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Policy measures to promote electric mobility – A global perspective

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ABSTRACT

Research that addresses policy measures to increase the adoption of electric vehicles (EVs) has discussed government regulations such as California's Zero Emission Vehicle (ZEV) or penalties on petroleum-based fuels. Relatively few articles have addressed policy measures designed to increase the adoption of EVs by incentives to influence car buyers' voluntary behavior. This article examines the effects of such policy measures. Two of these attributes are monetary measures, two others are traffic regulations, and the other three are related to investments in charging infrastructure. Consumer preferences were assessed using a choice-based conjoint analysis on an individual basis by applying the hierarchical Bayes method. In addition, the Kano method was used to elicit consumer satisfaction. This not only enabled the identification of preferences but also why preferences were based on either features that were "must-haves" or on attributes that were not expected but were highly attractive and, thus, led to high satisfaction. The results of surveys conducted in 20 countries in 5 continents showed that the installation of a charging network on freeways is an absolute necessity. This was completely independent from the average mileage driven per day. High cash grants were appreciated as attractive; however, combinations of lower grants with charging facilities resulted in similar preference shares in market simulations for each country. The results may serve as initial guidance for policymakers and practitioners in improving their incentive programs for electric mobility.

1. Introduction

Literature addressing electric mobility has primarily considered two aspects: technical issues like the optimal range of electric vehicles (EVs; Franke and Krems, 2013; Lin, 2014) or charging infrastructure (Flath et al., 2014), and marketing questions like acceptance of EVs and predictions for EV sales (Bunce et al., 2014; Carley et al., 2013; Egbue and Long, 2012; Gnann et al., 2015; Kieckhäfer et al., 2014; Lieven et al., 2011; Plötz et al., 2014; Skippon, 2014). Other research studies have addressed policy measures designed to reduce greenhouse gas (GHG) emission and promote the acceptance of EVs. Policymakers are interested in the promotion of alternative fuel vehicles to reduce the GHG emission. There exist several kinds of policy measures in this regard. Governments could implement repressive regulations such as California's Zero Emission Vehicle (ZEV) program that requires auto manufacturers to produce a certain percentage of zero emission vehicles (Green et al., 2014). Moreover, penalties could be placed on petroleum-based fuels, or taxes could be imposed on implementing a price floor to prevent the decline of petroleum price beyond a certain level (National Research Council, 2013). This could

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discourage consumers to buy cars with internal combustion engines (ICE). A compound measure comprising a repressive portion and an incentive portion are so-called feebates, which are a combination of fees for high pollution cars and rebates for low pollution cars (Greene et al., 2005; Mueller and de Haan, 2009; de Haan et al., 2009).

Another policy approach is to establish eco-friendly rules like the Corporate Fuel Economy (CAFE) standard that led to a 50% reduction of fuel consumption per passenger car mile (Greene et al., 2005). Instead of regulation, governments could motivate the industry to make increased R&D efforts. Åhman (2006) discussed policy regarding legislation and support for the automobile industry's R&D capabilities in Japan. Such subsidies for R&D in the field of climate policy have been shown to be effective (Abrego and Perroni, 2002; Popp, 2006). However, these subsidies do not provide sufficient incentive to encourage consumers to adopt new technologies. Thus, R&D subsidies have to be accompanied by additional incentives (Popp, 2006).

Consequently, policy should address car drivers' purchase decision by incentives to convince them to voluntary switch to less polluting vehicles. One of the most prominent incentives in the automobile sector was the 2009 Car Allowance Rebate System (CARS), popularly referred to as ''Cash for Clunkers,'' that offered up to $4500 to buyers of new cars when they scrapped their old vehicles. Similar programs have been implemented in other countries. All these incentives have been successful from the consumers' viewpoint. In the United States, subsidies were paid for approximately 700,000 vehicles amounting to a total sum of approximately $3 billion (Lenski et al., 2010). However, the evaluation of the overall economic effects revealed mixed results. Due to free-rider effects, approximately 45% of the incentives went to buyers who would have bought a new car anyway (Li et al., 2013). CARS had a positive effect on the reduction of GHG, albeit at a very high economic cost (Lenski et al., 2010). In recent years, a vast number of programs were offered for EV purchases worldwide with impressive results, such as in California and Norway. Thus, monetary incentives have shown positive effects.

Apart from monetary incentives such as tax credits or direct subsidies, there exist other measures that could boost EV sales, or at least, could clear some obstacles out of the way that prevent potential EV buyers from a purchase. These include the improvement of the charging infrastructure (Lin and Greene, 2011), road-tax exemptions, and traffic regulations such as the free use of bus lanes or downtown parking areas. Some of these incentives have been analyzed in literature (for direct subsidies see Helveston et al., 2015; for income tax credits see National Research Council, 2013; for charging infrastructure see Lin and Greene, 2011). However, these single measures have been analyzed in isolation and were not evaluated in comparison with each other in terms of the acceptance of potential EV buyers. It is still unknown which of these measures has the largest impact on increasing EV demand. Furthermore, the role of absolute must-haves is unclear. It is frequently argued that most car drivers cover daily distances of less than 40 miles and consequently do not deserve public charging facilities. However, the request of one or two longer vacation trips per year could make a charging network a *sine qua non* for an EV purchase. Consequently, governments could face the risk of pursuing a single-sided goal with an only-monetary policy since this could be insufficient to convince vehicle drivers to change over to EVs. The present article attempts to fill this research gap by focusing on those policy measures that convince consumers to voluntarily switch to electric mobility.

Furthermore, a global perspective regarding policy measures is missing. Sierzchula et al. (2014) have published an article that analyzes financial incentives and other factors related to EV adoption in 30 countries. However, these analyses were based on secondary data from national automotive institutions, government agencies, manufacturers, and automotive Web sites. In contrast, this article assessed primary data in 20 countries. The results stem from a more comprehensive study and the remaining findings concerning the general acceptance of EVs will be reported separately. The results could serve as guidelines for policymakers and practitioners. By utilizing a web appendix (www.researchfiles.com/Web Appendix.pdf) with a variety of figures and tables for each country, optimizing strategies can be simulated.

In the remainder of this article, the policy measures that are examined in this study are described as well as the research methods to assess consumers' preferences. Thereafter, the results of a large-scale survey in 20 countries with approximately 8000 participants are presented. The article is brought to a close with a discussion and conclusion.

2. Policy measures and research method

2.1. Policy measures

Due to the limitations present in any field research (Rao, 2014), only few of all existing policy measures could be included in the analyses. A workshop with drivers of conventional and electric vehicles was organized by members of a Swiss association of EV owners in which several proposals were discussed and seven policy measures were selected according to worldwide importance and sufficient coverage of several aspects such as monetary issues, traffic regulations, and charging infrastructure (Table 1).

With regard to the three categories of measures (monetary, traffic regulation, charging infrastructure), cash-related grant programs (monetary measures) in particular are often time limited or capped at a specific number of eligible recipients (Tyrrell and Dernbach, 2010–2011). For example, the UK government has limited its grant of up to 5000 GBP to a maximum of 50,000 cars or until the end of 2017, whichever comes first (UK Department of Transport, 2015). The nature of such grants requires them to be offered for each EV and without any increasing efficiency over time. This forces policymakers to quantitatively limit their offers (Tyrrell and Dernbach, 2010–2011). In contrast, the second category (traffic regulations) is the one that is less expensive when it is granted. Through merely altering traffic regulations and bus/fast lanes or parking spaces that

Table 1
Policy measures analyzed in this study.

