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Can Protection Motivation Theory predict pro-environmental behavior? Explaining the adoption of electric vehicles in the Netherlands

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ABSTRACT

Scholars have proposed that the Protection Motivation Theory provides a valuable framework to explain pro-environmental choices, by employing a wide set of predictors, such as the costs and benefits of current (maladaptive) behavior as well as prospective adaptive behavior. However, no comprehensive empirical tests of the Protection Motivation Theory in the slow onset environmental risk domain have been published yet to our knowledge. This paper aims at closing this gap. We first conceptualized the Protection Motivation Theory for the use in this environmental domain. Next, we present results of a questionnaire study among a large representative sample of Dutch drivers that showed that the Protection Motivation Theory is a relevant theory for modeling different indicators of full electric vehicle adoption. Notably, all theoretical antecedents proved to be significant predictors of different adoption indicators. Respondents were particularly more likely to adopt an electric vehicle when they perceived the negative consequences caused by conventional vehicles as more severe, and when they expected electric vehicles to decrease these consequences. The most important barriers for electric vehicle adoption were perceived high monetary and non-monetary costs of electric vehicles, and benefits associated with the use of a conventional vehicle. Interestingly, we found that environmental risks are more prominent in predicting close adoption indicators; while energy security risks are more prominent in predicting distant adoption indicators. As expected, our findings suggest that both collective concerns and individual concerns predict different indicators of adoption. Individual concerns (in particular perceived costs of driving an electric vehicle) played a more prominent role when predicting close measures of adoption, while collective concerns (e.g., perceived severity of environmental and energy security risks) played a somewhat more prominent role when predicting distant measures of adoption. Implications for research and practice are provided.

1. Introduction

Achieving a more sustainable, environmentally friendly future has long become an embraced goal of many societies worldwide where pro-environmental behavior is found at its core. Indeed, it is widely believed that changes in behavior are needed to promote a more sustainable future. However, engaging in and sustaining such behavior often comes at a price as it often costs more (e.g., organic products are more expensive than conventional products), requires more effort (like waste separation) or even new skills (like eco-driving). Important questions to be answered in this respect are: which factors determine whether people are willing to overcome such barriers to pro-environmental actions, and which factors promote pro-environmental (collective) actions?

Various theories have been applied to explain actions to reduce environmental risks. The most popular theories in environmental psychology to examine factors influencing environmental actions are the Theory of Planned Behavior (Ajzen, 1991), the Norm Activation Model (Schwartz, 1977; Schwartz and Howard, 1981),

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and the Value-Belief-Norm Theory of environmentalism (which is basically an extension of the Norm Activation Model; Stern, 2000; Stern et al., 1999). We argue that the Protection Motivation Theory (Rogers, 1975, 1983) offers another promising theoretical perspective for explaining environmental behavior. The Protection Motivation Theory, originally proposed to predict behavior in the context of personal health threats (Rogers, 1983; Prentice-Dunn and Rogers, 1986), employs a wider set of predictors than the Theory of Planned Behavior, Norm Activation Model and Value-Belief-Norm Theory that may enhance our understanding of motivators governing pro-environmental attitudes and behavior, which can be targeted to promote pro-environmental choices to reduce environmental risks. In particular, in addition to Theory of Planned Behavior, Norm Activation Model and Value-Belief-Norm Theory, Protection Motivation Theory not only focuses on cost and benefits of adaptive behavior that reduce environmental risks, but also considers benefits of current products or practices that increase the likelihood of maladaptive behavior that in turn increase environmental risks. Furthermore, similarly to Theory of Planned Behavior, Protection Motivation Theory is considering individual costs of adaptive action; but importantly, Protection Motivation Theory accommodates aspects of collective action as well (such as response efficacy, as we will explain below), which are key in Norm Activation Model and Value-Belief-Norm Theory.

The basic idea of the Protection Motivation Theory is that people engage in adaptive actions when confronted with (environmental) risks through perceived risk vulnerability and severity on the one hand, and by considering the possibilities to manage these risks through response efficacy and self-efficacy on the other hand. We will explain the Protection Motivation Theory in more detail below. A distinctive feature of Protection Motivation Theory is that the model assumes that individuals consider current behavior as well as their expectation of a new behavior in terms of respective costs and benefits when making pro-environmental choices. This way, Protection Motivation Theory allows identifying both barriers and facilitators to adoption of protective behavior. However, beyond the area of health risk, to authors' knowledge, so far Protection Motivation Theory has mainly been successfully applied in the domain of acute environmental risks such as floods and wildfires to predict (intentions to engage in) self-protective behavior (see Grothmann and Patt, 2005; Grothmann and Reusswig, 2006; Martin et al., 2007; Bubeck et al., 2012). While Gardner and Stern (2002, p. 244) argue that "the (Protection Motivation) theory appears to have broad applicability, including to natural and technological hazards and to environmental threats", to our knowledge it has not been applied to understand engagement in pro-environmental actions governed by slow onset risks such as climate change or environmental sustainability. Following Gardner and Stern (2002), we argue that Protection Motivation Theory has every potential to be a useful framework to understand why people do or do not engage in pro-environmental actions and how to motivate and facilitate pro-environmental behavior. In this paper we aim to test whether Protection Motivation Theory is successful in explaining pro-environmental actions (adaptive behavior) that are believed to reduce slow onset environmental risks such as climate change, environmental pollution, or security of energy supply. The following research questions will be answered: which barriers impede the adoption of pro-environmental actions and how to overcome them? And: which factors promote the adoption of pro-environmental actions?

In this paper, we will first present a general operationalization of the Protection Motivation Theory framework for application in the domain of slow onset environmental risks. Subsequently, we apply our conceptualization of the Protection Motivation Theory to modeling protective behavior related to slow onset risks. As a case in point, we focus on the adoption of full battery electric vehicles (which we refer to as electric vehicles from now on). In doing so, we explore the role of different types of risks, that is environmental and energy security risks, and examine which of these two risks is more likely to motivate pro-environmental action. Also, we consider different indicators of adoption, both 'close' and 'distant', as will be further explained below.

2. The Protection Motivation Theory

2.1. Description of the Protection Motivation Theory

The Protection Motivation Theory was introduced by Rogers (1975) as a model to explain which factors predict risk adaptive behavior that can be used for effective risk protection communication aiming at attitude and behavior change. The original model aimed to study behavioral change to address health-related risks (Rogers, 1975, 1983), although already in Maddux and Rogers (1983) posited that Protection Motivation Theory is a theoretical framework with broad applicability. The Protection Motivation Theory assumes that people balance different risks and benefits when making choices. This process of deliberation and decision-making does not necessarily have to be explicit and within conscious awareness (Rogers, 1975, 1983); the described processes may well posses a certain degree of latency. The theory proposes that two processes determine whether people engage in risk protective behavior: threat appraisal and coping appraisal (see Fig. 1).

Threat appraisal is a primary cognitive process essentially directed at answering the question: is the existing risk (so) threatening? It includes three elements: assessment of the perceived severity of the current threat, the perceived vulnerability to the current threat, and the rewards connected to current practices (which may inhibit risk protective actions). Perceived severity of the threat reflects how serious an existing risk is perceived to be. Perceived vulnerability reflects perceptions of how susceptible one is to the existing threat. Rewards represent all perceived benefits connected to current behavior or practice, which can be divided into intrinsic (inherent to self) and extrinsic

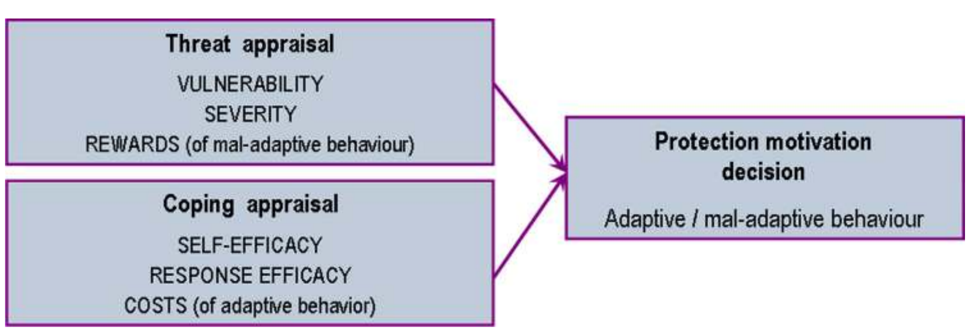

Fig. 1. Conceptual model of the Protection Motivation Theory.

