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Analysis

The power of green defaults: the impact of regional variation of opt-out tariffs on green energy demand in Germany

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ABSTRACT

The present paper focuses on green defaults as demand-side policies supporting the uptake of renewable energy in Germany. It sets out to gain a better understanding of whether and for whom green electricity defaults work. The present study is one of the first to use a large-scale data set to investigate this question. We combine micro-level data from the German Socio-Economic Panel (GSOEP) covering private households (including a wealth of individual information) with macro-level information such as population density of a region and proportion of energy suppliers in a given region that use a green opt-out tariff within their basic supply. We show that in Germany, green defaults, automatically enrolling customers in renewable energy sources, tend to stick, especially but not only among those who are concerned about the problem of climate change. This finding, based on real-world rather than experimental evidence, attests to the power of automatic enrollment in addressing environmental problems in Germany and potentially beyond, including climate change, and also adds to the growing literature on the substantial effects of shifting from opt-in to opt-out strategies.

1. Introduction

It is widely known that many industrialized countries are struggling to limit their greenhouse gas emissions according to their commitments under the Paris Agreement (COP21) and the 2030 Agenda. For years, the International Panel on Climate Change (IPCC, 2015) has been highlighting the importance of limiting and decarbonizing energy demand to keep warming to below 1.5 °C. Energy use and energy sources of production and consumption patterns constitute crucial issues in the climate debate, and climate and energy politics are inextricably connected. Based on scenario models, some experts urge that by 2050, energy production should be fully decarbonized – which means a stepwise reduction in using fossil fuels and a simultaneous increase in renewable energy sources (Rogelj et al., 2018). Alongside this major shift in energy production, reducing energy consumption, and increasing efficiency are major strategies to mitigate climate change.

Governments worldwide use different strategies and policies to achieve these goals; and paths and priorities to decarbonize and increase efficiency and sufficiency differ profoundly. In the present paper, we use data from Germany where the "Energiewende" (energy transition towards renewable energies and phasing out of nuclear energy) started politically in 2011 (Ethics Commission for a Safe Energy Supply, 2011). Since then, a profound transformation process has taken place in the energy industry and among sources of electricity production. In less than a decade, renewable energies (mostly solar and wind, to a lesser degree biomass, thermal, and others) have developed from a small niche market to the nation's most important source for electricity. In the first half of 2019, electricity produced from renewable energies made notable gains with about a 10% increase compared to 2018, and this energy now accounts for about 44% of total consumption (AGEE-Stat, 2019).

Notwithstanding the immense social challenges and economic costs (particularly for the individual households facing high energy prices, see e.g. IASS, 2017), the German population still strongly (about 90%) backs the Energiewende eight years into the project (AEE, 2019). The German Government's "Climate Cabinet" recently promised to act more rapidly and to prioritize climate change mitigation strategies and policies long agreed to in the National Climate Protection Plan (BMUB, 2016). For many officials and observers, making renewable energies the most important primary source of the future is one of the key policy goals on both the global (Gielen et al., 2019) and the national level (BMUB, 2016).

Meanwhile, experts and planners are keenly aware that it will not be enough to transform only the supply side of markets (e.g. Creutzig

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et al., 2018). As outlined by the "Ethics Commission for a Safe Energy Supply" (Ethics Commission for a Safe Energy Supply, 2011) and repeated by the German Academy of Technical Sciences (Acatech et al., 2017, 2018), the same attention, effort, and policy support are needed to promote transformation of the demand side, i.e., the small and large private and public households in their role as energy and electricity users. Household consumption, in general, puts great pressure on the environment, accounting for approximately 60% of global greenhouse gas emissions (Ivanova et al., 2016). Energy and electricity are needed in practically all consumption domains as well as at work, from ICT applications to heating and cooling, to mobility and travel, to the food system that is responsible for a large share of indirect energy use.

A key strategy for reducing greenhouse gas emissions is a massive shift in demand from carbon-intensive energy (mainly coal and oil) to "green," i.e., environmentally friendly, renewable, carbon-free energy sources such as wind, solar, biomass, and thermal energy. Nuclear power, another CO2-neutral ("clean") form of energy production, will be phased out stepwise until 2022 due what officials have deemed to be its high risks for the present and the unsustainable burden for future generations (Ethics Commission for a Safe Energy Supply, 2011). Demand-side policies may include "strategies targeting technology choices, consumption, behaviour, lifestyles, coupled production-consumption infrastructures and systems, service provision, and associated socio-technical transitions" (Creutzig et al., 2018, p. 260). The political challenge is to design cost-effective policies to shift the energy demand towards less energy use as well as towards renewable energy sources. In an ideal world, these instruments are effective in influencing diverse consumption domains and target groups; they are robust, inexpensive, flexible, socially acceptable, equitable, and have few unintended side effects such as unwelcome distributional or rebound effects (Reisch and Zhao, 2017). At the same time, if energy providers are involved, these instruments should be easy to implement and not unduly distort competition of markets.

