Research Paper

The Distributional Effects of Energy Taxes in Korea

December 2017

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Introduction

It is considered desirable that the energy tax is primarily levied based on environmental tax theory. In general, market prices reflect only private costs in the absence of government intervention. For this reason, social costs are not recognized as an expense incurred in each individual's consumption process. In this respect, it is necessary to have social costs reflected in market prices so that individuals can beware that the consumption of a certain type of fuel costs much higher than they might think and, thereby, make adjustments to their consumption patterns accordingly. The gist of environmental tax theory lies here: imposing as much excise tax as social costs as a way of internalizing social costs into market prices.

This is also directly linked to the Polluter Pays Principle (PPP), a basic principle in environmental policies. Recommended by the OECD Council to member states in 1972, the PPP enshrines an idea that the cost of preventing or managing pollution must be borne by the party that generated such pollution. Collecting as much tax as social costs arising from a particular type of fuel consumed is directly in line with the PPP because the amount of tax would be determined by the amount of social costs incurred by such consumption. Also, the Coase Theorem demonstrates that externalities can be resolved efficiently regardless of who owns them if the ownership is clearly established. According to the theorem, the internalization of an externality can be achieved by establishing ownership, which leads to a socially optimal level of consumption. It has been shown that imposing environmental taxes in proportion to social costs helps reach a social optimum by completely internalizing externalities (Gruber (2011), pp.148-149).[1)]

The energy tax can be a type of the excise tax. The excise tax is placed per unit of a goods consumed. To comply with the PPP, it is reasonable to impose an energy tax in the form of an excise tax because taxation on pollution should be proportionate to the consumption of a given goods that causes such pollution. However, due to the nature of the excise tax, there are some difficulties in operating the system in reality. This is because the excise tax is generally regressive in relation to income. Based on proportionality to income, taxation can be divided into three main types: proportional, progressive and regressive ones. A proportional tax is imposed at the same rate regardless of income level. A progressive tax is based on an increasing tax rate for higher income earners. In a regressive tax system, a tax rate has an inverse relationship with income level, thus benefitting higher income earners. Unless the entire amount of income is spent at all income levels, an excise tax is likely to be regressive. This is because the consumption of goods in general tends to increase as an income rises, but at a slower rate than the rate of income growth.[2)]

The problem with regressive taxation is that it is difficult to ensure compliance by taxpayers no matter how reasonable the policy is. This also concerns the question of tax equity. Even with robust theoretical backgrounds, it is not easy for taxpayers to accept a tax system if they perceive it to be unfair. In taxation theory, equity is discussed in two main aspects. One is vertical equity, and the other is horizontal equity. Vertical equity is a principle that wealthier people should be taxed more, and horizontal equity is a principle that those with the same amount of wealth should be taxed equally. Among these, this paper will focus, in particular, on vertical equity. In light of vertical equity, progressive taxation is a system that meets equity while regressive taxation hinders tax equity.

1) This is called a corrective tax in the sense that it corrects socially ineffective decision making to be efficient. It is also referred to as a Pigouvian tax, which is named after A. C. Pigou, an economist who first proposed it.

2) Not all goods show this tendency. For example, in the case of luxuries, the income elasticity is greater than 1. Thus, the growth rate of consumption gets higher than that of income as the income increases.

Now back to the energy tax system. In determining the direction of energy taxation, we can see that there are conflicts between the two values mentioned above; namely, taxation as a corrective and tax equity. When deciding on whether energy taxation should be strengthened or relieved, the principle of taxation as a corrective suggests the energy tax be further strengthened to better reflect social costs. This is what most academics and researchers argue for, including many environmental economists. For those who view tax equity as the cardinal value, however, raising the excise tax, which is known to be regressive, is problematic in the sense that it may worsen tax equity in light of distributive justice. Moreover, from the perspective of individual taxpayers, no one is willing to welcome the increased tax burden regardless of whether such move is valid. In this situation, it is not easy to expect that taxpayers would conform to increased energy taxes. Thus, this is a burdensome task for policymakers.

The purpose of this paper is to analyze the effect of energy taxation in Korea in terms of distribution. In general, research related to energy taxation is mainly concerned with the optimization problem (i.e. which type of taxation would be efficient for energy conservation and pollution abatement) or an empirical analysis of how effective a specific energy tax policy is. In contrast, it is not so common to delve into the question of distribution in relation to energy taxation. This is not because distribution is considered unimportant in and of itself. Rather, it is because the regressive or equitable nature of a given tax system should be evaluated with a comprehensive analysis of the entire system, instead of checking on each tax item. Some tax items are created to serve distinct purposes, such as mitigating a particular type of consumption. Excise taxes on speculative behaviors, tobacco taxes and environmental taxes are typical examples. Given the unique nature of the taxation purpose, it is not easy to achieve distribution equity with these tax items. Therefore, it is desirable to achieve overall equity in taxation by supplementing such limitations in distribution concerning those tax items with other tax items like income tax. In addition, it is possible to redress regressivity arising from the tax collection process by using revenues generated from the corrective taxation to support low income earners.

That said, there are two main reasons for which this paper examines the question of distribution in the energy tax system. First, there have been only a handful of empirical studies that analyze how regressive the recent energy tax system is in Korea while it is easy to assume that it is regressive given the general characteristics of the excise tax. As noted above, it is not necessary for each and every tax item to be progressive since evaluating tax equity should be based on an examination of the entire tax system. Nevertheless, identifying exactly how much equity is currently being hindered by an energy tax used as a corrective will help determine an appropriate level of progressivity for other tax items.

Secondly, if policies are expected to have similar effects, then analyzing which one is more helpful in achieving tax equity in distribution can serve as valuable implications for future energy tax reforms. If there are multiple policy options, it is important to first look at which tax policy is more conducive to attaining intended goals (i.e. energy savings and pollution abatement.) However, if different policy options are expected to have a similar outcome, then it would be reasonable to choose a policy that can minimize side effects (i.e. deterioration of the distribution structure.) This is because considering the distributional effects of different policy options as well will ultimately help improve social welfare.

The remainder of this paper is organized as follows. Chapter II looks at the current state and characteristics of the energy tax system in Korea. It will present a brief overview of the existing tax system and trends in tax revenue. As for the characteristics of the existing system, it will focus on the level of tax burden that can be linked to the distribution side. Chapter III estimates the distributional effect of the energy tax system in Korea by employing the micro-simulation method, followed by a comparative analysis of the estimated results with those obtained from other OECD member countries. Chapter IV will present a scenario analysis and discuss simulations results based on various scenarios regarding what effects are expected in terms of distribution if the existing taxation is to be reformed in the future. Finally, Chapter V will sum up results of analyses conducted in this study and conclude with policy implications drawn from these results.

Ⅱ

Current State and Characteristics of Energy Taxation in Korea

1 Current State of Energy Taxation

A. Energy Tax System

In Korea, the energy tax is not listed as a separate tax item. There is the transportation, energy and environment tax(hereafter TEET), but it is classified as an objective tax so that some of the tax revenue can be used for special purposes. The government bundles up taxes on energy sources and taxes on goods the consumption of which is considered to cause significant environmental damage and manage them together under the category of environment and energy tax. Korea's environment and energy tax consists largely of taxes on various fuels and automobile taxes imposed according to different stages of purchase, registration and ownership.[3] If quasi-taxes, such as levies and charges, are counted in as well, the range can be extended to include electric charges. However, as the scope of analysis in this paper is limited to taxes

3) However, different ministries are in charge of these taxes. For example, taxes related to oil and the motor vehicle purchase stage (TEET and individual consumption tax) are national taxes managed by the Ministry of Strategy and Finance. As for taxes on the motor vehicle registration and ownership stages (taxes on motor vehicle acquisition and registration and automobile tax), they are local taxes managed by the Ministry of the Interior and Safety.

on the consumption of energy sources, we will focus only on the taxes on various fuels for the sake of consistency.[4)]

Taxable fuels include various kinds of petroleum (gasoline, diesel, heavy oil, kerosene and byproduct oil), petroleum gases (propane and butane), natural gas and bituminous coal. Basically, taxes on various fuels are composed of individual consumption taxes and surtaxes belonging to them. Among these, individual consumption taxes on gasoline and diesel have been temporarily listed as the TEET in order to secure financial resources needed for transportation infrastructure. The individual consumption tax is a ad quantum tax, for which a certain tax rate is applied per unit of each fuel. Based on the individual consumption tax, an additional tax rate is applied in the form of surtax. The surtax on energy taxes includes education and motor fuel taxes. The education tax is levied at a fixed rate on the TEET, individual consumption tax and automobile tax. The education tax related to fuels, excluding propane, liquefied natural gas, and bituminous coal is imposed at the rate of 15% of the traffic, energy environment tax and excise tax on petroleum. The motor fuel tax is a local tax whose primary purpose is to raise funds for subsidizing increased oil prices, and the tax rate is 26% of the TEET. Additionally, there are tariffs and VATs on fuels, but these two items will be excluded from the discussions in this paper because they are uniformly applied to other goods as well. <Table II-1> lists tax rates for various energy taxes.

4) Also, taxes on various fuels will be referred to as the “energy tax” hereinafter for consistency’s sake.

〈Table II-1〉 **Current State of Energy Taxation (as of October 2016)**

(Unit: won)

Category	Unit	Tariff		Individual Consumption Tax		Traffic, Energy and Environment Tax		Education Tax	Auto mobile tax	VAT
		Basic	Quota	Basic	Elastic	Basic	Elastic			
Gasoline	ℓ	3%	–	475	–	475	529	79.35	137.54	10%
Diesel	ℓ	3%	–	340	–	340	375	56.25	97.50	10%
Butane	kg	3%	0%	252	275	–	–	41.25	–	10%
Propane	kg	3%	0%	20	14[2)]	–	–	–	–	10%
LNG	kg	3%	2%	60	42[3)]	–	–	–	–	10%
Kerosene	ℓ	3%	–	90	63	–	–	9.45	–	10%
Heavy oil	ℓ	3%	–	17	–	–	–	2.55	–	10%
By–Product Oil	ℓ	3%	–	90	63	–	–	9.45	–	10%
Anthracite Coal	kg	tax–free	–	–	–	–	–	–	–	tax–exempt
Bituminous Coal	kg	tax–free	–	24[1)]	27/21[4)]	–	–	–	–	10%
Electric Power	kWh	–	–	–	–	–	–	–	–	10%

Note: 1) Only bituminous coal used for power generation purposes is taxable; bituminous coal used by integrated energy business or for purposes other than power generation business is tax–exempt.
2) Applies to households and commercial uses only
3) The basic tax rate (60 won/kg) is applied to LNG used for power generation purposes; the elastic tax rate is applied to LPG used for purposes other than power generation (i.e. households and commercial uses) or supplied to integrated energy business entities.
4) Items with a net calorific value of 5,500 kcal per kilogram or more: 27 won per kilogram Items with a net calorific value of 5,000 kcal or more but less than 5,500 kcal per kilogram: 24 won per kilogram Items with a net calorific value of less than 5,000 kcal per kilogram: 21 won per kilogram

Source: National Law Information Center (http://www.law.go.kr; accessed on November 2, 2016); and Hong Seong–hun, Kang Seong–hun and Heo Gyeong–seon (2014), p. 27 (〈Table II–1〉 has been updated with recent tax rates.)

B. Trends in Energy Tax Revenue

Tax revenues related to energy sources are continuously on the rise (see <Table II-2>). As of 2015, tax revenues from the TEET reached nearly 15 trillion won. Taxes levied on various fuels, except for surtax, posted about 20 trillion won. With surtax included, the figure amounted to about 26 trillion won. Over the past five years, energy tax revenue has increased at an average annual rate of 3.42%. A similar pattern is observed in the growth rate of the total national taxes (3.16%) in the same period. Thus, energy tax revenue has maintained a stable level, marking about 12% of total national taxes in scale. In 2015, the proportion of the energy tax in the excise tax decreased slightly to 75% due to the individual excise tax on tobacco, but a steady level of around 80% had been maintained until 2014.[5] This shows that the energy tax has actually been of absolute importance in Korea's excise tax. In addition, the education tax added as part of the energy tax totaled about 2.45 trillion won as of 2015, accounting for about half of the total education tax.

〈Table II-2〉 **Trends in Energy Source-Related Tax Revenue**

(Unit: 100 million won, %)

Category	2011	2012	2013	2014	2015	Average Annual Growth Rate
Traffic, Energy and Environment Tax (A)	130,651	135,520	133,110	143,679	149,659	3.45
Individual Consumption Tax (Fuel) (B)	39,788	38,503	40,024	41,166	47,301	4.42
Education Tax (C)	23,159	22,748	22,278	23,661	24,503	1.42
Automobile tax (Local Tax) (D)	33,969	35,235	34,608	37,357	38,911	3.45

5) Various excise taxes refer to individual consumption tax, TEET and liquor tax, excluding surtaxes, which corresponds to A+E+F in 〈Table II–2〉.

〈Table II-2〉 **Continued**

Category	2011	2012	2013	2014	2015	Average Annual Growth Rate
Energy Tax (A+B+C+D)	227,567	232,006	230,020	245,863	260,374	3.42
Liquor Tax (E)	25,293	29,989	29,470	28,520	32,275	6.28
Individual Consumption Tax (Total) (F)	55,373	53,355	54,843	56,241	80,008	9.64
Education Tax (Total) (G)	42,445	46,339	45,091	46,052	48,691	3.49
Total National Taxes	1,923,812	2,030,149	2,019,065	2,055,198	2,178,851	3.16
(A+B)/(A+F)	91.62	92.14	92.12	92.46	85.76	−1.64
(A+B)/(A+E+F)	80.66	79.51	79.63	80.92	75.19	−1.74
C/G	54.56	49.09	49.41	51.38	50.32	−2.00
Energy Tax/Total National Taxes	11.83	11.43	11.39	11.96	11.95	

Note: 1. In the table, each excise tax is a figure excluding VAT.
2. The average annual growth rate represents the growth rate for four years from 2011 to 2015
3. As of the end of October 2016, the education tax is 15% of the traffic, energy, environmental tax and individual excise tax, while the driving tax is 26% of the TEET.

Source: Internal documents of the Ministry of Strategy and Finance; National Tax Service (2015), advance copy published by the National Tax Statistics (http://www.nts.go.kr/info/info_03_02.asp?minfoKey=MINF4920080211210012&top_code=&sub_code=&sleft_code=&ciphertext=; accessed on July 14, 2016)

2 Characteristics of Energy Tax

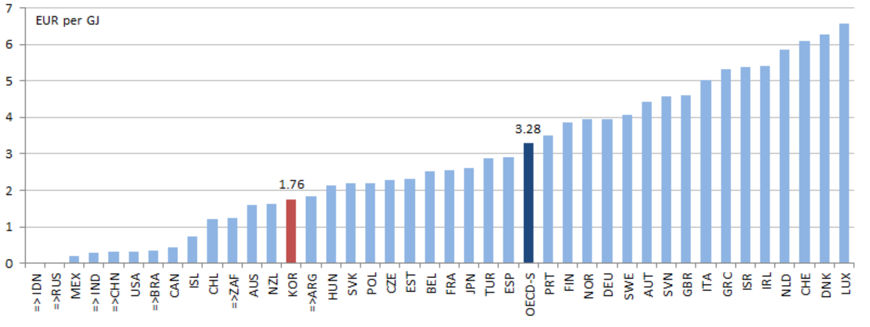
In this section, we examine the characteristics of the energy tax in Korea by comparing them with those of other OECD member countries in terms of effective tax rate. Among various features, we will zoom in on ones related to tax equity because the focus of our discussion is primarily about the problem of distribution in energy taxation. Tax equity is concerned with how appropriately tax burden is distributed, and in this respect, the effective tax rate needs due attention. The effective tax rate of energy tax can be approached with various standards. It can be based on the ratio of tax burden to income. Other ways include—but not limited to—calculating it based on the ratio of tax burden to the net calorific value, based on the ratio of tax burden to the price of fuel or based on the ratio of tax burden to the amount of pollutants generated. However, the tax burden to income ratio is not covered in this section since the corresponding effective tax rate will be discussed in Chapter IV based on the following analysis.

A. Tax Rate Levels

Based on the calorie standard used in the OECD's comparative analysis, Korea's effective energy tax rate is 1.76 EUR/GJ, which is about 54% of the OECD average (3.28 EUR/GJ), marking the eighth lowest among 34 OECD countries (see [Figure II-1]).[6] When compared to the amount of pollutants generated, a question arises about how to delimit the scope of the pollutants for analysis. There exists a great variety of pollutants generated by fuel consumption, ranging from carbon dioxide to nitrogen oxides, sulfur oxides and fine dust. It would be ideal to include all of them, but available for international comparison are reports by the OECD (OECD, 2013 and 2015), which include effective tax rates assessed based on carbon dioxide emissions. According to the OECD reports, Korea's effective energy tax rate is 26.47 euros per ton of carbon dioxide, which stands only at about 51% of the OECD average. Korea ranks eighth from the bottom among 34 countries, the same as by the calorie standard. Overall, Korea's level of taxation on energy consumption is relatively low compared to other developed countries, both on the basis of calories and carbon dioxide emissions.

6) GJ is equal to one billion times the joule (J), an international unit of energy. That is, GJ equals 10^9 J. Meanwhile, 1 J refers to the amount of work or energy required to move an object by 1 m with a force of 1 newton (N) in the direction of the force (Doosan Encyclopedia, Naver Encyclopedia, http://terms.naver.com/entry.nhn ? DocId = 1143272 & cid = 40942 & categoryId = 32227; accessed on November 16, 2016)).

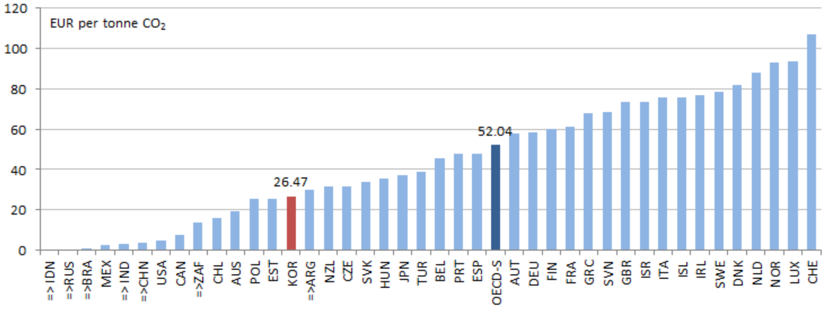
[Figure II-1] **Effective Energy Tax Rates of 41 Countries including OECD Members**



Note: 1. OECD-S refers to the arithmetic mean of OECD countries.
2. '⇒' refers to seven major non-OECD countries (IDN: Indonesia, RUS: Russia, IND: India, CHN: China, BRA: Brazil, ZAF: South Africa, ARG: Argentina).

