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The public's willingness to pay for securing a reliable natural gas supply in Korea

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HIGHLIGHTS

- We assess the public value of increasing LNG storage rate from 11% to 20% in Korea.
- To this end, contingent valuation survey of 1000 households was conducted.
- Willingness to pay (WTP) was elicited by one-and-one-half-bound model.
- A spike model was applied to deal with the zero WTP responses.
- The annual mean WTP per household is estimated as KRW 9671 (USD 8.71).

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ABSTRACT

With the increasing importance of natural gas (NG) in the energy mix, the search for a reliable liquefied NG (LNG) supply has received great attention along with energy security in Korea. However, the current level of LNG supply reliability in Korea is much lower than that in other industrialized countries. In order to improve the reliability of the LNG supply, diverse policy measures are required, which come at an additional cost paid by society. This study aims to investigate the public's willingness to pay (WTP) for improving the reliability of the LNG supply by increasing the LNG storage rate from the current level (11%) to 20%. To this end, the contingent valuation (CV) method is applied by using national survey data of 1000 households. In particular, this study employs a one-and-one-half-bound (OOHB) dichotomous choice model, combined with a spike model, to address the responses from the CV survey with zero WTP. The annual mean WTP is estimated to be KRW 9641 (USD 8.68) per household. Expanding the value to the national population provides a value of KRW 169.43 billion (USD 152.55 million). The results indicate that people are willing to shoulder the burden of safeguarding a reliable supply of LNG.

1. Introduction

The concept of energy security has received significant attention worldwide since the global oil crisis in the 1970s. In addition, the increasing global energy demand along with emerging economies and rapidly growing developing countries emphasizes the importance of energy security. Accordingly, the most industrialized nations have placed energy security at the heart of their energy policy agenda (Cohen et al., 2011). The definition of energy security can vary according to different viewpoints (Kruyt et al., 2009). Early definitions of energy security focused on the availability and price fluctuation of energy (e.g., Bohi and Toman, 1996). A more recent definition includes the importance of environmental issues corresponding to the global consensus of the Convention on Climate Change. Accordingly, the definition developed by the International Energy Agency (IEA) is widely accepted as a representative definition: "Uninterrupted physical availability at a price which is affordable, while respecting environmental concerns" (IEA, 2011). Although the recent concept of energy security includes the importance of environmental issues, the core concept of energy security is still based on a reliable energy supply. This is revealed in the concept of energy security that entails various time dimensions, such as short term and long term (Bielecki, 2002). According to Cabalu (2010), short-term security of the energy supply means the availability of energy despite exceptional demand and difficult supply conditions, including disruptions to the supply due to physical or economic

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factors. Long-term security of the energy supply refers to the ability to ensure that the future energy demand can be met by a combination of domestic and imported energy supplies. Both short-term security and long-term security of the energy supply emphasize the role of reliable energy security. This is because a reliable energy supply is an inevitable condition for a sustainably growing economy.

Since the global oil crisis in the 1970s, diverse policy measures for securing the reliability of the energy supply have mainly focused on the oil supply. Recently, however, there has been growing interest in the reliable supply of other energy resources, such as natural gas (NG) and electricity (IEA, 2003). Among various energy resources, NG has recently been receiving significant attention. With a poor penetration rate of renewable energy and increasing anxiety about nuclear energy after the Fukushima nuclear accident in Japan, NG has entered the spotlight as a relatively eco-friendly and safe energy source compared with other fossil fuels and nuclear energy. Moreover, large-scale development of shale gas in North America, often referred to as the shale gas revolution, is expected to make NG more economically competitive.

In Korea, NG has become one of the fastest-growing energy sources in the past two decades. As of 2011, the demand for NG has represented approximately 17% of the primary energy demand, and it showed the highest growth rate of 8% during the period 2001–2011. While the demand for NG has increased significantly, 99% of the NG supply depends on the importation. Thus, any disruption to the flow of the NG supply would significantly affect the economy. In order to secure a reliable NG supply, effective policy actions are required, such as developing liquefied NG (LNG) technology, improving the LNG storage rate, and securing emergency supply rights (Cayrade, 2004). However, the execution of these policy measures requires additional costs, which are paid by society. From this aspect, understanding the consumers' preference for a reliable LNG supply in monetary terms is critical to set an economically efficient and socially optimal investment plan for implementing these policy measures (Chou et al., 2011).

