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Factors Influencing the Purchase Intention of EVs Among Korean and Chinese Consumers

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Abstract

Purpose – Using the Model of Goal-Directed Behavior (MGB), this study identifies the critical factors that influence consumer intention to purchase an electric vehicle (EV). This study also provides differentiated policy implications to the Korean and Chinese governments and EV-related companies for the expansion of the EV market in both countries by comparing consumers' perceptions of EV purchase intentions.

Design/methodology – Our extended MGB model adds to the standard model consideration of financial incentives, perceived risks, and environmental concerns. An online survey was conducted of Korean and Chinese consumers. Based on the collected responses, all tested hypotheses were verified using PLS-SEM (Partial Least Squares-Structural Equation Modeling). Differences in the path analysis results between Korea and China were compared and verified using Henseler's MGA (multi-group analysis), the parametric test, and the Welch-Satterthwaite test.

Findings – The most critical factor that influences the intent to purchase an EV in consumers from both countries is personal desire. PBC and SN were identified as the critical factors that respectively increase personal desire in Korea and China. In addition, in Korea, among the three factors EC, FIP, and PR, environmental concerns were found to have the most significant impact on attitudes and purchase intention. In contrast, in China, economic factors (specifically financial incentives) had greater importance than environmental issues.

Originality/value – This study has academic contributions in that it presents a new research model that includes financial incentive policies, environmental concerns, and perceived risk variables based on the MGB to explore consumers' purchase intentions. This study can also make a practical contribution in that it provides some meaningful implications to the governments and EV-related companies of both countries based on the differences in the analysis results of the Korean and Chinese markets.

Keywords: Environmental Concern, Electric Vehicle (EV), EV Expansion Policy, Financial Incentive, Model of Goal-directed Behavior (MGB), Perceived Risk

JEL Classifications: F23, L62, M16, M31, O53

1. Introduction

In the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement, the contracting countries express their common goals and

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obligations, and articulate their responsibility for reducing greenhouse gas emission across industrial sectors, including the transportation, logistics, and energy sectors. In the transportation sector, many countries are introducing new strategies to switch drivers from internal combustion engine vehicles (ICEVs), which produce relatively high carbon emissions and therefore cause climate and environmental problems, to electric vehicles (EVs), which emit a relatively low amount of carbon (Santos, 2017).

The expansion of EVs is widely recognized as among the best means of combating climate change (Singh et al., 2020; Ellingsen et al., 2016), with many countries actively encouraging the sale and use of EVs through government policies. For example, in 2021 the United States implemented policies incentivizing infrastructure construction and EV purchases (Federal EV Policy, 2021). In India, the 2013 National Electric Mobility Plan 2020 (NEMMP 2020) increased the share of EVs in the automobile market. The German government has been financially supporting EVs by adopting the 2030 Climate Action Program, which provides for expanded EV distribution and related infrastructure in 2019. The Chinese government, for its part, has issued a Notice of the General Office of the State Council on the Issuance of the Development Plan for the New Energy Vehicle Industry (NDPNV, 2021-2035), which aims to increase new-generation EV vehicle sales to 20% of total vehicle sales by 2025 (www.gov.cn). The government of South Korea is also aiming to reduce automobile greenhouse gas emissions by 24% by incentivizing the supply of 7.85 million eco-friendly vehicles, including EVs, by 2030 (www.korea.kr). Yet despite these efforts at the government level, EV sales and usage remain at a negligible level (Ye et al., 2021).

EVs are also consumer goods, and the decision whether to purchase an EV depends on each consumer's judgment and intention (Bockarjova & Steg, 2014). In other words, the success or failure of government policies intended to expand the EV market ultimately depends on the decisions of individual consumers. Therefore, in order to increase the market share of EVs, it is necessary to understand consumers' attitudes towards EVs, their emotional responses before purchasing, and the psychological factors that affect their decision to purchase EVs (Chu et al. 2019). In fact, psychological factors were found to be more complex than demographic, situational, and contextual behavioral intentions for EVs (Singh et al., 2020). Most of the current research on predicting consumers' intention to purchase EVs is mainly based on the TPB theoretical framework (Dutta & Hwang, 2021; Hamzah & Tanwir, 2021; Huang & Ge, 2019; Kaplan et al., 2016; Li et al., 2020 Tu & Yang, 2019; Vafaei-Zadeh et al., 2022) and lacks the exploration of other psychological factors such as potential consumer emotions and desires (Perugini & Bagozzi, 2001). To better explain the psychological factors of potential consumers that affect the purchase intention of EVs, this study uses the extended theoretical model MGB of TPB as the basic research framework.

In addition, we also found that most of the current studies have examined the behavioral intentions of consumers to purchase EVs in a country, but cross-cultural studies are rare (Song et al., 2022). In this study, we compared the purchase intentions of potential consumers of EVs in Korea and China. A comparison between China and Korea is meaningful for several reasons. First, as China is a representative developing country, understanding the characteristics of Chinese consumers and the auto market is of great significance to auto exporting countries (Helveston et al., 2015). Second, consumers in developing countries may shift their green consumption patterns to those in developed countries as their economy progresses (Bong Ko & Jin, 2017). Therefore, comparing South Korea and China can help predict the changing pattern of the auto market in developing countries. Finally, Car-

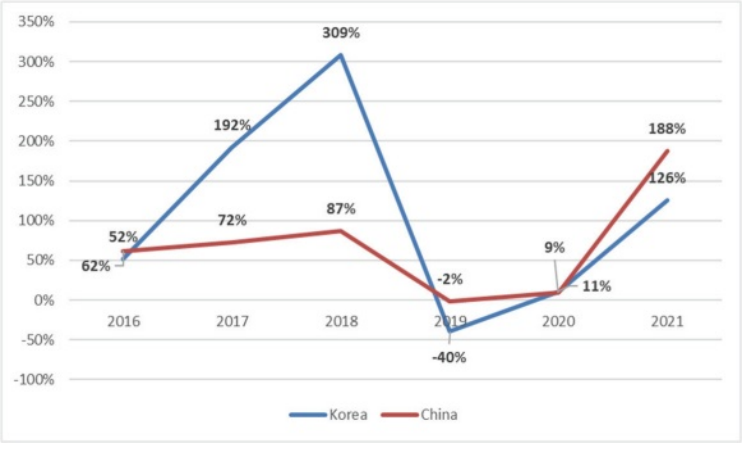
producing countries hope that their automakers can gain competitiveness in the international market. By comparing the willingness of potential consumers of EVs in developed and developing countries, it will help automakers make appropriate development layouts for different markets.

