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STATUTORY DECLARATION

I hereby declare to have written this master's thesis entitled "*Effects of Subsidies on Consumer Intention to Adopt Battery-electric Vehicles in Austria*" on my own, without having used other references and resources than the ones quoted. Thoughts from other resources having been integrated directly or indirectly into this thesis have been indicated as such. This thesis or parts of it have not yet been published or used in academic assessments.

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List of Abbreviations

AT	attitude
BEV	battery-electric vehicle
EB	environmental behavior
EC	environmental concern
EMO	affects and emotions towards BEVs
EU	European Union
EV	electric vehicle
EX	experience with BEVs
GHG	green-house gases
ICEV	internal combustion engine vehicle
IU	intention to buy/use battery-electric vehicles
PBC	perceived behavioral control
SDR	social desirability response
TPB	theory of planned behavior
RCT	rational choice theory
SMN	subjective media norm
SNP	subjective peers' norm
SPN	subjective personal norm
VAT	value-added tax

Abstract

In an effort to decarbonize the transportation sector, governments are setting their cards on battery-electric vehicles (BEVs). With sluggish adoption rates, several countries have resorted to subsidies to accelerate the process. These are designed to address one of the biggest barriers consumers face when it comes to BEVs, their high front-purchase prices. This thesis evaluates the effectiveness of such subsidies in Austria, making use of the theory of planned behavior. The experiment design entailed an information treatment in a survey, containing a control group to determine the treatments' effect.

Informing participants on the subsidies did not have the expected effect in either their intention to buy BEVs nor in their perception of barriers for the adoption of BEVs. Various potential reasons for these results are discussed in detail. Furthermore, this thesis adds up to the body of literature emphasizing the predictive value of affect and emotions on intention of behavior, a variable excluded from the theory of planned behavior.

Im Bestreben den Transportsektor von fossilen Brennstoffen zu befreien, setzen Regierungen vermehrt auf batteriebetriebene Fahrzeuge. Um den schleppenden Konsum zu beschleunigen, machen einige Länder Gebrauch von Subventionen. Diese sollen eine der größten Konsumbarrieren vor denen Verbraucher beim Kauf von batteriebetriebenen Fahrzeugen stehen, nämlich deren hohen Anschaffungspreis, tilgen. Diese Arbeit evaluiert anhand der Theorie des überlegten Handelns die Effekte dieser Subventionen in Österreich. Das Experiment betraf ein Informationstreatment in einer Umfrage, inklusive Kontrollgruppe, um die Effekte des Treatments zu bestimmen.

Informationen über die Subventionen hatten nicht den erwarteten Effekt, weder auf deren Intention batteriebetriebene Autos zu kaufen noch auf deren Einstellungen über die Barrieren sich einen solchen anzueignen. Verschiedene potentielle Gründe für dieses Ergebnis werden im Detail in der Arbeit diskutiert. Darüber hinaus wird in der Arbeit einen Überblick über die Literatur gegeben, die sich mit voraussagenden Faktoren auf Affekt und Emotionen bei der Intention einer Handlung beziehen, bei der es sich um eine Variable handelt, die aus der Theorie des überlegten Handelns exkludiert wird.

1. Introduction

Climate change is a topic that concerns us all and requires coordination among global actors in their efforts to tackle it. In the European Union (EU), public perception of climate change as a serious problem has never been higher (93%) (European Commission, 2019a). The current number of protests and movements around the globe demanding action against climate change is unprecedented and accentuates the urgency of the matter. However, the implementation of the much-needed reforms lags behind even among EU member states (European Commission, 2019b). As the EU embraces its role as the global leader in the fight against climate change, it has set up various plans of action to decarbonize the Union's economy. These are all part of the recently announced European Green Deal, which had been in discussion since the beginning of the last decade (European Commission, 2019b). The EU strives to drastically reduce its green-house gas (GHG) emissions and to completely decarbonize the Union's economy by 2050. The transportation sector is one of the key targets of the deal. They have set the goal to reduce the sector's GHG emissions by at least 90% by 2050 (European Commission, 2019b). In order to reach these objectives, several measures are being implemented at the EU-level, such as the Energy Performance Buildings Directive and the Strategic Action Plan for Batteries in Europe formed in 2018. However, as everything in the EU, the change ultimately depends on the implementation of the necessary measures by the member states.

Today 24 of the 27 member states of the EU have taken steps to stimulate the adoption rate of electric vehicles (EVs). Bonus payments or premiums i.e. subsidies are only offered by twelve of them, while most limit their incentives to tax reduction or exemptions for EVs (European Automobile Manufacturers Association, 2019; International Energy Agency, 2019). While incentives on BEVs in general are understood to be effective, the exact details on the size and extent of the incentives are subject of discussion. A look at the current EV-rate in the EU, shows a rather gloomy picture. EVs, that is battery-electric vehicles (BEVs) and hybrids together, constitute only 2% of newly registered vehicles in the EU (European Environment Agency, 2019). However, it may be too soon to draw conclusions, as some of the measures have only been in place for less than a year, as is the case in Austria. A look up north, provides a good example for member states to follow. Norway, having put in place various incentive programs for EVs since 1990, has long been one of the world's leading e-mobility societies. It has by far the most advanced transition rate and the biggest relative and absolute quantities of

EVs in all Europe (International Energy Agency, 2019). Its e-mobility market has been in constant growth and today, it continues to have the largest relative amount of EVs in the world (European Automobile Manufacturers Association, 2020).

In Austria, a nation with similar GDP to Norway, the total number of BEVs at the beginning of 2020 was 31,016. In Norway the total of BEVs on the streets at the same point in time was 260,692. In other words, only 0.6% of vehicles in Austria are electric, in contrast to the 9.3% share of BEVs in Norway (Statistik Austria, 2020; Statistisk sentralbyrå, 2020).

Subsidies are clearly one component of the successful transition in Norway. However, subsidies are only effective if people actually make use of them. This requires them to be ready to make the shift towards BEVs. Hence, the literature has increasingly focused on consumer acceptance and the factors influencing their behavior, such as the incentives themselves (Li et al., 2017). Due to the difficulties and costs observations of people's behavior entail, scholars, businesses and politicians rely mostly on surveys to obtain information about consumer intention of adoption, a critical predictor of actual adoption behavior. Considering that Austria implemented such subsidies at the beginning of 2019 to incentivize the adoption of BEVs, there is a clear need for the evaluation of these measures. Literature on consumers' perception of BEVs in Austria is rather lacking as the few that exist evaluate EVs in general and not BEVs specifically. This thesis is not only the first academic work (as far as my knowledge goes) to assess the public's perception of BEVs specifically, but the effectiveness of these incentives as well.

2. State of the art on BEV adoption

2.1 Consumer's perception of BEVs in Austria

Data on the population's perception of EVs in Austria had until the last decade been mainly collected as part of questionnaires on consumer opinion on the topic of renewable energy. This section provides a short overview of the current situation on BEV adoption and the population's perception in Austria. In general, most surveys until now assessed consumer's perception of EVs in general and not of BEVs specifically. This is a gap in the literature this thesis will not be able to fill but will hopefully motivate others to do.

As already mentioned above, only 0.6% (31,016) of registered vehicles in Austria are fully electric (Statistik Austria, 2020). In 2019 only 2.8% (9,242) of newly registered vehicles were electric and further 5% (16,505) were hybrids, while 92.1% were conventional internal combustion engine vehicles (ICEVs) (Statistik Austria, 2020). However, the adoption rate has actually been increasing over the years. The respective shares were 2% and 1.5% for BEVs and 2.7% and 2.3% for hybrids in 2018 and 2017 respectively (Statistik Austria, 2018; 2019).

The first survey to analyze consumer acceptance of electric powered vehicles, incl. BEVs, in Austria, was made by the Social Science Studies Organization for the Magistrate of City Development and Planning in 2009 (Bittner & Tschipan, 2009). Despite the sample being relatively big (1,007 inhabitants of Vienna), it seems to have been selectively biased, being composed of mostly highly educated Viennese inhabitants (59% at least high school graduated), from which 52% stated they “could imagine themselves purchasing a [B]EV”. This is a clear distorted picture of the Austrian population and an overestimation of the actual share of the population in the position to consider the possibility to buy BEVs (especially considering that the survey ran in 2009). However, more interestingly, 21% of those willing to purchase an EV, said they could only do so, if an economic incentive would be provided. Almost half (46%) of participants answered that they would surely not consider the purchase of a BEV. From a sociodemographic perspective, those intending to buy a BEV were overwhelmingly young, male and educated. Further analysis of the results showed an increase in readiness to purchase BEVs with higher heterogeneity of already owned means of transports (cars, motorcycles, bikes, etc.) (Bittner & Tschipan, 2009).

Since 2015, there has been a yearly barometer on consumer attitude towards renewable energy in general run by a conglomerate of institutions in Austria. The most recently published survey for 2018 was run mainly by the Institute for Management of Production, Energy and Environment of the University of Klagenfurt. According to their results 18% of Austrians want to buy a BEV in their next car purchase (2% more than in 2017), and 44% could imagine taking a BEV into consideration in their next car purchase (Alpen-Adria-University Klagenfurt et al, 2019). This coincides with the results of a survey by Innofact published in June 2019 run across several European countries. The question on BEVs only inquired if consumers would take the purchase of a BEV into consideration (“Für mich kommt der Kauf eines Elektroautos in Frage”) to which 37% (42% of men and 32% of women) from 1,063 Austrian car owners ratified that they would (Innofact, 2019). Furthermore, in the survey In Alpen-Adria-University

Klagenfurt et al, (2019) from 1,014 Austrians 42% said they would like to shift to an EV in the next five years. They derived this increase in market potential for EVs to an increase in personal experience with BEVs, since the proportion of participants who have driven a BEV and informed themselves about BEVs increased from 16% in 2017 to 24% in 2018 and from 29% in 2017 to 35% in 2018, respectively (Alpen-Adria-University Klagenfurt et al, 2019).

Early adopters of EVs in Austria have been identified by Priessner et al. (2018). Their findings concluded that psychological factors had a more significant role in predicting EV-adoption than socio-demographic aspects, but both aspects differed greatly between potential adopters and non-adopters. These results were further verified by Brezovec et al. (2019) who targeted *generation Z* in their study. Early adopters seem to be less individualistic and have a more egalitarian worldview than non-adopters and are characterized by clear pro-environmental and pro-technological attitudes. They are also more likely to live in regions where EV policy incentives are in place (Priessner et al., 2018). Furthermore, Brezovec et al. (2019) concluded that attitude towards EVs plays a critical role in potential EV adoption. Scepticism towards the technology and social norms had an influence on adoption as well. They also detected a relation between willingness to purchase EVs and energy-saving behavior in their participants.

Most recently, Priessner and Hampl (2020) conducted a choice-based conjoint experiment with 393 respondents in Austria, to see potential differences in purchase willingness, when products are presented in bundles. The bundle presented to participants, consisted of EVs, photovoltaic solar panels and battery storage for households. They concluded that the majority of potential EV owners would prefer to purchase an EV in such a bundle, if possible. Another outcome of their experiment was that policy incentives are more effective when product bundles are presented with already discounted price tags.

2.2 In comparison with other European nations

In other parts of Europe more extensive and systematic surveys have been taking place. An epitome is the *Nordic-EV-Barometer*, measuring consumer's readiness and willingness to adopt BEVs as well as surveying BEV owners on their experience with public infrastructure. The survey is usually run once a year and covers consumers from Norway, Iceland, Sweden, Finland and Denmark. This survey includes much more specific questions on consumer acceptance of BEVs, such as what type of car engine they are most likely to choose in their next car purchase; what type of barriers they face for the purchase of BEVs; and which elements

are important to get them to consider purchasing BEVs. From owners of BEVs they ask how often and where they charge their vehicles, as well as about their experiences with public charging stations. The Norwegian government has repeatedly used these data to adjust their policy measures to the assessed needs (Lorentzen, 2019; Norsk elbilforening, n.d.).

As stated above, the adoption rate in Norway is the highest worldwide, with a total of 260,692 BEVs registered at the beginning of 2020. Their share of BEVs in relation to the total fleet number currently on the streets is 9.3% (Statistisk sentralbyrå, 2020).

In Germany the adoption rate, similar to the Austrian one, is very low in comparison with more Northern states. There were only 83,175 BEVs registered at the beginning of 2020 (January 1st). With that, Germany's BEV share of only 0.17% is even lower than Austria's. (Kraftfahrt-Bundesamt Deutschland, n.d.). Current German subsidy programs, introduced in July 2015, are known as *environmental bonus* (German: *Umweltbonus*). For BEVs or fuel cell vehicles with a purchase price of up to 40,000 EUR, the bonus amounts to 3,000 EUR and 2,500 EUR for those above a purchase price of 40,000 EUR (Bundesministerium für Wirtschaft und Ausfuhrkontrolle, 2019).

Luckily EVs low market share is not equivalent with their presence in German-related EV adoption research. For example, in a survey with 1152 German participants, Lieven et al. (2011) tested consumer preferences on hypothetical vehicle types and criteria. They concluded that only 4.9% of the participants could be really considered potential EV purchasers. A number in line with governmental expectations. Most participants saw the high purchase cost of EVs as the biggest barrier (Lieven et al., 2011). Plötz et al. (2014) on the other hand, identified the characteristics of EV early adopters to accelerate the adoption process. They concluded that policy measures should target middle-age family men professionally active in the technology sector and residing in rural or suburban areas (Plötz et al., 2014).

2.3 Main obstacles and motivators for the adoption of BEVs

The importance of consumer acceptance for the successful adoption of any technology, is not only widely understood in academia but shapes policy-related recommendations as well. In 2015, Green eMotion submitted to the European Commission a report on the necessary measures for the deployment of EVs in the EU. Among the critical five points to consider was *consumer acceptance*, since the adoption of EVs ultimately depends on the attitudes and perceptions of consumers towards EVs. As for the obstacles of adoption, they identified three

main ones: (1) the high front purchase price of EVs; (2) the range anxiety of consumers; (3) and the access to (fast) public charging infrastructure (Green eMotion, 2015). These results coincide with further literature (Biresselioglu et al., 2018; Carley et al., 2013; Egbue & Long, 2012; Krupa et al., 2014; Li et al., 2017). Biresselioglu et al. (2018), concluded that the main obstacles for the adoption of EVs in Europe were: (1) cost concerns; (2) lack of information; and (3) lack of charging infrastructure. Li et al. (2017) identified not only the lack of access to charging infrastructure as a problem, but the time it demands as well, making fast-charging infrastructure a priority. Additionally, charging appears to be a problem that cannot be met with public charging stations, since consumers are less willing to charge BEVs in public than at home. Despite consumers recognition of the advantages of EVs, their interest in them is mainly shaped by their perception of their disadvantages (Carley et al., 2013). It is important to note, that despite providing an overview of common concerns, these may not necessarily represent the concerns consumers in all nations face (Biresselioglu et al., 2018).

Meanwhile the motivations to buy EVs can be differentiated into environmental, economic and technical benefits of EVs; personal and demographic factors have also been differentiated. Those who express early interest in EVs are usually highly educated, previous owners of conventional hybrids, environmentally conscious, and concerned about dependence on foreign oil (Biresselioglu et al., 2018). As for the psychological factors, consumer attitude towards the technology and personal experience with BEVs seem to be the best predictors of adoption intent (Li et al., 2017). In general, consumers recognize the benefits of EVs and see their enhanced fuel economy as the main argument in their favor. Nevertheless, this does not seem to have much of an effect on purchase intention (Carley et al, 2013). Even the most inclined to consider the purchase of an EV were unwilling to pay more than a small extra cost in relation to ICEVs (Krupa et al., 2014).

2.4 Evaluation of policy incentives

As characterized above, there are several barriers consumers face when it comes to the adoption of (B)EVs. High front-purchase prices and a lack of charging infrastructure have been identified to be among the main concerns consumers face. Accordingly, subsidies as well as the deployment of charging infrastructure are some of the most common incentive measures worldwide (Rietmann & Lieven, 2019). As a consequence, their evaluation is very present in the literature on EV adoption. The conclusions on the effectiveness of these measures are

mixed, as usual, but most scholars see them as effective actions in the promotion of (B)EVs (Hardman et al., 2017; Rietmann & Lieven, 2019).

Policy incentives in general have been determined to have a positive effect on consumer's intention to purchase EVs (Langbroek et al., 2016) as well as on actual purchase behavior (Rietmann & Lieven, 2019). EV promotion takes many forms, but the most common are incentive policies for charging, driving, vehicle registering and purchase (Li et al., 2020). According to actual purchase behavior, among the most effective ones are the introduction of dedicated license plates, financial incentives such as subsidies and tax exemptions as well as the abolishment of purchasing and driving restrictions (Li et al., 2019). Especially the first two interventions showed the best results (Li et al., 2019). Purchase incentive policies, such as value-added tax (VAT) and purchase tax exemption on EVs have been determined to be among the most effective incentive schemes (Hardman et al., 2017; Kim & Heo, 2019; Rietmann & Lieven, 2019). Some scholars, such as Næss-Schmidt et al. (2008) argued fixed-amount subsidies to be a better alternative than a VAT reduction, due to efficiency reasons (p. 43-44).