Policy Measure	Description
Monetary	
(1)	Direct subsidies for an EV purchase
(2)	Road Tax Exemption
Traffic regulations	
(3)	Free Use of Bus/Fast Lanes
(4)	Free City Center Parking
Charging infrastructure	
(5)	Charging at Public Parking
(6)	Charging at Workplace
(7)	Charging Network on Freeways

already exist, EVs can be accommodated. However, the disadvantage is the decreasing efficiency of this measure, because bus/fast lanes and city parking could become congested over time and the advantages for drivers disappear. The third category (charging facilities) involves investments in infrastructure. The establishment of charging stations at company workplaces cannot be conducted directly by the government; however, policy can support this setup through employment regulations. Additionally, subsidies or tax abatements for companies can expedite progress. Providing additional parking in towns and residential areas complete with charging stations is probably the most expensive measure, even though electricity grids may already be available. In contrast, the installation of a charging network on motorways could be an affordable measure, because the number of service areas (road houses) is limited. As an example, only approximately 1200 service areas exist alongside the interstates in the United States (Interstate Rest Areas). This number appears to be manageable for a consecutive installation of sufficient charging stations. The advantage of such infrastructure measures is the increasing efficiency over time. Once installed, charging networks will provide sufficient capacity for an increasing number of EVs (for a more detailed description of the associated figures see the discussion section).

To assess preferences regarding these seven policy measures, a combination of two methods was applied in this study: conjoint analysis and the Kano method.

2.2. Conjoint analysis

Conjoint analysis (CA) has been widely accepted to ascertain consumer preferences (Green and Srinivasan, 1978). Apart from contingent valuation and stated choice techniques, CA is one of the most common stated preference (SP) methods (Louviere, 1988; Ortúzar and Willumsen, 2011). Further, CA has frequently been refined over the past few decades, and one of the prevailing methods is the choice-based conjoint analysis with hierarchical Bayesian estimation (CBC/HB; Andrews et al., 2002; Arora et al., 1998; Lenk et al., 1996). Through the evaluation of survey participants' choices, part-worths can be calculated for several features. Applying the hierarchical Bayesian procedure (HB), these utilities can be calculated at the individual level. Based on these individual scores, markets can be clustered and simulated.

To elicit consumer preferences, choices with different levels on several attributes were offered to survey participants. Direct subsidies were offered as one monetary measure (Table 1, measure 1). Since this offer was not made with real cash and because the surveys described hypothetical settings, there existed the risk of the so-called hypothetical bias (Ajzen et al., 2004; Murphy et al., 2005). This bias could result in overestimation and premature acceptance of specific offers that would not be agreeable in real situations (Helveston et al., 2015). Several so-called incentive-compatible survey designs that encourage respondents to reveal their true preferences have been developed, such as the BDM procedure (Becker et al., 1964) or the Vickrey auction (Vickrey, 1961). In addition, CA is also able to mitigate the risk of a hypothetical bias (Green and Srinivasan, 1978). Additionally, research has shown that participants in hypothetical environments behave quasi realistically in cases where they have to solve a task. For example, the results of studies with simulated jurors in a hypothetical court trial were found to be generalizable in terms of the behavior of real jurors (Bornstein, 1999). Therefore, the decision regarding the acceptance of a monetary grant (measure 1) was related to a specific task in this research design. Participants had to imagine that they were getting a tax refund of $3000. However, because the government intended to encourage the purchase of purely battery driven EVs, tax authorities offered the opportunity to forgo the full or partial tax refund and in return provided the participant with a correspondingly disproportional enhanced grant toward the purchase of an EV. This setting is similar to a cash vs. voucher trade-off where the cash is freely available for any product or service; however, the disproportionally higher voucher is purpose-specific—in this case for the purpose of the acquisition of an EV. This cash vs. voucher trade-off has been shown to be as incentive-compatible as a Vickrey auction and a BDM procedure (Lieven and Lennerts, 2013). Following this procedure, four choices were set up (measure 1):

(1) $3000 tax refund without a grant toward the purchase of an EV.
(2) $2000 tax refund plus grant of $4000 toward the purchase of an EV.
(3) $1000 tax refund plus grant of $8000 toward the purchase of an EV.
(4) No tax refund, but a grant of $12,000 toward the purchase of an EV.

The inherent trade-off provides a grant of \$3000 to purchase an EV for every \$1000 that the participants relinquished. This results in total amounts of \$3000, \$6000, \$9000, and \$12,000. Those respondents who were not interested in the acquisition of an EV at all would only choose option (1); all other participants could choose one of the other three options. Since participants were getting the \$3000 tax refund anyway, the four options represented net governmental grant equivalents of \$0, \$3000, \$6000, and \$9000.

As a second monetary measure, EVs were exempted from road tax (measure 2). This applied for the entire service life of the vehicle. The net gain over the years could exceed that provided by a one-off grant toward vehicle purchase, depending on different tax regimes.

As a traffic regulation, purely battery-powered EVs were permitted to use bus and fast lanes (measure 3). Consequently, EVs could make faster progress through city centers or on freeways (the American term "freeway" will be used throughout this article as a synonym for motorway, interstate, expressway, or superhighway). As another traffic regulation, sufficient parking spaces were reserved in city centers for free usage by purely battery-powered EVs without any time restriction (measure 4). This would solve the problem of the otherwise limited amount of parking spaces available in city centers.

One measure to improve charging infrastructure is equipping public parking lots in cities and communities with charging stations (measure 5). Those who rent accommodation do not always have the option to install a charging station. If public parking lots are equipped with a charging facility, this problem would no longer exist. The vehicle can be charged anywhere at any time. The electricity used is payable at the standard rate via credit or subscription card.

Measure 6 could not be implemented directly by the government but instead via its regulations and construction approvals for company car parks where parking lots had to offer a charging facility. For commuters who only drive a few miles per day, the constant availability of their EV is of great importance. This availability was guaranteed by having recharging facilities available during work hours. The electricity used is payable at the standard rate via credit or subscription card.

As another infrastructure measure, a densely knit charging network was installed on freeways (measure 7). Those who drive long distances need a network of charging stations, primarily on freeways. The electricity used is again payable at the standard rate via credit or subscription card.

In recent literature, the inclusion of a "none" or "no-choice" option has become state-of-the-art for CBC analyses to make the choice task more realistic and to avoid squeezing respondents into an unwanted trade-off (Rao, 2014). With regard to the four alternatives in measure 1 with cash and/or grants toward the purchase of an EV, alternative (1) is the "none" or "no-choice" option in the conjoint analysis (Batsell and Louviere, 1991; Louviere and Woodworth, 1983), because participants state their unwillingness to give up any cash amount in favor of a substantially higher grant that could only be used to acquire an EV. Thus, with the three tax refund vs. grant alternatives along with two alternatives (yes/no) for the other six measures, $3 \times 2^6 = 192$ different combinations existed. This number is far too large to be evaluated by survey participants. Consequently, this number had to be reduced. Following one of the recommendations of Rao (2014), the software package *Ngene* developed by Choice Metrics was utilized. The aim of this procedure is to identify an efficient design that yields data that enables the estimation of the parameters with standard errors that are as low as possible (Ngene 1.1.2 user manual, 2014). The most widely used measure is the D-efficiency, which summarizes how precisely this design can estimate all the parameters of interest with respect to another design (Kuhfeld et al., 1994). A design with the lowest D-error is called D-optimal. In practice, it is very difficult to identify the design with the lowest D-error; therefore, it is sufficient if the design has a relatively low D-error, called a D-efficient design. In our case, the D-error resulted in an acceptably low 0.489. Twelve choice sets emerged and these are depicted in Table 2. Participants could choose either option B or option C, or in case of a complete denial, option A (the "none" option).