This study analyzes the structural relationships among variables that affect EV purchase intentions among consumers. By focusing on the two markets of Korea and China, which have similar cultural backgrounds (Ye et al., 2021; Chu, et al., 2019), this study isolates critical factors that expand the EV market. To do so, it applies an expanded model of goal-directed behavior (MGB) from the consumer's point of view. This study also reviews the key psychological factors that influence consumers' intention to purchase EVs in both countries by comparing consumers' perceptions of EVs in the two countries. Unlike previous studies, this study relied on a new extension model with an added relationship hypotheses to the effect that government financial incentive policy, consumer environmental concerns, and perceived EV risk affect consumer attitudes toward EVs and their purchase intentions.

2. EV market in Korea and China

The automobile industry in Korea and China operates with relative comparative advantage, and both countries are included in the top 5 automobile producing countries as of 2021 (OICA, 2022). As shown in Figure 1, there is a big difference in absolute figures when EV production volume between Korea and China. The EV sales growth rate is greater in Korea than in China prior to 2018, but both have shown a similar growth rate since then.

Fig. 1. EV sales growth in Korea and China



Source: IEA (2022).

The Korean EV market formed relatively late. The Korean government declared its goal of achieving carbon neutrality by 2050 and is expanding the supply of EV vehicles in the country. Thanks to its aggressive fuel cell EVs (FCEVs) expansion policy, Korea has already surpassed the US and China with more than 1 million units as of 2020 (Kim & Heo, 2019;

IEA, 2021). The Korean mechanisms of expanding the EV market can be divided into forms of financial and operational support. Financial support includes subsidies and tax cuts for consumers who purchase EVs, while operational support consists of reductions in tolls and parking fees for covered vehicles.

The Chinese government plans to increase the number of EVs to 7 million by 2025 and ban the sales of ICEVs by 2040 (Song et al., 2022). The Chinese government has taken other steps to encourage the purchase of EVs. For example, some local governments, including Beijing, Shanghai, Guangzhou, and Tianjin, provide subsidies as well as policy incentives, including the deregulation of license plates, provision of exclusive lanes, exemption from traffic regulations, and dedicated parking spaces (Diao et al., 2016). However, in recent years, the scale of subsidies has been gradually reduced (Wang et al., 2019b).

3. Literature review and hypotheses

3.1. The Model of Goal-directed Behavior (MGB) Model and Related Hypotheses

MGB is one of a widely used theory used to examine consumer intention and behavior through an examination of extended psychological factors (Chen et al., 2016; Chiu et al., 2018; Han & Ryu, 2012). MGB is, in fact, an extended version of the Theory of Planned Behavior (TPB), with the difference being that the desire factor is treated as an important intervening variable that induces motivation (Chen, 2013). In MGB model, desire is defined as a psychological state that emerges during an individual's decision-making. Desires represent volitional motivation and incorporate the emotional, cognitive, self-awareness, and social perspectives into the decision-making process (Perugini & Bagozzi, 2004). In other words, the desire in MGB is close to intention, and many researchers accordingly use desire as a parameter in their studies of the intention forming process (Han & Ryu, 2012; Perugini & Bagozzi, 2001; Taylor et al., 2009).

Another difference between MGB and TPB is the addition of positive and negative anticipated emotion factors to the TPB model. Positive and negative emotions create associated motives (Bagozzi & Dholakia, 2006; Leone et al., 2004). Some studies emphasize the inherent reasonableness of adding expectation emotions to the Theory of Reasoned Action (TRA) and TPB, as this enhances the predictive ability of individual behaviors (Lee et al., 2012; Taylor et al., 2016; Yim & Byon, 2021). For this reason, the MGB model has been used to predict human behavioral intentions and behaviors across research areas, including examinations of tourist (Meng & Choi, 2016; Song et al., 2014; Zhang et al., 2018) and consumer behaviors (Chiu et al., 2018; Ko, 2020). The application of this model is continuously expanding to ever more diverse academic fields. To date, most studies concerning EV selection have been based on the TPB model, with only a few applying MGB (Park et al., 2018; Smith et al., 2017; Tu & Yang, 2019; Will & Schuller, 2016; Singh et al. 2020).

In the MGB model, attitudes (ATT), subjective norms (SN), positive anticipated emotions (PAE) and negative anticipated emotions (NAE), as well as perceived behavioral control (PBC) are treated as the key factors that influence desire (DES) (Chiu et al., 2018). DES plays a vital role in that it is perceived as a more powerful predictor than ATT and SN (Sutton, 1998).

SN refers to social pressure felt by an individual. The thoughts and judgments of others can influence an individual's behavioral judgments (Ajzen and Fishbein, 1975; Ajzen, 1991). PAE

and NAE represent the psychological feelings associated with performing certain actions and function that are themselves determinants of the DES (Perugini and Bagozzi, 2001; Chiu et al., 2018). PBC is a concept like self-efficacy, which refers to an individual's belief that behavior is under one's control (Ajzen, 1991). In MGB, DES is affected by the ATT, PAE, NAE, SN, PBC, and DES provides a direct stimulus to intention. Finally, intention can influence the BI (Behavioral Intention) (Perugini & Bagozzi, 2001, 2004).

Previous studies have shown that ATT, SN, PAE, NAE, and PBC are each important in the formation of desire (Chiu et al.,2018; Kim et al., 2023; Lee et al., 2012; Meng & Choi, 2016; Song et al., 2014; Yim & Byon, 2021). Carrus et al. (2008) analyzed behavioral intentions to use public transport using the MGB. Their results showed that attitudes, subjective norms, perceived control, expected emotions, past behaviors, and desires exert a significant effect on pro-environmental behavioral intentions. Chiu et al. (2018) investigated consumer intent to purchase sporting goods online, and confirmed that attitudes, subjective norms, positive anticipated emotion, and negative anticipated emotion affect their desire, and that this desire has a positive effect on purchase intention.

With reference to these prior studies, the following relational hypotheses were set up to explore the factors that shape the purchase intention of EVs.

H1-1: Attitude positively affects consumer desire to purchase EVs.
H1-2: Subjective norm positively affects consumer desire to purchase EVs.
H1-3: Positive anticipated emotion positively affects consumer desire to purchase EVs.
H1-4: Negative anticipated emotion positively affects consumer desire to purchase EVs.
H1-5: Perceived behavioral control positively affects consumer desire to purchase EVs.
H2: Desire positively affects consumer intent to purchase EVs.