(external) benefits. Hence, threat appraisal is based on weighing the benefits of doing nothing (i.e., not engaging in risk protective behavior) against the existing risk. Higher perceived severity and vulnerability is likely to promote risk adaptive behavior, while higher perceived rewards of current practices will inhibit adaptive behavior.

The second cognitive process comprises coping appraisal. At this stage, the key question is: Will my action help avoid or decrease the threat? Coping appraisal consists of three elements: perceived self-efficacy, perceived response efficacy and perceived costs of protective action. Self-efficacy reflects whether one believes that one is able to perform protective measures or actions. Response efficacy relates to the efficacy of the protective actions or measures to reduce or avoid existing risks: will engaging in protective action actually reduce the risks? Perceived costs represent all perceived costs connected to protective measures or actions, including monetary costs as well as non-monetary costs such as effort, time or inconvenience. Thus in the coping appraisal stage, one weights the perceived ability to avoid or decrease risks against the perceived costs of protective action. Hence, higher perceived self-efficacy and response efficacy have a positive effect on risk adaptive behavior, while high perceived costs of risk protective behavior reduce the likelihood of adaptive behavior.

Please note that both types of appraisals are based on how people *perceive* the risks and benefits of adaptive and maladaptive behavior, which is likely to differ across individuals, and may well deviate from objective risks and benefits. The two types of appraisals result in a trade-off where perceived pros and cons of protective and maladaptive action are being weighted, after which a decision is made whether to adapt and undertake protective action, or not. High threat and coping appraisals increase the odds that adaptive action is taken, while low threat and coping appraisals reduce this likelihood. Ultimately, the Protection Motivation Theory is argued to be "especially useful (to analyze pro-environmental action) because it shows how several psychological processes and mechanisms can interact, reminds us that all of these processes and mechanisms can contribute to misestimation and inaction at the same time, and suggests multicomponent programs that are likely to be effective in efforts to increase ... people's estimation of environmental threats and/or their actions toward those threats" (Gardner and Stern, 2002, p. 244).

As explained above, it is assumed that Protection Motivation Theory can be readily applied to explain different kinds of risk protective behaviors, acute as well as slow-onset risks. Acute or rapid onset risks arrive and develop rapidly, damages thereof appear directly and response to those requires rapid and well coordinated interventions. Examples of acute risks are tropical storms, earthquakes, floods, volcano eruptions and tsunamis. On the other hand, chronic or slow onset risks arrive and develop relatively slowly, and even emerge not from a single, distinct event but one that emerges gradually over time, often based on a confluence of different events (OCHA, 2011). In this case, risk exposure is long and continuous, and consequences may become visible sometimes only after a substantial time period after the onset of a risk. Examples of slow onset risks are environmental risks such as droughts, sea level rise, increasing global temperatures, ocean acidification, glacial retreat and related impacts, salinization, land and forest degradation, loss of biodiversity and desertification (UN FCCC, 2012).

Yet, in the environmental domain thus far Protection Motivation Theory has mostly been applied to understand how people respond to acute natural hazards like wild fires (Martin et al., 2007) and floods (Grothmann and Patt, 2005; Grothmann and Reusswig, 2006; Bubeck et al., 2012). At the same time, in the past decades we have seen increasing effort directed at motivating pro-environmental behaviors aimed to reduce slow-onset risks, such as environmental pollution, climate change, or security of energy supply. It has been proposed that the Protection Motivation Theory is a suitable framework to understand whether people are likely to engage in pro-environmental actions to reduce such slow-onset environmental risks as well (Gardner and Stern, 2002). Surprisingly, however, to our knowledge, this theory has not yet been applied in empirical studies in the context of pro-environmental behaviors to reduce such slow-onset risks. We aim to address this knowledge gap by providing a first test of Protection Motivation Theory to explain adaptive behavior to reduce slow onset environmental risks. Before doing so, it is essential to define the key concepts of the Protection Motivation Theory in the domain of slow onset risks.

2.2. Conceptualizing Protection Motivation Theory to explain adaptive behavior to cope with slow-onset risks

In this section, we propose a general operationalization of the Protection Motivation Theory framework to adapt it to the purposes of modeling pro-environmental behavior in the context of slow-onset risks. Here, threat appraisal would refer to the current product or practice that is a source of environmental risks or gives rise to hazardous side-effects. In particular, perceived severity can be conceptualized as the perception of the seriousness of problems arising from engaging in current practices (referred to as maladaptive behavior). Perceived vulnerability would likewise reflect the likelihood to personally experience negative consequences of the risks in the current situation. Higher perceived severity and vulnerability should expectedly stimulate pro-environmental (i.e., adaptive) behavior. Expected rewards can be conceptualized as the benefits connected to keeping up to (current) environmentally unfriendly practices or products, and would expectedly inhibit adaptive behavior, and encourage current (i.e., maladaptive) behavior.

At the same time, in the domain of pro-environmental behavior, coping appraisal would refer to the evaluation of the efficacy and costs of adaptive behavior, such as switching to an environmentally friendly product or practice. This behavior should replace a 'hazardous' product or practice, which should result in a decrease or avoidance of negative environmental effects. In this context, response costs would refer to the expected individual costs of engaging in pro-environmental actions (the adaptive behavior), both monetary and non-monetary. Self-efficacy would refer to one's perceived ability to engage in the relevant pro-environmental behavior or to adopt an environmentally-friendly product or practice. Response efficacy would refer to the extent to which a person believes that environmental problems will be reduced or avoided if one engages in the adaptive pro-environmental action. Higher costs would expectedly negatively influence pro-environmental behavior, while high perceived self-efficacy and response efficacy should promote adaptive action. Fig. 2 depicts the conceptualized model.

3. Electric vehicle adoption as a step toward sustainable mobility

Among a variety of environmentally-friendly actions, a shift to sustainable modes of transport has recently received a prominent place on the political agenda. Indeed, current transport practices are a one of the major causes of environmental risks, including climate change (UITP, 2009; Pasaoglu et al., 2012). Electric vehicles are considered as one of the promising solutions in personal transportation and are believed to decrease negative impacts on the environment and to save scarce fossil fuel resources during the entire lifecycle (Wittenberg and Meurice, 1993; Funk and Rabl, 1999; Delucchi and Lipman, 2001; Pistoia, 2010), in particular

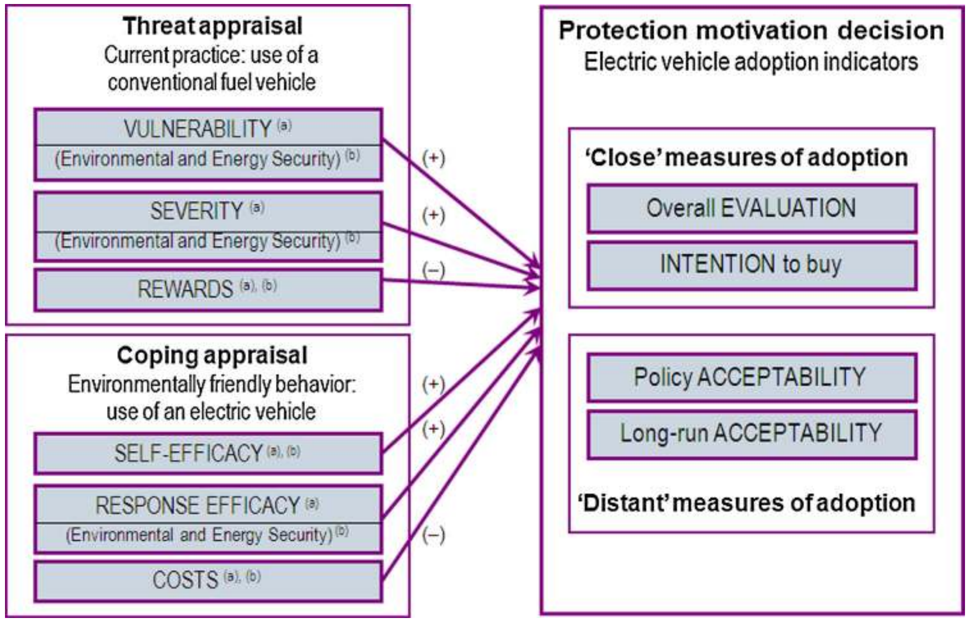

Fig. 2. Conceptual model of the Protection Motivation Theory for adoption of an electric vehicle as an environmentally friendly alternative to a conventional fuel vehicle. For each of the adoption measures, two models were tested: (a) a basic model with general scales to measure Severity, Vulnerability and Response Efficacy; (b) an extended model with the Severity, Vulnerability and Response Efficacy subscales, reflecting specific environmental and energy security aspects, respectively. *Note*. Plus and minus signs in brackets reflect the expected relationship between a predictor variable and the dependent variables reflecting adoption of electric vehicles.

when electricity is produced nationally or locally using sustainable sources (Hawkins et al., 2013). In the Netherlands, the political goal is to have about 200,000 electric vehicles on the road by 2020 (The Dutch Parliament, 2009).