Analogously, the deployment of charging infrastructure seems to stimulate BEV adoption at a similar level (Mersky et al., 2016; Rietmann & Lieven, 2019). However, some argue financial incentives alone, despite effectively encouraging consumers to adopt EVs, are not enough to actually facilitate the transition from ICEVs to EVs (Kim & Heo, 2019). There are also scholars such as Li et al. (2020) with contrasting results, in which purchasing incentive policies were the least preferred scheme from a bundle of incentives already in place in China. Financial subsidies for cars are especially important to support consumers in their consumption decisions. This is in part due to the high search costs relative to the savings per unit, but as well due to financial hurdles with high front-purchase prices (Næss-Schmidt et al., 2008, pp. 28-30).

On the other types of incentives, such as free parking or the right to use bus designated lanes, results are contradictory. Mersky et al. (2016) determined the latter to have not as much of an effect on BEV sales, while Langbroek et al. (2016) concluded them to be an efficient alternative to financial subsidies.

In the end, governments can choose any combination of incentives, but they will not serve their purpose, if civil society remains unaware of them. As a matter of fact, a big portion of the population in countries with incentives in place do not know about them. This can in part explain why, as in China, EV adoption rates remain rather low despite the measures. In fact,

less than one third of consumers have a better understanding of the incentive policies, and half knew little about them (Li et al., 2020). This is the reason why scholars such as Hardman et al. (2017) highlighted the value of education and awareness campaigns as ways to promote the incentives to consumers.

As for the eventual phasing out of the financial incentives, Zhang et al. (2018a) argued that EVs' environmental advantages over ICEVs, could progressively be emphasized as policymakers start phasing out the incentive policies for EVs. Rietmann and Lieven (2019) accentuate the effect of charging infrastructure to sum up over the years, and thus reduce the importance of large financial incentives over time. This would eventually allow governments to phase out expensive subsidy schemes. However, a premature and or abrupt removal of incentives should be avoided, and thus incentive programs should ideally be designed for a longer period of time (Hardman et al., 2017; Rietmann & Lieven, 2019).

3. Theories & sensitizing concepts

To assess the effectiveness of the subsidies and tax exemptions for BEVs implemented in Austria, it is important to first understand the operating principles of the public sector and markets. This is a prerequisite to comprehend the problem of externalities, where governments need to intervene in situations where market prices fail to reflect the real costs of goods in society. Such is the case in the transportation sector, where governments attempt to tackle the sector's GHG emissions by subsidizing BEVs. This is a common policy tool to accelerate the transition from a former environmentally harmful technology to a newer less polluting one. The next segments covers the government's role in society, the problem of externalities and the role subsidies play in the government's effort to address these. However, the effectiveness of these measures ultimately depends on the willingness of citizens to adopt the subsidized technology. The theories on consumer adoption of technology are covered in section 3.4.

3.1 The role of the government

Most of today's largest economies are capitalist, allowing individuals and businesses to own property and compete with one another in the search of profits and economic well-being. In these systems, it is the sum of the decisions of each individual consumer and producer which adds up to the bigger economic picture. Here, there are no central authorities setting up rules

on which products and services are to be provided and at which prices. This induces competing forces of supply (producers) and demand (consumers) to shape the prices that ultimately determine what and how something will be produced, as well as who will profit from it. This market dynamism takes place in a legal and social framework shaped by its corresponding government.

The exact role of the government in an economy is a topic of its own. Simply formulated, the main debate is about the extent to which a government may intervene in the market. The positions can be broadly split up into capitalist economy and socialist economy. The former in its more extreme form, *laissez-faire* capitalism, acts in accordance with the principle of neoliberalism, in which activities in the market are not to be regulated in any form by governmental intervention. This is due to fear that the government's self-regulatory nature may impede the Smithian spontaneous order, the natural self-organization of an economic system. The opposite of *laissez-faire* is understood as *dirigisme*, an economic doctrine in which the state has a strong regulatory and directive role in the economy to offset productive inefficiencies and market failures. There are many varieties of socialism but no single representative definition of all of them. Their only shared characteristic is the concept of social ownership, especially when it comes to public goods such as natural resources (Benedict, 1985; Hall, 1990).

The discussion about which approach works best is as old as history. Taking a look back, Adam Smith (1723 – 1790) is thought to be a strong *laissez-faire* supporter who saw the government as an essential institution but of necessarily limited activity. It is widely known that he argued for the government's role to entail the establishment of “a tolerable administration of justice” (Smith, 1776, as cited in Irwin, 2014), the defense of property rights, including adequate dispute settlement mechanisms to enable individuals to “secure the fruits of their own labour” (Smith, 1776, as cited in Irwin, 2014), allow investment and exchange, and to defend the nation against aggression (Irwin, 2014). After a more detailed analysis of his work by Viner (1927), we now understand that even the idol of *laissez-faire* economy, was a stronger supporter of government regulation as popularly thought. He argued for the government to assume various more responsibilities, such as the regulated labelling of products, the enforcement of contracts, wages paid in money, regulation of monetary and banking policy, the maintenance of infrastructure and public health and order the regulation of all institutions, including

companies, restriction on interests for borrowing to hinder investors to overspend, export taxation and most relevant for this work, governmental subsidies (Viner, 1927).

Since then, various economists have developed whole schools of thought on the role government should play in an economy. Despite their opinions diverging in several aspects, most economists agree that in general the government's function is to guarantee the stability of the infrastructure in which economic activities take place, i.e. maintain the educational, technological, financial, physical, and social infrastructure. Only when these are in place, can markets effectively fulfil their role in increasing wealth and well-being in society. And since the construction and maintenance of such frameworks is beyond the capacity and interest of any single company, it remains the main responsibility of the government. This is done through numerous laws and institutions directly and or indirectly affecting economic activity.

Most recently a further essential role of the government is being discussed, a role especially relevant for this thesis: the prevention of environmental degradation. This includes two responsibilities the government should definitely bear, the provision of public goods and the offsetting of externalities (Pleskovic & Stiglitz, 1999, p. 35). The concept of public goods was first proposed by Paul Samuelson in his theory of public goods (1954) and entails collectively consumed, non-rival and non-excludable goods. The nature of these goods, more specifically, their propensity to give rise to market failures, makes their provision and supervision by the government indispensable (Samuelson, 1954).

3.1.1 Public sector theory

The existence of market failures, understood as ways in which self-interested individual behavior in the market leads to economically inefficient allocation of resources, paves the way for welfare economics (*dirigisme*) to evaluate policy interventions. These have the goal of improving the system towards more dominant allocation of resources, potentially establishing Pareto efficiency (Vining & Weimer, 1990).

Two of the main perspectives on the public sector are the normative and the positive theories. While the normative theory discusses the activities that a government should perform to be in accordance with broadly accepted norms in society (Buchanan, 1987), the positive theory of the public sector focuses on the incentives generated by financing given goods and services through the public sector (Pryor, 1967). The latter concentrates on the policies' effects on the

economy but does not necessarily evaluate their effectiveness in terms of the normative theory (Dollery & Worthington, 1996).

On a side note, both theories' core assumption of people as rational economic actors has been at latest challenged by the field of behavioral economics. Today, human behavior is understood to be afflicted by cognitive biases, systematic errors in thinking which distort the actor's perception, judgement and decisions (Tversky & Kahneman, 1990; Sen, 1977).

There are two key questions in the normative public sector theory, collectively known as the theory of government expenditure, from which the following questions derive: in which areas of the economy is governmental intervention legitimate and under what decision rules? (Grand, 1991). This leads us to the issue of (negative) externalities, in which consequences of commercial activity affect third parties without these being represented in market prices. These are clear situations of market failure in which government's intervention is clearly legitimized. This is usually done via the implementation of taxes and subsidies, which contribute to the efficiency and equity in the system (Nault, 1996).

3.1.2 Theory of taxation

According to the traditional first-best principle of the Samuelson cost-benefit test, pollution taxes and subsidies should equal to the marginal external costs and benefits the commercial activity in question causes (Kaplow, 2008, p. 409). Clearly, any form of redistributive policy (taxes and subsidies included) leads to distortions in the market and can potentially lead to inefficiencies (Kaplow, 2008, p. 193). Considering this, along with the most visible effect of taxes, the reduction of taxpayers' purchasing power, the optimality of the government's redistributive program becomes especially relevant (Kaplow, 2008, p. 17).

The academic literature on the subject of optimal tax analysis can be traced back to Ramsey (1927). His work was further developed by Mirrlees (1971), Diamond and Mirrlees (1971), Atkinson and Stiglitz (1976), Stern (1982), and Stiglitz (1982). Their work has been refined and re-evaluated since then, as well as influenced by diverse areas of research such as behavioral economics, political economy, social choice, happiness economics, and dynamic macroeconomic analysis (Boadway, 2012, pp. 1-3). However, even then, Ramsey (1927) already recognized the distortion present in the markets, as market prices not necessarily represent their real cost to society. Accordingly, he named these hidden costs *shadow prices*

(Ramsey, 1927). In accordance with the standard methodological approach, normative decisions in tax policy are to be drafted so as to maximize the welfare levels of its members (Boadway, 2012, p. 6). Accordingly, the optimal taxation is to be designed so that consumers' welfare is maximized, assuming that consumers respond to whatever incentives the tax system provides (Mankiv et al., 2009, Ramsey, 1927).

One important aspect raised at latest by behavioral economics, is the questionability of the standard assumption of rational individual decision-making. On the one side, we have the aspect of bounded rationality, which means that some decisions are just too complicated to be made without an appropriate investment of time. On the other side, some decisions are actually based on motives other than self-interest. All these aspects raise questions on the basis of standard normative analysis and make government interference more appealing (Boadway, 2012, p. 5).

3.2 The problem of externalities

Externalities can be broadly defined as third-party effects, which are not reflected in the prices of economic activity by two parties. Shortly, an externality is when there is a divergence between private and social cost (Pigou, 1920/2013). Externalities have been central to the neoclassical critique of the free market. Government interference is perceived as necessary if two conditions are met: (i) "an activity by a set of economic agents enters ("alters") the utility functions of other consumers or the production functions of other producers, not directly involved in the activity" (Tresch 1981/2002, p. 146); and (ii) the gains and losses from these effects are not adequately reflected in the competitive market system (Dahlman, 1979).

There are several ways to classify externalities, ranging from their sources and effects to their addressability. One such differentiation is based on their consequences, which can be either beneficial or negative, referred to as external economies or diseconomies respectively (Liu & Turnovsky, 2005). Clearly, diseconomies are the externalities most strongly discussed in the literature and in politics. Another classification differentiates between consumption, production and consumption-production externalities; the first being those alterations in the utility function caused by some consumers to at least another consumer; the second generated due to alterations in the production function of at least one producer by some producers; and the third, caused by changes in the production function of at least one firm by some consumers, and vice versa (Liu & Turnovsky, 2005). Furthermore, there is a differentiation between

individualized and aggregate externalities, the former being those externalities in which the external effects of the activity depend not only on the nature of the activity but on the individual performing it as well. Aggregate externalities, on the other hand, are external effects generated only by the aggregate level of some exclusive economic activity. These include all forms of pollution externalities affecting individuals, including GHG emissions, which costs are independent of the identity of the producers (Liu & Turnovsky, 2005).

Concisely, the theory of externalities, as Tietenberg & Lewis (2009) put it and Biala (2019) outlined, postulates that:

For any negative externality-generating product, (1) the output produced will be excessively large, (2) excessive pollution externalities will be generated [*sic*], (3) the product's price will be too low, (4) the externality-generating firms will exert no effort to generate optimal level of pollution as long as the costs are external, and (5) recycling of the product will be deterred, because its residues are disposed of virtually free of charge. In summary, whenever a product generates a negative externality, inordinate amount of the product will be produced at an extremely low price.” (p. 3).

The model of negative externalities from Biala (2019, p. 4) illustrates the problem as follows:

Figure 1 models the case of a negative externality and depicts that when negative externalities exist, the marginal private cost (MPC) will be lower than the marginal social cost (MSC), the difference being the marginal external cost (MEC) imposed on the society. That is, $MSC - MPC = MEC$, which implies that $MSC = PC + MEC$. Likewise, marginal external benefit (MEB) plus marginal private benefit (MPB) equals marginal social benefit (MSB). In other words, $MSB = MPB + MEB$. Since $MEB = 0$ in the case of negative externalities, $MSB = MPB$. While the competitive equilibrium output is Q_c obtained where $MPC = MPB$, the efficient equilibrium output is Q_e , which is lower and occurs at the point where $MSC = MPB = \text{demand (D)}$. Note that $MSB = MPB = D$. (p. 3)

Negative externalities result from marginal private cost (MPC) being lower than the marginal social cost (MSC), resulting in the marginal external cost (MEC) imposed on society. So, $MSC - MPC = MEC$, implying that $MSC = PC + MEC$. Ditto, marginal external benefit (MEB) plus marginal private benefit (MPB) result in marginal social benefit (MSB). That said, $MSC = MPC + MEC$, and in the case of negative externalities, $MEB = 0$, $MSB = MPB$. While the

competitive equilibrium output Q^c results from $MPC = MPB$, the efficient equilibrium output Q^e lies lower and occurs where $MSC = MPB = \text{demand}$.

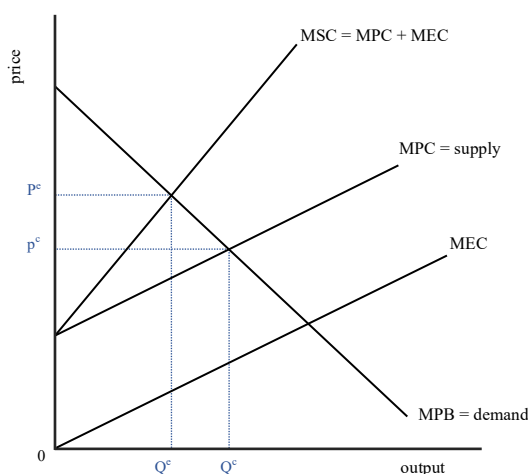


Figure 1. A model of negative externalities (self-drafted based on Figure 1. from Biala, 2019, p. 4)

In other words, the real costs of an externality-generating good or service are usually not represented in its market price (P^c being lower than the efficient P^e), “because private costs, which are reflected in market prices, fall short of the social costs of production and or consumption of the good or service” (Biala, 2019, p. 3). At such low levels, the market price P^c only reflects the MPC but not the MEC of the MSC equation. An efficient level of production would only be reached at the higher price P^e . Due to the competitive equilibrium output Q^c being greater than the efficient equilibrium output Q^e , the generation of societal costs are not represented in the market price of the externality-generating goods and services. This underpricing leads to the overproduction and overconsumption of such goods and services, where consumers and producers do not face the full consequences of their behavior. The result is a market system which does not result in a socially efficient outcome (Biala, 2019).

The textbook solution to any externality of such magnitude, as the GHG emissions in the transportation sector, are corrective taxes/subsidies, such as the Pigovian tax, named after its first proposer (Pigou, 1920/2013). The dimensions of these proposed taxes/subsidies should ideally equal the aggregate marginal damage/benefit effects to correct the externalities and achieve Pareto optimality. These forms of taxes/subsidies, feasible for governments to manage, correct the externality by a single tax levied on the externality-causing activity (Pigou, 1920/2013). However, consumers are known to prefer less-restrictive policies, such as

subsidies, over more-restrictive ones like bans, when it comes to incentivizing environmentally friendly behavior (Vringer et al., 2015). Consequently, when it comes to the decarbonization of the transportation sector, governments worldwide have been employing subsidies instead of so-called *sin taxes* or bans to incentivize BEV adoption (Bjerkan et al., 2016; Brand et al., 2013; European Automobile Manufacturers Association, 2019; Langbroek et al., 2016; Santini et al., 2016).

3.3 Incentive theory

Among the basic principles of economic theory, is the fundamental assumption that people respond to incentives. An incentive is something that influences a person to act a certain way, such as the prospect of a punishment or a reward. Under the assumption that people are rational decision-makers, incentives are meant to nudge them towards a specific outcome. This is the reason why changes in policy affecting prices of goods, such as the implementation of incentives, should affect people's utility function and ultimately their consumption behavior (Mankiw, 2014, p.7).

