Ecological Economics 152 (2018) 51–61

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Analysis

Divesting, Fast and Slow: Affective and Cognitive Drivers of Fading Voter Support for a Nuclear Phase-Out

Adrian Rinscheid[a,b,*], Rolf Wüstenhagen[a]

[a] Chair for Management of Renewable Energies, University of St. Gallen, Tigerbergstrasse 2, CH 9000 St. Gallen, Switzerland
[b] Woodrow Wilson School of Public & International Affairs, Princeton University, Andlinger Center, 86 Olden Street, Princeton, NJ 08544, USA

ARTICLE INFO

Keywords:
Divestment
Nuclear power
Voting behavior
Dual-process models
Affect heuristic
Asymmetric dominance effect

ABSTRACT

Overcoming reliance on non-renewable resources is a key concern of energy transitions worldwide. But as the literature on carbon lock-in has shown, overcoming path dependence is all but trivial. Even well-minded decision-makers tend to relapse into inertia when it comes to making concrete divestment decisions. We investigate one specific case, the 2016 Swiss popular initiative to phase out nuclear power, to explore the cognitive and affective drivers of energy path dependence on the individual level. Within eight weeks of an intense political campaign, support for this initiative dropped from more than 60 to just 45.8% of Swiss voters. Based on a representative longitudinal survey ($N = 1014$), we show that changes in perceived risk and benefit of nuclear power play key roles in explaining fading voter support for nuclear divestment, and that affect is in turn a significant driver of those changes. By framing it as a choice between the lesser evil of nuclear power or importing German coal power, opponents of the phase-out managed to introduce an asymmetrically dominated option into voters' choice set, leading many to change their original voting intentions. Our paper responds to calls for integrating dual-process theories ("*thinking fast and slow*") into research in Ecological Economics.

1. Introduction

The transition to a sustainable energy future requires two distinct processes: *Investing* in new energy technologies (such as solar and wind power), and *divesting* from unsustainable infrastructure of the past. While the former has received a lot of attention in policy circles and academic literature over the last decades, the latter has more recently made it to the headlines in the context of divesting from fossil fuels. Unlike fossil fuels, nuclear power is not a major contributor to climate change, but in the aftermath of the 2011 Fukushima accident and the bankruptcies of Tepco and Toshiba Westinghouse, questions about the ecological and financial sustainability of the nuclear industry have re-emerged with renewed intensity.

One of the countries that have started to rethink the role of nuclear power is Switzerland, where the world's oldest fleet of nuclear reactors contributes about one third of national power generation. Shortly after the Fukushima accident, the Swiss Green Party had launched a popular initiative to divest from nuclear power. The initiative proposed a ban on new nuclear power plants and a timeline for phasing out existing reactors between 2017 and 2029. It was submitted to a popular vote in November 2016. Opinion polls two months ahead of the vote indicated a solid majority of voters in favor of the proposal, but their support continuously faded during the political campaign until the initiative was finally rejected by a majority of voters.[1] What makes several hundred thousand voters[2] change their opinion from supporting to rejecting divestment from nuclear power in just eight weeks?

The current paper draws on recent literature in economic psychology to explore whether dual-process theories of human behavior can shed light on this question. It thereby relates to the wider issue of how fading support for divesting from unsustainable infrastructure can be explained, and possibly prevented. Especially, we seek to explore whether the changes in voting intentions represent a case of

* Corresponding author at: University of St. Gallen, Chair for Management of Renewable Energies, Tigerbergstrasse 2, CH 9000 St. Gallen, Switzerland.
E-mail addresses: adrian.rinscheid@unisg.ch (A. Rinscheid), rolf.wuestenhagen@unisg.ch (R. Wüstenhagen).
URL: http://www.iwoe.unisg.ch (A. Rinscheid).

[1] In another referendum half a year after the nuclear phase-out vote analyzed in this paper, Swiss voters accepted the "Energy Strategy 2050" with a 58% majority. This policy package, which had been proposed by the federal government, included a ban on constructing new nuclear power plants, but initial proposals to limit the operating life of existing reactors had been eliminated by the conservative majority in Parliament.

[2] 2.4 million voters participated in the referendum. Based on our survey, 61.2% of Swiss voters had supported the initiative eight weeks ahead of the vote, but only 45.8% supported it in the popular vote. The 15.4 percentage point decline in support for the initiative thus translates into nearly 370,000 votes. https://www.admin.ch/ch/d/pore/va/20161127/det608.html (accessed 31.08.17).

https://doi.org/10.1016/j.ecolecon.2018.05.015
Received 21 September 2017; Received in revised form 6 March 2018; Accepted 24 May 2018
Available online 05 June 2018
0921-8009/

the affect heuristic (Finucane et al., 2000; Slovic et al., 2004), which postulates that emotional and cognitive factors interact in decision-making. In contrast to experimental research in the lab or surveys in hypothetical settings, our research approach is unique in that we measure voter preferences and behavior in a real-life setting. A heated political campaign and the fact that voters actually had to come to a binary conclusion (either voting yes or no) create a decision-context that allows for both affective and cognitive considerations to occur.

Our research is part of a lively debate on overcoming path dependence (Goldstone, 1998; North, 1990), status-quo bias (Samuelson and Zeckhauser, 1988), inertia (Henderson, 2006) and procrastination (Andreou, 2007) in the energy sector (Lovio et al., 2011; Simmie, 2012; Wüstenhagen and Teppo, 2006). In a broad sense, path dependence describes the fact that past events have an impact on present choices. On a systemic level, this can lead to phenomena like carbon lock-in (Unruh, 2000), a situation that has been described by former U.S. president George W. Bush as an "addiction to oil". The idea to look at individual-level phenomena like addiction as potential sources of inspiration for explaining and overcoming system-level sustainability challenges has also recently been promoted in this journal (Costanza et al., 2017). We contribute to this debate by looking at the micro-foundations of nuclear lock-in.

2. Literature Review and Hypotheses

In traditional models of rational choice, the decision-maker is conceptualized as *homo oeconomicus*, a perfectly informed actor who rationally calculates the cost and benefit of different choice options and chooses the alternative that maximizes his utility (e.g., Edwards, 1954; Friedman, 1953). While these models tend to overemphasize humans' capacity for systematic information processing and leave little room for unconscious drivers of decision-making such as habits and emotions, behavioral decision research takes the limits of humans' cognitive abilities into account. Behavioral approaches emphasize the context-specific, dynamic and unconscious processes of decision-making. This perspective has been found to be useful in explaining how people actually make decisions (Redlawsk and Lau, 2013; Weber and Johnson, 2009).

In the behavioral literature, an influential conceptualization of information processing distinguishes between cognitive and affective processes (Chaiken et al., 1989; Epstein, 1994). The cognitive system relates to analytic and effortful processes, in which individuals base decisions on their thoughts, beliefs and perceptions related to an object (Weber and Johnson, 2009). While cognitive factors have, for a long time, been at the center of analysis in decision research, the role of affective processes has become more widely recognized since the 1980s (e.g., Zajonc, 1980). Researchers now acknowledge that in many decision contexts, choices are not only based on what people think or know about an object, but also on how they *feel* about it (Slovic et al., 2004). The affective system is based on associative, intuitive and less effortful processes that generally occur faster than conscious cognitive processing (Weber and Johnson, 2009), which is why nobel laureate Daniel Kahneman (2011) refers to both systems as "thinking fast and slow". In what follows, we base the development of theoretical expectations regarding fading voter support for nuclear divestment on such a dual-process perspective. We first shed light on the decision context – a popular vote – by theorizing about the stability of cognitive and affective factors during a political campaign (2.1). Subsequently, we derive hypotheses about the direct and indirect influences of cognitive and affective factors regarding fading voter support for nuclear divestment (2.2). Finally, we theorize how changes in the choice architecture can lead to preference reversals (2.3).