3.2. Financial Incentive Policies for the Expansion of EVs and Hypotheses

The government policies in place to expand EV supply in Korea and China are very similar. The EV-related policies of the Korean and Chinese governments can be broadly divided into two categories: those that provide financial support and those that provide other forms of support (Coffman et al., 2017; Kim et al., 2018; Li et al., 2017b). Financial support includes EV purchase subsidies, auto tax exemptions, and parking fee discounts. Other policies are designed to expand operational convenience by providing, for example, charging infrastructure and EV-dedicated parking spaces (Kim et al., 2018; Li et al., 2020).

For EV purchase subsidies, the size of the subsidy differs by region in the two countries. The reason is that the amount of the subsidy is determined by the local government as well as the central government. Generally, the subsidies that local governments provide are higher than those provided by the central government (Wang et al., 2017). Since consumers want to purchase products at a lower price, subsidy levels may determine their positive purchase intentions and attitudes toward EVs. In this context, some studies have discussed the impact of financial incentives on EV purchase attitudes and purchase intentions (Huang & Ge, 2019; Wang et al., 2021; Ye et al., 2021).

Financial incentives, such as subsidies, are perceived by consumers as additional benefits, facilitating positive beliefs among consumers, and influencing their positive attitudes and intentions (Ajzen & Fishbein, 1975; Wang et al., 2021). Li et al. (2017b) investigated the intention to purchase EVs in 14 international cities and found that subsidies and tax policies were important drivers of intent formation. Li et al. (2018) later found that purchase subsidies

are the most critical determinant of EV adoption by Chinese consumers. Kim et al. (2018; 2019) determined that financial supports positively influence the adoption and promotion of EVs by Korean consumers.

Therefore, based on previous studies, the following relational hypotheses were established:

H3-1: Financial incentive policies positively affect consumer attitudes toward the purchase of an EV.
H3-2: Financial incentives policies positively affect the intent to purchase an EV.

3.3. Perceived Risks and Related Hypotheses

Perceived risk refers to the anticipated negative utility that consumers associate with purchasing a particular product or service (Dunn et al., 1986). During the purchase process, consumers not only consider the immediate benefits, but also reflect on the long-term impact of the purchase (Li et al., 2017). The development of EVs in most countries is still in its infancy, and some consumers are unsure about the safety of EVs, which can easily have a negative impact on EV adoption.

Wang et al. (2018) divided the risks associated with EVs into five categories: performance risk, physical risk, financial risk, time risk, and psychological risk. Performance risk refers to uncertainty about EV technology and its functions. Consumers often feel anxiety and uncertainty about the maximum mileage, driving speed, and maximum mileage of EVs relative to gasoline vehicles (Jensen et al., 2013; White and Sintov, 2017). Physical risk refers to the uncertainty surrounding EV technology, safety, and reliability (Li et al., 2017a; Wang et al., 2018; Yang et al., 2020). For example, accidents from battery fires potentially causing greater physical injury are an anxiety of consumers. Financial risk refers to the economic losses that consumers are concerned they may suffer in the event of a problem with their EV (Wang et al., 2018). The repair cost of EVs is relatively high compared to gasoline vehicles, which can potentially cause resource and economic loss to consumers (Degirmenci & Breitner, 2017; Kim et al., 2018). Time risk refers to the fact that consumers can waste time by using EVs. Although EV infrastructure has evolved rapidly in recent years, finding a charging station, or requiring a long charging time remains a problem (Li et al., 2017a; Featherman et al., 2021). Finally, psychological risk arises primarily from a mismatch between the product and a consumer's self-image. Consumers are concerned that products may not reflect their social status and self-image, which can have a negative impact on the ultimate purchase of the product (Li et al., 2018; Wang et al., 2018). Therefore, the impact of perceived risk is often reflected in consumer decision-making processes, particularly when the purchase or consume new products or services (Featherman & Pavlou, 2003; He et al., 2018; Jaiswal et al., 2020; Qian & Yin, 2017; Wang et al., 2018; Yang et al., 2020; Hong et al., 2020).

Perceived risks can have a negative impact on consumer attitudes towards adopting or purchasing an EV (Wang et al., 2018), and therefore directly or indirectly effects consumer behavioral intentions (Jain et al., 2021; Kim et al., 2018; Qian & Yin, 2017; Wang et al., 2018). The risks associated with the purchase and use of EVs may cause consumers to hold a negative attitude and intention toward EVs.

We therefore hypothesized as follows:

H4-1: Perceived risks negatively affect consumer attitudes toward the purchase of an EV.
H4-2: Perceived risks negatively affect consumer intention to purchase an EV.

3.4. Environmental Concerns and Related Hypotheses

Environmental concerns are probably one of the most widely studied determinants of consumer EV adoption in the current literature (Carley et al., 2013; Chu et al., 2019; Hidrue et al., 2011; Ju and Kim, 2022; Wang et al., 2017). Environmental concerns refer to people's understanding and awareness of environmental issues (Schuitema et al., 2013; Yeung, 2004). Lopes et al. (2014) showed that consumers with deeply held environmental concerns perceive the purchase of low-carbon products as important to protecting the environment. Consumers with environmental concerns may change their decision-making behavior as they assess the ecological impact of their actions (He et al., 2018).

EVs are regarded as a sustainable means of transportation that can reduce greenhouse gas emissions (Featherman & Pavlou, 2003; Larson et al., 2014). The environmental concerns of EV buyers inform their preferences and motivations (Axsen et al., 2015). When consumers have a stronger attitude towards the environment, they will show stronger preferences and attitudes towards EVs (Jensen et al., 2013), which will lead to higher consumers' interest in and willingness to purchase EVs (Carley et al., 2013).

Bamberg (2003) confirmed that environmental concerns impact an individual's behavioral intentions through their attitudes. Other studies have shown that higher interest in the environment positively impacts individual attitudes and their intent to adopt or purchase green products such as EVs (He et al., 2018; Wang et al., 2016; Wu et al., 2019; Shalender & Sharma,2021).

