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Public's willingness to pay a premium for bioethanol in Korea: A contingent valuation study

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ABSTRACT

Bioethanol (BE), a renewable energy, is well-known to mitigate the greenhouse gas emissions compared with conventional gasoline. Thus, the Korean government is considering the introduction of a BE mandate in which the legal blend is 5% BE and 95% gasoline (E5) until 2020 in order to expand BE use. We should examine the public acceptability of the introduction, which incurs a rise in the fuel price. This study attempts to assess the public's willingness to pay (WTP) a premium for introducing the E5 program in Korea. To this end, a contingent valuation (CV) survey of 1000 randomly selected consumers was conducted in 2014 across the nation. We used a one-and-one-half-bound dichotomous choice question in the CV survey and applied the spike model to handle the WTP data with zeros. The mean WTP, a premium for the E5 per liter, is estimated to be KRW 290 (USD 0.27), which is statistically meaningful at the 1% level. This value amounts to 15.6% of the gasoline retail price in 2014 (KRW 1856 or USD 1.70) and can be interpreted as the external benefit of BE. We can conclude that gasoline consumers in Korea are ready to pay a significant premium for the E5.

1. Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) holds the increase in the global average temperature below 2 °C above pre-industrial level. All countries that signed the UNFCCC were asked to submit Intended Nationally Determined Contributions (INDC). Korea plans to reduce its greenhouse gas (GHG) emission by 37% from the business-as-usual (BAU) level by 2030 across all economic sectors. In the transport sector, the Korean government is introducing low-carbon standards for emissions produced by automobiles (United Nations Framework Convention on Climate Change, 2015).

The transportation sector emits carbon dioxide (CO_2) and other global warming emissions by using fossil fuel. In contrast, most renewable fuels can significantly mitigate GHGs and emissions of air pollutants. Consequently, biofuel is considered to be a good alternative to reduce CO_2 emissions (Intergovernmental Panel on Climate Change, 2014). The global production of biofuels has been growing steadily. According to the International Energy Agency (2015), biofuels provide 4% of total road transport fuel globally (on an energy basis), and will be reaching around 4.3% in 2020. In particular, the use of bioethanol (BE), the same type of alcohol found in alcoholic beverages, can contribute to the reduction of the emissions of GHGs (e.g., see Larsen et al., 2013; Tao et al., 2011). BE is most often used as a motor fuel, mainly as a biofuel additive for gasoline. BE is a clean fuel made from very common crops such as sugar cane, potatoes, cassava and corn and is readily available for any gasoline engines. Global BE production is projected to almost double over the next 10 years (180 billion liters by 2021) (Blanco et al., 2013).

Many countries establish a program: a minimum volume of renewable fuels must be blended into transport fuels. For example, the U.S. renewable fuel standard program included an E85 program (a blend of 85% BE and 15% gasoline) (United States Environmental Protection Agency, 2016), and Brazil has been allowed to add up to 5% of biodiesel to diesel since 2010 (Nogueira and Capaz, 2013). Furthermore, producers of BE blend benefit from the reduced rate of excise duty in the United Kingdom (Government of the United Kingdom, 2016).

The Korean government is also considering the introduction of the renewable fuel standard, which is mandated to blend biofuel with conventional fuel (Ministry of Trade, Industry and Energy, 2008). The BE mandate suggested that the 5% BE and 95% gasoline (E5) be legally blended until 2020. Through the E5 mandate, Korea will enjoy reductions in CO_2 emissions, a decrease in emissions of air pollutants, an increase in energy security by reducing crude oil imports from abroad, and the creation of new jobs related to BE production and distribution.

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This will raise the production cost of fuel, and consequently consumers will incur a rise in its price. In this regard, the public acceptability of the rise should be investigated to inform the decision-making about whether E5 policy is implemented or not, and/or an effective enforcement of it. That is, the public acceptability of introducing the E5 policy should be measured in monetary units. If the public supports the implementation of it, they will be willing to pay a premium for E5 over conventional gasoline.

Thus, we have attempted to assess public acceptability of the BE policy even though gasoline price will rise in Korea. To this end, we elicit the public's additional willingness to pay (WTP) for E5 instead of conventional gasoline by using a contingent valuation (CV) method. The remainder of the paper is made up of four sections. A short review of earlier related studies is provided in Section 2. The methodology adopted in this study and the data used here are explained in Section 3. The empirical results are reported and discussed in Section 4. The paper is concluded in the final section.

2. A short review of earlier related studies

A summary of the findings from some previous studies that measured the WTP a premium of biofuels using stated preference techniques such as a CV survey or choice experiment is presented in Table 1. Most studies are conducted in the United States (US) and European countries. For example, Solomon and Johnson (2009) used a CV method to understand the public's valuation of mitigating global climate change through its WTP for biomass or cellulosic ethanol in the US. The mean total WTP for expanding use of cellulosic ethanol was found to be USD 556 per capita per year.

