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**Working Paper**

## Nuclear accidents and policy: Notes on public perception

SOEPPapers on Multidisciplinary Panel Data Research, No. 590

**Provided in Cooperation with:**

German Institute for Economic Research (DIW Berlin)

*Suggested Citation:* Richter, Felix; Steenbeck, Malte; Wilhelm, Markus (2013) : Nuclear accidents and policy: Notes on public perception, SOEPPapers on Multidisciplinary Panel Data Research, No. 590, Deutsches Institut für Wirtschaftsforschung (DIW), Berlin

This Version is available at:

<https://hdl.handle.net/10419/83988>

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**SOEPpapers**  
on Multidisciplinary Panel Data Research

# Nuclear Accidents and Policy: Notes on Public Perception

Felix Richter, Malte Steenbeck, Markus Wilhelm

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ISSN: 1864-6689 (online)

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# Nuclear Accidents and Policy: Notes on Public Perception

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September 2013

## **Abstract**

Major nuclear accidents as recently in Fukushima set nuclear power plant security at the top of the public agenda. Using data of the German Socio-Economic Panel we analyze the effects of the Fukushima accident and a subsequent government decision on nuclear power phase-out on several measures of subjective perception in Germany. In the light of current political debates about the strategic orientation of this energy turnaround, such an analysis is of particular interest since non-pecuniary gains in measures of subjective perception might provide further aspects to be taken into consideration when evaluating the economic costs of the policy. We find that the Fukushima accident increases the probability to report greater worries about the environment. Furthermore, we find evidence for a decrease in the probability to be very worried about the security of nuclear power plants as well as for an increase in reported levels of subjective well-being following the government's resolution on nuclear phase-out. Finally we find that the probabilities of reporting very high concerns are related to the distance between the respondents' place of residence and the nearest nuclear power station.

*JEL classification:* I3, N7, Q4, R1

*Keywords:* Fukushima, nuclear accident, nuclear energy, nuclear phase-out, environment, subjective perception

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## 1. Introduction

Access to reasonably priced energy is often regarded as a major determinant for the competitiveness of an economy. With many fossil resources such as coal being criticized in terms of their sustainability and renewable energy sources still being expensive and not yet fully established, many countries worldwide regard nuclear energy as a key technology in the struggle for affordable electricity. However, major nuclear accidents as recently in Fukushima set nuclear power plant security on top of the public agenda and increase pressure on policy makers to provide adequate reactions. In the case of Germany, the origins of these discussions and the formation of an anti-nuclear movement can be traced back to the 1970s. Following the 1986 Chernobyl nuclear disaster with large areas of Germany being affected by radioactive fallout, public opinion increasingly turned against this source of energy generation. A first act on nuclear phase-out passed by the Social Democratic/Green party coalition in 2002 was dismissed by the Christian Democratic/Liberal coalition in September 2010. However, increasing opposition towards nuclear energy after the Fukushima catastrophe in March 2011 resulted in a change in policy. On June 6th 2011, the Christian Democratic/Liberal German government decided on a new accelerated phase-out with the final shutdown of eight power plants in August 2011 and a complete abandoning of nuclear energy by 2022.

In the light of substantial public opposition against the use of nuclear energy the question arises as to what extent far-reaching events such as nuclear accidents or changes in nuclear policy are reflected in subjective assessment. Regarding ongoing public discussions in Germany, such an analysis is of particular interest since nonmonetary gains in measures of subjective perception might provide further aspects to be taken into consideration when evaluating the economic costs of the energy turnaround. Using data of the German Socio-Economic Panel (SOEP) for the year 2011, we investigate the impact of the Fukushima accident and the subsequent decision on nuclear phase-out on reported subjective life satisfaction and concerns about the environment. Taking advantage of a set of new variables included in the SOEP directly after the Fukushima accident, we further analyze the effects of the phase-out on fears about nuclear power plant security as well as on the reliability of energy supply without the use of nuclear energy. In order to control for personal involvement, we complement our analysis by additional models that account for the distance from the respondents' place of residence to the nearest active nuclear power plant.

The remainder of the article is organized as follows: Section 2 looks into the relevant literature followed by a presentation of the data source and empirical strategy in Section 3.