Source: OECD (2015) data reprocessed by the authors

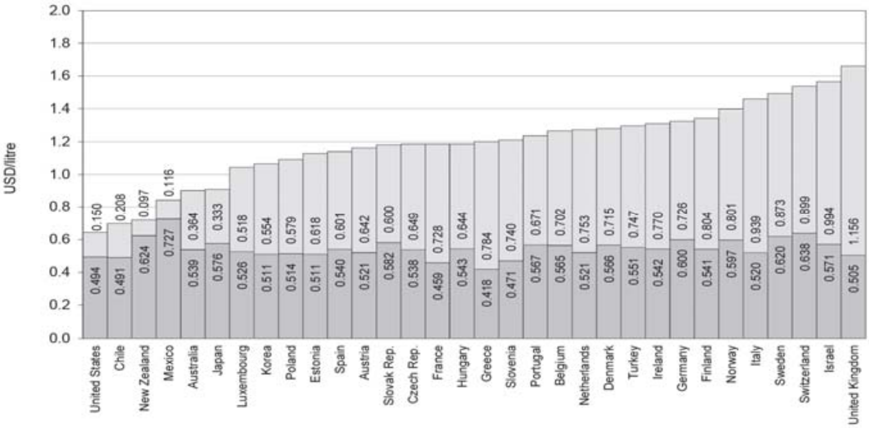
[Figure II-2] **Effective Energy Tax Rates of 41 Countries including OECD Members by CO_2 Emissions**



Note: 1. OECD-S refers to the arithmetic mean of OECD countries.
2. '⇒' refers to seven major non-OECD countries (IDN: Indonesia, RUS: Russia, IND: India, CHN: China, BRA: Brazil, ZAF: South Africa, ARG: Argentina).

Source: OECD (2015) data reprocessed by the authors

[Figure Ⅱ-3] Unleaded Gasoline Prices and Tax Rates in OECD Countries (based on the 4th Quarter Average in 2015)

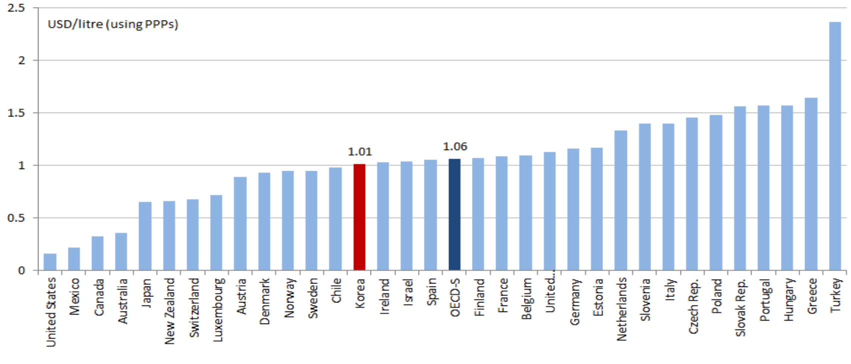


Note: 1. Figures for Australia, Canada, Japan, Korea, Mexico, New Zealand and the United States refer to general unleaded gasoline; the rest refers to premium unleaded gasoline 95.

2. The darker part on the bottom of each bar represents the pre-tax price, and the brighter part on the top represents the tax rate.

Source: IEA (2016) p. xxvi, Figure 14.

[Figure Ⅱ-4] PPP-Adjusted Tax Rates of Unleaded Gasoline in OECD Countries (based on the 4th Quarter Average in 2015)



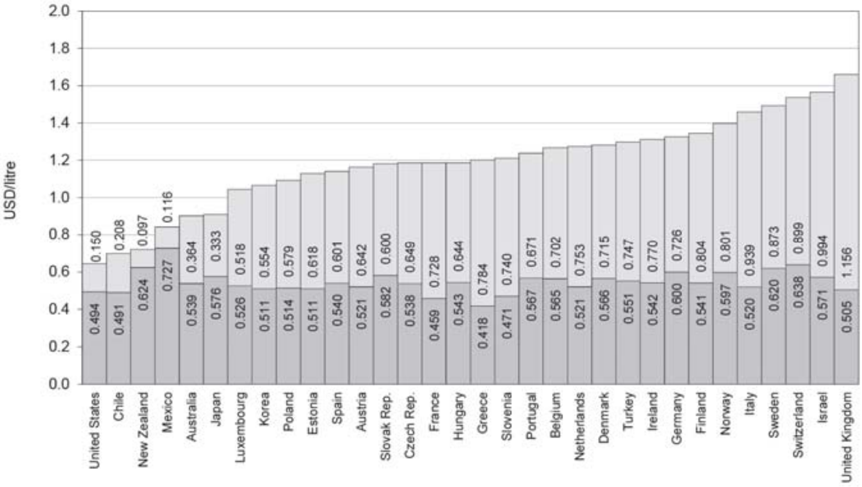
Note: 1. Figures for Australia, Canada, Japan, Korea, Mexico, New Zealand and the United States refer to general unleaded gasoline; the rest refers to premium unleaded gasoline 95.

2. OECD-S refers to the arithmetic mean of tax rates among the 33 countries listed in the data.

Source: IEA (2016) data reprocessed by the authors

Compared with other OECD countries, diesel shows a slightly lower tax burden than gasoline in Korea. The price of diesel is 1.07 USD per liter, the eighth lowest price in the OECD (see [Figure II-5]).[7] Even in terms of the PPP standard, the price is 1.46 USD per liter, which is lower than the OECD average (1.62 USD per liter). The tax rate is 0.55 USD per liter, accounting for 52.0% of the price. Even when adjusted with PPP, the tax rate for diesel is 0.76 USD per liter, which is lower than the OECD average (0.88 USD per liter) (see [Figure II-6]).

[Figure II-5] Diesel Prices and Tax Rates for Non-Commercial Vehicles in OECD Countries (based on the 4th Quarter Average in 2015)

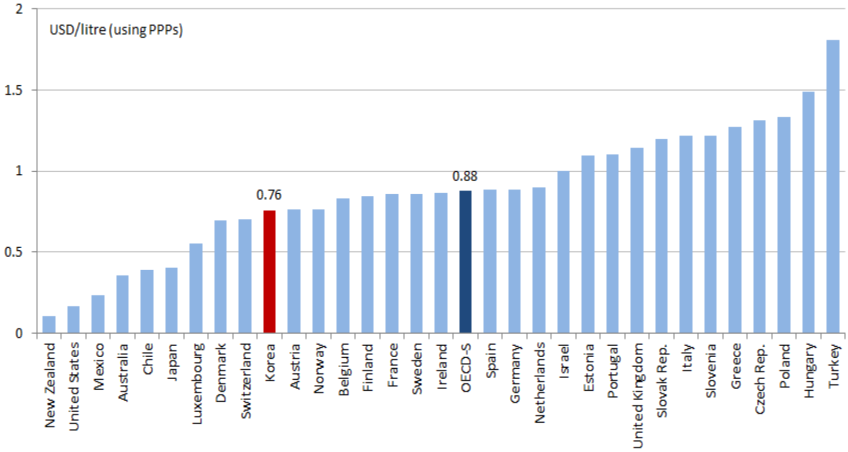


Note: The darker part on the bottom of each bar represents the pre-tax price, and the brighter part on the top represents the tax rate.

Source: IEA (2016) p. xxvi, Figure 15

7) The ranking is based on the IEA (2016) data and excludes Canada and Iceland as these countries are missing from the data. In particular, diesel in Canada is expected to be cheaper than in Korea due to the former's low tax rates on fuels and low price policy. However, even though the diesel prices in both countries are lower than in Korea, Korea ranks tenth (in descending order), which is still low.

[Figure II-6] **PPP-Adjusted Diesel Tax Rates for Non-Commercial Vehicles in OECD Countries (based on the 4th Quarter Average in 2015)**



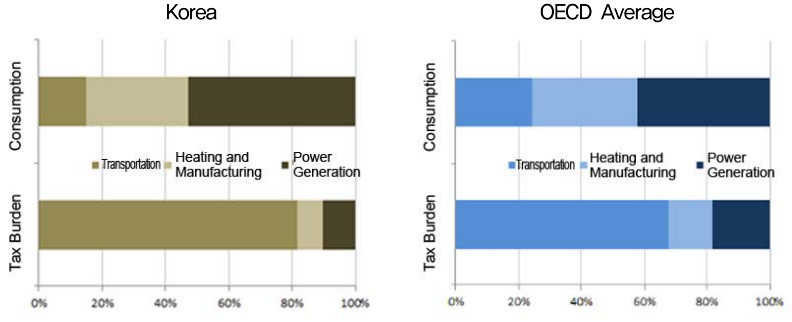
Note: OECD-S refers to the arithmetic mean of tax rates among 32 countries listed in the data.
Source: OECD (2016) data reprocessed by the authors.

B. Imbalance in Tax Rates

1) Imbalance among Sectors: Taxation Focused on Transportation Fuels

Looking at the structure of the energy tax burden on a calorie basis, Korea is overly focusing on taxation on energy sources for transportation purposes (see [Figure II-7]), compared to the OECD average. Of the total energy consumption in Korea, transportation accounts for only 15%, but it amounts to 82% of the total energy tax burden. In addition, nearly 90% of the tax burden of the transportation sector is composed of gasoline and diesel. While taxation on transportation sector makes up the largest portion in other OECD countries as well, the differential is still significant. As for the ratio of tax burden to consumption in the transportation sector, the tax burden is larger by 2.8 times on average in other OECD countries, but the figure reaches as much as 5.4 times in Korea. In other words, the tax burden on energy consumption is almost twice as concentrated in the transportation sector in Korea as it is on average in other OECD members.

[Figure II-7] **Energy Use and Tax Burden by Sector**



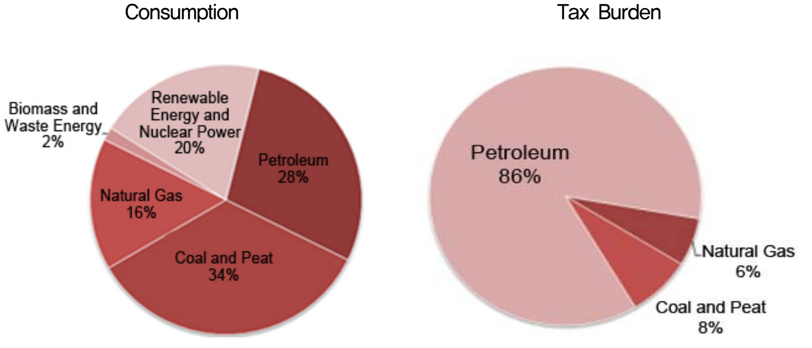
Note: The OECD data (2013) does not reflect Korea's taxation on bituminous coal for power generation and an increased tax rate on LNG for power generation in 2015, so the tax rate on bituminous coal for power generation (24 won/kg as the representative value) and the increase in the LNG tax rate on power generation purposes (42 won/kg→60 won/kg) were added to the OECD data (2013). The amounts of consumption were measured based on calorific values.

Source: Calculated by the authors based on data from OECD (2013), Korea Energy Economics Institute (2015).

2) Imbalance among Fuel Types: Taxation Focused on Petroleum

In addition to the imbalance among sectors in the structure of energy taxation, the imbalance among fuels is also noteworthy. As shown in [Figure II-8], coals and peats are consumed the most in Korea, which accounts for 34% of the total consumption in terms of calorific value. Petroleum comes next, making up 28%. In terms of tax burden, however, petroleum amounts to 86%, and coals and peats account for only 8%. Petroleum marks the largest share in the OECD countries as a whole, but the extent of concentration is far less severe in the latter (see [Figure II-9]). In particular, the type of fuel consumed the most is petroleum (36%) within the OECD as a whole, followed by natural gas and coals and peats. Even though the tax burden is concentrated on petroleum as well, it shows the same rank order as in the case of consumption. In other words, the largest tax burden is imposed on the type of fuel that is consumed the most, which indicates that the User Pays Principle (UPP) does apply properly in Korea.

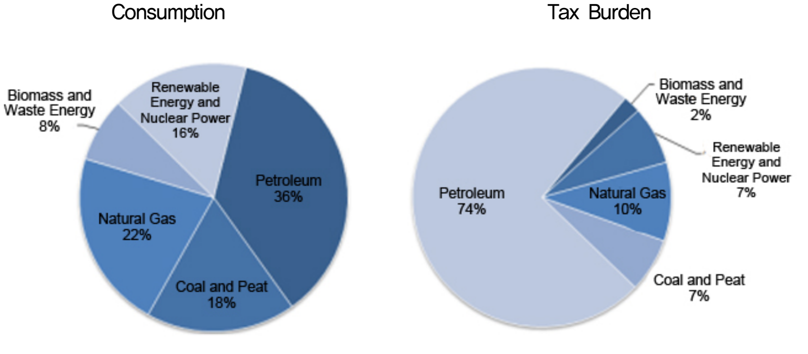
[Figure II-8] **Breakdown of Energy Consumption and Tax Burden by Fuel Type in Korea Based on Calories**



Note: The OECD data (2013) does not reflect Korea's taxation on bituminous coal for power generation and an increased tax rate on LNG for power generation in 2015, so the tax rate on bituminous coal for power generation (24 won/kg as the representative value) and the increase in the LNG tax rate on power generation purposes (42 won/kg→60 won/kg) were added to the OECD data (2013). The amounts of consumption were measured based on calorific values.

Source: Calculated by the authors based on data from OECD (2013), Korea Energy Economics Institute (2015).

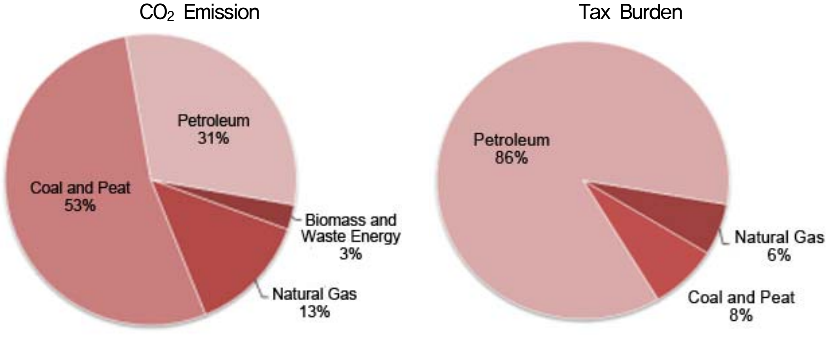
[Figure II-9] **Breakdown of Energy Consumption and Tax Burden by Fuel Type in Korea Based on Calories**



Source: Reorganized by the authors using the data from OECD (2013).

So far, we have examined how applicable the UPP is by looking at the breakdown of consumption and that of tax burden by type of fuel based on calories. However, even in the process of generating the same amount of calories, the degree of pollutants emitted varies by fuel. In light of the purposes of the environmental tax, the most ideal cost-bearing principle is the Polluter Pays Principle (PPP), according to which the polluter is required to pay social costs proportionate to the amount of pollutants generated. For example, the OECD reports (2015 and 2013) show that the share of coals and peats is 53%, the largest in Korea, followed by petroleum (31%) and natural gas (13%). However, in terms of tax burden by fuel type, petroleum makes up the largest portion at 86%, with coals and peats and natural gas standing at only 8% and 6% respectively (see [Figure II-10]).

[Figure II-10] CO_2 Emissions and Tax Burden by Fuel Type in Korea



Note: The OECD data (2013) does not reflect Korea's taxation on bituminous coal for power generation and an increased tax rate on LNG for power generation in 2015, so the tax rate on bituminous coal for power generation (24 won/kg as the representative value) and the increase in the LNG tax rate on power generation purposes (42 won/kg→60 won/kg) were added to the OECD data (2013). The amounts of consumption were measured based on calorific values.

Source: Calculated by the authors based on data from OECD (2015, 2013), Energy and Korea Energy Economics Institute (2015).

Ⅲ

Analysis of Energy Tax Burden Level by Stratum

1 Analytical Methodology and Empirical Data

In this chapter, microdata on household income and expenditure will be used to calculate the level of energy tax burden by social and economic stratum and analyze its distributional effect. Korea's energy tax is imposed in the form of ad quantum tax. Therefore, an accurate analysis is possible if the amount of consumption by fuel type is available in a given microdata set. However, the microdata used in this paper include expenditure on fuel consumption, instead of the amount of each fuel consumed. For this reason, we need to estimate the tax burden on each fuel and employ the micro-simulation method to make an estimate. To calculate the burden of the energy tax—which is a per unit tax—for each fuel type, annual average expenditure on fuel consumption is first divided by the average price to estimate the amount of fuel consumed, which in turn is multiplied by the ad quantum tax rate. That is, the energy tax burden can be calculated by using the microdata itself, without assuming a separate demand function or utility function.

In the meantime, we use the coding used in research on distributional effects in OECD countries, as described above. This is a common type of coding used in OECD reports on distributional effects, including Flues and Thomas (2015). Using the same coding structure makes it possible to make a direct comparison with other member states included in OECD reports. For example, income, which serves as the basis of determining a household's income bracket, can be operationalized in various ways, such as ordinary income, disposable income and market income, according to different research perspectives. In the OECD reports, disposable income is used as the reference point, and we use the same operationalization. Thus, income refers to disposable income in this paper unless stated otherwise. In addition, disposable income will be calculated by using the OECD's equivalence scale: i.e. equalized income by OECD-modified scale. By employing the same methodology as OECD reports in the detailed coding process, a direct comparison can be made with the distributional effect of energy taxation in other OECD members analyzed in the existing reports.

Basically, analytical concepts (e.g. income, weight, etc.) and formulae used in the coding process of this paper are consistent with those used in Flues and Thomas (2015). Still, there are some different aspects to be noted. As will be mentioned later again, tax burdens covered in this chapter will be estimated based on individual consumption tax, education tax and motor fuel tax imposed on each fuel type. However, VAT is excluded from analysis because we find it necessary to distinguish VAT from the energy tax in that the former is governed by separate tax laws. In light of comparability with other OECD countries, however, we use the same tax burden ratios, which include VAT, as in Flues and Thomas (2015) in the later section of this chapter in which we make a comparison with the analysis of 21 OECD countries.