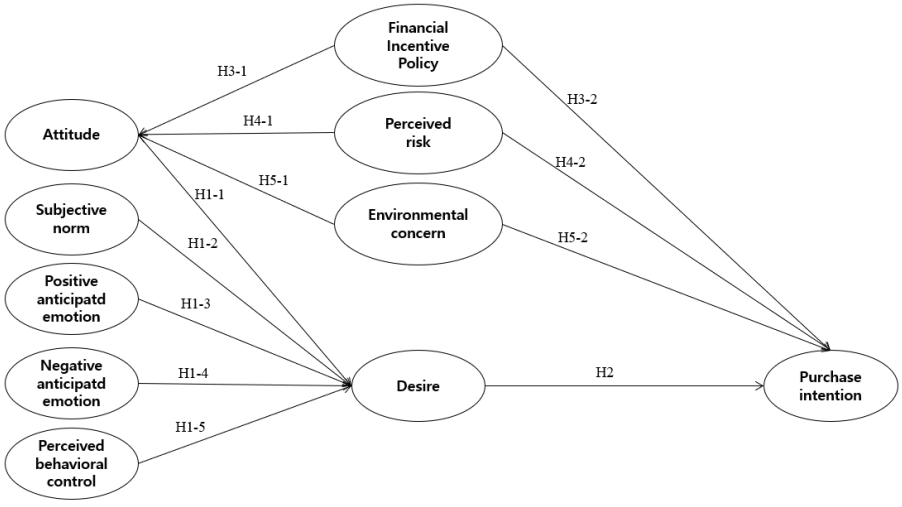
We therefore formulated the following hypotheses:

H5-1. Environmental concerns positively affect consumer attitudes toward the purchase of an EV.

H5-2. Environmental concerns positively affect consumer intent to purchase an EV.

Fig. 2 is a pictorial representation of the research hypotheses presented above.

Fig. 2. Research Model



4. Methodology

4.1. Research Design

This study conducted an online survey targeting Korean and Chinese consumers by administered by Dooit Survey (www.dooit.co.kr) in Korea and Questionnaire Star (www.Sojump.com), a Chinese research institute. All measurement items in the questionnaire were based on questions developed into prior literature, and all responses were measured on a 5-point Likert scale (Table 1).

Table 1. Latent variables and measurement items

Constructs	Operational Definitions	Items	Measurement items	Source
Attitude	Assessment of an individual's behavior	ATT1	I think it's a good idea to buy an EV.	Ajzen (1991), Chiu et al. (2018).
		ATT2	I think it's wise to buy an EV.	
		ATT3	I think buying an EV is worth it.	
		ATT4	I think it is advantageous to buy an EV.	
Subjective Norm	Social pressures on individuals	SN1	If the people around me use EVs, I will buy it too.	Ajzen (1991), Huang & Ge, (2019).
		SN2	People who influence me (family, friends, etc.) think I should buy an EV.	
		SN3	News media ads will prompt me to buy an EV.	
		SN4	People in my social environment currently drive EVs.	
Positive Anticipated Emotion	Positive emotions/feelings about future consequences	PAE1	If I could buy an EV, I will be excited.	Chiu et al. (2018) Meng & Choi, (2016).
		PAE2	If I could buy an EV, I will be glad.	
		PAE3	If I could buy an EV, I will be happy.	
		PAE4	If I could buy an EV, I will be satisfied.	
Negative Anticipated Emotion	Negative emotions/feelings about future consequences	NAE1	I'm worried if I can't buy an EV.	Chiu et al. (2018), Meng & Choi, (2016)
		NAE2	I'll be disappointed If I can't buy an EV.	
		NAE3	I'll be sad If I can't buy an EV.	
Perceived Behavioral Control	Reflects the self-esteem and ability of the individual to act	PBC1	whether I purchase EVs is completely up to me.	Ajzen (1991), Chiu et al. (2018), Huang & Ge (2019).
		PBC2	If I want, I can purchase EV.	
		PBC3	I can afford to buy an EV.	
		PBC4	I have enough money to purchase EV.	
Desire	The desire to buy an EV	DES1	I want to buy an EV in the future.	Perugini & Bagozzi (2001), Chiu et al., (2018)
		DES2	I have the desire to buy an EV in the future.	
		DES3	I hope to buy an EV in the future.	

Table 1. (Continued)

Constructs	Operational Definitions	Items	Measurement items	Source
Financial incentive policy	Consumer perceived benefits of financial policy.	FIP1	Overall, the financial policy helped me purchase EVs.	Kim et al. (2018), Wang et al. (2017).
		FIP2	Financial subsidies help me purchase EVs.	
		FIP3	Reducing purchase-related taxes helps me purchase EVs.	
Perceived Risk	Consumer perceptions of EV risks.	PR1	I am afraid of financial loss when using EVs.	Wang et al. (2018).
		PR2	I wouldn't feel completely safe when driving an EV on the road.	
		PR3	Considering the shortcomings of EVs (mileage limitation, long charging time, etc.), I think that using EVs can cause significant time loss.	
		PR4	I am concerned about whether EVs can perform as well as conventional gasoline vehicles.	
Environmental Concern	Consumers' consideration and awareness of environmental issues.	EC1	I get angry when seeing environmental damage.	Wang et al. (2019a).
		EC2	I am very interested in environmental protection, green consumption, and other related knowledge.	
		EC3	Each of us has an obligation to protect the ecological environment.	
		EC4	Limited resources and environmental pollution have threatened human health.	
Purchase Intention	Intention of individual behavior	PI1	I plan to buy an EV in the future.	Chiu et al. (2018).
		PI2	Next time I want to buy an EV.	
		PI3	I will try my best to buy an EV in the future.	
		PI4	I will try to buy an EV next time.	

The questionnaire was initially completed in English and later translated into Korean and Chinese respectively. Prior to a full-scale survey, a pilot test was conducted by emailing 50 questionnaires to Chinese and Korean consumers. Based on their responses, the questionnaire was revised and supplemented. This helps to improve the construct validity of the questionnaire (Bisbe et al., 2007).

Questionnaires are randomly sent to consumers who have reached the legal age and can obtain a driver's license through questionnaire survey companies in South Korea and China. Data for South Korea were collected between July and August 2021. A total of 398 questionnaires were collected, and after excluding 28 invalid questionnaires that were not fully answered or answered all the questions the same, the final 370 valid questionnaires were used for data analysis. The data in China was collected between June and August 2021. A total

of 636 questionnaires were recovered. Similarly, after excluding 136 invalid questionnaires that were not fully answered or had the same answers to all questions, the final 500 valid questionnaires were used for data analysis. Table 2 shows the demographic characteristics of the respondents to the valid questionnaire.