There is growing empirical evidence that simple, low-cost, choice-preserving, behaviourally informed approaches to steer people's choices into desired directions – regulatory nudges – can have marked positive effects (Sunstein, 2014a; Thaler and Sunstein, 2003, 2008), benefiting the environment in general and energy demand in particular (Andor and Fels, 2018; Hacker and Dimitropoulos, 2017; Michalek et al., 2016; Oullier and Sauneron, 2011; Schubert, 2017). *Green nudges* can be defined as stimuli that gently promote environmentally friendly choices and behaviours – that is, that change behaviour without imposing mandates or significantly altering economic incentives. The most relevant strategies are: framing, priming, and giving timely feedback; simplifying information and making it more salient; making information timely, socially relevant, and attractive; using social norms; asking for implementation intentions and offering self-binding commitments ("snudges"); removing barriers to access ("sludge"); and last but not least and perhaps most, pre-selecting choice options (defaults) (Sunstein, 2014b). "Choice architecture" is the careful design of the context in which people make decisions so that availability and accessibility of the better (here: more climate-friendly) option is improved (Thaler and Sunstein, 2008, p. 3). What Thaler (2015) termed "seemingly irrelevant factors" – such as the order of options, the number of options, and the opt-in design – can have major consequences for both decisions and outcomes.

Until recently, however, most demand-side policies were information-based (i.e., information, advice and education, campaigns), used financial incentives and disincentives (such as taxes and subsidies), or came in the form of hard regulation and bans. While environmental policy has often benefited from the use of those traditional instruments, behaviourally informed (BI) policies in the form of choice architecture and regulatory nudges remain comparatively less applied across countries and hence less well empirically tested, also in the field of energy policy (Mundaca et al., 2019). However, in the past decade, the field has experienced enormous advances, and policymakers and non-governmental organizations increasingly pin high hopes on BI policies for environmental and climate goals (e.g., OECD, 2017; Rare and BIT, 2019). The main advantage of such green nudges is that they are generally easy to implement, cheap to generate, and their cost-effectiveness can potentially be very high, even larger than economic incentives. Moreover, in many countries worldwide, citizens largely approve of behavioural-regulation approaches for the environment, including green energy defaults (Sunstein and Reisch, 2019; Sunstein et al., 2018).

A big hurdle, however, is that their effectiveness depends heavily on context and target group, which demands a challenging case-based policy process of designing, testing, adapting, learning, and then deciding on an optimal, target-group-specific policy mix (Troussard and van Bavel, 2018). Practitioners are well-advised to include the target groups for information on their needs and preferences, while also including the general public and electorate for legitimizing these policies in public debate (Peter, 2018). To help practitioners develop and implement such policies in the real world, "policy toolkits" offering guidance through the policy process based on principles of good governance have recently been developed (OECD, 2019).

The present paper focuses on one specific behaviourally informed instrument: green defaults, i.e., a pre-selected choice option for "green" (i.e., renewable) versus "grey" (i.e., non-renewable) electricity, while the non-renewable option can still be chosen by opting out. Defaults have proven to be powerful change-makers in many fields and countries, with substantial variation of effectiveness depending on the domain of application as well as on psychological channels of activation (such as: ease, endorsement, and endowment; Jachimowicz et al., 2019). More specifically, there is convincing empirical evidence (Ebeling and Lotz, 2015; Pichert and Katsikopoulos, 2008) and conceptual support (Sunstein and Reisch, 2013, 2014) for the effectiveness of green tariff defaults to increase renewable energy demand.

Building on this evidence, the present study sets out to gain a better understanding of whether and for whom green electricity defaults work. While there is now a wealth of research focusing on the micro-level of individual energy consumers and households, there is a lack of empirical evidence of the effects and effectiveness of green defaults from a macro perspective. To the best of our knowledge, the present study is one of the first to use a large-scale data set to investigate this question. We combine micro-level data from the German Socio-Economic Panel (GSOEP) covering private households (including a wealth of individual information) with macro-level information such as population density of a region and proportion of energy suppliers in a given region that use a green opt-out tariff within their basic supply.

The focus of our study is Germany. Since its energy market was liberalized in 1998, consumers have had a variety of choices regarding energy providers and energy tariffs. On average, and depending on where they are situated, private households can choose among 124 providers (Bundesnetzagentur (Federal Network Agency), 2019). Today, there are about 1300 electricity providers in Germany, each offering at least two different tariffs (BDEW, 2019). About 80% of the electricity suppliers had at least one green electricity tariff in their portfolio in 2017 (UBA, 2019). Only a few of these, however, offer "deep green" energy certified with trustworthy labels (Ökostrom-Anbieter.info, 2020), and qualitative differences in the product (ranging from "light green" to "deep green") are certainly relevant for consumer choice. Also, trust in the supplier will affect the consumer's interest. However, in the present study, our data do not allow for such analysis. Our main interest lies in the influence of preset options per se. Hence, we broadly (and somewhat loosely) define "green electricity" as those tariffs that, according to the energy provider, are based on 100% renewable energy. We do exclude the market for gas since we lack the needed long-term GSOEP data.

