to capital- and energy-intensive (not labour-intensive) production patterns, increase the financial burden of the government, result in higher taxes, and at the same time bring higher levels of external debt. These effects have negative impacts on economic output and growth (Zhuang 2006). To sum up, the negative impacts of energy subsidies are mainly the following:

(1) Energy subsidies damage the environment, lead to more premature deaths, cause heavier congestion and negative effects of vehicle operation, increase greenhouse gas emissions, and contribute to increasing air pollution.

(2) Energy subsidies require huge fiscal expenditure, which needs to be borne by funded by increased government debt and taxes. At the same time, they can detract from public expenditure on education, healthcare, infrastructure, and so on, and hinder rapid economic development.

(3) Energy subsidies can inhibit investment in energy efficiency, renewable energy, and energy infrastructure, and reduce a country's ability to respond to international energy price fluctuations.

(4) Energy subsidies are an inefficient way of providing support to low-income families because most of the benefits that come from energy subsidies are enjoyed only by richer families.

Energy subsidies reform is still one of the hottest issues in the field of energy policy. More governments are recognising the negative environmental, financial, macroeconomic, and social consequences of subsidies, and reforms are urgently needed.

At present, there are several methods of estimating the scale of energy subsidies. They are (1) the price-gap method, (2) snapshot method, (3) producer subsidy equivalent method, (4) consumer subsidy equivalent method, (5) specific item method, and (6) effective subsidy rate method. The price-gap method is the most commonly used method. The basic idea behind it is that energy subsidy policies decrease the consumer price so that it promotes the energy consumptions, so we can measure the size and effectiveness of energy subsidies through calculating the gap between the consumer price of energy products and the price of the no subsidy and no market reference price.

The basic formula for the price gap is as follows:

$$PG_i = M_i - P_i \quad (1.1)$$

$$ES_i = PG_i \times C_i \quad (1.2)$$

PG_i is the price gap of energy product *i*, M_i is the guide price of energy product *i*, P_i is the terminal consumer price of energy product *i*, ES_i is the energy subsidy of energy product *i*, and C_i is the total consumption of energy product *i*.

Removing an energy subsidy affects the price of the energy product and then its total consumption. Referred to Li (2011), this could be expressed as:

$$q = P^{\varepsilon} \quad (1.3)$$

$$\Delta q = Q_0 - Q_1 \quad (1.4)$$

$$\ln Q_1 = \varepsilon \times (\ln P_1 - \ln P_0) + \ln Q_0 \quad (1.5)$$

q is the energy product consumption, ε is the long-term demand price elasticity of energy, Δq is the change in energy consumption after removing the energy subsidy, Q_0 and Q_1 is the energy consumption before and after removing the energy subsidy, and P_0 and P_1 are energy product prices before and after removing the energy subsidy. Using formulas (1.1)–(1.5), we can calculate the amount of the energy subsidy, and the effect on energy consumption resulting from removing the energy subsidy.

Using the price-gap method to examine energy subsidies has many advantages. First, the method is intuitive, its calculation process is relatively simple, and there is good data availability. As a result, it is widely used around the world. It can also be used for research on cross-border energy subsidies. Secondly, the price-gap method focuses on the effect the energy subsidy on consumption. Thirdly, the method aims directly at the price, so combined with price elasticity we can analyse the effect of removing the energy subsidy on economic efficiency and greenhouse gas emissions.

The price-gap does, however, have some limitations. First, the price-gap method can only estimate the consumer energy subsidy, not the producer energy subsidy. Second, the method can only estimate the net price effect of the energy subsidy, and ignore that part of the energy subsidies that have no impact on the market, , such as market transformation, invisible subsidies, and so on. Additionally, the method cannot estimate all the efficiency losses related with the government subsidy policy, meaning it is not able to capture all information on the subsidy, so can only estimate a part of the total energy subsidy. Third, the price-gap method assumes that other factors remain unchanged, so it can only estimate the static effects, not the dynamic effects. Fourth, the method cannot be applied to all situations. For example, if there are mixed energy subsidies, the price-gap method does not reflect the true scale of the subsidies. Finally, due to the discrepancies of the reference price of the world, the estimation of energy subsidy scale usually had a big difference. Through detailed descriptions of the various fossil energy subsidies, we calculate the total fossil energy subsidy amount for China in 2010, as shown in Table 4.1. We consider only thermal power when calculating the electricity subsidies. Using the average price of residential electricity and industrial electricity we can obtain the terminal consumption price. For electricity consumption, because the coal that used in the thermal power has caculated in coal consumption, so when we calculating the energy subsidy of electricity we only consider the electricity that generated from renewable source, which is about 20% of the total power generation.

Table 4.1 shows that China's total energy subsidy in 2010 was about CNY1,929.65 billion and GDP was around CNY40,890.30 billion, so the total energy subsidy accounted for 4.7 % of GDP. The coal subsidy is the highest, which accounted for 1.97 % of total GDP. Because in table 4.1 we only calculated the energy subsidies for the major energy, so the total amount of energy subsidy would be a underestimated value.

Table 4.1. China's Energy Subsidies, 2010

	Base price (CNY)	Final consumption price (CNY)	Price gap (CNY)	Consumption (billion tonnes/m^3/kWh)	Energy Subsidy (CNY billion)	Proportion of GDP (%)
Coal (CNY/tonne)	988.80	731.30	257.50	3.12	804.01	1.97
Gasoline	7,799.50	6,464.10	1,335.40	0.07	91.96	0.22
Kerosene	7,209.30	5,548.20	1,661.10	0.02	28.97	0.07
Fuel oil	6,893.70	3,935.50	2,958.20	0.04	111.17	0.27
Diesel oil	4,134.50	5,800.00	1,665.50	0.15	249.83	0.61
Natural gas (CNY/m^3)	3.41	2.35	1.06	107.58	114.03	0.28
Electricity (CNY/kWh)	1.03	0.79	0.34	875.23	297.58	0.73
Total					1,929.65	4.72

GDP = gross domestic product, kWh = kilowatt hour.
Source: Authors.

2. Sectoral Effects of Removing the Energy Subsidy

Some Chinese scholars have studied the impacts of removing energy subsidies on various sectors. Li (2011) analysed the impacts of the energy subsidy reform on the urban residential sector and selected seven representative areas for the research sample. They used an input-output model to analyse the difference in effects on different urban residential areas from the perspectives of climate conditions, energy consumption levels, and regional income levels, and proposed fossil energy subsidy reform measures that are climate oriented, structure oriented, and income oriented. Zhou, Zhao, and Sheng (2011) analysed the mechanism of China's energy subsidy policy to improve the competitiveness of China's export products and carried out an empirical analysis of 22 sectors' energy subsidies for export products. They found that China is an energy exporting country, and energy intensive products accounted for a relatively high proportion of exports. . Around 10 % of the total energy subsidy is subsidised to foreign consumers, so the country has a trade surplus as well as serious ecological deficits.

Previous studies have mostly paid attention to the amount of fossil energy subsidies or the energy subsidy situation in specific areas. However, there has been little attention on the sector-level impacts, especially energy-intensive sectors, such as the residential sector. It is meaningful to study the impacts of energy subsidies on particular sectors, as downstream sectors are affected by the energy price. In this chapter, we take China's highly energy-intensive sectors as examples to study the impacts on downstream sectors of energy subsidy reforms.

2.1. Impact of the Energy Subsidy Reform on China's Energy-Intensive Sectors: Example of the Iron and Steel Sector

Energy subsidy reforms directly affect the energy price, and energy price fluctuations consequently have direct effects on several sectors. The energy saving cost curve and the emission reduction cost curve are important tools for examining the energy saving and CO_2 emission reduction of sectors. At the micro level, we can use the abatement cost curve to analyse the cost-effectiveness of technologies; at the macro level, we could use the abatement cost curve to analyse the production behaviour and economic effects on sectors. In this chapter, we analyse the impacts on China's energy-intensive sectors after an energy subsidy reform using a micro-level abatement cost curve.

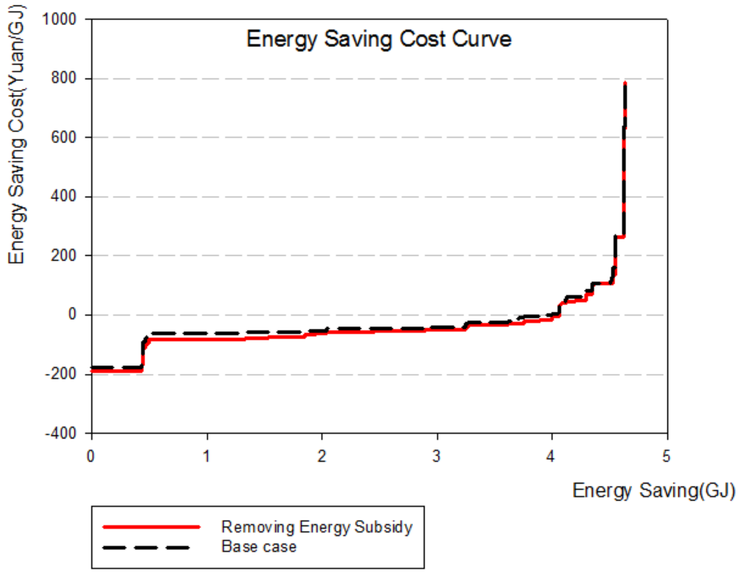
2.2. Abatement Cost Curve of China's Iron and Steel Industry after the Energy Subsidy Reform

Because the main energy sources in the iron and steel industry are coke and electricity, fluctuations in the price of coal and electricity will be passed on to the iron and steel industry after the energy subsidy reforms. We choose the energy price in 2010 as the base price.

Based on our calculations, the price-gap of coal is about CNY257.5/t. If we assume 6,500 kilocalories of coal is used in the iron and steel industry, the price gap is about CNY9.45/gigajoule (GJ). The price gap of electricity is about CNY0.24/kilowatt hour (about CNY66.67/GJ). Reflecting this in the abatement cost of the iron and steel industry, we get a new abatement cost curve, as shown in Figure 4.1 (the original abatement curve refers to Li and Zhu [2014]).

The energy cost increases after the energy subsidy reform, so the energy-saving technologies would be more cost-effective. . Under the base scenario, there are 25 cost-effective technologies, which would bring 3.89GJ in cumulative energy savings. After the energy subsidy reform, the number of cost-effective technologies increases to 28, and the cumulative energy savings increases to 4.05GJ, or by 4.1 % compared to the baseline scenario. This means removing the energy subsidy would increase the cost-effectiveness of energy-saving technologies and promote the diffusion of energy-saving technologies. Comprehensive energy costs increase from CNY110.22/GJ to CNY136.84/GJ after removing the energy subsidy, an increase of 19.45 %. However, the cumulative energy savings resulting from cost-effective technologies only rise by 4.1 %. That is, the comprehensive rise in energy costs do not bring matching energy saving effects. The energy savings increase caused by removing the energy subsidy is relatively low compared with the rise in energy prices.