2.3. The Kano method

The Kano method is named after one of its originators (Kano et al., 1984), and serves as a measuring instrument for customers' satisfaction with particular features of a product or service. Survey participants have to state their opinion regarding such a feature twice: once when it is available (functional question) and once when it is not available (dysfunctional question). Each question is answered by one of the same five statements, which yields a 5×5 matrix (Table 3).

Using this matrix, the quality of requirements can be identified. When participants dislike the absence of a feature, it is a must-have requirement (M) and its inclusion is expected. On the other hand, some features are not expected. However, customers are delighted when such features exist. These are termed attractive requirements (A). In between these are the so-called one-dimensional requirements (O). In the middle of the matrix, around the statement "I do not care," respondents are indifferent regarding this specific feature (I).

From this matrix, customer satisfaction and dissatisfaction coefficients can be calculated (Berger et al., 1993; Matzler and Hinterhuber, 1998), where A, O, M, and I are the summed up numbers of the respective requirements.

$$\text{Satisfaction} = (\text{A} + \text{O})/(\text{A} + \text{O} + \text{M} + \text{I}) \quad (1)$$

$$\text{Dissatisfaction} = (-1) \times (\text{M} + \text{O})/(\text{A} + \text{O} + \text{M} + \text{I}) \quad (2)$$

Table 2
CBC Choice Sets.

Choice Set	Option	Tax Refund	(1) Purchase Grant	(2) Road Tax Exemption	(3) Free Use Bus/Fast Lanes	(4) Free City Center Parking	(5) Charging at Public Parking	(6) Charging at Workplace	(7) Charging Network on Freeways
1	Option A	$3,000	–	–	–	–	–	–	–
	Option B	$2,000	$4,000	Yes	No	No	Yes	Yes	Yes
	Option C	$1,000	$8,000	No	Yes	Yes	No	No	No
2	Option A	$3,000	–	–	–	–	–	–	–
	Option B	$1,000	$8,000	Yes	No	No	No	No	Yes
	Option C	$0	$12,000	No	No	Yes	Yes	Yes	No
3	Option A	$3,000	–	–	–	–	–	–	–
	Option B	$1,000	$8,000	No	Yes	No	Yes	No	Yes
	Option C	$2,000	$4,000	Yes	No	Yes	No	Yes	No
4	Option A	$3,000	–	–	–	–	–	–	–
	Option B	$0	$12,000	Yes	Yes	Yes	No	No	Yes
	Option C	$1,000	$8,000	No	No	No	Yes	Yes	No
5	Option A	$3,000	–	–	–	–	–	–	–
	Option B	$1,000	$8,000	No	No	Yes	No	Yes	Yes
	Option C	$0	$12,000	Yes	Yes	Yes	Yes	No	No
6	Option A	$3,000	–	–	–	–	–	–	–
	Option B	$2,000	$4,000	No	Yes	Yes	Yes	No	Yes
	Option C	$0	$12,000	Yes	No	No	No	Yes	No
7	Option A	$3,000	–	–	–	–	–	–	–
	Option B	$2,000	$4,000	Yes	No	Yes	Yes	No	Yes
	Option C	$1,000	$8,000	No	Yes	No	No	Yes	No
8	Option A	$3,000	–	–	–	–	–	–	–
	Option B	$2,000	$4,000	No	Yes	No	Yes	Yes	Yes
	Option C	$1,000	$8,000	Yes	No	Yes	No	No	No
9	Option A	$3,000	–	–	–	–	–	–	–
	Option B	$2,000	$4,000	No	No	Yes	Yes	Yes	No
	Option C	$0	$12,000	Yes	Yes	No	No	No	Yes
10	Option A	$3,000	–	–	–	–	–	–	–
	Option B	$0	$12,000	No	No	Yes	Yes	No	Yes
	Option C	$2,000	$4,000	Yes	Yes	No	No	Yes	No
11	Option A	$3,000	–	–	–	–	–	–	–
	Option B	$0	$12,000	No	Yes	No	No	Yes	Yes
	Option C	$1,000	$8,000	Yes	Yes	Yes	Yes	No	No
12	Option A	$3,000	–	–	–	–	–	–	–
	Option B	$2,000	$4,000	No	Yes	Yes	No	Yes	Yes
	Option C	$0	$12,000	Yes	No	No	Yes	No	No

Table 3
The Kano matrix.

	Imagine that this feature is not included				
	I would be delighted to find it that way	It must be that way and I expect it to be that way	I do not care	I do not like it but I can live with it	I dislike it and it must not be that way
Imagine that this feature is included					
I would be delighted to find it that way	Q	A	A	A	O
It must be that way and I expect it to be that way	R	I	I	I	M
I do not care	R	I	I	I	M
I do not like it but I can live with it	R	I	I	I	M
I dislike it and it must not be that way	R	R	R	R	Q

Note: M = Must-have Requirement, O = One-Dimensional Requirement; A = Attractive Requirement; R = Reverse; Q = Questionable; I = Indifferent.

The Kano diagram in Fig. 1 explains the meaning of these requirements. The most important requirements are those for features that have to be included. Otherwise, a purchase is very unlikely. These are the must-have requirements (M). In cases where the feature is well implemented, the satisfaction increases, albeit to no higher than a medium range. Such a feature could be a remote control for a TV station, which absolutely has to be included. In cases where a customer is more satisfied with a more functional product and less satisfied with a less functional product, such a requirement is said to be one-dimensional (O) since it is a straight 45° line through the center of the diagram and encompasses the entire range from strong dissatisfaction to high satisfaction. Such a feature could be the size of a TV screen. Additionally, there exist features that may not even be expected that, however, evoke a high degree of satisfaction. Such a feature may be a completely integrated PC in a TV with sufficient memory and communication equipment. Most consumers could live without this feature and, in cases of its absence, may never be dissatisfied. However, in cases where it is available, satisfaction could increase strongly due to its high attraction (A).

The Kano results differ from the conjoint part-worths. The CBC procedure decomposes complete sets of choices regarding participants' preferences for separate features. This is achieved through trade-offs. With regard to choice set 12 in Table 2, someone who likes EVs, but frequently drives long distances and definitely requires charging facilities on freeways will choose option B. Thus, he or she is giving up a net amount of $6000 plus the tax exemption. In terms of CBC choices, one cannot have it all at once. This restriction does not exist in the Kano analyses. Each attribute is evaluated separately and theoretically, so all attributes could be perceived as must-have requirements. In CBC, it is unclear whether the preferences stem from the fulfillment of a necessary condition (must-have, e.g., charging network on freeways) or whether these attributes are not expected, but rather highly appreciated in cases where they are offered (e.g., net grant of $9000). The additional Kano satisfaction coefficients in this research design are able to answer this question.