To examine an energy expenditure pattern by the level of household income, we use the 『Household Income and Expenditure Survey』 published by the Statistics Korea has been used as basic microdata. The survey is designed to identify the living conditions and changes of households and utilize them as basic data for making various policies by keeping track of household income and expenditure. This is the most representative household-related survey in Korea, and the monthly household income and expenditure, including single-person households, are collected nationwide in the form of household ledgers distributed by survey officers and filled in by households. Although it is common in other surveys as well, the highest and lowest income groups are relatively undersampled in the 『Household Income and Expenditure Survey.』 Therefore, it should be taken into consideration that data on the highest and lowest income groups is likely to be either overestimated or underestimated when the analysis is conducted by income bracket. For example, the income or expenditure level of the top income bracket included in the survey is likely to be underestimated, compared to the actual level. In contrast, the energy tax burden of the highest income bracket is likely to be overestimated, compared to the actual level.

The scope of analysis in this chapter is as follows. The analysis of the energy tax burden mainly covers the individual consumption tax and the accompanying surtax (i.e. education tax and motor fuel tax) on fuels for household and transportation purposes, excluding VAT. Transportation fuels include gasoline, diesel, and LPG butane, and the tax burden effect on gasoline and diesel can be compared with other OECD member countries. Household fuels include city gas, LPG fuel, and kerosene. In the case of city gas, we apply the tax rate for LNG since it is the most common type of city gas.

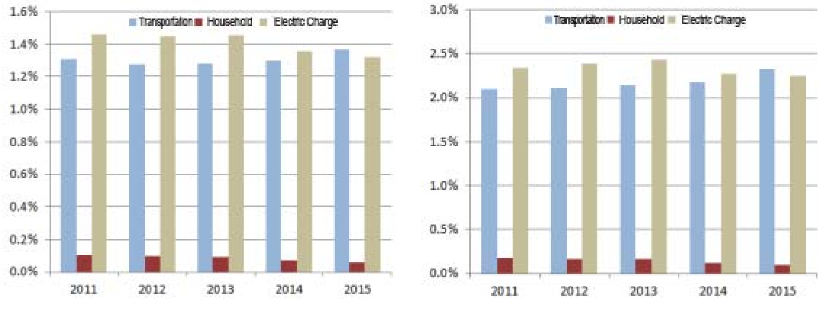
The analysis deals with two main aspects: income bracket and household characteristics. As for income bracket, we will look at the level of tax burden both by income decile and by expenditure decile. The income decile is based on disposable income, and the income-based tax burden refers to the ratio of the amount of tax burden to disposable income. In contrast, the expenditure decile is based on pre-tax expenditure on fuel consumption, and the expenditure-based tax burden refers to the ratio of tax burden to pre-tax expenditure on fuel consumption.[8] In the case of household characteristics, our analysis includes the characteristics of the head of household, the total number of household members, the number of those employed, and the type of residential area (i.e. urban vs. non-urban). The characteristics of the head of household cover gender, age, and education level.

8) For a direct comparison with other OECD member countries, we use both the decile and the tax burden ratio in accordance with the method employed in Flues and Thomas (2015), which will be applied consistently throughout this section. However, in the scenario analysis results presented in the next section, the income decile is based on ordinary income. In the case of scenario analysis, however, there are no previous studies through which we can make a comparison with other OECD countries, which is why we do not need to follow the method employed in Flues and Thomas (2015). In addition, many domestic studies on the income distribution effect have used ordinary income as the reference point for the income decile. There can be a slight difference in the figures, such as the tax burden ratio, due to different operationalization of income used in each section, but the key result, i.e. the structure of the distributional effect, is the same.

2 Results of Analysis of Korea's Energy Tax Burden Level

Based on the 『Household Income and Expenditure Survey』, Korea's energy tax burden ratios over the last five years are as shown in [Figure III-1]. The level of tax paid for the consumption of transportation fuel comprises about 1.3% of the total income. In terms of expenditure, the figure stands at about 2.2%. In particular, it is notable that the ratio of tax burden to expenditure on transportation fuel has been rising continuously. Considering that the tax rates remained fixed during the period, this suggests that the consumption of transportation fuel has increased more than expenditure. The level of tax burden for household fuels dropped from 0.11% of the total income in 2011 to 0.06% in 2015. As we will discuss below, the decrease seems to have been affected by the effect of a tax rate cut and a rise in temperature in winter.

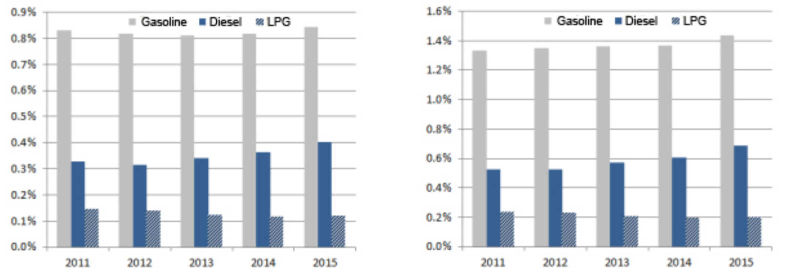
[Figure III-1] **Trends in Korea's Energy Tax Burden Ratio and Electric Charge Burden Ratio (based on Income(left) and Expenditure (right))**



Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

[Figure III-2] presents a closer look at the recent trends in the tax burden ratio concerning the consumption of fuels for transportation purposes. As for the tax burden on gasoline, the ratio is slightly higher than 0.8% of the total income, and it accounts for 1.4% of the total expenditure. In the case of the tax burden ratio on diesel consumption, it is about 0.3 to 0.4% of the entire income and around 0.5 to 0.7% of the total expenditure. The tax burden on LPG butane makes up around 0.1% of income and approximately 0.2% of expenditure, respectively. The recent tax burden ratio trends show that the tax burden ratios for gasoline and diesel are on the gradual rise while that of LPG is in slow decline.

[Figure III-2] **Trends in Korea's Ratio of Tax Burden on Transportation Fuels (based on Income(left) and Expenditure (right))**



Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

A. Level of Tax Burden by Decile

The results of the analysis of the energy tax burden level by decile are summarized in [Figure III-3] through [Figure III-8]. First, [Figure III-3] shows the share of the tax burden on transportation fuels by household during the analysis period. Each decile is defined in terms of both income and expenditure. In both cases, the ratio of tax burden on transportation fuels shows a pattern that is similar to a reversed U shape. That is, taxation on transportation fuels is progressive in the section that ranges from the low to middle income (expenditure) levels, but it gets regressive in the section that spans the middle to high income (expenditure) levels. Also, the asymmetry of the curve between the left and right sections indicates that the extent of progressivity in the lower income section is greater than that of regressivity in the higher income section. This phenomenon seems to result from the fact that the substitution of self-owned vehicles with public transportation is relatively large due to higher sensitivity to the oil price observed in the lower deciles while those who belong to higher deciles are less sensitive to the oil price and the share of vehicle fuel costs in the total income is relatively small in the latter group.

Now, let us take a look at changes in the period from 2011 to 2015. In the year 2015 (the solid red line in [Figure III-3]), in which the average oil price was the lowest, the peak is higher in the middle and the slopes on both the left and right are also steeper, compared to the year 2012, when the average oil price was the highest (the solid light brown line in [Figure III-3].) This can also be explained by the substitutability between self-owned vehicles and public transportation since those who belong to the middle deciles are likely to be the most responsive to a drop in the oil price and, thus, the most active in a transition from public transportation to self-owned cars. For low-income earners, it is not an easy option because purchasing a car is still burdensome even if oil prices fall. For high-income earners, a self-owned vehicle is already the most common choice of transportation, compared to other income groups.

[Figure III-3] Trends in Korea's Ratio of Tax Burden on Transportation Fuel by Decile (based on Income(left) and Expenditure (right))

Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

[Figure III-4] through [Figure III-6] provide more detailed information on the ratio of tax burden on transportation fuel by categorizing it into gasoline, diesel and LPG. While the ratio of tax burden on gasoline has remained almost the same over the past five years, diesel has seen a constant rise in recent years.

This is a consistent pattern observed across deciles, except for the lowest and the highest income deciles. Also, it is shown that the tax burden ratio curve moves upward and the slope becomes steeper over time. To identify the exact cause, a further analysis needs to be carried out with more detailed data. However, as explained above, we find it likely to be the result of falling oil prices and a relatively more active response from the median group in switching to self-owned, relatively cheaper diesel vehicles. While all the transportation fuels show the same patterns that are similar to a reversed U shape, the regressivity of the tax burden ratio observed in the high-decile group is the weakest in the case of gasoline consumption. On the other hand, LPG is characterized by a short progressive section and a long regressive section. In addition, the tax burden ratio of the highest income group is the lowest and the tax burden ratio is still lower for the same group even at a low price, unlike gasoline and diesel.

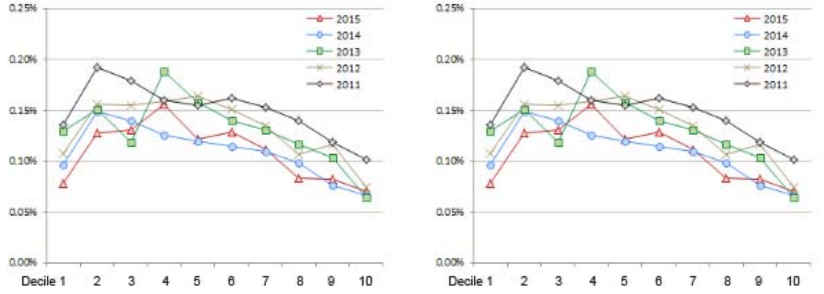
[Figure III-4] Trends in Korea's Ratio of Tax Burden on Gasoline for Transportation by Decile (based on Income(left) and Expenditure (right))

Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

[Figure III-5] **Trends in Korea's Ratio of Tax Burden on Diesel for Transportation by Decile (based on Income(left) and Expenditure (right))**

Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

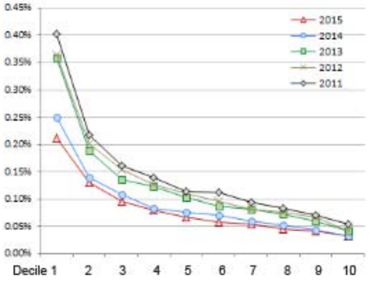
[Figure III-6] **Trends in Korea's Ratio of Tax Burden on LPG for Transportation by Decile (based on Income(left) and Expenditure (right))**

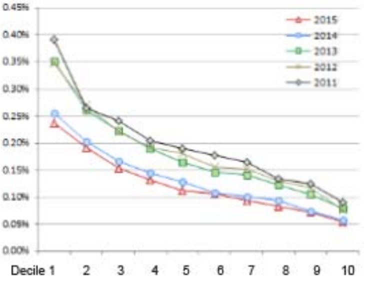


Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

The ratio of tax burden on household fuels is regressive regardless of the income or expenditure level (see [Figure III-7]). However, the degree of regressivity gets alleviated over time. This seems to be due to a decline in the individual consumption tax rates for kerosene, LPG and LNG since 2013 (see <Table III-1>). In addition, the consumption of heating oil is highly dependent on the climate (temperature). Seasonal changes in temperature for the last five years reveal that the average winter temperature has increased in general (see [Figure III-8]). It is shown that the consumption of household fuels is gradually decreasing in that heating oil makes up the most of the household fuels (see <Table III-2>).

[Figure III-7] **Trends in Korea's Ratio of Tax Burden on Household Fuel by Decile (based on Income(left) and Expenditure (right))**





Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

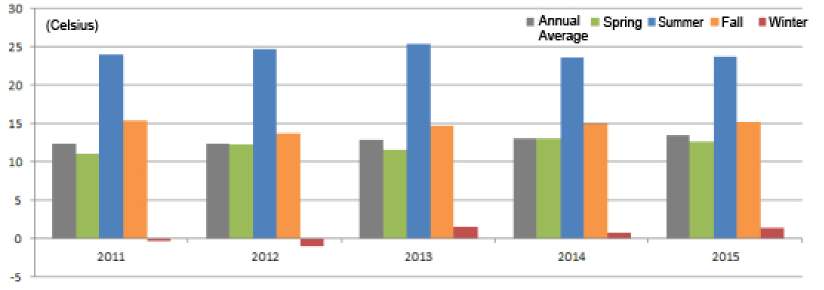
〈Table III-1〉 **Changes in Individual Consumption Tax Rate for Household Fuel in Recent 5 Years (2011-2015)**

(Unit: won/liter, won/kg)

	Kerosene	LPG Propane	LNG
2011.1.1. ~	90	20	60
2012.1.1. ~	90	14	60
2012.5.1. ~	90	20	60
2014.7.1. ~	63	14	42

Source: Korea National Oil Corporation (2014), National Law Information Center (http://www.law.go.kr/; accessed on August 25, 2016)

[Figure III-8] **Changes in Average Temperature by Season in Recent 5 Years (2011-2015)**



Source: e-Nara Index
(http://www.index.go.kr/potal/main/EachDtlPageDetail.do?idx_cd=1400 Access date: October 25, 2016)

〈Table III-2〉 **Changes in Household Fuel Consumption in Recent 5 Years (2011-2015)**

(Unit: thousand kl, million ㎥, thousand tons)

	Kerosene	LPG Propane	City Gas
2011	2,328	769	9,597
2012	2,057	660	9,720
2013	1,744	722	9,457
2014	1,634	703	8,748
2015	1,709	738	8,754

Source: Monthly Energy Statistics (June 2016)

B. Level of Tax Burden by Household Characteristics

In addition to income and expenditure deciles, now let us examine the level of tax burden by household characteristics. Our analysis focuses mainly on such aspects as the characteristics of the head of household and the number of household members. First, [Figure III-9] presents the level of energy tax burden by the gender of the head of household for both transportation and household fuels.

[Figure III-9] **Ratio of Tax Burden on Transportation Fuel (left) and Household Fuel (right) by Householder's Gender (as of 2015)**

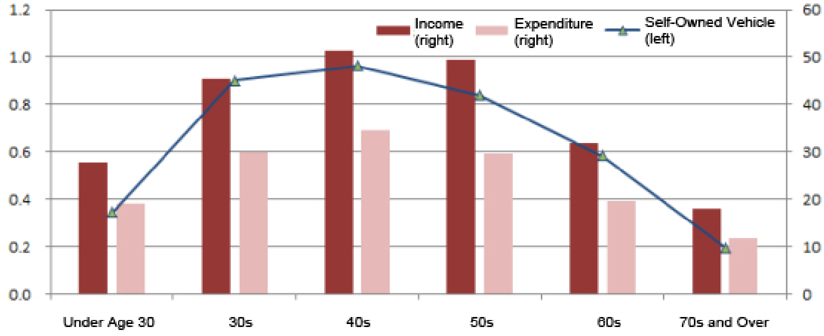
Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

The average income of female-headed households is 26 million won, which is only half the average income of male-headed households (47 million won). In the case of transportation fuels, the tax burden is higher for male-headed households than for their female counterparts. As for household fuels, the burden is higher for female-headed households. This seems to result from the fact that household fuels are essential to maintaining livelihood while the consumption of transportation fuels can be substituted with public transportation. As the level of income goes up, the share of household fuels becomes smaller due to the nature of necessities. In contrast, the share of transportation fuel consumption becomes smaller as income level goes down since transportation fuels can be replaced by cheaper substitutes. This is supported by the fact that the number of vehicles owned by female-headed households is only 0.33 while the figure reaches 0.89 in the case of male-headed households.

To compare the level of tax burden against the distribution of income based on householder's age, the results indicate that the tax burden is progressive in the case of transportation fuels while it is regressive in the case of fuels for household purposes (see [Figure III-11] and [Figure III-12]). In terms of age, the distribution of income and that of the number of self-owned vehicles are almost the same in shape (see [Figure III-10]). However, for those in their 70s and older, the share of car ownership falls sharply, which seems to reflect the fact that driving becomes physically demanding as well as a decline in income in the age group.

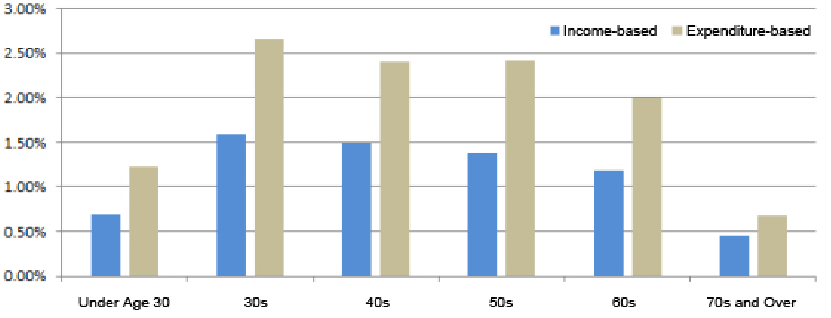
[Figure III-10] Income Distribution and Number of Self-Owned Vehicles by Householder's Age (as of 2015)

(Unit: vehicles (left), million won (right))



Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

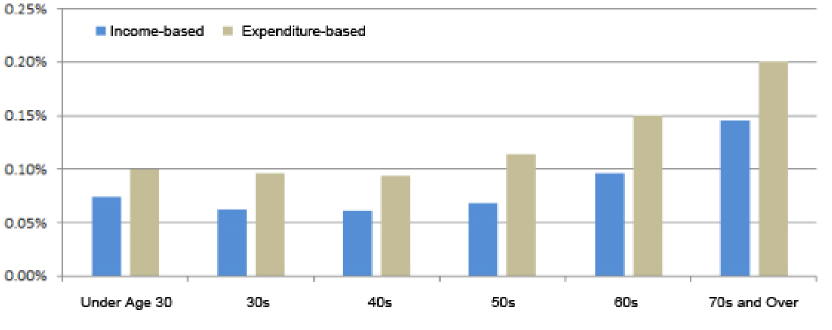
[Figure III-11] Ratio of Tax Burden on Transportation Fuel by Householder's Age (as of 2015)



Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

As for household fuels, the tax burden ratio tends to increase sharply for those in their 60s and 70s. Especially, households with householders aged 70 years old or more are more burdened than households with householders who are under 30 years old, which is because the former group not only has lower incomes, but they also spend more energy. The average number of household members headed by householders aged under 30 (1.67 persons) is not less than the average number of household members headed by householders aged 70 years old or more (1.63 persons). Also, with householders excluded, the number of household members in both groups is less than one on average. Considering these results, we can infer that older people tend to consume more household fuels than younger people. The difference can be attributed to the fact that the elderly spend more time at home than younger people, rather than an aged-based difference in consumption tendency per se. Meanwhile, the ratio of tax burden is pretty much the same for households headed by those who are in their 20s through 40s. In the same age group (i.e. from 20s to 40s), it is found that income increases with age while the tax burden ratio also increase almost in proportion to income. This seems to be affected by—along with other factors—the fact that the number household members tends to increase as income increases in the age group in question (the number of household members by householder's age: under 30 - 1.7 persons; 30s - 3.1 persons; and 40s - 3.4 persons.)