Figure 4.1. Energy Saving Cost Curve for the Iron and Steel Industry after an Energy Subsidy Reform with a 20 % Discount Rate

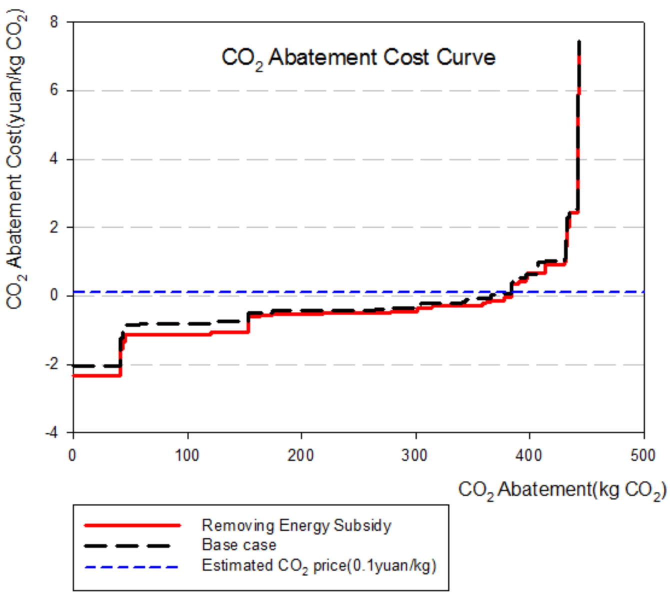


GJ = gigajoule.

Source: Authors.

The CO_2 abatement cost curve of the iron and steel industry after the energy subsidy reform is shown in Figure 4.2.

Figure 4.2. CO_2 Abatement Cost Curve for the Iron and Steel Industry after an Energy Subsidy Reform with a 20 % Discount Rate



kg = kilogram.

Source: Authors.

Because of the increase in the energy price after the energy subsidy reform, the CO_2 abatement cost also decreases. We assume the CO_2 price is CNY100/t, or CNY0.1/kg. Under the base scenario, there are 25 cost-effective technologies and the cumulative CO_2 abatement is 365.73kg of CO_2. The number of cost-effective technologies increases to 28 after removing the energy subsidy. The cumulative CO_2 abatement caused by the cost-effective technologies is 382.48kg of CO_2, or an increase of 4.6 % compared with the baseline scenario. For those not cost-effective technologies, the CO_2 abatement cost also decreased. The energy saving cost and the CO_2 abatement cost of China's iron and steel industry all decrease after the energy subsidy reform, and there are more cost-effective technologies as well as more cumulative energy savings. Energy subsidy reform can increase the cost effectiveness of energy conservation and emission reduction technologies and promote the adoption of better technologies in the industry.

2.3. Impacts of the Energy Subsidy Reform on the Competitiveness of Energy-Intensive Sectors: Example of the Iron and Steel Industry

After the year 2000, many industries began to show an oversupply situation with shrinking demand. Taking the iron and steel industry as an example, in 2009, China's crude steel production reached 568 million t, which was the highest in the world. The iron and steel industry is a high pollution and high emission industry, and the industry's energy consumption accounted more than 15 % of total domestic energy consumption in 2010. Because of the high proportion of Basic Oxygen Furnace (BOF)[1], the coal demand of China's iron and steel industry is also higher than the world average level (Ministry of Industry and Information, 2012). The average energy consumption of China's iron and steel industry is higher about 15 % compared with the world advanced level. This has led to greater energy waste and increases in emissions. From the perspective of industry operations, because of the single product category and low added value, the homogeneous competition phenomenon is more serious in China's iron and steel industry. The profit margins of the industry are generally low. In addition, due to the influx of many investments, the iron and steel industry is also facing a situation of excess production capacity.

Subsidies included in the energy price have made the energy costs of China's production sectors relatively low, and have led to low energy efficiency and severe environmental pollution. After an energy subsidy reform, the energy cost would increase, which would lead sectors' total costs to increase. For industries with low profits (like the iron and steel industry and the cement industry), the increase in cost would lead to further profit declines.

Referring to Demailly and Quirion(2008), the competitiveness loss mainly comprises two aspects: one is the production loss, the other one is profit loss. In this study, we also consider

[1] The proportion of BOF in 2003 was 82.40 %. This increased to 93 % in 2013. During the past 10 years, the ratio of BOF to EAF in the world is about 7:3.

the domestic production and the net export change.

2.4. Models

(1) Demand function

Demailly and Quirion (2008) established a two-country, two-goods model to research the impacts of the European Union's (EU) Emissions Trading Scheme (ETS) on its iron and steel industry. We establish a partial equilibrium model of China's iron and steel industry based on Demailly and Quirion (2008). We first assume the demand functions are expressed as:

$$Q_h(p_h, p_m) = \alpha_h p_h^{\eta_{hh}} p_m^{\eta_{hm}} \quad (2.1)$$

$$Q_x(p_x, p_f) = \alpha_x p_x^{\eta_{xx}} p_f^{\eta_{xf}} \quad (2.2)$$

$$Q_m(p_h, p_m) = \alpha_m p_h^{\eta_{mh}} p_m^{\eta_{mm}} \quad (2.3)$$

$$Q_f(p_x, p_f) = \alpha_f p_f^{\eta_{fx}} p_x^{\eta_{ff}} \quad (2.4)$$

Q_h is domestic demand, Q_x is export demand, Q_m is import demand, and Q_f is foreign demand. p_h is the domestic selling price that produced by the home country, p_m is the import price, p_x is the export price, and p_f is the foreign selling price of foreign goods. α_h, α_x, α_m, α_f on behalf of their own price elasticities; η_{hh}, η_{hm}, η_{xx}, η_{xf}, η_{mx}, η_{mm}, η_{fx}, η_{ff} on behalf of cross elasticities. Negative elasticities and positive cross elasticities indicated that the goods that produced by the home country could be replaced to some extent by the import goods.

(2) Description of the price change

The product cost would change after an energy subsidy reform. The change in the domestic market is as follows:

$$p_h^1 = p_h^0 + PT_h(ce(re) + ce(ua)) \quad (2.5)$$

p_h^1 is the product price after the energy subsidy reform, p_h^0 is the product price before the energy subsidy reform, PT_h is the pass-through of the domestic market, $ce(re)$ is the energy price increase caused by the energy subsidy reform, and $ce(ua)$ is the energy saving and CO_2 abatement cost by applying the energy-saving technologies.

Also, the export price would change as shown.

$$p_x^1 = p_x^0 + ce(re) + ce(ua) \tag{2.6}$$

p_h^1 is the export price after the energy subsidy reform, p_h^0 is export price before the energy subsidy reform, and PT_x is the pass-through of the export market.

Import price p_m^1 and foreign price p_f^1 are not influenced by the energy subsidy reform. They are shown as follows:

$$p_m^1 = p_m^0, p_f^1 = p_f^0$$

The change in total profit is

$$\Pi = p_h \times Q_h + p_x \times Q_x - (ce(re) + ce(ua)) \times (\mathrm{Q_h} + Q_\mathrm{x}) \tag{2.7}$$

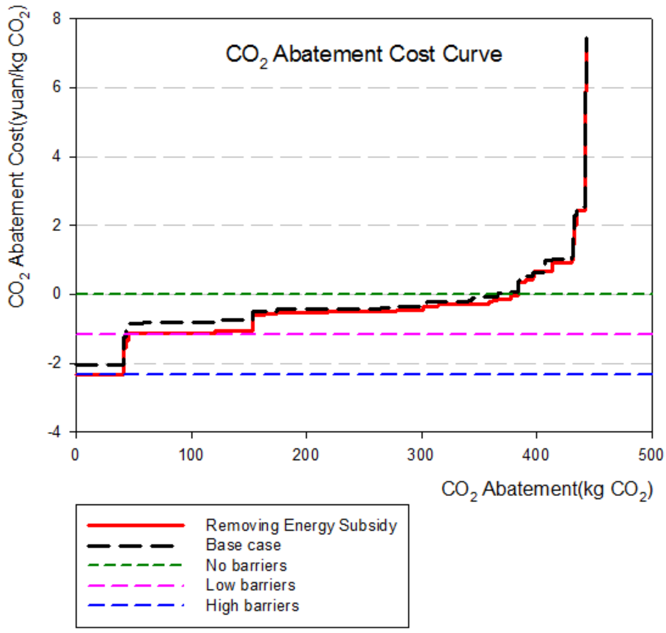
Q_h is the domestic product amount and Q_x is the export product amount.

The abatement cost curve, AC, is the integral of the marginal abatement cost curve, MAC:

$$AC = \int_0^{ua} MACdua \tag{2.8}$$

We set three barrier scenarios – the no barrier scenario, the low barrier scenario, and the high barrier scenario – to express the impacts on the abatement cost of different technology adoption barriers. The CO_2 abatement cost curves considering the adoption barriers are shown in Figure 4.3 and Figure 4.4.

Figure 4.3. CO_2 Abatement Cost Curve Considering Adoption Barriers (20 % Discount Rate)

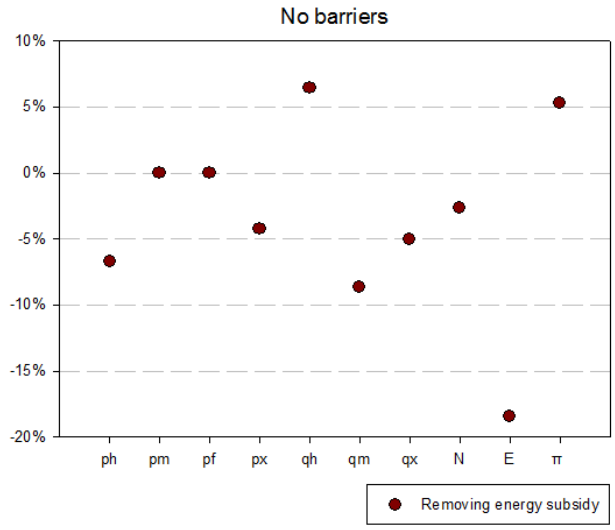


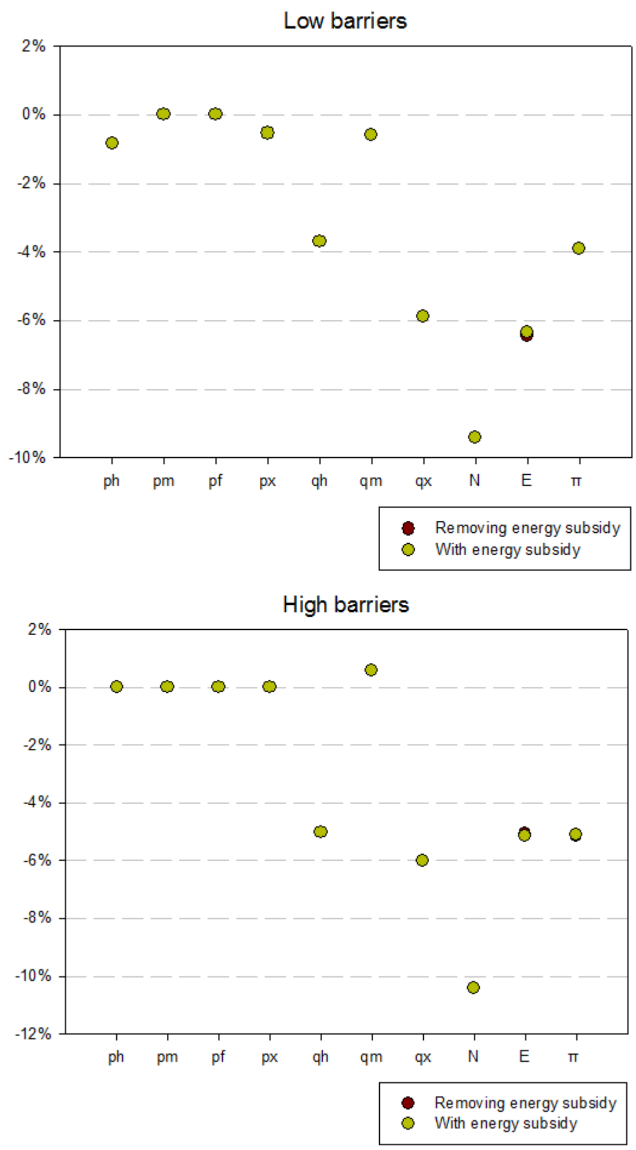
kg = kilogram.