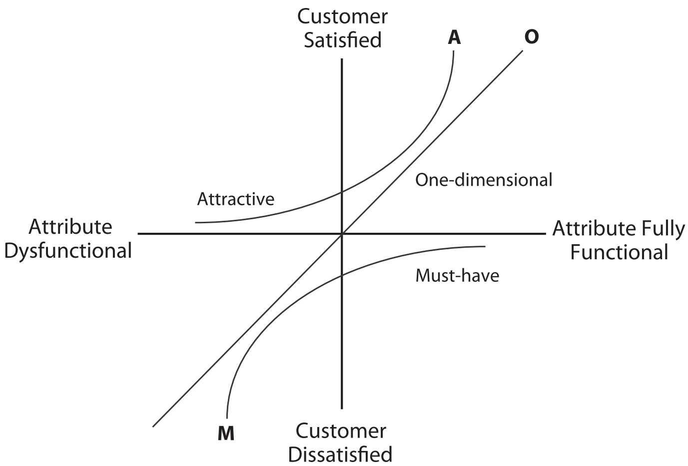

Fig. 1. The Kano diagram.

3. Empirical study

3.1. Participants

Surveys were conducted in 20 countries in 5 continents. These countries are Australia (AU), Belgium (BE), Brazil (BR), Canada (CA), Switzerland (CH), China (CN), Germany (DE), France (FR), Hong Kong (HK), India (IN), Italy (IT), Japan (JN), Korea (KR), Netherlands (NL), Norway (NO), Russia (RU), Taiwan (TW), United Kingdom (UK), United States of America (US), and South Africa (ZA). The selection followed the recommendations of a workshop where the characteristics of different countries regarding size, population, density, income, and region were discussed. The survey was conducted by a well-established global provider of data solutions for survey research with 30 offices in 21 countries. The provider collected completed questionnaires from participants aged from 18 to 65 years and according to the countries' demographics to provide a representation as close as possible to the population. Demographics in Table 4 demonstrate that these requirements could be met sufficiently within the different countries. Respondents who did not drive any miles per day were excluded. No data were assessed for income, education, or profession because of the risk of too many missing values due to lack of appropriate answers. The surveys were conducted until approximately 400 questionnaires per country were completed.

3.2. Procedure

For each country, US dollar amounts were adjusted to local currencies, taking into account exchange rates and general purchasing power (World Bank, 2013). Miles were used as distance measures in the United States and United Kingdom; in all other countries, kilometers were applied (1 mile = 1.61 km). Where necessary, the survey that was administered in the United States was translated into other languages following an iterative process to ensure validity. In countries with more than one official language (Belgium, Canada, Switzerland, and Hong Kong), participants could choose their language. Participants were first instructed on the topic of the research and the seven policy measures (Table 1). To introduce the choice-based task to participants, an example was first explained. Thereafter, the 12 choice sets (Table 2) were shown in a random sequence and, in each case, respondents were required to choose option A, B, or C. Then, the respective Kano features were presented once in the dysfunctional manner and once in the functional manner, again in a randomized order. The participants chose one of the five answers (Table 3). The respondents were also asked about the average mileage they travelled per day by car. Only those respondents who drove over zero miles per day were accepted. By this, we were able to ensure that all participants actively drove a car. Finally, the respondents' ages and genders were assessed.

After the collection of the data, the conjoint results were evaluated within each country by implementing the Sawtooth CBC/HB procedure resulting in the part-worths for each participant. The combinations of answers for the functional and dysfunctional Kano questions were recorded with the respective requirements. From this, the dissatisfaction and satisfaction coefficients could be calculated (Eqs. (1) and (2)). Based on the individual conjoint part-worths, an attempt was made to find a meaningful separation of potential EV buyers with a *k*-means clustering procedure.

Table 4
Country data.

Country	Invited	Does not drive a vehicle (%)	Remaining	Female	M_{Age}	SD_{Age}	Average mileage per day	Mileage at the 75% quantile	Average mileage below 75% quantile	Average mileage above 75% quantile
Australia	511	22.1	398	50.6	41.8	13.4	29	31	15	71
Belgium	586	25.4	437	49.8	42.3	14.4	35	41	20	79
Brazil	593	30.2	414	43.5	37.9	11.8	43	56	23	105
Canada	512	20.9	405	49.6	42.2	13.4	31	38	17	73
Switzerland	563	25.8	418	47.9	42.2	13.0	33	38	19	76
China	543	23.2	417	39.7	35.7	9.6	31	31	17	72
Germany	489	17.8	402	50.9	41.0	12.8	33	38	19	73
France	464	15.5	392	41.6	41.1	13.2	33	38	20	72
Hong Kong	705	45.7	383	45.2	38.3	10.5	42	50	17	116
India	504	19.6	405	36.7	36.1	11.4	38	41	22	86
Italy	468	13.0	407	49.1	41.9	12.0	31	38	18	71
Japan	655	35.6	422	43.0	43.6	12.3	19	19	9	50
Korea	516	18.6	420	40.9	40.3	10.8	27	31	16	61
Netherlands	596	32.4	403	48.7	42.4	13.9	32	38	17	78
Norway	587	31.3	403	50.1	42.1	14.5	19	22	8	51
Russia	495	19.2	400	45.8	40.0	12.4	55	63	30	130
Taiwan	570	31.2	392	40.6	38.7	11.4	23	31	13	53
UK	623	33.9	412	43.9	40.8	12.8	38	50	20	92
US	487	17.9	400	53.4	40.9	13.8	34	45	20	75
South Africa	514	18.9	417	54.0	37.4	10.6	51	63	29	117
Total	10,981	25.8	8147	46.7	40.3	12.6	34	38	18	82

3.3. Results

3.3.1. Worldwide aggregated results

Worldwide, approximately 10,981 respondents were invited to participate in the survey. Among them, 25.8% did not drive any miles per day. Thus, they were not included in the sample. Table 4 shows the number of participants per country, their demographics, daily mileage, the mileage that three out of four never exceeded, as well as the average mileage for the 75% quantile and the remaining 25%. The mileages differ across countries ($p < 0.001$). No relationship with area size, population, or population density could be found.

There was a total of 8147 respondents remaining in the global sample (46.7% female, $M_{Age} = 40.3$ years, $SD_{Age} = 12.6$ years). On average, each respondent drove 34 miles per day (54 km). The distribution shows that 75% drove only 18 miles per day, whereas the other 25% drove 82 miles on average.

3.3.1.1. Conjoint analysis and k-means cluster. In total, 20.8% chose the "none" option A. However, only 10.5% declined to forego the tax refund in favor of a higher grant for all 12 choices, thereby demonstrating that they were not interested at all in the purchase of an EV. Approximately 60% did not choose the "none" option in any of the 12 choices and 8.9% chose only one "none" option out of the 12 choices (note that the "none" options were included in the CBC calculation and thus have influenced the part-worth estimation).

Table 5 presents the worldwide part-worths per cluster and in total (note that only in cases of the tax refund/grant combinations are all three part-worths denoted; in all other cases, the negative part-worths for the "no" alternatives equal the negative value of the "yes" alternative and thus are redundant). In Fig. 2, these numbers are depicted graphically. In the first cluster, representing 1841 respondents (22.6%), the monetary attribute is the most important. In the third cluster, 2891 participants (35.5%) have almost opposite part-worths. Participants are willing to give up high subsidies in favor of good charging opportunities, particularly on freeways. Group 2, with 3415 respondents (41.9%), has the most even distribution of part-worths.