Section 4 discusses the results of our baseline models whereas Section 5 presents the findings of the extended models including regional characteristics. The paper closes with a conclusion.

## 2. Literature

There is a growing field of economic literature looking into potential effects of international catastrophes such as the attacks of 9/11 in the United States, Hurricane Katrina, the earthquake 2005 in Pakistan, and the nuclear accidents in Chernobyl or in Fukushima on measures of subjective perception. Most of the literature focuses on subjective life satisfaction but there are also a number of studies that focus on subjective fears.

Berger (2010) analyzes effects of the 1986 Chernobyl accident on happiness and environmental concerns in Germany. While her results support the thesis that environmental concerns are affected by nuclear accidents, no such evidence is found concerning an impact on reported happiness. Danzer & Danzer (2011) test the long run influence of the Chernobyl accident on subjective life satisfaction in the Ukraine. As expected they find a negative impact on happiness for individuals exposed to the catastrophe. Remennick (2002) analyzes the health of Chernobyl survivors that immigrated into Israel whereas Bromet et al. (2000) focus on the happiness of local children that were infants or unborn at the time of the accident. Further economic or socioeconomic literature on the relationships between subjective life satisfaction respectively concerns about the environment and nuclear accidents is on the rise. As the events in Fukushima happened only recently, existing works mainly focus on Chernobyl.

Exceptions are Hommerich (2012), who investigates the effects of the Fukushima accident on trust and happiness in two Japanese regions and Rehdanz et al. (2013) who use Japanese panel data in combination with regional information about the respondents' place of residence to analyze the effects of the Fukushima nuclear catastrophe on individual well-being in Japan. Using a difference-in-difference approach they find that individual well-being declined after the catastrophe with increasing proximity to the site of the accident. Using US data, Greenberg (2009) examines differences between people who live near nuclear facilities and a control group from other regions. The findings suggest that people who live near reactors have greater concerns about nuclear issues than the control group.

Thematically related, Luechinger & Raschky (2009) analyze the effect of natural disasters on life satisfaction, but focus on flood catastrophes. Their findings point out that flood

catastrophes are negatively related with life satisfaction. Carroll et al. (2009) estimate the effects of droughts on happiness in Australia in order to quantify arising costs.

Hinman et al. (1993) and Cha (2013) assemble a list of environmental risks. By means of international data they find out that risks about nuclear issues such as nuclear accidents are top ranked. The studies of Kimball et al. (2006) and Metcalfe et al. (2011) investigate the impact of catastrophes on happiness in the country of the accident and in other countries. Kimball et al. show amongst others that the earthquake in Pakistan in the year 2005 has an impact on life satisfaction in America. Metcalfe et al. provide evidence that the terror attacks of 9/11 have a significant impact on people's life satisfaction in the UK.

The literature on the effects of general socioeconomic determinants of happiness is broader, including Easterlin (1995) on income, Clark & Oswald (1994) on unemployment status, or Frijters & Beatton (2012) on age as prominent representatives. Good surveys are provided by Diener et al. (1999) and Stutzer & Frey (2010), among others. For literature on socioeconomic determinants of environmental concern see Berger (2010) and Shen & Saijo (2007).

### **3. Data & Empirical Strategy**

We model the effects of the Fukushima nuclear accident and the subsequent change in nuclear policy on life satisfaction, on concerns about the environment as well as on concerns about the reliability of energy supply without the use of nuclear energy and on fears about the safety of nuclear power plants. Our working hypothesis is that the accident has a significant impact on environmental concerns, i.e. leads to an increase in fears. In contrast, the nuclear phase-out could increase subjective life satisfaction and worries about reliable energy supply but lead to a decrease in fears concerning nuclear power plant security.

