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The impact of government policy on preference for NEVs: the evidence from China

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Abstract: To reduce gasoline consumption and emissions, the Chinese government has introduced a series of preferential policies to encourage the purchase of New-Energy Vehicles (NEVs). However, enthusiasm for the private purchase of NEVs appears to be very low. This timely paper addresses the need for an empirical study to explore this phenomenon by identifying purchase motivations of potential NEV consumers and examining the impact of government policies introduced to promote NEVs in China. A questionnaire survey was carried out. The acceptance of NEVs is measured in three different Logistic models: the willingness of consumers to purchase NEVs, the purchasing time and the acceptable price, the establishment of three multivariate logistic regression models. The results showed that financial benefits, performance attributes, environmental awareness and psychological needs are the four most important factors influencing consumers' acceptance of NEVs. Among these, performance attributes rather than financial benefits is the most important indicator. The moderating effect of government policies to relations between purchasing intention, time and price is not strong as respected while the policy implications are clear that the 'public awareness of government policy' functions as a moderator in the process of acceptance. These findings could give some hints to the government to make better NEV industry policy.
Keywords: New Energy Vehicles, Government Policy, Purchasing Motivations

1 Introduction

1.1 Background of NEV development in China

Transport, as an important source of CO2 emissions, has attracted world-wide concern in terms of environmental protection. According to the evidence from the IEA (IEA, 2009), transportation sector was responsible for 23% of total CO2 emissions worldwide. In China, the transport sector was responsible for only 6% and 8% of total CO2 emissions in 1990 and 2000 respectively. However, the number of vehicles in China increased from 0.8 million in 1990 to 65.39 million in 2010. It is projected that the private vehicle population will reach 400 million by 2030 (Hu et al., 2010). Given the rapid growth of private vehicle ownership, there can be no doubt that the transport sector will become one of the major factors affecting national energy security and GHG emissions in the near future (Yan and Crookes, 2009; Tang and Wu, 2011).

It has been acknowledged that the adoption of NEVs is an effective way to reduce harmful emissions of greenhouse gases. In order to achieve the target of reducing carbon dioxide emissions per units of GDP by 40%-45% of the 2005 level by 2020, China declared

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the ‘developing NEV industry’ to be one of the seven new strategic sectors. However, commercializing NEVs is not easy, given the well-known barriers to successful NEV implementation. Experience in developed countries demonstrates that the promotion of NEVs will be challenged by their high initial purchasing price, inconvenient refueling system, high running costs, and liabilities and performance concerns compared with traditional vehicles (Romm, 2006; Tang and Zheng, 2011).

1.2 Government policies towards NEV diffusion

Since NEVs are not only eco-friendly means of transportation, but also crucial to the national energy security of China, the Chinese government has been making great efforts to introduce and promote NEVs. China has set the target of having more than 500,000 battery-electric vehicles (BEVs) and plug-in hybrid vehicles (PHEVs) on the road by 2015 and 5 million by 2020 (SCC, 2012). Various efforts have been initiated to encourage their production and adoption, which include providing financial supports for NEV production companies, issuing marketing promotion policies, conducting market demonstrations of NEVs, and enhancing the construction of infrastructural facilities. The central government aims to establish one or two auto-manufacturers with the production capability of more than 1 million NEVs per year, and three to five auto-manufacturers of more than 50,000 per year. On January 24th, 2009, the Chinese central government initiated the “Ten Cities, Thousand Vehicles Program” (hereafter referred to as ‘the program’) to stimulate the adoption of NEVs. Beijing, Shanghai, Chongqing, Changchun, Dalian, Hangzhou, Ji’nan, Wuhan, Shenzhen, Hefei, Changsha, Kunming and Nanchang were selected as the cities for the demonstration and promotion of NEVs. Each city was challenged to roll out pilots of at least 1000 NEVs. In July 2010, the pilot cities of NEV demonstration were increased to 30; and the program was further expanded from focusing on government fleet applications to including private consumers in Shanghai, Changchun, Shenzhen, Hangzhou, and Hefei. The policies state that the Chinese central government will pay a subsidy of up to 50,000 yuan to any consumer who purchases a plug-in hybrid vehicle (PHEV) and 60,000 yuan for an all-electric, or battery-electric vehicle (BEV). These subsidies for consumers are enhanced by additional subsidies from local government. For example, in Beijing and Shenzhen, NEV buyers can claim additional subsidies of RMB 60,000 for BEVs; and in Shanghai RMB 40,000-50,000 for NEVs are being offered. To accomplish the program, rapid construction of infrastructure facilities has been initiated by governments. For example, in Beijing, the local government provides subsidies of 30% of the construction costs of charging facilities for NEV companies; 36,000 slower, lower power charging points, 100 rapid charging stations, one battery swap station and two battery recycle stations will be deployed around the city by the year 2015. The program continues to grow and evolve on an almost daily basis. According to the “China New Energy Vehicle Development Project” issued in July 2011 (hereafter referred to as the project), the Ministry of Finance will grant a total of RMB 100 billion to support the development of the NEV industry from 2011 to 2020. Specifically, 50 billion yuan will be invested to assist in the research and industrialization of key technologies of NEVs; 30 billion will be given to stimulate the demonstration and consumption of NEVs.

The incentive policies for NEVs in China are generous and could substantially reduce the incremental cost of purchasing a NEV. However, despite the policy of intensive support, their efficacy in actually promoting the adoption of NEVs is limited, and enthusiasm for the private purchase of NEVs seems to be very low in China. According to the statistics from the

Ministry of Finance, the planned subsidy budget for NEV purchase was 5 billion yuan; however, less than 0.1 billion yuan was actually used for private purchases of NEVs from July 2010 to July 2011. In terms of sales, the situation of individual NEV enterprises is not optimistic either. In 2012, BYD (a NEV company) admitted that it had sold only 1200 units of the F3DM (the first new-energy passenger vehicle in China) and that only 1700 units of the E6 (the first purely electric vehicle produced by BYD) had been sold since its launch. The turnover of NEVs accounted for less than 0.63% of the total annual sales of BYD in 2010.

1.3 Research questions and objectives

The disparity between strong incentive policies and unsatisfied NEV sales indicates that NEVs as new products are facing public skepticism. The models of modern welfare economics suggest that consumers will choose options that maximize utility subject to their preferences, knowledge of alternatives and budget (Roche et al., 2010). Government policies, particularly demand-side incentives for NEVs can be a helpful means of stimulating NEV adoption by potential customers only when the government has adequate information related to the preferences and the determinants of demand of these consumers (Roche et al., 2010). Therefore, private customers' low level of enthusiasm for purchasing NEVs highlights the necessity for a careful empirical study to explore the factors that would potential influence customers' acceptance of NEVs. This paper responds to this research gap and attempts to address two issues: what the main factors that determine the NEV acceptance of potential consumers are, and how government policies affect these factors.