Table 2. Demographic characteristics (Korea = 370, China = 500)

Items		No. of Questionnaire (Korea)	%(Korea)	No. of Questionnaire (China)	%(China)
Gender	Male	172	46.5	255	51
	Female	198	53.5	245	49
Age	21~30	85	23	230	46
	31~40	106	28.6	196	39.2
	41~50	100	27	54	10.8
	≥51	79	21.4	20	4
Education	Below high school	1	0.3	34	6.8
	High school	34	9	23	4.6
	Associate's degree	65	17.6	100	20
	Bachelor's degree	200	54.1	299	59.8
	Master's degree or higher	37	10	44	8.8
Vehicle possession	No vehicle	122	33	123	24.6
	Gasoline vehicle	174	47	268	53.6
	Diesel vehicle	55	14.9	6	1.2
	Electric vehicle	4	1.1	67	13.4
	Own two or more vehicles	15	4	36	7.2
Total		370	100	500	100

As seen in Table 2, the gender ratio of the respondents from both countries was similar. In China, the proportion of respondents in their 20s and 30s was very high, but in Korea, respondents were relatively evenly distributed by age. Responses from Korea and China showed the highest gasoline vehicle ownership rates at 47% and 53.6%, showing that gasoline vehicles still dominate the automobile market. There is a notable gap in the number of diesel and EVs owned by consumers. The share of diesel vehicles was significantly higher in Korea, while the EV percentage was considerably higher in China.

4.2. Methodology

The data was analyzed using structural equation modeling (SEM) using partial least squares (PLS). PLS-SEM is an SEM method based on synthetic and causal prediction, which is used to explain the relationships and structural causality among the conceptual factors (Law & Fong, 2020; Rigdon, 2012: Han et al., 2018). In addition, this allows for the handling of complex models and does not require a normal distribution of data (Huang & Shiau, 2017; Roh et al., 2021). SEM evaluation using PLS is based on a two-step evaluation method in which the measurement model is evaluated first, after which the structural equation model is evaluated if no problems are found in step one (Chin, 2010; Hair et al., 2011).

In this study, reliability and validity were first reviewed using SPSS, after which a two-step analysis was performed through PLS. Differences in path analysis between Korea and China were compared using Henseler's multi-group analysis (MGA), a parametric test, and a Welch-Satterthwaite test.

5. Results

5.1. Analysis of the Measurement Model

As the measurement items for the questionnaire were derived from previous studies applying the TPB, TRA, and MGB, we first conducted a confirmatory factor analysis to analyze the measurement model. Through confirmatory factor analysis, we evaluated whether the covariance matrix of the data matched the estimated covariance matrix of the research model. In other words, we confirmed that the measurement model was free from problems by checking whether the research model fit the data, and had internal consistency, convergent validity, discriminant validity, and reliability.

Table 3 shows the average variance extracted (AVE), composite reliability (CR), and Cronbach's α coefficient of each latent variable in two groups: Korea and China Measurement model analysis showed that the factor loading value of the PBC1 item was low and the AVE value was less than 0.5. Therefore, this was analyzed again, now with PBC1, removed.

For reliability and the internal consistency of the measurement items, in Korea and China, the Cronbach's α value of the latent variables exceeded the recommended standard of 0.6 (Fornell & Larcker, 1981), and the CR value also exceeded the recommended standard of 0.7, confirming high reliability and internal consistency. In addition, the AVE values of all latent variables exceeded the standard value of 0.5 (Hair et al., 2016), indicating appropriate convergent validity.

Table 3. Reliability and validity analysis (Korea = 370, China = 500)

Latent variables		Loadings		C.R.		AVE		Cronbach's α	
	Items	Korea	China	Korea	China	Korea	China	Korea	China
Attitude (ATT)	ATT 1	0.845	0.842	0.919	0.900	0.738	0.691	0.882	0.851
	ATT 2	0.869	0.833						
	ATT 3	0.865	0.826						
	ATT 4	0.857	0.825						
Subjective Norm (SN)	SN 1	0.905	0.856	0.919	0.887	0.739	0.662	0.881	0.829
	SN 2	0.823	0.853						
	SN 3	0.813	0.763						
	SN 4	0.905	0.779						
Positive Anticipated Emotion (PAE)	PAE 1	0.919	0.847	0.951	0.907	0.829	0.708	0.931	0.863
	PAE 2	0.892	0.833						
	PAE 3	0.927	0.851						
	PAE 4	0.903	0.836						
Negative Anticipated Emotion (NAE)	NAE 1	0.892	0.812	0.940	0.921	0.840	0.796	0.905	0.882
	NAE 2	0.941	0.934						
	NAE 3	0.916	0.925						

Table 3. (Continued)

Latent variables		Loadings		C.R.		AVE		Cronbach's α	
	Items	Korea	China	Korea	China	Korea	China	Korea	China
Perceived Behavioural Control (PBC)	PBC 1	-	-	0.948	0.880	0.858	0.709	0.917	0.795
	PBC 2	0.948	0.853						
	PBC 3	0.922	0.864						
	PBC 4	0.910	0.809						
Desire (DES)	DES 1	0.943	0.886	0.961	0.925	0.891	0.804	0.939	0.878
	DES 2	0.943	0.883						
	DES 3	0.946	0.921						
Financial Incentive Policy (FIP)	FIP 1	0.928	0.841	0.952	0.886	0.867	0.722	0.923	0.807
	FIP 2	0.947	0.854						
	FIP 3	0.919	0.853						
Perceived Risk (PR)	PR 1	0.722	0.841	0.864	0.897	0.616	0.685	0.796	0.847
	PR 2	0.880	0.808						
	PR 3	0.797	0.840						
	PR 4	0.731	0.822						
Environmental Concern (EC)	EC 1	0.777	0.838	0.873	0.878	0.632	0.643	0.806	0.816
	EC 2	0.788	0.785						
	EC 3	0.822	0.759						
	EC 4	0.790	0.825						
Purchase Intention (PI)	PI 1	0.873	0.855	0.939	0.897	0.794	0.685	0.913	0.846
	PI 2	0.896	0.781						
	PI 3	0.892	0.838						
	PI 4	0.901	0.836						

The discriminative validity of latent variables can be estimated using the Fornell-Lacker criterion. It is judged when the square root of the AVE is greater than all other construct correlations (Fornell and larcker 1981). Tables 4, 5 show that all diagonal values of the square root of AVE are greater than the off-diagonal values. Another way to test the discriminative validity between latent variables is through the heterosexual-monosexual correlation ratio (HTMT) method validation of PLS (Henseler et al., 2015). As shown in Tables 6 and 7, it was confirmed that both datasets had discriminant validity with the HTMT value below the 0.9 threshold (Kang et al., 2019).