We use data from the SOEP v28-edition (SOEP, 2012), a population-representative panel survey conducted in Germany (Wagner et al., 2007). Our constructed data set comprises the year 2011. To operationalize subjective perception we use four different single-item measurements included in the SOEP: Worries about environmental protection, about the reliability of energy supply without the use of nuclear energy and about the security of nuclear power plants are captured on an ordinal three category scale, originally coded "very worried",

“slightly worried” and “not worried”. For ease of interpretation, all variables are mirrored.<sup>1</sup> The more comprehensive question on life satisfaction in general is answered on an 11-point scale ranging from “completely dissatisfied” to “completely satisfied”.<sup>2</sup>

While the variables concerning environmental protection and life satisfaction in general are available for all waves of the panel, both the question on worries about the reliability of energy supply and the question on security of nuclear power plants have been included in the SOEP surveys since April 2011. The main independent variables consist of dummy structures describing the various time periods of interest. Additionally we control for a set of common socioeconomic variables including age, age squared, health, gender, log of monthly household income, marital status, children in household, educational level, and labor market status in addition to regional dummies.

The empirical strategy consists of the following steps: For the models on general life satisfaction and environmental concerns, we divide the observation period into three sub-periods. The questionnaires completed before the Fukushima accident are considered as control group, and the effect periods include (1) the weeks after the Fukushima catastrophe until the day before the decision on nuclear phase-out (03/11/2011 – 06/05/2011) and (2) the months after the government resolution (06/06/2011 – 09/30/2011). Regarding the questions on concerns about the reliability of energy supply and about nuclear power-station safety we use a modified layout in the corresponding models, where the period from April 1st until June 5th is used as reference period. The effect period between June 6th and September 30th should thus reflect the effects of the government resolution on nuclear phase-out.

Finally one might argue that the size of potential effects depend on regional differences, especially the distance to the nearest nuclear power plant. To account for this possibility, we extend the preceding analysis by including a distance measure and the interaction between our effect variables and the distance indicator. In the SOEP, access to the respondents’ geographical location is limited for privacy protection. However, the data at hand allows regional identification on a Raumordnungsregion (ROR) level – planning units that divide

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<sup>1</sup> The exact passages in the questionnaire are: “*What is your attitude towards the following areas – are you concerned about them (Environmental Protection; Security of Nuclear Power Plants; Reliability of Energy Supply Without the Use of Nuclear Energy)?*” Possible answers are “*Very worried*”, “*Slightly worried*” and “*Not worried*”.

<sup>2</sup> The exact passages in the questionnaire are: “*In conclusion, we would like to ask you about your satisfaction with your life in general. Please answer according to following scale: 0 means ‘completely dissatisfied’, 10 means ‘completely satisfied’. How satisfied are you with your life, all things considered?*”



Germany into 96 regions of an average size of 3,720 square kilometres (1,436 square miles) and an average population of 852,539. Hence, for each ROR  $z$  with a population of  $POP_z$ , we calculate a population-weighted average distance to the nearest active nuclear power station:

$$DIST_z = \sum_{i=1}^n \left( \frac{POP_i}{POP_z} \right) \cdot DIST_i$$

where  $POP_i$  is the population in community  $i$  of ROR  $z$  with a distance of  $DIST_i$  to the nearest active power station. The population data is obtained from the Statistisches Bundesamt (2012). We also take into account active nuclear power plants in directly neighbouring countries within a 100-km radius around Germany. The following sections present our empirical results.

#### 4. Baseline Models

Table 1 shows the estimates for the effects on reported subjective life satisfaction. As outlined in the previous section, we compare both the period directly after the Fukushima accident and the months following the government decision on nuclear phase-out to the weeks before the catastrophe of March 2011. In detail, we divide our 2011 sample period in three sub-periods: The period from the beginning of February until before Fukushima, the period directly after the accident and the period after the government's resolution on the nuclear phase-out.

In Table 1 we present the main results for our estimates on life satisfaction using the described dummy structure. Berger (2010) finds little evidence on the existence of an effect of the Chernobyl nuclear disaster on subjective life satisfaction. However, since our models include both, the Fukushima accident as well as the subsequent decision on a nuclear phase-out, we examine whether reported levels of happiness show sensitivity to any of the two events. As happiness is reported on an 11-point ordinal scale it is relatively save to regard the variable as continuous. Following Ferrer-i-Carbonell & Frijters (2004) we hence estimate the model equations using ordinary least squares (column 1) and report ordered logit parameters as robustness check (column 2). As in all models of the study we include a common and appropriate set of socioeconomic control variables. Detailed information on the variables is included in the notes of each table. The estimated parameters of the control variables in all models show the expected signs and magnitudes and are not reported. The full estimates are available upon request.