Although a growing body of literature addressing the NG (energy) supply security exists, few studies have focused on the valuation of a reliable NG supply. Most studies that have estimated the value of a reliable NG supply in monetary terms have used consumers' willingness to pay (WTP) to avoid energy insecurity or the damage-cost approach, assessing the economic damage if a supply disruption occurs. For example, Chou et al. (2011) analyzed households' WTP for a reliable NG supply using the choice experiment (CE) method. In the CE method, they considered the number of occurrences and the NG supply disruption duration in the attributes. They concluded that the degree of economic impact of disruption of the NG supply is a function of the duration and the season in which a supply cut occurs. Based on empirical studies for three European countries, France, Italy, and the United Kingdom, the costs of unsupplied NG were estimated as EUR 2.65 to 41.48 per cubic meter of NG across the three different countries. Leahy et al. (2012) studied the cost of NG shortages in Ireland. They approached the economic impact of the hypothetical NG supply disruption on the macro level, including items such as the cost of electricity shortages, consumer and producer surplus loss, and the lost value-added tax owing to the NG shortage. They estimated the cost of losing gas-fired electricity at EUR 0.1 to 1.0 billion per day and at EUR 80 billion for 3 months.

Additional studies regarding energy supply security have been conducted on the electricity sector rather than on NG. In the studies addressing the electricity sector, energy insecurity is often mentioned as the value of lost load (VOLL). To estimate the economic value of the VOLL, a number of studies have estimated households' WTP to avoid an electricity outage (e.g., Baarsma et al., 2005; Carlsson and Martinsson, 2007; Goett et al., 2000). While many studies have addressed the impact of energy insecurity or the cost of avoiding it, some studies have focused on policy measures for improving energy security. Longoa et al. (2008) estimated UK residents' WTP for energy programs to promote the production of renewable energy by using the CE method. In order to set the scenario for the energy program, they used the annual reduction in greenhouse gas emissions, annual length of blackouts, changes in employment, and increases in the electricity bills as attributes. Li et al. (2009) estimated households' WTP to support increased energy R&D activities designed to replace fossil fuels to reduce both the future dependence on foreign oil and the CO_2 emissions using the contingent valuation (CV) method.

Damigos et al. (2009) also applied the CV method to assess households' WTP for certain policy measures to safeguard the security of the NG supply in the electricity sector. The result showed that on average consumers are willing to pay a premium of 7% of their annual electricity bill in order to ensure the supply of gas. Aldy et al. (2012) investigated the public's willingness to pay for a national clean energy standard (NCES) in the United States. NCES is the policy for promoting the use of clean energy technologies for electricity generation targeting 80% of clean energy, defined as renewables, nuclear, fossil fuel with carbon capture and storage (CCS), and natural gas, by 2035. Using the CV method, they concluded that the average citizen of the United States is willing to pay USD 162 per year in higher electricity bills.

With regard to the analysis of the energy security cost in the Korean context, only one previous study can be found in the literature. Jun et al. (2009) analyzed the cost of energy security in the Korean electricity sector. They used the energy security measure consisting of the cost of supply disruption and price volatility in terms of GDP loss. They estimated the cost of LNG supply security for various disruption periods, and the estimation results were USD 466.71 million, USD 938.57 million, and USD 1882.14 million for 6 months, 1 year, and 2 years, respectively. With the consideration that NG is used not only for electricity generation but also for heating and cooking, this study can only provide limited information related to a reliable LNG supply. In addition, this study cannot provide information on the public's preference for a reliable NG supply since it estimates the cost of energy security by GDP loss assuming the situation of energy supply disruption.

In this regard, it is necessary to investigate the public's preference for a reliable NG supply in the Korean context, which has not yet been studied. The purpose of this study is, therefore, to investigate the value that consumers place on a reliable LNG supply. In order to analyze the value of a reliable LNG supply from the consumers' perspective, using the CV method; we attempt to measure people's WTP for a reliable LNG supply through a policy measure for improving the NG storage rate. This is regarded as a relatively urgent matter for a reliable LNG supply in Korea, and it is detailed in the following section. Among the different formats for eliciting the respondents' WTP, this study employs a one-and-one-half-bound (OOHB) dichotomous choice (DC) format, which can reduce the potential for response bias while maintaining much of the efficiency of other CV formats (Cooper et al., 2002). In addition, the spike model is applied in the OOHB DC format to deal with zero WTP responses. The remainder of the paper is organized as follows. Section 2 describes the current status of the NG supply in Korea. Section 3 presents the methodology employed in the study. The empirical results are reported and discussed in Section 4. Section 5 concludes the paper.

2. Current status of the NG supply in Korea

Korea is the eighth-highest energy-consuming country in the world. In total, 97% of the primary energy is imported from abroad