Germany's electricity market is divided into different grid areas with one basic supplier ("Grundversorger") for each area. The basic supplier for each household is preset by default, and is legally obliged to supply every household in the corresponding grid area with electricity, unless another contract has been concluded. More precisely, the German Energy Industry Act (EnWG, 2005) stipulates that energy companies in the grid areas in which they are basic suppliers must supply each household customer on the basis of the general conditions and prices published by them (so-called "Grundversorgung" or "basic provision"). If a household does not choose an energy supplier and/or tariff, it is automatically supplied by the respective basic supplier ("provider default"). The basic supplier is determined by the Net Agency every three years for each grid area; it is always the company that supplies most household customers with electricity within each grid area. Household customers who do not actively opt for an energy company or a tariff are therefore exposed to a double default: both the company and the tariff are preset, and both depend exclusively on the region (i.e., the grid area) in which the customer lives.

Even though this basic tariff (sometimes green, sometimes not) is usually among the most expensive tariffs for households, about 28% of all consumers currently subscribe to it (Bundesnetzagentur (Federal Network Agency), 2019). About 41% purchase electricity from the local basic supplier but choose a different tariff from the basic one, and about 31% of the consumers are supplied by a different electricity provider from the local basic supplier (ibid.). This means that 69% of all households are still supplied by the local service provider (either with the basic or any other tariff), reflecting a strong attachment to the local service provider. This status quo bias was found repeatedly (e.g., Pichert and Katsikopoulos, 2008; UBA, 2019). Arguably, traditional demand-side policy instruments that were implemented long ago – such as consumer education, information and advice, labeling and social marketing, as well as supportive switching campaigns and price-based incentives – have not been effective enough to overcome inertia.

Choosing Germany as our case offers several advantages. First, since the start of the Energiewende in 2011, there has been increasing interest in using behaviourally informed demand-side policies to shift energy (electricity and heating) demand towards renewable energy sources, and there is a lively academic and political debate on green energy and electricity defaults. Relatedly, the next Intergovernmental Panel on Climate Change's Sixth Assessment Report (IPCC, 2020) features a chapter on demand-side policies, including behaviourally based policies such as defaults. Second, the present work was conducted within a large research project (ENavi) on behalf of the German Ministry of Research and Education with the aim to study and help navigate the German Energiewende process. While we do not claim external validity of our results, we do hope not only that our results are useful for German energy policy, but also that they might provide lessons and insights for other countries that aim to make consumers switch to renewable energy plans. Third, the panel data set we use (the German Socio-Economic Panel, GSOEP) is unique, providing a wealth of data within Germany only.

In a nutshell, we formulate our key research question as follows: Can green defaults be an effective behavioural policy tool to foster green(er) electricity consumption in Germany? To answer this question, we capitalize on the fact that a geographic area with a higher percentage of (only) green opt-out tariffs offered by electricity suppliers results in a higher probability that a household in this area will receive a green tariff as the default option. On principle, we should hence observe a higher green electricity consumption in areas with a higher share of green opt-out tariffs. (As hypothesized, we do indeed find empirical support for this causal chain.) We subsequently proceed as follows: We first give a concise overview of the literature on green defaults and the situation of the energy market in Germany. After introducing our study design, we explain the data and data sources used as well as the methodology employed. We then present and discuss the empirical results in light of prior findings and new avenues of action. Recognizing some limitations of the study, we conclude with implications for future research and a call for behaviourally informed energy policies.

2. Green energy and electricity defaults in the literature

To get an overview of the empirical evidence provided in the literature, we aimed for a comprehensive list of experimental studies investigating green defaults' impact on renewable energy demand and on direct and indirect (via more efficient products) energy savings. Using a systematic approach, we searched the following databases: Academic Search Premier, Business Source Premier, EconLIT, GreenFILE, PsycARTICLES, PsycInfo (EBSCO), Applied Social Sciences Index and Abstracts (ASSIA), International Bibliography of the Social Sciences, PAIS Index (ProQuest), Scopus, and Web of Science. We also sent requests for papers to our network of Behavioural Public Policy researchers as well as project partners and practitioners from the energy sector for additional studies to be incorporated in a snowball process. For the systematic search, we used three groups of search terms in different combinations: (1) "default" or "nudg*" or "behavio* economics" or "choice architecture" or "behavio* policy*"; (2) "sustain*" or "green" or "eco*" or "environment*" or "pro-environment*" or "eco-effect*"; (3) "energy" or "electricity" or "green energy" or "green electricity" or "clean energy" or "energy conservation" or "green products." The search concluded in July 2019 (Bernauer and Reisch, 2017, 2019). In total, we found 17 studies that fully fit the inclusion criteria (see Table 1).