2.1. Voters' Evaluation of Nuclear Power in a Contested Political Setting

2.1.1. Perceptions of Nuclear Risk and Benefit

In terms of cognitive factors, prior research on public support of nuclear technology has emphasized the importance of people's evaluation of the risks and benefits of nuclear power. Perceived risks – i.e., concerns about nuclear accidents, radioactive leakage, nuclear waste disposal, proliferation, and other challenges related to the technology – have been shown to negatively influence public acceptance of nuclear power (Peters and Slovic, 1996; Renn, 1990; Tanaka, 2004; Whitfield et al., 2009). In contrast, citizens who perceive the benefits of nuclear power – such as its contribution to security of supply or low electricity prices – to be high, tend to show higher acceptance rates (Corner et al., 2011; Visschers and Siegrist, 2013).

Contrasting with rational choice models of decision-making, behavioral approaches do not assume perceptions and preferences to be stable. During a political campaign, voters are exposed to a variety of views and opinions, and political actors have ample opportunities to influence citizens' perceptions. This has inspired a large number of studies on the effects of political campaigns on opinion formation (Iyengar and Simon, 2000; Kriesi, 2002; Sciarini and Tresch, 2011). We therefore hypothesize that voters' perceptions of risk and benefit can significantly change in the run-up to a direct democratic vote:

H1. Voters' perceptions of nuclear risk and benefit change during a political campaign.

2.1.2. Affective Evaluation of Nuclear Power

Political campaigns are emotionally loaded events, and politicians appeal to voters' feelings and emotions (Brader, 2005). Inspired by psychological research, scholars of political communication have found that messages targeted at voters' feelings can have advantages in gaining voter support over messages targeted at cognitive channels (Abelson et al., 1982; Marcus, 2000; Ragsdale, 1991). However, research on the role of feelings in political controversies related to sustainability and divestment is scarce (Menzel, 2013). We aim to shed light on the role of affect by analyzing to what extent voters' affective evaluations of nuclear power are malleable in the context of a political campaign:

H2. Voters' affective evaluations of nuclear power change during a political campaign.

2.2. Cognitive and Affective Precursors of Fading Voter Support for Divestment

2.2.1. Preference Reversal via the Cognitive Route

Our main objective is to explain why many voters have changed their voting preference regarding the ballot proposition in the run-up to the Swiss referendum. If political actors succeed in changing voters' perceptions relating to the technology's risks or benefits, this might trigger a reconsideration of related voting intentions and thus influence choices made at the ballot box. This perspective ties in with reason-based analysis rooted in cognitive psychology, according to which individuals base their decisions on their perceptions of a problem and

evaluate different choice options accordingly (Shafir et al., 1993). Hence, we hypothesize that fading voter support for the proposed nuclear phase-out can be explained by changes in perceptions of nuclear risks and benefits:

H3a. The higher voters' perceptions of nuclear benefits become during a political campaign, the more likely they are to withdraw their support for nuclear divestment.

H3b. The higher voters' perceptions of nuclear risks become during a political campaign, the less likely they are to withdraw their support for nuclear divestment.

2.2.2. Preference Reversal via the Affective Route

In a dual-process perspective, affective evaluations can have a direct influence on decisions that is independent from cognitive processing (Way and Masters, 1996, p. 51). Accordingly, Brader (2005) shows that political ads that appeal to emotions (such as enthusiasm) directly affect political behavior (such as the intention to participate in a vote). Studying direct democratic votes, Kühne et al. (2011) find that emotions evoked by political campaigns can influence voting behavior.

Previous studies demonstrate that acceptance of nuclear power is strongly related to affective evaluations of the technology (Keller et al., 2012; Peters and Slovic, 1996). While negative feelings towards nuclear power such as fear or anger are associated with low acceptance, neutral or positive feelings predict support for nuclear power. With regard to the opinion swing in the Swiss vote, the aforementioned findings suggest that swing voters might have changed their affective evaluation of nuclear power from negative to positive during the campaign. Based on these considerations, we formulate the following hypothesis:

H4. The more positive voters' affect towards nuclear power becomes during a political campaign, the more likely they are to withdraw their support for nuclear divestment.

2.2.3. Modeling the Interplay of Affect and Cognition: The Affect Heuristic

Apart from the direct influences of affect and cognition on the formation and stability of political preferences, we acknowledge what decision scientists have called the “dance of affect and reason” (Slovic et al., 2004, p. 314). According to this perspective, and compatible with research in evolutionary psychology (Cosmides and Tooby, 2004) and neuropsychology (Damasio, 1994), the affective system provides a basic orienting mechanism that interacts with cognition and thus relates to preference formation in an indirect way. The assumption that affective processing might have a cognitively mediated influence on preference formation and political behavior has been confirmed by political psychologists (Marcus, 2000; Way and Masters, 1996) and scholars of voting behavior (Wirth et al., 2012).

Finucane, Slovic and colleagues have modeled the interaction of affect and cognition as an “affect heuristic”. Their model suggests that positive and negative feelings come prior to, and serve as a guide for, judgement and decision-making (Finucane et al., 2000; Slovic et al., 2004). The affect heuristic is based on the puzzling observation that lay people's perceptions of benefits and risks are often negatively related, whereas risk and benefit of many activities tend to be positively related in the real world. For example, in the financial realm, stocks of technology companies offer higher returns, and tend to also be riskier, whereas government bonds provide lower returns, and are usually less risky. In contrast, as Finucane et al. (2000) point out, lay people frequently perceive the risks of beneficial activities to be low, and vice versa. The reason is that they use affective evaluations as a cue or heuristic for making judgements (Slovic et al., 2004).

Based on these premises, we contend that stability of preferences is a result of an affect-cognition-interaction. More specifically, we hypothesize that feelings towards nuclear power can explain both citizens' perceptions of nuclear benefit and risk:

H5a. Negative feelings towards nuclear power lead to higher perceived risk and lower perceived benefit.

H5b. Positive feelings towards nuclear power lead to higher perceived benefit and lower perceived risk.

