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Consumer preferences and willingness to pay for advanced vehicle technology options and fuel types

Jungwoo Shin [a,1], Chandra R. Bhat [b,c,*], Daehyun You [d,2], Venu M. Garikapati [d,2], Ram M. Pendyala [d,3]

[a] Environmental Policy Research Group, Korea Environment Institute, 370 Sicheong-daero, Sejong-si 339-007, South Korea
[b] The University of Texas at Austin, Department of Civil, Architectural and Environmental Engineering, 301 E. Dean Keeton St. Stop C1761, Austin, TX 78712, United States
[c] King Abdulaziz University, Jeddah 21589, Saudi Arabia
[d] Georgia Institute of Technology, School of Civil and Environmental Engineering, Mason Building, 790 Atlantic Drive, Atlanta, GA 30332-0355, United States

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ABSTRACT

The automotive industry is witnessing a revolution with the advent of advanced vehicular technologies, smart vehicle options, and fuel alternatives. However, there is very limited research on consumer preferences for such advanced vehicular technologies. The deployment and penetration of advanced vehicular technologies in the marketplace, and planning for possible market adoption scenarios, calls for the collection and analysis of consumer preference data related to these emerging technologies. This study aims to address this need, offering a detailed analysis of consumer preference for alternative fuel types and technology options using data collected in stated choice experiments conducted on a sample of consumers from six metropolitan cities in South Korea. The results indicate that there is considerable heterogeneity in consumer preferences for various smart technology options such as wireless internet, vehicle connectivity, and voice command features, but relatively less heterogeneity in the preference for smart vehicle applications such as real-time traveler information on parking and traffic conditions.

1. Introduction

The automotive industry is going through a period of rapid change (CAR, 2010). In the past few years, automobile manufacturers and technology developers have been moving rapidly to develop advanced vehicular technologies, smart vehicle options, and alternative fuel types that enhance the driving experience and are cleaner and greener in terms of their carbon footprint. In addition to moving forward with the deployment of alternative fuel vehicles (such as hybrid, electric, natural gas, and hydrogen vehicles), many auto manufacturers are teaming up with technology providers to enhance the driving experience, both from a safety and a convenience perspective (Kirk, 2011; NIPA, 2013). Toyota is teaming up with

* Corresponding author at: The University of Texas at Austin, Department of Civil, Architectural and Environmental Engineering, 301 E. Dean Keeton St. Stop C1761, Austin, TX 78712, United States. Tel.: +1 512 471 4535; fax: +1 512 475 8744.
E-mail addresses: jwshin@kei.re.kr (J. Shin), bhat@mail.utexas.edu (C.R. Bhat), dyou31@gatech.edu (D. You), venu.garikapati@gatech.edu (V.M. Garikapati), ram.pendyala@ce.gatech.edu (R.M. Pendyala).
[1] Tel.: +82 44 415 7624; fax: +82 44 415 7644.
[2] Tel.: +1 404 894 2201; fax: +1 404 894 5418.
[3] Tel.: +1 404 385 3754; fax: +1 404 894 2278.

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Microsoft for the development of cloud telematics, and with RIM to offer a multimedia platform in vehicles that is compatible with both Android and Apple phones. Ford has teamed up with Microsoft to provide consumers the "SYNC" telematics platforms in select Ford vehicles and developed the "Hohm" application that provides information about electric power usage in Ford electric cars. General Motors has teamed up with Google to install an Android operating system in electric vehicles, and with Verizon to provide internet-based multimedia service in the GM OnStar platform. Likewise, Hyundai is collaborating with Samsung and Korea Telecom, and BMW is working in tandem with Vodafone, to develop communication modules and multimedia platforms in their respective vehicles (BusinessKorea, 2013). In the meantime, Google and a number of other auto manufacturers are moving forward with the development of self-driving or autonomous driving systems using a number of sensor-based systems (USA Today, 2012).