Several nations, facing the decline in air quality as well as the pressure to meet their climate goals, have been working on ways to accelerate the decarbonization of transportation. In order to incentivize consumers away from ICEVs and towards EVs, they have applied several incentivizing measures, e.g., subsidies, tax breaks, exemptions from rules, outreach campaigns, as well as improvements in e-charging infrastructure. The policy currently most emphasized are financial incentives, which are known to influence behavior in people (and firms) to act in a specific way (Yang et al., 2016). These incentives, either in the form of bonuses or tax-breaks are purchase-based policy incentives and reduce the purchase price and the fixed costs of (B)EV ownership (Sierzechula, 2014; Lieven et al, 2011; Yang et al., 2016). Use-based policy incentives on the other hand, reduce the margin costs of EVs and can take the form of free parking for EVs, allowance of EV drivers to use the bus lanes, or an exemption from congestion charging for EV drivers. The deployment of e-charging infrastructure has been determined to be equally relevant to the financial incentives in influencing consumers' behavior (Rezvani et al., 2015).

The effectiveness of policy incentives is determined by its effect on the probability of consumers purchasing the product, in this case (B)EVs. Only when considerably increasing this chance, can a policy measure be described as effective. In some studies, subsidies have

indeed been previously found to have a positive effect on the intention of EV adoption (described in section 2.4.). However, actual adoption of EVs, and specifically of BEVs is very hard to study due to the low market shares of these types of vehicles. Additionally, it is hard to determine if an eventual increase in adoption is caused by the subsidies or not, without consumers' surveys. For these reasons, the literature on consumer (B)EV adoption relies mainly on surveys assessing intention of adoption to evaluate consumer's readiness to adopt BEVs. As further elaborated below, intention is widely understood to be the proximate variable of actual behavior (Arts et al., 2011; Ehrlich, 1969; Glasman & Albarracín, 2006; Rezvani et al., 2015; Rokeach & Kliejunas, 1972; Sample & Warland, 1973; Schuitema et al., 2013).

3.4 Theories on consumer adoption behavior

Consumer adoption of goods, in this case of innovations, is defined in the academy as a behavioral response in the form of purchase and use of the innovation (Schuitema et al., 2013; Huijts et al., 2012; Jansson et al., 2010). It is a wide field with various schools analyzing the phenomenon from several perspectives. While some scholars, such as Rogers (1962/2003) center upon the characteristics of the process of *diffusion* of an innovation, others focus on the decision-making process of individual consumers (Ajzen, 1985; Ajzen & Fishbein, 1980).

Despite BEVs being invented even before ICEVs (Energy.Gov, 2014), most consider them as an *innovation* and a few see them even as a *disruptive innovation* (Dijk et al., 2016). Truth be told, at that point in time, the technology of ICEVs was superior to that of BEVs, thus leading to its almost complete displacement out of the market. As time went on and research on the climate catastrophe grew, today we understand more than ever how problematic ICEVs' emissions are. This led EVs and especially BEVs to re-enter the scene as a viable *innovative* solution to the problem.

Academic discussion on the diffusion of innovations was especially marked by the theory of diffusion of innovation from Everett M. Rogers (1962/2003). He described diffusion as a “process by which (1) an innovation (2) is communicated through certain channels (3) over time (4) among the members of a social system” (Rogers 1962/2003, p. 60). Innovation is understood primarily as an *evolution* of products to better fit consumer preferences, by fulfilling five qualities: (1) relative advantage; (2) compatibility with existing values and practices; (3) simplicity and ease of use; (4) trialability; and (5) observable results (Rogers, 2003). But the most highlighted requirements, not only by Rogers (1962) but by several other

authors, for the effective adoption of a technology are (i) the ability of potential adopters to adapt the innovation to their own needs, (ii) the degree of uncertainty perceived, and (iii) the meaning of the innovation for the intended adopter (Greenhalgh et al., 2004; Rogers, 1962/2003; Meyer & Goes, 1988; Meyer et al., 1997).

People can be active seekers of innovations, experiment with and challenge them, evaluate them, and develop feelings and opinions about them (Greenhalgh et al., 2004). The stereotypical categorizations of adopters into *adopter categories* seems to have been extensively misapplied and according to Greenhalgh et al. (2004) lacks empirical support. For this reason, Greenhalgh et al. (2004) identified in an extensive amount of literature personality traits of individual adopters and summarized them as follows: (1) general psychological antecedents, being traits associated with the propensity to try out and use innovations; (2) context-specific psychological antecedents, such as motivation and ability to use the innovation in question; (3) meaning the intended adopter gives to the innovation; and (4) the adoption decision, the dependence of the final decision by the individual from other contingent, collective or authoritative decisions. These factors are further partitioned into measurable variables and items by several models of decision-making, some of which will be further described in detail in the following segments.

In general, the different antecedents or predictors broadly characterized above and further segmented below around the behavioral response, i.e., the adoption and use of the technology at hand, are mainly different types of intentional measures such as consumer readiness and willingness to adopt the technology. These variables are understood as the main predictors of and are considered as the proxy variables for adoption behavior (Arts et al., 2011; Schuitema et al., 2013).

One of the main theories to predict human behavior and widely used as a presupposition by economic theories, is the rational choice theory (RCT) found in section 3.4.1. It is implicit in several of the most basic principles of economics, including in the theories on taxation and in the concept of incentives described above. The theory basically assumes that human behavior is driven by rational assessment of benefits and costs with the ultimate end of maximizing their own utility. The RCT is a standard example of models derived by economists for economists, characterized by its analytical power, broadness and simplicity. This may be ideal for some economists' wide-ranging analysis of society, but for sociologists and other social scientists it lacks descriptive richness (Coleman 1994; Coleman & Fararo, 1992). Over the years,

economists started to adapt their models and integrate more sociological aspects into their analyses. Traditional economic models, such as RCT, were progressively adapted to suit its users' new needs. But a theory can only go so far as its fundamental assumptions and that of RCT is its foundation itself: human behavior being driven by rational benefit-cost analysis. A growing body of research and several schools of thought have highlighted the theory's deficits and shortfalls in predicting human behavior (Tversky & Kahneman; 1990). They see the nature of the RCT to be mainly a normative theory and not an explanatory one.

With time, several more complex alternatives started to emerge and are today well established in academia. A commonly used model is the theory of consumption values (TCV), which includes the lacking psychological factors in RCT into its evaluation (section 3.4.2.). But despite this, the TCV like the RCT, jumps from its main components to actual behavior, without an intermediary. This implies studying human behavior directly, i.e., the actual purchase behavior. A task so costly only a fraction of academia can perform. Luckily, there have been scholars who have developed models that evaluate the intermediate intentional stage before behavior. One such key model, and the model used in this thesis, is the theory of planned behavior (TPB), developed by Fishbein and Ajzen (1975). It characterizes the essential aspect of *intention of behavior* as a proxy to behavior and centers on the variables affecting it.

The theory of planned behavior (Fishbein & Ajzen, 1975) is known for its strong predictive power and is widely used in the field of consumer adoption of environmentally friendly products, including (B)EVs (Adnan et al., 2017). It is presented in detail in section 3.4.3. However, in their attempt to fit all into a tiny concept, even the best models, exclude essential information and variables which later on turn out to be indispensable. This is the case for the TPB as well, which commonly highlighted shortcomings are further discussed in section 3.4.4.

3.4.1 Rational choice theory

The rational choice theory (RCT) has been the dominant model in economics for a very long period of time. It has also been adopted in disciplines like sociology, political sciences and anthropology (Green & Shapiro, 1994; Bernholz & Radnitzky, 1986; Swedberg, 1990). As Green (2002) put it: “[RCT] is based on the fundamental premise that the choices made by buyers and sellers are the choices that best help them achieve their objectives, given all relevant factors that are beyond their control” (pp. 4). In other words, it assumes benefits and utility maximization under a set of given circumstances to be the determinants of agent behavior.

As Green (2002, p. 5) summarized, the RCT of consumer behavior entails four axioms on consumer preferences: (i) the consumer faces a known set of alternative choices; (ii) the consumer's preferences are *complete*, i.e. preferences between two alternatives are not arbitrary; (iii) these preferences are *transitive*, meaning that if a consumer prefers A to B and B to C, then they automatically prefer A to C, the same applies for indifference between alternatives; and (iv) the consumer will always choose the most preferred alternative, unless there is indifference, then they will make a choice between the alternatives, which is not possible to deduct in advance (Green, 2002; Kreps, 1990; Mas-Collel et al., 1995). *Rational behavior* is understood in RCT as behavior that is in accordance with these four axioms (Green, 2002).

The model sets to explain the making of the optimal decision in a situation with a set of uncertain possibilities and values. The individual actor is assumed to be able to collect adequate evidence and adapt its beliefs to consequently make the optimal decision to maximize their utility function based on their long-term preferences (Myerson, 1991; Tversky & Kahneman, 1990). RCT assumes agents to perform only those actions that best satisfy their desires, given their beliefs. These desires and beliefs are themselves assumed to be rational or at least internally consistent. The agent is expected to update their beliefs in accordance to only the relevant and optimally weighted evidence available to the agent. The amount of resources invested for the collection of the evidence is determined by the subjective relevance of the agents' desires. This is in part defined by their prior beliefs about the likely cost, quality and relevance of different types of evidence (Green, 2002; Tversky & Kahneman, 1990). These relations are schematically presented in Figure 2.

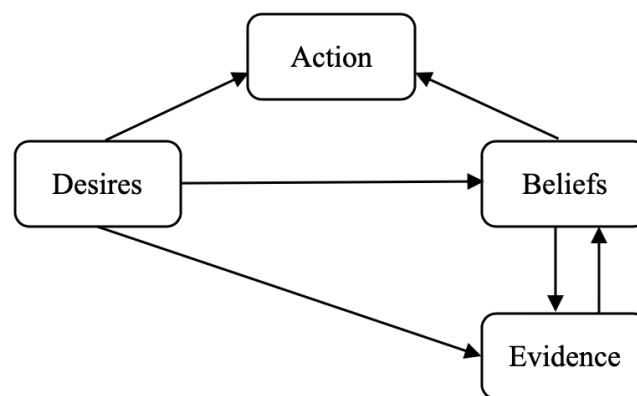


Figure 2 Rational choice theory scheme (adapted from Tversky & Kahneman, 1990, p. 21)

Criticism and shortcomings

Looking at Figure 2, three optimizing operations become visible: (i) determining the best action, for a set of prior beliefs and desires; (ii) building the most valid beliefs, based on the evidence available; and (iii) collecting the optimal amount of evidence, for given desires and beliefs. This means that the framework of RCT can go wrong at three levels and the failure may be due either to indeterminacy or to irrationality. Possible failures may be due to the non-existence of an optimal action, preference or amount of evidence. Agents might as well fail to carry out the ideal action, form the correct belief or collect the necessary *rational* amount of evidence (Tversky & Kahneman, 1990).

Scholars have increasingly raised doubts about the actual power of the RCT to predict what it aims to predict. This ranges from questioning if the theory as a whole asks the right sort of questions to criticizing its lack of empirical validity (Coleman & Fararo, 1992; Green & Shapiro, 1996; Leontief, 1971). The premises of rationality and of agents systematically reviewing their beliefs have often been put into question, latest by behavioral economics. The theory is often seen to be primarily a normative theory rather than an explanatory framework (Tversky & Kahneman, 1990). Definitely, one of the most pronounced criticisms is that of Kahneman and Tversky (1990), who argued RCT to be more of a prescription of behavior than a predictor. The theory's core assumption of rationality is according to our current understanding of human decision making rather outdated (Tversky & Kahneman, 1990).

Furthermore, Tversky and Kahneman (1990) argue that the RCT fails to yield unique predictions, which is essential for the validity of a theory. They explained this as follows: "There may be *several* options that are equally and maximally good. More importantly, there may be *no* option with the property that it is at least as good as any" (Tversky & Kahneman, 1990, p. 25). *Indifference* between *several* options arises when consumers are unable to rank and compare the alternatives. Scenarios, in which there may be *no* optimal action, are cases in which an agent may be *unable* to compare and rank all the alternatives they have, to form preferences. In such situations, the agent is not even being irrational because rationality does not entail having complete preferences and insisting on it could end up being a form of hyperrationality, i.e., irrationality (Tversky & Kahneman, 1990).

The lack of an optimal belief may in part be caused by uncertainty and/or strategic interactions. Uncertainty is here understood as the inability to define probabilities to possible outcomes.

This might either be a consequence of too little information or poor judgement. Rationality would require them to abstain from forging judgements and acting upon them, which could not be more distant from reality. Strategic interactions in social settings can also hinder agents from forming rational beliefs, as typical situations known in game theory arise. Without enforcement or commitment devices, agents are just unable to form rational beliefs about each other. And to make matters even more complicated, i.e., more realistic, there are situations in which both uncertainty and strategic interactions are present (Tversky & Kahneman, 1990).

Another relevant aspect of Tversky and Kahneman's (1990) critique is the *determinacy problems* that arise from the need to decide the amount of information needed to form an opinion. There are opportunity costs that need to be accounted for when evaluating the level of effort required to collect relevant information. Theoretically, an agent should stop collecting information at the point at which the marginal cost of acquiring information equals its expected marginal value. The problem is that the real value of additional information cannot be determined in advance (Tversky & Kahneman, 1990). As Tversky and Kahneman (1990) rightly criticize, while the remark that a rational agent should make "greater investment in information when undertaking major than minor decisions" (Becker, 1976, p. 7) is true, it does not define the amount of resources they need to invest.

In summary, RCT has been the dominant paradigm in economics and has collected a lot of criticism over the years. There are of course scholars such as Coleman and Fararo (1992) arguing for the value of RCT in economics and other social sciences. But the shortcomings and weaknesses highlighted over the years, especially by Tversky and Kahneman (1990) who question all premises of the theory, make its use questionable. Additionally, it does not include any intention lever before action, making it only usable for settings evaluating actual behavior. This excludes all studies in which such costly observations are utterly or nearly impossible.

Besides rational choice theory, several other models of human behavior have been developed over the years. Many of them include aspects completely absent in the rational choice theory, identified as relevant for the prediction of human behavior. They tend to focus much more on the beliefs of consumers about the product or action being evaluated and identify the variables affecting these beliefs.

3.4.2 Theory of consumption values

The theory of consumption values, developed by Sheth et al. (1991), is widely used in the analysis of consumer behavior. It focuses on the different psychological aspects that affect an individual's decision before consuming a product, here called *consumption values*. These explain “why consumers choose to buy or not to buy (or use or not to use) a specific product, why consumers choose one product type over another” (p. 159). This theory has been applied in the evaluation of diverse goods, and services (e.g. Lee et al, 2002; Park & Rabolt, 2009; Williams & Soutar, 2009) and was determined to have an outstanding predictive validity in over 200 studies (Sheth et al., 1991). It is an established theory in the evaluation of consumer adoption of green products, that is products which are environmentally more sustainable than their counterparts (e.g. Finch, 2006; Lin & Huang, 2012).

According to the theory of consumption values, consumer behavior is a function of five consumption values, which are independent from each other and have different contribution intensities in any purchase situation (Sheth et al., 1991). Therefore, a purchase decision is determined by at least one or all of the consumption values (Gonçalves et al., 2015). In the case of environmentally friendlier alternatives, such as BEVs, it has been common practice to add a further value: environmental value. This was done for example by Zhang et al. (2014) to evaluate the importance the concern for environmental protection has on the purchase decision of consumers.

