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Analysis

Fukushima and the preference for nuclear power in Europe: Evidence from subjective well-being data

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ABSTRACT

The sustainable supply of energy is high on the agenda of many European countries. One of the pertinent issues, the future role of nuclear power, has gained increasing attention after the nuclear disaster at Fukushima, Japan. As a contribution to preference elicitation, we test whether the relationship between subjective well-being (SWB) of European citizens and the supply of nuclear power has changed after the Fukushima nuclear accident of March 11, 2011. Survey data for about 124,000 individuals in 23 European countries reveal that while European citizens' SWB was statistically unrelated to the share of nuclear power before the Fukushima disaster, it was negatively related to the nuclear share after the disaster. Taking the relationship between SWB and the nuclear share as an indicator of preference, this suggests the existence of an induced preference change.

1. Introduction

The sustainable supply of energy is high on the agenda of many European countries. A controversial issue in this context is the future role of nuclear power. While some countries, such as Germany, have long been skeptical towards nuclear energy, France has recently extended the lifetime of its nuclear power plants, and the UK is planning to build new ones.

With respect to sustainability and the environment, nuclear power may appear attractive since it is largely free from greenhouse gases and air pollution, but it poses unresolved problems of nuclear waste disposal and the latent threat of nuclear disaster. The latter issue has recently gained renewed attention in the aftermath of the nuclear accident at Fukushima, Japan. This disaster may have altered European citizens' perceptions of nuclear safety, that is, of subjective accident probabilities as well as expectations as to the damage potential of an accident. Moreover, increased concern over nuclear safety may have affected people's subjective well-being, and this effect, if any, can be expected to be larger the greater is the contribution of nuclear power to a country's power supply.

A number of studies have found that the disaster at Fukushima–Daiichi on March 11, 2011, caused mental distress not only among people directly affected (Ohtake and Yamada, 2013; Rehdanz et al., 2013) but, due to media coverage, in people thousands of miles away from the place of the event. Goebel et al. (2013) for instance found an increase in environmental concern in Germany after the Fukushima disaster. Similarly, an increase in German people's concern about the environment was found after the Chernobyl nuclear accident in 1986 (Berger, 2010).

In contrast to studying disaster-related well-being per se, the present paper is concerned with the question of whether a disaster abroad – the Fukushima nuclear accident – may have changed the *relationship* between subjective well-being (SWB) and the structure of electricity supply. Using data for about 124,000 individuals in 23 European countries we test whether a relationship exists between SWB and the contribution of nuclear power to power supply in these countries and whether this relationship is different before and after the Fukushima disaster. Taking SWB as a measure of experienced utility (Kahneman et al., 1997) we interpret a change in the SWB–nuclear relationship as a change in people's implicit preference for nuclear power, as will be explained in the next section.

We find that European citizens' SWB was statistically unrelated to the contribution of nuclear power before the Fukushima disaster but negatively and significantly related to nuclear power after the disaster. This change in the SWB–nuclear relationship is robust to several specifications. Quantitatively, a 1-standard-deviation increase in the supply share of nuclear power is associated with a drop in SWB comparable to the drop associated with major personal life events. The change in the SWB–nuclear relationship applies to women and men, to all age

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groups and to environmentalists and non-environmentalists, but was stronger in the former than the latter.

We note that the percentage contribution to a country's power supply is a crude approximation to (perceived) exposure to nuclear risk. Arguably, the latter might be better represented by distance to nuclear power stations. Rehdanz et al. (2013) have pursued such an approach for the case of Japan. They found no change in the relationship between SWB and the distance to the nearest nuclear power plant after the Fukushima disaster, which, they argue, reflects the fact that nuclear plants were shut down after the event. Goebel et al. (2013) used German data and found that changes in SWB after Fukushima did not differ between respondents within and outside a radius of 5 km from the nearest nuclear power plant, whereas changes in environmental concern did differ according to distance. To the best of our knowledge, similar studies on a European scale have not been undertaken, presumably because information on the location of respondents in European-wide surveys is relatively crude.

The paper is organized as follows. Section 2 explains our general approach and conceptual framework. Section 3 presents the empirical framework and Section 4 the empirical results. Section 5 concludes.

2. General Approach and Conceptual Framework

2.1. Experienced Preference

Previous literature has used data on SWB as a novel tool for measuring people's preferences for non-market goods. Examples with respect to environmental preferences include Welsch (2002, 2006), Rehdanz and Maddison (2005), Van Praag and Baarsma (2005), Luechinger (2009), Ferreira and Moro (2010), Levinson (2012), and Welsch and Biermann (2014).