The clusters were derived from a *k*-means procedure that was separately applied within each of the 20 countries. The validity of the structure of these clusters is crucial for the analysis and the subsequent inferences of this research. Consequently, several tests were conducted to evaluate the fit of the clustering: an analysis of variance (ANOVA), a discriminant analysis, and a multinomial logistic regression of the cluster-numbers on the part-worths.

The one-way ANOVA showed significant differences for all nine part-worths across the three clusters (all $F(2,8144) > 68.0$, all $ps < 0.001$), that is, the clusters represented a significant distinction among respondents. The resulting functions of the discriminant analysis could significantly split the participants in three groups. Box's M was lower than the threshold of 0.001. The canonical correlation was 0.898. Its square represents an effect size of 0.801, which describes an existing coherence between the part-worths and their ability to predict group membership. The statistical significance of the prediction model was high (Wilk's $\lambda = 0.182$, $\chi^2(16) = 13852{,}311$, $p < 0.001$). Furthermore, the discriminant functions could correctly classify 86.2% of the original data. Finally, the multinomial regression showed the significant capability of all nine part-worths to predict group membership. From the odds ratios, it was concluded that the probability of belonging to group 3 instead of group 1 was 967 times higher when the part-worth for the $2000 refund/$4000 grant combination increased by 1. The same holds for an increase by 1 of the part-worth for the charging network on freeways (more than four times higher probability of belonging to cluster 3). The results that are depicted in Table 6 reflect the findings presented in Table 5 and Fig. 2.

As a result of the three tests, there is sufficient support that these three clusters are a valid representation of the different types of consumers who could be classified as showing a strong affinity to allowances in money (group 1), as being more interested in the charging infrastructure than in cash (group 3), and as being part of a relative majority of respondents whose utilities stem from all of the offered attributes (group 2).

Significantly, more female consumers belonged to group 3 with the highest part-worths for a charging network on freeways (39.2% in group 1 vs. 47.7% in group 2, and 50.4% in group 3, $\chi^2 = 57.823$, $p < 0.001$). The distribution is summarized in Table 7.

Table 5
Worldwide CBC part-worths.

Cluster	Percentage (%)	$2000 Tax Refund + $4000 Purchase Grant	$1000 Tax Refund + $8000 Purchase Grant	No Tax Refund + $12,000 Purchase Grant	Road Tax Exemption	Free Use Bus/ Fast Lanes	Free City Center Parking	Charging at Public Parking	Charging at Workplace	Charging Network on Freeways
1	22.6	−3.1416	−0.1746	3.3162	−0.0189	0.4233	0.1364	−0.0209	−0.1696	−0.4463
2	41.9	−0.4875	0.0730	0.4145	0.3297	0.1538	0.2723	0.3494	0.1853	0.3557
3	35.5	0.9748	0.2990	−1.2738	0.1370	0.0103	0.2536	0.3377	0.3059	0.7740
Total	100.0	−0.5684	0.0973	0.4711	0.1826	0.1638	0.2349	0.2615	0.1479	0.3229

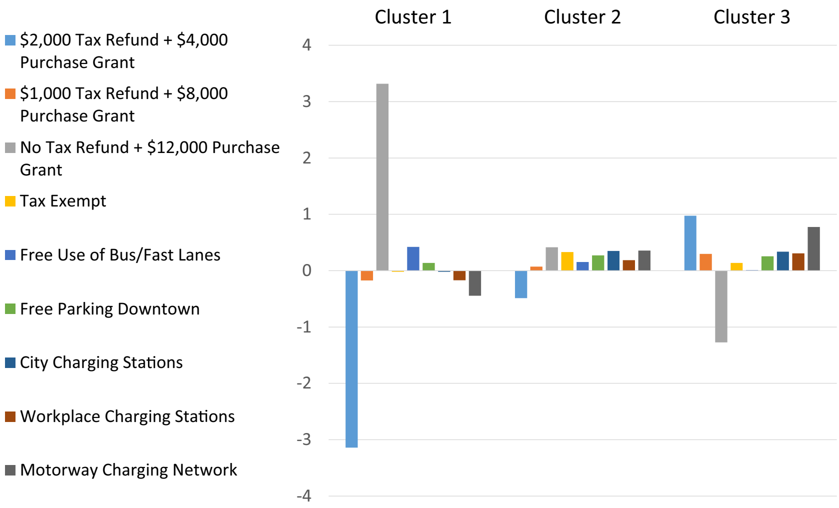

Fig. 2. CBC part-worths aggregated worldwide.

Table 6
Results of multinomial logistic regression of clusters on part-worths.

Cluster[a]		B	Odds ratio
2	Intercept	5.84***	
	$2000 Tax Refund + $4000 Purchase Grant	3.19***	24.39
	$1000 Tax Refund + $8000 Purchase Grant	1.94***	6.94
	No Tax Refund + $12,000 Purchase Grant	0[b]	
	Road Tax Exemption	0.51***	1.67
	Free Use of Bus/Fast Lanes	−0.65***	0.52
	Free City Center Parking	0.03	1.03
	Charging at Public Parking	0.52**	1.68
	Charging at Workplace	0.46**	1.58
	Charging Network on Freeways	0.82***	2.28
3	Intercept	3.73***	
	$2000 Tax Refund + $4000 Purchase Grant	6.88***	967.53
	$1000 Tax Refund + $8000 Purchase Grant	4.20***	66.65
	No Tax Refund + $12,000 Purchase Grant	0[b]	
	Road Tax Exemption	0.18	1.19
	Free Use of Bus/Fast Lanes	−0.96***	0.38
	Free City Center Parking	0.43	1.53
	Charging at Public Parking	0.74***	2.10
	Charging at Workplace	1.14***	3.14
	Charging Network on Freeways	1.44***	4.22

[a] The reference category is cluster 1.
[b] This parameter is set to zero because it is redundant.

Table 7
Demographical data for three clusters.

Cluster	*N*	%	Female %	Male %	M_{Age}	SD_{Age}
Cluster 1	1841	22.6	39.2	60.8	43.6	12.0
Cluster 2	3415	41.9	47.7	52.3	39.9	12.7
Cluster 3	2891	35.5	50.4	49.6	38.8	12.6
Total	8147	100.0	46.7	53.3	40.3	12.6

3.3.1.2. Kano method. From both the answers to the functional and dysfunctional questions regarding the nine attributes, the requirements were calculated for each participant. They were summed up and resulted in the satisfaction and dissatisfaction coefficients according to Eqs. (1) and (2). The sums per requirement and the satisfaction results for the combined worldwide sample are depicted in Table 8 and Fig. 3.

It is now easier to interpret certain relationships. Although the option with the highest purchase grant ($12,000) leads to the highest satisfaction, it is the absence of a charging network on freeways that causes the most dissatisfaction among

Table 8
Percentages of requirements, satisfaction, and dissatisfaction coefficients (Kano).