To identify multicollinearity problems arising between construct concepts (latent variables), the variance inflation factor (VIF) was confirmed. We confirmed that there was no multicollinearity problem between latent variables, as the reference value of VIF was less than 3.3 (Lee and Xia, 2010) in Korea and China. To determine how well the data samples fit a given distribution and population, goodness of fit (GoF) was analyzed (Tenenhaus et al. 2005; Park et al. 2023). The GoF value of this study is 0.638, so the fit of the model is appropriate. In addition, we also refer to the standardized root mean square residual (SRMR) and normalized fit index (NFI) to test the model fit. SRMR values <0.1 are considered acceptable, ≤0.08 indicate good fitness (Hair et al. 2011), and NFI values closer to 1 demonstrate better model fit Bentler and Bonett (1980). The SRMR value of this study is 0.08, and the NFI is 0.866. Therefore, the requirements of model fitting are met, and further analysis can be carried out.

Table 4. Fornell-Larcker Criterion for Discriminant Validity (Korea).

	ATT	SN	PAE	NAE	PBC	DES	FIP	PR	EC	PI
ATT	.831									
SN	.658	.814								
PAE	.680	.595	.842							
NAE	.070	.078	.124	.892						
PBC	.535	.396	.464	-.076	.842					
DES	.484	.514	.549	.100	.453	.897				
FIP	.553	.468	.550	.032	.485	.400	.849			
PR	-.284	-.243	-.211	.138	-.221	-.196	-.169	.828		
EC	.403	.253	.383	-.022	.474	.319	.456	-.103	.802	
PI	.611	.490	.636	.059	.568	.643	.575	-.257	.470	.828

Notes: ATT=Attitude, SN=Subjective Norm, PAE=Positive Anticipated Emotion, NAE=Negative Anticipated Emotion, PBC=Perceived Behavioral Control, DES=Desire, PI=Purchase Intention, FIP=Financial Incentive Policy, PR=Perceived Risk, EC= Environmental Concern.

Table 5. Fornell-Larcker Criterion for Discriminant Validity (China).

	ATT	SN	PAE	NAE	PBC	DES	FIP	PR	EC	PI
ATT										
SN	0.841									
PAE	0.791	0.809								
NAE	0.289	0.379	0.462							
PBC	0.300	0.371	0.309	0.248						
DES	0.638	0.696	0.724	0.478	0.495					
FIP	0.511	0.585	0.568	0.258	0.497	0.543				
PR	0.181	0.164	0.166	0.149	0.164	0.215	0.097			
EC	0.668	0.559	0.527	0.169	0.338	0.436	0.481	0.085		
PI	0.721	0.733	0.778	0.340	0.488	0.820	0.608	0.250	0.648	

Notes: ATT=Attitude, SN=Subjective Norm, PAE=Positive Anticipated Emotion, NAE=Negative Anticipated Emotion, PBC=Perceived Behavioral Control, DES=Desire, PI=Purchase Intention, FIP=Financial Incentive Policy, PR=Perceived Risk, EC= Environmental Concern.

Table 6. The result of the HTMT ratio (Korea)

	ATT	SN	PAE	NAE	PBC	DES	FIP	PR	EC	PI
ATT										
SN	0.841									
PAE	0.791	0.809								
NAE	0.289	0.379	0.462							
PBC	0.300	0.371	0.309	0.248						
DES	0.638	0.696	0.724	0.478	0.495					
FIP	0.511	0.585	0.568	0.258	0.497	0.543				
PR	0.181	0.164	0.166	0.149	0.164	0.215	0.097			
EC	0.668	0.559	0.527	0.169	0.338	0.436	0.481	0.085		
PI	0.721	0.733	0.778	0.340	0.488	0.820	0.608	0.250	0.648	

Notes: ATT=Attitude, SN=Subjective Norm, PAE=Positive Anticipated Emotion, NAE=Negative Anticipated Emotion, PBC=Perceived Behavioral Control, DES=Desire, PI=Purchase Intention, FIP=Financial Incentive Policy, PR=Perceived Risk, EC= Environmental Concern.

Table 7. The result of the HTMT ratio (China)

	ATT	SN	PAE	NAE	PBC	DES	FIP	PR	EC	PI
ATT										
SN	0.783									
PAE	0.794	0.704								
NAE	0.083	0.133	0.122							
PBC	0.650	0.489	0.559	0.108						
DES	0.560	0.601	0.630	0.102	0.540					
FIP	0.667	0.576	0.660	0.063	0.605	0.475				
PR	0.333	0.294	0.248	0.192	0.270	0.227	0.203			
EC	0.479	0.308	0.452	0.066	0.579	0.376	0.557	0.140		
PI	0.720	0.586	0.745	0.072	0.691	0.745	0.695	0.302	0.558	

Notes: ATT=Attitude, SN=Subjective Norm, PAE=Positive Anticipated Emotion, NAE=Negative Anticipated Emotion, PBC=Perceived Behavioral Control, DES=Desire, PI=Purchase Intention, FIP=Financial Incentive Policy, PR=Perceived Risk, EC= Environmental Concern.

5.2. Analysis of the Structural Model

In this study, path analysis was conducted from three perspectives (i.e., Entire, Korea, and China). In all these three perspectives, desire was found to be the most important psychological factor that influences purchase intention, and these results are consistent with those from previous research (Chen, 2013; Chiu et al., 2018; Piçarra & Giger, 2018). The determinant factor having the most significant influence on this desire was the PBC in Korea and the SN factor in China.

In the case of Korea, one hypothesis out of a total of 12 hypotheses was rejected, and 11 hypotheses were accepted. Excluding the ATT factor, SN, PAE, NAE, and PBC had a positive impact on the purchase desire, with PAE (β=0.344, p <0.001) showing the highest influence coefficient on the purchase desire. Furthermore, FI, PR, EC show a positive effect on the attitudes toward EVs and the purchase intention, with EC showing the highest influence coefficient on ATT (β=0.448, p<0.001) and PI (β=0.275, p<0.001). These results are consistent with the previous studies (Kim et al., 2018; Wang et al., 2017; Wang et al., 2018; Wang et al., 2019a).