The consumption values according to the TCV are understood as follows:

a. Functional Value

The functional value is the perceived utility of a product or service, resulting from its characteristics such as durability, reliability, and price (Sheth et al., 1991). On price, scholars have observed, some consumers care enough about the environmental impact of their consumption habits that they are willing to pay a premium price for green products (Ling & Huang, 2012). At the same time, price remains one of the biggest barriers for consumers to trial and eventually adopt greener products, such as in the case of organic food (Finch, 2006) and BEVs (Biresselioglu et al., 2018).

b. Social Value

The social value refers to the perceived utility derived from the association of a product or service with one or several social consequences, as well as demographic, socioeconomic, and cultural groups (Sheth et al., 1991). Social values drive consumers to make consumption choices that fit an image congruent with the norms of reference groups to which they belong or aspire to belong (Finch, 2006).

c. Emotional Value

Emotional value is understood as the perceived utility that results from a product or service that induces feelings or affective states. It is often associated with the evaluation of aesthetic alternatives (Finch, 2006; Gonçalves et al., 2015). As depicted in the study of Bei and Simpson (1995), where 89.1% of participants felt they were preserving the environment when buying recycled goods, consumption of green products has an emotional value for consumers which ultimately influences their behavior (Finch, 2006; Lin & Huang, 2012).

d. Epistemic Value

Epistemic value can be understood as the perceived utility from a product or service that stimulates curiosity, provides novelty or satisfies a desire for knowledge (Finch, 2006). Consumers are expected to have a preference for goods with novel characteristics which bring them new skills and knowledge (Lin & Huang, 2012).

e. Conditional value

The conditional value covers the perceived utility that a product or service has for a specific situation or set of circumstances which forces the buyers to alter their typical behaviors, e.g. organic food during pregnancy (Finch, 2006; Gonçalves et al., 2015). In these cases, the

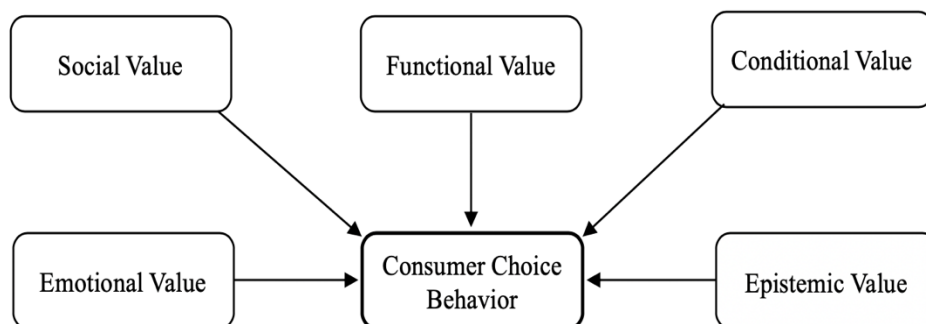


Figure 3. Consumption values theory (adapted from Sheth, 1991, p. 16)

product or service obtains its value due to the specific situation and context by increasing the good's perceived value on another of the consumption values, such as the functional value or the social value (Sheth et al., 1991).

f. Environmental value

As explained above, the model is usually expanded to include an environmental aspect when studying consumption of green products, such as alternatively fueled cars. Environmental value refers to the utility derived from the environment-friendly feature of a given technology (Biswas & Roy, 2015; Li & Huang, 2012; Zhang et al., 2020).

Criticism & shortcomings

Despite the CVT covering psychological factors the RCT does not entail, both models fail to include the intermediary aspect of intention of behavior before actual behavior. This limits the use of the model to observations of behavior only and excludes studies relying on surveys, such as this thesis. In fact, it is not always possible to analyze human behavior directly as intended in both theories. Luckily, further models have been developed, that evaluate the intermediate intentional stage before behavior. One such key model, the theory of planned behavior, developed by Fishbein and Ajzen (1975), characterizes the essential aspect of *intention of behavior* before behavior and centers on the variables affecting it.

3.4.3 Theory of planned behavior

The theory of planned behavior is one of today's best-established theories in many fields, e.g. social sciences (Richard et al., 1995), economics (Cauberghe & De Pelsmacker, 2008), behavioral science and information system research (Seyal & Abd Rahman, 2017). According to Seyal and Abd Rahman (2017), it is one of the most common models in the literature on pro-environmental behavior including, energy-saving (Zhang et al., 2014), low carbon commuting (Cai et al., 2019), environmental innovation (Long et al, 2017a; 2017b), green hotelery (Chen & Tung, 2014) and purchase of environmentally friendly products (Liu et al., 2017; Wang et al., 2017; Yadav & Pathak, 2017; Zhang et al., 2020; Zhao et al., 2014). Several scholars have made use of the TPB to analyze consumer adoption of cleaner vehicles, such as BEVs (Adnan et al., 2017; Egbue & Long, 2012; Lane & Potter, 2007; Moons & De Pelsmacker, 2012, 2015; Picket-Baker & Ozaki, 2008; Tan et al., 2017; Zhang et al., 2018a, 2018b).

The theory of planned behavior was first introduced by Ajzen in 1985, as an extension of Fishbein and Ajzen's (1975) theory of reasoned action. In the decades to follow it became one of the most influential models in studies on human behavior (Seyal & Abd Rahman, 2017). The extension of the TRA into the TPB consisted mainly in adding a further component, *perceived behavioral control*, to the two already modeled ones in TRA, *attitude* and *social norms*. Thus, the TPB understands intention to be determined by three components, attitude, subjective norms, and perceived behavioral control (PBC) (Ajzen, 1985). The reason for the inclusion of PBC was that the TRA application was, due to the lack of that third component, mainly limited to behavior that is under a subject's volitional control (Ajzen, 1991). The model is depicted in Figure 4 in the form of a structural diagram, as used by Ajzen (1991). Despite much criticism, the TPB is still one of the most common models used to study human behavior. This is especially the case for situations in which individuals have incomplete volitional control (Seyal & Abd Rahman, 2017).

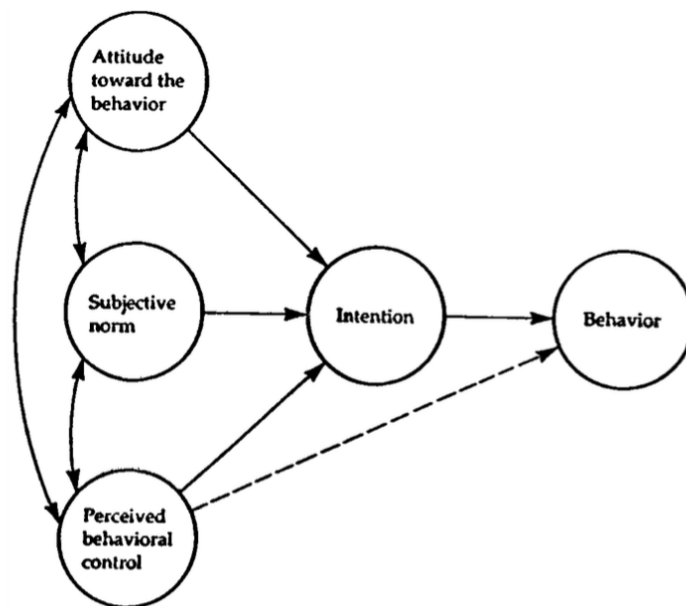


Figure 4. Theory of planned behavior (adopted from Ajzen, 1991, FIG. 1. p. 182)

3.4.3.1 Intention

The TPB assumes intention to be the most proximate determinant of behavior, representing how willing a subject is to perform a specific behavior. Intention entails the motivational factors as well as the effort the actor is willing to invest to perform the behavior (Ajzen, 2011). The proxy nature of intention on behavior is widely recognized in the literature (Arts et al., 2011; Ehrlich, 1969; Glasman & Albarracín, 2006; Rokeach & Kliejunas, 1972; Sample &

Warland, 1973; Schuitema et al., 2013). The stronger the intention to carry out a behavior is, the higher the likelihood of it being performed. Consumer acceptance of technology is understood as the intention to adopt and or use, as well as to support the development of the technology (Ajzen, 1991). This includes support for policies in its favor. It is important to note that the predictive power of intention is limited to the individual's volitional control. That is, the extent to which the person has the power and ability to decide whether to perform or not to perform the behavior (Ajzen, 1991).

3.4.3.2 *Attitude*

The first component of the TPB is *attitude*. This dimension is affected by knowledge and experience and is understood as “the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior” (Ajzen, 1991, p. 188), i.e. the perceived sum of positive and negative possible consequences of a behavior (Bamberg & Möser, 2007; Egbue & Long, 2012). It is the result of an interplay between the object or the action being analyzed and the individual's summarized evaluation of the object or action (Fazio, 1995).

It is widely accepted in various fields, ranging from medicine to economics, that attitude has an effect on intention of adoption as well as on actual adoption behavior (Hagger et al., 2016; Glasman & Albarracín, 2006; Topa & Moriano, 2010; Shah Alam & Mohamed Sayuti, 2011). Attitude is declared by Lawton et al. (2009) in regard to health behaviors, to have a direct effect on behavior not fully covered by intention. Furthermore, Jaccard et al. (1977) concluded that attitude towards the performance of the behavior has a stronger predictive power of actual behavior than attitude toward the object of the behavior. In social aspects, such as behavior towards people with disabilities, attitude's strong predictive power on behavior has been identified as well (Fortini, 1987). There are also numerous studies arguing for the positive relation between attitude towards environmentally friendly products, purchase intention and actual purchase behavior (Bang et al., 2000; Chan, 2001; López-Mosquera et al., 2014; Maichum et al., 2016; Moons & De Pelsmacker, 2015). This is also the case for other environmentally friendly behaviors, such as electricity saving (Zhang et al., 2014) and food management to avoid food waste (Soorani & Ahmadvand, 2019).

3.4.3.3 Subjective norms and normative beliefs

In the original model this component was presented as *normative beliefs and subjective norms* but is commonly and will be further referred to as *subjective norms* (Ajzen, 1991). *Subjective norms* are based on the perception of approval or disapproval of a given behavior by important referent individuals or groups (Ajzen, 1991; Venkatesh, et al, 2003). A reference group is understood as a group that serves an individual to determine whether to perform or to abstain from performing a certain behavior (Moons & De Pelsmacker, 2015). This component outlines social acceptability of a given technology, a very important element of innovation adoption (Petschnig et al., 2014). As Rogers (1962) argues in his work “Diffusion of Innovations”, this is especially relevant for technologies with a given degree of uncertainty, such as in the case of alternatively fueled vehicles. Peer-peer conversations and peer networks are relevant for the spread of innovations. His argument relied on the management of risk through trustworthy information via personal relationships as well as social support on the behavioral changes and the adoption of the innovation demanded (Rogers, 2003).

Subjective norms also include feelings of social pressure from other individuals or groups (Ajzen 1991). So, subjective norms represent the individual’s normative behavioral beliefs and the pressure they perceive from reference groups to perform or abstain from a behavior. This will either encourage or inhibit an individual’s action (Klöckner, 2013; López-Mosquera et al., 2014). It is important to differentiate here, that subjective norms as normative beliefs are “located within, but not identical to the broader construct of social norms while social norm refers to a rather broader range of permissible, but not necessarily required behavior” (Ajzen and Fishbein, 1972, p.2). Petschnig et al. (2014) described subjective norms, as a social component based on the psychological need of an individual to comply with the preferences of their social referents.

As for the effect of subjective norms on environmentally friendly behavior, we see it present in energy-saving behavior (Hori et al., 2013), green product purchase (Albayrak et al., 2013), preferences for environmentally friendly hotels (Chen & Tung, 2014), healthy eating behavior (Kim et al., 2013), and especially relevant for this thesis, in the adoption of alternatively fueled vehicles (Petschnig et al., 2014; Zhang et al., 2018).

Subjective norms are also influenced by mass media and the connotated behavioral norm it entails (Moons & De Pelsmacker, 2015). Media publicity on environmental issues seems in

fact to have certain promoting effects on green behavior (Zhang et al., 2019). The degree of repetition of advertising positively affects consumers' judgement of a given product, increasing their favorable impression and consequently their purchase intention (Kirmani, 2013). Consumers are hence led to accept further environmental-related information and actively buy green products (Lee, 2010). Zhang et al. (2019) concluded that knowledge and information on energy-saving appliances promoted through any media strengthen consumers' cognition of energy-saving appliances. This way, media coverage of green products in a certain frequency, enhances consumers' attitude towards the energy-saving appliances and consequently positively affects their willingness to purchase them (Zhang et al, 2019).

3.4.3.4 *Perceived behavioral control*

Lastly, *perceived behavioral control* is understood as the subject's perception of the degree of ease or difficulty the performance of a behavior entails. It is affected by perceived ability and constraints as well as facilitators of the behavior by external sources (Ajzen, 1985; Bandura, 1986; Taylor & Todd, 1995). PBC tends to depend greatly on the situation and action being analyzed. Ajzen based his concept of PBC mainly on the dominant results from the research program of Bandura and his colleges (e.g. Bandura et al., 1977; Bandura et al., 1980). They demonstrated that people's confidence in their ability to perform a certain behavior, i.e., PBC, strongly influence their actual behavior. The relevance of *actual* behavioral control is self-explanatory and determined mostly by external factors, such as resources and opportunities available to the subject (Ajzen, 1991).

Ultimately the beliefs that determine PBC, are those handling the perception of availability or absence of necessary resources and opportunities and are assumed to reflect personal past experience with the behavior in question (Doll & Ajzen, 1992). These beliefs are also influenced by information on experiences of acquaintances and friends. Furthermore, these control beliefs are also affected by other factors influencing the perceived difficulty of performing the behavior in question. "The more resources and opportunities individuals believe to possess, and the fewer obstacles or impediments they anticipate, the greater should be their perceived behavioral control over the behavior" (Ajzen, 1991, p. 196).

Experience

Especially for the adoption of innovations, and particularly for expensive ones such as BEVs, personal past experience has been determined to be a strong predictor for consumer acceptance.

(Bühler et al., 2014). In their experiment, Bühler et al. (2014) observed a change in perception of advantages and barriers and even in intention of adoption of EVs in participants after experiencing a test drive. Equivalent results were obtained in further studies assessing changes in range anxiety via personal experience (Franke & Krems, 2013; Franke et al., 2017; Rauh, 2017). This has not been the case in all studies testing direct experience with EVs, but it is worth considering for this thesis (Skippon et al., 2016).

Direct experience has frequently been determined to have a greater positive effect than indirect experience on both, attitude-behavior relation and intention-behavior relation (Doll & Ajzen, 1992). Experience also seems to affect PBC besides attitude, as described above. Consequently, it has often been assessed independently from attitude and PBC to better control it and evaluate its effect on the variables (Ajzen, 1998; Doll & Ajzen, 1992).

Predictive validity

Given the TPB's dominant presence in academics, its predictive validity is well-researched. When the measures of attitude, subjective norms, perceived behavioral control, intention and behavior are well-designed, the model's reliability ranges between 0.75 and 0.80 (Ajzen, 2011). However, even the theory's author, Ajzen (2011) suggests to rather expect correlations among the theory's constructs of about 0.60. Meta-analyses such as Sheeran (2002) concluded a mean overall correlation of 0.53 between intention and actual behavior. In a nutshell, attitudes, subjective norms and perceived behavioral control had a mean multiple correlation with intentions from 0.59 to 0.66 (Armitage & Conner, 2001; Cheung & Chan, 2000; Notani, 1998; Ravis & Sheeran, 2003; Schulze & Wittmann, 2003).

Important to note, the correlation between intention and actual behavior, usually significant, can vary to a high extent (Ajzen, 2011). In their meta-analysis McEachan et al. (2011) concluded that the longer the time interval between measurements of intention and observation of behavior, the weaker the correlation becomes. This is also observed by Sheeran et al. (1999) and by Conner et al. (2000).

Likewise, intentions sometimes result in poor predictors of behavior, even when time periods between intention measurement and behavior observation are kept short. For instance, Kor and Mullan (2011) observed participants' intentions of three different behaviors to have a correlation of only 0.17 with behavior. PBC alone had somewhat better results, with a

correlation of 0.25. A possible explanation for cases such as these, is peoples' general (in)ability to control impulses, an aspect of self-regulation, i.e., *actual* control over behavior. Shortly, a lack of actual control and/or strong inaccuracy in the perceptions of control over a behavior are expected to reduce the predictive power of intentions in the TPB (Ajzen, 2011).

This may be an issue for further research evaluating intention to purchase and actual behavior in relation to BEVs. However, this study limits itself to the evaluation of the factors influencing intention of adoption or use.

Criticism and shortcomings

The TPB has collected much criticism and debate over the years. Various scholars question the completeness of TPB to predict behavior and even to predict its main aim, behavioral intentions (Parker et al., 2011; Perugini & Bagozzi, 2001). As usual, there are those pointing out that the model oversimplifies human behavior, leading to an incomplete picture of what it is supposed to assess (Bagozzi, 2007). On a much stronger note, is the criticism from scholars such as Wegner (2002) and Wegner and Whatley (1999), who deny the relevance of consciousness as a causal factor on behavior. They, among other scholars, view human behavior as the mere result of implicit attitudes (Greenwald & Banaji, 1995) and other unconscious mental processes (Aarts & Dijksterhuis, 2000; Bargh, 1989; Bargh & Chartrand, 1999; Brandstätter et al., 2001) rather than through rational evaluation of alternatives. Nevertheless, most scholars accept the theory's main assumptions and rather hint at its limitations (Ajzen, 2011).

On a similar note, many have criticized the model to be too *rational* and exclude our current understanding of the many biases and fallacies that cloud human judgment and behavior. But the theory's author himself, asserted that the model does in fact not assume behavioral, normative and control beliefs to be formed in a rational unbiased way nor that they necessarily represent reality (Ajzen, 2011). Agent's attitudes, intentions and behaviors will always be consistent with their beliefs, independently of how they were formed. So, the way in which they arrive at their beliefs, either rational or not, does not matter for the TPB model (Geraerts et al., 2008).