[Figure III-12] Ratio of Tax Burden on Household Fuel by Householder's Age (as of 2015)

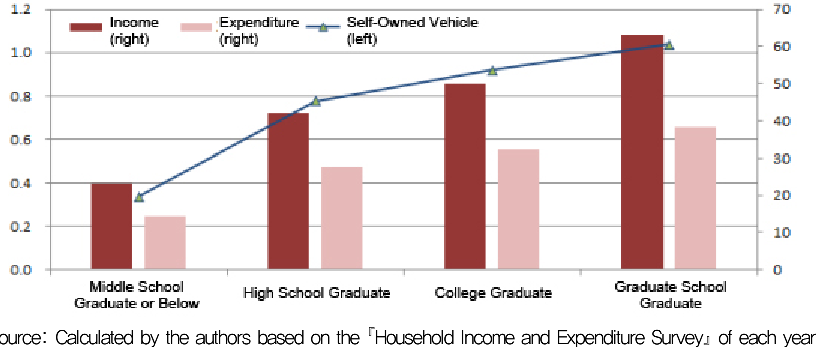


Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

By householder's education, it seems more apt to say that a variation in the tax burden ratio is due to income, rather than education level in and of itself. As the level of education goes up, the ratio of tax burden on transportation fuels is progressive at first and, then, gradually becomes proportionate. In contrast, the ratio of tax burden on household fuels is regressive in terms of education level. Still, it is difficult to conclude that the fact that the tax burden on household fuels is higher for households headed by those who finished high school than for households headed by those who finished college is simply due to the nature of necessities, the income elasticity of which is lower than 1. This is because our analysis shows that the amount of tax paid for oil consumption is higher in households headed by householders who are high school graduates. That is, the amount of fuel consumption itself is larger among households headed by high school graduate householders. The difference does not result from the number of dependents since the number of household members headed by high school graduates is not larger, compared to households headed by college graduates (2.9 and 3.0, respectively). Rather, it is highly likely that it is due to a high level of fuel consumption among the elderly, considering that high school graduate householders are older than college graduate householders (51.0 and 44.3 years old, respectively), which is consistent with the results of our analysis of tax burden based on age.

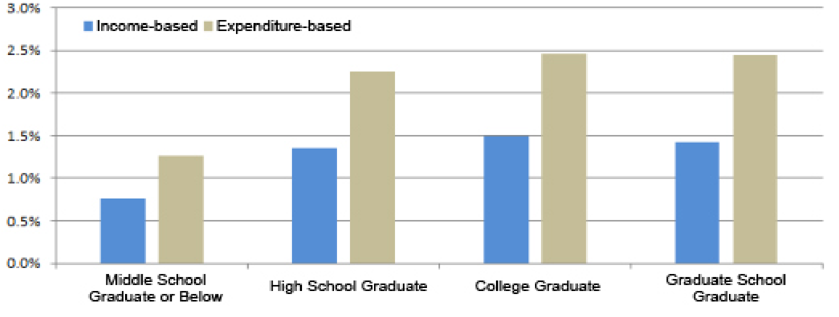
[Figure III-13] Income Distribution and Number of Self-Owned Vehicles by Householder's Education Level (as of 2015)

(Unit: vehicles (left), million won (right))



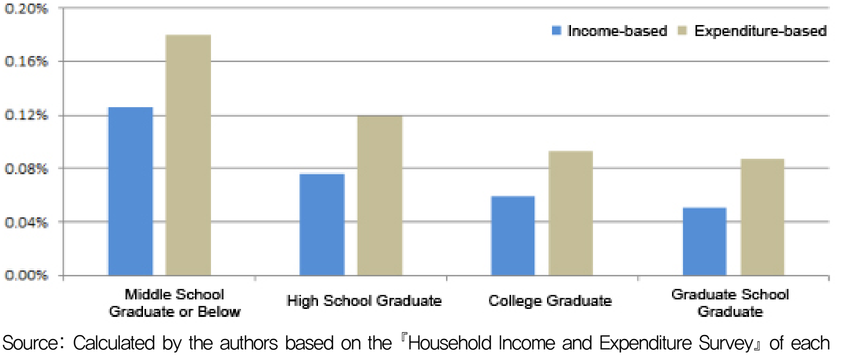
Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

[Figure III-14] **Ratio of Tax Burden on Transportation Fuel by Householder's Education Level (as of 2015)**



Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

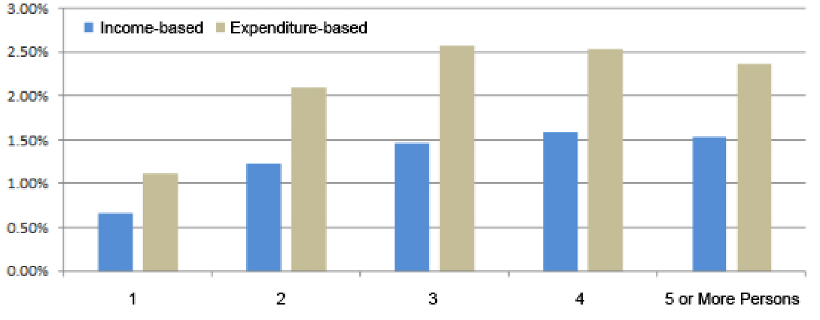
[Figure III-15] **Ration of Tax Burden on Household Fuel by Householder's Education Level (as of 2015)**



Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

The number of household members, income level, and the number of self-owned vehicles tend to be proportional to one another. It is natural to expect that the frequency of using self-owned cars would increase as the number of household members increases. However, our analysis shows that the ratio of tax burden on transportation fuels becomes lower, albeit on a small scale, as the number of household members increases to three or more. This is possibly because the extent of an increase in income is higher than in the frequency of using self-owned vehicles.

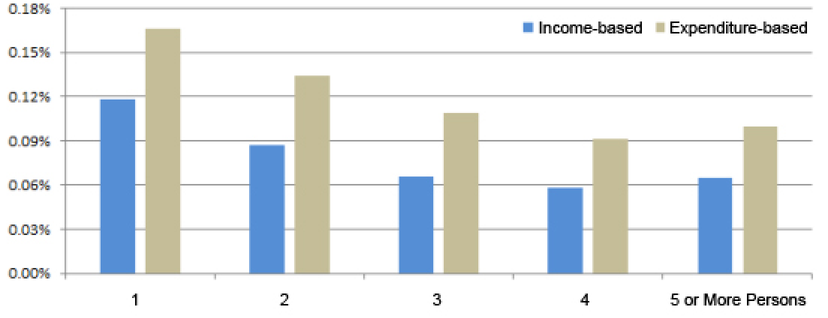
[Figure Ⅲ-16] **Ratio of Tax Burden on Transportation Fuel by Total Number of Household Members (as of 2015)**



Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

With regard to household fuels, the regressivity of the tax burden ratio becomes eased as the number of household members increases. In the case of households with 5 or more members, the burden even increases. This should be because the extent of an increase in income is exceeded by the extent of an increase in the consumption of the energy source resulting from an increase in the number of household members. Characteristics by the number of the employed in a given household also turn out to be more or less the same as characteristics by the total number of household members.

[Figure Ⅲ-17] **Ratio of Tax Burden on Household Fuel by Total Number of Household Members (as of 2015)**

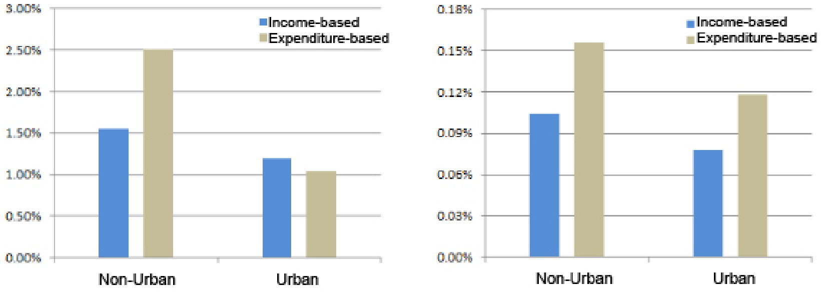


Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

Finally, let us examine the difference in the tax burden ratio according to whether or not the residential area of a given household is located in a city. In the case of transportation fuels, the tax burden ratio is higher in non-urban areas than in urban areas. While non-urban households show a lower level income than urban households (non-urban: 37.78 million won, urban: 41.46 million won), the tax burden is larger for the former group (non-city: 618 thousand won, city: 522 thousand won). In other words, non-urban households use self-owned vehicles more than their urban counterparts do. This seems to be mainly because it is relatively easy to substitute self-owned vehicles with public transportation in urban areas, in which the infrastructure is well developed.

The ratio of tax burden on household fuels is also higher for non-urban households than for urban households. Again, the consumption elasticity—which is lower than 1 in the case of household fuels—alone cannot explain this. It is because non-urban households consume household fuels more than urban households do. Our analysis also finds that householders are older in non-urban areas than in urban areas (non-urban: 54.8 years old, urban: 52.2 years old), which may be one of the factor that explain the relatively high level of household fuel consumption among non-urban households.

[Figure III-18] **Ratio of Tax Burden on Transportation (left) and Household Fuels (right) by Residential Area (as of 2015)**



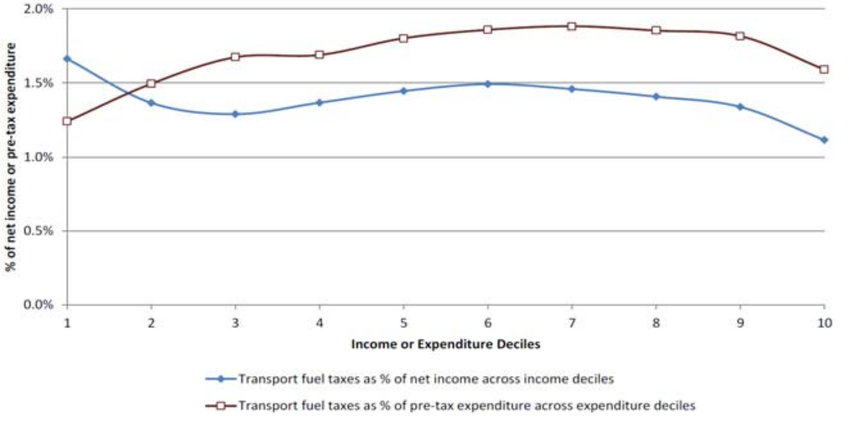
Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

C. Comparison with Analysis Results on 21 OECD Countries

In this subsection, we make a comparison between the ratio of energy tax burden in 21 OECD member countries estimated by Flues and Thomas (2015) and our estimates of the energy tax burden ratio by stratum in Korea. As explained in Section 1 above, Flues and Thomas (2015) calculate the ratio of tax burden by including individual consumption tax and value-added tax (VAT) as well. To present an international comparison in this subsection, we also include VAT to calculate the tax burden ratio in Korea. Meanwhile, Flues and Thomas (2015) limit the scope of transportation fuels to gasoline and diesel. However, our analysis covers LPG butane as well. With this difference in mind, we will exclude LPG in this subsection and limit the scope of transportation fuels to gasoline and diesel only, as per Flues and Thomas (2015).

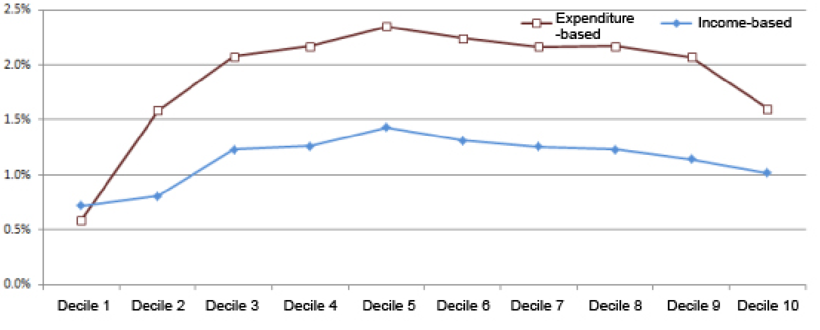
Let us begin with the taxation on transportation fuels. Based on the expenditure, the average ratio of tax burden in 21 OECD countries shows a progressive tendency, except in the higher deciles (see [Figure III-19]). Based on the income, however, the tendency is more close to—albeit slightly—regressivity. In Korea, the ratio of tax burden shows a more progressive character in the lower deciles, compared to the average tax burden ratio in the OECD 21 countries (see [Figure III-20]). This tendency is more evident especially when we base the comparison on the expenditure.

[Figure III-19] **Average Ratio of Tax Burden on Transportation Fuel by Decile in 21 OECD Countries**



Source: Flues and Thomas (2015), p. 19, Figure 2

[Figure III-20] **Ratio of Tax Burden on Transportation Fuel by Decile in Korea (as of 2015)**



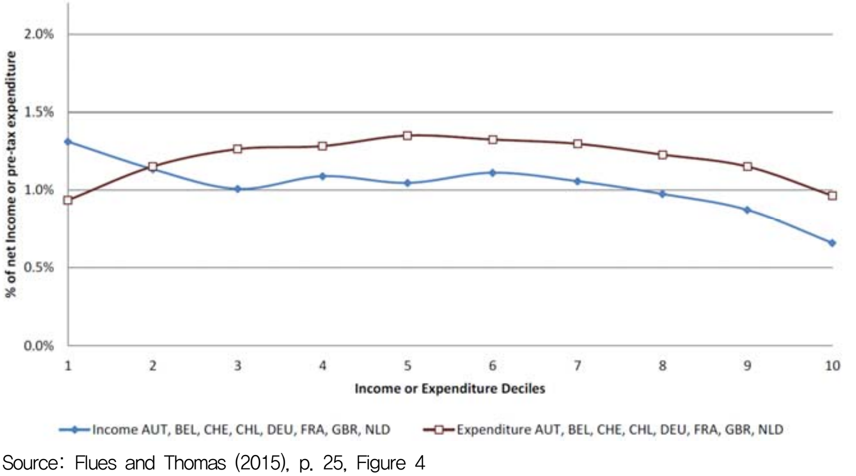
Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

To look at each of the 21 OECD countries, we can observe all of the three types of taxation: the regressive type (when the tax burden ratio curve is downward sloping); the progressive type (when the curve is upward sloping);

and the proportional type (when the curve is nearly horizontal). Overall, taxation is more equitable in terms of expenditure decile than in terms of income decile. Based on the expenditure, taxation is regressive in Switzerland, Italy and Luxembourg; Chile, Estonia, Hungary and Turkey show a progressive character. Korea, Belgium, Germany and the United Kingdom are characterized by a pattern that is similar to a reversed U shape. When it comes to the income, we can observe an increase in the number of countries with a relatively regressive tax system. However, Chile, Slovakia and Turkey remain progressive even in terms of income decile.

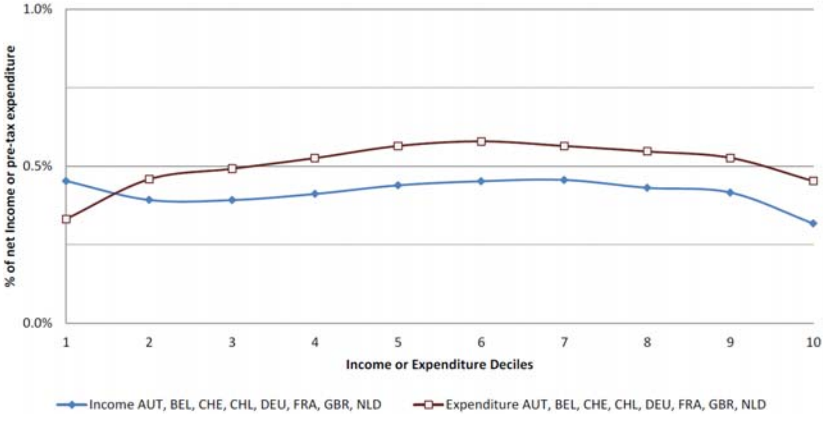
Flues and Thomas (2015) examine in more detail the cases of eight countries—in which separate data is available on gasoline and diesel—by dividing transportation fuels into gasoline and diesel (see Figure III-21 through [Figure III-22]). On average, the analysis reveals a regressive—although weak—tendency in the lower deciles in both gasoline and diesel in terms of income decile. However, a gentle, reversed U-shaped curve is observed in terms of expenditure decile.

[Figure III-21] Average Ratio of Tax Burden on Gasoline for Transportation by Decile in 8 OECD Countries



Source: Flues and Thomas (2015), p. 25, Figure 4

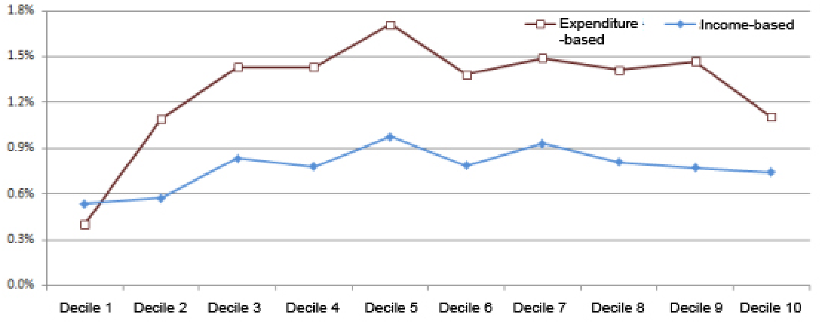
[Figure III-22] **Average Ratio of Tax Burden on Diesel for Transportation by Decile in 8 OECD Countries**



Source: Flues and Thomas (2015), p. 25, Figure 5

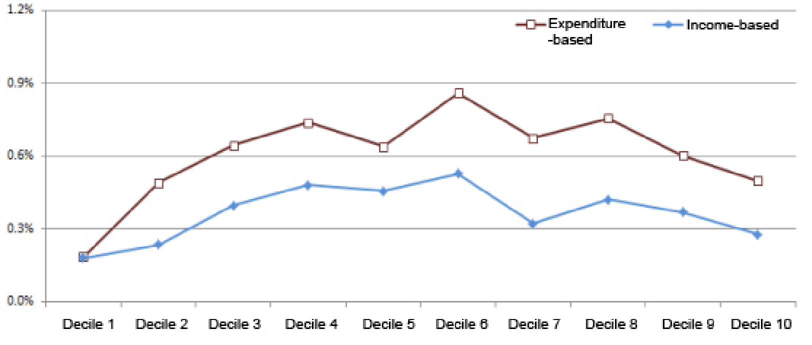
In the case of Korea, we can observe a progressive tendency in the low- to middle-decile section based on the income. Also, the degree of progressivity is much higher in terms of expenditure decile, compared to the average of the eight OECD countries (see [Figure III-23] and [Figure III-24]).