For the data concerning China, 2 out of 12 hypotheses were rejected and 10 were supported. We found that Chinese consumers' ATT and NAE did not statistically affect EV purchase desire. Three independent factors (SN, PAE, and PBC) had a positive (+) effect on purchase desire, with SN (β=0.249, p<0.001) showing the highest coefficient of influence on purchase desire. FIP, PR, and EC had a positive effect on attitudes toward EVs and purchase intention, with FIP was found to be the key factor that had the greatest influence on ATT (β=0.437, p<0.001) and PI (β=0.296, p<0.001).

These results reflect interesting differences from the data relevant to Korea. In Korea, environmental concern (EC) exerted the greatest influence on attitudes and the purchase intentions toward EVs, while in the case of China, financial support was the most important factor. In this research model, the effect size f^2 was used to determine the relative influence of predictor constructs on endogenous structure. f^2 values of 0.02, 0.15, and 0.35 reflect low,

medium, and large effects, respectively (Jacob 1988). The effect sizes for this study are shown in Table 8. The explanatory power of EV purchase intention was 68.5% in Korea and 56.9% in China, showing high explanatory power.

Table 8. The structural model analyzed (Entire, Korea, and China)

Ethnicity	Hypothesis path	Standard beta	Standard error	t-value	f^2	Supported
Entire (Two countries)	H1-1: ATT->DES	0.033	0.044	0.741	0.001	NO
	H1-2: SN->DES	0.181	0.037	4.885***	0.033	YES
	H1-3: PAE->DES	0.364	0.045	8.134***	0.121	YES
	H1-4: NAE->DES	0.106	0.024	4.436***	0.023	YES
	H1-5: PBC->DES	0.297	0.031	9.650***	0.157	YES
	H2: DES->PI	0.523	0.027	19.296***	0.542	YES
	H3-1: FIP->ATT	0.365	0.039	9.285***	0.172	YES
	H3-2: FIP->PI	0.214	0.031	6.901***	0.086	YES
	H4-1: PR->ATT	-0.159	0.028	5.653***	0.040	YES
	H4-2: PR->PI	-0.086	0.018	4.820***	0.020	YES
	H5-1:EC->ATT	0.315	0.037	8.505***	0.130	YES
	H5-2: EC->PI	0.225	0.027	8.251***	0.113	YES
Korea	H1-1: ATT->DES	0.099	0.066	1.494	0.009	NO
	H1-2: SN->DES	0.173	0.062	2.799**	0.025	YES
	H1-3: PAE->DES	0.344	0.064	5.361***	0.102	YES
	H1-4: NAE->DES	0.156	0.039	3.996***	0.047	YES
	H1-5: PBC->DES	0.242	0.040	6.067***	0.121	YES
	H2: DES->PI	0.560	0.037	15.116***	0.681	YES
	H3-1: FIP->ATT	0.265	0.055	4.832***	0.096	YES
	H3-2: FIP->PI	0.154	0.042	3.689***	0.052	YES
	H4-1: PR->ATT	-0.116	0.051	2.274*	0.022	YES
	H4-2: PR->PI	-0.086	0.028	3.086**	0.023	YES
	H5-1:EC->ATT	0.448	0.050	8.921***	0.274	YES
	H5-2: EC->PI	0.275	0.040	6.796***	0.188	YES
China	H1-1: ATT->DES	-0.002	0.065	0.024	0.000	NO
	H1-2: SN->DES	0.249	0.050	4.955***	0.054	YES
	H1-3: PAE->DES	0.290	0.060	4.837***	0.067	YES
	H1-4: NAE->DES	0.062	0.036	1.723	0.006	NO
	H1-5: PBC->DES	0.225	0.046	4.852***	0.057	YES
	H2: DES->PI	0.447	0.039	11.473***	0.370	YES
	H3-1: FIP->ATT	0.437	0.053	8.210***	0.236	YES
	H3-2: FIP->PI	0.296	0.047	6.295***	0.145	YES
	H4-1: PR->ATT	-0.192	0.035	5.492***	0.057	YES
	H4-2: PR->PI	-0.101	0.029	3.416**	0.022	YES
	H5-1:EC->ATT	0.184	0.050	3.702***	0.042	YES
	H5-2: EC->PI	0.182	0.037	4.926***	0.059	YES

Notes: ATT=Attitude, SN=Subjective Norm, PAE=Positive Anticipated Emotion, NAE=Negative Anticipated Emotion, PBC=Perceived Behavioral Control, DES=Desire, PI=Purchase Intention, FIP=Financial Incentive Policy, PR=Perceived Risk, EC= Environmental Concern.

*p<0.1, **p<0.05, ***p<0.001.

5.3. Comparison of results for Korea and China

This study performed parametric and non-parametric tests to confirm the difference in structural path coefficients between the two groups (Korea and China). The Welch–Satterthwaite test is a parametric test method that can be used when the variance between two groups is different (Welch, 1947). Unlike parametric tests, PLS-MGA is a non-parametric test method that uses bootstrapping. If the p-value derived from these methods is less than 0.05 or greater than 0.95, there is a significant difference between groups with a 5% error probability (Henseler et al., 2009).

Our results show statistically significant differences between the two countries in 4 out of 12 path hypotheses: specifically, the relationship between DES and PI, FIP and ATT, FIP and PI, and EC and ATT (Table 9). First, the most significant difference between the two groups was found in the relationship between consumer environmental concerns and attitudes toward EVs. This means that environmental issues act as an important variable that induces a positive attitude towards EVs among Korean consumers, but not Chinese consumers. We also noted significant differences between Korean and Chinese consumers in the impact of financial incentive policy on purchase attitudes and intentions. Financial incentive policies played a more critical role in forming EV purchase intentions and attitudes in Chinese consumers than Korean consumers. Finally, we showed that a stronger positive relationship is established for Korean consumers than for Chinese in the path connecting DES to PI.