**Table 1**

Fukushima accident and nuclear power phase-out in Germany: Models on life satisfaction

<i>Life satisfaction</i>	OLS	Ordered logit
<i>Before Fukushima accident:</i> 02/01/2011 – 03/10/2011	(Ref.)	(Ref.)
<i>Fukushima accident:</i> 03/11/2011 – 06/05/2011	0.058 (0.040)	0.063 (0.049)
<i>Nuclear power phase-out:</i> 06/06/2011 – 09/30/2011	0.184*** (0.052)	0.261*** (0.065)
Observations	14097	14097
(Pseudo) $R^2$	0.324	0.102

Notes: OLS and ordered logit estimates; dependent variable: General life satisfaction (coded: 0 – 10); robust standard errors in brackets; coefficients of the models, with error probability in parentheses: \*\*\* $p < 0.01$  - \*\* $p < 0.05$  - \* $p < 0.1$ ; cross section weights for all waves; controlled for other exogenous variables: Health, gender, age, age (squared), log household income, child in household, marital status, employment status, education, worries about own economic situation and overall economic development, state dummies and regional dummy (East).

Columns 1 and 2 in Table 1 show no evidence for an influence of the Fukushima nuclear disaster on subjective life satisfaction in Germany. Both estimates – OLS and ordered logit – show insignificant parameters. Similar to the findings of Berger (2010) we are able to confirm that major nuclear accidents appear to have no direct influence on subjective life satisfaction in Germany. However, we find clear evidence for an increase in reported levels of happiness by 0.184 scale points (OLS estimate – column 1) for the time after the decision on the nuclear phase-out in Germany. This sharp increase is also confirmed by the corresponding ordered logit parameters reported in column 2 that equal the OLS coefficients in direction and significance. In summary, the Japanese nuclear disaster shows no direct influence concerning life satisfaction in Germany, but the subsequent German nuclear phase-out decision results in positive, significant and robust effects on life satisfaction in Germany. Hence one can interpret the increase in life satisfaction after the phase-out decision as nonmonetary gains for the German public.

**Table 2**

Fukushima accident and nuclear power phase-out in Germany: Model on worries about the environmental protection

<i>Worries about environmental protection</i>	$\frac{\partial \Pr(y_i = \text{not worried})}{\partial x_i^j}$	$\frac{\partial \Pr(y_i = \text{slightly worried})}{\partial x_i^j}$	$\frac{\partial \Pr(y_i = \text{very worried})}{\partial x_i^j}$
<i>Before Fukushima accident:</i> 02/01/2011 – 03/10/2011	(Ref.)	(Ref.)	(Ref.)
<i>Fukushima accident:</i> 03/11/2011 – 06/05/2011	-0.023*** (0.005)	-0.027*** (0.006)	0.050*** (0.011)
<i>Nuclear power phase-out:</i> 06/06/2011 – 09/30/2011	0.008 (0.006)	0.009 (0.007)	-0.017 (0.012)
Observations		16181	
Pseudo $R^2$		0.016	

Notes: Ordered logit estimates; dependent variable: Worries about environmental protection (coded 1 – 3); marginal effects; robust standard errors in brackets; coefficients of the models, with error probabilities in parentheses: \*\*\*p<0.01 - \*\*p<0.05 - \*p<0.1; cross-section weights; other exogenous variables: Gender, age, age (squared), log household income, child in household, marital status, employment status, education, state dummies and regional dummy (east).

Table 2 shows the main results for the specification in which we assess the effects on reported worries about the environment. All reported parameters are marginal effects calculated from pooled cross-section ordered logit regressions. For clarity, we report the marginal effects for all outcomes as “not worried”, “slightly worried” and “very worried”. It is expected that any changes in fears related to the nuclear accident would predominantly appear in the category “very worried”. Whereas the parameters for the months after the resolution on nuclear phase-out are of no significance, highly significant effects on reported worries about the environment can be observed for the weeks immediately after the Fukushima catastrophe. In particular, the probability of reporting very high concerns about environmental protection increased by up to 5 percentage points compared to the reference period. A closer inspection of the estimated probabilities for the other two outcomes further reveals that this increase in very high fears does not just rely on answers by respondents with some already-existing ecological sensitivity (-2.7 percentage points) but also seems to be a result of a changed perception among people who previously reported no worries about environmental protection (-2.3 percentage points). We note that the ecological awareness among the German public is sensitive about international environmental disasters such as the one in Fukushima, potentially leading to non-pecuniary costs for the German public (c.f. Berger, 2010).