Ten of the 17 studies focus specifically on the influence of green defaults on the choice of electricity from renewable sources and hence deserve a closer look in the context of our study. This type of research started about a decade ago and kept a strong geographical focus on Germany and Switzerland. Overall, clear positive effects were observed: Pichert and Katsikopoulos (2008) found an increase in green energy uptake in both opt-out and active choice conditions. The study was replicated by Vetter and Kutzner (2016) – and extended by testing a potential influence of attitudes. Again, green default treatment substantially and significantly increased the choice of green electricity more than fourfold (and environmental attitudes had no influence). Momsen and Stoerk (2014) found that compared to five other nudges (priming, mental accounting, framing, decoy, and social norms), only the opt-out default had a significant effect on the choice of green electricity. Ebeling and Lotz (2015) carried out a large randomized controlled trial also in Germany where they found a large and significant default effect on the uptake by households. In Switzerland, Chassot et al. (2013) confirmed this result in a case study of a local energy provider. Ghesla (2017a) found that an opt-out default significantly increased the number of green electricity customers. Ghesla (2017b) and Ghesla et al. (2020) further assessed the fit between existing electricity defaults and consumers' preferences, finding that poor households often pay more money for an energy tariff than their actual willingness to pay, and that other consumers would potentially spend more on green energy than on the low-cost pre-set tariff if they were better informed. In a lab experiment in Germany, Grabicki (2019) found energy contract defaults to be highly effective with subjects choosing the default contract significantly more often than the other options showing a strong status quo bias. Based on a U.S. online survey, Hedlin and Sunstein (2016) showed that in certain situations, it may be more effective to make people choose between green and standard tariffs actively (82% uptake of green energy) rather than pre-selecting a green default (76%) or a standard energy default (69%) (also: Sunstein, 2017a).

The other seven studies tested different default settings for choices that directly or indirectly help save energy (electricity and heating). In an experiment investigating the uptake of energy-saving (and money-saving) dynamic "time of use" (TOU) tariffs, Fowlie et al. (2017) found that 20% of participants accepted time-varying tariffs through an opt-in, and 90% through an opt-out default setting. Based on a systematic review of the evidence, Nicolson et al. (2018) estimate that if TOU enrollment is designed as opt-out, consumer uptake is likely to be between 57% and 100% and therewith much higher than with an opt-in

Table 1
Experimental evidence on green energy defaults.

		Outcome
Brown et al., 2013	Choice of energy-saving behavior	The largest savings could be achieved by lowering the room temperature by 1 °C by default.
Chassot et al., 2013	Choice of green electricity	An opt-out default significantly increased the number of green electricity customers: only 10% chose the opt-out, 72% stayed with the default, 18% chose a different (qualitatively better) green electricity tariff.
Dinner et al., 2011	Choice of energy-efficient light bulbs	Over three experiments, the default increased the choice of energy-efficient incandescent lamps by an average of 28.5%.
Ebeling and Lotz, 2015	Choice of green electricity	The opt-out default increased the choice of green electricity by 59.64%.
Fowlie et al., 2017	Choice of time-varying tariffs (use of smart meters)	90% accepted time-varying tariffs due to an opt-out default; only 20% accepted them due to an opt-in default.
Ghesla, 2017a	Choice of green electricity	An opt-out default significantly increased the number of green electricity customers.
Ghesla, 2017b	Choice of green electricity	Whether consumer preference in the absence of a default matches the default settings depends on the price of the green electricity tariff.
Ghesla et al., 2020	Choice of green electricity	Defaults are effective, but set at a green but relatively cheap rate, they do not match consumers' preferences. Poorer households are paying more for electricity consumption than they are willing to and at the same time, the willingness to pay a higher price by richer households is not exhausted.
Grabicki, 2019	Choice of green electricity	In a lab experiment, the status quo bias (i.e., the default) significantly influenced the choice of (green) energy contracts.
Hedlin and Sunstein, 2016	Choice of green electricity	By active choice, 82% of the participants voted for green electricity; in an experiment with a green default, 76% stayed with the default.
Heydarian et al., 2016	Choice of energy-saving behavior	Opt-in defaults show a strong effect over all experiments.
Hirst et al., 2013	Choice of energy-saving behavior	Energy-saving effects were implemented through opt-out defaults.
Momsen and Stoerk, 2014	Choice of green electricity	Compared to five other nudges (priming, mental accounting, framing, decoy, social norms), only the default had a significant effect.
Pichert and Katsikopoulos, 2008	Choice of green electricity	Strong default effects over four different experiments.
Steffel et al., 2016	Choice of additional ecological services	Strong default effect, even if the intention of the default was disclosed.
Toft et al., 2014	Choice of energy-saving behavior	The installation rate of a Smart Grid was increased by 18% in the default treatment.
Vetter and Kutzner, 2016	Choice of green electricity	Strong default effect for both green and grey energy. An opt-out default quadrupled the choice of green power over an opt-in default.