The adoption of electric vehicles may seem a pure consumer choice problem, so that actual adoption remains by far and large within the individual decision-making domain. Therefore, it is important to understand which factors promote and inhibit the adoption of electric vehicles on the individual level. However, the introduction of electric vehicles to the market is not just a variety of an existing product. Rather, an electric vehicle possesses certain functional characteristics that require behavioral adjustments on the part of consumers. This situation is comparable with health-related behaviors like smoking or lack of exercising where behavioral patterns need to be broken and new behaviors should be established, and where Protection Motivation Theory is often used to analyze factors promoting and inhibiting such behavioral change. In this way, electric vehicle introduction lends itself as an appropriate subject of investigation with the help of Protection Motivation Theory because an electric vehicle can be seen as a solution to environmental problems caused by the use of a "hazardous" conventional fossil fuel vehicle.

It is important to mention that there is a latent conflict between collective benefits and individual costs associated with an electric vehicle, as is often the case for pro-environmental behavior (e.g., Steg and Vlek, 2009). On the one hand, electric vehicles are expected to bring about substantial *collective* benefits such as environmental risk mitigation and decreased dependency on fossil fuel imports (e.g., Steg and Vlek, 1997; Funk and Rabl, 1999; Steg, 2007; Pistoia, 2010). On the other hand, at least in the present situation, it involves *individual* costs for prospective users such as a higher purchasing price, and (costly) behavioral adjustments associated with driving and charging. Due to the collective environmental benefits of electric vehicles and positive effects on security of energy supply, electric vehicle adoption has become a direct target for government intervention to achieve climate and sustainability goals. Thus, governments around the globe stimulate the introduction and adoption of alternative vehicles, for example, by providing financial incentives (Diamond, 2009; Chandra et al., 2010; Beresteanu and Li, 2011; Gallagher and Muehlegger, 2011). However, recent findings suggest that monetary incentives have not lead so far to the desired levels of adoption propagation in the US (with the state of California as an exception), Canada or Europe alike (Chandra et al., 2010; Beresteanu and Li, 2011). Moreover, current monetary schemes have even lead to sub-optimal income effects and overproportional adoption of full hybrid vehicles relative to full electric vehicles. In addition, non-monetary incentives, such as vehicle access to bus lanes or free parking have proved to be less effective than initially assumed. Governments are therefore urged to explore alternative policy options in order to effectively shift consumer preferences away from fuel inefficient vehicles and to encourage the adoption of low duty vehicles such as electric vehicles. We propose that Protection Motivation Theory includes important factors beyond the monetary and functional aspects commonly addressed in policies that increase our understanding of the motivations behind individual adoption of electric vehicles that may provide important implications for the design of interventions to encourage electric vehicle adoption. Notably, the Protection Motivation Theory assumes that collective as well as individual costs and benefits drive pro-environmental behavior, such as electric vehicle adoption.

Hence, we aim to test whether Protection Motivation Theory is suitable to increase our understanding of electric vehicle adoption. As mentioned above, electric vehicles are particularly deemed to offer solutions to risks related to security of energy supply and environmental risks. Therefore, besides testing the predictive power of the Protection Motivation Theory in explaining electric vehicle adoption, we will also explore which of these two types of risks will most strongly affect the adoption of electric vehicles, as to understand which type of risk is most likely to motivate adoption of electric vehicle, and hence, which types of risks can best be addressed to promote electric vehicle adoption. This is an important question, as both types of risks have different implications for individual consumers. On the one hand, environmental problems, such as climate change, pollution, and decreased biodiversity, are relatively 'distant' and become apparent in the long term, and individual contributions to these problems and their solution are very limited. It has been argued that people tend to discount risks that will become apparent in distant future only and are less motivated by such future collective risks (Gifford, 2011). Yet, literature on alternative fuel vehicles shows that environmental considerations can be important motivators for such vehicle adoption (Kahn, 2007; Ozaki and Sevastyanova, 2011), which imply that environmental risk perceptions can play a significant role in this respect, even though environmental problems will hardly be visible in the near future. Also, related to this, research suggests that people tend to be less likely to discount future environmental risks than other (notably financial) risks, probably because environmental risks tap into moral values, which apply irrespective of temporal aspects (Böhm and Tanner, 2012; Böhm and Pfister, 2005; Gattig and Hendrickx, 2007).

On the other hand, energy security risks connected to the dependence on fuel supply from politically instable countries and high volatility of fuel prices is a somewhat 'closer' threat with more direct consequences for personal budget. Here, individual action (such as a switch from a conventional to an alternative fuel vehicle) can more directly reduce risks related to own dependency on fossil fuels. Research shows that higher fuel prices are related to electric vehicle adoption (Gallagher and Muehlegger, 2011), suggesting that risks related to security of energy supply affect electric vehicle adoption. Hence, both environmental and energy security risks may motivate electric vehicle adoption. However, as yet, little is known about their relative importance and thus relative effectiveness in promoting electric vehicle adoption. This paper will address this issue by testing to what extent environmental and energy security risks motivate individuals to adopt an electric vehicle.

To test the robustness of our findings, we will examine whether the Protection Motivation Theory is successful in predicting different indicators of adoption. Indeed, adoption of a new product or a new practice is a process that essentially involves a number of stages or dimensions (e.g., Prochaska and DiClemente, 1984; Rogers, 2000; Dijkstra et al., 2006; Bamberg, 2013). In the current study we will distinguish the following dimensions of adoption and explore to what extent they are related to the Protection Motivation Theory variables: (i) overall evaluation of electric vehicles; (ii) intention to purchase electric vehicles; (iii) acceptability of policies directed at facilitating the adoption of electric vehicles; and (iv) long-run acceptability of electric vehicles. Essentially, for the purposes of this study, (i) and (ii) can be considered as 'close' indicators of adoption, while (iii) and (iv) can be seen as more 'distant' indicators of adoption. 'Close' indicators of adoption would thus reflect a direct personal engagement in the adoption process measured by personal appreciation of the pro-environmental product (electric vehicle) and personal commitment to adopt one as reflected in the intention to buy an electric vehicle. At the same time, 'distant' measures of adoption reflect adoption as a collective commitment as reflected by long-run acceptability of electric vehicles in general and support for policy measures facilitating electric vehicle adoption within society. We note that this classification does not presume any order or sequence of acceptability and behavioral intention; we leave this discussion beyond the scope of this paper.

In sum, we aim to test whether the Protection Motivation Theory is successful in explaining adaptive behavior directed at mitigating slow-onset risks, such as environmental degradation and climate change. More specifically, we aim to examine to what extent the Protection Motivation Theory explains the adoption of electric vehicles as presented in Fig. 2. In doing so, we include different indicators of adoption. We test the basic Protection Motivation model, in which we focus on risks in general (i.e., environmental and energy security risks), and an extended Protection Motivational Model, in which we included specific indicators for environmental and energy security risks (see Fig. 2 and Section 4.2) and we consider the motivating power of two types of risks, notably environmental risks, and risks related to the security of energy supply.