	$2,000 Tax Refund + $4,000 Purchase Grant	$1,000 Tax Refund + $8,000 Purchase Grant	No Tax Refund + $12,000 Purchase Grant	Road Tax Exemption	Free Use of Bus/Fast Lanes	Free City Center Parking	Charging at Public Parking	Charging at Workplace	Charging Network on Freeways
I(ndifferent)	37.4%	34.1%	31.0%	39.3%	56.1%	42.5%	34.8%	40.5%	33.4%
A(ttractive)	14.5%	17.9%	21.2%	22.5%	18.6%	21.3%	15.2%	19.4%	10.5%
O(ne-dimensional)	13.3%	19.8%	26.6%	15.9%	5.9%	13.9%	24.7%	19.2%	26.3%
M(ust-have)	22.1%	17.8%	11.6%	8.0%	4.7%	9.3%	13.7%	11.1%	18.9%
Dissatisfaction if not available	−0.405	−0.420	−0.423	−0.279	−0.124	−0.266	−0.434	−0.335	−0.507
Satisfaction if available	0.319	0.421	0.529	0.448	0.287	0.405	0.452	0.428	0.413

Note: Satisfaction = (A + O)/(A + O + M + I); Dissatisfaction = (−1) × (M + O)/(A + O + M + I).

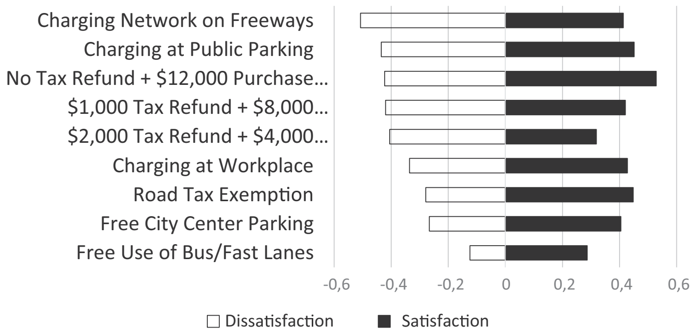

Fig. 3. Satisfaction and dissatisfaction diagram. Note: Satisfaction in case of availability (functional); dissatisfaction in case of non-availability (dysfunctional).

drivers. Thus, charging stations on freeways are must-haves. There is no such need for high grants. However, cash grants are highly appreciated as attractive requirements.

The correlation between the part-worths from the CBC and the indices from the Kano method was 0.641 ($p < 0.010$). As depicted in Fig. 4, the tax refund/grant combination with the lowest part-worth is an outlier. This is naturally caused by the fact that the part-worths have to sum up to zero for all attributes. In the Kano model, the satisfaction for this alternative is lower than that for the other two refund/grant combinations but is not negative. The exclusion of this data point resulted in a higher correlation of 0.860 ($p < 0.001$). The positive correlation supports the assumption of consistent results.

3.3.1.3. Simulations and shares of preference. Incentive programs that are financed with public subsidies are difficult to support over a long period of time (Tyrrell and Dernbach, 2010–2011). Thus, policymakers face the problem of ensuring that the results are as positive as possible, while minimizing monetary expenses. Here, four proposals were tested to delineate monetary measures, traffic regulations, and investments in charging infrastructure (for a more detailed description of the underlying figures see the discussion section). In option A, the government suggests foregoing the complete tax refund and instead offers a high purchase grant of $12,000. This costs a net of $9000 dollars ($3000 belongs to the recipient anyway as a tax refund). As there are only few further expenses for the government, the free use of bus/fast lanes and the free parking downtown in city centers are granted for EVs as well. In option B, a tax sum of $1000 is refunded and a purchase grant of $8000 is offered; thus, the net cost is $6000. Additionally, EVs are exempted from road tax. In option C, a tax sum of $2000 is refunded and a purchase grant of $4000 is offered; thus, the net cost is only $3000 dollars. Additionally, public parking areas and

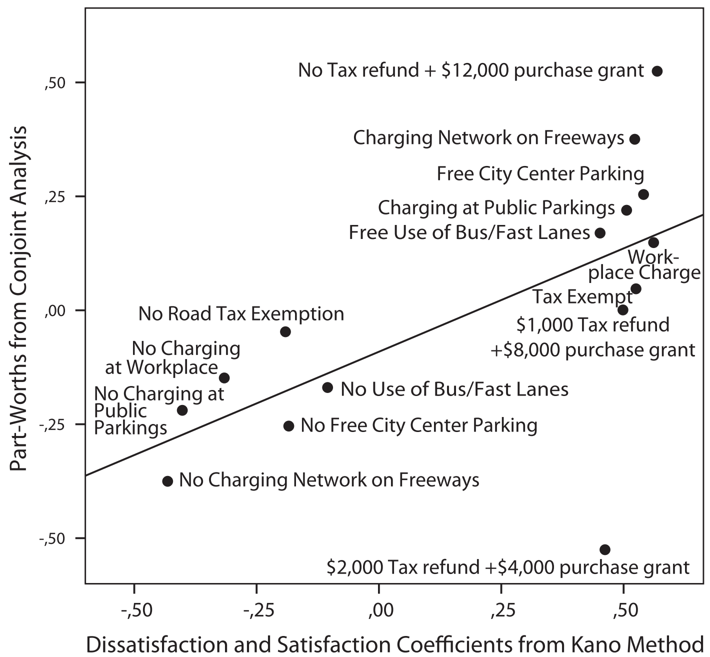

Fig. 4. Kano coefficients vs. conjoint part-worths.

workplaces will be equipped with charging facilities. Similar to option C, in option D, a tax sum of $2000 is refunded and a purchase grant of $4000 is offered. However, here freeways are equipped with a densely knit charging network.

The shares of preferences were calculated for the total sample as well as separately for the three clusters using the individual path-worths with the logit procedure ($\beta = 1$). The results are illustrated in Fig. 5.

The highest net grant of $9000 leads to the highest share of option A in cluster 1 (93.7%). In this cluster, respondents with the highest part-worths for the zero refund/$12,000 grant are combined. This group also appreciated the free use of bus/fast lanes and downtown parking, which may have increased the preference share for option A. The other alternatives are not significant in cluster 1. In contrast, the monetary measures are not significant in cluster 3; however, the investments in the charging infrastructure do. Since in both options C and D the same amounts are offered, one can conclude that the charging network on freeways (47.6%) is appreciated more than the charging facilities at public parking and workplaces (35.4%) in this cluster. The group with evenly distributed part-worths for all alternatives (cluster 2) shows a similar even distribution of shares, with a maximum of 34.1% for option A and a minimum of 20.8% for option D.

3.3.2. Reporting per country

3.3.2.1. Part-worths and clusters. Both the assessment of part-worths and the *k*-means clustering were conducted separately in each country. With regard to group sizes, group 1 was the smallest and group 2 was the largest one in 13 countries. In five countries, group 1 was the smallest as well; however, the largest group here was group 3 (Belgium, Brazil, Canada, Korea, and Russia). In Switzerland and Hong Kong, group 2 was the largest, while group 3 was the smallest.

Members of group 1 were highly attracted by cash, with the highest part-worth for the zero refund/$12,000 grant alternative and negative part-worths for the three charging attributes. In group 2, this zero refund/$12,000 grant alternative was also high; however, the road tax exemption showed high or the highest part-worths. Group 3 had the highest part-worth for the charging network on freeways. Conversely, this group gave the lowest part-worths to the highest grant alternative and gave the highest part-worths to the lowest alternative with $2000 tax refund and $4000 grant. This distribution over the three groups held for the majority of countries. The exceptions were Canada and France with only low part-worths for the tax exemption, particularly in group 2. This might be due to the low road taxes in these countries. A comparison of the road taxes that exist in the different countries with the part-worths of the tax exempt alternative revealed a positive correlation of $r(20) = 0.434$, although with a significance at only the 90% level ($p = 0.056$). This might be mostly due to the low number of cases, as is evident from the *t*-value (2.046) which, in general, is located above the approximate cutoff-value of 1.96 for the two-sided significance and the 95% level.