The remainder of this paper comprises five main sections. Section 2 consists of a literature review related to customer acceptance and government policy on NEVs. Grounded on this review, the conceptual model is formulated and its hypotheses are posited in section 3. In section 4, after the research methodology and data used are described, the research results and key findings arising from factor analysis, reliability analysis and logistic regression analysis are presented. The last section concludes with a discussion of practical implications emerging from the findings and directions for further research

2 Literature Review

This section starts with a summary of the main conceptual frameworks which are applied in customer preference research, and then moves on to a brief description of current studies on factors influencing customer preference for NEVs; finally, the impact of policy on preference is analyzed.

2.1 Factors influencing NEV acceptance

Most public attitude studies have followed three main research approaches: attitudinal research, risk perception research, and research on stated preference techniques for economic valuation (Roche, et al., 2010). While attitudinal research usually measures the relationship between attitudes behaviour and intended behaviour (Ajzen, 1991), risk perception studies focus on the dynamics of behaviour in the face of risk (Slovic et al., 1984; Slovic, 1987). Stated preference research has been widely adopted to capture public attitudes or preferences in hypothetical or constructed markets. The stated preference approach is adopted in this paper for two reasons: first, it is not feasible to study purchasing behaviour, given the fact that NEVs are not widely traded in Chinese markets and the current market share of private NEV demand is close to zero; second, stated preference is an efficient and appropriate approach to

examine the factors that are likely to influence customer attitude in a hypothetical market under new government policies. With reference to the stated preference approach, a review of literature on the antecedents of NEV preference was conducted in this research. Although most studies on purchase motives focus on Western countries, such as the UK, US and Switzerland (Lane and Potter, 2007; Ozaki and Sevastyanova, 2011; Diamond, 2009; Gallagher and Muehlegger, 2011), there are some empirical researches on 'potential' demand for NEVs in Japan (Kishi and Satoh, 2005), Korea (Kang and Park, 2011) and China (Xu and Xu, 2010). The determinants influencing NEV purchase intention are summarized in table 1, which captures the homogenous nature of most studies in this domain.

Table 1 Factors affecting consumers' preferences of NEVs.

Determinants in this study	**Determinants in the literatures**	**Sources**
Financial benefit	➢ Financial consideration ➢ Fuel economy, running cost ➢ Reduction in monetary costs ➢ Purchase price ➢ Reduction in overall costs ➢ Lower fuel bills	➢ Segal,1995;Mourato et al., 2004 ➢ Adamson, 2005 ➢ Potoglou and Kanaroglou, 2007 ➢ Lane and Potter, 2007 ➢ De Haan et al., 2006 Klein, 2007 ➢ Ozaki and Sevastyanova, 2011
Performance	➢ Driving performance ➢ Having an automatic gearbox ➢ The safety, reliability, comfort, speed, and practicality ➢ Comfort, quietness, ease of driving, and automatic transmission	➢ Kang and Park, 2011 ➢ Adamson, 2005 ➢ Xu and Xu, 2010 ➢ Ozaki and Sevastyanova, 2011
Environmentalism	➢ Environmentalism ➢ Environmental considerations ➢ Environmental awareness ➢ Environmental protection ➢ Concern about global warming ➢ Low emission rates	➢ Heffner et al., 2007 ➢ Mourato et al., 2004 ➢ O'Garra et al., 2007 ➢ Erdem et al., 2010 ➢ Turrentine and Kurani, 2007
Psychological needs	➢ Community's values and norms ➢ Wants of person in question ➢ Self-actualization	➢ Kahn, 2007;2008 ➢ Schulte et al., 2004 ➢ Viardot, 1998 ➢ Kang and Park, 2011

Government policies	➢ Tax incentive ➢ Perceived need for government involvement ➢ Personal experience of government policy	➢ Potoglou and Kanaroglou, 2007 ➢ Ellen et al., 1991 ➢ Slovic et al., 2004 ➢ Gallagher and Muehlegger, 2011

2.1.1 Financial benefits

Empirical researches on NEV acceptance reveal that consumers are concerned with financial benefits, and welcome the NEVs which could reduce running costs and improve fuel-efficiency (Segal, 1995; Mourato et al., 2004). Lane and Potter (2007) suggest that the purchase price of vehicles is the most important determinant of NEV adoption. They argue that high purchase cost usually associated with NEVs is often considered as a major barrier to adoption. In addition, potential consumers may consider the fuel cost of NEVs (Heffner et al., 2007; Klein, 2007). The advantage of lower fuel bills can be attractive to potential NEV buyers (Heffner et al., 2007; Ozaki and Sevastyanova, 2011). Furthermore, some other factors, such as the maintenance costs and some other complementary expenditure related with the purchase of a NEV, may also influence the decision to adopt NEVs (Adamson, 2005; de Haan et al., 2006; Potoglou and Kanaroglou, 2007). The evidence up to date shows that financial benefits are an important motive of individual consumers to purchase NEVs.

2.1.2 Performance

Besides of economic concerns, the considerations of NEVs' performance also play an important role in the purchase decision-making process (Adamson, 2005; Kang and Park, 2011). Some researchers argue that financial benefit as an incentive to attract potential buyers can only be achieved by compromising the performance of NEVs (Lane and Potter, 2007). The meaning and connotation of performance are different to different researchers. For instance, Lane and Potter (2007) investigate performance by considerating comfort, size, practicality, reliability and other issues. Based on a questionnaire survey of 1263 respondents in the UK, Ozaki and Sevastyanova (2011) found performance considerations, such as comfort,quietness, ease of driving and automatic transmission were the most important factors affecting consumers' adoption of hybrid vehicles (Ozaki and Sevastyanova, 2011). This finding is consistent with a study on China's NEVs by Xu and Xu (2010). They found the evidence that the acceptance of Chinese NEV buyers is predominantly driven by performance considerations, including safety, reliability, comfort, speed, and practicality. These researches indicated that some potential consumers pay close attention to various factors of 'performance' of NEVs before their purchase. To sum up, throughout this paper we utilize the term 'performance' to refer consumers' comprehensive evaluation for the quality of a NVE, which includes various factors such as comfortability, practicality, and reliability. Note that the evaluation is comprehensive; therefore if NEV A is considered to have better performance than NEV B, it does not mean that all factors of A measuring the quality of NEVs are superior to those of B.

2.1.3 Environmental factors

As Heffner et al. (2007) pointed out, the environmental factors are also important in the purchase of NEVs. Consumers with high environmental awareness and considerations are

more willing to buy a NEV because they hold the purchase as a way to preserve the environment (Mourato et al., 2004; O'Garra et al., 2007). These consumers would like to express an explicit commitment on reducing ecological footprint through taking active actions to protect environment (Erdem et al., 2010). The environmental factors of NEVs that draw most concern include low emission rate and consuming fewer natural resources (Turrentine and Kurani, 2007).