4. Method

4.1. Respondents and procedure

We conducted an Internet-based questionnaire study among a large-scale sample of driving license holders in the Netherlands in June 2012 using a commercial respondent panel (www.panelinzicht.nl). The questionnaire included questions reflecting the key concepts of the Protection Motivation Theory. Besides, we included a stated choice experiment, questions on current vehicle possession and use, socio-demographics, and a number of other questions that are not relevant for the present study. On average, it took respondents about 30 min to complete the entire questionnaire. Before the large-scale data collection started, a pilot study was run to test the questionnaire in focus groups followed with in-depth interviews. At that stage, specific item formulations, general understanding of the questions, question order and overall attitude to the questionnaire were scrutinized. The adjusted version of the questionnaire was subsequently pre-tested in a soft launch stage, which proved to yield valid responses, and therefore was followed by the large-scale data collection that lasted 4 weeks. Three requirements were set to guarantee data quality and avoid non-genuine responses: (i) time spent on filling out the questionnaire of min 15 min; (ii) correct answers on 3 control questions spread throughout the questionnaire; and (iii) no straight lining in clustered items.

Only responses that had complied with all three requirements mentioned above were considered as valid and were stratified according to age, gender, income and education. The final sample ($N = 2974$) is representative of the population of car owners in the Netherlands in terms of age, and of the general Dutch population in terms of education and income distributions (see Table 1). The sample comprised slightly less people with lowest and highest income deciles compared to the population distribution; this is perhaps due to the portion of respondents (25%) who did not report their household income. Further, of the sample, 49.6% are male; mean age 47.5 ($SD = 14.03$); mean household size 2.6 ($SD = 1.21$) and mean gross household income between 30,000 and 40,000 euro per year (the latter is based on 2233 respondents who provided income information), which mirrors the census data.

4.2. Questionnaire

The questionnaire comprised items to measure the Protection Motivation Theory variables following the conceptualization of the model as explained in Sections 2.1 and 3 (see also Fig. 2). We included questions on both threat and coping appraisals that should govern electric vehicle adoption as a (more) environmentally friendly vehicle. All Protection Motivation Theory items were measured on a 6-point Likert scale. Precise question formulations are available in the Appendix and descriptive statistics for all variables are found in Table 2.

4.2.1. Threat appraisal

Threat appraisal (that is a primary appraisal) refers to the current product, a conventional vehicle fueled by gasoline, and focuses on the maladaptive behavior. Three indicators were included. As explained earlier, to measure perceived SEVERITY of problems caused by fossil fuel cars, we included 7 items reflecting environmental problems as well as energy-security problems. These measures reflect collective concerns. A confirmatory factor analysis,

Table 1
Sample socio-demographic characteristics.

	Car owners (%)[a]	Dutch population[b]	Sample
Gender (male)	n.a.	49.5%	49.6%
Age[c]			
19–25	6.7%	8.1%	6.4%
26–35	15.0%	15.7%	15.6%
36–45	21.5%	19.0%	25.9%
46–55	22.9%	19.6%	22.3%
56–65	18.4%	17.2%	15.9%
65 and older	15.5%	20.4%	14.0%
Education			
Primary or lower	n.a.	5.1%	8.1%
Secondary and vocational	n.a.	60.3%	56.6%
College and university	n.a.	33.6%	35.3%
Household income[d]			
Below €15,900	n.a.	20%	9.9%
€15,900–€22,400	n.a.	20%	14.9%
€22,400–€30,400	n.a.	20%	17.4%
€30,400–€41,000	n.a.	10%	11.0%
€41,000–€51,000	n.a.	20%	14.6%
Above €51,000	n.a.	10%	7.3%
Unknown/not reported	n.a.	–	24.9%

n.a. – not available.
[a] Source: BOVAG-RAI (2012).
[b] Source: Statistics Netherlands (CBS, 2011).
[c] Data for the Dutch population (Statistics Netherlands, 2011) is provided for the population of age 20 and older.
[d] Data on income is available from Statistics Netherlands (CBS, 2011) for disposable household income deciles (appear in the table). Our data were gathered for household gross income using the following breakdown: below €15,000; €15,001–€20,000; €20,001–€25,000; €25,001–€30,000; €30,001–€40,000; €40,001–€50,000; €50,001–€60,000; €60,001–€70,000; €70,001–€95,000; above €95,001.

the oblique multiple group method (OMG; Stuive et al., 2009; see also Section 5), revealed that the items indeed loaded on two separate factors. We computed mean scores on the following 4 items that formed a reliable scale of perceived severity of environmental risks caused by fossil fuel cars (α = .85): noise nuisance, air quality, negative environmental effects, and climate change caused by the increased concentration of greenhouse gases (M = 4.12, SD = .96). The other 3 items (partially adopted from Axsen, 2010) formed a reliable scale reflecting perceived severity of energy-security risks caused by the dependence on fossil fuels (α = .69): depletion of scarce resources, dependence on energy supplies from politically instable countries, and fluctuations in fossil fuel prices. Mean score on these 3 items were computed (M = 4.77, SD = .84). In addition, we computed mean score of all 7 severity items, which reflects the perceived severity of problems caused by fossil fuel cars. This scale has a good reliability as well (M = 4.39, SD = .79, α = .84). For specific items see Box 1.

Table 2
Descriptive statistics of dependent and independent variables.

	Mean	Min	Max	Std. dev.
Predictors				
SEVERITY	4.40	1.29	5.86	0.80
SEVERITY env.	4.12	1.00	6.00	0.96
SEVERITY energy	4.77	1.00	6.00	0.84
VULNERABILITY	3.96	1.14	5.86	0.91
VULNERABILITY env.	3.46	1.00	6.00	1.10
VULNERABILITY energy	4.62	1.00	6.00	1.00
REWARDS(cv)	4.48	1.25	5.88	0.65
Resp.EFFICACY	4.67	1.00	6.00	0.91
Resp.EFFICACY env.	4.82	1.00	6.00	0.96
Resp.EFFICACY energy	4.45	1.00	6.00	1.10
Self EFFICACY	4.15	1.25	5.88	0.90
COSTS(ev)	4.21	1.62	5.92	0.67
Independent variables				
overall EVALUATION	−0.60	−5.00	5.00	2.44
INTENTION to buy	2.83	1.00	6.00	1.26
policy ACCEPTABILITY	4.62	1.00	6.00	1.18
long-run ACCEPTABILITY	4.22	1.00	6.00	1.51

Perceived VULNERABILITY reflected the perceived likelihood that respondents would experience negative consequences themselves due to risks related to the use of conventional fuel vehicles. These measures thus reflect individual concerns. We used similar risk items as included in the severity scale. We computed mean scores on the 4 environment-related risks, reflecting the perceived vulnerability related to environmental problems caused by fossil fuels (M = 3.46, SD = 1.10, α = .85). Also, we computed mean scores of the 3 energy security risks, reflecting perceived vulnerability to energy-security risks related to the use of fossil fuel cars (M = 4.62, SD = .99, α = .81). Again, we also computed mean score on all 7 items, which reflects the perceived vulnerability to problems caused by fossil fuel cars in general (M = 3.96, SD = .91, α = .85).

The third concept relevant for threat appraisal, expected REWARDS of using fossil fuel vehicles, included 8 items reflecting functional benefits (e.g., a conventional vehicle can be used at any time if necessary), symbolic benefits (e.g., a conventional vehicle states who I am) and affective benefits (e.g., a conventional vehicle offers comfort; see Appendix 1 for a full overview of the items included). These measures reflect individual concerns. To serve the purposes of current analysis we computed mean scores on these 8 items, reflecting the aggregated rewards derived from the use of fossil fuel vehicles (M = 4.48, SD = .65, α = .75).

Box 1. Items used for measuring perceived severity, perceived vulnerability and perceived response efficacy

ENVIRONMENTAL risks
- Noise nuisance
- Air pollution
- Environmental problems
- CO_2 emissions and climate change

ENERGY SECURITY risks
- Exhaustion of fossil
- Dependency on other countries in fossil fuel imports
- Volatility in fossil fuel prices

4.2.2. Coping appraisal

Following our conceptualization of the Protection Motivation Theory as described in Section 2.2, coping appraisal (that is, secondary appraisal) refers to the new product, a full electric vehicle, and thus focuses on the adaptive behavior. We included three indicators of coping appraisal.