Note: In alphabetical order. Green electricity tariff studies in italics.

design, even if the latter is heavily promoted by other instruments. Toft et al. (2014) tested opt-out defaults successfully for smart grid acceptance; other studies showed how opt-out defaults can help reduce heating temperature and power usage of computers, increase choice of energy-efficient lamps and lighting, and increase demand for green services (see Table 1 for details).

While all these published studies report a solid effectiveness of green defaults (see also: Jachimowicz et al., 2019), they do not clearly explain *why* these defaults work – and when they might fail. For defaults in general, moderating factors have been found to be (1) the nature and the intensity of antecedent preferences (such as whether people are strongly opposed to the outcome produced by the default, which may lead them to reject it), (2) personal characteristics (socio-demographic, socioeconomic, and psychographic variables), and (3) environmental setting and context (different environmental problems may produce stronger or weaker default effects). Factors (2) and (3) may in the end be largely reducible to (1). In addition, the characteristics of the product or service itself (e.g., its complexity and novelty) can moderate effectiveness. For example, default effects might increase in the face of complexity. Details have been discussed elsewhere (e.g., Schubert, 2017; Sunstein, 2014a, 2017b; Sunstein and Reisch, 2013) and are beyond the scope of this paper. We restrict ourselves to a brief summary of the key claims and findings.

The default effect is generally explained by a number of concepts and theories developed in behavioural economics. In brief:

- *Status quo bias and inertia*: Inertia can be a powerful force, which means that people tend to stick with where they or what they have. The power of inertia can be increased if the decision is complex, difficult, or technical, or when morality is involved; switching to or from green energy has all these characteristics.
- *Endorsement and expert advice*: People often assume that the default has been set as such for good reasons and interpret it as an implicit recommendation; endorsement is stronger when decisions are viewed as complex and difficult and hence call for expert knowledge.
- *Ease and satisficing behaviour*: Aside from inertia, changing a default can impose a cognitive and attentional burden. If the pre-selected choice even roughly fits with or matches the preferences of the consumers, they may not search further. People who suffer from some sort of scarcity (perhaps because of a lack of time, as in the case of the poor, or perhaps because of cognitive decline, as in the case of elderly) may be especially unlikely to change a default, other things being equal.
- *Loss aversion and reference points*: People tend to be averse to losses (prospect theory), and defaults provide reference points and to whether switching to another option is judged as a gain or a loss. For those who have green energy by default, for example, switching can be seen as a loss, perhaps with economic or social consequences.
- *Endowment effect*: The initial allocation of an entitlement can increase valuation. The default establishes what people are initially endowed with (not just for goods but also for services such as electricity), and this sense of endowment can appear in very short time; as the initial endowment, the default is valued higher than other options, making it more likely that people remain with it.
- *Social norms*: The default can also be interpreted as the most common choice and hence a sort of implicit social norm (Ebeling and Lotz, 2015). Social norms are highly influential in shaping environmental behaviour (Farrow et al., 2017; Huber et al., 2020). If the default reflects social norms, people might stick with it for that reason. At the same time, people who reject the norm, or do not want to have it imposed on them, might reject it and thus show "boomerang effects" – for instance, when the choice architect is viewed as opposed to one's (political) ideology (Costa and Kahn, 2013).
- *Personal norms and anticipated guilt or shame*: Violation of one's personal norms can produce guilt or shame. Defaults might lead to anticipated negative feelings of guilt for opting out and result in sticking with the default (some evidence was found by Hedlin and Sunstein, 2016; Theotokis and Manganari, 2015). This effect might be especially large in the environmental setting, where switching away from a green default might trigger feelings of conscience

(Sunstein, 2016; Sunstein and Reisch, 2014).

3. The study

Against this backdrop, we designed and carried out a study that aims to test the impact of green energy tariff defaults. The general approach is to combine micro-level data from the German Socio-Economic Panel covering private households with macro-level information such as population density and proportion of energy suppliers in a given region that use a green opt-out tariff within their basic supply.