2.1.4 Psychological needs

The intention to satisfy psychological needs is one of the most important factors affecting the acceptance of or preference for NEVs (Schulte et al., 2004). On one hand, NEV ownership is a reflection of sharing the community's values and norms (Kahn, 2007; 2009); in other words, the need of compliance with norms of the community may influence consumer preference of NEVs. On the other hand, NEV ownership may also be considered by consumers as being different from others who cannot afford an NEV, or as a label to show their tendency to embrace something new or better (Kang and Park, 2011).

2.2 Moderating effects of government policies

The arguments developed above focus on the importance of individual factors affecting consumers' preferences. A large number of studies have examined the relationship between government policy and NEV adoption or preference (Gallagher and Muehlegger, 2011). Sallee (2007) studied the effect of government incentives offered to Prius buyers based on consumer-level purchase data concluding that consumers took advantage of most tax incentives and timed Prius purchases to coincide with generous federal incentives. Using data from a Canadian province, Chandra et al. (2010) found that tax incentives were an effective way to increase hybrid vehicle sales. Another study conducted by Berensteanu and Li (forthcoming) also found that federal incentives had a positive influence on hybrid vehicle sales.

While some scholars have tried to explore the direct effects of either state or provincial government policies, the interactions between government policies and other motives for NEV preference have not been explicitly studied. This paper is a timely response to this research gap in its exploration of the moderating effect of government policies on the relationship between other determinants and consumer preference.

Although China has been in transition from a centrally-planned to a market-based economy, Chinese firms' strategies and consumer behavior are still fundamentally shaped by government policy (Child and Tse, 2001). Central and local governments in China use a variety of incentives to encourage individual adoption of NEVs. Apart from the direct effect of these incentives, the joint impact of the incentives and individual determinants of NEV preference may also be significant. In other words, government policy and other individual determinants may be interrelated, in the sense that some factors may complement or reinforce each other in bringing about NEV adoption or preference. However, there are limited empirical studies on the interaction of government policy and other factors as determinants of NEV preference. For example, low tax, subsidies and other financial incentives will further reduce the price and/or maintenance costs of NEVs. Private consumers with higher concerns over financial benefits may be more likely to buy NEVs when more subsidies are offered. Moreover, the target of having a large number of NEVs on the road in future and the

construction of infrastructure facilities in China will provide additional motivation for firms' investment and innovation, which may in turn increase the popularity of NEVs. Consumers with higher concerns for performance may have higher stated preference for NEVs when greater government support is provided. Moreover, the pro-environmental behaviors like "low carbon life style" and "environmental protection" are becoming increasingly popular in China. These policies may further reinforce the effect of customers' environmentalism and psychological needs. Therefore, customers with high environmental awareness and stronger psychological needs may have higher stated preference when government policies are better perceived.

The relationship among the variables mentioned above could be summarized by the proposed research model (see Figure 1 below)

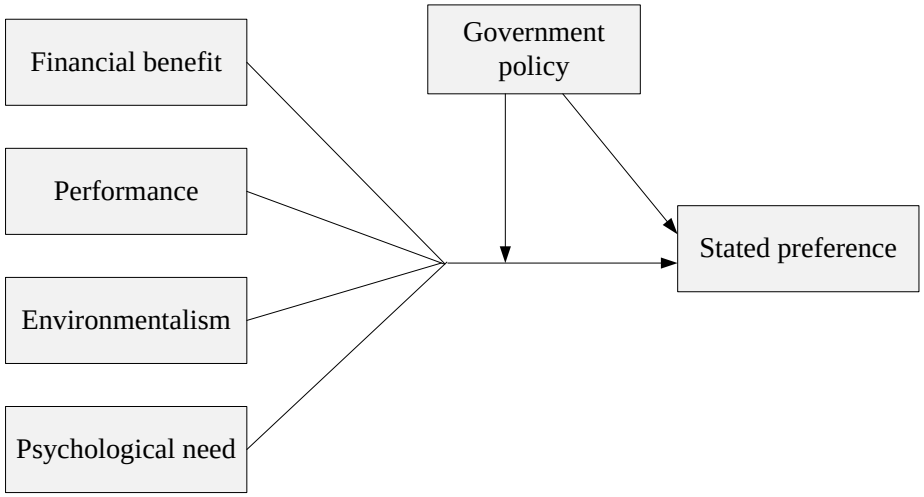

Fig. 1 The research model on the determinants of the stated preference of potential NEV consumers in China

3 Methodology

3.1 Sample and data description

As mentioned previously, this research aims to explore the moderating effects of government policy on the relationship between determinates and consumers' stated preference for NEVs. A questionnaire, which was duly devised and revised through a pilot testing, was distributed to potential customers in 39 Auto 4S shops in 13 of the first demonstration and promotion cities of NEVs (Beijing, Shanghai, Chongqing, Changchun, Dalian, Hangzhou, Ji'nan, Wuhan, Shenzhen, Hefei, Changsha, Kunming and Nanchang). Authorized by the vehicle manufacturers, Auto 4S shop is a kind of "Four in One" sales stores which include vehicle sales (Sale), parts (Spare part), service (Service), and information feedback (Survey). It has established close relationship between production and marketing with a beautiful shopping environment, brand awareness and strong advantages. Auto 4S shop has gradually been introduced into China from abroad since late 1990s, and in recent years, the Auto 4S shop developed very fast in this country. According to data from the State Administration for Industry & Commerce, the number of China's Auto 4S shop was about 20,000 at the end of April 2012 and was expected to reach 30,000 by 2015.

In our pilot testing, the targeted participants are potential car consumers, who are expected to own a car in the near future. The car they are likely to purchase could be a NEV

or a traditional oil powered car. Therefore, a survey conducted in Auto 4S shops is an effective way to gauge the preferences and demands of potential consumers for NEVs, and hence can effectively identify the factors that impact consumers' preference for NEVs. The research team distributed a total of 390 copies of the questionnaire between 1st Oct and 15th Oct, 2011. To increase the response rate, the paper-and-pen interview (PAPI) method was adopted. 349 valid copies out of the total of 390 (87.3%) were collected. Table 2 below presents some preliminary statistics of the survey results.