Technology development is occurring at a rapid pace, but there remains considerable debate about consumer preferences and willingness to pay for these emerging vehicular technologies and smart vehicle options. The rate at which these technologies, features, and fuel types penetrate the market depends substantially on whether consumers are interested in and willing to pay for these technologies and options. There are many potential benefits that advanced vehicular features and fuel types can offer. Sensor-based intelligent/autonomous driving systems can virtually eliminate human error, the primary contributing factor for highway crashes (Nelson, 2014). Multimedia platforms, when combined with intelligent and autonomous driving systems, could make the in-vehicle travel time more productive and enjoyable as vehicle occupants will be able to multitask during the trip. Alternative fuel types offer energy and environmental benefits in terms of a reduced carbon footprint. Advanced communication systems embedded in automobiles could lead to more efficient vehicular navigation and traffic flow, resulting in decreased congestion and elimination of critical bottlenecks (Kraan et al., 2000).

The planning community is grappling with the difficult task of understanding the implications of the advent of these technologies, smart vehicle options, and alternative fuel types in the marketplace. To effectively forecast and plan for the adoption of these technologies and options by consumers, a greater understanding of consumer preferences and willingness to pay for these technology options is needed. This paper aims to address this need by modeling consumer preferences and willingness to pay for smart vehicular options and applications using a stated preference data set collected from a sample of individuals in South Korea. As these options have not yet made their way into the marketplace in a significant way, typical revealed preference travel survey data will not include information on consumer preferences and willingness to pay for these emerging technologies and options. The use of stated choice experiments for understanding consumer preferences, adoption, and willingness to pay is well established in the field of transportation and choice modeling (Rose et al., 2009) and hence appropriate for a study of this nature.

The analysis presented in this paper consists of two parts. First, this study presents an analysis of consumer preferences for smart technology options and alternative fuel types using the multiple discrete–continuous probit (MDCP) model. The MDCP model is ideally suited for this modeling effort due to its ability to (1) accommodate consumer choices of multiple smart technology options simultaneously (multiple discreteness), (2) capture both the discrete choice and continuous usage dimensions embedded in consumer preferences, and (3) account for correlated unobserved factors that may affect these multiple choice dimensions. Within this paper, differences in preferences across socio-economic groups defined by age, income, and driving status are explored. Second, the study analyzes consumer willingness to pay (WTP) for smart options and technologies through the use of the multinomial probit model (MNP). This model offers the ability to account for heterogeneity in consumer preferences while relaxing the assumption of independence from irrelevant alternatives (IIA) that characterizes the logit-based discrete choice model formulations.

The remainder of this paper is organized as follows. The next section offers a brief discussion on emerging vehicular technologies, fuels, and options and recent work on modeling consumer preferences for these entities. The third section presents the modeling methods used in this paper while the fourth section offers a description of the survey data set. Results of model estimation are provided in the fifth section, and conclusions and directions for future research are presented in the sixth and final section.

2. Emerging vehicular technologies

The phrase "emerging vehicular technologies" refers to an array of intelligent navigation and safety systems, fuel options, communications devices, and multimedia platforms that are under development or finding their way into the marketplace. All of these options are intended to make the vehicle "smarter" and the term "smart vehicle" is used in this paper to reflect the array of technology and fuel options that constitute the heart of the emerging automotive revolution. To provide some clarity on the options considered in this paper, this section offers a definition of various terms in light of the emerging convergence of automotive and information technologies, and provides a description of the label "smart vehicle" as used in this study.

As noted by Kirk (2011), emerging automotive technology increasingly features mobile device connectivity and enables vehicle-to-vehicle communication and vehicle-to-infrastructure communication, resulting in the notion of *connected vehicles*. The connected vehicle offers the ability to perform various tasks and provides services on-the-go via mobile Wi-Fi. The *infotainment systems* that have recently appeared in some vehicle models combine information and entertainment, allowing users to connect to in-vehicle entertainment and multimedia systems. The infotainment systems may be included in vehicles regardless of whether they are connected vehicles. The recently launched in-car application suites Ford SYNC,