First, to measure perceived RESPONSE COSTS, we included 13 items reflecting perceived individual costs connected to the use of an electric vehicle, including functional aspects (such as high purchasing price, limited range, long charging times, high frequency of charging, behavioral changes related to the use of an electric vehicle) and uncertainty aspects (concerning the battery, reduced road safety, maintenance costs and the resale price of an electric vehicle). These measures reflect individual concerns. We computed mean scores on these 13 items ($M = 4.20$, $SD = .67$, $\alpha = .79$).

SELF-EFFICACY was measured with 8 items reflecting the perceived ability to adjust one's behavior as to be able to drive an electric vehicle, including resourcefulness in finding alternatives like taking shorter routes, arranging alternative transportation for long trips, and charging such as readiness to make use of charging possibilities at home, at work and in public places. These measures reflect individual concerns. We computed mean scores on these 8 items ($M = 4.15$, $SD = .90$, $\alpha = .66$).

RESPONSE EFFICACY was measured with 8 items reflecting the potential of electric vehicles to solve or avoid problems caused by the conventional car; this measure reflects collective concerns. We included items reflecting the same risks as those used in the vulnerability and severity scales (see Box 1). Hence, 4 items reflected whether electric vehicles would reduce environmental problems caused by conventional vehicles ($M = 4.82$, $SD = .96$, $\alpha = .81$), while 3 items reflected whether electric vehicles would enhance security of energy supply ($M = 4.45$, $SD = 1.10$, $\alpha = .77$). Again, we also computed the mean score on all 7 response efficacy items, reflecting whether respondents believed that electric vehicles would reduce problems caused by conventional fuel vehicles in general ($M = 4.67$, $SD = .91$, $\alpha = .85$).

4.3. Dependent variables

At the moment adoption of electric vehicles in the Netherlands is found in its early stage. Indeed, as of July 2012, there were about 1400 electric vehicle registrations in the Netherlands while the total private car fleet amounts to about 8 million cars (BOVAG-RAI, 2013). This means that at this stage, the majority of population is not using or is even not familiar with electric vehicles. Therefore, we included a number of indicators that reflect various phases of adoption, namely overall evaluation of an electric vehicle, intention to purchase an electric vehicle when buying a next car, acceptability of an electric vehicle as a substitute for a fossil fuel car in the long-run, and acceptability of policy instruments directed at facilitation of electric vehicle purchase and use. All items reflecting the dependent variables (i.e., the different indicators of adoption) were measured on a 6-point Likert scale (from 0 – totally disagree to 5 – totally agree) unless mentioned otherwise.

Respondents first provided their OVERALL EVALUATION of an electric vehicle considering all its advantages and disadvantages on the scale of -5 (an electric vehicle has predominantly disadvantages), 0 (the advantages and disadvantages are about equal) to +5 (an electric vehicle has predominantly advantages). Mean score for this question is just below zero ($M = -.6$, $SD = 2.44$), suggesting that on average respondents think electric vehicles possess slightly more disadvantages than advantages.

INTENTION to purchase an electric vehicle was measured with the following 3 items: being interested in an electric vehicle; considering an electric vehicle when purchasing a next car; and intending to purchase an electric vehicle. We computed mean scores on these three items, which formed a reliable scale ($M = 2.83$, $SD = 1.26$, $\alpha = .83$).

LONG-RUN electric vehicle ACCEPTABILITY reflected the acceptability of electric vehicle adoption in general in the long run (one item). More particularly, respondents indicated to what extent they found it acceptable that electric vehicles should replace fossil fuel vehicles in the long run ($M = 4.22$, $SD = 1.51$).

POLICY ACCEPTABILITY reflected the acceptability of policies aimed to promote the use of electric vehicles and included the following 4 items: acceptability of policies aimed to stimulate (a) purchase and (b) use of electric vehicles; and acceptability of subsidizing the (a) purchase (via upfront cost reductions) and (b) use of electric vehicles (via road tax exemptions). We computed mean scores on these items, which formed a reliable scale ($M = 4.62$, $SD = 1.18$, $\alpha = .90$).

4.4. Analyses

We ran a series of regression analyses to test to what extent the Protection Motivation Theory is successful in predicting the 4 different indicators of adoption of electric vehicles. We have tested two model formulations, following our reasoning above. We first estimated the basic Protection Motivation model which included the overall scales of severity, vulnerability, and response efficacy, including all 7 generalized risk items (see Box 1). Next, to study to what extent environmental versus energy security risks motivate consumers to adopt an electric vehicle, we ran the same models including the two different risk indicators of severity, vulnerability, and response efficacy separately, reflecting environmental risks versus energy security risks, respectively. These are referred to as extended model (note that no *additional* variables were used in the extended models, but that the severity, vulnerability, and response efficacy scales were split in two subscales each in this case with specific risk items). We tested the models via multiple regression analyses, and report standardized regression coefficients to examine the relative importance of the different Protection Motivation Theory variables in explaining the adoption indicators.

5. Results

Before testing the Protection Motivation Theory models, we first checked bivariate correlations between the independent variables, and conducted a confirmatory factor analysis to examine whether the Protection Motivation Theory variables can indeed be distinguished empirically, as to ensure that statistical analyses do not suffer from estimation biases. Table 3 shows bivariate correlations among the independent variables, and between the independent and dependent variables of the basic Protection Motivation Theory model. Table 4 presents the bivariate correlations between Protection Motivation Theory variables and dependent variables included in the extended models. Most bivariate correlations between independent variables are below 0.5, which implies that they do not strongly overlap. Somewhat stronger bivariate correlations were observed between the severity and vulnerability constructs ($r = 0.64$), and between the environmental and the energy-related aspects of these two concepts ($r = 0.59$ and $r = 0.64$, respectively). Neither of bivariate correlation, however, exceeds the critical 0.75 threshold, which indicates that multicollinearity problems are unlikely. More importantly, a confirmatory factor analysis, the oblique multiple group method (OMG; Stuive et al., 2009), revealed that all Protection Motivation Theory variables can indeed be distinguished empirically. This indicates that the theoretical distinction between the variables included in the Protection Motivation

Table 3
Correlations between dependent and independent variables: basic Protection Motivation model with general risk indicators.

	Var. nr.	1	2	3	4	5	6	7	8	9
SEVERITY	1									
VULNERABILITY	2	0.637								
REWARDS(cv)	3	−0.123	−0.112							
Resp.EFFICACY	4	0.435	0.339	−0.048						
Self EFFICACY	5	0.128	0.113	0.058	0.156					
COSTS(ev)	6	−0.091	−0.054	0.278	−0.108	−0.022				
overall EVALUATION	7	0.298	0.254	−0.243	0.299	0.154	−0.475			
INTENTION to buy	8	0.341	0.299	−0.263	0.285	0.183	−0.410	0.642		
policy ACCEPTABILITY	9	0.379	0.287	−0.122	0.435	0.210	−0.221	0.392	0.482	
long-run ACCEPTABILITY	10	0.402	0.313	−0.196	0.345	0.159	−0.225	0.371	0.565	0.521

Theory is validated empirically, and that all measured Protection Motivation Theory variables reflect different constructs.

5.1. Predictive power of the basic Protection Motivation Theory including general indicators of risks

We first tested to what extent the Protection Motivation Theory variables (including the aggregate constructs of severity, vulnerability, and response efficacy) predicted the four indicators of adoption, that is, overall electric vehicle evaluation, intention to buy an electric vehicle, long-run electric vehicle acceptability and acceptability of policy directed at facilitation of electric vehicle adoption, respectively (see Table 5). All four models show a good fit (adjusted R^2 vary between 0.25 and 0.34), and importantly, in all models all Protection Motivation Theory constructs significantly contributed to the explanation of electric vehicle adoption, in the expected direction. The only exception is that own vulnerability to risks posed by the use of conventional vehicle did not significantly contribute to the explanation of policy acceptability.