Source: Authors.

For the no barrier, low barrier, and high barrier scenarios, the impacts of the key factors after the energy subsidy (compared with the no energy subsidy situation) are shown in Figure 4.4.

Figure 4.4. Impacts of the Energy Subsidy on Key Factors (No Barriers, Low Barriers, and High Barriers)





Source: Authors.

In the no barrier scenario, removing the energy subsidy would increase domestic production and decrease net exports. At the same time, from the perspective of industry competitiveness, profit and net exports increase after removing the energy subsidy compared with the base case. That is, using energy-saving technologies increases the cost of energy intensive sectors, but does not necessarily harm the profits of the industries. Regarding CO_2 emissions, total CO_2 emissions decrease significantly after using energy-saving technologies, however, due to the production increase, the total emissions for the sector are higher after removing the energy subsidy.

When increasing the barriers, the impacts of energy subsidy on the key factors are not remarkable, almost all key parameters had not obviously change. . At the same time, in the low barriers and high barriers scenarios, the profit and net exports decrease. Reducing the adoption barriers of the energy-saving technologies at the same time as removing the energy subsidy would not lead to a profit loss when adopting the energy-saving technologies for the energy intensive sectors.

3. Effect of Removing the Energy Subsidy after the Implementation of the Emissions Trading Scheme

Market-oriented carbon emissions trading mechanisms have been the focus of many scholars in recent years. The world's largest carbon emissions trading system at present, the EU's Emissions Trading Scheme (ETS) has played an important role in meeting the EU's emissions reduction targets. As a complete system, a carbon emissions trading mechanism is complicated to implement as it needs to consider the CO_2 emissions target, the quota allocation method, the banking and borrowing mechanism, the recycling use of the CO_2 profit, and so on.

3.1. Research Background

China has established seven carbon emissions trading pilots in Beijing, Shanghai, Tianjin, Chongqing, Hubei, Guangdong, and Shenzhen to further control its greenhouse gas emissions. It is planning to establish a national unified emissions trading market in 2017. The energy intensive sector would become the most important covered sector in the ETS. It would be a great challenge for the sector's competitiveness, on one hand, as many domestic high energy-consuming industries have been in a low-profit status, and additional carbon emissions costs might have further negative impacts on the industry's competitiveness. On the other hand, the change in the relative price of the products produced by domestic manufacturing enterprises compared with international products due to the implementation of the ETS would have negative impacts on imports. Currently, there is a lack of research focusing on the impacts of the ETS on China's energy intensive sectors.

If removing the energy subsidy is combined with the implementation of the ETS, energy intensive sectors would face higher energy use costs and trading costs in the carbon market. This research takes a partial equilibrium model as the basis for studying the impacts of removing the energy subsidy and implementing the ETS on industry in China. We take China's iron and steel industry as the example and analyse the key factors, including profit, production, imports and exports, and CO_2 emissions. We then take China's iron and steel industry and cement industry as examples to study the relationship across sectors.

3.2. Model

The production cost would change after removing the energy subsidy and implementing the ETS. The domestic price change is shown in (3.1).

$$p_h^1 = p_h^0 + ce(re) + ce(ua) + p_{CO_2}(u_e^0 - ua) - p_{CO_2} \cdot FA \cdot u_e^0 \qquad (3.1)$$

p_h^1 is the product price after the energy subsidy reform, p_h^0 is the product price before the energy subsidy reform, PT_h is the pass-through rate of the domestic market, $ce(re)$ is the energy price increase due to the energy subsidy reform, $ce(ua)$ is the energy saving and CO_2 abatement cost due to the adoption of the energy-saving technologies, $p_{CO_2}(u_e^0 - ua)$ is the allowance purchase cost in the carbon market, and $p_{CO_2} \cdot FA \cdot u_e^0$ is the cost compensation resulting from free allocation.

The change in the export price is shown in (3.2):

$$p_x^1 = p_x^0 + ce(re) + ce(ua) + p_{CO_2}(u_e^0 - ua) - p_{CO_2} \cdot FA \cdot u_e^0 \qquad (3.2)$$

p_h^1 is the export price after the energy subsidy reform, p_x^0 is the export price before the energy subsidy reform, and PT_x is the pass-through rate of the foreign market.

The import price p_m^1 and foreign price p_f^1 are not affected by the ETS. They are:

$$p_m^1 = p_m^0,\ p_f^1 = p_f^0$$

Here we assume:

$$p_m^0 = p_f^0 \cdot (1+\eta) \qquad (3.3)$$

η is the tariff for the import goods.

The change in the profit of the industry is:

$$\Pi = p_h \times Q_h + p_x \times Q_x - (ce(re) + ce(ua)) \times (\mathrm{Q_h} + Q_\mathrm{x}) + p_{CO_2}(\mathrm{FA} - u_e \times (\mathrm{Q_h} + Q_\mathrm{x})) \qquad (3.4)$$

Q_h is the total quantity of domestic products, Q_x is the export amount, and $p_{CO_2}(\mathrm{FA} - u_e \times (\mathrm{Q_h} + Q_\mathrm{x})$ is the profits or purchases of the sector in the carbon market.

The abatement cost curve, AC, is the same as in Section 2.3, which is the integral of the abatement cost curve, MAC:

$$AC=\int_{0}^{ua} MACdua \quad (3.5)$$

3.3. Synergistic Effect of Removing the Energy Subsidy and Implementing the ETS based on the Multisector Model

Because there is a close interrelationship between the high energy consuming sectors, for the implementation of one or more energy policies, we should study the linkages and interactions across sectors under different energy saving and CO_2 emissions reduction policies in addition to the policy implications for the sectors themselves.

Implementing multiple policies generates different policy effects compared with implementing only a single policy. There may often be certain contradictions or interactions when a policy combination is implemented in more than one sector. Firstly, different policies have different targets. For example, removing energy subsidies aims to promote the rational return of energy prices and guide the rational consumption of energy; but the target of the ETS is to control CO_2 emissions through a cap-and-trade system and to reduce abatement costs through the trading scheme. Secondly, different policies may have different impacts on the covered sectors. Also, different sectors of the economy show a variety of characteristics under different policies. This heterogeneity may lead to different effects from the same policy in different sectors. As a result, it is important to study the synergistic effect of the ETS and removing the energy subsidy, and at the same time analyse the interaction among sectors.

3.3.1. Models

For sector j, we assume the demand function is a linear function, $p_j = \mu_{dj} - \sigma_{dj} q_j$. p_j is the product price of j, and q_j is the production of j.

We assume the abatement cost curve takes a quadratic form (Meunier, Ponssard, and Quirion", 2014),

$$AC_j(a) = \alpha_j a_j + \beta_j a_j^{\,2} \quad (3.6)$$

Because of the implementation of the ETS, sectors need to pay for the CO_2 quota. The quota purchase cost of sector j is PC_j. It can be expressed as follows:

$$PC_j(q_j, a_j, \phi) = \phi\,(\tau_j q_j - a_j) \quad (3.7)$$

ϕ is the CO_2 price, which is the same for all departments. τ_j is the average carbon intensity of sector j before the emission reduction.

The profit function of sector j can be expressed as

$$\prod_j = p_j \cdot q_j - AC_j(a_j) - C_j(q_j) - PC_j(q_j, a_j, \phi) \quad (3.8)$$

The total emission cap is the sum of every sector's emission cap. Each sector can purchase or sell its quota under the trading framework. The total emission cap cannot exceed the cap satisfied by

$$\sum_j (\tau_j q_j - a_j) \le \Omega \quad (3.9)$$

We assume the cost of purchasing the CO_2 quota is all paid back to society, so the social welfare function $W(\Omega)$ is

$$W(\Omega) = \sum_j (CS_j(p_j) + \prod_j - dam_j(q_j, a_j) + PC_j(a_j, q_j, \phi)) \quad (3.10)$$

$CS_j(p_j)$ is the consumer surplus of sector j ; $dam(q_j, a_j) = \varepsilon(\tau_j q_j - a_j)$ is the environmental loss function, which is used to depict the social loss of the CO_2 emissions.

3.3.2. Data Sources

We focus on China's iron and steel industry and the cement industry. The abatement cost curve comes from the GTAP model. We choose the average crude steel and cement price in 2010 as the marginal production cost. Based on the 2010 base data, we multiply the different energies by their emission factors to get the unit carbon intensities. For the damage function, Lecuyer and Quirion (2013) assume the unit loss is €10–€30/t CO_2, which is in a large range. In this study, we assume the unit loss is CNY100/t CO_2. The parameter details are listed in Table 4.2.

Table 4.2. Parameter Values

Parameter	Unit	Iron and Steel Industry	Cement Industry
μ_d	CNY/Mt	8,213.35	750.04
σ_d	CNY/Mt	5.29	0.18
σ_c	CNY/Mt	4,542.40	365.00
α	CNY/Mt CO_2	-65.98	-86.20
β	CNY/Mt CO_2	1.99	1.07
τ	t CO_2/t	1.68	1.06
ε	CNY/t CO_2	100.00	100.00

Mt = megaton, T = tonne.
Source: Authors.

We analyse the energy structure of the iron and steel industry as well as the cement industry by including the energy price change due to removing the energy subsidy into the abatement cost curve. For the cement industry, based on the average situation of China's cement industry, the standard coal consumption per tonne of clinker is 113 kg of coal equivalent, and the standard electricity consumption per tonne clinker is 64.23kWh. Based on our calculations, the comprehensive energy cost increases by 33 % when adjusting the abatement cost curve based on the energy cost change after removing the energy subsidy.

3.3.3. Results

In the multisector scenario, we choose two sectors, the iron and steel industry and the cement industry. In the baseline case, we assume there is no removal of the energy saving subsidy but ETS is implemented. We then look at removing energy saving subsidy and comparing the scenario with the baseline case. We first assume all CO_2 quotas are auctioned in the carbon market and then set a free allocation share to analyse the effects under the partly auctioned condition

(1) Quotas are all auctioned

Table 4.3 shows the changes in CO_2 abatement, product price, production, CO_2 price, total CO_2 emissions, profit, and social welfare of two sectors after removing the energy subsidy. *a* is the abatement, *p* is the product price, *q* is production, *E* is the total emissions, *π* is the profit, and *W* is the social welfare. The subscript 1 represents the iron and steel industry; subscript 2 represent the cement industry.