[Figure III-23] **Ratio of Tax Burden on Gasoline for Transportation by Decile in Korea (as of 2015)**



Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

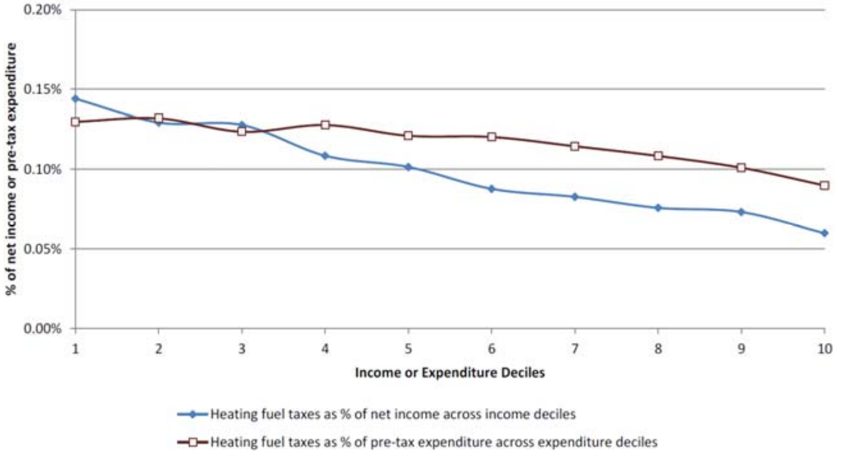
[Figure III-24] **Ratio of Tax Burden on Diesel for Transportation by Decile in Korea (as of 2015)**



Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

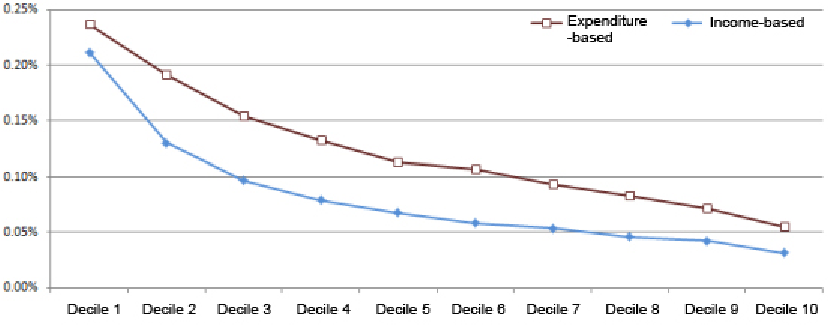
While the taxation on transportation fuels is progressive to some degree, a regressive tendency is evident for heating fuels in both Korea and the 21 OECD countries (see [Figure III-25] and [Figure III-26]). The tax burden ratio of the 21 countries is already regressive on average. Yet, the curve slopes downward in most of the countries even when we look into each of them. Chile and Poland impose only slight tax rates on heating fuels, so a regressive tendency is not observed in the countries. Meanwhile, Turkey is exceptional in that its tax burden ratio shows a progressive character. In the case of Italy, Slovenia, etc., we observe a gentle, reversed U-shape curve in terms of expenditure. Yet, the tax burden is between 0.03% and 0.25% of the total income in Korea as well as on average in the 21 OECD countries. In this respect, the distributional effect seems limited.

[Figure III-25] Average Ratio of Tax Burden on Heating Fuel by Decile in 21 OECD Countries



Source: Flues and Thomas (2015), p. 26, Figure 6

[Figure III-26] Ratio of Tax Burden on Household Fuel by Decile in Korea (as of 2015)



Source: Calculated by the authors based on the 『Household Income and Expenditure Survey』 of each year

IV

Scenario Analysis of Energy Tax Reform's Distributional Effect

In this chapter, we present several scenarios for energy tax reform that can be considered in the process of reorganizing the tax system in the future, and examine each scenario to predict and analyze the ripple effects on distribution in quantitative terms. By looking at each of the detailed directions that a possible tax reform can take, we analyze how the effects of tax burden will vary according to diverse consumer characteristics, such as income level, based on an economic model. In building a possible scenario for each energy source, we consider a set of environmental cost factors—including carbon emissions and air pollution that are recently emerging as social issues—and discuss distributional effects from various viewpoints. By doing so, we aim to provide policymakers with implications about different distributional effects to be brought about by each of the possible scenarios for energy tax reform in Korea.

Specifically, we take into account several possibilities of tax rate adjustment in relation to the detailed structure of the current energy taxation—e.g. gasoline, kerosene, light oil, heavy oil, propane, butane, bituminous coal, electricity, etc.—to analyze the economic ripple effects on distribution. To this end, we conduct a quantitative simulation of each scenario concerning the tax burden effects and distributional effects and draw policy implications by classifying Korea's energy sector in as much detail as possible to reflect the current structure of tax rates and by linking data from the Bank of Korea's 2013 Input-Output Tables with raw data from the Household Income and Expenditure Survey published by the Statistics Korea in 2015.

1 Scenario Building

In this section, we examine the distributional effects of possible scenarios for energy tax reform. To do so, we have selected a set of aspects that have recently arisen as social issues and reflect various external costs incurred by energy use—e.g. air pollution including carbon emissions and fine dust, nuclear-related safety issues and accidents and social conflicts concerning the transmission and distribution of electric power—among a wide range of improvement factors related to each energy source discussed in previous studies on energy taxation reform in Korea.

Let us begin with taxation on carbon emissions that has been proposed as a way to reduce greenhouse gas emissions and emerging as a social issue both at home and abroad since the launch of the Post-2020 climate change mitigation commitments (Paris Agreement, December 2015). It is expected that the need for reshuffling energy taxation will increase to reduce carbon emissions for each energy source in the domestic energy sector in compliance with the new climate commitments. Next, raising tax rates is another area to be considered so as to reduce the costs incurred by air pollution—e.g. fine dust that has arisen as a serious social issue since 2016—by reflecting social cost resulting from of the use of diesel for transportation purposes or of bituminous coal for power generation. In the case of bituminous coal for power generation, it is still considered an inexpensive energy source despite environmental damage like fine dust. This is because the overall costs of such environmental damage remain not properly reflected in the current price of bituminous coal. The social cost of bituminous coal is higher in terms of the scale of air pollution and greenhouse gas emissions, compared to other fossil fuels. Also possible is to introduce individual consumption tax on electricity in the form of an environmental tax. The share of electricity consumption is expanding in terms of energy demand in Korea’s overall economy. Nevertheless, it is necessary to reform electricity taxation to improve tax equity in comparison with other energy taxes, such as the tax on petroleum, given that the sales price of electricity has been set below the production cost.

As discussed above, our analysis reflects major social issues of recent years. As such, we present the following four hypothetical scenarios for Korea’s energy tax reform in <Table IV-1> below.

〈Table IV-1〉 **Major Issues of Energy Tax Reform**

Scenario		Detail
A	Introduction of carbon tax rate for greenhouse gas mitigation	Among greenhouse gases that cause global warming via various energy sources, reduce CO_2 emissions. To that end, taxes are imposed in proportion to the carbon content of a given energy product
B	Increase of diesel tax rate for the reduction of fine dust	Raise the tax rate on diesel in order to alleviate air pollution, including fine dust, in the transportation sector
C	Increase of bituminous coal tax rate for the reduction of fine dust	Raise the tax rate on bituminous coal so as to alleviate air pollution, including fine dust, in the power generation sector
D	Introduction of individual consumption tax that reflects various social costs in the power generation sector	Impose the electricity tax at the final consumption stage in accordance with various external costs incurred in the power generation sector—such as environmental damage, nuclear-related safety issues and accidents and social conflicts related to the transmission and distribution of electric power—and, thereby, promote tax equity in that the new tax allows fair competition with other fuels, such as petroleum, used for heating, industrial and trans-portation purposes.

Scenario A is concerned with the introduction of a carbon tax to mitigate greenhouse gas. Scenarios B and C are ones in which tax rates on diesel for transportation and bituminous coal for power generation are raised first to reduce air pollution, such as fine dust. Lastly, Scenario D refers to the introduction of the individual consumption tax on electricity with due consideration of various social costs incurred by the power generation sector. As such, our analysis prioritizes taxation on CO_2 emissions, diesel, bituminous coal and electricity, among various realistic scenarios for energy tax reform.

Theoretically, an accurate estimation of the cost social damage caused by each energy source should be carried out before establishing an appropriate level of taxation that reflects the social cost of on a given energy source.

However, no precise estimates have made about the electric power industry or social costs incurred by each energy source in international and academic aspects. In this respect, we build our hypothetical scenarios for energy tax reform by drawing on appropriate assumptions about the amount of social costs caused by each energy source from previous studies, which is presented in <Table IV-2>. Based on these scenarios, we conduct a simulation analysis of the effects of energy tax reform on distribution for illustration.

For the hypothetical simulation analysis of the effect of energy tax reform on distribution in Korea, we assume the carbon tax rate of Scenario A as 3,183 won per ton of CO_2 by energy source, which is based on Kim (2010) or on the 「Carbon Tax Act」 that was proposed in the National Assembly (Office of Assemblyperson Sim Sang-jeung, 2013). As for Scenario B, there is no accurate estimate made regarding taxation on diesel for transportation, so we assume the tax rate, for illustration, to be set at an additional tax rate of 67.7 won, which is one tenth of the differential (677 won) between the cost of air pollution per liter of diesel (1,470 won) and the current tax rate (528 won), based on the data from Kang (2015). In the case of Scenario C, the tax rate on bituminous coal is assumed, for illustration, as 21.9 won, which is the differential between the current tax rate (24 won) and one tenth of the estimated cost of air pollution per kg of bituminous coal (45.9 won), based on the data from Kang (2015). For Scenario D, we assume, for illustration, the tax rate on electricity to be 2.4 won, which is one tenth of the estimated social cost per kWh (24 won) that includes the risk cost of nuclear power generation per kWh (7 won) and the social cost resulting from social conflicts, etc. (14 won), based on the data from Kang (2015).

〈Table IV-2〉 **Assumed Value of Tax Rate in Energy Tax Reform Scenario**

Tax Item		Transportation			Non-Transportation					
		Gasoline (won/ℓ)	Diesel (won/ℓ)	Butane (won/ℓ)	Kerosene (won/ℓ)	Heavy oil (won/ℓ)	Propane (won/kg)	LNG (won/kg)	Bituminous Coal (won/kg)	Electricity (won/kWh)
Current Tax Rate		745	528	185	104	20	20	60	24	Tax-Exempt
Additional Tax Rate	Scenario A	6.7	8.2	5.3	7.8	9.5	9.2	8.8	3.3	1.4
	Scenario B	0	67.7	0	0	0	0	0	0	0
	Scenario C	0	0	0	0	0	0	0	21.9	0
	Scenario D	0	0	0	0	0	0	0	0	2.4

To conduct a comparative analysis of the energy tax reform scenarios based on equal-yield standard, we set up Scenario A′, B′, C′ and D′ as presented in <Table IV-3> by adjusting the structure of tax rate of each scenario presented in <Table IV-2> to yield the same amount of 1 trillion won as tax revenue.

〈Table IV-3〉 **Equal Yield –Adjusted Assumed Value of Tax Rate in Energy Tax Reform Scenario**

Tax Item		Transportation			Non-Transportation					
		Gasoline (won/ℓ)	Diesel (won/ℓ)	Butane (won/ℓ)	Kerosene (won/ℓ)	Heavy oil (won/ℓ)	Propane (won/kg)	LNG (won/kg)	Bituminous Coal (won/kg)	Electricity (won/kWh)
Additional Tax Rate	Scenario A′	4.1	4.7	5.0	5.7	5.6	5.5	5.3	2.0	0.8
	Scenario B′	0.0	43.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Scenario C′	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.8	0.0
	Scenario D′	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1

2 Analysis of Distributional Effect by Scenario

In this section, we make an estimation of the ripples effects on tax revenue, prices, changes in tax burden level and various types of income distribution, and examine advantages and disadvantages in quantitative terms with regard to each of the four possible scenarios for energy tax reform introduced earlier in this chapter. To this end, we conduct an simulation analysis by employing the input-output analysis method used in Fullerton (1995), Wier et al. (2005), Hassett et al. (2007), Kim (2009), etc., based on the combined microdata from the Bank of Korea's latest 2013 Input-Output Tables (384 basic sectors) and from the Statistics Korea's 2015 Household Income and Expenditure Survey. Meanwhile, the current structure of energy tax rate has a very detailed classification system concerning energy-related products. For this reason, it is too complicated to categorize by industry and income level, which leads to a lack of reliable parameter estimates with regard to the elasticity of demand or substitution of a given item. In this respect, we conduct our simulation analysis by combining microdata from the Input-Output Tables and with microdata from the Household Income and Expenditure Survey, as in the input-output analysis method employed by Fullerton (1995), Metcalf (1999), Wier et al. (2005), Hassett et al. (2007), Kim (2009), etc., instead of using the computable general equilibrium (CGE) model.

A. Distributional Effect by Household Characteristics

Not only are the effects of various possible energy tax reforms—with the mitigation of carbon emissions and fine dust and increased social costs of fuels used for power generation taken into account—directly concerned with energy prices. The effects also ripple through the entire economy by indirectly changing the prices of all intermediate goods that use a given energy source. [Figure IV-1] and [Figure IV-2] show the results of our simulation analysis of each scenario regarding the ripple effects on changes in price competitiveness for each sector of the Korean economy.

First, the effects on price competitiveness in each of the original scenarios A, B, C and D, which reflects factors related to energy tax reform on each energy source are presented in [Figure IV-1]. According to the results of the analysis, raising tax rates on CO_2, diesel, bituminous coal and electricity causes an increase in energy prices. Also, it leads to additional burdens due to a rise in the prices of all intermediate and final goods produced with the energy sources. Meanwhile, the demand structure of each energy source varies by sector in each of the four scenarios concerning taxation on CO_2, diesel, bituminous coal and electricity taxation, respectively. Thus, the overall effect on price competitiveness varies as well for each sector that uses intermediate goods produced with a given energy source.

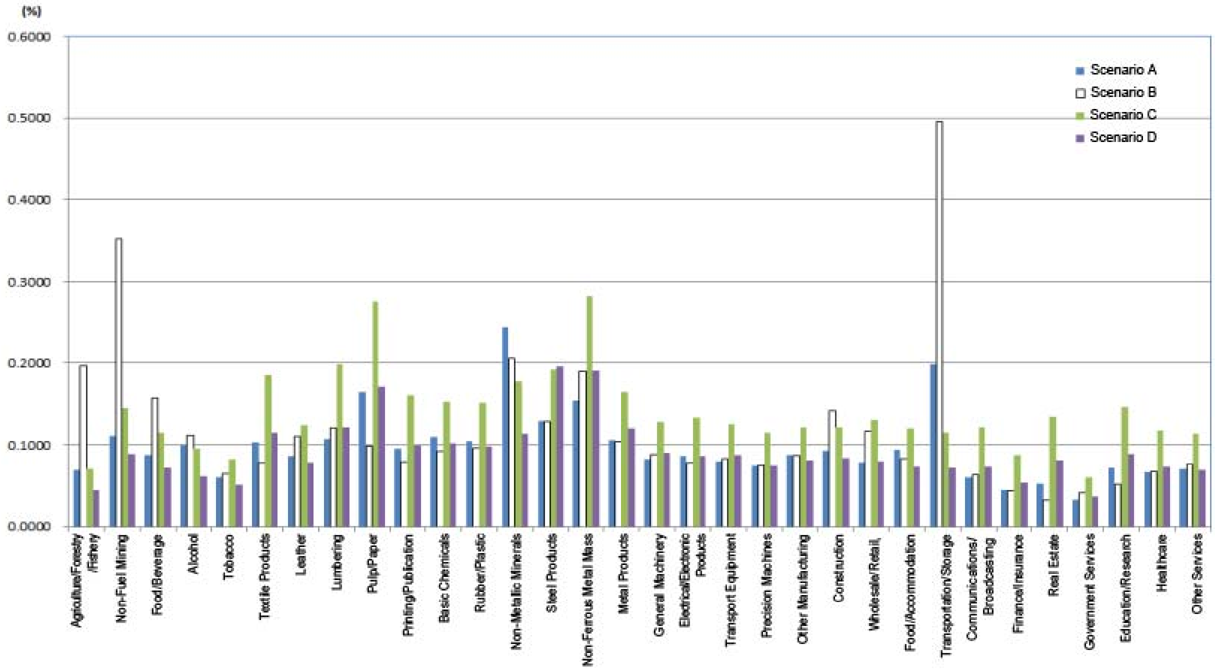
In Scenario A, CO_2 taxation, which concerns all energy sources, increases the prices of energy products by around 0.0355 to 1.2859%, which, in turn, can lower the price competitiveness of each sector in other non-energy industries by about 0.0323 to 0.2477%. Especially, pulp/paper, non-metallic minerals, steel products, non-ferrous metal mass and transportation/storage are likely to experience a significant deterioration of competitiveness in production cost, compared to other sectors. In Scenario B, taxation on diesel brings about an increase in the price of diesel by about 5.0729%, thereby undermining the price competitiveness of each sector in other non-energy industries by around 0.0317 to 0.4963%. In particular, non-fuel mining, non-metallic minerals, non-ferrous metal mass and transportation/storage are expected to be more affected than other sectors. In the case of Scenario C, taxation on bituminous coal is expected to increase the price of thermal power generation by around 4.9978%, which can lower the price competitiveness of each sector in other non-energy industries by about 0.0604 to 0.2827%. Among others, it is expected that the cost competitiveness of pulp/paper, non-metallic minerals, non-ferrous metal mass and transportation/storage will face a considerably larger reduction in the competitiveness of production cost than other sectors. Lastly, in the case of Scenario D, electricity taxation increases the price by about 2.4501 to 2.5268%, reducing the price competitiveness of each sector in other non-energy industries by about 0.0369 to 0.1956%. Especially, steel products and non-ferrous metal mass are likely to be experience a more considerable deterioration of competitiveness in product cost, compared to other sectors.