The validity of the clustering was again examined with a one-way ANOVA. *F*s in all countries were significant (*p*s < 0.001), which showed that the data was detached over the three groups. All discriminant analyses showed a significant separation into the three groups in each country. The respective discriminant functions could mostly classify the original grouped cases correctly. The percentage of correctly classified cases went from 94.2% in South Africa up to 97.3% in the US and 97.5% in Australia, Germany, and Norway.

The combined global sample showed a significant differentiation regarding participants' gender. Group 3 had 11% more female participants than in group 1. The same held for the majority of countries; however, it was not always significant. In Brazil, China, Hong Kong, India, Norway, and Russia, these relations were evident as well; however, not as clearly as in the other countries. In general, females have a higher preference for the installation of charging networks on freeways and are thereby willing to forego a net grant of $6000.

3.3.2.2. Kano results. With regard to the Kano method, the participants are by far most strongly attracted by the no tax refund/$12,000 purchase grant alternative. This alternative's satisfaction indices are ranked first in all 20 countries, except

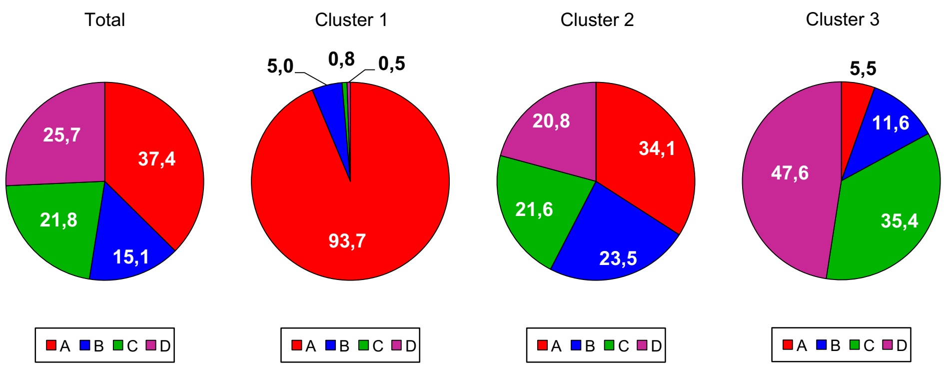

Fig. 5. Shares of preferences for simulated policy options. Note: *Option A:* No tax refund + $12,000 grant + free use of bus/fast lanes + free city center parking; *Option B:* $1000 tax refund + $8000 grant + road tax exempt; *Option C:* $2000 tax refund + $4000 grant + charging at public parking + charging at workplace; *Option D:* $2000 tax refund + $4000 grant + charging network on freeways. Shares calculated from individual part-worths.

Russia where it is ranked second. It is not seen so strongly as a must-have; on average, the dissatisfaction indices are ranked third. All three refund/grant alternatives have similar dissatisfaction indices; however, their satisfaction decreases with lower grant portions (the $2000 tax refund/$4000 grant alternative is ranked eighth on satisfaction only).

The road tax exemption is an attractive requirement, but it is not a must-have. It is ranked first or second on satisfaction in BE, DE, IT, UK, AU, BR, and NL. However, it is ranked only sixth or seventh on the dissatisfaction scale. The free use of bus/fast lanes neither generates dissatisfaction nor satisfaction; it is mostly ranked ninth. Free parking opportunities in city centers are ranked somewhat higher.

On average, the charging facilities in public parking areas are ranked on the second highest rank for satisfaction and the second highest rank for dissatisfaction, which implies that this attribute is a one-dimensional requirement. This holds for NO, JN, KR, CA, NL, RU, UK, US, AU, ZA, and CN. Charging at workplaces is a much more attractive requirement; on average, it ranks fourth on satisfaction and only sixth on dissatisfaction. In CN, HK, ZA, BR, KR, TW, and DE, it is ranked rather high on the satisfaction scale (rank 2 or 3). One of the most required must-haves are charging networks on freeways. The absence of such networks caused the highest dissatisfactions in almost all countries, except in Hong Kong (fifth rank), Norway (second rank), and Taiwan (fifth rank). It was less perceived as an attractive requirement; on average, it was ranked sixth. In Russia, it ranked high on both satisfaction (second) and dissatisfaction (first).

3.3.2.3. Correlations between CBC and Kano results and Shared Preferences. The correlations between the part-worths and the Kano indices were all positive and mostly significant, thereby indicating sufficient support for consistency. The results of the market simulations are also depicted according to country in Table 9.

3.4. Discussion

It can be expected that those who frequently drive long distances have higher part-worths for a densely knit charging network on freeways and perceive it as a must-have. However, this does not hold from the data. The correlation between daily mileage and part-worths is an insignificant 0.01. From this, it can be concluded that the frequency of long distance trips is not the critical factor. It appears that such a network is also crucial for vehicle owners who regularly drive only some miles per day, but where there exists a likelihood that they may want to drive for longer, even if it is only once a year on vacation. By this, the charging network is the bottleneck, and the argument that EVs with a limited range are well-suited for the majority of drivers does not hold. Thus, the charging network is a must-have to avoid range anxiety. This range anxiety appears to be higher for women, as can be concluded from the 11% higher proportion of females in cluster 3 vs. cluster 1 (McLean and Anderson, 2009).

To better understand consumer needs, the requirements in the Kano diagram (Fig. 1) can be assigned by examining Table 8. The net $9000 grant obtained the most ratings as an attractive requirement and consequently led to the highest sat-

Table 9
Correlations and shared preferences according to country.

	Correlation between CBC and Kano results	Option A (No Tax Refund + $12,000 Grant + Free Use of Bus/Fast Lanes)	Option B ($1000 Tax Refund + $8000 Grant)	Option C ($2000 Tax Refund + $4000 Grant + Charging at Public Parking + Charging at Workplace)	Option D ($2000 Tax Refund + $4000 Grant + Charging Network on Freeways)
Australia	0.663**	41.8%	16.6%	16.3%	25.4%
Belgium	0.687**	35.2%	23.5%	19.9%	21.3%
Brazil	0.787***	23.1%	20.3%	21.8%	34.8%
Canada	0.537*	43.8%	10.8%	22.5%	23.0%
Switzerland	0.580*	38.2%	18.9%	22.0%	21.0%
China	0.641**	40.9%	10.8%	21.7%	26.7%
Germany	0.663**	42.5%	13.9%	20.9%	22.7%
France	0.336n.s.	49.3%	10.1%	21.3%	19.3%
Hong Kong	0.511*	36.1%	10.6%	20.8%	32.4%
India	0.662**	20.2%	15.5%	29.1%	35.2%
Italy	0.629*	36.7%	17.2%	21.4%	24.7%
Japan	0.408n.s.	43.7%	13.7%	25.1%	17.5%
Korea	0.540*	51.0%	11.0%	22.1%	15.9%
Netherlands	0.804***	32.1%	18.8%	18.9%	30.2%
Norway	0.794***	30.9%	23.8%	17.5%	27.9%
Russia	0.812***	31.6%	18.0%	20.3%	30.1%
Taiwan	0.758**	38.4%	11.8%	26.9%	22.8%
UK	0.301n.s.	42.6%	9.2%	17.4%	30.8%
US	0.749**	34.3%	10.8%	20.8%	34.1%
South Africa	0.804***	35.6%	15.8%	28.8%	19.8%