Table 4.3. Change in Key Factors after Removing the Energy Subsidy (Fully Auctioned)

Parameter	Unit	Base case	Removing energy subsidy	Percentage change
a_1	Mt CO_2	41.66	46.69	12.05%
p_1	CNY/t product	4,667.70	4,802.70	2.89%
q_1	Mt	669.72	644.22	-3.81%
a_2	Mt CO_2	86.63	99.68	15.07%
p_2	CNY/t steel	470.50	481.45	2.33%
q_2	Mt clinker	1,562.96	1,501.73	-3.92%
P_{CO2}	CNY/t CO_2	100.00	100.00	0.00%
E	Mt CO_2	2,772.04	2,664.68	-3.87%
W	CNY million	4,298,050.00	4,430,990.00	3.09%
π_1	CNY million	3,457.68	3,617.73	4.63%
π_2	CNY million	8,064.97	8,214.21	1.85%

Mt = megaton, t = tonne.
Source: Authors.

Table 4.3 shows that the abatement of both sectors increases significantly after removing the energy subsidy, meaning the removal provides abatement promotion for the sectors. The product prices of the two sectors increase, reflecting that the increased cost is passed on to the consumer price, and production in the two sectors is decreased. Removing the energy subsidy reduces the total CO_2 emissions in the iron and steel industry by 3.87 %. The total social welfare increase caused by these two sectors increases by 3.09 % after removing the energy subsidy, and the profits of the two sectors also increase. Here we do not consider other external factors, so the CO_2 price is equal to the marginal loss of CO_2, which is CNY100/t, and removing the energy subsidy does not affect the CO_2 price.

(2) Quotas partly auctioned

Next, we assume the quotas are partly auctioned. The free allocation share is set at 0.5, which means that half of the quotas have free allocation. The results are shown in Table 4.4. The parameters are the same as in Table 4.3.

Table 4.4. Change in Key Factors after Removing the Energy Subsidy (Free Allocation Share = 0.5)

Parameter	Unit	Base case	Removing energy subsidy	Percentage change
a1	Mt CO_2	59.29	66.29	11.81%
p1	CNY/t product	4,642.73	4,773.42	2.81%
q1	Mt	674.43	649.75	-3.66%
a2	Mt CO_2	119.30	139.04	16.55%
p2	CNY/t steel	454.79	463.03	1.81%
q2	Mt clinker	1,650.80	1,604.73	-2.79%
P_{CO2}	CNY/t CO_2	170.22	165.08	-3.02%
E	Mt CO_2	2,872.62	2,782.62	-3.13%
W	CNY million	4,320,740.00	4,413,700.00	2.15%
π1	CNY million	35,258.50	27,294.01	-22.59%
π2	CNY million	15,294.50	15,982.30	4.50%

Mt = megaton, t = tonne.

Source: Authors.

Table 4.4 shows that if 50 % of the quotas are freely allocated, removing the energy subsidy will not only affect the abatement decision of the sector but also affect the production and product price. The CO_2 abatement of the two sectors increases, but production decreases. Because of the constraint of the demand curve, the product prices of two sectors increased by different amounts.

Removing the energy subsidy also affects the CO_2 price, reduces the equilibrium CO_2 price in the market, and at the same time reduces the total CO_2 emissions of the two sectors. The total emission reduction by around 3.13 %. Removing the energy subsidy would also bring a welfare increase of 2.15 % when 50 % of the quotas are allocated freely. The profit of the cement industry increases, but the iron and steel industry's profit decreases. That is, when there is more than one trading agent in the market, the profit change is related to the parameters of the specific sectors.

However, giving free allocation would decrease the welfare benefit compared with the fully auctioned condition, as there would be greater CO_2 emissions. When there is more than one trading sector in the market, the performance of the various departments is different due to the parameter difference after removing the energy subsidy. Taking the iron and steel industry and cement industry as an example, free allocation is more favourable for the cement industry. Removing the energy subsidy on the basis of free allocation would further expand the profit of the cement sector (compared with the iron and steel industry).

4. Conclusions

Energy subsidies have a direct impact on energy prices and energy supply and demand, and consequently the economy. As the downstream sectors of energy products, energy intensive industries, residents, and other sectors are sensitive to changes in energy prices. As a result, energy subsidies generate direct and indirect impacts. We estimated the energy subsidy of China in 2010, and analysed the impacts of removing the energy subsidy on profit, production, CO_2 emissions, technology diffusion, and social welfare at the sector level. We also analysed the synergistic effect of removing the energy subsidy and implementing the ETS.

We used the price-gap method to calculate the reference price and the consumer price for main energy products, such as coal, petroleum, natural gas, and electricity, based on our estimates of China's energy subsidy amount in 2010. The country's total energy subsidy in 2010 was about CNY1,929.65 billion when GDP was CNY40,890.30 billion, so the total energy subsidy accounted for 4.7 % of GDP. We estimate the coal subsidy to be the highest, accounting for 1.97 % of total GDP.

Taking China's iron and steel industry as an example, we studied the sectoral impacts of removing the energy subsidy. We chose 41 technologies that are widely used in China's iron and steel industry and calculated the micro-level abatement cost curve. We found that the increase of energy cost reduced the cost of energy-saving technologies, so the technologies became more cost effective. After removing the energy subsidy, the comprehensive energy cost increased from CNY110.22/GJ to CNY136.84/GJ, an increase of 19.45 %. However, the cumulative energy savings from the cost-effective technologies only increased by 4.1 %. That is, the energy savings and CO_2 abatement from removing the energy subsidies would not match the decreased cost. We used a partial equilibrium model to study the impacts on industry competitiveness based on the micro-level abatement cost curve. If we do not consider the adoption barriers of technologies, profit and net exports increase after removing the energy subsidy. But this situation changes when we include the barriers in our model as the competitiveness of the sector decreases. Removing the energy subsidy has a positive impact on the diffusion of energy-saving technologies. This is especially important for technologies that become cost effective due to the energy price reform. At the same time, technologies that are affected more by energy prices obtain greater promotion opportunities after removing the energy subsidy.

Combining the ETS with removing the energy subsidy could help to control CO_2. In the ETS, which has free allocation, if the free allocation share is higher than 90 %, the negative impacts on sector competitiveness would be mostly compensated for, and at the same time, the CO_2 emissions control effect would decrease significantly. In the multisector analysis, we focused on China's iron and steel industry and the cement industry as an example. The combination of full-auctioned ETS and removing the energy subsidy would benefit profit for the two sectors. The combination of 50 % auctioned ETS and removing the energy subsidy would cause a profit increase in the cement industry, but would damage profit in the iron and steel industry. Full-auctioned and 50 % ETS and removing the energy subsidy would bring a better CO_2 control effect, increase product prices, and improve social welfare. Removing the energy subsidy would reduce the equilibrium price of the ETS (in addition to the full-auctioned situation, as in this situation, the CO_2 price is equal to the marginal loss of CO_2). The performance of various departments is different because of heterogeneity in the sector parameters after removing the energy subsidy. For the iron and steel industry and the cement industry, free allocation is more favourable for the cement industry, while removing the energy subsidy on the basis of ETSwould further expand the profit of the cement sector.

There are some limitations in our research. First, we use the price-gap method to estimate China's energy subsidy, which would underestimate the real subsidy amount as we only consider the main energy used. Second, we used the micro-level abatement cost curve based on the technologies. This does not cover all technologies, so the actual energy savings would be relatively low. Third, we only consider the iron and steel industry and the cement industry. If more sectors were covered in our model, it is possible the conclusions could change. These limitations can be improved in future work.

References

Coady, D., I. Parry, L. Sears, and B.P. Shang (2015), How Large Are Global Energy Subsidies? *IMF working Paper*. Washington, DC: International Monetary Fund.

Demailly, D. and P. Quirion (2006), 'CO_2 Abatement, Competitiveness and Leakage in the European Cement Industry under the EU ETS: Grandfathering versus Output-based Allocation', *Climate Policy*, 6, pp. 93–113.

Demailly, D. and P. Quirion (2008), 'European Emission Trading Scheme and Competitiveness: A Case Study on the Iron and Steel Industry', *Energy Economics*, 30, pp. 2009–2027.

Jiang, Z.J., X.L. Ouyang, and G.X. Huang (2015), 'The Distributional Impacts of Removing Energy Subsidies in China', *China Economic Review*, 33, pp. 111–122.

Lecuyer O., P. Quirion (2013), '*Can uncertainty justify overlapping policy instruments to mitigate emissions?* ',*Ecological Economics*, 93,PP.177–191.

Li, H. (2011),' *Fossil fuel subsidies and carbon emissions in China-- Theoretical and Empirical Analysis on the scale of energy subsidies'* (in Chinese), *Economic Perspectives*, 3,pp.92-96. Li, Y. and L. Zhu (2014), 'Cost of Energy Saving and CO2 Emissions Reduction in China's Iron and Steel Sector', *Applied Energy*, 130, pp. 603–616.

Li, H., L. Dong, and D. Wang (2013), 'Economic and Environmental Gains of China's Fossil Energy Subsidies Reform: A Rebound Effect Case Study with EIMO Model', *Energy Policy*, 54, pp. 335–342.

Liu, W. and H. Li (2011), 'Improving Energy Consumption Structure: A Comprehensive Assessment of Fossil Energy Subsidies Reform in China', *Energy Policy*, 39, pp. 4134–4143.

Mao, Y.S., H. Sheng, F.W. Yang, K. Jiang, Z. Ma, H. Wang, X. Pan and Q. Shang (2008), *The True Cost of Coal* (in Chinese). Beijing: China Coal Industry Publishing House.

Meunier, G., J.-P. Ponssard, and P. Quirion (2014), 'Carbon Leakage and Capacity-based Allocations: Is the EU right?', *Journal of Environmental Economics and Management*, 68, pp. 262–279.

Ministry of Industry and Information Technology of the People's Republic of China (2010), *Guiding Opinions on Energy Saving and Emission Reduction in the Cement Industry* (in Chinese). Available at: http://www.miit.gov.cn/n1146295/n1652858/n1652930/n3757017/c3758444/content.html (accessed on 28 March 2016).

Ministry of Industry and Information Technology of the People's Republic of China (2011), *The "12th Five-Year" Planning of the Building Materials Industry* (in Chinese). Available at: http://www.gov.cn/gzdt/att/att/site1/20111129/001e3741a2cc103e75b901.pdf (accessed on 11 April 2016)

Ministry of Industry and Information Technology of the People's Republic of China (2012), *The "12th Five-Year-Plan" of Industrial Energy Saving* (in Chinese). Available at: http://www.miit.gov.cn/n1146285/n1146352/n3054355/n3057542/n3057544/c3864850/content.html (accessed on 11 April 2016)

National Bureau of Statistics of the People's Republic of China (2011), *China Energy Statistics Yearbook* (in Chinese). Available at: http://www.stats.gov.cn/tjsj/ndsj/ (accessed on 17 March 2016).

Yao, X., Z.J. Jiang, and J.H. Liu (2011), 'Reform of Fossil Energy Subsidies Can Support the Development of Clean Energy' (in Chinese), *Journal of Financial Research*, 3, pp. 184–197.

Zhou, Q., J. Zhao, and Q.Y. Sheng (2011), 'Research on the Relationship between the Formation of China's Energy Subsidy Policy and the Competitive Advantage of Export Products' (in Chinese), *China Industrial Economy*, 3, pp. 47–56.