2.3. Preference Formation and Choice Architecture: The Asymmetric Dominance Effect

Research on decision-making has demonstrated that in many decision contexts, people pay particular attention to certain reference points, such as the status quo option, when forming their preferences (e.g., Kahneman and Tversky, 1979; Tversky and Kahneman, 1991) – in other words, “the presence of certain types of options may affect the choice behavior” (Ok et al., 2015, p. 299). The initiators of the Swiss nuclear phase-out vote had conceived of their proposal as a decision between two alternative views of the country's energy future: continued reliance on nuclear power versus divesting from nuclear and investing in a cleaner energy supply with renewables and energy efficiency. During the campaign, the opponents of the proposed divestment introduced a third scenario by suggesting that divesting from nuclear would make Switzerland dependent on imports of coal-fired power from Germany and thus lead to unintended effects in terms of climate change mitigation.[3] While rational choice theory assumes that preferences between two decision objects are independent of the presence of a third alternative, there is some interesting evidence in the psychology and behavioral economics literature pointing out that this may not always be the case. Ariely and Wallsten (1995, 223) describe a situation where a person sitting in a restaurant looks at the dessert menu and chooses a crème brûlée over a tiramisu. When the waiter tells him that the special dessert of the day is an orange sherbet, the guest changes his mind and orders the tiramisu. The phenomenon described here is called the asymmetric dominance effect (Huber et al., 1982) or attraction effect (Huber et al., 2014) – introducing a third alternative that is asymmetrically dominated, in the sense that it performs clearly worse on one of the utility dimensions than the originally non-preferred alternative, can shift the preference ordering of the other alternatives (Ariely and Wallsten, 1995; Ok et al., 2015).

In our case, similar to the crème brûlée and tiramisu example, the choice was initially one between nuclear energy and renewable energy. Did the introduction of coal power, a reference point that is asymmetrically dominated by nuclear in that it contributes to climate change by emitting CO_2, influence voters' assessment of the proposed divestment? If so, what we would expect to see is that people who were previously critical of nuclear power and saw renewable energy as a preferable alternative reframed the decision problem as choosing the lesser evil. Introduction of coal as a reference point should thus have reversed the preference ordering between nuclear and renewables:

H6. Introducing an alternative that is asymmetrically dominated by nuclear power increases the probability that voters withdraw their support for nuclear divestment.

[3] While the popular initiative did not include any explicit mention of this option, and one could therefore categorize it as a “phantom alternative” (Doyle et al., 1999), the complexities of interconnected electricity markets make it difficult to exclude the possibility that more imports of coal power might have been an unintended (and perhaps temporary) side-effect of accepting the initiative and implementing the proposed timeline for a nuclear phase-out. However, an in-depth discussion of the factual correctness of both camps' claims would go beyond the scope of this paper.

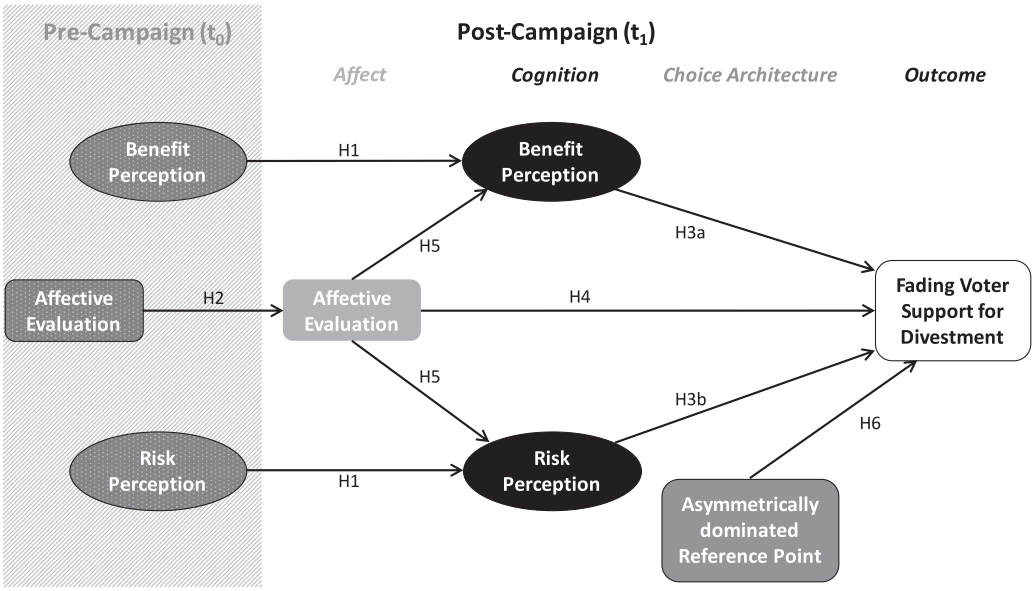

Fig. 1. Conceptual model to explain fading voter support for nuclear divestment.

Fig. 1 summarizes our extended dual-process framework, which we apply to study fading voter support in the context of the Swiss nuclear phase-out referendum.

3. Material and Methods

3.1. Sampling Strategy and Survey Design

Our analyses are based on a panel survey with Swiss voters. Whereas the development of public preferences over time is frequently studied based on repeated cross-sectional surveys, such a design is not suitable to investigate changes of perceptions, affect and voting intentions on the individual level. For instance, in their otherwise remarkable work, Ansolabehere and Konisky (2014, p. 102) assert that individuals' preferences in the US about energy are fairly stable. However, as their study is based on repeated surveys with varying samples, this conclusion is on rather shaky grounds.

Participants of our study were drawn from a Swiss online consumer panel operated by an experienced market research agency. The panel is entirely actively recruited and includes nearly 70,000 registered individuals.[4] To obtain a representative sample of the voting population from the German- and French-speaking parts of Switzerland, we employed stratified random sampling with proportionate allocation, stratifying the population by region, gender, age, education, and partisan orientation.[5] Respondents were surveyed based on computer-assisted web interviews (CAWI).[6] The pre-vote questionnaire (t_0, $n = 1216$) was administered before intensive political campaigns started (October 10–19, 2016). The post-vote survey (t_1, $n = 1014$) started one hour after the polling stations had closed (November 27) and ended four days later (December 1). The drop-out rate was 16.6%.[7] As our sample well represents the Swiss voting population, our analyses are based on unweighted data.

Our data perform well in replicating the actual ballot outcome. Whereas 45.8% of voters who participated in the referendum accepted the initiative, 45.7% of participating survey respondents did so.[8]

We implemented several measures to address sources of bias. First, to mitigate self-selection into the survey, respondents were only informed about the survey topic after having accepted to participate. Second, our first questionnaire included an attention test, and 54 persons who did not pass the test were automatically excluded from further participation. Third, 15 speeders who failed to provide meaningful responses were excluded.[9]

We informed respondents that the same person should fill in the questionnaires in both survey rounds. Datasets were linked based on a 9-digit identifier and information on age and gender. Datasets for seven respondents were deleted as it could not be ensured that the same individual had filled in the questionnaires. Respondents were incentivized according to the standards of Swiss market research, receiving shopping vouchers worth one Swiss Franc per five minutes of inquiry.

3.2. Measures and Aggregation Techniques

3.2.1. Outcome Variable

To construct our main dependent variable – fading voter support for nuclear divestment – we used two questions. First, at t_0 we asked *"If the*

[4] https://www.intervista.ch/en/panel (accessed 12.06.17). While opt-in panels consist of a self-selected sample of volunteers, Intervista's actively recruited panel comes close to a probability sample of the Swiss voting population.

[5] Table A1 in the supporting information includes the sample distribution of socio-demographic variables and partisan orientation. Because only 6.1% of Swiss voters live in the Italian-speaking region of Switzerland, this area was excluded for reasons of research efficiency. https://www.bfs.admin.ch/bfs/de/home/statistiken/bevoelkerung/sprachen-religionen.assetdetail.2220343.html (accessed 23.05.17).