The next segments cover some of the most commonly highlighted deficiencies of the TPB and elucidates the rationale for their inclusion into the research model, besides the basic components of the TPB.

3.4.4 Further relevant aspects

3.4.4.1 *Affect and emotions*

By far the most frequently highlighted shortcoming of the TPB is its neglect of *affect and emotions* (Conner & Armitage, 1998; Moons & De Pelsmacker 2012, 2015; Rapaport & Orbell, 2000; Richard et al., 1998; Wolff et al., 2011). This gap does not confine itself to the TPB, but to the field of economics in general. As Loewenstein (1996) epitomized: “With all its cleverness, however, decision theory is somewhat crippled emotionally, and thus detached from the emotional and visceral richness of life” (p. 289). Emotions are long understood to play a determinant role on planning behavior and sometimes to have even more far-reaching effects than previously thought (Forgas, et al., 1984; Johnson & Tversky, 1983; Richins, 1997; Schaller & Cialdini, 1990; Wood & Moreau, 2006). Affect and emotions’ effect on the decision-making process of individuals should therefore not be confined as a *background effect* to be supposedly indirectly measured by the main components of the TPB (Moons & De Pelsmacker 2012). Ergo, many authors argue for the integration of emotions into decision models of human behavior (Hirschman & Holbrook, 1982; Norman, 2004; Parker et al., 2011; Pavlou & Fygenson, 2006; Perugini & Bagozzi, 2001; Peterson, 1986; Pham, 2004; Richard et al., 1995).

In response, Ajzen (2011) recognized the important role emotions and affect play in the formation of beliefs and evaluations. However, he considered this criticism to be unwarranted, since the influence of affect and emotions are indirectly assessed as background factors that shape behavior, normative and/or control beliefs. They also co-determine which beliefs are most easily recalled (Clark & Waddell, 1983; McKee et al., 2003). Nevertheless, a meta-analysis of 24 datasets by Sandberg and Conner (2008) increased their predictive model of intention by 7% after including anticipated affect and emotions in the prediction equation of the variance in intention. This gave scholars further material to argue for the independent effect of affect and emotions on intention and behavior (Abraham & Sheeran, 2003; Conner et al., 2003). The indirect assessment of affect and emotion in the TPB as defended by Ajzen (2011) is seen as insufficient by its critics (Conner & Armitage, 1998; Wolff et al., 2011).

To accentuate Ajzen’s (2011) point, Ajzen and Sheikh (2013) published a study on a potential explanation for the strong effect anticipated affect and emotions have in the prediction of intentions. They observed the strong tendency in the literature to measure affective reactions

in relation to *not* performing the behavior (Fishbein & Ajzen, 2010, chapter 9). This, according to them, resulted in the studies not only assessing the general affective attitude towards a given behavior but an affective attitude towards *not* performing it as well (Ajzen & Sheikh, 2013). In their study, they added model questions on anticipated affect to the classical TPB, either on performing or not performing a behavior. They concluded that the added value of anticipated affect and emotions was only given when measuring the non-performance of a behavior (Ajzen & Sheikh, 2013).

Despite this, many scholars still insist the extension of the TPB with measurements of affect and emotions to be necessary. They find the assumption and *measurement* of affect and emotions solely as a background effect to be insufficient. But to be fair, one of the reasons for the model's popularity is its flexibility and the possibility to expand the standard construct to include other aspects. Most of the authors using the TPB, *correct* the model's shortcoming by expanding it to include an emotional component measured as a direct effect on intention of behavior and or actual behavior (e.g. Amit & Jacobson, 2017; Gibson, 2016; Londono et al., 2017; Carvalho & Mazzon, 2011; Moons & De Pelsmacker, 2015; Soorani & Ahmadvand, 2019). This thesis' research model includes the aspect of affects and emotions as an independent variable.

3.4.4.2 *Environmental Concern*

Another commonly used aspect in the study of environmentally friendly behaviors are environmental awareness and environmental concern (Biswas & Roy, 2015; Zhang et al., 2019). Environmental awareness results from consumers being attentive to environmental problems and reflects consumers' views and judgements on certain environmentally friendly behaviors (Tan et al., 2017). Environmental concern develops from environmental awareness (Hansla et al., 2008). It is understood as "the degree to which people are aware of problems regarding the environment and support efforts to solve them and or indicate the willingness to contribute personally to their solution" (Dunlap and Michelson, 2002, p. 485). Environmental concern has repeatedly been identified to have a strong effect on consumers' willingness to buy environmentally friendly products (Albayrak et al., 2013; Davies et al., 1995; Harun, 2012; Hutchins & Greenhalgh, 1995; Maichum et al., 2016). It is therefore a strong driving force for the evaluation of consumer adoption of green products (Biswas & Roy, 2015; Tan et al., 2017; Zhang et al., 2019).

Some authors have concluded the link between environmental concern and actual environmentally friendly behaviors to be rather weak (Bamberg, 2003; Paul et al., 2016). However, a bigger body of literature, defends the variable's value. It has even been characterized as a component of its own in the TPB model for studies related to environmentally friendly products (Chen & Tung, 2014; Maichum et al., 2016; Yadav & Pathak, 2016), including alternatively fueled vehicles (Brand et al., 2013; Graham-Rowe et al., 2012; Hackney & de Neufville, 2001; Petschnig et al., 2014). Consumers concerned about the environmental effects of their consumption tend to have better attitudes towards environmentally friendly innovations (Bang et al., 2000; Ewing & Sarigollu, 2000; Kirmani & Khan, 2016; Lane & Potter, 2007; Oliver & Rosen, 2010) and stronger preference for environmentally friendly products (Bang et al., 2000; Hanson, 2013; Maichum et al., 2016). This is also the case for alternatively fueled vehicles (Ewing & Sarigollu, 2000; Oliver & Rosen, 2010; Rezvani et al., 2015). Kahn (2007) and Ziegler (2012) concluded that consumers with higher environmental concern are more likely to adopt hybrid vehicles. Some scholars such as Kim and Choi (2005) even argue environmental concern to have a direct effect on purchase behavior. Environmental concern is therefore included in the thesis' research model as an independent variable.

3.4.4.3 Past environmental behavior

Even Ajzen (2011) himself, recognized the saliency in the literature of past behavior and habit as a proxy for intention of behavior. Several scholars have concluded past behavior to even have an independent contribution to the prediction of intentions. Some even argue it to have a predictive value above attitudes, subjective norms and PBC (Albarracín et al., 2001; Sandberg & Conner, 2008). Ajzen (2011) took these results seriously enough to say that they may invalidate the sufficiency of the TPB and encouraged more research on the subject to be done.

Environmental-specific past behaviors are not independent from each other but tend to overlap between various areas of action (Thøgersen, 1999). When people take up one environmentally friendly behavior, their likelihood of adopting another one increases. Individuals with a high rate of environmental behavior are among the most likely to adopt EVs (Bamberg, 2003; Jansson, 2011; Kahn, 2007; Kilbourne & Beckmann, 1998; Moons & De Pelsmacker, 2012; Thøgersen, 1999). Past environmental behavior is therefore included in the model as an independent variable.

4. Research model and hypotheses

4.1 Research model

The aim of this study was to assess the effectiveness of the recently introduced subsidies for BEVs in Austria. That is, according to the theory of planned behavior elaborated above, their effect on consumers' intention to buy or to use BEVs. For this, an online questionnaire was distributed in which participants were randomly assigned to either the test group (aka informed participants) or the control group. The former obtained information on the financial incentives in addition to the general information on BEVs. The dependent variables expected to be affected by the treatment were intention to buy or to use (ITB) BEVs and PBC. Furthermore, the study assessed the main components of the TPB (3.4.3.), as well as three commonly highlighted aspects, understood to affect ITB BEVs (3.4.4.). The research model is illustrated in Figure 5.

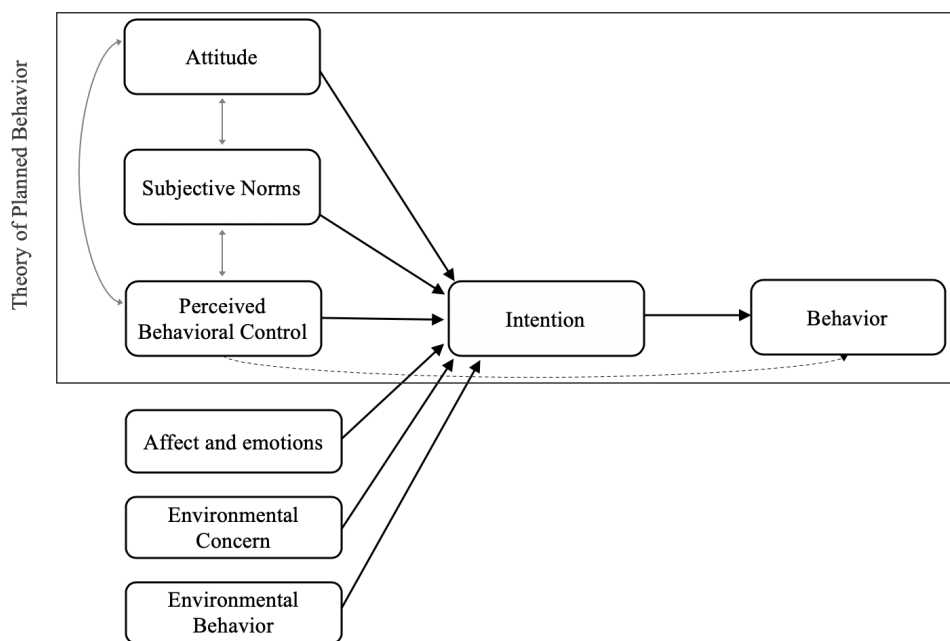


Figure 5. Research model based on the theory of planned behavior and further commonly highlighted aspects affecting intention to buy/use BEVs

4.2 Policy incentives in Austria

The financial incentives to be tested are those in place in Austria since March 2019. These include the following subsidies for both BEVs as well as hybrids (Bundesministerium für Finanzen, 2019, 2020a):

EUR	object
3.000	BEVs and hybrids (for vehicles under 50.000 EUR purchase price)
200	e-charging infrastructure (wallbox and/or cable)
400	wallbox/home charging station in apartment buildings

Furthermore, there are the following tax breaks for BEVs exclusively:

- No standardized consumption tax (german: NOVA) (Bundesministerium für Finanzen, 2020a)
- No engine related insurance tax (german: Motorbezogene Versicherungssteuer) (Bundesministerium für Finanzen, 2019)

Just as a side note on the real value of the tax breaks. They diverge widely in real cost savings for consumers, with the engine related insurance tax being more substantial than the standardized consumption tax. Despite the recent tightening in standardized consumption tax on January 1st, 2020, the actual cost paid by car owners is lower than ever. This is due to its rather loose nature, in which its value is derived from the vehicle's CO₂ emissions in grams CO₂ /km (according to the Worldwide harmonized Light Vehicle Test Procedure) minus 115 grams, then the value is divided by five to result in the final tax value. For vehicles with very high CO₂ emissions (above 275g/km) 40 euro are added per each g/km to the final sum (Bundesministerium für Finanzen, 2020b). Taking into consideration the average CO₂ emissions of current diesel and petrol vehicles, 121.5 g CO₂ per km and 123.4 g CO₂ per km respectively (European Environment Agency, 2019), this tax is much smaller than the engine related insurance tax.

In contrast to the standardized consumption tax, the engine related insurance tax is regularly raised by the car insurance companies. The tax rate ranges from 6,20 euro to 72 euro per month, when paid annually, depending on the vehicle's performance (kW). Should it be paid monthly the range increases to 6,82 euro to 79,2 euro per month (Bundesministerium für Finanzen, 2019).

4.3 Hypotheses

The experiment-related hypotheses are as follows:

- Informing participants leads them to have a higher intention to buy/use BEVs.
- Informing participants leads them to have higher values in perceived behavioral control.

The solely TPB-based hypotheses are the following:

- Attitude towards BEVs is positively associated with intention to buy/use BEVs.
- Subjective norms on BEVs are positively associated with intention to buy/use BEVs.
- Perceived behavioral control in relation to BEVs is positively associated with intention to buy/use BEVs.

The hypotheses based on the commonly highlighted gaps of TPB are as follows:

- Affect and emotions towards BEVs are positively associated with intention to buy/use BEVs.
- Environmental concern is positively associated with intention to buy/use BEVs.
- Past environmentally friendly behavior is positively associated with intention to buy/use BEVs.

5. Methods

5.1 Methods of data collection

The survey ran on the SoSciSurvey website and was accessible during the whole month of March 2020 under <https://www.soscisurvey.de/beaumfrage/>.

It ran first in a number of lectures in the faculty of economics at the University of Vienna at the beginning of the month and was then further diffused on various Facebook groups (“*Women in Vienna*”, “*Umfragen für Studienarbeiten*”, “*Master IBWL Universität Wien*”, “*BWL/IBWL Universität Wien*”) during the end of March. The participants at the university accessed the questionnaire either via link or QR-code. On the Facebook groups the link was posted with the text in Appendix 1.

5.2 Relevant aspects

Social desirability bias and social desirability responding

The social desirability bias is a methodological effect arising from the interview situation and affecting participants' responses in surveys (Börger, 2012, pp. 53-60). This bias, widely known in the literature as socially desirable responding (SDR), must be differentiated from the “warm glow” individuals may experience when acting morally. While the latter forms part of the utility function of agents, SDR does not and is to be seen as a measurement error that needs to be corrected (Börger, 2012, p. 60). SDR is compounded by three factors: (i) the need for social approval, (ii) the lack of total anonymity of an interview situation, and (iii) a perceived difference in the desirability of different response options (personality traits desirability); all of which depend on the culture's prominent social norms (Börger, 2012, pp. 53-57; DeMaio, 1985; Goove & Geerken, 1977; Hebert et al., 1997; Paulhus, 1991).

This response bias needs to be controlled in consumer surveys where the participants are in *direct* interaction with the interviewers (Nederhof, 1985). Its control is especially crucial when the survey includes information, which could potentially trigger SDR, such as goods known to be environmentally friendly. Nevertheless, in a setting without a direct interviewer or other outside institutions that could grant social approval sought by the respondent, as in this experimental setting, SDR seems not to apply (Börger, 2012, p. 59).

Data Privacy

To make the experiment compliant with the General Data Protection Regulation (GDPR) of the EU, several points were taken into consideration. All participants were of age (at least 18). The form lacked any questions that could potentially help track participants, such as name, exact birthdate, social security number, phone number, etc. To add to the anonymity of the participants' information, their IP addresses and devices used to fill the form were not collected either. At the beginning of the questionnaire, all participants were informed on the nature of the experiment and how their data were collected and processed. They were also briefed on the survey's non-commercial purpose. Contact details for eventual inquiries or remarks on their individual rights to their data as well as to the survey in general were highlighted at the beginning and at the end of the questionnaire.

5.3 The questionnaire

The questionnaire had a total of 36 questions, 30 main questions and six demographic ones. These were distributed into nine pages as seen in Appendix 2.

Participants first had to choose the language setting, they could opt either for German or English and were then introduced to the survey. The aims and procedures of the questionnaire were described. On the same page, participants were informed that the collection and evaluation of their data was completely anonymous, and a contact person e-mail address was made available.

The next segment of the questionnaire contained the sociodemographic aspects. The decision to include these questions right at the beginning, despite possible stereotype reinforcement was taken so as to avoid half-filled questionnaires lacking essential demographic data, which would have made them unusable for the evaluation. The questions in the demographic section of the questionnaire were scaled down to the absolute necessary. These were based on the national standards of the German federal office of statistics (Beckmann et al., 2016). These section assessed gender, age, city of residence, education level, occupation, as well as income range. In the occupation section the participants were able to choose several of the options, as some participants were working and studying simultaneously.

The assignment procedure into the control or test group was performed by a random generator. The control group obtained exclusively *general information on BEVs*, a short explanation of BEVs with vocabulary as neutral as possible. The treatment group obtained in addition to the general information on BEVs an *additional information* segment with information on the policy measures of the Austrian government (4.2.).

The next segment comprised the dependent variables, all summarized in Table 1. These were distributed into three pages as follows: (i) Intention of behavior, attitude, norm and PBC; (ii) affect and emotions, environmental concern, and environmental behavior; and (iii) experience with BEVs. The main items were answered via a five-point Likert scale, labelled in every point (1 = ‘strongly disagree’; 2 = ‘somewhat disagree’, 3 = ‘neither agree nor disagree’, 4 = ‘somewhat agree’; 5 = ‘strongly agree’).