Zhu, B., W.J., Zhou, S.Y.,Y.Jin,. 'CO_2 Emissions and Reduction Potential in China's Chemical Industry', *Energy*, 35, pp. 4663–4670.

Zhuang, G.Y. (2006), *'Energy Subsidy Policies and Their Reform—Providing economic incentives for climate change mitigation'* (in Chinese), *Advances in Climate Change Research*,2, pp.78-81

Chapter 5

Socio-economic Impacts of an LPG Subsidy Removal on the Household Sector in India

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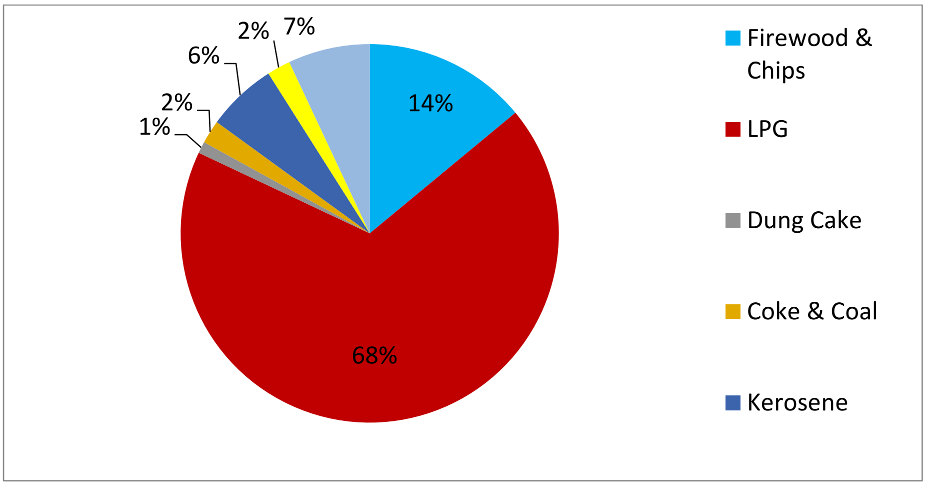
Abstract

This study examines the socio-economically acceptable strategies that India should adopt for removing its liquefied petroleum gas (LPG) subsidies. In India, a large number of rural households and poorer households in urban areas still use inefficient fuels for cooking and other household needs. The use of clean forms of energy, namely LPG, as a cooking fuel and for lighting, is mostly restricted to urban and affluent households. This energy-use inequity has adverse socio-economic impacts, such as negative effects on health, increased deforestation, and environmental degradation. The Government of India provides large subsidies on LPG use in the household sector, resulting in a negative impact on the country's economy. To reduce the LPG subsidy burden on the fiscal budget, the Government of India has introduced many ameliorative measures, such as fixing the number of annual subsidised LPG cylinders per household, providing direct beneficiary cash transfers, and encouraging affluent consumers to forgo their subsidies. In our study, we use sets of regressions to predict the socio-economic impacts of the removal of LPG subsidies on the Indian economy. However, a limitation of our analysis is the availability of data, as we use data for the period 2001–2014. This data is available only on an annual basis, so we have 14 observations per variable for all sets of regressions. From our analysis, we infer that the impact of the LPG subsidy removal indicates a positive relationship between gross domestic product and the consumption of LPG, as income generated during the fiscal year is positively related to LPG consumption. Secondly, estimating the total LPG subsidy as a function of total consumption, we see that consumption is not a determinant of the total subsidy bill of LPG. Thirdly, when total LPG consumption is regressed on the LPG market price, gross domestic product, and the regressand's lagged value, the results indicate that the price of LPG, with or without the subsidy, is not a significant determinant of its consumption expenditure. Finally, evaluating the macroeconomic impact of a change in the LPG subsidy on the economy suggests that the rate of growth of the economy is not affected by changes in the LPG subsidy. Thus, we summarise that removal or reduction of the current LPG subsidy will not have a significant impact on the Indian economy.

1. Introduction

In India, liquefied petroleum gas (LPG) is used as the primary cooking fuel by urban and rural households as well as commercial establishments. At the national level, a larger share (about 68.4 %) of LPG is consumed by urban households, followed by firewood and chips (14 %) and kerosene (5.7 %), while 6.9 % households do not have any arrangement for cooking. In terms of the change in the type of energy used for cooking for the period 1999–2000 to 2011–2012, for urban households, the use of firewood and chips dropped from about 22.3 % to 14.0 %; and kerosene from 21.7 % to 5.7 %; while LPG use increased from 44.2 % to 68.4 %. The share of energy for cooking for urban households by primary source is shown in Figure 5.1 (MoSPI, 2012).

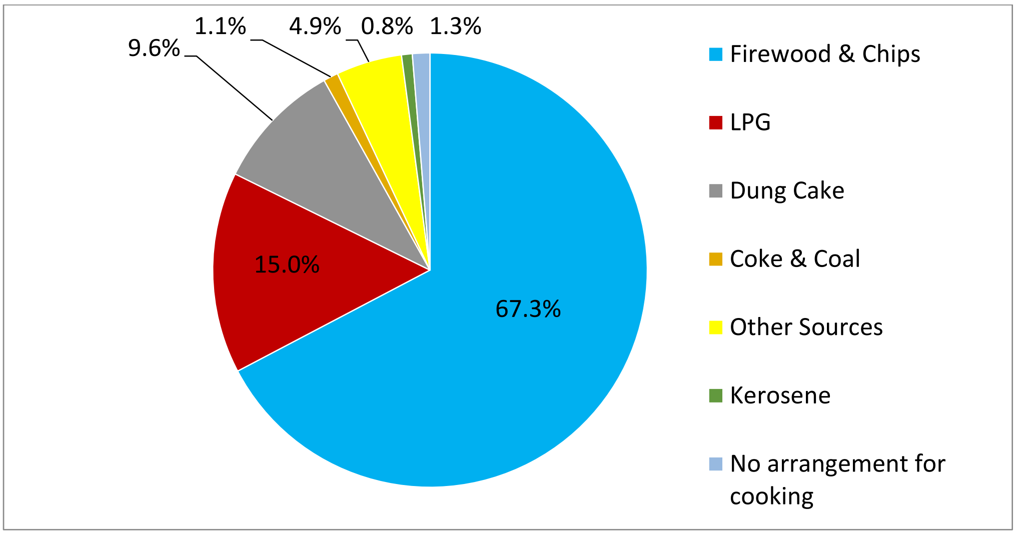
Figure 5.1. Primary Source of Energy for Cooking for Urban Households in India



LPG = liquefied petroleum gas.
Source: MoSPI (2012).

In sharp contrast, the majority of rural households across India still depend on polluting fuels for cooking and other household needs. Firewood and chips are used as a primary cooking source by more than two-thirds (67.3 %) of rural households, followed by LPG (15.0 %), dung cake (9.6 %), and coke and coal (1.1 %) , while 1.3 % of households do not have any arrangement for cooking. For the type of energy used for cooking for the period 1999–2000 to 2011–2012, for rural households, the use of firewood and chips (67.3 %) dropped by only 8.2 %, while the use of LPG increased from about 5.4 % to 15.0 % as shown in Figure 5.2 (MoSPI, 2012).

Figure 5.2. Primary Source of Energy for Cooking for Rural Households in India



LPG = liquefied petroleum gas.
Source: MoSPI (2012).

Thus, a large number of rural households still use inefficient fuels for cooking, which are not only detrimental to the health of the household members but are also responsible for increased deforestation and environmental degradation. This energy-use inequity has larger social implications, as women and children in the household using inefficient fuels are more likely to suffer from the resulting adverse health impacts and are also forced to go through the drudgery of collecting firewood. LPG for both urban and rural households is provided at a highly subsidised rate in India, while LPG for commercial use is sold at a non-subsidised rate.

Most of the beneficiaries of LPG subsidies are enjoyed by urban households, many of which are affluent and can afford LPG at non-subsidised rates. The subsidies on LPG for the household sector may be negatively affecting the Indian economy. Meanwhile, it has been observed in India and elsewhere that the removal of such subsidies may not have much effect on even poor households, and, in the long run, lead to socio-economic development (Gangopadhyay, Ramaswamy, and Wadhava, 2005; Musa and Hounsou, 2014).

Recently, there has been an impetus on the removal of LPG subsidies for domestic consumers and the number of subsidised LPG cylinders per year has been fixed for each household. Through regular awareness campaigns, the Government of India (GoI) is encouraging people to voluntarily give up their LPG subsidies so that the government can continue to provide these subsidies to the economically weaker sections of society. These efforts include an appeal by the prime minister to consumers, particularly the affluent households, to forgo their subsidies and buy LPG at the market (non-subsidised) rate.

Under the “Give It Up” campaign, launched by the GoI, around 10 million consumers have voluntarily given up their LPG subsidies, helping the government save Rs.41.660 billion. The initiative asking consumers to give up their LPG subsidy started in 2012, but the movement gathered pace in the past year due to a massive outreach programme run by the petroleum ministry. For each “Give It Up” consumer, one free connection is given to a below poverty line

(BPL) family under a scheme called the “Give Back Scheme”. Thus, every consumer who voluntarily gives up the LPG household connection is matched against a BPL consumer who gets the LPG in lieu of the subsidy saved. At present, about 6.5 million poor households have been given new LPG connections under the scheme (MoPNG, 2016).

This research focuses on investigating the socio-economic impacts of a removal of the LPG subsidy on the household sector in India. Removal of this subsidy may reduce consumption and wasteful use of LPG, which consequently could have a positive impact on the national economy, but some marginal negative impact on households’ economies. The market price of LPG may induce other impacts too, such as social and environmental impacts. A complete removal of the LPG subsidy for all domestic consumers may adversely affect the economically weaker households as it may compel them to use cheaper but unclean fuels, thereby creating indoor air pollution and adversely affecting their health. On the other hand, the high cost of non-subsidised LPG may reduce its consumption, in general, and discourage wasteful use, particularly by rich households. This could reduce greenhouse gas (GHG) emissions and thus may positively affect the environment.

The research questions raised by the study are as follows:

- What is the impact of LPG subsidies on the economic growth of India? Are the subsidies an incentive or a deterrent?
- What will be the impact of an LPG subsidy removal on the national economy and fiscal balance?
- How would the removal of the LPG subsidy affect real income per household?
- What could be the other impacts, such as the social repercussions or the environmental impacts of the LPG subsidy removal?
- Which strategies should India adopt for removing the LPG subsidies so that they are socially acceptable?

2. Energy Subsidies: A Brief Overview

Energy is heavily subsidised across the globe and energy subsidies exert an extensive economic burden on many countries, particularly on developing economies. ERIA and the International Energy Agency (IEA) (2013) estimate that inefficient energy subsidies amounted to US$51 billion in 2012 in Southeast Asia alone. Theoretically, a reduction or removal of energy subsidies should result in several socio-economic and environmental benefits, such as more energy efficient consumption and a reduction in local and global pollution. It is often argued that subsidies, in general, seldom benefit the poor and needy and are more favourable to the affluent sections of society, thereby defeating the very purpose of subsiding energy. According to the World Bank (2008), energy subsidies are a burden on fiscal budgets, and also on the environment as they increase GHG emissions due to the increased or wasteful consumption of energy.