Table 2 Sample description

Responders' characteristics	Level	Percentages
Gender	Male	51.3
	Female	48.7
Age	Younger than 21	5.7
	21-28	28.1
	29-36	22.3
	37-44	22.1
	45-52	11.9
	53-60	7.5
	Older than 60	3.4
Education	Junior middle school or lower	3.2
	Senior middle school	12
	Associate	31.8
	Bachelor	46.1
	Master or Ph.D	6.9
Income (RMB)	Less than 2000	5.2
	2000-5000	7.1
	5001-8000	26.3
	8001-15000	24.4
	15001-20000	17.2
	More than 20000	19.8
Number of family members	1	5.4
	2	22.3
	3	37.5
	4	22.1
	5	11.2
	6	0.6
	More than 6	0.9
Number of cars owned by the family	0	39
	1	52.4
	2	7.7
	More than 2	0.9
Number of family members with driving licenses	0	21.5
	1	37.2
	2	20.6
	3	15.8
	4	4.6

More than 4	0.3

3.2 Measurement development

3.2.1. Dependent measures

To measure a potential consumer's preference for a NEV, each participant was asked whether they would choose a NEV as their new car, the time to fulfill the purchase behavior, and the acceptability of the purchase price of a NEV. The questionnaire was designed in the way that the dependent variable used in this study has a dichotomous nature. For example, We set the value of 1 as "willing to purchase NEVs" and the Value of 2 as "not willing to purchase NEVs"; 1 also refers to "will become a NEV owner within 3 years" and 2 refers to "will not purchase a NEV within 3 years". By the same token, we set a value of 1 as more than CNY 200,000 being an acceptable price and value 2 less than CNY 200,000 being an acceptable price. The questionnaire is attached to the appendix of the paper.

3.2.2. Independent measures

The independent variables are encapsulated into four constructs. These constructs, mainly developed on the basis of previous literature (Heffner et al., 2007; Lane and Potter, 2007; Ozaki and Sevastyanova, 2011; Kang and Park, 2011), represent financial considerations, car performance, environmental factors, and psychological needs. Each of the constructs consists of a set of items describing the construct theme from different angles. For each item, a 7-point Likert scale (1 refers to completely disagree and 7 to fully agree) is used to enable participants to indicate the extent to which they agree with these items. In particular, financial consideration consists of items describing the financial concerns that a respondent may take into account when they purchase and maintain a NEV including fuel cost, purchase price, maintenance cost and overall cost (refer to section B of the questionnaire shown in the appendix). In the questionnaire the car performance is measured by eight factors, which are riding comfort, quality, safety, size, appearance and interior decoration of the car, ease and convenience of use, duration distance and operability, respectively. The other two constructs are designed in a similar pattern. The environmental factors construct is composed of items representing environmental awareness; for example, to what extent do you think NEV purchasing is helpful in reduce the effects of climate change? The psychological need construct includes items regarding the motivation of consumers to pursue love, esteem and self-actualization through belonging to a group; for example, would people respect someone who drives a NEV?

3.2.3. Moderating variable

To measure the public awareness of government policies, the questionnaire has a brief description of relevant policies. To measure their knowledge and experience of government policies related to NEVs, respondents were asked to give answers rated on a scale between 1 and 7 where 1=Strongly Disagree, 4 = Neutral and 7=Strongly Agree. Therefore, the higher point implies a better perception of government policy. The relevant questions could be found in the questionnaire in the appendix.

3.2.4 Controlled variable

In the literature, it is suggested that the demographic and socio-economic

characteristics of respondents may be associated with the acceptance of NEVs (e.g. Zhang, et al., 2011; Erdem et al., 2010). For example, the purchase of a NEV may be influenced by gender, age, education level, annual income and car ownership of the consumer (O'Garra et al., 2005). Other researchers consider that the size of the family (Erdem et al., 2010) and the number of family members with driving licenses (Zhang, et al., 2011) may influence consumers' acceptance of NEVs. In this paper, the consumers' age, gender, educational level, annual income, the number of family members, the number of family members owning driving licenses, and the number of automobiles that a family has are employed as control variables.

4 Results and Analysis

4.1 Measurement model

A principle component analysis with varimax rotation was conducted to examine the factor structure of NEV acceptance antecedent measures. Four factors with an eigenvalue above 1.0 emerged and these were generally consistent with the constructs proposed, i.e. financial benefits (FB), car performance attributes (PA), environmental awareness (EA), and psychological needs (PN). Together, these four factors explained a total of 80.87 of the variance. Items were retained in a factor if they had a loading of 0.5 or above on the factor and the differences between this loading and two other cross-loadings were more than 0.3 (Howell et al. 2005; Kline, 1994). The items retained and dropped in conjunction with the loadings and cross-loadings are shown in table 3.

Table 3 Loadings and cross-loadings of the items

	Component			
	1	**2**	**3**	**4**
Retained items				
FB1	**0.866**	0.306	0.208	0.171
FB2	**0.846**	0.346	0.246	0.200
FB3	**0.880**	0.283	0.189	0.166
FB4	**0.865**	0.323	0.210	0.135
PA1	-0.127	**0.915**	-0.293	-0.117
PA2	-0.119	**0.920**	-0.300	-0.117
PA3	-0.124	**0.921**	-0.284	-0.123
PA4	-0.108	**0.921**	-0.292	-0.103
PA5	-0.117	**0.916**	-0.297	-0.111
EA1	-0.191	0.290	**0.910**	-0.185
EA2	-0.186	0.310	**0.899**	-0.189
EA3	-0.192	0.307	**0.902**	-0.181
EA4	-0.189	0.316	**0.899**	-0.181
PN1	-0.324	0.230	0.133	**0.880**
PN2	-0.322	0.240	0.147	**0.860**
PN3	-0.296	0.262	0.129	**0.859**
Dropped items				
PA6	0.109	0.433	-0.153	-0.039
PA7	-0.100	0.385	-0.138	0.006

PA8	-0.091	0.457	-0.211	-0.149
EA5	-0.242	0.187	0.476	-0.079
Eigenvalues	3.587	5.746	4.242	2.599
Percent of variance	17.935	28.731	21.208	12.993

The resulting instrument was further examined for content validity. Parasuraman et al. (1988) suggest that the content validity of a construct depends on the extent to which the construct items represent the construct's theme. The constructs in this research are considered to possess high content validity, as the measuring items were predominantly derived from the literature, such as Segal (1995), Mourato et al. (2004), Klein (2007), Ozaki (2011), Turrentine and Kurani (2007), Sevastyanova (2011), and Kang and Park (2011). These items were further filtered through extensive discussions with researchers in the domain. The reliability of the constructs was also tested by Cronbach's Alpha. The Cronbach's Alpha scores of the four constructs were all above 0.9. Because an alpha of 0.8 or above is usually considered highly acceptable for assuming homogeneity of items (Nunnally, 1978), the constructs in the research are highly reliable.