Intention to buy or to use (ITB) had two items assessing intention to purchase and or use BEVs. ITB item Nr. 1 (ITB1) was adapted from Moons & De Pelsmacker (2012) and assessed the

intention to purchase. Additionally, to cover today's growing 'sharing economy', a self-designed item (ITB2) on the use of BEVs in car-sharing was included as well. There were two items on attitude (AT), the first one on whether the participants preferred BEVs over ICEVs and another on whether they supported financial subsidies for BEVs. Both items were self-designed.

Subjective norms were further divided into (i) subjective personal norm (SPN); (ii) subjective peers' norm (SNP); (iii) subjective society norm (SCN); and subjective media norm (SMN). Personal opinion on BEVs was assessed via SPN1, adapted from Moons and De Pelsmacker (2012) and SPN2, self-designed. The latter was included as a contrast to the former. The items on the subjects' peers' perception of BEVs were SNP1 and SNP2. These were both adapted from Moons and De Pelsmacker (2012) to exclusively ask about BEVs, instead of EVs in general. SCN1 and SCN2 were both self-designed and assessed the participants' perception of social pressure to purchase a BEV over a conventional one. The last variable of subjective norms was on their perception of the norm generated by the media (SMN1) and was adapted from Moons and De Pelsmacker (2012).

Perceived behavioral control (PBC) consisted of four items in total, all adapted from items used by Moons and De Pelsmacker (2012). The items in this section assessed participants' own opinion on the biggest barriers for BEV adoption, identified above (section 4.3). The most common barriers included were (i) total cost of BEVs, (ii) range anxiety as well as (iii) concerns related to charging possibilities. Additionally, their perception on societal support for BEV adoption was assessed. Previous experience with BEVs (EX) was measured via three self-designed items, assessing the participants' level of exposure to BEVs and their knowledge about the technology.

Affect and emotion (EMO) were assessed via four items. Subject's emotional state when confronted with a BEV (EMO1) was assessed via a self-designed item. EMO2 and EMO3 were adapted from Cauberghe and De Pelsmacker (2008). Furthermore, their excitement for the technology (EMO4) was evaluated via a self-designed item.

On general environmental concern (EC) participants were asked whether they thought the purchase of BEVs was more environmentally responsible (EC1; self-designed). The rest of the items were adopted from Moons and De Pelsmacker (2011) and Preisendörfer (1998) and assessed general perceived urgency of action. Current environmental behavior (EB) was

assessed via four items on activities that are not required by law but are known or at least understood to be environmentally friendly. They were adopted from the questionnaire of the German Federal Environment Agency (2018) on the subject (Williams et al., 2019).

Some of the items were not adopted exactly as in the original works but were adapted to better fit the purposes of the study. This was usually made to improve the items' clarity or specificity. Some of the changes were made after participants of the test-phase made some remarks.

Table 1. Variables and items of questionnaire

Latent Variable	Item Number	Observation Item	Reference
Intention to buy/use battery-electric cars (ITB)	1	Should I purchase a car, it will be a battery-electric car	adapted from Moons & De Pelsmacker (2012)
	2	Should I use car-sharing in near future, I would prefer to drive a battery-electric vehicle over a conventional one	self-designed
Attitude (AT)	1	I think battery-electric cars should be used over conventional ones	self-designed
	2	I think the government should provide subsidies for battery-electric cars	self-designed
Subjective Personal Norm (SPN)	1	People driving a battery-electric car are making a fool of themselves [r]	adopted from Moons & De Pelsmacker (2012)
	2	People driving a battery-electric car are forward-thinking	self-designed
Subjective Peers' Norm (SNP)	1	People who are important to me have a positive attitude towards battery-electric cars	adapted from Moons & De Pelsmacker (2012)
	2	People I look up to have positive attitudes towards battery-electric cars	
Subjective Society Norm (SCN)	1	It is socially expected to purchase a battery-electric vehicle instead of a conventional one	self-designed
	2	More and more people are considering purchasing a battery-electric car over a conventional one	
Subjective Media Norm (SMN)	1	The media gave me a good feeling about using a battery-electric car	adapted from Moons & De Pelsmacker (2012)

Perceived Behavioral Control (PBC)	1	The costs (insurance, electricity, etc.) of using a battery-electric car are acceptable	adapted from Moons & De Pelsmacker (2012)
	2	The range of a battery-electric car would suffice for my daily commutes	
	3	I will not be able to charge a battery-electric car at home [R]	
	4	Our society offers the necessary means and instruments to use a battery-electric car	
Experience with BEVs (EX)	1	Have you ever driven a battery-electric car?	self-designed
	2	Does anyone on your inner social circle own a battery-electric vehicle?	
	3	How would you rate your knowledge about battery-electric cars?	
Affect and Emotions towards BEVs (EMO)	1	I feel positive emotions when seeing a battery-electric car on the street	adapted from Cauberghe & De Pelsmacker (2011)
	2	I find the design (interior and bodywork) of battery-electric car aesthetically pleasing	self-designed
	3	I would enjoy (or did enjoy) the experience of driving a battery-electric car for the first time	adapted from Kim et al. (2007)
	4	I find the technology of battery-electric cars exciting	self-designed
Environmental Concern (EC)	1	I think it is more responsible to buy a battery-electric car over a conventional one, from an environmental point of view	Adapted Moons & De Pelsmacker (2012); and Preisendörfer (1998)
	2	The majority of the population does not act in an environmentally friendly way	
	3	Politicians do far too little for environmental protection	
	4	Environmental protection measures should be carried out even if this costs jobs	
Environmental Behavior (EB)	1	I selectively separate garbage for recycling purposes	German Federal Environment Agency (2018); Moons & De Pelsmacker (2012); and self-designed
	2	I intentionally buy regional and seasonal vegetables and fruits	

3	I intentionally selected an electricity provider who offers 100% green energy (energy obtained from renewable resources)
4	I intentionally try to reduce my meat consumption

5.4 Variable aggregation and statistics

Variable aggregation

As depicted in Table 1., the predictor variables were attitude (items AT1 and AT2), subjective norms (SN; items SPN1, SPN2, SNP1, SNP2, SCN1, SCN2 and SMN1), and perceived behavioral control (items PBC1 to PBC4 and EX1 to EX3) as part of the original planned behavior model. The research model was augmented by three additional variables, affect and emotions (items EMO1 to EMO4), environmental concern (items EC1 to EC4) and environmental behavior (items EB1 to EB4). The outcome variable, intention to buy/use (ITB) was also aggregated from the respective questionnaire items via their mean (items ITB1 and ITB2).

Apart from experience all variable scores were aggregated by taking the mean over the respective questionnaire items, which were assessed on 5-point Likert-scales. For experience, a variable, called Exp1, was constructed by combining item EX1 and item EX2 in the following manner:

T	EX1	EX2
1	3	1
2	3	2
3	2	1
4	2	2
5	1	1
6	1	2

Secondly, Exp1 was scaled to a range between 1-6 and calculated its mean with item EX3 to yield the experience variable.

Statistics

Data analysis was performed using R Studio (version 1.2.5001) and SPSS (version 1.0.0.1347). To distinguish whether the information presented to the test group had increased intentions to buy or use a BEV, a t-test for independent samples was calculated for the ITB variable between the two groups. In order to assess influences of our model's factors on ITB, a variable selection approach (R package "leap") was employed separately for each of the two groups. The leap package provides an exhaustive subset search for finding the subset of predictors that maximizes R^2 adjusted across all linear models. Note that this is easily computationally feasible since the total number of possible predictor subsets is only $2^6 - 1 = 63$ in this case. Finally, the test group's optimal model was cross-validated with a leave-one-out cross-validation in order to arrive at a less overestimated effect size, R^2 , thereby quantifying the model's predictive capabilities.

6. Results

6.1 Demographics

In total there were 228 forms, from which 181 inputs were used for the analysis. All forms with less than 66% of responses filled were excluded from the analysis. More specifically, forms with more than 9 from 28 of the main items (33%) and or two of the six demographic items (33%) left blank were excluded. This left a total of 181 forms (79.4% of the collected forms) for the evaluation. From these, there were 92 participants in the control group and 89 in the test group.

There were no-significant differences between the test group and the control group in regard to most demographic variables (gender: $X^2 = 0.0034$; $p = 0.95$; age: $F = 0.644$; $p = 0.42$), as illustrated in Table 2. Only the income range distribution was significantly different ($p < 0.0001$) between female and male participants in the test group, but not in the control group

Table 2. Demographic description of participants in control and test groups

	Control group	Test group	Total
N (%)	92 (51%)	88 (49%)	180
Female	50 (51%)	48 (49%)	98
University degree	72 (53%)	65 (47%)	137
Age	m = 31.13 SD = 9.54	m = 29.67 SD = 7.63	

Table 3, 4). Most participants lived in Austria (155 participants; 86%). The 35 participants not living in Austria were similarly distributed between groups ($X^2 = 0.097$; $p = 0.76$). Most of the non-Austrian residents indicated to be living in Germany.

Table 3. Income range frequency per group and gender

Income range	Control group		Test group	
	Female	Male	Female	Male
	N (%)	N (%)	N (%)	N (%)
No personal income	23 (46%)	14 (32.6%)	29 (60.4%)	7 (16.7%)
< 250 €	3 (6%)	1 (2.3%)	1 (2.1%)	0
250 € - 500 €	3 (6%)	2 (4.7%)	3 (6.3%)	2 (4.8%)
500 € - 1000 €	1 (2%)	1 (2.3%)	5 (10.4%)	3 (7.1%)
1000 € - 1500 €	6 (12%)	5 (11.6%)	4 (8.3%)	4 (9.5%)
1500 € - 2000 €	3 (6%)	6 (14%)	1 (2.1%)	1 (2.4%)
2000 € - 2500 €	4 (8%)	5 (11.6%)	2 (4.2%)	8 (19%)
2500 € - 3000 €	3 (6%)	3 (7%)	0	7 (16.7%)
3000 € - 3500 €	1 (2%)	2 (4.7%)	0	3 (7.1%)
3500 € - 4000 €	0	0	0	4 (9.5%)
> 4000 €	0	3 (7%)	1 (2.1%)	1 (2.4%)
n.d.	3 (6%)	1 (2.3%)	2 (4.2%)	2 (4.8%)
Total	50	43	48	42

Table 4. Differences in income range distribution per group between genders

	Control group	Test group
Mann-Whitney U	869.00	421.00
Wilcoxon W	2144.00	1597.00
Z	-1.64	-4.92
Asymp. Sig. (2-tailed)	0.100	0.00****

**** Difference is significant at the 0.0001 level (2-tailed)

All aggregated variables of both control group and test group are summarized in Table 5 showing their distribution parameters mean, standard deviation and standard error of the mean.

Table 5. Description of aggregated variables of both control and test group

Aggregated variable	Group	N	Mean	Std. Deviation	Std. Error Mean
Intention to buy	Control	92	3.41	0.96	0.10
	Test	88	3.14	1.14	0.12
Attitude	Control	91	3.81	1.03	0.11
	Test	89	3.66	1.19	0.13
Subjective norm	Control	92	3.59	0.56	0.06
	Test	90	3.50	0.66	0.07
Perceived behavioral control	Control	92	3.17	0.73	0.08
	Test	88	3.15	0.84	0.09
Experience	Control	93	2.98	1.40	0.15
	Test	90	2.60	1.34	0.14
Affect and emotions	Control	90	3.82	0.84	0.09
	Test	88	3.71	0.97	0.10
Environmental concern	Control	91	3.99	0.70	0.07
	Test	88	3.87	0.80	0.09
Environmental behavior	Control	91	4.00	0.81	0.09
	Test	88	3.71	0.79	0.08

6.2 Statistics

Between group t-tests

The t-test between the two groups regarding the dependent variable, intention to buy (or to use) (ITB) yielded a trendwise significant difference ($t=1.86$, $DF=169$, $p=0.064$). The control group had a somewhat higher intention to buy or to use BEVs than the test group. The distribution of responses is illustrated in Figure 6.

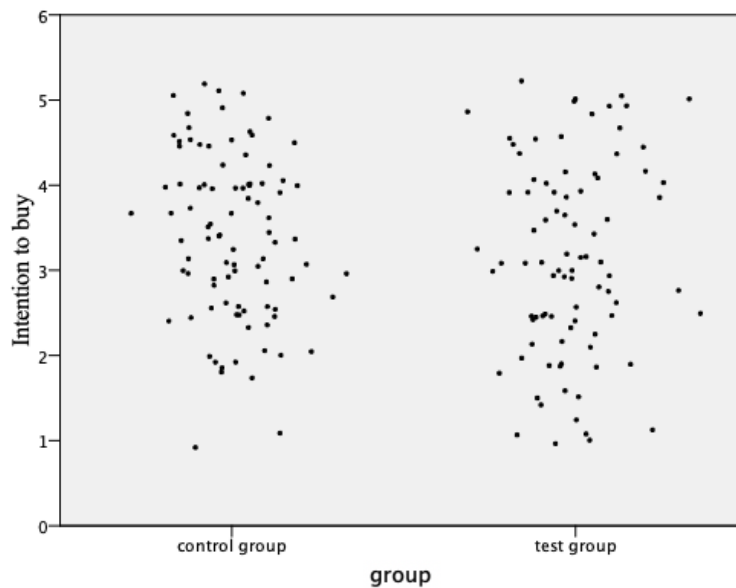


Figure 6. Scatter plot of group differences in intention to buy between control ($m= 3.41$, $SD=0.96$) and test group ($m=3.14$, $SD=1.14$).

The t-test results for all aggregated variables between groups are illustrated in Table 6. As stated above, ITB exhibited a trendwise significant difference. Only environmental behavior was significantly different ($p < 0.05$) between control ($m = 4.00$, $SD = 0.81$) and test group ($m = 3.71$, $SD = 0.79$). The scatter plot is shown in Figure 7.

Table 6. *t*-test for equality of means between control and test groups

Aggregated variables	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Intention to buy	1.729	178.000	0.086	0.271	0.157
Attitude	0.941	178.000	0.348	0.156	0.166
Subjective norm	0.955	180.000	0.341	0.087	0.091
Perceived behavioral control	0.241	178.000	0.810	0.028	0.117
Experience	1.865	181.000	0.064	0.378	0.203
Affect and emotions	0.805	176.000	0.422	0.109	0.136
Environmental concern	1.022	177.000	0.308	0.115	0.113
Environmental behavior	2.396	177.000	0.018*	0.287	0.120

*. Difference is significant at the 0.01 level (2-tailed).

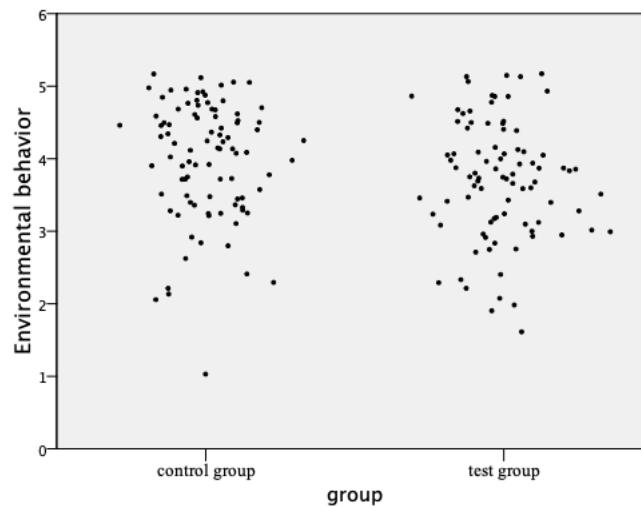


Figure 7. Scatter plot of significant ($p < 0.05$) group differences in environmental behavior between control ($m = 4.00$, $SD = 0.81$) and test group ($m = 3.71$, $SD = 0.79$).

The correlation between the main components of the theory of planned behavior, attitude, subjective norm and perceived behavioral control, were as expected by the theory, all

significant in the test group. In the control group, on the other hand, only attitude-subjective norm was significant ($p < 0.01$). The results are illustrated in Table 7.

Table 7. Pearson Correlation between main components of the theory of planned behavior.