As a final step in this section we alter our model to include two new variables measuring the worries about the reliability of energy supply without the use of nuclear energy and the worries about the security of nuclear power plants, recently included in the SOEP questionnaire directly after the Fukushima events. Hence, we only observe the period from

April 2011 until the end of 2011. As we cannot account for the Fukushima accident, we only consider the two categories before the nuclear phase-out resolution on 06/06/2011, and after the announcement.

**Table 3**

Nuclear power phase-out in Germany: Models on worries regarding the use of nuclear energy

	$\frac{\partial \Pr(y_i = \textit{not worried})}{\partial x_i^j}$	$\frac{\partial \Pr(y_i = \textit{slightly worried})}{\partial x_i^j}$	$\frac{\partial \Pr(y_i = \textit{very worried})}{\partial x_i^j}$
<i>Worries about the reliability of energy supply without the use of nuclear energy</i>			
<i>Fukushima accident:</i>			
04/01/2011 – 06/05/2011	(Ref.)	(Ref.)	(Ref.)
<i>Nuclear power phase-out:</i>	0.022	-0.011	-0.011
06/06/2011 – 09/30/2011	(0.017)	(0.008)	(0.008)
Observations		4039	
Pseudo $R^2$		0.020	
<i>Worries about the security of nuclear power plants</i>			
<i>Fukushima accident:</i>			
04/01/2011 – 06/05/2011	(Ref.)	(Ref.)	(Ref.)
<i>Nuclear power phase-out:</i>	0.073***	0.018***	-0.091***
06/06/2011 – 09/30/2011	(0.012)	(0.004)	(0.015)
Observations		4048	
Pseudo $R^2$		0.034	

Notes: Ordered logit estimates; dependent variable: Worries about the reliability of energy supply without the use of nuclear energy (coded 1 – 3), worries about the security of nuclear power plants (coded 1 – 3); marginal effects; robust standard errors in brackets; coefficients of the models, with error probabilities in parentheses: \*\*\* $p < 0.01$  - \*\* $p < 0.05$  - \* $p < 0.1$ ; cross section weights; other exogenous variables: Gender, age, age (squared), log household income, child in household, marital status, employment status, education and state dummies.

The top half of Table 3 shows the results of the estimation on worries about the reliability of energy supply without the use of nuclear energy. The bottom half of Table 3 presents the estimates on concerns about the safety of nuclear power stations. In both parts a pooled cross-section ordered logit model approach is used. We also report the marginal effects for all three possible outcomes of the dependent variable.

The results in the bottom half of Table 3 resemble our earlier findings on life satisfaction with the central result being the parameter in the last column: Being interviewed after the government's resolution on nuclear phase-out reduces the probability to be very worried about the security of nuclear power plants by 9.1 percentage points. Accordingly, being interviewed after the announcement increases the probability of reporting no worries or only slight concerns by 7.3, respective 1.8 percentage points. All effects are highly significant. Concerning reported worries about the reliability of energy supply without the use of nuclear

energy, no significant effects are detected for the period after the actual phase-out decision (c.f. top half of Table 3). We conclude that the phase-out decision reduces the probability to report greater worries about nuclear power plant security. Interestingly, the German public does not seem to relate the decision to the expected reliability of energy supply. The results are in line with our previous findings, indicating nonmonetary gains generated by the phase-out decision.