[6] Several controlled comparisons have shown that internet-based surveys can be at least as reliable and accurate in estimating parameters of voting behavior as surveys using more traditional modes (Ansolabehere and Schaffner, 2014; Sanders et al., 2007), which makes us confident about using CAWI as survey mode.

[7] A comparison of respondents who participated only at t_0 but not at t_1 ($n = 202$) to those participating in both waves ($n = 1014$) shows no systematic differences with regard to most variables, such as education, gender, political orientation and place of residence. The only socio-demographic variable that influences dropout is age: nonrespondents at t_1 were considerably younger (M = 44.91, SD = 16.20) than those participating in both waves (M = 49.59, SD = 16.96). Moreover, a systematic relationship exists between initial vote intention and dropout. Whereas 17.7% of those indicating a yes-preference at t_0 dropped out of the sample, dropout amounts to 13.2% among respondents indicating a rejection at t_0 ($\chi^2(1) = 4.228$, $p = 0.04$).

[8] Similar to other post-referendum-surveys, our survey produces an overestimation of voter turnout (88.4% vs. 45.3% in reality). This is not surprising, as "turnout gaps" are a typical phenomenon of post-election studies (Selb and Munzert, 2013). The magnitude of the gap in our data is comparable to turnout gaps documented in panel studies in the context of other Swiss referenda (Hänggli et al., 2012).

[9] For discussion of excluding speeders, see Greszki et al. (2015).

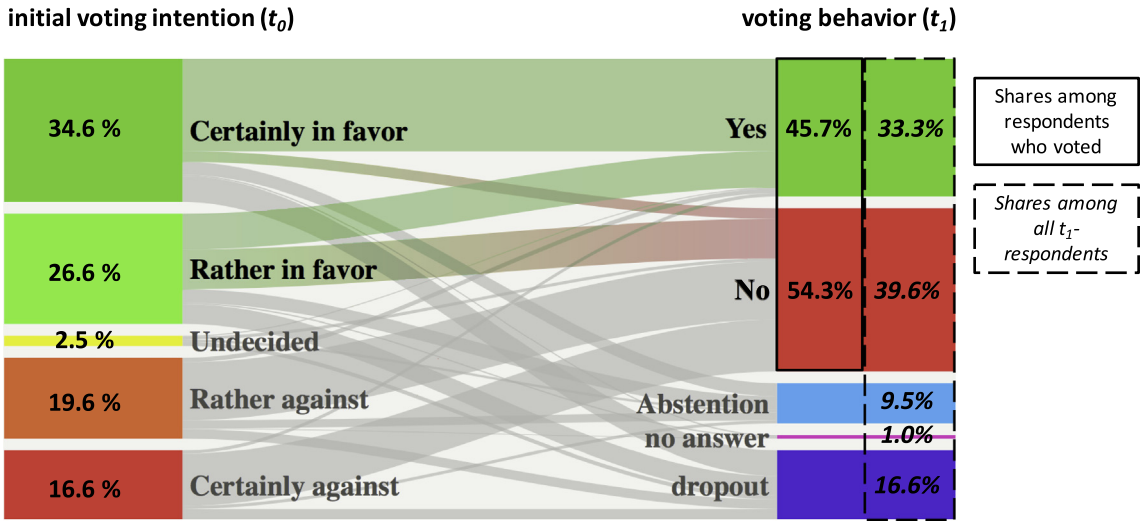

Fig. 2. Initial voting intentions and actual voting behavior.

popular initiative on the nuclear phase-out was put to the vote today, how would you vote?". We provided a five-point scale ranging from "*certainly in favor*" to "*certainly against*". Second, the survey at t_1 contained an inquiry about respondents' participation in the vote. In case of affirmation, they were asked "*How did you vote?*". Respondents could indicate "*yes (in favor of the nuclear phase-out)*" or "*no (against the nuclear phase-out)*", including a "*no response*" option. We constructed a binary variable, indicating whether respondents had sticked to their original vote intention or not. Respondents who did not participate in the vote were neither coded as stable nor instable.

The sankey diagram depicted in Fig. 2 visualizes our main dependent variable. It illustrates initial voting intentions and reported voting behavior of survey respondents, as well as the extent to which support for the phase-out proposal faded between t_0 and t_1. Whereas 61.2% of respondents participating at t_0 had initially planned to support the initiative, only 45.7% of respondents who participated in t_1 and casted a vote finally voted "yes". On the other hand, 36.2% were initially against the initiative, but 54.3% of respondents who participated in the referendum voted "no". To shed light on fading voter support for nuclear divestment, we compare respondents who were in favor of the phase-out throughout the referendum campaign (n = 379; flows from "*Certainly* [Rather] *in favor*" to "*Yes*") to those who were initially in favor of the initiative but finally rejected it (n = 148; flows from "*Certainly* [Rather] *in favor*" to "*No*").[10]

3.2.2. Explanatory Variables

In terms of cognitive evaluation of nuclear power, we measured perceived risk and benefit with four survey items per construct (see Table 1). The items were partly adopted from scales used by Siegrist et al. (2014) and mirror the multifacetedness of risk and benefit perceptions. All items were measured on 5-point scales (from "*fully disagree*" to "*fully agree*"). To track individual-level changes in perceptions over time, all items were used identically at t_0 and t_1. We also allowed respondents to provide "*no answer*" to avoid forcing participants to give potentially meaningless answers for certain aspects on which they could not form an opinion.

Confirmatory factor analysis (CFA) was used to investigate whether the survey items are valid representations of the underlying latent constructs. We used regression analysis to obtain scores representing the two latent factors on the individual level, taking the salience of items into account (i.e., assigning greater weight to items with higher factor loadings). Based on the full information maximum-likelihood method, indicators of risk and benefit perception were estimated also for respondents with missing values, using all available information from answered items.[11] As can be seen in Table 1, all factor loadings are in the range of 0.5 to 0.9, which supports the validity of our final two-factor model.[12] For both constructs, Cronbach's alpha is in the recommended range between 0.7 and 0.9, indicating high reliability of both scales.[13] According to various fit indices (see Schreiber et al., 2006, p. 330), the hypothesized model fits our data well ($\chi^2(16) = 26.31$, $p = .05$, Comparative fit index (CFI) = 0.998, Root mean squared error of approximation (RMSEA) = 0.025).

Affect, in our context, is defined as a feeling state that – consciously or not – assigns a positive or negative quality to a specific object (Slovic et al., 2004, p. 312). We measured affect towards nuclear power following the procedure proposed by Peters and Slovic (1996), which is based on the method of continued associations, adapted for use in an online survey. After having elicited their voting intention/behavior at t_0 and t_1, respectively, respondents were asked "*What is the first thought or image that comes to your mind when thinking about 'nuclear energy'?*". Next, participants were asked to evaluate their feelings with regard to the reported associations on a semantic differential affect scale from −3 ("*very negative*") to +3 ("*very positive*"). This procedure generated affective evaluations for 1005 respondents.

To assess whether the asymmetric dominance effect can explain parts of fading voter support for nuclear divestment, we asked respondents at t_1 whether they perceived imports of coal power to be imminent in case the nuclear phase-out would be accepted. The item was measured on a 5-point scale ("*fully disagree*" to "*fully agree*").[14]

3.2.3. Control Variables

In the first questionnaire, we gathered information on sociodemographic characteristics such as respondents' age, gender, education, and place of residence. Based on the latter, the binary variables "Language Region" and "Danger Zone" were generated. "Language Region" indicates whether

[10] Table A2 in the supporting information presents initial voting intentions and reported voting behavior of all respondents.