Note:
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

isfaction. This is evident by the A-line of the diagram. Consumers do not coercively require such a high grant; however, they are delighted in cases where it is offered. This attractiveness decreases for the other two lower grants. With regard to the other monetary measures, road tax exemption is not a must-have but rather an attractive requirement. Further, the free use of bus/fast lanes and downtown parking are neither expected nor perceived as reasonably attractive. The charging at public parking areas and, to a lesser extent, the charging at workplaces are one-dimensional requirements and are represented by the O-line in the diagram. The M-line in the diagram represents the charging network at freeways as an absolute must-have. From a consumer's viewpoint, the must-have conditions have to be complied with before he or she will consider the purchase of an EV. Consequently, policymakers could adjust their incentive programs, moving away from large cash amounts toward lower grants combined with investments in necessary infrastructure.

With regard to a net grant of $9000 in the above market simulation and assuming the total sum of governmental subsidies in the 'Cash for Clunkers' program (2009) of $3 billion, approximately 350,000 subsidies could be paid as EV purchase grants. In cases where the government also grants the free use of bus lanes and downtown parking for EVs, this measure is represented as option A in the US market simulation and results in a preference share of 34.3%.

In cases where the government decides to choose option D and thus reduces the net grant to $3000 and invests in a charging network on freeways, this results in a 34.1% share of preference in the US market simulation, which is similar to option A. The US American Interstate network includes approximately 26,000 miles with 1200 rest areas (http://www.interstaterestareas.com/), thereby indicating that there is an average distance of approximately 40 miles between rest areas (northbound-southbound and westbound-eastbound areas are separately included). To install five fast chargers will cost approximately $750,000 per area, which totals up to $900 million for all interstates. With a similar total sum to the CARS program of $3 billion, $2.1 billion remains the amount that can be granted to 700,000 EV buyers with $3000 for each. Compared to option A, not only could the number of EV purchases be doubled, a densely knit charging network on interstates would also be established. From the US data, it is evident that 75% of respondents drive less than 45 miles per day, with an average of 20 miles (Table 4). For those who recharge at home during the night, it will be sufficient. From the 700,000 EV buyers who made use of the above governmental incentive, 25% = 175,000 drive more than 45 miles per day, with an average of 75 miles. They may benefit from the charging network. Under the assumption of a consumption of approximately 0.25 kWh per mile, 18.75 kWh had to be recharged for that distance. A fast charging station needs about 20 min to accomplish this. Assuming a reserve of 10 min, which sums up to a charging time of half an hour, approximately 30 vehicles could be recharged at one charger during daytime. Given the number of stations ($1200 \times 5 = 6000$) on all interstates, the capacity would be sufficient for the 175,000 EV drivers. This is a model calculation, which assumes that all EV drivers and all charging stations are evenly distributed across the United States. Additionally, there may also be a need for charging on interstates for those who normally drive only a few miles; however, only occasionally engage in a long distance trip. Several facts have not been taken into account that could augment the benefits for many more drivers. There exist fast superchargers that recharge 40 kW h in 20 min. Moreover, scaling effects may result in lower costs for the equipment. This calculation may enable an understanding of the benefits from a combined incentive with a lower-than-usual grant and adequate investment in charging infrastructure.

4. Conclusion, limitations, and further research

The results of this global study are similar for most countries in terms of the segmentation of consumers into three clusters with one cluster comprising those who have an affinity for monetary incentives, another comprising those who appreciate charging infrastructure and particularly charging networks on freeways, and another cluster comprising those whose preferences are evenly distributed over the seven policy measures. In addition to these results that were based on a CBC procedure, the Kano method could be employed to ascertain why these preferences exist with regard to satisfaction with the attributes in cases where they are offered and dissatisfaction in cases where they are not available. Through this, missing charging facilities and, in particular, a missing charging network on freeways caused the strongest dissatisfaction. Thus, these attributes are must-haves. It can be assumed that for anyone interested in EVs, a respective acquisition is out of question as long as the existence of an adequate charging infrastructure is not guaranteed. In return, drivers are willing to give up some of the cash grants, since high subsidies are attractive but not must-haves. The often granted free use of bus/fast lanes is a feature that drivers may perceive as somewhat attractive; however, no absolute need could be found for it. Therefore, it is obvious that this measure will have to be terminated if the number of EVs increases. By applying both the CBC and Kano methods, these important understandings could be clarified. Policymakers may adapt their programs to an optimal mixture of fulfilling necessary conditions and additional attractive incentives, albeit somewhat differently in all countries. Further details can be found in the web appendix (www.researchfiles.com/Web Appendix.pdf).

Most of the assumptions in this article were based on information that is publicly available. The EV market is still premature and thus technical capabilities are likely to be further enhanced. A major concern was the assessment of local road tax regimes, which can be complicated. Occasionally, it is divided into a one-time registration fee and an annual tax. The questionnaires were translated by native speakers from the respective countries and the validation suggested that the terms were accurately translated. However, mistakenly translated words cannot be precluded completely. The evaluation of existing incentive programs in different countries was beyond the scope of the article. There exist too many programs although they are, however, mostly composed of the measures included in this research.

Examining the classification of the results of the Kano analyses, over one-third were indifferent regarding the different attributes, which varies across countries. This might be due to the premature stage of electric mobility. Anyway, it did not cause problems in this study because, in the calculations of both the satisfaction and dissatisfaction indices, the I-value was included in the denominators, which only caused these indices to become smaller. However, the comparability across attributes was still ensured.

It could be argued that the option where participants declined to forego any portion of the tax return was erroneously declared as the "none" option in the CBC. It could have been particularly interesting to examine how respondents evaluate the CBC choice when only $3000 tax is returned and some other features are additionally offered. However, this seriously weakened the trade-off. In the actual design, participants had to pay an amount of the tax refund to make choices. One could also imagine a design where the option with a full tax refund of $3000 and no grant is combined with various other attributes. However, this resembles choices for regular products where no price has to be paid. This is a very unlikely setting in CBC.

Although the CBC procedure itself and the additional task that respondents had to solve regarding the monetary grant (measure 1) should have mitigated the risk of a hypothetical bias, respondents had to make a decision "as if." The only boundary condition that was positively known was that respondents drove a vehicle for at least a few miles per day. Whether they intended to buy a car in the near future was unknown. Knowledge on such intentions could have made the results more significant. However, since only a small percentage of respondents had come into question for the survey on a recently upcoming vehicle purchase and given the global structure of the research, such a purchase decision was not included as a further boundary condition.

The designation of this study as an instruction for the global planning of EV incentives would be presumptuous. Conditions are different worldwide and the findings of this research can only offer limited guidance for local policymakers and practitioners. However, the fact that many governments are reluctant to invest in the charging infrastructure and instead rely on high cash grants shows that the clarification in this article could be helpful to initiate further local research. Individual datasets for each country are available from the author on request.

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