## 5. Regional Models

As shown in the preceding analyses, both the Fukushima accident and the announcement of nuclear phase-out appear to have a significant influence on subjective perception in the German public. One might argue, however, that the effects are predominantly determined by regional influences, especially the varying proximity to active nuclear power plants, resulting in different levels of sensitivity. To account for this possibility, we include the distance proxy described in Section 3 and interact it with our effect variables. Since, in the preceding analyses, predominant effects were observed for the outcome “very worried”, we focus on this category by testing its probability against the two other possibilities using a standard logit approach. For consistency we generate a dummy variable for life satisfaction as well. This indicator is coded 1 above the mean of seven and zero below. Following Winkelmann and Winkelmann (1998) we hence model the effect category for people with high life satisfaction. Table 4 reports the estimated results of all regional interaction models for each endogenous variable used in the previous analyses. All logit models are estimated including the weighted distance measures. The interaction effects are reported at means. Furthermore Figure 1 visualizes this influence of the respondents’ distance to the nearest active power plant on worries about the environment and on worries about the security of nuclear power plants. Both models are visualized because of detected regional influences. In detail, Figures 1a, 1c and 1e correspond to the main effects of the estimates reported in Table 4 columns 2 and 4. Figures 1b, 1d and 1f show the distribution of each corresponding interaction effect. To avoid possible biased estimates arising from the use of interaction terms in nonlinear models, the corresponding coefficients, standard errors and visualizations are calculated according to Norton et al. (2004) and Mitchell and Chen (2005).

**Table 4**

Fukushima accident and nuclear power phase-out in Germany – distance to the nearest active power plant

	Life satisfaction	Environement	Energy supply	Power plant security
<i>Before Fukushima accident:</i> 02/01/2011 – 03/10/2011	(Ref.)	(Ref.)		
<i>Fukushima accident:</i> 03/11/2011 – 06/05/2011	0.0129 (0.0130)	0.0554*** (0.0119)	(Ref.) <sup>a</sup>	(Ref.) <sup>a</sup>
<i>Nuclear power phase-out</i> 06/06/2011 – 09/30/2011	0.0470*** (0.0176)	-0.0059 (0.0141)	-0.0142 (0.0125)	-0.1106*** (0.0174)
<i>Distance to the nearest active power plant (weighted)</i>	-0.0004 (0.0003)	0.0004 (0.0002)	0.0002 (0.0003)	0.0002 (0.0004)
<i>Fukushima accident *</i> <i>Distance (weighted)</i>	0.0001 (0.0002)	-0.0005*** (0.0002)		
<i>Nuclear power phase-out *</i> <i>Distance (weighted)</i>	0.0003 (0.0002)	-0.0004** (0.0002)	-0.0003 (0.0002)	-0.0005** (0.0003)
Observations	14097	16181	4039	4048
Pseudo R <sup>2</sup>	0.2098	0.0161	0.0299	0.0435

<sup>a</sup>Reference Period: (04/01/2013 – 06/05/2013)

Notes: Logit estimates; dependent variables: General life satisfaction (0/1), worries about environmental protection (0/1), worries about the reliability of energy supply without the use of nuclear (0/1), worries about the security of nuclear power plants (0/1); marginal effects: Probability of being “very worried”; robust standard errors in brackets; coefficients of the models, with error probabilities in parentheses: \*\*\*p<0.01 - \*\*p<0.05 - \*p<0.1; cross section weights; other exogenous variables: see Table 1, 2 and 3.

Confirming our previous findings, there is no measurable effect of the Fukushima accident on reported life satisfaction. However, regarding the phase-out decision, a respondent at mean distance to the nearest active reactor has a probability of reporting high life satisfaction increased by about 4.7 percentage points (cf. Table 4 – column 1). As the interaction terms are non-significant, these results are not sensitive to the respondents’ geographic locations. Similarly, the effects on worries about the reliability of energy supply without the use of nuclear energy show no significant regional diversity for the nuclear phase-out decision (column 3). Both parameters and the interaction term are non-significant. In contrast, the interaction effects for concerns about the environment and the worries about the security of nuclear power plants turn out to be highly significant, indicating some degree of regional variation. We note that it is not the absolute distance to the nearest nuclear power plant that drives these effects, which is non-significant throughout all models. According to column 2 of Table 4, the sole probability of reporting very high concerns about the environment increases by about 5.5 percentage points when the interviews are conducted in the weeks after the Fukushima accident. However, each additional kilometer between a respondent’s place of

residence and the nearest active reactor has an average compensatory effect of about 0.05 percentage points (c.f. Figures 1a and 1b).

