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Carbon Pricing
— The limits of the price elasticity coefficient, and the policy considerations based on that —

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In recent years, carbon pricing has come under the spotlight as a "trump card" for addressing climate change issues. However, in order to make it a truly effective system, it is vital to have the correct understanding of the mechanism by which changes in energy prices affect energy consumption. In an earlier paper titled "Carbon Pricing—Understanding the Structure of Price Effects" (January 2024 issue), the author introduced the concept of the reduction mechanism in relation to price effects, using the energy consumption behavior of households as an example. This time, the author will continue to consider the effects of carbon pricing by using the household sector as a case study, while placing the focus on the price elasticity coefficient, an indicator that is used to quantitatively measure the magnitude of the price effect.

The price elasticity coefficient of energy is an indicator that is based on microeconomics, and it shows the degree of impact that fluctuations in energy prices have on consumption volume. According to the law of demand, consumption falls when price increases, and consumption increases when the price falls. Therefore, the price elasticity coefficient is usually marked with a negative sign. When the absolute value of price elasticity is greater than 1, it means that there is a significant change in consumption; when it is less than 1, it means that the response in consumption is small. For example, if the price elasticity coefficient of gasoline is -1.5 (absolute value greater than 1), a 10% increase in the price of gasoline will reduce demand by 15%. On the other hand, if the price elasticity is -0.5 (absolute value less than 1), demand will be reduced by only 5% for the same price increase.

The price elasticity coefficient of energy is a useful indicator that is used in many situations when considering energy policies. For example, many energy supply and demand predictive models incorporate the price elasticity coefficient of energy as one of the explanatory variables because it makes it possible to predict the impact that future changes in energy prices may have on energy consumption. Moreover, from the perspective of policy reviews, it is possible to estimate the degree of reduction in energy demand caused by carbon pricing (in other words, the additional costs of energy use), as well as the scale of the accompanying tax revenue. As the price elasticity coefficient of energy is a simple and convenient indicator, several points need to be kept in mind when using it.[i] However, it can be described as a powerful and effective indicator that provides important information when considering energy policies.

In academic research, research on the price elasticity coefficient is one of the main topics in the field of energy economics, and various studies are being conducted around the world. Previous studies to date share the consensus that energy demand is inelastic to price.

Looking at specific previous research, for example, an analysis of household power consumption in the European Union from 1996 to 2016[ii] confirmed that the long-term price elasticity of household power consumption is inelastic. Another study on household power demand in 12 major European countries,[iii] which used data spanning an even longer period from 1975 to 2018, also pointed out that the price elasticity of household power is extremely low. Turning our attention to the U.S., an analysis of household power consumption in California[iv] revealed that 44% of the households surveyed were not responsive to prices at all.

An analysis of household gas consumption in the U.S. [v] confirmed that both low-income and high-income households were not responsive to prices. In Japan as well, an analysis of the price elasticity coefficients of energy that took into account changes in the demand structure,[vi] showed that household and industrial energy consumption exhibited low elasticity to price fluctuations. An analysis of income elasticity and price elasticity of consumer goods in the household sector,[vii] conducted using data from the National Survey of Family Income and Expenditure, showed that even among the 18 consumer goods groups, electricity and other utility bills presented the lowest income elasticity and price elasticity coefficients. An analysis using regional power demand functions based on data from regional electric power companies[viii] showed that the price elasticity coefficient of energy is low in the household and industrial sectors, although there were regional differences. Furthermore, an analysis conducted by region, energy mix, and income bracket, using data from household CO_2 statistics,[ix] revealed that the lower the income bracket of households, and in northern Japan, the lower the energy price elasticity coefficient and the greater the share of the burden on household expenditure. The same study points out that even if energy prices were to increase, it would be difficult for those in the low-income bracket in particular to switch to energy-saving equipment. This could in turn lead to an increase in energy spending, and thereby place a greater burden on household finances.

As such previous research has demonstrated, the tendency for energy demand to be inelastic to price has been widely confirmed. Low price elasticity coefficients are due to the fact that energy is a lifeline and necessity that supports the foundations of our daily lives. Therefore, this suggests that, if high carbon prices are introduced in situations where there is low responsiveness to prices, the costs borne by society are highly likely to outweigh the benefits gained from reducing emissions. In fact, even in the recent energy crisis, rising fossil fuel prices did not necessarily lead to a significant reduction in energy demand, but instead, put pressure on household finances. This fact supports the above view.

Based on the examination presented above, it is not realistic to place high expectations on the effects that carbon pricing may have on reducing emissions. In order to maximize its effects, it is necessary to take into consideration the characteristic that energy demand has in terms of its inelasticity to prices, and to employ a policy mix that combines carbon pricing with other policy measures rather than using it alone. In order to ensure that carbon pricing demonstrates its effects properly, it is first essential to secure alternative energy sources that are cheap and offer a stable supply. In addition, it is important to consider taking a multifaceted approach, such as promoting the widespread adoption of energy-saving technologies, offering support measures to low-income households, providing incentives to improve energy efficiency, developing a decarbonized energy infrastructure, and enhancing consumer awareness through education and activities to raise awareness. Carbon pricing is not a silver bullet. There is a need to put in place policies that understand the actual situation, and to promote effective emissions reductions while easing the burden on society as a whole.

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[i] For example, elasticity coefficients can vary significantly depending on the sample period used; elasticity coefficients differ depending on the energy source being targeted (for example, whether the target is total energy demand or whether the analysis is carried out by individual energy sources); elasticity coefficients can vary when prices are rising and falling even for the same energy source; and further, there are hidden factors behind elasticity, other than prices (such as changes in social structure and industrial structure). A review paper* on price elasticity coefficients also reviewed various previous studies and pointed out that analysis results change depending on the approach taken with respect to the target scope for sample period, country, sector, fuel type, and methodology. *Liu, Gang (2004),

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