[11] At t_0, 8.8% (n = 107) of respondents did not complete all items gauging risk perception, and 14.3% (n = 174) did not complete all items on benefit perception. At t_1, 8.5% (n = 86) of respondents participating in both survey waves did not complete all items gauging risk perception, and 12.0% (n = 122) did not complete all items on benefit perception.

[12] All factor loadings are significant at the $p < .001$ level.

[13] The supplementary materials include a correlation matrix of all items measuring perceived risks and benefits (Table A3).

[14] Item wording (translated from German): "*Prematurely phasing out nuclear power makes imports of dirty coal power from foreign countries imminent*".

Table 1
Survey items and results of two-factor CFA for risk and benefit perception.

Latent factors and observed variables		Cronbach's alpha t_0/t_1	Standardized factor loadings t_0/t_1
Risk perception			
R1	*"I am worried about the risks of nuclear power plants in Switzerland."* (*)	0.802/0.832	0.69/0.73
R2	*"The catastrophe risks in new nuclear power stations are very small."* (*) (−)		0.82/0.84
R3	*"The use of nuclear energy burdens future generations."*		0.58/0.70
R4	*"Swiss nuclear power plants must be shut down before they come to a tragic end."*		0.82/0.80
Benefit perception			
B1	*"Even after withdrawing from using nuclear power, the power supply in Switzerland will be ensured at all times."* (−)	0.871/0.880	0.76/0.77
B2	*"Without nuclear power, the standard of living in Switzerland would decline."*		0.76/0.76
B3	*"The continued operation of Swiss nuclear power plants is of utmost importance for security of supply and grid stability."*		0.89/0.92
B4	*"Thanks to nuclear power, Switzerland is independent from foreign countries."*		0.68/0.71

Notes: Items translated from German. Items marked with stars (*) adopted from Siegrist et al. (2014). (−): negative item, recoded.

respondents live in the German- or French-speaking part of Switzerland. "Danger Zone" indicates whether a participant's place of residence is within a radius of 20 km from one of the four nuclear power plants. This radius corresponds to the legally defined 'danger zone', where a serious accident could pose a threat to the population which requires protective measures.[15]

We also included partisan orientations, as it can be assumed that these are systematically related to both preference instability and perceptions of risks and benefits. Partisan orientations were assessed in the first questionnaire by the question *"Which political party best represents your political views?"*. Participants could choose among the seven major parties and the category "others". We generated two binary variables, one capturing citizens leaning towards one of the three major parties that supported the popular initiative ("Left Partisans"), and the other one capturing citizens leaning towards one of the four parties that opposed the initiative ("Right Partisans").

Finally, the strength of preferences at t_0 was taken into account: voters with a 'weak' preference for nuclear divestment at t_0 ("*rather* in favor") were assigned a 1; while those with a strong preference ("certainly in favor") were assigned a 0. Our expectation was that weak initial preferences might be a predictor of withdrawing support for nuclear divestment.[16]

4. Empirical Analysis and Results

4.1. Changes in Cognitive and Affective Evaluation of Nuclear Power

4.1.1. Changes in Risk and Benefit Perceptions

To recall, our first hypothesis states that perceptions of risks and benefits can be altered during a political campaign. In a first step, we shed light on this hypothesis by inspecting the distributions of risk and benefit perceptions, focusing on the subgroups of stable supporters ($n = 379$) and voters who revoked their initial preference for a phase-out ($n = 148$). Figs. 3 and 4 show density plots based on the overall perception scales obtained through CFA. Comparing the area below the light gray line in Fig. 3 with the area delimited by the green line suggests that risk perceptions of voters with stable preferences increased in the run-up to the referendum. Conversely, as the areas below the dark gray and red lines show, voters with fading support for the phase-out proposal perceived nuclear risks to be markedly smaller at t_1 than at t_0. These findings are substantiated by Wilcoxon signed-rank tests. Comparing the evolution of risk perceptions over time shows systematic differences for both stable supporters ($z = 10.32$; $p < .001$) and swing voters ($z = -2.49$; $p = .01$). Another way to look at these data is by comparing the groups at both points in time. While the groups did not differ in terms of risk perception at t_0 (Wilcoxon-Mann-Whitney test: $z = 0.54$; $p = .59$), the difference was substantial and statistically significant at t_1 ($z = 12.74$; $p < .001$).

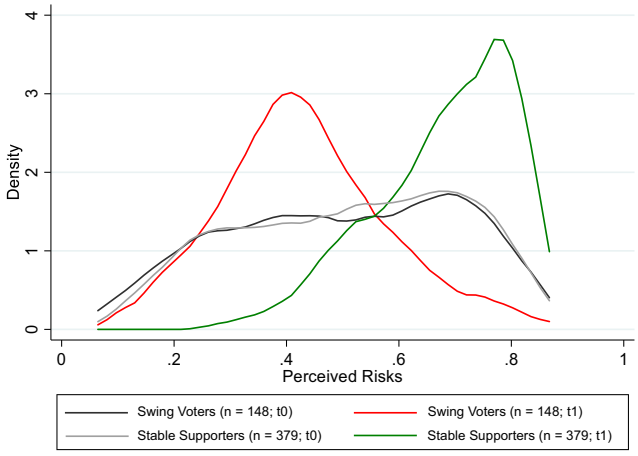

Fig. 3. Perceptions of nuclear risk, pre-campaign (t_0) and post-campaign (t_1).
Notes: The density plots are based on logistically transformed factor scores. Higher values correspond to higher risk perception. Means (M) and standard deviations (SD): Swing voters: $M(t_0) = 0.50$; $SD(t_0) = 0.20$; $M(t_1) = 0.43$; $SD(t_1) = 0.15$. Stable supporters: $M(t_0) = 0.51$; $SD(t_0) = 0.19$; $M(t_1) = 0.68$; $SD(t_1) = 0.12$.

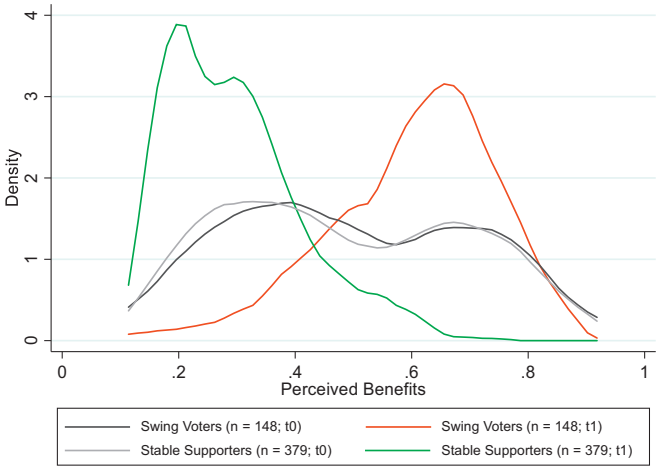

Fig. 4. Perceptions of nuclear benefit, pre-campaign (t_0) and post-campaign (t_1).
Notes: Similar to Fig. 3. Higher values correspond to higher benefit perception. Swing voters: $M(t_0) = 0.50$; $SD(t_0) = 0.20$; $M(t_1) = 0.60$; $SD(t_1) = 0.14$. Stable supporters: $M(t_0) = 0.49$; $SD(t_0) = 0.20$; $M(t_1) = 0.30$; $SD(t_1) = 0.11$.