It is estimated that fuel subsidies alone are 2–7.5 times as large as public spending on health in some countries, namely in Bangladesh, Ecuador, the Arab Republic of Egypt, India, Indonesia, Morocco, Pakistan, Turkmenistan, Venezuela, and the Republic of Yemen. The lack of energy reforms implies diverting public funds from investments that fight poverty and fostering inefficient economies that are increasingly exposed to energy shocks. Energy pricing reforms and the removal of subsidies encourage energy efficiency and are conducive to the promotion of renewable energy. Strategies that are designed and implemented to keep in mind social safety nets can facilitate energy price reforms that protect the economically weaker sections of society (World Bank, 2008).

The various factors that determine the provision of subsidies are their total cost, the fiscal burden on the economy, the social benefits, and impact on the welfare of the beneficiaries. The IEA defines an energy subsidy as any government action that lowers the cost of energy production by either raising the price received by energy producers or lowering the price paid by energy consumers. Many countries across the world, subsidise fossil fuels to provide financial support and compensate for steep increases in international energy prices. The IEA estimates that fossil fuel subsidies worldwide amounted to US$548 billion for the year 2013 (IEA, 2015). However, these subsidies prove to be very costly in economic terms as they create huge spending for government budgets and distort national and international markets. Studies suggest that fuel subsidies hamper economic growth and undermine the fundamental principle of equity, and therefore should be reduced, if not eliminated completely. Experiences from countries that have implemented reforms show a remarkable improvement in social services delivery (IISD, 2014; Musa and Hounsou, 2014).

The strategies and policies for the removal or reduction of energy subsidies vary from country to country. In general, subsidy policies in most developed nations are framed based on issues related to the environment, international trade, and market competitiveness. On the other hand, in developing nations, like India, the subsidy framework is consumer driven and based upon more pressing issues, namely social welfare, poverty alleviation, and electoral politics, as the beneficiaries of the subsidies are often considered as the voting banks.

Fuel subsidy removal programmes in any country must be responsive to the country's economic structure, level of development, political system, and economic state. Most countries that have taken a phased or gradual approach for subsidy removal programmes, after deliberations based on in-depth research and a dedicated approach to policy making, have been successful in the removal or reduction of subsidies. Governments in such countries have created awareness and gained the trust of their citizens through effective communication.

In India, for a long time, the high cost of imported fossil fuels was subsidised to make them affordable to masses. However, due to their excessive burden on the economy, the GoI took steps to reduce or remove the subsidies. Subsequently, subsidies on diesel and petrol were removed, but subsidies on kerosene and LPG for domestic consumers were kept in place. The removal of subsidies on LPG may create problems for economically weaker sections of society and may also become a political issue with repercussions for the government. Thus, a reduction or removal of subsidies on LPG warrants carefully designed strategies and policies that do not have long-term negative impacts on beneficiaries and that are also able to address the politics involved.

2.1. LPG Subsidy in India

Since fossil fuel subsidies have a negative impact on India's economy, there has been increasing attention on reducing and removing the subsidies. Although subsidies on petrol and diesel have been removed completely, those on kerosene and LPG are still imposing a tremendous pressure on the government's fiscal budget. India's total subsidy bill for the current (2015–2016) budget was estimated at Rs2.43 trillion (Indian Rupees), about 9 % below the revised estimate of Rs2.66 trillion for 2014–2015. The reduction has been aided by the fall in the price of crude oil, the decontrol of diesel and petrol prices, and the cash transfer scheme for disbursing LPG subsidies.

The total petroleum subsidy in the current budget (2015–2016) is estimated at Rs300 billion, which includes Rs220 billion for cooking gas (LPG) and Rs80 billion for kerosene, a cut of 50.22 % from the revised estimate of Rs602.7 billion for 2014–2015. The revised estimate is almost 5 % below the budgeted estimate of Rs634.27 billion. This provision is based on taking the average crude price at US$70 a barrel during the fiscal yearl. According to the GoI, until now, Rs63.35 billion has been transferred directly as LPG subsidies to 115 million LPG consumers. The estimates for the current fiscal year indicate a saving of about Rs65 billion in LPG subsidies due to the direct cash transfers to the bank accounts of beneficiaries (Bhaskar, 2015; Sinha, 2015). Table 5.1 shows the total subsidy on kerosene and domestic LPG for the past decade.

LPG subsidies are supposed to benefit economically weaker households, but in reality, often fail to reach the target population. For example, while the GoI provides a large subsidy for LPG, the majority of Indians who use LPG as a cooking fuel are urbanites and the economically well-off. On the other hand, most of India's 1.2 billion people who are below the poverty line dwell in rural areas and continue to use traditional fuels, such as coal, wood, or dung, for cooking and heating. Also, both subsidised kerosene and LPG, which were made available to needy people through a public distribution system, have in the past been wrongly diverted for commercial use. Table 5.2 shows the sector-wise outgoing subsidies and their proportion of GDP for 2011–2012 to 2014–2015.

Table 5.1. Total Subsidy on Kerosene (Rs/litre) and Domestic LPG (Rs/cylinder) (2002–2003 to 2014–2015)

Year	*Public Distribution Scheme, Kerosene			Domestic LPG		
	From government budget	By public sector oil companies	Total subsidy	From government budget	By public sector oil companies	Total subsidy
2004–2005	0.82	7.96	8.78	22.58	124.89	147.47
2005–2006	0.82	12.10	12.92	22.58	152.46	175.04
2006–2007	0.82	15.17	15.99	22.58	156.08	178.66
2007–2008	0.82	16.23	17.05	22.58	214.05	236.63
2008–2009	0.82	24.06	24.88	22.58	234.88	257.46
2009–2010	0.82	14.85	15.67	22.58	178.13	200.71
2010–2011	0.82	17.39	18.21	22.58	249.94	272.52
2011–2012	0.82	26.46	27.28	22.58	320.30	342.88
2012–2013	0.82	31.16	31.98	22.58	427.14	449.72
2013–2014	0.82	33.98	34.80	22.58	499.52	522.10
2014–2015	0*	27.93	27.93	0*	409.72	409.72

*

Rs = Indian Rupees

Extension of Subsidy schemes for 2014–2015 approved by Government. However, no payment was made in 2014–2015.

Source: Ministry of Petroleum and Natural Gas, Government of India (2016).

Table 5.2. Sector-wise Outgoing Subsidies and their Share of GDP in India (2011–2012 to 2014–2015)

Year	Subsidy (Rs billion)				Share of GDP (%)			
	Food	Fertilizer	Petroleum	Total	Food	Fertilizer	Petroleum	Total
2011–2012	728.22	700.13	684.84	**2,113.19**	0.81	0.78	0.76	**2.35**
2012–2013	850.00	656.13	968.80	**2,474.93**	0.84	0.65	0.96	**2.45**
2013–2014 BE	-	-	-	**-**	0.79	0.58	0.57	**1.94**
2013–2014 RE	920.00	679.71	854.80	**2,454.51**	0.81	0.60	0.75	**2.16**
2014–2015 BE	1,150.00	729.70	634.27	**2,513.97**	0.89	0.57	0.49	**1.95**

BE = budget estimate, GDP = gross domestic product, RE = revised estimate.

Source: Lok Sabha (2015).

The GoI has also initiated the Direct Benefit Transfer scheme for LPG subsidies, now renamed as PaHaL, an abbreviated form of Pratyaksha Hastaantarit Laabh, meaning "Direct Benefit Transfer", which covers more than 65 % of the 154 million LPG consumers. This scheme is the largest in the world and surpasses similar cash-transfer programmes in other countries, such as China, Mexico, and Brazil, where the maximum number of beneficiaries is no more than 22 million (Economic Times, 2015).

Under the PaHaL scheme, LPG cylinders are sold at the market rate and consumers receive the subsidy amount directly into their bank accounts to enable them to buy the fuel at the market rate. The main objective of the PaHaL scheme is to cut down diversions and eliminate ghost beneficiaries in LPG connections. Subsidies amounting to Rs320 billion have been directly transferred into the bank accounts of the beneficiaries. Also, 33.4 million duplicate/inactive/ghost accounts have been identified and blocked. PaHaL has resulted in a government saving of over INR 210 billion worth of subsidy (MoPNG, 2016).

LPG is distributed to retail customers through a network of three public sector oil marketing companies (OMCs), namely the Indian Oil Corporation Limited, Bharat Petroleum Corporation Limited, and Hindustan Petroleum Corporation Limited, and the burden of the subsidy is shared by these OMCs and the GoI. Each household must be registered with one of the authorised LPG dealers in order to buy an LPG cylinder for domestic use. As per the present scheme of the GoI, there is a limit on the LPG subsidy, and domestic consumers can only avail of 12 refills of subsidised LPG cylinders per household per year.

In addition, the GoI also regulates the price at which the OMCs can sell domestic LPG, leading to under-recoveries (the difference between the cost price incurred by the companies and the price realised upon sale to the final consumer). Subsequent to the realisation of under-recoveries by the OMCs, the government then applies an *ad hoc* burden-sharing mechanism, distributing the total subsidy cost between the exchequer (through direct budgetary transfers to the companies, the OMCs, and the main upstream and midstream public sector undertakings, mainly the Oil and Natural Gas Corporation, and to a lesser extent Oil India Limited and the Gas Authority of India Limited (IISD, 2014). Thus, any reform on the removal or reduction of the LPG subsidy will have a direct impact on government spending at the macro level, and on household budgets at the micro level. The indirect impact could be in terms of reduced fuel consumption and subsequent reductions in air pollution and emissions of GHGs.

3. Data and Methodology

The main objective of this study is to thoroughly review India's subsidy on LPG, a common and highly subsidised household fuel in the country, and analyse the socio-economic impacts of its removal. The study involves empirical analysis and suggests steps and approaches that could be acceptable to various stakeholders and help sustain efforts to remove the LPG subsidy. The study uses econometric and statistical tools for examining the socio-economic impacts of the LPG subsidy removal.

The study uses secondary data from 2000 to 2015 obtained from various sources, namely the World Bank Database; the Reserve Bank of India; the Petroleum Planning and Analysis Cell of the Ministry of Petroleum and Natural Gas; and the Ministry of Statistics and Programme Implementation, Government of India. The most limiting part of this analysis is the availability of data, and the current study uses data from 2001–2014. As this data is available only on an annual basis, we have only 14 observations per variable, thus time series techniques are not used as there could be a significant loss of degrees of freedom, making the estimates erratic.

The following sets of regressions have been assessed to predict the socio-economic impact of the removal of the LPG subsidy as given below.

(1) Impact of the LPG subsidy removal on LPG consumption

Step 1

$$LPGC = f\,(GDP, LPGP/CPI, LPGC{-}1) \qquad (1)$$

where:
LPGC = LPG consumption (kg)
GDP = gross domestic product (Rs)
LPGP = LPG retail price (including subsidies; Rs/kg)
CPI = consumer price index (2010 = 100)
LPG–1: lag of LPG consumption
f: linear function

The econometric model used in the study is stated as follows:

$$LPGC = \beta_0 + \beta_1 GDP + \beta_2 LPGP/CPI + \beta_3 LPGC - 1 + ut \qquad (2)$$

where:
B_0 = constant factor
β_1 = coefficient of GDP
β_2 = coefficient of LPG Rs/kg divided by the consumer price index
β_3 = coefficient of lagged value of the dependent variable
ut = error term

The log of equation (2) is calculated as:

$$\ln LPGC = \beta_0 + \beta_1 \ln GDP + \beta_2 \ln LPGP/CPI + \beta_3 \ln LPGC - 1 + ut \qquad (3)$$

B_0, β_1, β_2, and β_3 are the parameters in the model to be estimated, and we expect β_1<0, β_2>0, and β_3 >0. Thus, we expect that the LPG subsidy removal in the short term could have a negative impact on social welfare. However, in the long term, the impact of the LPG subsidy removal could be positive. The lagged value of the dependent variable, which is LPG consumption, is expected to have a positive relationship with GDP.