Table 4 shows the results of the descriptive statistics of the independent variables, moderators and dependent variable. It can be seen from Table 4 that the importance of the potential motivations to purchase NEVs are ranked as follows: psychological needs, environmental awareness, financial benefit and performance of NEVs. The results indicate that currently most of the potential consumers only have limited knowledge of government policy related to NEVs. Despite the common belief that NEVs are eco-friendly and consistent with community's values, most potential consumers are unsatisfied with their performance and unfamiliar with their economic benefits. Therefore, it is necessary to give more publicity to the economic benefits of the NEVs in order to stimulate their private purchase.

The correlations between independent and moderating variables are also presented in table 4. The relatively low inter-correlations indicate that multicollinearity might not be a major problem.

Table 4 Descriptive Statistics of Variables

	Mean	Sd.	1	2	3	4	5	6	7
1.Financial benefit	3.810	1.630							
2.Performance attributes	2.760	1.470	0.103						
3.Environmental awareness	4.140	1.840	0.093	0.073					
4.Psychological needs	4.240	1.620	-0.024	0.123 [b]	0.103				
5.Government policy	3.680	1.660	0.063	-0.186[a]	0.160 [a]	0.041			
6.Acceptance Degree of NEVs	3.570	1.200	0.237[a]	0.385[a]	0.244 [a]	0.277 [a]	0.141 [a]		
7.Purchase time	4.270	1.250	-0.189 [a]	-0.310 [a]	-0.249 [a]	-0.287 [a]	-0.240 [a]	-0.825 [a]	
8.Acceptable Purchase price	3.320	1.517	0.220 [a]	0.309 [a]	0.254 [a]	0.185 [a]	0.165 [a]	0.404 [a]	-0.404 [a]

[a] Correlation is significant at the 0.01 level (2-tailed).

[b] Correlation is significant at the 0.05 level (2-tailed).

4.2 Public acceptance of NEVs

Figure 2, 3 and 4 intuitively show the shares of the respondents answering the following questions in the questionair: willingness of consumers to buy NEVs, the distribution of their purchasing time and the acceptable price.

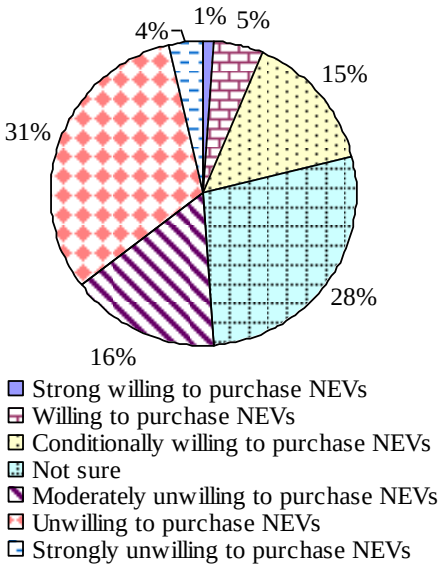

Fig. 2 Public acceptance degree of NEVs

As is shown in Fig 2, 31% of respondents are reluctant to purchase NEVs, while 16% show their moderate unwillingness, and another 4% have strong unwillingness. As a result, a total of 51% of respondents are apparently not likely to buy NEVs. By comparison, 6% of all respondents have expressed their purchasing will, and 15% would like to purchase one under certain conditions. To add these figures up, only 21% of respondents are willing to buy NEVs. And the remaining 28% stay unsure whether to buy a NEV or not. In a word, currently the public acceptance for NEVs is still notably low.

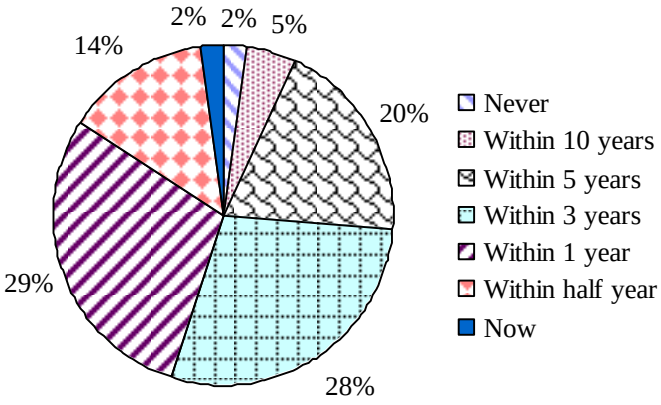

Fig. 3 Time period to purchase NEVs

Figure 3 shows the time for the potential consumers to buy a NEV. The majority of

respondents (73%) will buy NEVs in the next 3 years, among which 29% might purchase one in the next half to one year and 28% might purchase in the next 1-3 years. In addition, the proportion of respondents who intend to buy one in the next 3-5 years is around 20%, and those who will purchase one in less than half a year account for 14%.

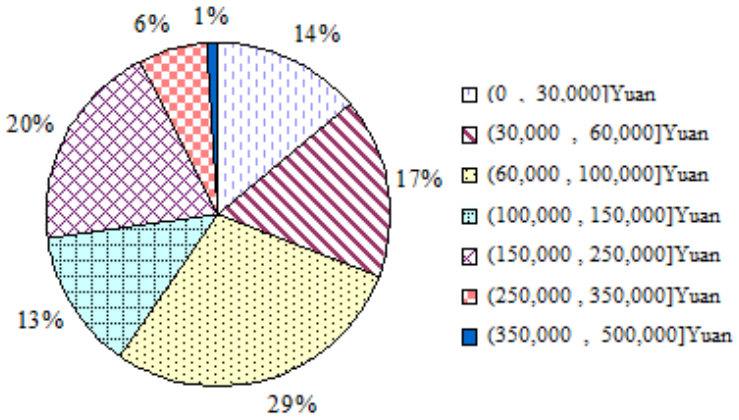

Fig.4 Acceptable purchase price of NEVs

From the perspective of price (see Fig. 4), 29% of the respondents are able to accept the NEV worth between 60,000 and 100,000 yuan. This ratio is the highest among all groups. The second highest ratio is 20% for those who can afford the price between 100,000 and 250,000 yuan, while only in total 7% could afford high-priced NEVs between 250,000 and 500,000 yuan. These observations indicate that most Chinese potential consumers are only able to accept low-priced NEVs.

4.3 Regression analysis

To further analyze the acceptance level of NEVs was measured by three issues, three regression models were estimated through the use of SPSS 1.7. In table 5, the determinants of the willingness to purchase NEVs, time period to purchase NEVs, and acceptable price of NEVs are estimated in Columns 1, 2, and 3, respectively. Because the most interested influencing factors include the Financial benefit (FB), Performance attributes (PA), Environment awareness (EA) and Psychological needs (PN), these four factors are categorized as “concerned variables”. Besides of these four most interested variables, there are other factors that may affect the dependent variable of each model. Therefore a series of control variables are also added in each model to control for these influences. In additional, some interactional terms of the explanatory variables are also included to control for the potential heterogeneity because some explanatory variables may take into effect at the same time.