Following the announcement of the nuclear phase-out, the estimated probability of reporting very high concerns about the security of nuclear power plants decreases by 11.1 percentage points on average (c.f. Table 4, column 4). With increasing distance to the nearest active reactor, the predicted probability of being very worried about the security of nuclear plants decreases even further (about 0.05 percentage points per kilometer). The corresponding interaction term can be located as the difference of the slope of the effect line minus the slope of the reference line (c.f. Figure 1e). Thus, it can be concluded that even though the resolution of a nuclear phase-out leads to a decrease in fears, this relief is less pronounced the nearer the respondent lives to an active nuclear reactor. Taking into account that the process of complete nuclear phase-out in Germany is supposed to last until the year 2022, these results can also be interpreted as a reflection of the higher sensitivity towards atomic energy when one lives in the vicinity of a nuclear power station.

Fig. 1a: Fukushima accident: Predicted probability of being “very worried” about the environment

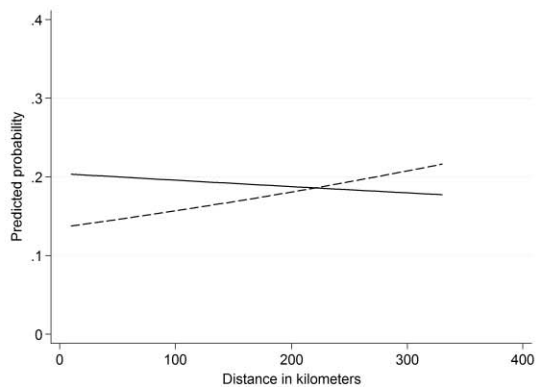


Fig. 1b: Interaction effect: Fukushima accident \* distance – probability “very worried” about the environment

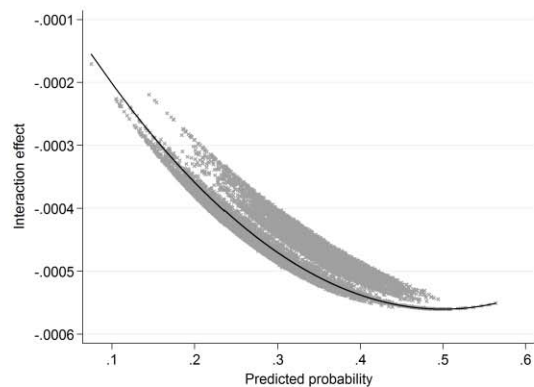


Fig. 1c: Phase-out: Predicted probability of being “very worried” about the environment

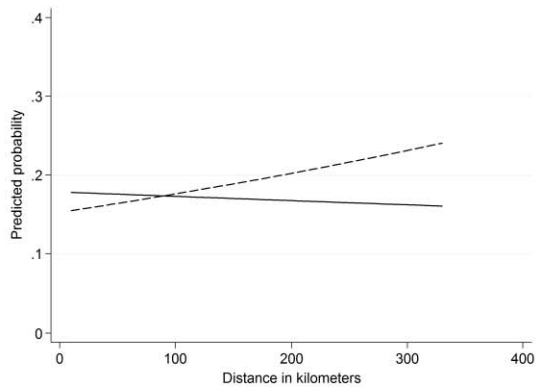


Fig. 1d: Interaction effect: Phase-out \* distance – probability “very worried” about the environment

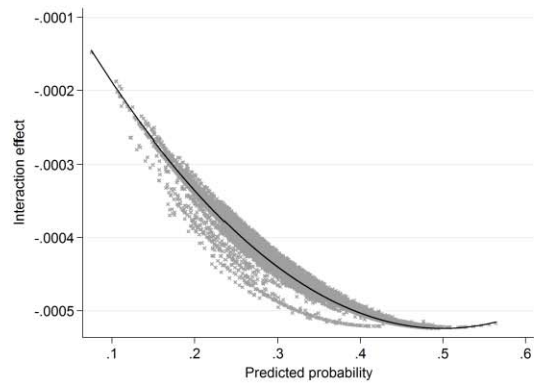


Fig. 1e: Phase-out: Predicted probability of being “very worried” about the security of nuclear plants