3.1. Data

We base our analysis on cross-sectional data for the year 2015 from the German Socio-Economic Panel (GSOEP, 2017), an annual representative household survey program initiated in 1984. This unique panel includes information for up to 14,000 households and 30,000 individuals within Germany. Besides a range of socioeconomic as well as sociodemographic characteristics, attitudes, and interests, the data set provides information about the electricity consumption pattern of the households. As shown in Table 2, sociodemographic variables include: age, gender, marital status, number of persons living in the household, number of children, years of education, employment status, and a natural logarithm of pre-government household income. We include "nationality" since we cannot rule out that migrants differ systematically from non-migrants regarding their preferences as well as their socioeconomic background. More variables are included in order to rule out omitted variable bias, namely: subjective health status, life satisfaction, health satisfaction, interest in politics, environmental concerns, and worries about climate change. A change in health status, for instance, may be associated with a change in preferences, which might affect consumption decisions, including electricity consumption. At the same time, a change in health status is likely to impact covariates such as income or life satisfaction, which are themselves related to electricity consumption. Also, to assess external influencing factors we check for electricity costs on the household level and population density on the regional policy level.

In particular, the panel participants are asked whether their household receives green power or not, whether the household has changed its electricity provider during the past five years, and how much money the household spends on electricity per month. We match these data with information from the German Federal Network Agency (Bundesnetzagentur (Federal Network Agency), 2020), specifically, disclosures about which provider acts as the basic electricity provider in a particular region and whether this provider uses green energy as a default option in its basic tariff. As outlined above, the basic electricity providers are determined by the Federal Network Agency for a period of three years. In the present study, we use information for the period between 2016 and 2018. Based on this we can infer that a household receives its electricity from this provider – unless the household has actively chosen to opt-out and to select another provider.

In order to test our core research question, i.e., whether the share of electricity providers (in a specific region) that use green electricity as a default option has an impact on the green electricity demand, we exploit the regional information of the GSOEP data set. That is, we use the information in which a specific household is located at the time of the panel interview in each one of the 96 regional policy levels (Raumordnungsregionen, ROR) that exist within Germany (Knies and Spiess, 2007; BBSR, 2017). This allows us to calculate the share of green electricity supply among German utilities as well as the average green electricity demand among households on a specific ROR level in order to test a potential relationship between these two variables.

After excluding outliers with regard to age, household income, and electricity costs, our final data set contains information about 26,033 individuals (this number decreases to 17,111 in the main analysis), with an average of approximately 276 observations per ROR level. As Table 2 shows, 15% (0.15) of the households in Germany are enrolled in a green electricity tariff, and 26% (0.26) of the households claim that they have changed their energy provider during the last five years. In contrast, the average share of green opt-out tariffs in the basic provision among German utilities is 17% (0.17).

On average, the individuals in our data set are approximately 48 years old and live in a household with an average size of three individuals, including roughly one child. Ninety percent of the individuals are German, 60% (0.6) are married, 45% (0.45) are men, and

Table 2
Variables' coding, means, and standard deviation (N = 17,111).

	Description/coding	Mean	Standard deviation
Type of tariff			
Green tariff	0 = not enrolled in a green tariff, 1 = enrolled in a green tariff	0.15	0.35
Default	Share of green opt-out tariffs within a regional policy level	0.17	0.15
Change	0 = has not changed energy provider, 1 = has changed energy provider	0.26	0.44
Sociodemographics			
Age	In years	48.03	16.15
Gender	0 = female, 1 = male	0.45	0.50
Marital status of individual	0 = not married, 1 = married	0.60	0.49
Number of persons in household	Count	2.94	1.45
Number of children in household	Count	0.84	1.13
German	0 = non-German, 1 = German	0.89	0.32
(Socio)economic			
Years of education	Count	12.27	2.71
Employment status	0 = not employed, 1 = employed	0.66	0.47
Natural logarithm of (household) income	Pre-government household income in €	9.50	2.78
Health status	1 = excellent to 5 = bad	2.63	0.96
Life satisfaction	0 = bad to 10 = excellent	7.37	1.70
Health satisfaction	0 = bad to 10 = excellent	6.74	2.17
Population density	Inhabitants per square kilometer	559.38	816.27
Natural logarithm of electricity costs	Average monthly spending on electricity in €	4.36	0.50
Attitudes			
Interest in politics	1 = very strong to 4 = not at all	2.74	0.83
Environmental concerns	1 = big concerns to 3 = no concerns	1.91	0.63
Worried about climate change	1 = huge worries to 3 = no worries	1.93	0.67