In all four models, higher perceived risk severity posed by the use of conventional vehicles promotes the adoption of electric vehicles. Also, higher perceived own vulnerability to existing risks results in more positive evaluations of electric vehicles, stronger intentions to buy an electric vehicle and higher long-run acceptability of electric vehicles. As expected, higher perceived rewards associated with a conventional vehicle negatively affect adoption of electric vehicles in all four models. Response efficacy, that is, the extent to which electric vehicles are believed to be effective in reducing environmental and energy security risks is positively associated with their adoption. Also, in all models higher perceived self-efficacy to adjust to electric vehicle use facilitates adoption. Finally, Dutch drivers are less likely to adopt an electric vehicle when they expect high monetary and non-monetary costs associated with electric vehicle purchase and use.

In determining the two ‘close’ measures of adoption (i.e., evaluation of an electric vehicle, and intentions to buy an electric vehicle, see models 1 and 2, see Table 5), both collective and individual concerns are prominent. Yet, electric vehicle evaluation and the intention to buy an electric vehicle particularly depend on perceived costs associated with electric vehicle possession (reflecting individual concerns) that act as a barrier to adoption, as reflected in the highest standardized regression coefficients. The second strongest predictor of electric vehicle evaluation (model 1, ibid) is response efficacy, that is, the extent to which electric vehicle use is believed to avoid or diminish the negative effects caused by the use of conventional fossil fuel vehicles (reflecting collective concerns). For the intention to purchase an electric vehicle (model 2, ibid), alongside with the negative effect of cost, also higher rewards associated with the use of a conventional vehicle substantially inhibit electric vehicle adoption (also reflecting individual concerns). Further, severity of negative effects of the use of conventional fossil fuel vehicles and self-efficacy in adjusting to electric vehicle use contribute positively to the intention to buy an electric vehicle; vulnerability and response efficacy followed them closely in predicting purchase intention.

For the two ‘distant’ measures of electric vehicle acceptability (i.e., long-run electric vehicle acceptability and policy acceptability, see models 3 and 4, ibid), again both collective and individual concerns are important predictors. However, the picture is somewhat different. Here, costs of electric vehicle possession (reflecting individual concerns) play a less prominent role. Rather, severity of threat posed by the use of conventional fossil fuel vehicles is the strongest predictor of long-run electric vehicle acceptability followed by perceived response efficacy, both reflecting collective concerns. For policy acceptability, response efficacy is the most important predictor, followed by perceived severity, again both reflecting collective concerns.

Table 4
Correlations between dependent and independent variables: extended Protection Motivation model with specific risk indicators.

	Var. nr.	1	2	3	4	5	6	7	8	9
SEVERITY env.	1									
SEVERITY energy	2	0.511								
VULNERABILITY env.	3	0.585	0.339							
VULNERABILITY energy	4	0.370	0.641	0.486						
REWARDS(cv)	5	−0.154	−0.036	−0.116	−0.070					
Resp.EFFICACY env.	6	0.409	0.304	0.284	0.246	−0.058				
Resp.EFFICACY energy	7	0.292	0.330	0.229	0.292	−0.026	0.584			
Self EFFICASY	8	0.108	0.118	0.084	0.118	0.058	0.162	0.112		
COSTS(ev)	9	−0.140	0.013	−0.077	−0.002	0.278	−0.121	-0.067	−0.022	
overall EVALUATION	10	0.317	0.174	0.257	0.168	−0.243	0.288	0.241	0.154	−0.475
INTENTION to buy	11	0.336	0.241	0.264	0.253	−0.263	0.284	0.219	0.183	−0.410
policy ACCEPTABILITY	12	0.353	0.298	0.241	0.262	−0.122	0.413	0.357	0.210	−0.221
long-run ACCEPTABILITY	13	0.368	0.326	0.247	0.307	−0.196	0.338	0.272	0.159	−0.225

Table 5
Regression of four adoption indicators on Protection Motivation Theory variables (basic Protection Motivation model).

	overall EVALUATION (model 1)				INTENTION to buy (model 2)				policy ACCEPTABILITY (model 3)				long-run ACCEPTABILITY (model 4)			
	b	s.e.	std.beta		*b*	s.e.	std.beta		*b*	s.e.	std.beta		*b*	s.e.	std.beta	
(Constant)	*1.925*	*0.425*		**	*3.491*	*0.223*		**	*2.170*	*0.215*		**	*2.278*	*0.281*		**
SEVERITY	0.346	0.062	0.113	**	0.242	0.033	0.153	**	0.276	0.031	0.187	**	0.457	0.041	0.240	**
VULNERABILITY	0.226	0.052	0.084	**	0.156	0.027	0.113	**	0.049	0.026	0.038		0.110	0.034	0.067	**
REWARDS(cv)	−0.388	0.059	−0.103	**	−0.271	0.031	−0.140	**	−0.083	0.030	−0.045	**	−0.268	0.039	−0.115	**
Resp.EFFICACY	0.419	0.045	0.155	**	0.161	0.024	0.116	**	0.391	0.023	0.301	**	0.304	0.030	0.182	**
Self EFFICACY	0.277	0.041	0.102	**	0.186	0.022	0.133	**	0.176	0.021	0.134	**	0.161	0.027	0.096	**
COSTS(ev)	−1.499	0.057	−0.413	**	−0.629	0.030	−0.336	**	−0.271	0.029	−0.154	**	−0.330	0.038	−0.146	**
adjusted R^2	*0.337*				*0.317*				*0.279*				*0.249*			
df	*2973*				*2973*				*2973*				*2973*			
F	*253.16*				*230.66*				*192.44*				*165.21*			

** Estimated standardized regression coefficient is statistically significant at 5% level.

5.2. Predictive power of the extended Protection Motivation Theory model including specific indicators of environmental and energy security risks separately

Next, we analyzed the extended Protection Motivation model, in which we included environmental and energy security related risks as separate indicators of severity, vulnerability and response efficacy, respectively, in the multiple regression analyses. Not surprisingly, the fit of the models is similar to the overall models: the adjusted R^2 remained the same for all dependent variables, with a slight increase for the model predicting long-run acceptability (see Table 6). Again, most Protection Motivation Theory predictors significantly contributed to the different indicators of electric vehicle adoption.

Results of the extended models (Table 6) reveal a number of important findings. First, our estimated models show that there are two major barriers to adaptive behavior as postulated by the Protection Motivation Theory, and that both of them are important to individual decision-making. On the one hand, these are higher perceived monetary, functional and symbolic rewards associated with conventional vehicles; on the other hand, these are higher perceived monetary and non-monetary costs of an electric vehicle that inhibit electric vehicle adoption for Dutch drivers. Interestingly, particularly perceived expected costs of electric vehicles and to a lesser extent the perceived benefits of a conventional vehicle (both reflecting individual concerns) are strong obstacles for the 'close' adoption measures (i.e., evaluation of electric vehicles, and intention to buy an electric vehicle, see models 1 and 2, ibid), but exert less negative influence on the two 'distant' adoption measures reflecting acceptability (models 3 and 4, ibid).

Second, among motivators of adaptive behavior, environmental risks such as air pollution, noise and CO_2 emissions caused by conventional vehicles play in general a more prominent role in electric vehicle adoption than energy-security related risks. For all four included measures of adoption (models 1–4, ibid), perceived severity of environmental risks associated with the use of conventional fuel vehicles, and perceived response efficacy related to environmental risks (i.e., the belief that adoption of an electric vehicle would decrease or avoid these environmental risks) are significant predictors of electric vehicle adoption in the Netherlands, while energy security risks seem to play a less dominant role in decision-making with regard to electric mobility (as reflected in lower and even sometimes non-significant standardized regression coefficients). Interestingly, environmental risks seem to more strongly determine 'close' measures of adoption (i.e., overall evaluation of electric vehicles and the intention to buy one, models 1 and 2, ibid) as reflected in perceived severity, vulnerability and response efficacy than energy security risks do. At the same time, both environmental and energy-security risks predict the more 'distant' measures of adoption (i.e., long-run vehicle acceptability and policy support, models 3 and 4, ibid) as reflected in perceived risk severity and response efficacy.