Table 9. Multi-group comparative analysis: Korea (n=370) vs. China (n=500)

	Path-coefficient (β)		**MGA**		**Parametric Test**	**Welch-Satterwait Test**	**Remark**
Parameters	**Korea (K)**	**China (C)**	**Diff**	**p-value (K) vs (C)**	**p-value (K) vs (C)**	**p-value (K) vs (C)**	
ATT -> DES	0.099	-0.002	0.100	0.283	0.294	0.284	Not Supported
SN -> DES	0.173	0.249	-0.076	0.341	0.335	0.341	Not Supported
PAE -> DES	0.344	0.290	0.054	0.536	0.540	0.534	Not Supported
NAE -> DES	0.156	0.062	0.095	0.075	0.078	0.075	Not Supported
PBC -> DES	0.242	0.225	0.016	0.794	0.799	0.791	Not Supported
DES -> PI	0.560	0.447	0.113	0.034*	0.038*	0.033*	Supported
FIP-> ATT	0.265	0.437	-0.172	0.025*	0.028*	0.026*	Supported
FIP -> PI	0.154	0.296	-0.142	0.020*	0.027*	0.022*	Supported
PR -> ATT	-0.116	-0.192	0.076	0.209	0.195	0.212	Not Supported
PR -> PI	-0.086	-0.101	0.015	0.717	0.721	0.714	Not Supported
EC -> ATT	0.448	0.184	0.264	0.000***	0.000***	0.000***	Supported
EC -> PI	0.275	0.182	0.092	0.090	0.093	0.090	Not Supported

*p<0.1, **p<0.05, ***p<0.001.

6. Discussion and Conclusions

EVs are an important solution to climate change. EV sales in Korea and China are gradually increasing, though their increase remains at a negligible level (Ye et al., 2021). This study examined the psychological factors the inform Korean and Chinese consumer perceptions of EVs and their related purchase intentions. The success or failure of the EV market ultimately depends on individual consumers. Our study investigated the critical factors that affect consumer intentions to purchase EVs. And proposed a new research model that involved more psychological factors incorporated into the MGB model, including financial incentives for EV purchases, perceived risk, and environmental concerns. A comparative analysis was conducted to identify any differences in the purchasing behavior of Korean and Chinese consumers.

As a result of the analysis, individual desire was the decisive factor affecting purchase intention in both countries. These results are consistent with previous studies (Chen, 2013; Chiu et al., 2018; Piçarra & Giger, 2018), and it suggests that consumers' intention to purchase EVs can lead to future purchase behavior. The most decisive influence on the desire was the factor of perceived behavioral control in Korea and the factor of social pressure in China. According to the Korea and China analysis results, the attitude toward EVs did not affect their desire to purchase an EV in both countries. This result is contrary to Chiu, et al. (2018), but in line with the findings of other studies (Han & Sa, 2022; Han & Hwang, 2015). In short, consumer attitude toward EVs was shown to have only a weak ability to induce the desire to act. In addition to attitude factors, other psychological factors have a positive impact on desire. This can be interpreted because of reflecting the results of previous studies that it is very important to form positive expectations for customers, especially in the early stages of product development (Chen, 2013; Chiu et al., 2018; Piçarra & Giger, 2018). We also observed that in Korea environmental concern had the most significant influence on attitudes and purchase intention, followed by financial support and perceived risk. In contrast, in China, the FIP (financial incentives policy) was a key variable that strongly influenced attitude and purchase intention.

Whether the difference in these results in the two countries was statistically significant was reviewed using MGA, a parametric test, and the Welch-Satterwait test. We noted significant differences between consumers in the relationship between DES and the PI. The effect of desire on purchase intention was much stronger in Korea than in China. Second, FIP had a more significant positive effect on Chinese consumer purchase intentions and attitudes than it did for Korean consumers. In short, Chinese consumers are more sensitive to the actual price point at which they can buy EVs than Korean consumers. As shown through previous studies (Wang et al., 2021), the most important support for the expansion of EVs in China has been financial support policy. Finally, in the relationship between the EC and the PI, we confirmed that environmental concerns were more relevant to Korean than Chinese consumers. Lashari et al. (2021) confirmed that environmental factors are the most critical factors in predicting Korean consumer attitudes toward EVs.

Based on the results of this study, some academic and practical implications can be provided. From an academic point of view, in contrast with previous studies concerning TPB-based EVs, this study included more psychological factors in its MGB model, incorporating financial incentive policies, environmental concerns, and perceived risk variables by presenting a new research model. Our research model applying the MGB shows improved

predictive power in the issue of consumer EV purchases (Meng & Choi, 2016; Meng & Han, 2016; Song et al., 2014), and it enriches EV-related studies.

Meanwhile, from a practical point of view, the following implications can be presented to governments and EV-related companies in two countries. First, the governments and various companies should induce personal desire, highlighting the PBC reflecting individual self-efficacy and belief that behavior is under one's control, and anticipated emotion, which reflects positive emotion about potential outcomes, as personal desire can lead to an actual purchase. For example, to induce personal desire, it can create consumers' purchase emotions and social pressure by promoting and sharing EV users' experiences using social media.

Second, the governments of both countries, especially in China, should expand EV adoption by continuing financial incentives. The FIP for EV purchases positively affected consumers' attitudes and purchase intentions about EVs in both countries. This finding implies that buying EVs at reduced prices can be an effective encouragement strategy, and it has been supported in numerous relevant studies (Münzel et al., 2019; Wang et al., 2021). Furthermore, it is important to recognize that factors like operational expenses encompassing charging fees and supplementary costs linked to supporting infrastructure can significantly influence consumers' EV purchases (Chu et al., 2019). Given these considerations, the governments of Korea and China should persistently provide sustained financial and non-financial support in the interim period.

Third, the governments and related companies of both countries should work to eliminate negative perceptions of EVs by ensuring certainty about the safety issues of EVs. Consumers tend to perceive the risk and uncertainty of innovative new products as relatively high (Wang et al., 2018). Therefore, when information or experience about these products is lacking, consumers' perceived risk may increase (Li et al., 2017). Consequently, it is essential for the governments and EV-related companies to provide consumers with basic knowledge and information about EVs through effective communication channels and to maintain continuous communication.

Fourth, in both countries, the environment concerns positively impacted attitudes and purchase intentions towards EVs, with a particularly noticeable effect in Korea. Therefore, both governments should encourage consumers to act to protect the environment, and EV-related companies should actively develop the positive effects and benefits of EVs on the environment to instill the value of eco-friendly transportation to consumers.

Finally, based on the analysis results highlighting significant differences between Korea and China, it will be important for both governments and EV-related companies to tailor their marketing focus. Environmental approaches should be given precedence for Korean consumers, while for their Chinese consumers, economic incentives should be emphasized. This approach will aid in shaping effective policies and marketing strategies for expanding EV market in both regions.

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