[15] https://www.admin.ch/opc/de/classified-compilation/20091050/index.html (accessed 02.05.17).

[16] See Table A4 in the supporting materials for descriptive statistics of all variables used in the analyses.

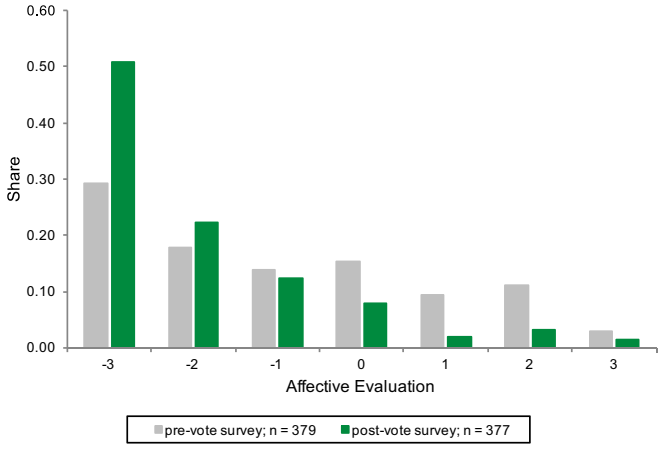

Fig. 5. Affect towards nuclear power, stable supporters, pre-campaign (t_0) and post-campaign (t_1).
Notes: −3 corresponds to a very negative evaluation, 0 corresponds to a neutral evaluation, and +3 corresponds to a very positive evaluation. $M(t_0) = -0.97$; $SD(t_0) = 1.83$; $M(t_1) = -1.98$; $SD(t_1) = 1.40$.

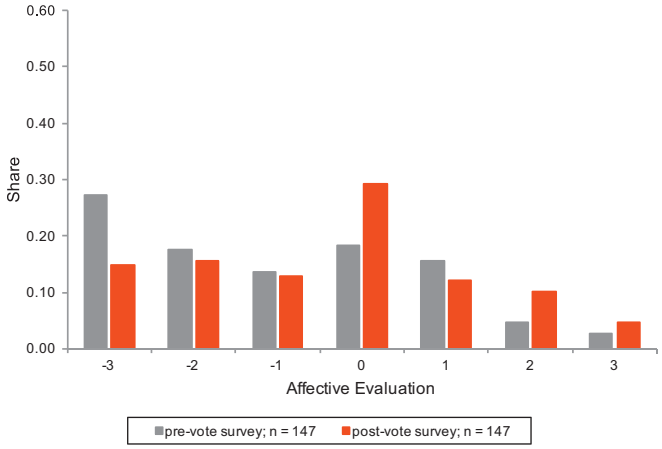

Fig. 6. Affect towards nuclear power, swing voters, pre-campaign (t_0) and post-campaign (t_1).
Notes: Similar to Fig. 5. $M(t_0) = -0.97$; $SD(t_0) = 1.72$; $M(t_1) = -0.42$; SD

The pattern is mirrored for benefit perceptions (Fig. 4). While benefit perceptions of voters with stable preferences decreased in the run-up to the referendum ($z = -11.45$; $p < .001$), voters with preference reversals perceived nuclear benefits to be higher at t_1 than at t_0 ($z = 4.66$; $p < .001$). Again, both groups did not systematically differ in terms of benefit perceptions at t_0 (Wilcoxon-Mann-Whitney test: $z = -0.43$; $p = .67$), but right after the vote benefit perceptions among stable supporters were significantly lower than among swing voters ($z = -15.29$; $p < .001$).

4.1.2. Changes in Affective Evaluations

At both t_0 and t_1, a majority of voters connected their associations relating to nuclear power with negative feelings (55.6% at t_0; 51.3% at t_1). Fig. 5 shows affective evaluations of voters with stable support for nuclear divestment at t_0 and t_1, while Fig. 6 depicts affect for voters with fading support. Affective evaluations of voters with stable support became more negative in the run-up to the referendum (Wilcoxon signed-rank test: $z = -7.63$; $p < .001$). Voters whose support for the divestment faded, on the other hand, significantly shifted away from negative towards neutral or positive affective evaluations ($z = 2.68$; $p = .007$), providing support for hypothesis 2. Moreover, while stable and swing voters did not systematically differ at t_0 (Wilcoxon-Mann-Whitney test: $z = -0.19$; $p = .85$), those with stable preferences had significantly more negative feelings towards nuclear power at t_1 than those with instable preferences ($z = -9.74$; $p < .001$).

4.2. Explaining Fading Voter Support for Divestment

4.2.1. Direct Influence of Cognition and Affect

We use logistic regression analysis to jointly test hypotheses 3 and 4 about the cognitive and affective drivers of fading support for divestment from nuclear power. The outcome variable takes on the value 0 for voters supporting the phase-out throughout and 1 for voters who revoked their support during the campaign. The main predictors in Model 1 (Table 2) are the scales for risk and benefit perceptions obtained through CFA, and our measure of affective evaluation.[17] Given that the model controls for lagged values of perceptions and affect, the coefficients indicate the influence of ***changes*** of perceptions and affect on preference stability (Finkel, 1995, p. 15). Our panel data hence allow for stronger causal inferences than would have been possible with a mere cross-sectional survey.

The coefficients for both risk and benefit perceptions at t_1 are in the expected direction and statistically significant: higher risk perceptions decrease the likelihood of revoking support for nuclear divestment, while higher benefit perceptions increase the likelihood of revoking support. These findings corroborate both hypotheses 3a and 3b: in the run-up to the referendum, changes in voters' perceptions about nuclear power clearly influenced their voting behavior.[18] Looking at the affective correlates of preference instability, in turn, we do not find the expected direct effect. Changes in voters' feelings about nuclear power did not directly translate into changes in voting intentions. We thus reject hypothesis 4.

4.2.2. How Affect Shapes Cognition

Apart from the direct influence of affective evaluations on voting behavior, we were interested in the interplay of affect and cognition (hypothesis 5). Models 2 and 3 therefore assess how risk-benefit-perceptions are formed based on ordinary least squares regression, with affective evaluation of nuclear power being the main predictor. To adequately address the fact that hypotheses 5a and 5b distinguish between two qualitatively different states (negative vs. positive affect), we transformed the affect variable into two dichotomous measures: "Negative affect" takes on the value 1 if affect at t_1 is −2 or −3, and 0 otherwise, while "Positive affect" takes on the value 1 if affect at t_1 is 2 or 3, and 0 otherwise.

In both models, affective evaluations are a strong and significant predictor of risk-benefit-perceptions.[19] This finding supports the affect heuristic, which asserts that people rely on gut feelings when forming perceptions (Finucane et al., 2000). Negative feelings towards nuclear energy are associated with higher perceived risks and lower perceived benefits, while positive feelings relate to higher perceived benefits and lower perceived risks. The influence of affect on the stability of support for nuclear divestment thus appears to be mediated entirely through its

[17] The number of observations in Model 1 is 523, as four respondents from the subsample of individuals who were initially in favor of divestment and participated in the referendum did not provide answers to the question measuring affect in both panel waves.