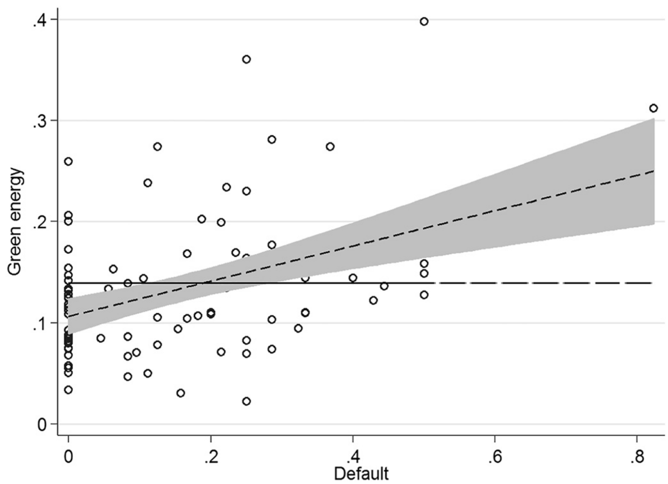

Fig. 1. Green electricity demand and opt-out tariffs across regions.
Note: The figure shows the linear relationship between green electricity demand and the share of green opt-out tariffs (defaults) across regional policy levels. The horizontal line indicates the overall mean of green energy demand among all households in the sample. The grey shaded area indicates the 95% confidence band of the corresponding linear predictions (dotted line; $N = 96$, adjusted $R^2 = 0.1734$).

66% (0.66) are employed. The average value for years of formal education is twelve years. Individuals show an intermediate health status (2.63) and claim to be comparatively satisfied with health (6.74) and life (7.37). On average, the participants' responses indicated that they are only weakly interested in politics (2.74), while being slightly concerned about the environment (1.91) and climate change (1.93).

As Figs. 1 and 2 indicate, there exists sufficient variation among both the green electricity demand of households and the share of green opt-out tariffs across regional policy levels to set up an appropriate econometric model. While Fig. 1 shows the linear relationship between green electricity demand and the share of green opt-out tariffs across regional policy levels, the amount of regional variation for both variables across the 96 ROR levels is depicted in Fig. 2. Although both figures are only descriptive, it can be reasonably assumed that there exists an association between the share of green opt-out tariffs and the demand for green energy at the regional level due to the strong graphical correlation.

3.2. Methods

In the following, we present and employ a logistic regression model and execute a multilevel mixed-effects logistic regression.

3.2.1. Logistic regression model

Our model is based on the latent variable y_{ij}, which is equal to 1 if individual i located in ROR region j receives green electricity, and 0 otherwise. In order to estimate the coefficient vector θ we model y_{ij} as a function of sociodemographic and socioeconomic characteristics as well as (environmental) attitudes of the individuals or households. These variables are captured by the vectors d_{ij} (sociodemographics), e_{ij} (socioeconomics), and a_{ij} (attitudes), as given in Eq. (1). Our variable of interest – the share of green opt-out tariffs in region j – is given by b_{ij}, a vector including a dummy variable indicating whether the respective household of individual i has changed its electricity provider during the last five years, along with a term capturing possible interaction effects between both variables. The logistically distributed error component is given by ε_{ij}.

$$y_{ij} = I(\theta_0 + b_{ij}\theta_1 + d_{ij}\theta_2 + e_{ij}\theta_3 + a_{ij}\theta_4 + \varepsilon_{ij} > 0) \tag{1}$$

We use the logistic function $H(\cdot)$ to reformulate the linear relationship given above, which allows us to estimate the coefficients and to calculate the conditional probability of receiving green electricity (see Eq. (2)).

$$E(y_{ij}) = \Pr(y_{ij} = 1 \mid x_{ij}, \theta) = H(x_{ij}\theta) \tag{2}$$

3.2.2. Multilevel mixed-effects logistic regression

In order to account for the regional as well as the nested structure of our data, we allow for random effects on the ROR level. Hence, we reformulate Eq. (2) by including a random intercept u_j for each region and solve the model by using the mean-variance adaptive Gauss-Hermite quadrature method (Rabe-Hesketh and Skrondal, 2008). The