Finally, the results of the extended models with specific risk items show that alongside with environmental risks, another important determinant of adoption is the higher perceived own capability to fit an electric vehicle to the traveling needs and to

Table 6
Regression of four adoption indicators on Protection Motivation Theory variables specifying environmental and energy security risks (extended Protection Motivation model).

	overall EVALUATION (model 1)				INTENTION to buy (model 2)				policy ACCEPTABILITY (model 3)				long-run ACCEPTABILITY (model 4)			
	b	s.e.	std.beta		*b*	s.e.	std.beta		*b*	s.e.	std.beta		*b*	s.e.	std.beta	
(Constant)	*2.046*	*0.428*		**	*3.430*	*0.224*		**	*2.111*	*0.216*		**	*2.118*	*0.282*		**
SEVERITY env.	0.278	0.054	0.110	**	0.156	0.028	0.120	**	0.164	0.027	0.134	**	0.263	0.036	0.167	**
SEVERITY energy	0.053	0.063	0.018		0.068	0.033	0.045	**	0.099	0.032	0.071	**	0.166	0.042	0.092	**
VULNERABILITY env.	0.192	0.045	0.086	**	0.048	0.023	0.042	**	−0.010	0.023	−0.010		−0.044	0.029	−0.032	
VULNERABILITY energy	0.016	0.052	0.006		0.126	0.027	0.100	**	0.076	0.026	0.064	**	0.199	0.034	0.131	**
REWARDS(cv)	−0.377	0.059	−0.101	**	−0.269	0.031	−0.139	**	−0.082	0.030	−0.045	**	−0.268	0.039	−0.115	**
Resp.EFFICACY env.	0.221	0.050	0.087	**	0.125	0.026	0.095	**	0.250	0.025	0.203	**	0.235	0.033	0.148	**
Resp.EFFICACY energy	0.199	0.042	0.089	**	0.038	0.022	0.034		0.143	0.021	0.133	**	0.072	0.028	0.052	**
Self EFFICASY	0.283	0.041	0.104	**	0.182	0.022	0.130	**	0.173	0.021	0.132	**	0.153	0.027	0.091	**
COSTS(ev)	−1.478	0.057	−0.407	**	−0.628	0.030	−0.335	**	−0.272	0.029	−0.155	**	−0.338	0.038	−0.150	**
adjusted R^2	*0.340*				*0.318*				*0.280*				*0.257*			
df	*2973*				*2973*				*2973*				*2973*			
F	*170.80*				*154.88*				*129.60*				*115.01*			

** Estimated standardized regression coefficient is statistically significant at 5% level.

perform charging routines (perceived self-efficacy). Higher self-efficacy is associated with a higher policy acceptability, more positive electric vehicle evaluation, and higher intention to buy an electric vehicle (models 1–3, ibid).

6. Discussion and conclusions

6.1. General conclusions

Contemporary societies are facing serious environmental risks. Research provides a record of evidence that in order to manage, and especially to decrease environmental risks, behavior change is needed. One of the main questions in this respect is: What motivates people to change their behavior to reduce these risks by engaging in pro-environmental actions? Protection Motivation Theory lends itself as a suitable theoretical framework to understand what governs individual attitudes and behavioral change. The basic idea of the Protection Motivation Theory framework is that individual motivation is governed by the recognition of existing risks and the perception of the ability to cope with the risks in question. The added value of Protection Motivation Theory in understanding pro-environmental behavior is its focus on the costs and benefits of current (maladaptive) behavior as well as prospective adaptive behavior, both of which are just as relevant to the decision-making process. In the environmental risk domain, the Protection Motivation Theory has mainly been used to understand behavior related to acute risks (such as natural hazards like forest fires or floods). However, to our knowledge, it has not yet been applied to model behavior in the context of slow-onset environmental risks such as air and water pollution, noise, climate change or exhaustion of natural resources. In this paper, we aimed to test whether Protection Motivation Theory is indeed successful in explaining pro-environmental behavior in the context of decreasing a slow onset risk. As a case in point, we considered adoption of electric vehicles in the Netherlands, which is expected to address environmental and energy security problems related to the use of conventional fuel vehicles.

We first proposed how key Protection Motivation Theory concepts can be conceptualized with regard to behavioral responses to slow onset risks. As a case in point, we focused on the adoption of electric vehicles. Threat appraisal of Protection Motivation Theory is proposed to refer to a current risky product or practice that has its advantages but essentially brings negative environmental effects, which in turn also may yield negative consequences to self (at least in the longer term). Threat appraisal depends on perceived severity of and perceived vulnerability to risks caused by the maladaptive behavior (in this case conventional vehicles), and expected rewards of the maladaptive behavior. Alternatively, coping appraisal of Protection Motivation Theory can be seen as referring to a new, sustainable product or practice, which comes at a cost, but may reduce or help avoid negative environmental effects, provided that individuals see themselves capable of adopting this new product or practice. Coping appraisal depends on perceived response efficacy (i.e., does the adaptive behavior, in this case, an electric vehicle, reduce the risks) and self-efficacy (i.e., can I engage in the adaptive behavior), and perceived costs of the adaptive behavior.

Next, we tested the predictive power of the Protection Motivation Theory in explaining adoption of electric vehicles using data from a large-scale questionnaire study among a representative group of Dutch car drivers. To test the robustness of our findings we included four different indicators of electric vehicle adoption. Two types of dependent variables were used in our analyses to measure various dimensions of adoption intention: (i) 'distant' measures of adoption (electric vehicle acceptability as replacement for a conventional fossil fuel car in the long run, and acceptability of policy supporting electric vehicle adoption); and (ii) 'close' measures of adoption (overall electric vehicle evaluation and intention to purchase an electric vehicle).

A first relevant finding is that we succeeded in constructing Protection Motivation Theory concepts that included relevant indicator items resulting in highly reliable scales. Moreover, confirmative factor analyses validated the theoretical distinction between the Protection Motivation Theory variables, suggesting that the variables indeed reflect different constructs. Future research should test the robustness of our findings, by testing the Protection Motivation Theory in other environmental domains.

Second, the Protection Motivation Theory proved to be successful in explaining all four different indicators of adoption included in our study. Importantly, all Protection Motivation Theory variables appeared to uniquely contribute to the explanation of the four different indicators of adoption of electric vehicles (see Table 5). More specifically, all of the Protection Motivation Theory variables turned to be statistically significant predictors of the adoption indicators in the expected direction, with one minor exception in modeling policy acceptability, suggesting that our results are robust. In line with our expectations, adoption of electric vehicles is more likely the more people perceive problems caused by conventional fossil fuel vehicles as severe, the more they feel vulnerable to these problems, the less favorably they evaluate the advantages of fossil fuel cars (all reflecting high threat appraisal); and the more they think electric vehicles can potentially solve the problems caused by conventional vehicles, the more they feel able to drive an electric vehicle, and the less negative they evaluate the disadvantages of electric vehicles (all reflecting high coping appraisal). This suggests that consumers appear to consider all concepts included in Protection Motivation Theory for electric vehicle adoption (although not necessarily deliberately, as mentioned in Section 2.1 of this paper), and hence take account of individual and collective consequences of adaptive as well as maladaptive behaviors when making pro-environmental choices. As explained in Section 1, prominent theories in environmental psychology (e.g., the Theory of Planned behavior, Norm Activation Model and Value-Belief-Norm Theory) tend to focus on costs and benefits of the adaptive behavior. Yet, our results reveal that individuals seem to consider the perceived benefits of (current) maladaptive behavior as well, which appeared to inhibit electric vehicle adoption. These findings demonstrate the contribution of Protection Motivation Theory to our understanding of what motivates people to engage in action to mitigate slow onset risks. Future studies could explicitly compare the predictive power of various theories to further examine the added value of the Protection Motivation Theory.

Furthermore, our results reveal that both individual and collective considerations are relevant predictors of 'close' and 'distant' indicators of electric vehicle adoption (see Tables 5 and 6). Our findings thus confirm persistent evidence in psychological literature that next to individual considerations, collective considerations are important for motivating pro-environmental actions to mitigate slow onset risks (Lindenberg and Steg, 2007; Steg and De Groot, 2012; Steg, 2012). Collective considerations such as severity of environmental and energy security risks posed by the use of conventional vehicles and beliefs that electric vehicles can mitigate these problems (response efficacy) appeared to be particularly important in governing the 'distant' adoption indicators (i.e., long-run electric vehicle acceptability and policy acceptability). Yet, individual considerations (like costs and benefits) seem to be relatively stronger motivators for the 'close' adoption indicators (i.e., overall evaluation of electric vehicles and intention to purchase an electric vehicle) than collective consideration. Future research could study whether these findings can be replicated in other domains, as well as the conditions under which individual and collective considerations affect pro-environmental behaviors.