[18] In a series of additional exploratory analyses, we interacted the cognitive variables with stable socio-demographic factors and partisan orientations. We find considerable stability of cognitive effects across different model specifications and no significant interaction effects. Subgroup analyses indicate that risk perceptions slightly fail to reach statistical significance as a predictor of preference instability among respondents under 30, highly educated respondents and left party supporters.

[19] Table 2 shows the results for the full sample ($n = 1005$), as we assume these relationships to hold not only for citizens who had, at some point in time, a preference for nuclear divestment. Replications based on the subsample of initial supporters of nuclear divestment yield similar results (see Table A.5 in the supplementary materials). Table A.5 also contains replications of models 2 and 3 with the original, 7-point affect scale. No matter whether the original scale or the dichotomized measures are used, the results remain substantively the same.

Table 2
Multivariate results.

	(1) Withdrawal of support		(2) Perceived risks	(3) Perceived benefits	(4) Withdrawal of support	
	Logit coefficients (standard errors)	Marginal effects (standard errors)	Coefficients (standard errors)	Coefficients (standard errors)	Logit coefficients (standard errors)	Marginal effects (standard errors)
Perceived risks	−1.377***	−0.099***	–	–	−1.362***	−0.090***
	(0.297)	(0.019)			(0.319)	(0.019)
Perceived risks (t_0)	−0.332	−0.024	0.029	–	−0.449	−0.030
	(0.280)	(0.020)	(0.025)		(0.300)	(0.020)
Perceived benefits	2.901***	0.208***	–	–	2.304***	0.152***
	(0.363)	(0.018)			(0.400)	(0.022)
Perceived benefits (t_0)	−0.187	−0.013	–	0.013	−0.219	−0.014
	(0.291)	(0.021)		(0.025)	(0.305)	(0.020)
Affect	0.035	0.003	–	–	−0.000	−0.000
	(0.113)	(0.008)			(0.124)	(0.008)
Affect (t_0)	0.006	0.000	–	–	−0.068	−0.004
	(0.121)	(0.009)			(0.132)	(0.009)
Negative affect	–	–	0.670***	−0.647***	–	–
			(0.052)	(0.053)		
Positive affect	–	–	−0.456***	0.442***	–	–
			(0.064)	(0.065)		
Coal power	–	–	–	–	0.859***	0.057***
					(0.208)	(0.013)
Young	−0.371	−0.027	−0.108	0.011	−0.587	−0.039
	(−0.461)	(0.033)	(0.063)	(0.064)	(0.486)	(0.032)
Elderly	0.037	0.003	−0.065	0.082	−0.128	−0.008
	(0.392)	(0.028)	(0.051)	(0.052)	(0.425)	(0.028)
Gender	−0.543	−0.039	0.015	0.065	−0.383	−0.025
(Female)	(0.348)	(0.025)	(0.046)	(0.046)	(0.376)	(0.025)
Education	0.163	0.012	−0.005	−0.019	0.110	0.007
	(0.095)	(0.007)	(0.013)	(0.013)	(0.102)	(0.007)
Danger zone	0.487	0.035	0.003	−0.014	0.446	0.029
	(0.493)	(0.035)	(0.062)	(0.062)	(0.537)	(0.035)
Language region	−0.112	−0.008	0.125*	−0.086	−0.232	−0.015
(French)	(0.410)	(0.029)	(0.055)	(0.055)	(0.438)	(0.029)
Left party supporter	−0.448	−0.032	0.160	−0.200*	−0.404	−0.027
	(0.730)	(0.052)	(0.099)	(0.099)	(0.810)	(0.053)
Right party supporter	−0.478	−0.034	−0.317**	0.432***	−0.381	−0.025
	(0.721)	(0.052)	(0.095)	(0.095)	(0.798)	(0.052)
Strength of initial preference	−1.092**	−0.078**	–	–	−1.007**	−0.066**
	(0.362)	(0.025)			(0.390)	(0.025)
Constant	0.610	–	−0.179	0.101	−1.868	–
	(1.382)		(0.166)	(0.168)	(1.655)	
Log-likelihood	−123.39				−108.77	
R^2	0.60		0.40	0.42	0.64	
N	523	523	1005	1005	499	499

Note: Coefficients are from logit models for withdrawal of support for nuclear divestment, and from ordinary least squares for risk and benefit perceptions. Standard errors in parentheses. R^2 values for logit regressions are McFadden's pseudo R^2 scores. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

impacts on perceptions of nuclear risk and benefit. Apart from the affect heuristic, voters seem to make use of their partisan orientations as a second heuristic when forming their perceptions, as three out of four coefficients for partisan orientations attain statistical significance.

The coefficients for the lagged dependent variables provide further evidence for the malleability of perceptions during political campaigns. Risk and benefit perceptions measured seven weeks before the vote do not predict perceived risk and benefit perceptions measured on the voting day, which corroborates hypothesis 1.

4.3. The Influence of Choice Architecture

4.3.1. How the Prospect of Coal Power Leads to Fading Support for Nuclear Divestment

Hypothesis 6 states that the introduction of coal, as an asymmetrically dominated reference point with regard to nuclear power, might have played a role in the process of fading voter support for nuclear divestment. We shed light on the asymmetric dominance effect by replicating Model 1, but introducing the perceived relevance of coal power as an additional predictor. As can be seen in Table 2 (Model 4), this variable indeed exerts a statistically significant influence on the dependent variable: voters who believed a premature nuclear phase-out would make coal imports imminent were significantly more likely to withdraw their support for divestment.[20] The analysis thus lends support to the effectiveness of the asymmetric dominance effect. There are no significant changes regarding the coefficients of other variables which could have been brought about by introduction of this additional variable, albeit the decrease of the coefficient of benefit perception is worth noting. This indicates that by introducing the issue of potential imports of coal-based power, the opponents of the divestment initiative added another facet to the perceived benefits of nuclear power, while the prospect of coal imports is unrelated to perceptions of nuclear risk.

4.3.2. Asymmetric Dominance and Emotions Towards Different Energy Sources

As an additional exploratory analysis of the asymmetric dominance effect, we compare respondents' emotions towards three different

[20] As 24 individuals did not provide an answer to the question tapping perceptions of imports of coal power, the number of observations in Model 4 is reduced to 499.

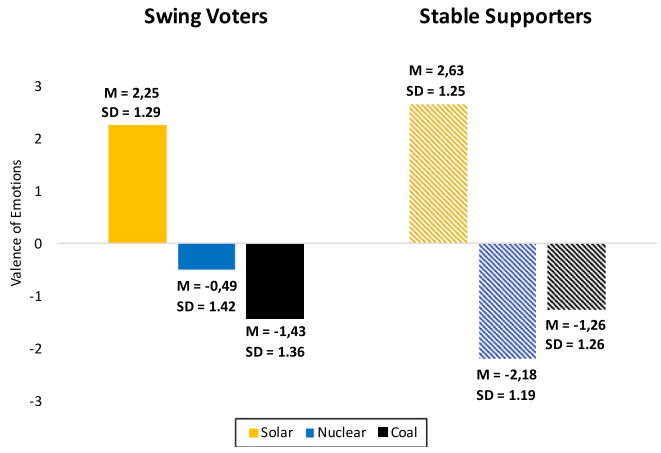

Fig. 7. Emotions towards coal, nuclear and solar: swing voters vs. stable supporters.