Components of theory of planned behavior	Statistics	Control group			Test group		
		AT	SN	PBC	AT	SN	PBC
Attitude (AT)	Pearson Correlation	1	.563**	0.011	1	.637**	.251*
	Sig. (2-tailed)		0.000	0.920		0.000	0.018
	N	91	91	91	89	89	88
Subjective norm (SN)	Pearson Correlation	.563**	1	0.103	.637**	1	.414**
	Sig. (2-tailed)	0.000		0.326	0.000		0.000
	N	91	92	92	89	90	88
Perceived behavioral control (PBC)	Pearson Correlation	0.011	0.103	1	.251*	.414**	1
	Sig. (2-tailed)	0.920	0.326		0.018	0.000	
	N	91	92	92	88	88	88

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

The correlation between all aggregates variables of the control group are shown in Table 8. As stated above, in the control group the correlation between ITB and both, attitude and subjective norm were significant ($p < 0.01$). Furthermore, the correlation between ITB and affect and emotions (ITB-affect and emotions) was significant as well ($p < 0.01$), as were ITB-environmental concern ($p < 0.05$) and ITB-experience ($p < 0.05$). The correlations attitude-affect and emotions as well as attitude-environmental concern were significant as well ($p < 0.01$). Subjective norm-affect and emotions was significant ($p < 0.01$) as well as was subjective

Table 8. Correlation results between variables in the control group

Variable	Statistic	Intention to buy	Attitude	Subjective norm	Perceived behavioral control	Affect and emotions	Environmental concern	Environmental behavior	Experience (PBC subvariable)
Intention to buy	Pearson Correlation	1	.565**	.385**	0.085	.525**	.239*	0.040	.224*
	Sig. (2-tailed)		0.000	0.000	0.419	0.000	0.023	0.708	0.032
	N		91	92	92	90	91	91	92
Attitude	Pearson Correlation		1	.563**	0.011	.641**	.433**	0.115	0.006
	Sig. (2-tailed)			0.000	0.920	0.000	0.000	0.282	0.958
	N			91	91	89	90	90	91
Subjective norm	Pearson Correlation			1	0.103	.456**	.289**	0.119	0.005
	Sig. (2-tailed)				0.326	0.000	0.006	0.260	0.965
	N				92	90	91	91	92
Perceived behavioral control	Pearson Correlation				1	0.150	-0.051	-0.025	0.041
	Sig. (2-tailed)					0.158	0.628	0.817	0.700
	N					90	91	91	92
Affect and emotions	Pearson Correlation					1	.272**	0.059	0.178
	Sig. (2-tailed)						0.010	0.584	0.092
	N						90	90	90
Environmental concern	Pearson Correlation						1	.460**	-0.116
	Sig. (2-tailed)							0.000	0.275
	N							91	91
Environmental behavior	Pearson Correlation							1	0.022
	Sig. (2-tailed)								0.838
	N								91
Experience	Pearson Correlation								1
	Sig. (2-tailed)								
	N								

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

norm-environmental concern ($p < 0.01$). Remarkably, no variable was significantly correlated with PBC (Table 8).

In the test group all correlations between ITB and all independent variables but experience were significant ($p < 0.01$). In this group all correlations between independent variables except experience were significant ($p < 0.01$ or $p < 0.05$). Only environmental behavior was significantly correlated with experience ($p < 0.05$). These results are summarized in Table 9.

Table 9. Correlation results between variables in the test group

Variable	Statistic	Intention to buy	Attitude	Subjective norm	Perceived behavioral control	Affect and emotions	Environmental concern	Environmental behavior	Experience (PBC subvariable)
Intention to buy	Pearson Correlation	1	.690**	.546**	.338**	.631**	.547**	.296**	0.062
	Sig. (2-tailed)		0.000	0.000	0.001	0.000	0.000	0.006	0.567
	N		88	88	87	86	86	86	88
Attitude	Pearson Correlation		1	.637**	.251*	.625**	.710**	.244*	-0.200
	Sig. (2-tailed)			0.000	0.018	0.000	0.000	0.023	0.060
	N			89	88	87	87	87	89
Subjective norm	Pearson Correlation			1	.414**	.634**	.478**	.246*	0.035
	Sig. (2-tailed)				0.000	0.000	0.000	0.021	0.744
	N				88	88	88	88	90
Perceived behavioral control	Pearson Correlation				1	.549**	.348**	.312**	-0.025
	Sig. (2-tailed)					0.000	0.001	0.003	0.820
	N					87	87	87	88
Affect and emotions	Pearson Correlation					1	.549**	.431**	0.132
	Sig. (2-tailed)						0.000	0.000	0.222
	N						88	88	88
Environmental concern	Pearson Correlation						1	.321**	-0.132
	Sig. (2-tailed)							0.002	0.221
	N							88	88
Environmental behavior	Pearson Correlation							1	.211*
	Sig. (2-tailed)								0.049
	N								88
Experience	Pearson Correlation								1
	Sig. (2-tailed)								
	N								

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The regression results of ITB with the dependent variables for the control group are illustrated in Table 10. All variables but perceived behavioral control and environmental behavior

Table 10. Control group: Regression results between the independent variables and intention to buy/use (ITB)

Variable	Unstandardized	Coefficients	Standardized	t	Sig.
	B	Std. Error	Beta		
Attitude	0.526	0.081	0.565	6.467	0.000***
Subjective norm	0.652	0.165	0.385	3.956	0.000***
Perceived behavioral control	0.112	0.138	0.085	0.812	0.419
Affect and emotions	0.596	0.103	0.525	5.781	0.000***
Environmental concern	0.325	0.140	0.239	2.320	0.023*
Environmental behavior	0.047	0.125	0.040	0.376	0.708
Experience	0.156	0.071	0.224	2.183	0.032*

***. Regression is significant at the 0.001 level (2-tailed).

*. Regression is significant at the 0.05 level (2-tailed).

displayed a significant relationship with intention to buy. The regression of ITB with the variables attitude, subjective norms and affect and emotions were especially significant ($p < 0.001$). ITB regression with environmental concern and experience were significant as well ($p < 0.05$).

The regression results in the test group are shown in Table 11. All variables but perceived behavioral control and environmental behavior displayed a significant relationship with intention to buy. ($p < 0.001$, $p < 0.01$, $p < 0.05$).

Table 11. Test group: Regression results between the independent variables and intention to buy/use (ITB)

Variable	Unstandardized	Coefficients	Standardized	t	Sig.
	B	Std. Error	Beta		
Attitude	0.666	0.075	0.690	8.850	0.015*
Subjective norm	0.652	0.165	0.385	3.956	0.000***
Perceived behavioral control	0.474	0.143	0.338	3.308	0.001**
Affect and emotions	0.596	0.103	0.525	5.781	0.000***
Environmental concern	0.788	0.132	0.547	5.983	0.000***
Environmental behavior	0.446	0.157	0.296	2.842	0.006**
Experience	0.052	0.091	0.062	0.574	0.567

***. Regression is significant at the 0.001 level (2-tailed).

**. Regression is significant at the 0.01 level (2-tailed).

*. Regression is significant at the 0.05 level (2-tailed).

6.3 Main models

Control group models

The optimal model (Figure 8, left panel) for the control group ($F = 18.34$ on 3 and 85 DF, $p < 0.001$, $R^2 = 0.39$, R^2 adjusted = 0.37) was achieved through $ITB \sim \text{Attitude} + \text{Emotions} + \text{Experience}$. Significances of individual predictors in this model were in order of ascending strength, $p = 0.08$ for Experience (estimate = 0.12), and $p = 0.029$ for Emotions (estimate = 0.26), and $p < 0.001$ for Attitudes (estimate = 0.37). Three data points could not be included in the model estimation due to missing entries.

Test group models

The optimal model (Figure 8, right panel) for the test group ($F = 40.09$ on 3 and 81 DF, $p < 0.001$, $R^2 = 0.6$, R^2 adjusted = 0.58) was again achieved through $ITB \sim \text{Attitude} + \text{Emotions} + \text{Experience}$. Significances of individual predictors in this model were in order of ascending

strength, $p = 0.032$ for Experience (estimate = 0.15), $p = 0.014$ for Emotions (estimate = 0.28), and $p < 0.001$ for Attitudes (estimate = 0.57). Three data points could not be included in model estimation due to missing entries. Leave-one-out cross-validation of the optimal model yielded $R^2 = 0.56$.

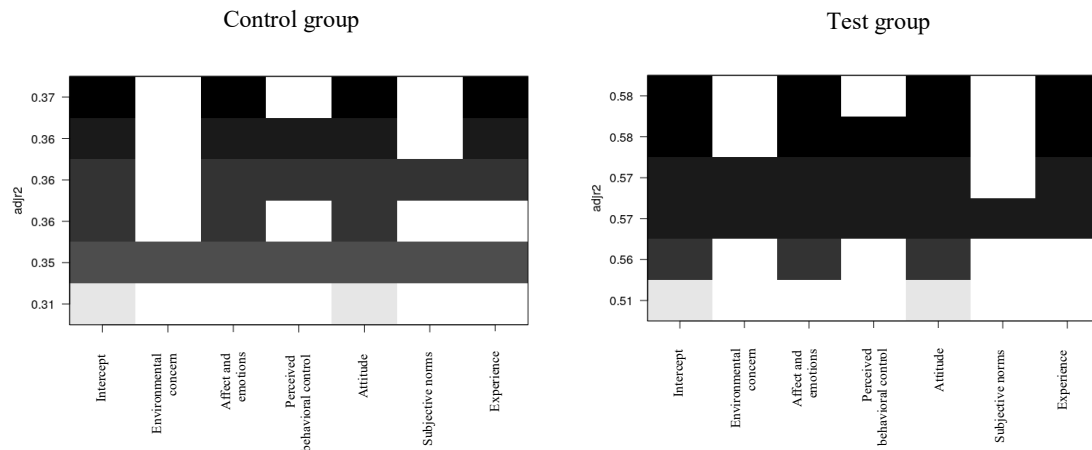


Figure 8. Six best models according to R^2 adjusted (vertical axis) for control (left) and test group (right), respectively. Black or white blocks indicated the inclusion or exclusion of predictors shown on the horizontal axis.

7. Discussion

The aim of this study was to test the effects of the recently introduced financial incentives for BEVs in Austria on consumers' intention to buy or to use BEVs. For this, half of the participants obtained in addition to the general information on BEVs, information on the incentives program. The experiment resulted in non-significant differences in intention to buy or to use BEVs between test and control groups. The control group was even trendwise significantly likelier to assert having the intention to purchase or use a BEV than the test group. Thus, the information seems not to have had the intended effect on participants. There were no differences in perceived behavioral control between both groups either. It can be concluded that the financial incentives did not have the expected effect, so both experiment-related hypotheses were rejected. The only significant difference between the groups was their past environmental behavior, being somewhat higher in the control group. These results are further discussed in 7.1.

On the other hypotheses, the results are mixed. In the test group all variables but experience were significant predictors of intention to buy or to use BEVs. This is in accordance with both expectations, on the main components of the theory of planned behavior, as well as on the

additional aspects evaluated (affect and emotions, environmental concern and environmental behavior). In contrast, the control group's attitude, subjective norm, affect and emotion, environmental concern and experience were significant predictors of intention to buy or to use BEVs. Neither environmental behavior or perceived behavioral control had a significant relationship with intention to buy or to use BEVs in the control group. This was unexpected, as perceived behavioral control is one of the main components of the theory of planned behavior and has been continuously identified as one of the strongest predictors of intention of behavior. In the control group perceived behavioral control had, in fact, no significant correlation with none of the independent variables. Furthermore, all variables but experience showed significant correlations between them in the test group. Experience only correlated significantly with environmental behavior in the test group.

For both groups, the optimal model resulted being attitude + emotions + experience, with stronger predictive power in the control group. This is contrary to expectations, as it only contains one of the main variables of the theory of planned behavior, which is attitude. This is further discussed in 7.2.

7.1 Ineffectiveness of subsidies

Beginning with the apparent ineffectiveness of the subsidies in the experiment, there are several potential explanations. The most intuitive one could be that the current financial incentive is just too small to affect consumers' intention to adopt BEVs. There are studies arguing for the effects of financial incentives to depend on income level. Particularly for low-income households, stronger incentives seem necessary to change purchase behavior (Stern et al., 1986). However, in this experiment, income did not have a significant effect on intention to buy or to use BEVs.

Another explanation might be that participants' (lack of) intention to adopt BEVs is strongly influenced by other aspects, such as attitude and emotions towards BEVs than on the vehicles' financial costs. This might rely on a general philistinism on BEVs and their advantages in comparison to ICEVs. Some scholars see this as an indication that the government should devote more resources to improve the population's general attitude towards environmentally friendly technologies to promote their adoption rates (Yang & Zhao, 2015).

It might also be the case that the information treatment led participants in the test group to reflect more on the subject and rely less on their affective system. Such a shift towards the reflective, goal-oriented system, triggered by an “information nudge” has been observed in the field before (Altmann et al., 2018; Mühlböck et al., 2020). In other words, the information on the subsidies triggered participants to think more critically about their responses in the questionnaire, therefore reducing the effect of the incentives.

An interesting aspect is the significant difference in stated knowledge on BEVs between groups. The control group stated to have a significantly higher knowledge on BEVs than the test group (Appendix 2). This might mean that participants in the control group already knew about the incentive programs in place, offsetting the treatment effect. It could also be just a result of our human tendency to overestimate our abilities and knowledge (Bjork, 1999, p. 435). To control this overestimation effect in future research, specific true-false questions on facts about BEVs could be included in the survey.

In general, more information about the general advantages of a given technology is expected to improve consumers’ perception and consequently their intention to purchase it (Irianto, 2015; Yang & Zhao, 2015). It is important to note that not all information has the same value for consumers. More information on the ethical and environmental aspects of green products does not seem to contribute to an increase in actual purchase behavior to the same degree as a price reduction does (Andorfer & Liebe, 2015). Consequently, additional information on the long-term cost advantages of BEVs is expected to lead to better results in purchase intention of green technologies. This might be especially relevant for low-income individuals, as the financial perspective seems to have the strongest influence on their adoption intention and behavior (Galarraga et al., 2011; Yang & Zhao, 2015). So, for them specifically, the current subsidies might be just too low to have an effect on their intention to adopt BEVs. The reasons for this stark contrast may rely on consumers’ price sensitivity, as the front purchase price of BEVs, even if subsidized, remains higher than that of ICEVs. These findings coincide with previously observed results in the literature on other environmentally friendly technologies (Yang & Zhao, 2015), including EVs (Zhang et al., 2018a, 2018b). To test if the results would have been different with a bigger subsidy, further research could entail an experimental setting in which this variable is altered. This would shed a light on the ideal subsidy size to effectively influence consumers’ intention to purchase BEVs. Nonetheless, the results of previous findings on the effects of price reductions on purchase intentions of various products are mixed. Even

in the hypothetical case of the price of biodiesel being reduced to the same level as conventional diesel, less than 50% of all motorists would purchase it (Gracia et al., 2014). This raises the question of whether the government should focus its efforts of BEV promotion on the high-income segment and *early adopter* of the population to accelerate the adoption process.

Another potentially influential variable not addressed in this experiment, is *price framing* i.e. the form the subsidies were presented to the participants. Consumers are known to be highly susceptible to the framing of prices in general and of price reductions in particular (Chen et al., 1998; Gourville, 1998; Krishna et al., 2002; Sinha & Smith, 2000; Soo Ong et al., 1997). Interestingly, they are more susceptible to perceive an advantage when their savings are spelled in monetary units rather than as percentages (Sinha & Smith, 2000; Yang & Zhao, 2015). Despite having framed the subsidies as such, a mere listing of the financial incentives may be too abstract for consumers to digest. A different presentation such as an illustrative calculation of the price reduction on an average front purchase price for BEVs could have a different effect. Further research might test different forms of presenting the subsidies to consumers to see if there is a way to make the offer with the financial incentives more attractive.

Furthermore, it could be the case that other components of perceived behavioral control on BEVs have a stronger effect on intention than price. A small change in the latter may not have a big enough effect to tip the balance in favor of BEVs. Similar results have been observed in studies using the TPB to evaluate the variables affecting intention of consumption of different goods. For instance, Siddique (2012) identified risk to play a much bigger role than price in consumers' willingness to purchase dry fish. All participants indeed reported low values in some of the items of perceived behavioral control (PBC3 and PBC4), as seen in Appendix 2. They did not think they would be able to charge an EV at home, and surprisingly for the test group, both groups thought that society does not offer the necessary means to use BEVs. There were no significant between-group differences in either of these items. So, it seems that consumers might require either higher financial incentives and or further efforts by the government to reduce common barriers of adoption. As discussed above, public charging stations seem to be similarly effective to subsidies in tipping the balance in favor of BEVs.

Moreover, the higher rate of environmentally friendly past behavior in the control group might indicate a randomly generated overrepresentation of subjects willing to adopt new environmentally friendly behaviors. The control group was also significantly likelier to think

that the general population does not act in an environmentally friendly way (EC2 in Appendix 2). Similarly, they were more likely to separate garbage (EB1) and have an energy provider who offers 100% renewable energy (EB3). They were also trendwise likelier to purchase regional and seasonal vegetables and fruits (EB2 in Appendix 2). As Thøgersen (1999) showed, environmentally friendly behaviors are not independent from each other but tend to overlap between them. When people take up one environmentally friendly behavior, their likelihood of adopting another one increases. Indeed, individuals with a high rate of past environmental behavior, in combination with particular psychological traits, such as benevolence, are among those most strongly inclined to use or buy EVs (Bamberg, 2003; Jansson, 2011; Kilbourne & Beckmann, 1998; Moons & De Pelsmacker, 2012; Thøgersen, 1999). This could explain the trendwise significant higher intention to buy or use BEVs assessed in the control group.