Petrolia et al. (2010) analyzed consumers' preferences for fuel blends, E10 (a blend of 10% BE and 90% gasoline for use in standard vehicles) and E85 (a blend of 85% BE and 15% gasoline for use in flex-fuel vehicles) in the US. That is, they estimated additional WTP for them by the use of a nationwide CV survey. The results indicate that consumers of E10 and E85 are inclined to pay USD 0.12 and 0.15 per gallon of gasoline premium, respectively. Skevas et al. (2016) elicit landowners' willingness to supply marginal land for bioenergy crops using CE, and they are willing to rent at a rate of USD 100–300 per acre. Using a choice experiment based on a national survey of consumers, Jensen et al. (2010) estimated the US consumers' WTP for E85 (automotive fuel blend of 85% BE and 15% gasoline). The finding from the study implies that additional WTP estimates for E85 from corn, switchgrass, and wood wastes are USD 0.14, 0.19, and 0.17 per gallon, respectively.

Table 1
Summary of the findings from some previous studies dealing with a premium for biofuel.

Countries	Sources	Methodologies[a]	Mean willingness to pay estimates
United States	Solomon and Johnson (2009)	CV	USD 556 per person per year for expanding use of cellulosic ethanol
United States	Petrolia et al. (2010)	CV	USD 0.12 per gallon of gasoline (E10) surcharge USD 0.15 per gallon of gasoline (E85) surcharge
United States	Jensen et al. (2010)	CE	USD 0.14 per gallon for E85 from corn surcharge USD 0.19 per gallon for E85 from switchgrass surcharge USD 0.17 per gallon for E85 from wood waste surcharge
United State	Skevas et al. (2016)	CV	Landowner is willing to supply land for bioenergy crops at USD 100–300 per acre
Greece	Savvanidou et al. (2010)	CV	EUR 0.06–0.079 per liter of biofuels surcharge
Spain	Loureiro et al. (2013)	CV	EUR 0.07 per liter of gasoline EUR 0.08 per liter of biodiesel surcharge
Italy	Cicia et al. (2012)	CE	EUR 40.06 per household bi-monthly for biomass power
Italy	Lanzini et al. (2016)	CE	EUR 0.01–0.14 per liter of biofuel surcharge

Note.
[a] CV and CE indicate contingent valuation and choice experiment, respectively.

With regard to biofuels in the EU, people revealed their opinion to shoulder a burden with an additional WTP a premium for biofuels. Savvanidou et al. (2010) suggested that consumers are surcharged EUR 0.06–0.079 per liter for biofuels. Loureiro et al. (2013) investigated the data from a survey of Spanish households aimed at measuring preferences for climate change policies and found a positive WTP (in the form of higher car fuel prices) for a policy to reduce GHG emissions through biofuels. Cicia et al. (2012) discovered that consumers who have a strong preference for green energy are willing to pay EUR 40.06 more every two months to be able to use electrical energy from biomass power. Lanzini et al. (2016) examined consumers' WTP for biofuels and detected that most respondents reported their WTP an amount of up to EUR 0.14.

As shown in Table 1, many studies have examined the consumer's WTP for biofuels by employing the CV method, one of the most popular methods used by environmental and resource economists to value environmental and non-market goods. The authors found various empirical evidences in which people have a WTP for biofuels in the literature. Of the above-mentioned eight case studies presented in Table 1, five studies used CV. There are public opinions regarding consuming biofuel with a significant premium payment. As people could surcharge for using extra biofuel, it means they estimate biofuel blending programs positively.

There are the number of studies that dealt with consumer preferences for renewable energy using a CV approach (Oerlemans et al., 2016). For example, some studies recently analyzed the WTP for green electricity. Kim et al. (2013) examined the willingness for Korea consumers to pay a premium for renewable electricity under a differentiated good framework, Guo et al. (2014) estimated the WTP of Beijing residents for renewable electricity and identified the factors which affect their WTP, and Lee and Heo (2016) identified the level of acceptance for electricity generated with renewable energy in Korea by estimating Korean consumers' additional WTP. Thus, the strategy of employing CV in our study is consistent with the practices of former studies.

3. Methodology and data

3.1. Goods to be valued

The goods to be valued in this study is obviously the dollar value of the public acceptability for consuming BE or a premium for BE over conventional gasoline. More specifically, we assess the governmental policy of introducing the E5 mandate until 2020 in order to expand the use of BE. The instruments to accomplish the policy include: regulating and monitoring strongly the blend of BE by oil-refining companies, expanding the farms for plants from which to extract BE by using idle agricultural and reclaimed lands, improving the system of gathering and reusing cooking oil to increase its use, and financially supporting the research and development of technology for low-cost production of BE.

The expected effects from the policy implementation are summarized as four-fold. First, the E5 mandate contributes to the reduction of GHG emissions. Second, the use of BE from domestic sources improves the trade balance in that most of the petroleum consumed in Korea is imported from abroad. Third, the use of BE from domestic sources reduces energy dependency and increases the supply security of fuels. Fourth, the E5 mandate stimulates the research and development of