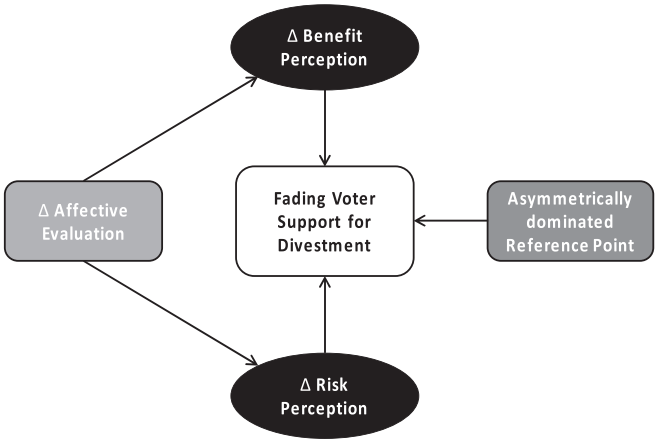

Fig. 8. Main findings.

energy sources: nuclear, solar, and coal power. Emotions towards these energy sources were gauged at t_1 on a 9-point scale (ranging from −4 to +4).[21]

Fig. 7 illustrates mean values of emotional appraisals of swing voters and stable supporters of nuclear divestment. The results show that solar power evokes very positive emotions among both groups. Both nuclear and coal receive more negative than positive ratings, but the majority of swing voters indeed perceives nuclear power to be the "lesser evil", as it elicits on average less negative emotions than coal. These findings suggest that the asymmetric dominance effect also has a bearing on the affective system.

5. Discussion

5.1. Summary and Main Contributions

Transitioning to a sustainable energy future requires not only investments in new technologies, but also divesting from unsustainable infrastructure of the past. A popular vote on the Swiss nuclear phase-out initiative provided a unique setting to study divestment decision-making in real time. Within just eight weeks ahead of the vote, about 370,000 voters changed their opinion from supporting divestment to rejecting it. Based on a large-scale panel survey, we have shown that an interplay of cognitive and affective factors have led to this opinion swing. Fig. 8 summarizes our main findings.

Our analysis supports the idea that people rely on an affect heuristic in forming preferences towards a proposed divestment. In our case study, the opponents of divestment managed to alter affective evaluations of nuclear energy, which resulted in shifting perceptions of risk and benefit and thereby indirectly affected voter behavior. Furthermore, fading voter support for divestment was amplified by introducing an asymmetrically dominated reference point, which made some voters choose the initially rejected option as the 'lesser evil'. Our analysis suggests that the affect heuristic can be boosted in campaign communications by incumbents if they successfully introduce an asymmetrically dominated alternative (or "phantom alternative", Doyle et al., 1999).

While our research provides rich empirical evidence for the challenges of divestment decision-making, it also offers some hints for designing successful pro-divestment campaigns. First, our findings support the idea that emotions matter in environmental decision-making (Menzel, 2013). The good news, however, is that solutions to key sustainability challenges, such as solar power, evoke positive emotions among a wide range of voters. Leveraging these positive emotions can increase the chances of successful divestment campaigns. Second, our results provide startling evidence of how risk and benefit perceptions are driven by affect. The attempts by generations of climate change researchers to convey rational knowledge of climate risk and the potential economic benefits of climate change mitigation will therefore fall short of being behaviorally relevant unless they are coupled with relevant emotional hooks. Such affective cues can either be positive (such as pride to leave a healthy planet to future generations) or negative (such as disgust of continued reliance on polluting energy sources). Finally, our study highlights the importance of choice architecture and framing (Druckman, 2011; Sunstein and Reisch, 2014; Thaler and Sunstein, 2008). Divestment campaigners need to be mindful of incumbents' attempts to lure decision-makers' attention away from positive solutions by framing the status quo as a 'lesser evil' compared to an even less desirable, albeit perhaps only hypothetical, choice option. With sufficient resources at hand, pro-divestment communicators might try to use the asymmetric dominance effect in their favor by suggesting a second, more radical divestment proposal, and positioning a moderate proposal as the 'lesser evil' from skeptical decision-makers' point of view.

5.2. Limitations and Further Research

In contrast to many studies that elicit citizens' preferences about energy policies and technologies in politically 'neutral' times or based on lab experiments, we have investigated preference formation about divestment in a real-world politicized setting. While this has important benefits, we also acknowledge that observational studies have certain limits. In particular, we cannot be certain whether the hypothesized relationships are indeed causal. While we are confident about the theoretical soundness of our assumptions, lab experiments would be a plausible next step to study the interplay of affect and cognition in a more fine-grained manner. For instance, future research could try to "zoom in" on the mechanisms of interaction between affect and cognition in an experimental setting (e.g., using the Implicit Association Test or Functional Magnetic Resonance Imaging). Moreover, it would be interesting to explore the dynamics of affect-cognition-interactions in other areas of sustainable behavior, such as divestment from coal or overcoming diesel lock-in, and choice situations other than voting behavior.

Another limiting factor of our study is the fact that the direct democratic setting in Switzerland is a rather idiosyncratic one, and that the dynamics of preference formation might follow different patterns in

[21] Participants were asked to indicate whether they experienced one or several of the following emotions towards the respective energy technology: enthusiasm, joy, satisfaction, curiosity (positive emotions); fear, anger, fury, disgust (negative emotions). To generate an overall score, the number of reported negative emotions was subtracted from the number of reported positive emotions.

systems where citizens do not have the opportunity to cast a vote on a variety of political questions. Hence, our findings might not be easily transferable to other cases. Nevertheless, we expect our study to have broader implications that go beyond the specific case dealt with. Public opinion plays an utterly important role also in other countries that currently contemplate divesting from unsustainable infrastructure, as the important role of the energy sector (as a provider of jobs, taxes and a driver of investment) makes moves towards divestment highly contested (McKnight and Hobbs, 2013). Further research could focus more on the societal forces that ultimately shape citizens' preferences about divestment in the energy sector as well as sustainability more broadly – in particular, to what extent organized interests are able to influence citizens' affect and cognition and, thereby, contribute to advancing (or slowing down) the transformation of today's economies.

Like breaking societal addictions, overcoming path dependence is a subtle interplay between phenomena on the individual, group, organizational, and societal levels. Our research is one of the first to connect individual-level changes in affect and cognition to a society-level outcome (divestment from nuclear power), but more research would be welcome to make sure we understand how the different levels interact – i.e., how and to what extent fast and slow brain processes interact, and how this relates to the speed of organizational and societal transformations towards sustainability.

Competing Interests Statement

The authors declare no competing interests.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgement

This work has benefited from fruitful exchanges with the members of the Swiss Competence Center for Energy Research SCCER CREST, supported by Innosuisse - Swiss Innovation Agency. Moreover, we would like to thank Klaus Dingwerth, the participants of the Public Policy workshop at the 2017 Annual Congress of the Swiss Political Science Association in St. Gallen (January 11-12, 2017) and the reviewers of Ecological Economics for their valuable comments and remarks.

Appendix A. Supplementary Data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2018.05.015.

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