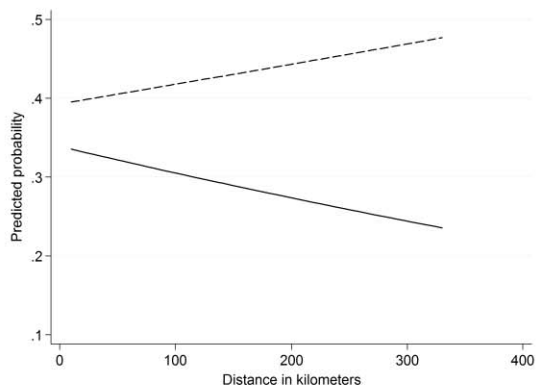
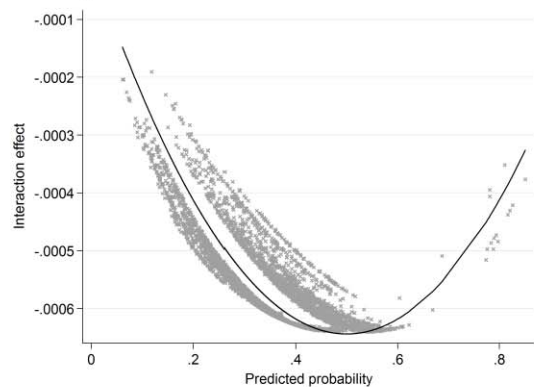


Fig. 1f: Interaction effect: Phase-out \* distance – probability “very worried” about the security of nuclear plants



Notes: All Fig.: logit estimations (controlled for correct marginal effects in non-linear equations with interaction terms).

Fig. 1a: Dashed line, reference period (before Fukushima accident) – solid line, effect period (Fukushima accident).

Fig. 1c: Dashed line, reference period (before Fukushima accident) – solid line, effect period (nuclear phase-out).

Fig. 1e: Dashed line, reference period (Fukushima accident) – solid line, effect period (nuclear phase-out).

Fig. 1b, 1d, 1f: Solid line – Incorrect marginal effects, crosses – correct marginal effects.



## 6. Conclusion

The use of nuclear power is often controversially discussed. While widely accepted as a power source, it also faces strong public opposition in some countries. Major nuclear accidents as in Chernobyl or recently in Fukushima set nuclear power plant security on top of the public agenda. In Germany, facing public pressure, a nuclear power phase-out plan was passed by the government in the aftermath of Fukushima 2011.

In this article, we analyze the effects of the Fukushima nuclear accident and the subsequent phase-out on subjective perceptions in Germany, using four single item measurements from the SOEP: general life satisfaction, concerns about the environment, worries about the reliability of energy supply without the use of nuclear energy and concerns about the safety of nuclear power stations.

Our findings suggest that the Fukushima accident itself led to an increase in the probability of reporting high concerns about environmental protection of about 5 percentage points. Moreover, both, general life satisfaction and worries about the safety of nuclear power plants are strongly affected by the governments decision on nuclear power phase-out, resulting in an increase in reported levels of happiness by 0.184 scale points (OLS estimates) on a scale from zero to ten, respectively a decline in the probability of being very worried about power plant security of 9.1 percentage points. While the respondents' individual geographic proximity to an active nuclear power plant turns out to be insignificant in context of general life satisfaction, the magnitude of the detected effects for environmental concerns as well as fears about nuclear power plant safety depend on such regional characteristics.

In summary, our results are conclusive that catastrophes and changes in policies can have an immediate impact on public perception. While these results are consistent with reasonable prior beliefs, this study adds to the literature that provides empirical evidence, and provides an approximation of the magnitude of such effects. Moreover, one can conclude that the German government's decision on an energy turnaround in the weeks after the Fukushima accident had a significant positive influence on the German public perception. Even though the corresponding effects are of nonmonetary nature and are thus difficult to compare with the classical monetary costs associated with the accelerated nuclear phase-out, they should probably still be taken into consideration when evaluating the total economic welfare effect of this change in policy.

These positive subjective externalities appear even more pronounced when taking into consideration that no evidence was found for an increase in concerns about the reliability of energy supply without the use of nuclear energy during the weeks after the actual government resolution. However, it should be noted that the analysis presented here focuses on a short to medium time horizon after the actual events. It is up to future research to look into longer term effects that could for instance be caused by continuously rising energy prices as observed in recent years.

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