A number of similarities were found in the predictive power of the Protection Motivation Theory variables across the four indicators of adoption. Two determinants of maladaptive behavior were found to be particularly important (see Table 5). Perceived benefits or advantages associated with the use of conventional vehicles have a negative effect on electric vehicle adoption, and include the possibility to use the conventional vehicle for all trips at any time; the convenience of existing infrastructure and the fact that drivers feel at ease in a conventional vehicle. These benefits especially weaken the intention to adopt an electric vehicle and reduce long-run electric vehicle acceptability. Also, costs or disadvantages associated with electric vehicle possession and use such as high purchasing price, high charging times, frequent charging, underdeveloped charging infrastructure and uncertainties related to the duration and performance of the battery appear to be substantial barriers for two 'close' measures of adoption, that is, the evaluation of electric vehicles and the intention to purchase one, but appeared to be relatively less impeding for the 'distant' measures of adoption, that is, long-run electric vehicle acceptability and acceptability of policies aimed to promote the adoption of electric vehicles. Another consistent predictor of different indicators of adoption of electric vehicles is the perceived self-efficacy related to managing charging routines and trips to be made. Self-efficacy is a significant predictor of all four adoption indicators included in this study, including 'close' and 'distant' measures of adoption.

Next, we examined which types of risks most strongly motivate adoption of electric vehicles. In this respect, we distinguished between environmental risks and risks related to security of energy supply (see Table 6). Our findings indicate that perceptions related to environmental risks proved to significantly motivate adaptive behavior: perceived severity of negative environmental impacts of conventional vehicles on air pollution, noise, CO_2 emissions and climate change and perceived ability of electric vehicles to reduce these problems all predicted the four indicators of adoption of electric vehicles; while perceived personal vulnerability to the consequences of these impacts predicted two 'close' indicators of adoption. This finding is in line with results from other studies that repeatedly found that environmental risks are important determinant of pro-environmental behavior such as electric vehicle adoption (e.g., Kahn, 2007; Ozaki and Sevastyanova, 2011). At the same time, not all Protection Motivation Theory predictors related to energy security risks represented by depletion of oil resources, dependency on other countries in fossil fuel imports and fuel price volatility (again, for severity of impacts caused by conventional vehicles, perceived own vulnerability to their consequences and the effectiveness of electric vehicle to decrease these impacts) turned to be significant determinants of different indicators of electric vehicle adoption. In fact, generally, compared to perceptions related to environmental risks, perceptions related to energy-related risks appear to exert a stronger and more significant influence on the two 'distant' adoption indicators. This suggests that energy security risks are less prominent determinants of pro-environmental behavior than are environmental risks for the 'close' adoption indicators; while they are more prominent determinants of pro-environmental behavior for the 'distant' adoption indicators. Future research should test the significance of environmental risks and energy security risks for pro-environmental actions in other domains in relation to slow-onset risk mitigation.

6.2. Policy implications

Our findings have important implications for policy concerning adoption of desirable behaviors and behavioral change that mitigate slow onset risks. First, our results suggest that in order to increase public acceptability and adoption of electric vehicles, environmental advantages of electric mobility should be stressed. In particular, highlighting the severity of negative environmental impacts resulting from the use of conventional vehicles, such as air pollution, noise and CO_2 emissions, and elaborating in which way electric vehicles are effective in decreasing or even avoiding such negative environmental impacts are likely to enhance long-run electric vehicle acceptability, the evaluation of the attractiveness of electric vehicles and the intention to buy an electric vehicle. It is important however to bear in mind that individual perception of the extent to which electric vehicle can reduce environmental problems is brought in connection with the way electricity is generated (as evidenced from the pilot of this study). While this finding is yet suggestive and deserves further exploration, it points at desirability of switching to renewable sources of energy in view of increasing electric vehicle effectiveness especially if broad adoption of electric mobility is expected.

Another effective intervention may include removing barriers to adoption of electric vehicles, which proved to be particularly important for electric vehicle acceptability and the intention to purchase electric vehicles. The majority of such barriers are essentially non-monetary costs that are connected to the battery (uncertainty with respect to its lifetime, limited range and long charging time) and charging infrastructure. While the battery in itself and its improvements lie in the technology domain, charging infrastructure is one of the factors that can be improved on the spot. Research has shown that countries with well-developed charging infrastructure before the introduction of electric vehicles to the market tend to have higher electric vehicle adoption rates (Sierzchula, 2012). Availability of fast charging points decreases driver uncertainty about electric vehicle's range and as a consequence are related to the increased use of electric vehicles (Anegawa, 2010; besides, more insights into the perception of range see Franke et al., 2012). Furthermore, research findings suggest that decreased time associated with charging, including shorter detour times, is highly appreciated by car drivers (Bockarjova et al., 2013). Therefore, improved charging infrastructure, both for the availability of slow and fast charging points, should enhance perceived self-efficacy in adopting electric vehicle, which should in turn lead to higher electric vehicle acceptability and adoption intention. At the same time, high adopter numbers shall ensure the economies of scale and profitability of charging facilities in the light of high costs associated with the installation of charging infrastructure (Schroeder and Traber, 2012).

Furthermore, building on the two previous implications, we notice that individual choices are embedded in a more general, collective context. This implies that not only individual behavioral change, but also changes in collective customs are necessary to ensure a successful adoption of pro-environmental practices (Schwanen et al., 2012). Here, such scenarios can be considered as making adoption of electric vehicle a part of integrated efforts to move to a more sustainable society. Such efforts may include, among others, transition to sustainable electricity sources, decentralization of electricity production, off-peak electricity storage in the framework of security of electricity supply (such as vehicle-to-grid construction, Sovacool and Hirsh, 2009), and development of charging infrastructure. All of these elements can in turn be embedded within sustainable built residential and business environments, where electric vehicle is no more a mere means of transport, but becomes a part of a new lifestyle and obtains new functionalities.

6.3. Future research

This study is a first one in applying Protection Motivation Theory framework to the domain of slow onset environmental risks. The Protection Motivation Theory appeared to be a relevant framework to predict pro-environmental behavior, such as electric vehicle adoption. Future studies need to test whether Protection Motivation Theory can be used to predict other types of pro-environmental actions related to such slow onset risks as energy savings, recycling, or eco-driving. Another important direction for future research is to explore the relative merits and effectiveness of various theoretical frameworks used in modeling pro-environmental behavior (for example, comparing Protection Motivation Theory to the widely used Norm Activation Model or Theory of Planned Behavior). As discussed above, Protection Motivation Theory includes a broader set of indicators than these theories, and our studies shows that all these indicators contribute to the explanation of variation in various adoption indicators. Future studies should test whether Protection Motivation Theory is more predictive of different types of pro-environmental behavior, including electric vehicle adoption, than other theoretical models including the Norm Activation Model, the Value-Belief-Norm Theory of environmentalism, or Theory of Planned Behavior.

Besides, the conceptualization of the Protection Motivation Theory in the domain of slow-onset risks should be tested further. Confirmatory factor analyses revealed that all Protection Motivation Theory variables could be clearly distinguished empirically in our study. Future research should examine whether these results can be replicated in different domains.

Finally, future research could test other versions of the Protection Motivation Theory with additional variables. For example, the Protection Motivation Theory focuses on perceived costs of pro-environmental products or practices. Interestingly, recent research suggests that environmentally-friendly alternative vehicles such as electric vehicles may also have some benefits that can promote their adoption. Notably, symbolic factors such as identity and status considerations may promote adoption of electric vehicles: electric vehicles enable people to enhance their status or express their identity (Noppers et al., 2014; Schuitema et al., 2013; Axsen and Kurani, 2012). Future studies could test whether including perceived benefits of risk protective behavior would enhance the predictive power of the Protection Motivation Theory.

In sum, our study was a first test of the Protection Motivation Theory in the domain of slow-onset risks. It has shown that the theory is relevant in predicting adaptive behaviors, with unique contribution of all Protection Motivation Theory variables, and lends itself as a promising area for future research.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:10.1016/j.gloenvcha.2014.06.010.

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