Now let us turn to a horizontal comparative analysis, which is based on the equal-yield standard, regarding the ripple effects on the price competitiveness of each sector in each scenario for energy tax reform. To carry out this analysis, we have come up with the standardized scenarios A', B', C' and D' by making adjustments to the original scenarios to yield the same amount of 1 trillion won as tax revenue. The results of the analysis are shown in [Figure IV-2].

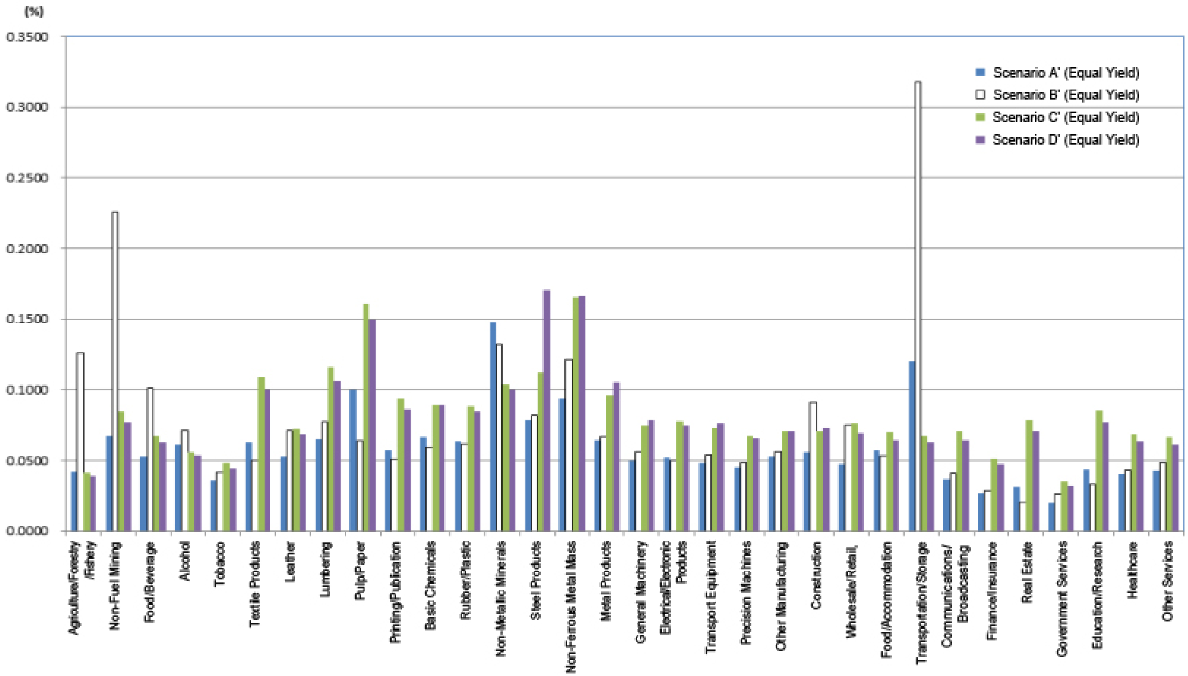
In Scenario A', CO_2 taxation increases the prices of energy products by around 0.0215 to 0.7773%, which is expected to reduce the price competitiveness of each sector in other non-energy industries by about 0.0195 to 0.1479%. In Scenario B', taxation on diesel leads to a rise in the price by around 3.2539%, lowering the price competitiveness of each sector in other non-energy industries by 0.0203 to 0.3184%. In Scenario C', taxation on bituminous coal causes an increase in the price of thermal power generation by around 2.9173%, thereby undermining the price competitiveness of each sector in other non-energy industries by approximately 0.0353 to 0.1650. Finally, in Scenario D', electricity taxation raises the price of electric power generation by about 2.1374 to 2.2044%, lowering the price competitiveness of each sector in other non-energy industries by around 0.0322 to 0.1706%.

As for related intermediate and final goods produced with the energy sources, changes in price competitiveness vary depending on the scenarios for energy tax reform—i.e. taxation on CO_2, diesel, bituminous coal and electricity. Thus, the extent of additional tax burdens varies as well by the level of household income, as shown in [Figure IV-3] and [Figure IV-4]. Here, a change in the tax burden on households—which results from each of the four energy tax reform scenarios—represents a change in the total amount of tax burden due to the ripple effects on the overall economy. This includes changes in the amount of direct expenditure on energy products and changes in the amount of indirect expenditure as a consequence of price changes in non-energy products. We calculate the value for each income decile by using data from the year 2015.

[Figure Ⅳ-1] Ripple Effects on Price Competitiveness by Scenario



[Figure IV-2] Ripple Effects on Price Competitiveness by Equal Yield-Adjusted Scenario



[Figure IV-3] presents the incidence of tax burden by income level in each of the original tax reform scenarios A, B, C and D, which reflect taxation on CO_2, diesel, bituminous coal and electricity, respectively.

According to the results of the analysis, introducing taxation on CO_2, as hypothesized in Scenario A based on the 2015 data, is expected to increase the total tax burden by 12,000 won for income decile 1; by 32,000 won for income decile 2; by 62,000 won for income decile 10; and by an average of 35,000 won for all households. Now, let us take a closer look by examining changes in direct expenditure on energy products and indirect expenditure resulting from price changes in other non-energy products by income level. The details are as follows. As for CO_2 taxation, direct expenditure on energy products increases the tax burden by 6,700 won for income decile 1; by 16,000 won for income decile 5; by 27,000 won for income decile 10; and by 17,000 won for all households on average. In the case of indirect expenditure due to price changes in non-energy goods, the tax burden increases by 5,900 won for income decile 1; 16,000 won for income decile 5; by 35,000 won for income decile 10; and, on average, by 18,000 won for all households. In terms of the share of the tax burden in income, the figure stands at 0.2370% for income decile 1; 0.0982% for income decile 5; the 10th income decile is at 0.0591% for income decile 10; and an average of 0.0844% for all households. As discussed in previous studies, the results of our analysis indicate that taxes imposed on expenditure on energy sources as necessity goods is regressive in relation to income. In terms of the share of the tax burden in total consumption expenditure, CO_2 taxation will be proportional in general. The results are: 0.1556% for income decile 1; 0.1434% for income decile 5, 0.1247% for income decile 10; and, on average, 0.1365% for all households.

In Scenario B, diesel taxation is expected to increase the total tax burden, based on the 2015 annual data, by 13,000 won for income decile 1; by 42,000 won for income decile 5; by 86,000 won for income decile 10; and by 45,000 won for all households on average. In terms of the share of the tax burden in income, the result is 0.2470% for income decile 1; 0.1265% for income decile 5; 0.0816% for income decile 10; and an average of 0.1094% for all households. In terms of the share of the tax burden in total consumption expenditure, diesel taxation turns out to be nearly proportional: 0.1622% for income decile 1, 0.1846% for income decile 5; 0.1722% for income decile 10; and 0.1770% for all households on average.

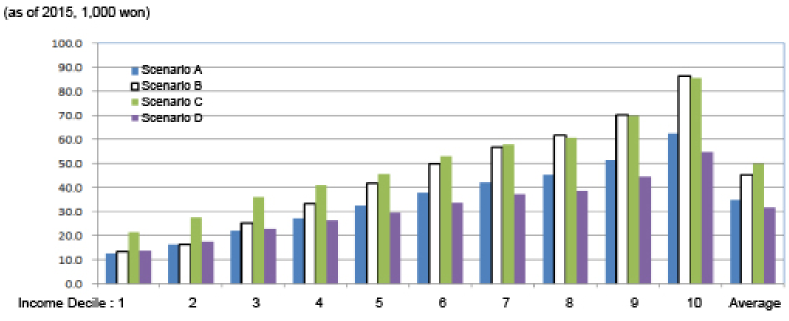
As for Scenario C, taxation on bituminous coal leads to an increase in the total tax burden by 21,000 won for income decile 1; by 46,000 won for income decile 5; by 85,000 won for income decile 10; and by an average of 49,000 won for all households, based on the 2015 annual data. In terms of the share of the tax burden in income, the figure stands at 0.4022% for income decile 1; at 0.1387% for income decile 5; at 0.0810% for income decile 10; and, on average, at 0.1201% for all households. In terms of the tax burden in total consumption expenditure, the overall result is slightly regressive: 0.2641% for income decile 1; 0.2024% for income decile 5; 0.1710% for income decile 10; and 0.1943%. for all households on average.

Lastly in Scenario D based on the 2015 data, taxation on electricity is expected to result in a rise in the total tax burden by 14,000 won for income decile 1; by 29,000 won for income decile 5; by 55,000 won for income decile 10; and by an average of 32,000 won for all households. In terms of the share of the tax burden in income, the results are 0.2564% for income decile 1; 0.0886% for income decile 5; 0.0519%% for income decile 10; by, and, on average, 0.0768% for all households. In terms of the share of the tax burden in total consumption expenditure, we find that electricity taxation is slightly regressive: 0.1683% for income decile 1; 0.1294% for income decile 5; 0.1096% for income decile 10; and an average of 0.1243% for all households.

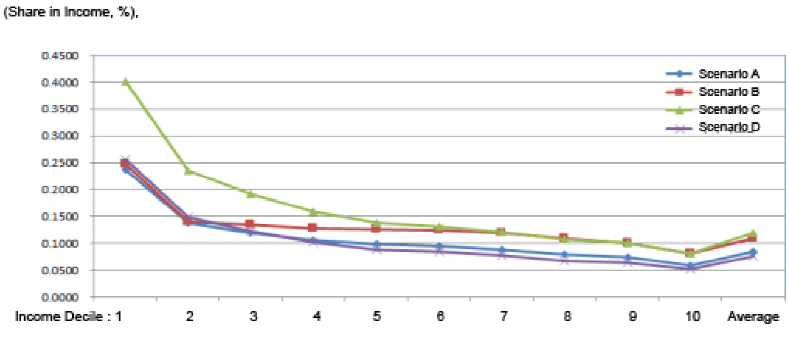
Now let us present our horizontal comparative analysis based on the standardized scenarios A', B', C' and D' for energy tax reform, which have been designed to yield the same amount of 1 trillion won as tax revenue. [Figure IV-4] shows each scenario's incidence of tax burden by household income decile.

In terms of household income decile, the increase of tax burden by 1 trillion won—which reflects factors related to energy tax reform including CO_2, diesel, bituminous coal and electricity—leads to an average tax burden of 21,000 won in Scenario A'; 29,000 won in Scenario B'; 29,000 won in Scenario C'; and 28,000 won in Scenario D'. This indicates that the average tax burden increases as the source of taxation gets narrower. To look at the results as per income decile, Scenario A' shows an increase in the tax burden of 7,600 won for income decile 1 and 37,000 won for income decile 10. As for Scenario B',

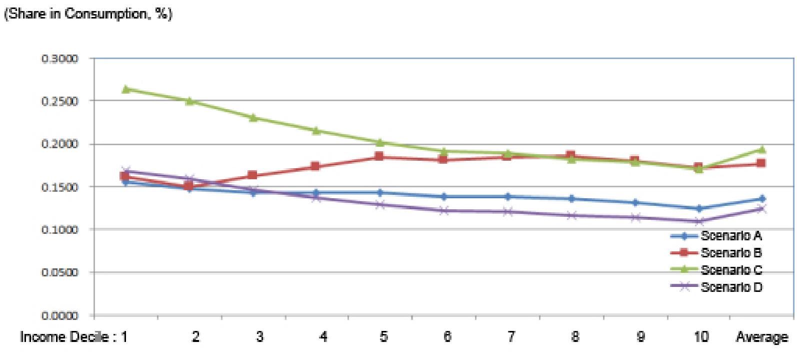
[Figure Ⅳ-3] Distributional effect by Scenario: by Income Decile



(a) Change in Tax Burden



(b) Share of Tax Burden Change in Income



(c) Share of Tax Burden Change in Consumption

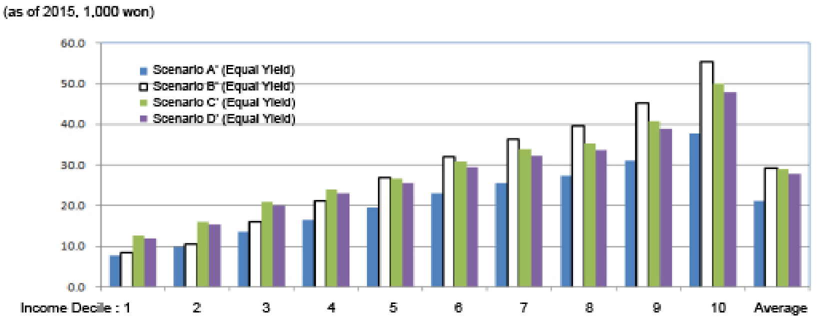
the figure stands at 8,400 won for income decile 1 and at 55,000 won for income decile 10. In Scenario C', income deciles 1 and 10 post 12,000 won and 50,000 won, respectively. Lastly, Scenario D' shows an increase of 12,000 won for income decile 1 and an increase of 48,000 won for income decile 10. Among the four scenarios, Scenario C' is the one in which the tax burden is concentrated the most in low-income households—rather than high-income households—which is followed by Scenarios D', B' and A' in order. The result suggests that financial support for the low-income households needs to be provided with regard to taxes on bituminous coal tax and electricity, compared to taxation on diesel or CO_2.

In addition to household characteristics by income decile, [Figures IV-5] and [Figure IV-6] list the incidence of tax burden in each of the four energy tax reform scenarios by household type, number of household members and residential area.

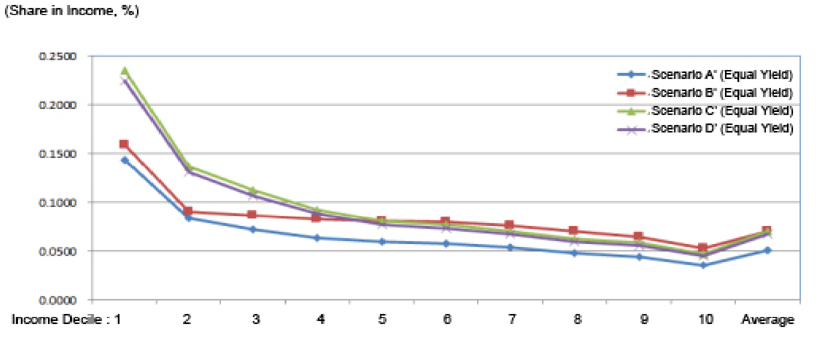
Let us begin with the incidence of tax by household type. Taxation on CO_2 in Scenario A leads to 38,000 won for wage-earner households and 31,000 won for self-employed households. In Scenario B, the burden of diesel taxation is 52,000 won for wage-earner households and 38,000 won for self-employed households. As for Scenario C, taxation on bituminous coal results in the tax burden of 53,000 won for wage-earner households and 46,000 won for self-employed households. Lastly, taxation on electricity in Scenario D, the figure stands at 34,000 won for wage-earner households and 29,000 won for self-employed households. Across all four scenarios, we find that the increase of tax burden is relatively larger for wage-earner households. In addition, similar results are observed in the standardized scenarios A', B', C' and D', which have been adjusted to yield the same tax revenue of 1 trillion won.

As for the number of household members, CO_2 taxation in Scenario A leads to the tax burden of 17,000 won for single-person households and that of 50,000 won for households with four persons or more. In Scenario B, the burden of diesel taxation is 19,000 won for single-person households and 67,000 won for households with four persons or more. As for Scenario C, taxation on bituminous coal results in the tax burden of 26,000 won for single-person households and 69,000 won for households with four persons or more. Lastly, taxation on electricity in Scenario D, the tax burden stands at 16,000 won for

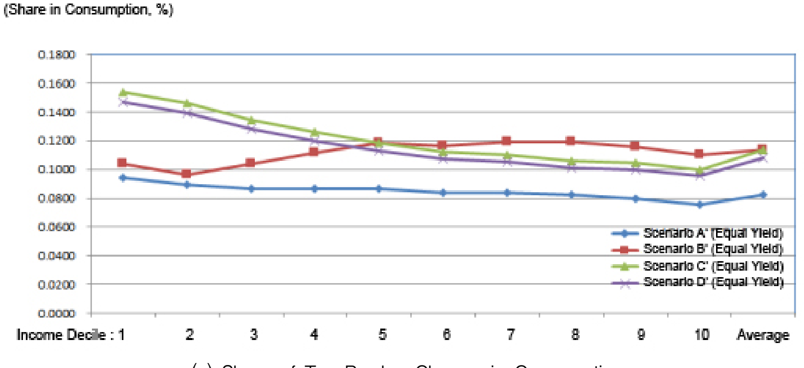
[Figure Ⅳ-4] Distributional effect by Equal Yield-Adjusted Scenario: by Income Decile



(a) Change in Tax Burden



(b) Share of Tax Burden Change in Income



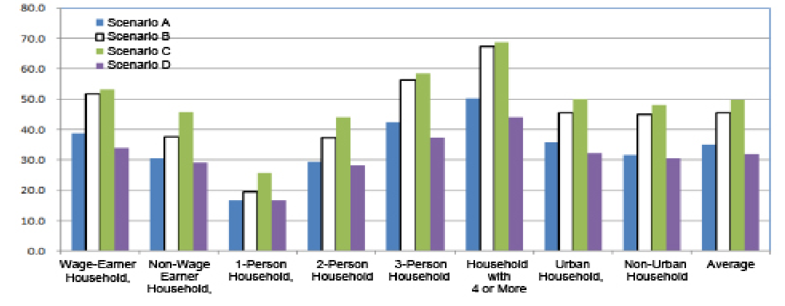
(c) Share of Tax Burden Change in Consumption

single-person households and 44,000 won for households with four persons or more. Across all four scenarios, the results indicate that the tax burden increases as the number of household members goes up. To compare the four standardized scenarios—which have been adjusted to yield the same tax revenue of 1 trillion won—, as for one- or two-person households, the increase of tax burden is the largest in Scenario C' on bituminous coal taxation and the smallest in Scenario A' concerning CO_2 taxation. In the case of households with three or more members, the increase of the tax burden is the largest in relation to diesel taxation in Scenario B' and the smallest in relation to CO_2 taxation in Scenario A'.