Table 5 Results of multiple regressions

Models	The willingness to purchase NEVs		The time period for purchasing NEVs		The acceptable price of NEVs	
	Coef.	S.D.	Coef.	S.D.	Coef.	S.D.
Constant	-0.037	0.441	7.241	0.459	-1.049	0.542
Concerned variables						
Financial benefit (FB)	0.136 [a]	0.033	-0.095 [a]	0.035	0.160 [a]	0.041

Performance attributes (PA)	0.323 [a]	0.04	-0.276 [a]	0.041	0.306 [a]	0.049
Environment awareness (EA)	0.083 [a]	0.03	-0.081 [a]	0.031	0.115 [a]	0.037
Psychological needs (PN)	0.151 [a]	0.034	-0.155 [a]	0.036	0.079	0.042
Moderating variable						
Public awareness of government policy	0.084 [b]	0.035	-0.165 [a]	0.037	0.161 [a]	0.043
Control variables						
Gender	0.186	0.107	-0.091	0.112	0.135	0.132
Age	0.005	0.005	0.004	0.005	-0.003	0.006
Education level (EL)	-0.088	0.056	0.139 [b]	0.058	0.141 [b]	0.068
Income	0.101[a]	0.039	-0.064	0.04	0.142 [a]	0.047
Number of family members	0.078	0.055	-0.103	0.057	0.126	0.067
Number of cars owned by the family	-0.010	0.090	0.146	0.093	0.020	0.110
Number of family members with driving licenses(NFML)	0.060	0.056	-0.132 [b]	0.059	-0.059	0.069
Interacting effects						
FB* PGP	0.059 [a]	0.02	-0.066 [a]	0.020	0.200 [a]	0.024
PA* PGP	0.053 [b]	0.025	-0.021	0.026	-0.050	0.031
EA* PGP	0.005	0.017	-0.026	0.017	-0.029	0.021
PN* PGP	0.032	0.021	-0.051[b]	0.022	-0.017	0.026
N	349		349		349	
Adjusted R^2	0.337		0.334		0.37	

Note: For each model, the first column (Coef.) presents the coefficients of all variables, while the corresponding standard errors are reported in the second column (S.D.).

[a] Correlation is significant at the 0.01 level (2-tailed).

[b] Correlation is significant at the 0.05 level (2-tailed).

Column 1 of table 5 shows how the most interested factors influence the consumers' willingness purchasing NEVs. As shown in Table 5, all four concerned variables are significant with the coefficients 0.136 ($p<0.01$), 0.323($p<0.01$), 0.083 ($p<0.01$), and 0.151($p<0.01$), respectively. This means that financial benefits (FBs), performance attributes (PAs), environmental awareness (EA) and psychological needs (PN) all have positive effects on the willingness of potential consumers to purchase NEVs. Because the awareness of government policy (PGP) has a significant influence on the consumers' willingness to purchase NEVs with a coefficient of 0.084 ($p<0.05$), the interaction of financial benefit-perception of government policy (FB*PGP) and environmental awareness-perception of government policy (EA*PGP) as appear to be significant with coefficients of 0.059 ($p<0.01$) and 0.053 ($p<0.05$), indicating that consumers' awareness of government policy indeed enhances the relationship between the purchase motivation and NEV acceptance, thus affirming the existence of moderating effects. The only control variable with significant coefficient is the income level of consumers (coef.=0.101, $p<0.01$). Therefore, if we only retain the significant variables in the equation, the regression for consumers' purchase willingness for NEVs could be written in the following way:

$$\begin{aligned} Purchase\,Willingness &= B_0 + B_1 \cdot FB + B_2 \cdot PA + B_3 \cdot EA + B_4 \cdot PN + B_5 \cdot PGP + \\ &\quad B_6 \cdot EA \cdot PGP + B_7 \cdot FB \cdot PGP + B_8 \cdot Income \\ &= -0.037 + 0.136FB + 0.323PA + 0.083EA + 0.151PN + 0.084PGP + \\ &\quad 0.053EA \cdot PGP + 0.059FB \cdot PGP + 0.101Income \end{aligned}$$

The impacts of the explanatory variables on time period of purchasing NEVs are shown in column 2 of Table 5. Once again, the coefficients of four concerned variables are also significant, but they are all negative in magnitude. The coefficients for these four variables are -0.095 ($p<0.01$), -0.276($p<0.01$), -0.081 ($p<0.01$), and-0.155($p<0.01$), respectively. The results also reveal that government policy has a negative impact on the time period of purchasing NEVs (coef.=-0.165, $p<.001$). The negative and significant coefficient of the interactions of financial benefit-perception of government policy (FB*PGP: coef.=-0.066, $p<0.01$) suggests that consumers who care more aboutfinancial benefits are more likely to buy a NEV in a short period. Similarly, the interaction of psychological needs and the public awareness of government policy (PN*PGP: B=-0.051, $p<0.05$) has a significantly negative coefficient, suggesting that consumers with higher psychological needs may purchase NEVs earlier when supportive government policies are available. Two control variables also appear to be significant: education level (EL: coef.=0.139, $p<0.05$) and number of family members with driving license (NFML: coef.=-0.132 $p<0.05$). Therefore, the regression for the time period of purchasing NEVs including all significant variables can be defined as the following:

$$\begin{aligned} Time\ Period &= B_0 + B_1 \cdot FB + B_2 \cdot PA + B_3 \cdot EA + B_4 \cdot PN + B_5 \cdot PGP + \\ &\quad B_6 \cdot FB \cdot PGP + B_7 \cdot PN \cdot PGP + B_8 \cdot EL + B_9 \cdot NFML \\ &= 7.241 - 0.095FB - 0.276PA - 0.081EA - 0.155PN - 0.165PGP + \\ &\quad - 0.066FB \cdot PGP - 0.051PN \cdot PGP + 0.139EL - 0.132NFML \end{aligned}$$

Column 3 of table 5 depicts the regression results for the acceptable price of NEVs. It can be seen that three of four concerned variables have significant and positive influences on the acceptable price of NEVs. These are financial benefits (FB: coef.=0.160, $p<0.01$), performance attributes (PA: coef.=0.306, $p<0.01$), and environmental awareness (EA: coef.=0.115, $p<0.01$), respectively. While public awareness of government policy (PGP) has a significant and positive association with the acceptable prices of NEVs (coef.=0.161, $p<0.01$), this variable also positively moderates the relationship between financial benefits and the acceptable price of NEVs (coef.=0.200, $p<0.01$). Moreover, two control variables, education level (EL: coef.=0.141, $p<0.05$) and income (coef.=0.142, $p<0.01$), are positively related to the acceptable price of NEVs with significance. Thus, regression function for the acceptable price of NEVs can be expressed as the following equation:

$$\begin{aligned} Acceptable\ \mathrm{Pr}ice\ of\ NEVs &= B_0 + B_1 \cdot FB + B_2 \cdot PA + B_3 \cdot EA + B_4 \cdot PGP + \\ &\quad B_5 \cdot FB \cdot PGP + B_6 \cdot EL + B_7 \cdot Income \\ &= -1.049 + 0.160FB + 0.306PA + 0.115EA + 0.161PGP + \\ &\quad 0.2FB \cdot PGP + 0.14EL + 0.142Income \end{aligned}$$