Step 2

$$LPGS = f(LPGC) \qquad (1)$$

where:
LPGS = LPG subsidies (retail price)
LPGC= LPG consumption (kg)

Accordingly, the econometric model used in the study is stated as follows:

$$LPGS = \beta_0 + \beta_1 LPGC + ut \qquad (2)$$

where:
B_0 = constant factor
β_1 = coefficient of LPG consumption/kg
ut = error term

The log of equation (2) is as follows:

$$\ln LPGS = \beta_0 + \beta_1 \ln LPGC + ut \qquad (3)$$

We expect that the spending on the total LPG subsidy is not determined by the consumption expenditure on LPG.

(2) Estimation of government savings on LPG consumption (LPGSV) and LPG subsidies from the removal of the LPG subsidy (LPGSS)

$$LPGCC = f\ (GDP,\ LPGPP/CPI,\ LPGC–1) \qquad (1)$$

where:
LPGCC = LPG consumption (kg) at the market price
GDP = gross domestic product (Rs)
LPGPP: LPG price without subsidies (market price)
CPI = consumer price index (2010 = 100)
LPGC = LPG consumption (kg)

We estimate LPGSS = f(LPGSV), where LPGSV = LPGC – LPGCC.

The econometric model used in the study is stated as follows:

$$LPGCC = \beta_0 + \beta_1 GDP + \beta_2 LPGPP/CPI + \beta_3 LPGC - 1 + ut \quad (2)$$

where:

B_0 = constant factor

β_1 = coefficient of GDP

β_2 = coefficient of LPG price without subsidies (market price)/kg divided by consumer price index

β_3 = coefficient of lagged value of the dependent variable

ut = error term

The log of equation (2) is as follows:

$$\ln LPGCC = \beta_0 + \beta_1 \ln GDP + \beta_2 \ln LPGPP/CPI + \beta_3 \ln LPGC - 1 + ut \quad (3)$$

(3) Macro impact

$$GDPP = GDP + LPGSS$$

where:

GDPP: GDP after removing the LPG subsidies

LPGSS: saving amount of LPG subsidies after removing the subsidies

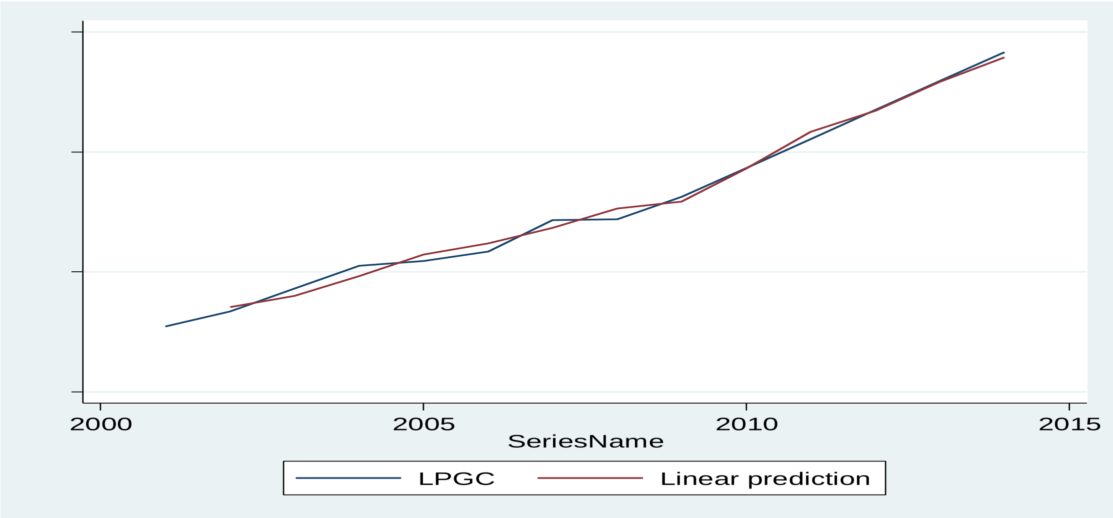
3.1. Results and Discussion

3.1.1. Impact of the LPG subsidy removal on LPG consumption

$$LPGC = \beta_0 + \beta_1 GDP + \beta_2 LPGP/CPI + \beta_3 LPGC - 1 + ut$$

In terms of the impact of the LPG subsidy removal on LPG consumption, when we regress the total consumption of LPG in the Indian economy over the total GDP, the discounted price of LPG (including subsidies), and the lagged value of the repressor (LPGC), we observe that GDP is the only significant variable. The results show a positive relation between GDP and consumption of LPG, which is expected since the greater the income generated in a fiscal year, the higher we can expect consumption to be. Figure 5.3 shows the actual values and the fitted values. The fit is very good and this is supported by the value of R-squared and adjusted R-squared (Figure 5.3 and Appendix A).

Figure 5.3. Impact of the LPG Subsidy Removal on LPG Consumption



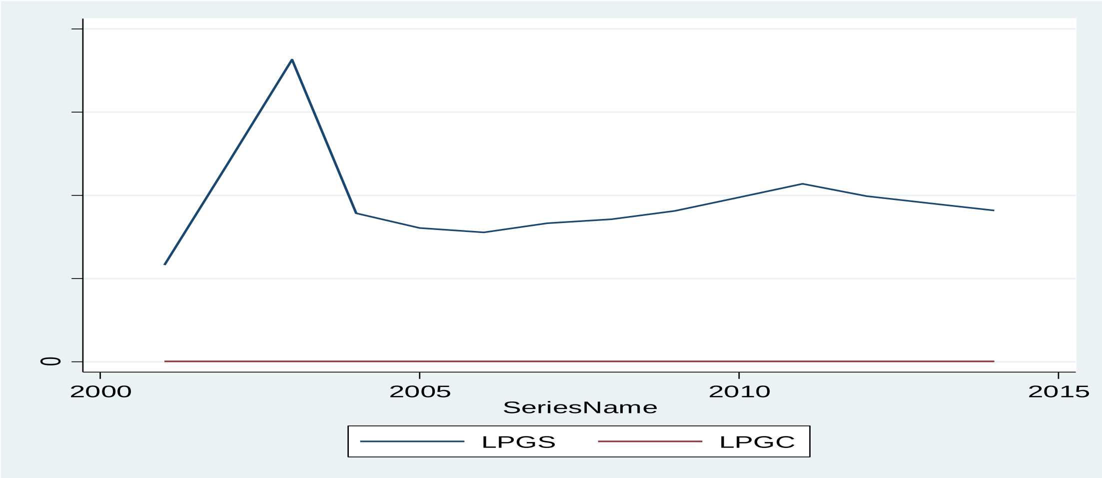
LPGC = liquefied petroleum gas consumption.
Source: Authors.

3.1.2. Impact of the total LPG subsidy on LPG consumption expenditure

$$LPGS = \beta_0 + \beta_1 LPGC + ut$$

From the regression analysis for estimating the total subsidy on LPG as a function of the total consumption (Appendix B), we see that the consumption is not a determinant of the total subsidy bill of LPG. Even if we use the lagged value of the total consumption, the results remain the same. Hence, we can interpret that the total subsidy bill is not determined by the consumption expenditure on LPG. This can be seen in Figure 5.4, where the LPGS curve is volatile while the LPGC curve does not share the same trend.

Figure 5.4. Estimate of the Influence of the Total LPG Consumption on the Total Subsidy Bill of LPG



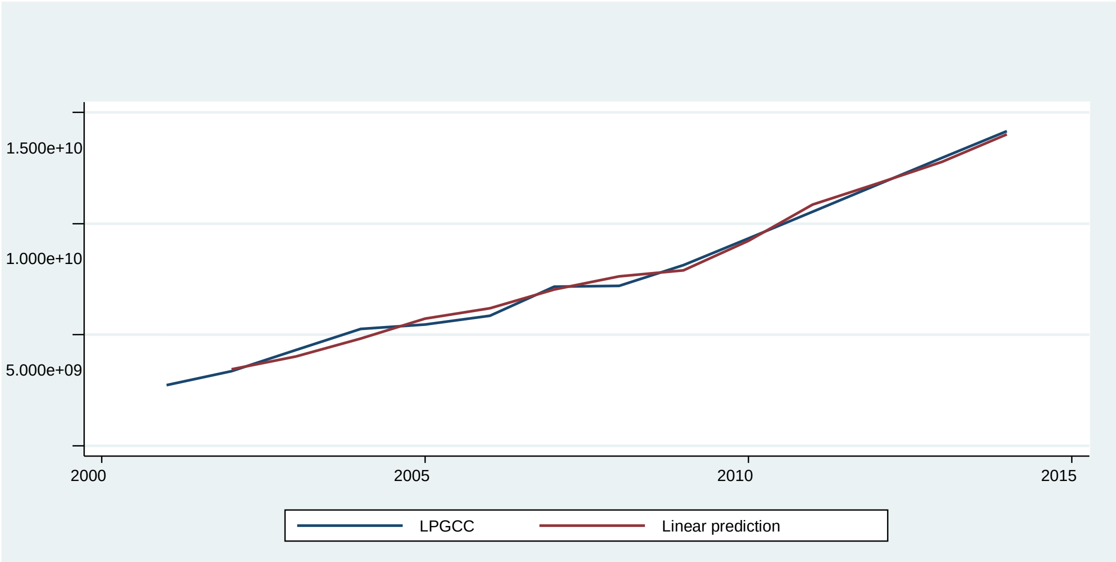
LPGC = liquefied petroleum gas consumption, LPGS = liquefied petroleum gas subsidy.
Source: Authors.

3.1.3. Estimating government savings on LPG consumption (LPGSV) and LPG subsidies due to removal of the LPG subsidy (LPGSS)

$$LPGCC = \beta_0 + \beta_1 GDP + \beta_2 LPGPP/CPI + \beta_3 LPGC - 1 + ut$$

When total LPG consumption is regressed upon the LPGPP, GDP, and the regressand's lagged value, the results indicate the same observations as earlier. In this analysis, too, only the coefficient for GDP is significant, while the others are insignificant. Further, the relation is positive as expected. Thus, it can be concluded that *the price of LPG, with or without subsidy, is not a significant determinant of the consumption expenditure.* In this case, also, the R-squared and adjusted R-squared values are very high, indicating that the model is a good fit (Figure 5.5 and Appendix C).

Figure 5.5. Estimates of Government Savings on LPG Consumption (LPGSV) and LPG Subsidies due to Removal of the LPG Subsidy (LPGSS)



LPGCC = liquefied petroleum gas consumption at the market price.
Source: Authors.