By residential area, CO_2 taxation in Scenario A results in an increase of 36,000 won for urban households and 31,000 won for non-urban households. In Scenario B on diesel taxation, the tax burden increases by 45,000 won for urban households and by 44,000 won for non-urban households. In Scenario C regarding taxation on bituminous coal, the figure stands at 50,000 won for urban households and at 48,000 won for non-urban households. Lastly, in Scenario D, electricity taxation leads to the increase of 32,000 won for urban households and that of 31,000 won for non-urban households. Across all four scenarios, the increase of tax burden turns out to be relatively larger for urban households. Comparing the effects of the increase of tax burden between the four standardized scenarios that increase the tax burden by 1 trillion won, in urban households, the bituminous coal tax in Scenario C’ has the largest increase in tax burden, and the CO_2 tax in Scenario A is the smallest. In the case of non-urban households, the increase of tax burden in diesel of Scenario B’ is the largest and the least is in CO_2 of Scenario A'. To compare the four standardized scenarios—which have been adjusted to yield the same tax revenue of 1 trillion won—, as for urban households, the increase of tax burden is the largest in Scenario C' on bituminous coal taxation and the smallest in Scenario A' concerning CO_2 taxation. In the case of non-urban households, the increase of the tax burden is the largest in relation to diesel taxation in Scenario B' and the smallest in relation to CO_2 taxation in Scenario A'.

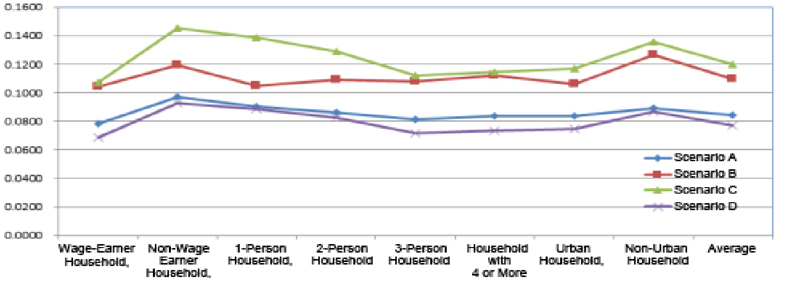
[Figure Ⅳ-5] **Distributional effect by Scenario: by Household Type, Number of Household Members and Residential Area**

(as of 2015, 1,000 won)



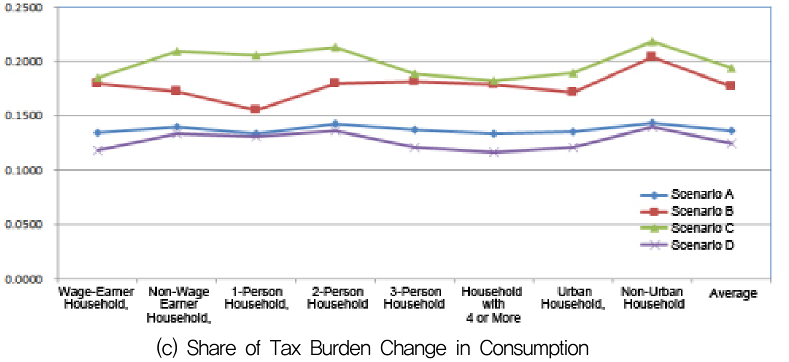
(a) Change in Tax Burden

(Share in Income, %)



(b) Share of Tax Burden Change in Income

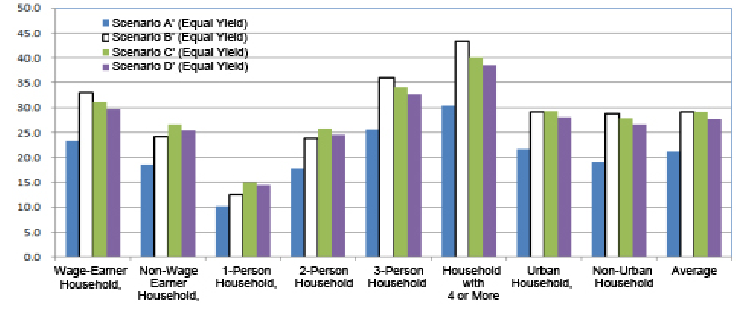
(Share in Consumption, %)



(c) Share of Tax Burden Change in Consumption

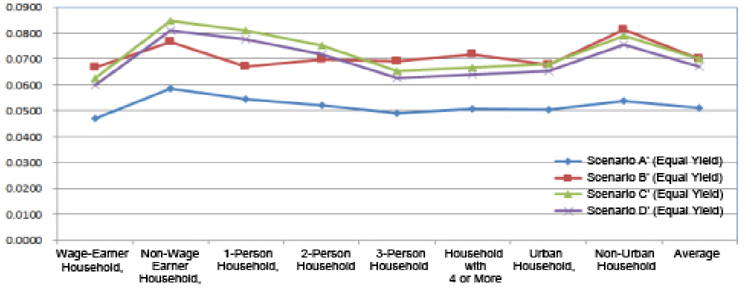
[Figure IV-6] Distributional effect by Equal Yield-Adjusted Scenario: by Household Type, Number of Household Members and Residential Area

(as of 2015, 1,000 won)



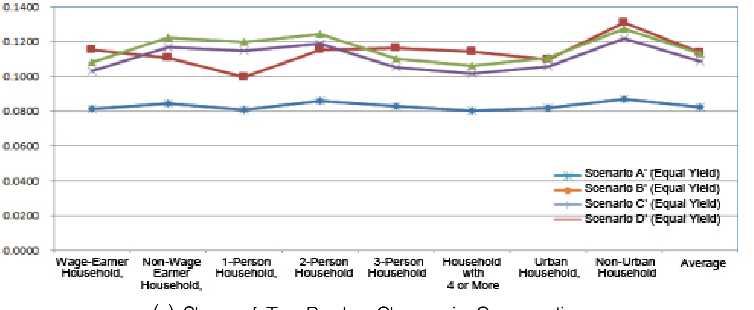
(a) Change in Tax Burden

(Share in Income, %)



(b) Share of Tax Burden Change in Income

(Share in Consumption, %)



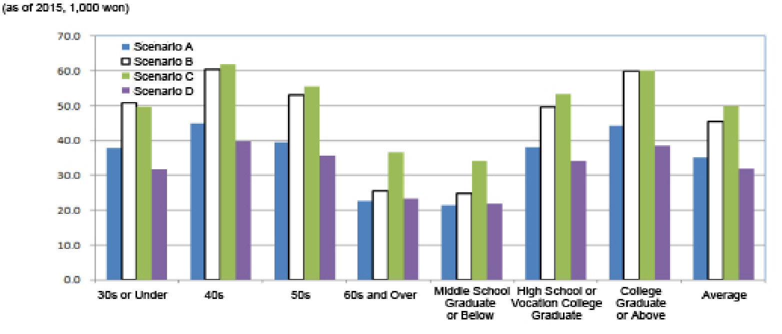
(c) Share of Tax Burden Change in Consumption

Finally, [Figure IV-7] and [Figure IV-8] show the incidence of tax burden in each of the four energy tax scenarios by householder's age and education level as follows.

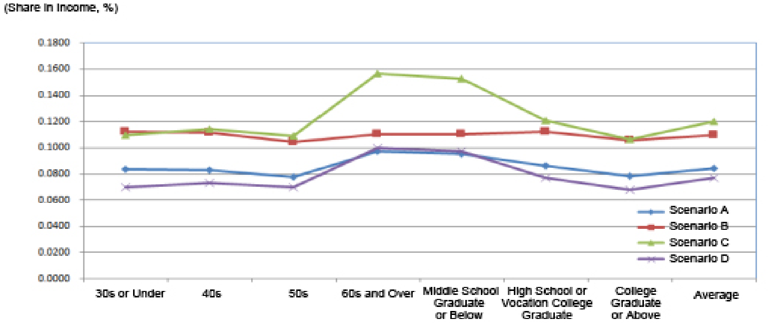
By householder's age, CO_2 taxation in Scenario shows that the tax burden increases from 38,000 won for households headed by those in 30s or under to 45,000 won for households headed by those who are in their 40s. Then, the figure falls to 39,000 won for 50s and to 22,000 won for 60s and over. In Scenario B concerning taxation on diesel, the tax burden rises from 51,000 won for households headed by those in their 30s or under to 61,000 won for households headed by 40s. Then, the burden decreases to 53,000 won for households headed by 50s and to 26,000 won for 60s and over. In Scenario C on bituminous coal taxation, the burden goes up from 49,000 won for 30s or under to 62,000 won for 40s, and then declines to 55,000 won for 50s and to 36,000 won for 60s and over, respectively. In Scenario D in relation to electricity taxation, the tax burden rises from 32,000 won for 30s or under to 39,000 won for 40s. Then, the figure drops to 35,000 won for 50s and to 23,000 won for 60s and over. To compare the four standardized scenarios—which have been adjusted to yield the same tax revenue of 1 trillion won—, as for households headed by 30s or under, by 40s and by 50s, the increase of tax burden is the largest in Scenario B' on diesel taxation and the smallest in Scenario A' concerning CO_2 taxation. In the case of households headed by those who are in 60s and over, the increase is the largest in relation to taxation on bituminous coal in Scenario C' and the smallest in relation to CO_2 taxation in Scenario A'.

In terms of householder's education level, the incidence of tax burden is 21,000 won for middle school graduates or below; 38,000 won for high school or vocational college graduates; and 44,000 won for college graduates or over in Scenario A on CO_2 taxation. In Scenario B regarding diesel taxation, the figure posts 25,000 won for middle school graduates or below; 49,000 won for high school or vocational college graduates; and 59,000 won for college graduates or above. In Scenario C regarding taxation on bituminous coal, the result is 34,000 won for middle school graduates or below; 53,000 won for high school or vocational college graduates; and 60,000 won for college graduates or above. Lastly, in Scenario D about taxation on electricity, the incidence of

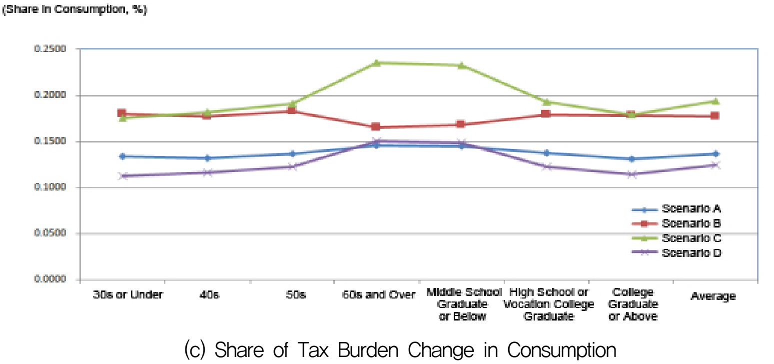
[Figure Ⅳ-7] **Distributional effects by Scenario: by Householder's Age and Education Level**



(a) Change in Tax Burden

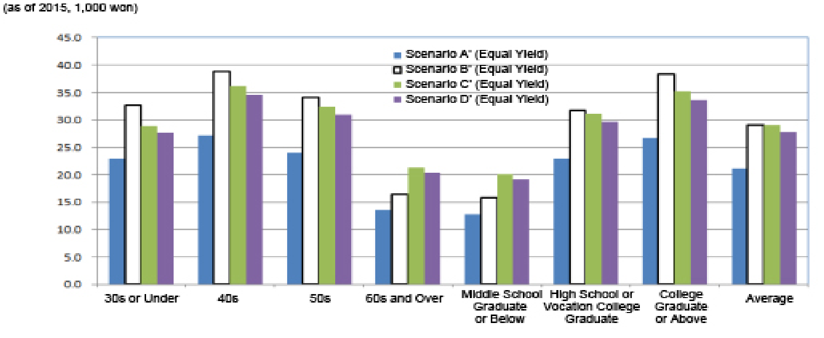


(b) Share of Tax Burden Change in Income

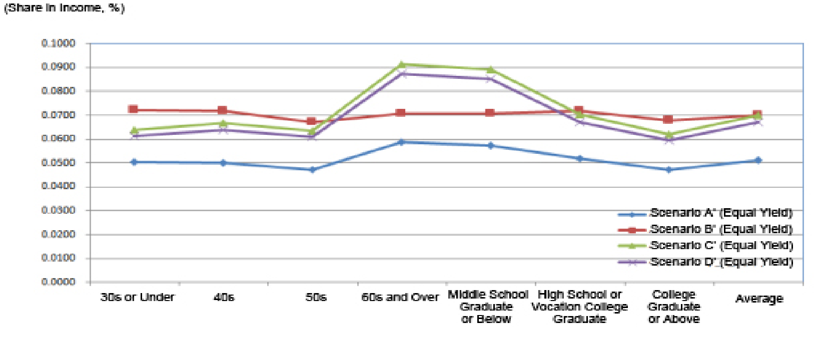


(c) Share of Tax Burden Change in Consumption

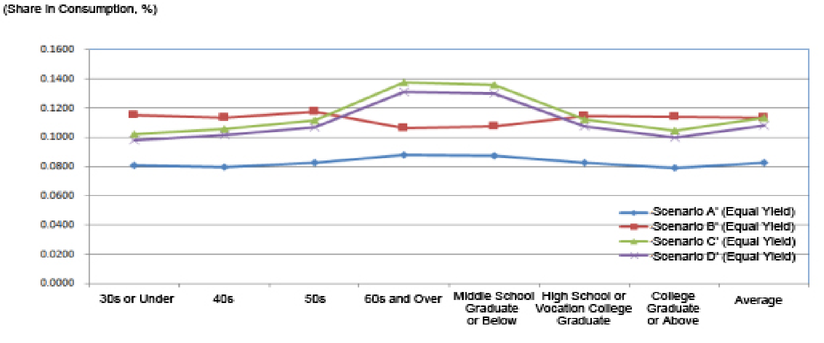
[Figure IV-8] Distributional effects by Equal Yield-Adjusted Scenario : by Householder's Age and Education Level



(a) Change in Tax Burden



(b) Share of Tax Burden Change in Income



(c) Share of Tax Burden Change in Consumption

tax burden stands at 22,000 won for middle school graduates or below; at 34,000 won for high school or vocational college graduates; and at 38,000 won for college graduates or above. Across all of the four scenarios, it is shown that the increase of tax burden rises as the householder's education level goes higher. To compare the four standardized scenarios—which have been adjusted to yield the same tax revenue of 1 trillion won—, as for households headed by middle school graduates or below, the increase of tax burden is the largest in relation to taxation on bituminous coal in Scenario C' and the smallest in relation to CO_2 taxation in Scenario A'. In the case of households headed by high school or vocational college graduates or by college graduates or above, the increase is the largest in relation to taxation on diesel in Scenario B' and the smallest in relation to CO_2 taxation in Scenario A'.

B. Synthesis and Other Considerations

Summarized in <Table IV-4> are the ripple effects of the scenarios-which reflect factors related to energy tax reform, such as CO_2 taxation, diesel taxation, bituminous coal taxation, and electricity taxation. The results are categorized as per the effect on tax revenue, the effect on prices, changes in tax burden by household characteristics (e.g. income level) and income distribution effects. Scenarios A, B, C and D for energy tax reform—which consider taxations on CO_2, diesel, bituminous coal and electricity—are expected to increase tax revenue by about 1.65 trillion won, 1.56 trillion won, 1.71 trillion won and 1.14 trillion won, respectively. As for the share of the tax revenue in GDP, the figures stand at 0.116%, 0.109%, 0.120% and 0.080%, respectively. The increased tax revenue, however, will be accompanied by an increase in energy prices, which in turn will amount to additional economic burdens incurred by rising prices of related intermediate and final goods.

According to the results of the analysis, the ripple effects on overall prices are as follows: taxation on bituminous coal in Scenario C shows the largest effect of 0.174%; and electricity taxation in Scenario D marks the lowest effect of 0.114%. With the equal yield of 1 trillion won applied, however, taxation on bituminous coal tax in Scenario C has the largest impact of 0.101%. CO_2 taxation in Scenario A shows the lowest effect of 0.072%. The results suggest that taxation on CO_2 can be a relatively more favorable policy in that it is expected to have a broader tax source under the condition of equal yield in tax revenue. If price management should regarded as a critical element in macroeconomic policymaking, we need to be relatively more cautious when handling taxation on bituminous coal for power generation purposes or on electricity, compared to taxation on CO_2 or diesel.

What follows is changes in the Gini coefficient—a representative inequality index—, through which we examine how changes in tax burden on households affect income distribution in each energy tax reform scenario and explore the question of social equity by the effect on income distribution.[9] In Scenarios A, B, C and D—which reflect taxations on CO_2, diesel, bituminous coal and electricity— the Gini coefficient increase— albeit slightly—by 0.030%, 0.069%, 0.112% and 0.021%, respectively. This implies that income redistribution per income level may deteriorate to some degree in the process of reflecting social costs. To compare the income distribution effects of the four standardized scenarios A', B', C' and D'—which have been adjusted to yield the same tax revenue of 1 trillion won—, taxation on bituminous coal in Scenario C' marks the largest, and CO_2 taxation in Scenario A' shows the lowest effect on income distribution. This indicates that energy tax reform needs to be accompanied by complementary financial support measures for low-income households. In addition, the results show that the share of consumption of coal, gas and electricity in total consumption expenditure increases as the level of income goes down. This is expected to deteriorate regressivity per income to some extent in the process of introducing energy tax reform. Nevertheless, the negative effect of energy tax reform on income distribution is not significantly large vis-à-vis the scale of tax revenue. Instead, the negative effect can be considerably offset if some of the additional tax revenues from related energy sources are used effectively in increasing social welfare expenditure or providing tax exemption for low-income earners for the purpose of improving energy welfare in the aspect of government expenditure.

9) The Gini coefficient is a measure of how unevenly distributed the income is, with a value between 0 and 1, which means that the closer it is to 1, the higher the income inequality is.

Therefore, it is crucial to design policy measures to effectively recycle increased tax revenues in government expenditure in order to provide complementary support for low-income households and to lessen tax regressivity, in addition to considering the negative effect on regressivity per income resulting from strengthening the energy tax system to address climate change and mitigate air pollution, such as fine dust. In this respect, relevant policymaking will be increasingly important for reducing energy poverty and improving energy welfare, considering distribution problems to be caused as a result of strengthening energy-related taxation in response to strict environmental regulations in the future.