The SWB approach to preference elicitation involves using these data as a proxy for experienced utility (Kahneman et al., 1997) and to employ them as the dependent variable in a preference function over non-market goods. In contrast to stated preference methods, this approach – dubbed by Welsch and Ferreira (forthcoming) the experienced preference approach – does not rely on what people say about their preference, but solely on the statistical association between SWB and the non-market good in question. While the experienced preference approach requires to make the non-standard assumption of ordinal interpersonal comparability of utility (Ferrer-i-Carbonell and Frijters, 2004), it avoids problems of strategic or socially desired response inherent in stated preference methods (Welsch and Ferreira, forthcoming).

2.2. Conceptual Model and Hypotheses

The non-market good considered in this paper is perceived nuclear safety, denoted by S. The preference for S is captured by a strictly increasing utility function $U(S,A)$, where A denotes attributes of nuclear power other than safety (e.g. cost, pollution).

Perceived nuclear safety is assumed to be inversely related to subjective accident probability, p, and to the subjective expected damage associated with an accident, D; hence $S = f(p,D)$ with negative partial derivatives. Moreover, the subjective probability of a nuclear accident in a country is assumed to be increasing in the contribution of nuclear power to overall power supply, N, that is, $p = p(N)$ with $p(0) = 0$.[1]

We thus have $S = f(p(N),D) =: g(N)$ as the (downward-sloping) relationship between perceived nuclear safety and nuclear power supply and $U = U(S,A) = U(g(N),A) =: V(N)$ as a reduced-form utility function. The latter represents the preference for nuclear power in terms of perceived safety and other attributes. Its slope is undetermined a priori.

[1] The latter assumption neglects the possibility of nuclear risk from power plants abroad.

We hypothesize that the Fukushima nuclear accident may have changed the functions $g(N)$ and, hence, $V(N)$ by changing European citizens' assessment of accident probabilities associated with a given level of N (that is, p) and/or their assessment of the damage potential of an accident (that is, D). In addition, the accident may have changed $V(N)$ by changing the utility weights people place on nuclear safety relative to other attributes and it may have raised people's awareness of the role of nuclear power (N) in their countries.

3. Empirical Framework

3.1. Econometric Strategy

Our aim is to test whether the reduced-form utility function $U = V(N)$ is different before and after the Fukushima nuclear accident. To do so, we use SWB data elicited in surveys as a proxy for U and specify $V(N)$ as follows:

$$SWB_{ict} = \alpha * nuke_{ct} + \beta * post_{ict} + \gamma * post_{ict} * nuke_{ct} + \delta \cdot controls_{ict} + country_c + time_t + \varepsilon_{ict}$$

where *nuke* is the percentage of nuclear power in the electricity mix, *post* is a dummy variable taking the value 1 if *SWB* was elicited after the Fukushima accident (March 11, 2011) and 0 otherwise, *controls* is a vector of control variables, *country* and *time* are fixed effects, ε is the error term, and i, c and t denote individuals, countries and time periods, respectively. The vector of controls comprises person-specific (micro) variables (sex, age, marital status, household size, employment status, household income) and macro variables (GDP per capita, inflation rate, unemployment rate). The *country* dummies account for unobserved time-invariant country characteristics that affect well-being whereas the *time* dummies account for unobserved time-specific well-being factors that are common to all countries.

With respect to the time dimension it should be noted that the variable *nuke* is measured on an annual basis (as are the macro controls) whereas the person-specific variables, in particular *SWB*, are identified by calendar date. For the *time* fixed effects we use several alternative specifications capturing the quarter, year and season in which *SWB* was measured. Controlling for season serves to account for seasonal mood patterns (Rosenthal, 2006) that may interfere with the Fukushima event.

In the specification above the coefficient on *nuke* measures the relationship between nuclear power generation and SWB before the Fukushima accident whereas the coefficient on *post* * *nuke* measures if and how that relationship has changed after the accident. Likewise, it measures if and how a change in SWB at the time of the accident varies with nuclear power. The coefficient on *post* measures a change in SWB in countries without nuclear power. Consistent with the conceptual model in Section 2.1, these countries serve as the control group where nuclear risk is assumed to be absent. A change in their SWB at the time of the event (nonzero coefficient on *post*) may have any reason and cannot necessarily be attributed to the Fukushima disaster. Rather than the coefficient on *post*, the crucial parameter in our analysis is the coefficient on *post* * *nuke*. It represents our hypothesis that at the time of the event the relationship between life satisfaction and nuclear power changed or, equivalently, that life satisfaction changed *differently* in countries with different nuclear shares (difference-in-differences). Specifically, we expect the coefficient on *post* * *nuke* to be negative.[2]

[2] Our approach assumes that people have some knowledge of the importance of nuclear power in their countries. In particular, the Fukushima event may have directed their attention to this issue. A change in the relationship between life satisfaction and nuclear power after the accident, if any, may thus partly reflect people's increased awareness of the role of nuclear power. To account for the circumstance that knowledge may be imprecise, we run an additional regression with broad categories of nuclear percentages.