3.1.4. Macroeconomic impact of change in the LPG subsidy on the economy

$$GDPP = GDP + LPGSS$$

When evaluating the macroeconomic impact of a change in the LPG subsidy on the economy, one must account for the other variables which impact the GDP's rate of growth. Under this analysis, it has been assumed that the rate of growth for an economy depends upon the employment rate, the savings rate and the lagged value of the rate of growth (Appendix D). It is seen that the coefficient for the LPG subsidy is insignificant; this suggests that changes in the LPG subsidy will not influence the rate of growth of the economy. Thus, based on the above analysis, we can conclude that the LPG subsidy, in its current form does not have a significant impact at the economy level.

4. Conclusions and Policy Implications

In India, LPG is one of the primary fuels used by households for cooking and it is subsidised by the government for domestic consumption where the exchequer provides LPG to consumers at a discounted price. This not only causes an immense burden on the fiscal budget, but also leads to market distortions as it affects government debt, imports, and the exchange rate, etc. A gradual deregulation of subsidised petroleum products has been witnessed over the past few years wherein the GoI deregulated the prices of diesel and petrol in 2010–2012, thereby reducing some of the fiscal burden. However, in an environment in which the least intervention in market operations is desirable, the policy option of doing away with these subsidies or reforming them needs to be considered.

This study has assessed the socio-economic impacts of an LPG subsidy removal in India through empirical analysis. It recognises that removal of this subsidy must be gradual and also socio-economically acceptable to all stakeholders and consumers. This is not an easy task, and thus any reform or removal of the LPG subsidy must be done through policy that benefits poorer households. The recent success of the GoI's "Give it Up" scheme to encourage voluntary refusal of the LPG subsidy by affluent households is a new and promising beginning. Around 10 million households have surrendered their LPG subsidy, resulting in government savings of about Rs41.660 billion. Additionally, these subsidised LPG connections can be provided to economically weaker households, who are and should be the real beneficiaries. Based on the results of the analysis, we suggest the following policy implications.

- In order to implement the domestic LPG subsidy removal in India, it is important to involve all the stakeholders in consultations or discussions related to the current cash transfer subsidy scheme and the government programme related to it. Based on intense discussions among the stakeholders and in-depth research and analysis, the LPG subsidy data should be made readily available and the beneficiaries must be educated about the pros and cons in the long run for the subsidy removal to be acceptable economically and socially.
- The government should create more awareness through publicity and campaigns to sensitise citizens to the benefits of phasing out or removing the LPG subsidy. Subsequently, the government should adopt a transparent policy to brief the citizens on how the money saved due to the removal of the LPG subsidy in the household sector will be channelled to other social welfare measures, such as healthcare, education, increased job opportunities, and better infrastructure, to benefit low-income groups.
- An empirical analysis of the socio-economic impacts of the removal of the LPG subsidy estimates the fiscal pressure of the LPG subsidy policy on the household sector for government spending and GDP. The results of the regression analysis suggest a positive relationship between GDP and the consumption of LPG. Estimates of the total LPG subsidy as a function of the total consumption reveal that the consumption is not a determinant of the total subsidy bill of LPG. Further, the analysis indicates that the LPG price (both the subsidised price as well as the market price) is not a significant determinant of India's consumption expenditure. Thus, as the total subsidy bill is not determined by the consumption expenditure on LPG, the removal of the LPG subsidy will not have a negative impact on the consumption of LPG.
- In terms of the macroeconomic impact of the change in the LPG subsidy on the economy, using variables that have an impact on the rate of GDP growth indicates that the coefficient for the LPG subsidy is insignificant. This implies that the rate of growth of the Indian economy is not influenced by the LPG subsidy, and thus removal of the LPG subsidy will not have a broad impact on the economy.

- The study also suggests that any decision for the removal of the LPG subsidy needs to be a dedicated effort that is buffered by social security programmes to protect the economically weaker households from the consequences of such a policy transformation.
- Finally, the amount of government spending that is saved due the removal of the LPG subsidy for the current beneficiaries can be the channelled to provide these LPG connections to the economically weaker sections of society, in both urban and rural areas. This section of the population is still using polluting fuels, and the GoI can provide them with LPG connections at subsidised rates to encourage them to switch to cleaner fuels. This will also result in better health in these households and also save the time spent on cooking. It will result in a cleaner environment and benefit women and children, who would otherwise be continuously exposed to the air pollutants emitted by the polluting fuels.

References

Bhaskar, U. (2015), Budget 2015: Petroleum Subsidy Slashed by Half. *Live Mint*. 1 March. Available at: http://www.livemint.com/Politics/OQaYOOKMJcCNNliEV6SWTJ/India-to-spend-37-billion-on-major-subsidies-in-201516.html, (accessed June 01, 2015).

Economic Times (2015), DBT for LPG is World's Largest Direct Benefit Transfer Scheme. *Economic Times of India*. 5 February. Available at: http://articles.economictimes.indiatimes.com/2015-02-05/news/58838422_1_lpg-subsidy-54-districts-subsidised-lpg, (accessed July 07, 2015).

Gangopadhyay, S., B. Ramaswamy, and W. Wadhava (2005), 'Reducing Subsidies on Household Fuels in India: How Will It Affect the Poor?', *Energy Policy*, 33(2005), pp. 2326–2336. Available at: http://ijecm.co.uk/wp-content/uploads/2014/12/21213.pdf, (accessed, April 13, 2016).

International Energy Agency (IEA) (2015), *World Energy Outlook*. International Energy Agency. Available at: http://www.worldenergyoutlook.org/resources/energysubsidies/, (accessed August 08, 2015).

International Institute for Sustainable Development (IISD) (2014), Subsidies to Liquefied Petroleum Gas in India: An overview of Recent Reforms. IISD. Available at: https://www.iisd.org/publications/subsidies-liquefied-petroleum-gas-india-overview-recent-reforms, (accessed July 08, 2014).

Lok Sabha (2015), Lok Sabha Starred Question No. 342, dated on 01.08.2014, Available at: http://164.100.47.132/lssnew/psearch/QResult16.aspx?qref=5366, (accessed July 25, 2015).

Ministry of Petroleum and Natural Gas (MoPNG) (2016), Ministry of Petroleum & Natural Gas, Government of India, Report-2016-two-years-of-work. Available at: http://jan-sampark.nic.in/jansampark/images/campaign/2016/10-Jun/index.html (accessed, May 16, 2016).

Ministry of Statistics and Programme Implementation, Government of India (MoSPI) (2012), *NSS Report No.567: Energy Sources of Indian Households for Cooking and Lighting, 2011-2012*, Report No. 567 (68/1.0/4). Ministry of Statistics and Programme Implementation, Government of India, National Sample Survey Office.

Musa, A. and R. Hounsou (2014), 'The Impact of Fuel Subsidy Removal on Socio-Economic Development In Nigeria: An Econometric Investigation', *International Journal of Economics, Commerce and Management*, Vol. II(12).

Sinha, S. (2015), 'Subsidy Bill to Drop to Rs.40,000 Cr in 2015-16', The Hindu Business Line. Available at: http://www.thehindubusinessline.com/economy/subsidy-bill-to-drop-to-40000-cr-in-201516/article7474538.ece, (accessed June 05, 2015).

World Bank (2008), 'Climate Change and the World Bank Group - Phase I: An Evaluation of World Bank Win-Win Energy Policy Reforms', World Bank: Washington, DC. Available at: https://openknowledge.worldbank.org/handle/10986/10594, (accessed May 15, 2016).

Appendix A: Impact of the LPG subsidy removal on LPG consumption

```
. reg LPGC GDP LPGP_CPI L1_LPGC
```

Source	SS	df	MS
Model	1.3907e+20	3	4.6357e+19
Residual	9.9168e+17	9	1.1019e+17
Total	1.4006e+20	12	1.1672e+19

Number of obs	=	13
F(3, 9)	=	420.71
Prob > F	=	0.0000
R-squared	=	0.9929
Adj R-squared	=	0.9906
Root MSE	=	3.3e+08

LPGC	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDP	.0001551	.0000595	2.61	0.028	.0000204	.0002898
LPGP_CPI	4.09e+09	2.29e+09	1.79	0.108	-1.09e+09	9.26e+09
L1_LPGC	.1604388	.3680857	0.44	0.673	-.672229	.9931065
_cons	-5.73e+08	5.86e+08	-0.98	0.354	-1.90e+09	7.53e+08

Appendix B: Impact of the total LPG subsidy on LPG consumption expenditure

```
. reg LPGS LPGC
```

Source	SS	df	MS
Model	2.3103e+24	1	2.3103e+24
Residual	4.1544e+26	12	3.4620e+25
Total	4.1775e+26	13	3.2134e+25

Number of obs	=	14
F(1, 12)	=	0.07
Prob > F	=	0.8005
R-squared	=	0.0055
Adj R-squared	=	-0.0773
Root MSE	=	5.9e+12

LPGS	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LPGC	-117.6382	455.3799	-0.26	0.801	-1109.826	874.5495
_cons	2.09e+13	6.00e+12	3.48	0.005	7.81e+12	3.40e+13

Appendix C: Estimating government savings on LPG consumption (LPGSV) and LPG subsidies due to removal of the LPG subsidy (LPGSS)

```
. reg LPGC GDP LPGPP LPGPP_CPI L1_LPGC
```

Source	SS	df	MS
Model	1.3916e+20	4	3.4791e+19
Residual	8.9826e+17	8	1.1228e+17
Total	1.4006e+20	12	1.1672e+19

Number of obs =	13
F(4, 8) =	309.85
Prob > F =	0.0000
R-squared =	0.9936
Adj R-squared =	0.9904
Root MSE =	3.4e+08

LPG LPGCC	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDP	.0001852	.0000706	2.62	0.031	.0000224	.0003479
LPGPP	-5.83e+07	4.94e+07	-1.18	0.272	-1.72e+08	5.56e+07
LPGPP_CPI	8.66e+09	5.42e+09	1.60	0.149	-3.84e+09	2.12e+10
L1_LPGC	.1566728	.3455851	0.45	0.662	-.640248	.9535936
_cons	-3.65e+08	5.25e+08	-0.70	0.507	-1.58e+09	8.46e+08

Appendix D: Macroeconomic impact of change in the LPG subsidy on the economy

```
. reg rog_gdp SAVINGS EMPLOYMENT constant_consumption ROG_LPGS L1_rog_gdp
```

Source	SS	df	MS
Model	36.9975381	5	7.39950763
Residual	17.0853435	7	2.44076336
Total	54.0828816	12	4.5069068

Number of obs =	13
F(5, 7) =	3.03
Prob > F =	0.0903
R-squared =	0.6841
Adj R-squared =	0.4584
Root MSE =	1.5623

rog_gdp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
SAVINGS	1.538088	.5636535	2.73	0.029	.2052589	2.870916
EMPLOYMENT	1.903132	1.379521	1.38	0.210	-1.358916	5.16518
constant_consumption	2.72e-11	2.19e-11	1.24	0.255	-2.46e-11	7.90e-11
ROG_LPGS	.0128749	.0193456	0.67	0.527	-.0328701	.0586198
L1_rog_gdp	-.7422076	.3115449	-2.38	0.049	-1.478894	-.0055211
_cons	-158.7723	106.0911	-1.50	0.178	-409.6379	92.09331