5 Discussions

5.1 Acceptance of NEVs

Table 5 summarizes the results of the hypotheses testing. Through the findings of three regression models, four drivers of NEV acceptance are identified: financial benefits, performance attributes, environmental awareness and psychological needs, respectively. The four drivers positively influence purchase willingness and purchase price, while the coefficient of four drivers for NEV purchase time is negative. However, performance attributes of NEVs are recognized as having the strongest effects on consumers' acceptance among these drivers. This means that although economic concerns, environmental awareness and interpersonal influence have significant effects on the acceptance of NEVs, the performance of the NEVS plays an even more important role in the purchase decision-making of potential customers (Adamson, 2005; Kang and Park, 2011). This confirms the finding of Xu and Xu (2010) that safety, reliability, comfort, speed, and practicality are the predominant incentives of NEVs to attract potential buyers in China.

Using the acceptable price of NEVs as the dependent variable, the coefficient of psychological needs is significant when only control variable and independent variables are included in the model, but is non-significant when perceived government policies and the interaction of perceived government policy and four independent variables are added as the predictors. This is a new finding in our research. A possible explanation for this finding is that government policies may dramatically reduce the cost of NEVs, and NEV ownership is therefore no longer considered by consumers as being different from others who cannot afford NEVs. Thus, potential customers may not choose NEVs as something better or luxuries to treat themselves after supporting government policies related to NEVs are issued.

Furthermore, the income level of consumers is positively related to the willingness to purchase NEVs and acceptable price of the NEVs. Keeping all other conditions constant, consumers with a higher income are more likely to purchase NEVs and accept a higher price of the NEVs. It is also easy to understand why education level has positive effect on both purchasing time and acceptable price of NEVs. Consumers with higher education level are more willing to pay a higher price for NEVs because they are generally more concerned over the environmental issue and they are usually wealthier. However, because in China the technology of NEVs is overall not as advanced as that in Western countries, and because highly educated consumers are often more rational and more likely to know the disadvantages of domestic NEVs, they are unwilling to buy NEVs in the short term. Besides, the number of NEVs owned by a family would significantly affect the time when a potential consumer would buy a new NEV. As shown in the first model (the first two columns of table 5), As shown in the second equation of table 5 (middle two columns), the potential consumers in the family with more family members owning driving licenses are more willing to purchase NEVs in a short time. This finding is consistent with the study of Zhang et al. (2011) that consumers from the family in which more than one family member can drive usually have more personal choices, and are more likely to to purchase NEVs.

5.2 The moderating effect of government policies

The awareness of government policy positively influences the purchase willingness and purchase price, but negatively affects the purchase time. This is similar to the results of research in other countries (O'Garra et al., 2005); the promotion of NEVs usually benefits

from supportive government policies. However, the absolute values of coefficients of government policies are relatively small (0.084, -0.165, and 0.161 respectively); it seems that government policies make a limited contribution to increasing consumers' acceptance. Possible explanations for this limited contribution are that current government incentive policies focus mainly on subsidies and that it also takes time for consumers to realise the effects of some promotion policies related to infrastructure development.

The results of the regression analysis indicate that government policies have positive moderating effects on the relationship between financial benefits and willingness and purchase price, but negative moderating effects on the relationship between financial benefits and purchase time. Subsidies on NEVs provided by national and local governments dramatically reduce their purchase price; therefore, consumers can afford more expensive NEVs. This is why consumers who are sensitive to economic benefits are more likely to purchase NEVs in the near future when low tax, subsidies and other incentives are introduced. While the coefficient of interaction of government policies-financial benefits for purchasing price is moderate (coef.=0.2), interaction between government policies and financial benefits makes little difference to consumers' purchase willingness and time (coef.=0.059 and 0.051, respectively). This is also likely to be because incentive government policies are mainly on subsidies.

Table 5 suggests that the interaction between government policies and performance attributes of NEVs also has a weak but significant effect on consumers' purchasing willingness, which can be explained by the government's target to develop the NEV industry and establish infrastructure facilities. Although it takes time to realize the targets of having a large number NEVs on the road and a reasonable infrastructure for NEVs, related government policies to some extent encourage investment and innovation in NEV industry. Therefore, consumers with a greater concern for performance may be more willing to purchase NEVs when these government policies are perceived. Furthermore, the results of the regression indicate that the interaction between government policies and consumers' psychological needs has a weak negative influence on consumers' purchasing time. It is likely that this effect results from the government incentive policies related to NEVs which may more or less enforce the 'green' or 'environmental protection' value. NEV ownership is in turn more likely to be considered by consumers with environmental concerns as a reflection of a 'low carbon life style'. Therefore, the need of compliance with norms of 'environmentalism' may influence these consumers to purchase NEVs in the shorter term.

6 Conclusion

Research on the topic of NEV acceptance remains at an embryonic stage in China, although a growing demand has arisen to explore what motivates consumers to purchase NEVs and how government policies can effectively promote NEVs. Based on a review of NEV acceptance literature, a conceptual framework was elaborated and statistically tested in our research. One of the key contributions of this research is the finding of drivers of NEV acceptance and the moderating effect of government policies on NEV acceptance.

While providing interesting insights into the determinants of NEV acceptance and the moderating effect of government policies, this paper also highlights the demand for further research on this topic. A broader analysis of how consumers respond to a particular type of NEV could be conducted, as more and more types of NEVs are being introduced into the auto market. Moreover, additional years of acceptance

data would be helpful in developing a more sophisticated model to provide a more accurate indication of determinants of NEV acceptance and the impact of government policies. Furthermore, the proposed framework has only been quantitatively examined, and qualitative studies are required for further validation.

Referring to the status of the NEV market in China, not only the market but also the government might fail due to a lack of knowledge relating to new technology and consumer preference. Since the regression results suggest that several factors - financial benefits, performance attributes, environmental awareness and psychological needs - have significant influences on NEV purchase willingness, time to buy and the purchase price, government policies need to take into account of possible customer responses and address each of these factors. For example, affirmative signals attached to NEVs may provide additional psychological motivation for customers to purchase NEVs. Encouraging and stimulating the public environmental protection consciousness might be an effective means to promote NEVs.