In the case of price-side support, it applies only to households consuming an energy source in question. So, it may not support households to which price discounts are not applicable. Therefore, in order to solve energy poverty and improve energy welfare, it will be necessary to expand direct income supports for the vulnerable class and, in particular, to make an active use of energy vouchers that guarantee an appropriate level of energy use. It is possible to apply elastic tax rates on a temporary basis when the need arises. In the medium to long term, however, it will be inevitable to raise basic tax rates gradually in order to conserve energy and comply with international environmental regulations. In so doing, the new tax system can be complemented by ensuring more effective financial support for the vulnerable class (esp. low-income earners), which includes energy vouchers (service vouchers), oil price subsidy for livelihood-type business and other energy welfare programs.

The following studies aptly demonstrate the importance of making a right policy combination for effective recycling of related tax revenues in relation to the distributional effect of energy taxation. In order to minimize the negative effects of various energy tax reforms on the economy, additional accrued tax revenues can be linked with an expansion of investments in environmental and energy-related technology (R&D) in strategic industries. For instance, Kim et al. (2015) show that the adverse effects of the initial tax reform on industrial competitiveness and costs related to the efficiency and effectiveness of income distribution can be canceled out significantly if the additional tax revenues accrued from tax reform are invested in support for technological development (process innovation) in major industries—e.g. as steel, basic chemicals, electrical and electronic equipment, transport equipment, general machinery and construction—and also if this bears fruit with a 10% increase in total factor productivity in each target industry. Moreover, as demonstrated by Callan et al. (2009), income redistribution can even improve if some of the additional tax revenues are used effectively to provide social assistance or tax exemption for low-income households and energy-vulnerable groups.

When it comes to energy-related distribution policy, energy support policy for the vulnerable should be based on the price condition of a given energy source. In this respect, the bolstering of energy tax system and energy welfare policy can be designed and operated closely in line with each other. In addition, support for the energy-vulnerable can be implemented in combination with energy taxation and pricing—not just as welfare policy like the national basic living security system—since fundamentally eliminating and preventing the diverse sources of energy poverty requires a simultaneous coordination between energy-related distribution policy, on the one hand, and such projects as energy-efficiency improvement for housing and facilities or energy voucher support, on the other.

As financial resources for the current energy voucher program belongs to special accounts for energy, not to financial resources appropriated for welfare purposes from general accounts, it is important to recycle part of energy-related tax revenues for the vulnerable class, which will serve as a means to complement the promotion of political receptiveness to an increase in tax rates when energy tax reform is carried out in the future. As for the criteria selecting the recipients of energy welfare-related support, we can consider taking a flexible approach to eligibility requirements by focusing on vulnerable households—such as the elderly with low income, the disabled and households with children—or by evaluating household characteristics related to income and wealth within the range between 30 to 50% of median income.

So far, we have discussed a set of policy implications with regard to changes in the tax burden and distributional effects by income level, in order to address various challenges ahead in relation to energy tax reform, including the reduction of social costs in the power generation sector in Korea—e.g. green house gas mitigation in response to climate change, the reduction of air pollutants like fine dust and social conflicts involving nuclear power generation and the transmission and distribution of electric power. In this section, we have focused on examining the ripple effects and policy implications of some elements of energy tax reform on distribution by income level. However, future research needs to be conducted for a more in-depth analysis about how energy tax reform could be combined with the reshuffling of other general taxation, such as income tax, corporation tax and VAT and what kind of ripple effects the reform would have on macroeconomics in the mid to long term.

〈Table Ⅳ-4〉 **Comparison of Energy Tax Reform Scenario's distributional effects: Synthesis**

1. Effect on Tax Revenue		Scenario				Equal Yield-Adjusted Scenario (1 trillion won)			
		A	B	C	D	A′	B′	C′	D′
Change in Tax Revenue (100 million won, annual)		16,543	15,590	17,132	11,462	10,000	10,000	10,000	10,000
Share of Tax Revenue in GDP (%)		0.116%	0.109%	0.120%	0.080%	0.070%	0.070%	0.070%	0.070%
2. Effect on Prices		Scenario				Equal Yield-Adjusted Scenario (1 trillion won)			
		A	B	C	D	A′	B′	C′	D′
Change Rate (%)		0.119	0.141	0.174	0.114	0.072	0.091	0.101	0.100
3. Change in Tax Burden by Household Characteristics (thousand won, as of 2015)		Scenario				Equal Yield-Adjusted Scenario (1 trillion won)			
		A	B	C	D	A′	B′	C′	D′
Income Decile	Decile 1	12.6	13.2	21.5	13.7	7.6	8.4	12.5	11.9
	Decile 2	16.2	16.5	27.5	17.5	9.8	10.6	16.0	15.3
	Decile 3	22.3	25.2	35.8	22.8	13.5	16.2	20.9	19.9
	Decile 4	27.3	33.1	41.1	26.2	16.5	21.3	24.0	22.9
	Decile 5	32.4	41.8	45.8	29.3	19.6	26.8	26.7	25.5
	Decile 6	38.1	50.0	52.8	33.8	23.0	32.1	30.8	29.5
	Decile 7	42.2	56.6	57.8	37.0	25.5	36.3	33.7	32.3
	Decile 8	45.2	61.8	60.5	38.7	27.3	39.6	35.3	33.7
	Decile 9	51.3	70.3	69.8	44.6	31.0	45.1	40.7	38.9
	Decile 10	62.4	86.2	85.6	54.9	37.7	55.3	50.0	47.9
	Average	35.0	45.4	49.8	31.9	21.2	29.1	29.1	27.8
Household Type	Wage Earner	38.6	51.6	53.1	34.0	23.3	33.1	31.0	29.7
	Self-Employed	30.5	37.7	45.7	29.2	18.5	24.2	26.7	25.5

〈Table IV-4〉 **Continued**

3. Change in Tax Burden by Household Characteristics (thousand won, as of 2015)		Scenario				Equal Yield-Adjusted Scenario (1 trillion won)			
		A	B	C	D	A′	B′	C′	D′
Number of Household Members	1-Person Household	16.8	19.5	25.8	16.5	10.1	12.5	15.1	14.4
	2-Person Household	29.4	37.2	44.1	28.2	17.8	23.9	25.8	24.6
	3-Person Household	42.4	56.1	58.5	37.4	25.6	36.0	34.1	32.7
	Household with 4 or More	50.3	67.4	68.9	44.1	30.4	43.2	40.2	38.5
Residential Area	Urban	35.8	45.4	50.2	32.1	21.7	29.1	29.3	28.0
	Non-urban	31.5	44.8	47.9	30.6	19.0	28.7	28.0	26.7
Householder's Age	Under 30s	37.9	50.9	49.6	31.8	22.9	32.6	28.9	27.7
	40s	45.0	60.5	62.0	39.7	27.2	38.8	36.2	34.6
	50s	39.7	53.2	55.5	35.5	24.0	34.1	32.4	31.0
	60s and over	22.6	25.6	36.5	23.3	13.7	16.4	21.3	20.3
Householder's Education Level	Middle School Graduate or Below	21.3	24.7	34.2	21.9	12.9	15.8	20.0	19.1
	High School or Vocational College Graduate	38.0	49.6	53.3	34.1	23.0	31.8	31.1	29.8
	College Graduate or Above	44.2	59.9	60.2	38.6	26.7	38.4	35.2	33.7

4. Income Redistribution Effect – Change in Gini Coefficient (%)	Scenario				Equal Yield-Adjusted Scenario (1 trillion won)			
	A	B	C	D	A′	B′	C′	D′
Income-based	0.030	0.069	0.112	0.021	0.018	0.049	0.062	0.056
Consumption-based	0.014	0.101	0.198	-0.005	0.008	0.078	0.108	0.093

Note: The Gini coefficient (inequality index) is a measure of how unequal income distribution is. It is expressed as $[1/[n(n-1)]\Sigma_j|\Sigma_k I_j - I_k|]/2\mu$ in terms of average income (μ) and sample size (n), and the value ranges between 0 and 1. As the value gets closer to 1, it means that the level of income inequality is higher. Here, the standard value of the Gini coefficient is set at 0.379331 based on ordinary income as of 2015 and at 0.273196 based on total consumption expenditure of the same year.

V

Conclusion and Implications

1 Energy Taxation: Efficiency vs. Equity

In this section, we aim to sort out the significance of efficiency and equity in energy taxation, which are regarded as the most important elements in evaluating the tax system in general. We spare a separate section for discussing the question of equity in the energy tax system because of our concern that this study might unintentionally mislead readers into believing that energy taxation should be used as a means of promoting distributional justice. As already discussed in the introduction, we examine the issue of equity in energy taxation in this paper, but this does not necessarily mean that energy taxation must contribute to tax equity. The purpose of discussing efficiency and equity for the assessing of a given tax system lies not in finding out whether each and every tax is in line with the goal of efficiency and equity, but in evaluating how efficiently the entire tax system is being managed and how positively it affects distribution from on the part of taxpayers. Should each tax item satisfy both efficiency and equity, the corrective tax becomes subject to the same requirement, regardless of its originally intended purpose. Yet, we need to deliberate on how valid this requirement is. The purpose of the corrective tax is to reduce the consumption of a given goods to a socially appropriate level by reflecting its negative externalities in the market price. Thus, the corrective tax should be approached according to how effectively a given tax system internalizes externalities. In other words, efficiency is the most important virtue in the evaluation of the corrective tax.

Let us assume that a certain corrective tax is efficient in achieving its original purpose yet impairs equality. In this situation, should the system be discarded altogether because it fails to satisfy both efficiency and equity? If meeting the intended purpose of the corrective tax compromises tax equity, it is desirable to approach the problem in two main aspects. One is to find an institutional alternative that can serve to achieve the same purpose while improving equity. And the other is to compensate for the negative effect on distribution caused by the corrective tax with another taxation or revenue from the corrective tax. As for compensation by other taxation, it means offsetting the negative effects of the corrective tax by strengthening equity in other items, such as income tax. Compensation with revenue from the corrective tax means using the revenue as a resource for implementing financial policy to promote equity in distribution. Along with the introduction of the corrective tax, these complementary measures need to be coordinated in harmony with the broader framework of the entire tax system, through which both efficiency and equity can be improved in the system as a whole.

In this respect, it carries considerable significance to identify and improve equity in energy taxation. The core function of the energy tax system is efficiency, but improving equity with a systemic approach bears much importance on the tax system as a whole. Identifying and redressing existing problems for enhancing tax equity can part of the solution to address issues concerning distribution within the entire tax system.

This paper focuses on ways to offset the negative distributional effect of the corrective tax, such as energy taxation by examining equity in energy taxation as a type of corrective tax. By doing so, we aim ultimately to contribute to the establishment effective environmental and energy taxation systems that taxpayers can consent to. The efficiency of energy taxation is not within the scope of this study. So far, many reports have focused on the issue. The purpose of this paper is to provide policy implications for policy makers concerning the question of equity in energy taxation, leaving the issue of efficiency to other studies. In the following section, we present the summary of the results of our analysis discussed so far and conclude with policy implications.

2 Summary and Policy Implications

So far, we have analyzed the expected distributional effects of energy tax reform by drawing on the current state of Korea's main energy tax burdens and examining some probable scenarios for future energy tax reform, based on the 『Household Income and Expenditure Survey』. First, with respect to the level of tax burden of major energy taxes by stratum in Korea, it has been demonstrated that the tax burden on fuels for transportation purposes shows a pattern that is similar to a reversed U shape in terms of decile. The taxation is progressive in the lower income (expenditure) decile; nearly proportional in the middle; and slightly regressive in the higher income (expenditure) decile. To compare with the average of 21 OECD countries, Korea shows relatively strong progressivity here as well. Given that our data does not include the highest income decile sufficiently, it is possible that regressivity in higher income deciles has been underestimated to some extent. However, it is evident that the taxation is progressive between the low income and middle income deciles.

As for transportation fuels, there is much room to adjust means of transportation by income or expenditure level. As the level of income goes down, households become more sensitive to the price of vehicle and fuel efficiency. If income is sufficient, it is relatively easy to go for mid- or large-sized sedans in spite of low fuel efficiency. As a result, the consumption of oil will increase even when driving the same distance. On the other hand, low-income households can reduce their fuel consumption by driving economy cars with high fuel efficiency. Or, they can choose to stop driving use public transportation only according to their economic conditions. The tax burden on transportation fuels is progressive especially in low-income households, for which it seems that the substitution effect of public transportation—which can replace self-owned vehicles—plays a major role.

In contrast to the progressivity of taxation on transportation fuels, the result of our analysis reveals a clearly regressive tendency in the case of taxation on household fuels. The tax burden is regressive in all deciles, in terms of both income and expenditure, regressivity is even larger in the low deciles. A similar tendency is observed in most of the OECD countries as well. Based on these results, it seems that the use of household fuels is not significantly affected by income or expenditure level. That is, a certain necessary amount of consumption that applies to all households, regardless of income or expenditure level. Also, the amount of consumption does not increase greatly past the necessary amount even if one can afford more.

To take a look at the tax burden effect by household characteristics, income exerts the greatest impact on the amount of energy consumption. As for transportation fuel, the number of self-owned vehicles plays a large part in accounting explaining the amount of consumption. However, considering that the number of self-owned vehicles is also highly correlated with income, it can be concluded that the level of income is the pivotal factor in determining differentials in the consumption of transportation fuels. In the meantime, the consumption of household fuel increases as the number of household members grows and as the householder’s age rises. The result is consistent with common sense in the sense that there is the minimum amount of household fuel necessary for one person and that the elderly are likely to spend more time in their homes during the day.

There are several policy implications to consider based on our analysis of the level of energy tax burden. First, strengthening the corrective function of energy taxes on transportation fuels is rather positive in terms of tax equity. In particular, efficiency and equity can be improved at the same time in the low- to middle-income households. When the function of the environmental tax is emphasized in the energy tax system, one of major concerns would be raised that the regressive nature of a typical excise tax will appear in energy taxes as well. The results of this study, however, show that—at least as for transportation fuels, such as gasoline and diesel—the level of regressivity is not significant enough to deserve attention. We find that it can be more effective in terms of equity as well to actively bolstering the corrective function of the energy tax on

Meanwhile, some argue that the tax burden on households should be alleviated by lowering the TEET on gasoline and diesel. Those in favor of reducing tax rates on transportation fuels to reduce the tax burden on households seem to think that a decrease in oil prices and, thus, in the cost of oil consumption can free up that amount of money to be spent on other useful purposes. However, the amount of money spent on oil does not necessarily decline when the oil price is lowered. From the economic perspective, a drop in the price of a given goods can be broken down into income and substitution effects. Depending on the relative size of each effect, the total amount of money spent on the goods may decrease, increase or stay the same. According to our empirical analysis, the ratio of tax burden on transportation fuels increased to a certain degree even when the oil price decreased and the tax rate remained unchanged(in 2014 and 2015.) During that period, households increased their consumption on vehicle fuels beyond the increase of their incomes. Given these results, it seems that the tax burden on oil consumption will not decrease even if the tax rate on transportation fuels is lowered. Rather, lowering the tax rate is highly likely to increase the share of the cost of oil consumption in total income (or expenditure) by increasing the amount of consumption as well. This shows that, in terms of the aggregate amount of money, the tax burden can increase, opposed to the intended goal, since people tend to consume cheaper fuels more. In this respect, we can conclude that the energy tax on transportation is efficient in terms of changes in the pattern of household consumption vis-à-vis price as well while not significantly impairing tax equity.

Next, it is inappropriate to solve distribution issues with energy taxation in the case of household fuels because there is a certain amount of consumption necessary for all, including low-income households. We might be able to expect efficiency in this sector, but regressivity is unavoidable in terms of equity. Therefore, energy taxation on household fuels (mainly heating fuels) should be designed to be faithful to its role as the corrective tax. Further, we need to ease the negative effects on distribution by expanding financial support, such as income support or vouchers, for the vulnerable class. Here, it should be noted that it is not advisable to provide price-side support to promote equity in distribution. This is due to the fact that price-side support leads to a loss in the efficiency of energy taxation and, thereby, fails to motivate the target population to, cut down on their energy consumption. Thus, financial support should be carried out in the form of income-side support, which helps maintain efficiency inherent in the energy tax system while improving equity in distribution at the same time.

The second analysis in this paper concerns distributional effects of energy taxation demonstrated in each of the energy tax reform scenarios. We have come up with four basic scenarios for comparison. These are: introducing carbon taxation according to the amount of greenhouse gas emitted by each energy source (Scenario A); strengthen taxation on diesel only (Scenario B); strengthening taxation on bituminous coal for power generation purposes (Scenario C); and impose an excise tax on electricity (Scenario D). We have also presented the standardized scenarios (A', B', C' and D'), in which the tax rate is adjusted to yield the same additional tax revenue of 1 trillion won for comparison. In total, eight different scenarios have been analyzed to compare distributional effects.

As for the four basic scenarios, it is estimated that strengthening taxation on bituminous coal for power generation (Scenario C) results in the largest effect on both tax revenue and inflation. It also worsens the Gini coefficient— a measure of income distribution—the most. In contrast, the excise tax on electricity shows the lowest effect on both tax revenue and inflation. Also, the extent of a rise in the Gini coefficient is estimated to be the smallest; so is a decrease in distributive equity. As for the scenarios in which additional tax revenues are adjusted to the same level, the worst impact on inflation or equity in distribution is expected to result from strengthening taxation on bituminous coal, as in the case of the analysis of the basic scenarios. However, the most positive effects (i.e. the lowest inflation effect and the least adverse effect on distribution equity) are expected to be brought about by carbon taxation on all fuels, unlike the analysis of the basic scenarios.

The results of our scenario analysis provide some implications for policymakers who will reform energy taxation in the future. First, imposing the carbon tax in proportion to the social cost of each fuel—rather than imposing the tax only on certain energy sources, such as diesel, bituminous coal and electricity—is likely to have relatively less negative effects on both distribution and price management. Our scenario analysis suggests that a comprehensive consideration of externalities is important not only in terms of corrective function, but also in terms of distribution and prices. That is, it is more advisable for the future to make adjustments to tax rates in a comprehensive fashion according to the level of externalities incurred by each fuel type, instead of focusing only on certain fuels that draw attention in society.

Based on the various scenarios discussed in this paper, however, it seems difficult to avoid negative effects on distribution in the process of bolstering the energy tax system. In this regard, we need to recycle additional tax revenues accrued from energy tax reform to support financial policies that enhance income redistribution. According to the results of scenario analysis, the negative effects of energy tax reform on income distribution are not larger, compared to the total amount of tax revenue to be generated. Thus, we expect that the negative effects on distribution will be largely offset if some of the tax revenues are used for redistribution purposes. If tax revenues are used appropriately for income redistribution, strengthening the function of the environmental tax can be a good policy alternative that can have positive effects on both efficiency and equity in the future.

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