Moreover, it is important to note that intentions, the core of the TPB model, are not necessarily always good predictors of behavior (Ajzen, 2011; Kor & Mullan, 2011). All measured factors in the model, attitudes, subjective norms, and perceived behavioral control, as well as those additional ones measured in this experiment, affect and emotion, past behavior, and environmental concern are assumed to feed into and explain behavioral intentions. But despite the strong link between intention and behavior being well established, intentions' prediction of actual behavior depends partially on factors beyond the individual's control. In other words, the model is limited by the strength of the intention–behavior relation, moderated by actual control over the behavior (Ajzen, 2011). Consequently, we cannot expect to obtain a full picture of actual behavior through the TPB and may assume actual adoption of BEVs to be lower than the intention of adoption.

7.2 Optimal model

As depicted in Figure 8, the optimal model to predict participants' responses in both groups entailed in ascending strength the predictors experience, affect and emotions, and attitudes. It did not entail neither perceived behavioral control nor subjective norms, contrary to the expectations derived from the standard model of TPB. Ergo, affect and emotions had an even stronger predictive power than subjective norms and perceived behavioral control, the other two main variables of the TPB model besides attitude. These findings coincide with previous results (Ellaway et al., 2003; Koller et al., 2011; Moons & De Pelsmacker, 2012; 2015; Steg et al., 2001; Tyrinopoulos & Antoniou, 2013). Affect and emotions have often been determined

not only to be more important than subjective norms, but to be one of the most important factors in determining EV purchase intention. It is relevant to note, that it is the predictive power of anticipated i.e. cognitively oriented emotions related to EVs that seem to be important, not emotions towards car driving in general (Moons & De Pelsmacker, 2012).

These results further support the arguments of Bagozzi et al. (1999), Chaudhuri et al. (2010), Kim et al. (2007), Moons and De Pelsmacker (2012), Perugini & Bagozzi, 2001, Richins (1997), and Wood and Moreau (2006) to reconsider the importance of anticipated emotional reactions for the adoption of innovative products and new behaviors. The influence of emotions seems to be particularly salient during the early learning stages of product usage (Kwortnik & Ross, 2007; Wood & Moreau, 2006). This is especially the case for technological or functional innovations (Wood & Moreau, 2006). The emotional aspect seems to be at least as important as the cognitive one in the formation of consumers' intention of behavior. This is also the case for environmentally friendly consumer durables, such as BEVs (Moons & De Pelsmacker, 2012, 2015).

That said, these findings add to the literature challenging Ajzen's refusal to recognize the predictive power of affect and emotions. Ajzen (2011) dismissed this often-highlighted gap of the theory to be merely based on the framing of the questions assessing the variable. He repeatedly emphasized that the items on anticipated affect and emotions are usually measured in relation to *not* performing the behavior in question, unlike the main variables of TPB (Ajzen, 2011; Ajzen & Sheikh, 2013; Fishbein & Ajzen, 2010). Ajzen (2011) and Ajzen and Sheikh (2013) relied on the notion of non-action not necessarily being the opposite of action (Richetin et al., 2011) and discussed negatively framed items to trigger beliefs about experiencing regret or upset following a non-action.

However, all items of anticipated affect and emotions (EMO) used in this experiment were positively framed, like the rest of the questionnaire. Thus, the results presented in this thesis defy Ajzen's dismissal of the predictive power of anticipated affect and emotions on intention of behavior. The variable had an even stronger predictive power than subjective norms, one of the main variables of the TPB model, only confirming the importance of integrating affect and emotions in the TPB when evaluating adoption intention of BEVs. In conclusion, this thesis adds up to the body of literature arguing for the inclusion of affect and emotions in the TPB, at least when it comes to the early stages of adoption of BEVs.

8. Summary

Already suffering the consequences of climate change around the world, people are increasingly pressuring governments to take action and enforce a reduction of GHG emissions. The EU assimilated this call for action by striving to decarbonize its economy by 2050. As for the transportation sector, the EU is already drafting and implementing plans to promote its electrification. Accordingly, most member states have already put various incentives in place to nudge society towards EVs. Several of these incentive plans include financial subsidies as well as tax breaks for (B)EVs, such as in the case of Austria. With only 0.6% of registered vehicles being electric, Austria has a long way to go to decarbonize its economy by 2050. Since March 2019, the Austrian government grants a payment of 3.000 EUR for the purchase of a BEV or a hybrid below the value of 50.000 EUR. For the purchase of BEVs only, it provides additional tax breaks from the standardized consumption tax and the engine related insurance tax. There is also a 400 EUR grant to help with the costs of setting up e-charging stations in apartment buildings and a 200 EUR grant for e-charging infrastructure.

Subsidies such as these, are used by governments in their attempt to address market failures and the consequently generated negative externalities. In this case, the financial incentives on BEVs are designed to accelerate the decarbonization of the transportation system. Deployment of e-charging infrastructure as well as financial subsidies are understood to be effective in accelerating the adoption process of BEVs. However, the exact details on the size and extent of the incentives are subject of discussion. Thus, an evaluation of the effectiveness of the recently introduced subsidies for BEVs in Austria seemed appropriate. And as far my knowledge goes, this is the first work assessing their effect on consumers in Austria.

Consumer adoption as one of the main topics in economics, has many theories attempting to explain and predict it. The most traditional model, the rational choice theory, assumes consumer behavior to be, as its name predicts, the result of a rational calculation. However, this assumption has at the latest been defied by behavioral economics, asserting human behavior to not always be as rational as once assumed. Other models, such as the theory of consumption values, include psychological factors, known to affect human decision-making. However, evaluations of actual purchase behavior of goods, as intended in both theories, are very difficult to make. Fortunately, among the strongest theories in the field is the theory of planned behavior. It recognizes intention of behavior, an easily measurable variable, to be the

most proximate predictor of actual behavior. Intention of behavior is itself influenced by three components, attitude, subjective norms and perceived behavioral control. Attitude results from a sum-up of knowledge and experience on the behavior or good in question. Subjective norms are based on the perception of approval or disapproval of a given behavior by the individual, important referent individuals or groups and the media. Perceived behavioral control is the subject's perception of the ease or difficulty of performing a behavior, and is affected by perceived ability, and constraints and facilitators of the behavior by external sources.

Additionally, aspects commonly highlighted to be missing in the theory of planned behavior were included in the research model. The most emphasized element by far has been affect and emotions. They have been repeatedly identified to have strong predictive power on consumer intention of behavior and actual behavior. The other aspects, environmental concern and past environmental behavior, are specific for the evaluation of consumer adoption of environmentally friendly products and behaviors.

Based on the theory of planned behavior, informing participants on the financial subsidies on BEVs was expected to increase their intention to buy/use BEVs and to improve their perception of perceived behavioral control. According to the main assumptions of the theory, attitude, subjective norms and perceived behavioral control relating to BEVs were expected to be positively associated with intention to buy/use BEVs. From the additional aspects, affect and emotions towards BEVs were expected to be positively associated with intention to buy/use BEVs. Environmental concern as well as past environmentally friendly behavior were also expected to be positively associated with intention to buy/use BEVs.

The experiment design was based on a questionnaire. Both, the control and the test group, obtained an identical questionnaire, but in addition to the general information on BEVs both groups received, the test group obtained the information on the subsidies in Austria as well. The survey ran on the SoSciSurvey website and was first distributed in a number of lectures at the institute of economics of the University of Vienna and later further dispersed on Facebook groups.

The final dataset consisted of 181 forms, with 92 participants in the control group and 89 in the test group. There were non-significant differences between groups in neither of the demographic aspects. Only the test group had significant differences of income between male and female participants. Against all expectations, there was also only a trendwise significant

difference in intention to buy/use of BEVs between groups, with the control group being somewhat likelier to do so. The groups only significantly differed in past environmental behavior, again with the control group having higher reported values. Contrary to expectations, the calculation of an optimal predictive model resulted to be attitude, affect and emotions and experience, in descending strength. This was true for both groups and supported the commonly highlighted gap of the theory of planned behavior on the predictive value of affect and emotions.

There are several possible explanations for these results that would need to be evaluated by further studies. On the ineffectiveness of the information treatment, the subsidies in place might not be high enough to affect consumers' intention to adopt BEVs nor perceived behavioral control. This might mean either the need to increase the subsidies and or expand the current policy incentives, such as deploying e-charging infrastructure. It could also be the case that the information treatment triggered the test group to reflect more on the subject and rely less on their affective system. This would reduce the effects of the information treatment. Another possibility might lay on price framing, as consumers are known to be affected by the way prices and discounts are presented. It could also be the case that participants in the control group already knew about the incentives, offsetting the effect in the experiment, as their reported knowledge on BEVs was significantly higher than that of the control group. They could also be just more willing to adopt BEVs, as they reported to already have adopted significantly more environmentally friendly behaviors than the test group. Furthermore, the results of the optimal model entailing affect and emotions besides attitude, instead of the other two components of the theory of planned behavior, adds up to a large body of literature arguing for the variable's predictive value of behavioral intention. Affect and emotion seem to be important components of human intention of behavior and actual behavior and should be included in models on intention of adoption of BEVs, especially in the early stages of adoption.

9. Limitations and further research

This study only covers a tiny fraction of the gap in the BEV literature and has clear limitations that provide ground for further research. An experiment with varying subsidy sizes could help determine the size the financial incentive requires for it to be effective in promoting BEV adoption. Furthermore, the way the subsidies are presented might be varied as well to evaluate

the effect of price framing. This might as well take the form of a long-term price comparison between BEVs and ICEVs, highlighting the lower total costs of BEVs over time. A farfetched but interesting idea would be to include so-called *sin taxes* on ICEVs in a choice experiment with subsidized BEVs. This would test whether such penalty measures on conventional vehicles would make BEVs more attractive for consumers.

On a similar note, it is currently unknown how many people actually know about the subsidies. So, a survey on consumers' awareness of the subsidies would provide a picture on whether the dispersion of the information was actually successful or not. This experiment had no screening mechanism to identify individuals who already knew about the financial subsidies for BEVs. Additionally, an insight into the changes in new registrations of BEVs in Austria since the introduction of the subsidies might be even more valuable. The reason this was not done in this thesis, was that the official Austrian statistics institution did not provide such numbers for BEVs. They were presented mixed with hybrid vehicles into one category. Only since recently have they started publishing the numbers independently from each other.

Furthermore, it would be interesting to evaluate the effects the subsidies have had on the market, specifically on the behavior of car sellers. Ideally, they should be advertising the subsidies to promote their BEVs sales. In the worst-case scenario, they have increased the purchase prices of BEVs, thus offsetting the subsidies. This concern is not completely unjustified as recent events in Germany depict, where the tax reduction on female sanitary products lead to a market price increase.

A potentially relevant remark is the fact that opinions are not solely formed in individuals' heads but are shaped by discussion and exchange with peers as well (Franklin & Kosaki, 1989). This creates varying approaches to evaluate the effects of the information on consumers. Either measure the immediate response to the information and/or expose them to the information and assess their intention of adoption at a later point in time. The latter would give the individuals a longer timespan to process the information and discuss it with peers to form a solid and organic opinion. This would allow for a much more *natural* decision-making procedure that would portray reality to a much better degree than assessing people's immediate response to the information. Having both measures would allow a comparison pre- and post-*socialization* of the individuals' opinion on BEVs, a likewise interesting aspect.

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Appendix 1. Text for diffusion of survey on Facebook groups.

Hello fellow [...],

I am currently doing a survey on consumer attitude towards electric cars for my Master's thesis to better understand the factors influencing our attitude towards them.

If you could invest 5min of your time to fill the form, I would very much appreciate your help. 🚗

Thank you all and stay safe!

Best wishes, Camila

Appendix 2. Results of evaluation of single items of each variables

Table 12. Descriptive results of single items of all variables

Descriptive statistics of items by group					
Items	Group	N	Mean	Std. Deviation	Std. Error Mean
EX3	Control group	70	3.39	1.00	0.12
	Test group	65	2.98	1.05	0.13
Exp1	Control group	93	2.83	1.77	0.18
	Test group	90	2.56	1.68	0.18
IU1	Control group	87	3.15	1.08	0.12
	Test group	85	2.92	1.28	0.14
IU2	Control group	90	3.64	1.14	0.12
	Test group	85	3.38	1.26	0.14
AT1	Control group	90	3.67	1.09	0.12
	Test group	84	3.43	1.30	0.14
AT2	Control group	89	3.97	1.10	0.12
	Test group	87	3.84	1.24	0.13
SPN1 reverse	Control group	90	4.70	0.61	0.06
	Test group	84	4.57	0.85	0.09
SPN2	Control group	90	3.89	1.00	0.11
	Test group	88	3.63	1.02	0.11
SNP1	Control group	84	3.45	0.99	0.11
	Test group	81	3.33	1.00	0.11
SNP2	Control group	82	3.34	0.97	0.11
	Test group	79	3.23	0.96	0.11
SCN1	Control group	91	2.88	1.09	0.12
	Test group	84	2.94	1.10	0.12
SCN2	Control group	91	3.59	0.99	0.10
	Test group	84	3.39	0.89	0.10
SMN1	Control group	88	3.27	0.85	0.09
	Test group	84	3.23	0.83	0.09
PBC1	Control group	80	3.70	1.04	0.12
	Test group	75	3.59	1.08	0.13
PBC2	Control group	91	3.86	1.11	0.12
	Test group	83	3.64	1.29	0.14
PBC3 rev	Control group	85	2.35	1.52	0.16
	Test group	80	2.44	1.35	0.15
PBC4	Control group	86	2.60	1.13	0.12
	Test group	79	2.80	1.11	0.13
EMO1	Control group	89	3.76	1.05	0.11
	Test group	83	3.53	1.19	0.13
EMO2	Control group	78	3.47	1.07	0.12
	Test group	74	3.43	1.04	0.12
EMO3	Control group	81	3.93	1.29	0.14
	Test group	79	4.04	1.09	0.12
EMO4	Control group	88	4.10	1.06	0.11
	Test group	84	3.87	1.18	0.13
EC1	Control group	91	3.71	1.16	0.12
	Test group	85	3.56	1.33	0.14
EC2	Control group	89	4.33	0.72	0.08
	Test group	86	3.99	0.87	0.09
EC3	Control group	88	4.26	0.85	0.09
	Test group	87	4.20	0.94	0.10
EC4	Control group	90	3.78	1.08	0.11
	Test group	86	3.71	1.23	0.13
EB1	Control group	91	4.00	0.81	0.09
	Test group	88	3.71	0.79	0.08
EB2	Control group	91	3.95	1.11	0.12
	Test group	87	3.63	1.06	0.11
EB3	Control group	88	3.33	1.49	0.16
	Test group	80	2.84	1.51	0.17
EB4	Control group	91	4.13	1.28	0.14
	Test group	87	3.86	1.30	0.14

Table 13. *t*-test results between groups of each item of the aggregated variables

t-test for Equality of Means					
Items	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
EX3	2.273	133	0.025*	0.401	0.176
Exp1	1.067	181	0.287	0.272	0.255
IU1	1.280	170	0.202	0.232	0.181
IU2	1.478	173	0.141	0.268	0.181
AT1	1.311	172	0.192	0.238	0.182
AT2	0.720	174	0.472	0.127	0.177
SPN1 rev	1.150	172	0.252	0.129	0.112
SPN2	1.743	176	0.083	0.264	0.151
SNP1	0.770	163	0.443	0.119	0.155
SNP2	0.746	159	0.457	0.114	0.152
SCN1	-0.369	173	0.712	-0.061	0.166
SCN2	1.405	173	0.162	0.201	0.143
SMN1	0.363	170	0.717	0.047	0.128
PBC1	0.667	153	0.506	0.113	0.170
PBC2	1.199	172	0.232	0.219	0.182
PBC3 rev	-0.377	163	0.706	-0.085	0.224
PBC4	-1.102	163	0.272	-0.193	0.175
EMO1	1.370	170	0.172	0.234	0.171
EMO2	0.246	150	0.806	0.042	0.171
EMO3	-0.592	158	0.555	-0.112	0.189
EMO4	1.364	170	0.174	0.233	0.171
EC1	0.797	174	0.427	0.150	0.188
EC2	2.792	173	0.006**	0.337	0.121
EC3	0.487	173	0.627	0.066	0.135
EC4	0.394	174	0.694	0.068	0.174
EB1	2.396	177	0.018*	0.287	0.120
EB2	1.924	176	0.056	0.313	0.163
EB3	2.127	166	0.034*	0.492	0.231
EB4	1.390	176	0.166	0.270	0.194