One important finding from our empirical analysis is that the most important factors that influence the purchase decision of potential Chinese consumers are ranked as follows according to their importance: performance attributes (PA), psychological needs (PN), financial benefit (FB) and environment awareness (EA). This finding is basically consistent with previous literature on the influencing factors of NEVs purchases in western countries, such as Lane and Potter (2007), Kang and Park (2011), and Erdem et al. (2010) (refer to table 1 for more examples). One important feature of China's NEVs consumers is that they consider the environmental factors very little in their purchase decisions, because the environmental factors have lowest coefficients in all three models in table 5. This is somehow worrisome because this finding reveals that Chinese consumers generally do not realize the biggest advantage of the NEVs: they are environmentally friendly and produce no pollutions. Therefore there is a long way to go for Chinese government to promote the environmental awareness of Chinese consumers. The results of the regressions also indicate that there are varying degrees of consumer response to each of these factors. The coefficients of the variable performance are larger in magnitude than the coefficients of the variable financial benefits serves in all three equations, implying that the potential consumers tend to put a higher weight on the general performance of the NEVs to determine which NEVs to buy. Therefore, it is reasonable to believe that relative technology research or development in NEV industry will lead to a significant increase in NEV sales. Policy-makers in China may consider alterative types of government policies, such as research funding to NEV manufacturers, importing advanced technology from Western countries, and reducing regulatory barriers to new technologies.

The weak moderating effects of government policies on the relationship between financial benefits and purchase willingness, time and price also have significant policy implications. Because currently NEVs still underperform traditional oil power cars in some aspects (including maximum speed, driving range after each charging and charging interval), the subsidies provided by the government could be attractive only when they are large enough to compensate the relative disadvantage of NEVs' performance. This could be another explanation for the current status of NEV market in China; although strong monetary incentive policies have been developed to promote NEVs, the relatively poor sales indicate that NEVs as new innovative products are facing public scepticism in Chinese markets. If the

focus of government policies was on the research and development of technology related to NEVs rather than merely on subsidies, a more effective use of government funds could be expected. A possible future research direction coud be through a follow-up suvey to answer some key questions to China's NEVs market in more details. For example, how much the improved performance of NEVs (such as more driving range) or how much lower price caused by government subsidy would help spur potential consumers' interest to buy new NEVs?

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Appendix: Questionnaire

Section A: Personal Profile

1. Gender: (M).Male (F).Female
2. Age: **1.** Younger than 21/ **2.** 21-28 / **3.** 29-36/**4.** 37-44/**5.** 45-52/**6**. 53-60 / **7**. Older than 60
3. Have you got married? (Y) yes (N) no
4. Education level 1. Junior middle school or lower 2. Senior middle school or equivalent 3. Associate 4. Bachelor 5. Master or Ph.D
5. What is your net monthly household income? 1. less than 2000 2.2000-5000 3.5001-8000 4.8001-15000 5. 15001-20000 6. more than 20000
6. Family size (number of family members) 1. 1 2. 2 3. 3 4. 4 5. 5 or more than 5
7. Please indicate number of cars in your household? _____
8. The number of family members with driving licenses _____
9. What is your postcode? _____.
10. Whether you have an understanding on NEV? (1 refers to "definitely do not know", 7 refers to "clearly know") 1. 1 2. 2 3. 3 4. 4 5. 5 6. 6 7. 7

Section B: Purchase motives of individual consumers

Please respond by ticking the appropriate box against each of the questions below.

Please indicate your perceptions on NEV by rating on a scale between 1 and 7 where 1=Strongly Disagree, 4 = Neutral and 7=Strongly Agree.

NEVs will bring following financial benefits. (FB)	1	2	3	4	5	6	7
Low fuel cost (FB1)							
Low purchase price (FB2)							
Low maintenance cost (FB3)							
Low overall cost (FB4)							

I satisfy with the following attributes and performance issues of NEVs. (PA)	1	2	3	4	5	6	7
Riding comfort (PA1)							
Quality (PA2)							
Safety (PA3)							
Size (PA4)							
Exterior appearance and interior decoration (PA5)							
Ease and convenience of use (PA6)							
Duration distance (PA7)							
Operability (PA8)							

	1	2	3	4	5	6	7
NEV purchasing is helpful to reduce the effects of climate change. (EA1)							
NEV purchasing is helpful to reduce the carbon footprint. (EA2)							
NEV purchasing is helpful to reduce the pollution level. (EA3)							
NEV purchasing is helpful to reduce the consumption							

of natural resources. (EA4)							
NEV purchasing is helpful to preserve the environment. (EA5)							

	1	2	3	4	5	6	7
A NEV driver seems to be an individual having environmental concern and acting for the environment's preservation. (PN1)							
People would respect someone who drives a NEV. (PN2)							
I will feel proud of myself when I drive a NEV because it is something new and better. (PN3)							

Section C: Government policy

	1	2	3	4	5	6	7
To what extent are you familiar with the following policy?							

According to China's blueprint, the government will help create one or two automakers that can each produce more than 1 million new-energy cars per year by 2020. It will also help establish three to five automakers which can each produce more than 500,000 new-energy cars per year.

According to the new policy, the central government pays a subsidy of up to 50,000 yuan to any citizen that buys a plug-in hybrid vehicle (PHEV) and 60,000 yuan for an all-electric, or battery-electric vehicle (BEV).

Local governments also paying subsidies: For example, in Hefei, BEV buyers can receive a 10,000-20,000 yuan local government subsidy and in Shanghai they can get 40,000-50,000 yuan.

Under the plan of State Grid, a state-owned power company, China will build 4,000 BEV charging stations over the next five years. By 2020, the number of charging stations will reach 10,000.

	1	2	3	4	5	6	7
I know about the above policies in detail.							
I became aware of the above policies through diverse means including mass media.							
The above policies are generous.							
The above policies are strongly promoting NEV adoption.							
The above policies are efficient to encourage NEV purchase.							
The above policies are necessary to encourage NEV purchase.							

Section D: Acceptance and preference of NEVs

How do you compare on each of the following questions? (1 refers to very low, 7 refers to very high)

Acceptance	1	2	3	4	5	6	7
I hope that more NEVs are							

coming soon							
I would recommend my friends to buy a NEV							
I would buy a NEV							
Time period to purchase a NEV	1	2	3	4	5	6	7
I would like to purchase a NEV within	Never	10 years	5 years	3 years	1 year	Half a year	Very soon
Acceptability of purchase prices of a NEV	1	2	3	4	5	6	7
To buy a NEV, my acceptable price is no more than	CNY 30,000	CNY 60,000	CNY 100,000	CNY 150,000	CNY 250,000	CNY 350,000	CNY 500,000 or even more