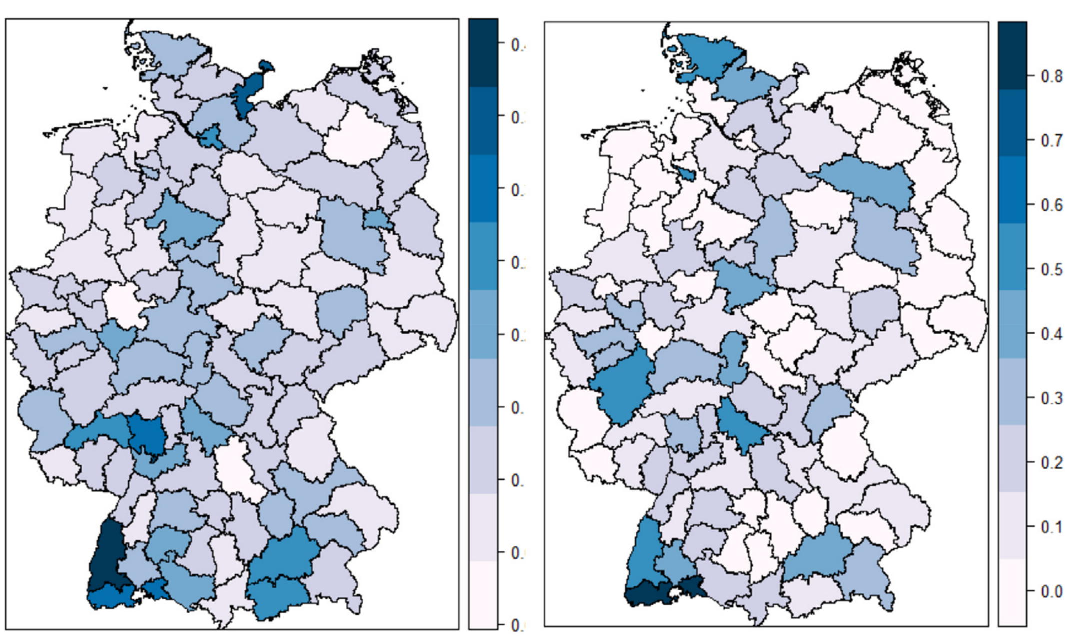

Fig. 2. Green electricity demand and opt-out tariffs across regional policy levels.
Note: The map on the left-hand side shows the regional variation of green energy demand among households, while the one on the right shows the share of green electricity supply among German utilities. (For interpretation of the references to colour in this figure, the reader is referred to the web version of this article.)

modification is displayed in Eq. (3).

$$E(y_{ij}) = (x_{ij}\theta + u_j) = \frac{\exp(x_{ij}\theta + u_j)}{1 + \exp(x_{ij}\theta + u_j)} \quad u_j \sim N(0, \theta^2) \tag{3}$$

Although we cannot identify a (possible) causal relationship in our cross-sectional setting, we believe that the rich set of covariates in our logistic regression helps to absorb most possible confounding factors. However, we cannot entirely rule out the possibility that we do not measure supply-side-driven effects but rather a demand-side-driven effect. For instance, electricity consumers in one region could hold especially strong environmental values and vote for political parties or politicians that are specifically engaged in environmental politics that again drive suppliers to offer such green tariffs. Such a case might be the region of Freiburg im Breisgau (the dark blue region in Fig. 2, left side) – a region known for its strong Green political party politics and home of one of the first exclusively renewable energy providers. However, since we allow for regional variation, most of these supply-side-driven effects should be absorbed. Nonetheless, we are aware of this limitation and discuss it below.

4. Results

The regression analysis provided several significant results that we share in the following. First, we cover the main results of the full sample; second, we share results of a stratified analysis that only includes individuals showing *no worries* about the environment or climate change; third, we present predicted probabilities for both models.

4.1. Main results

Table 3 shows the results of the (multilevel) logistic regression of green energy demand on the regional share of green opt-out tariffs among German utilities without (Columns 1–4) and with (Column 5) regional effects. While Column 1 shows the parsimonious baseline model without any additional covariates, Columns (2), (3), and (4) depict the results of more sophisticated models including variables representing sociodemographic (2) and socioeconomic (3) characteristics, as well as (health) attitudes (4).

In a nutshell: All specifications show a positive and significant effect of green opt-out tariffs (*defaults*) on green electricity demand, indicating that an increase in the regional supply of green opt-out tariffs leads to a higher green electricity demand among local households. Expressed in probabilities (and evaluated at the mean of the covariates), the coefficient of the *default* variable implies that the probability of purchasing green electricity increases by 19 percentage points if we compare a region that exhibits no green opt-out tariffs with a region where every basic electricity supplier is offering a green opt-out tariff.

As the significant and positive coefficient of the *change* variable shows, we observe that individuals are more likely to switch to green energy in high-supply regions than in low-supply regions, conditional on having switched during the past five years. Although the coefficient of the interaction term between the *default* and the *change* variable loses its significance in the multilevel regression, its negative sign might indicate that individuals do indeed opt-out if they do not want to receive green electricity.

Concerning sociodemographic and socioeconomic variables, the results are largely in line with prior literature. They indicate that:

- individuals with a German nationality are more likely to buy green electricity compared to non-German individuals;
- households with more children are more likely to have green tariffs than those with fewer children;
- respondents with higher formal education (measured in years of schooling) are more likely to have a green electricity tariff; the same holds true for a higher household income and greater life satisfaction. These variables are statistically highly significant and positively associated with the uptake of a green electricity tariff.

As we do not test for possible interaction effects between these three characteristics (i.e., nationality, number of children, education) and the default variable, the increased purchase of green electricity could either be due to households (or individuals) opting for green tariffs or refusing to opt out. At the same time, individuals who report to have high electricity costs in their household have a lower, statistically significant probability of receiving green electricity. This finding is not entirely surprising, since previous research has shown that in Germany green electricity tariffs are not necessarily associated with a higher amount of money spent on electricity consumption (Reichmuth, 2014; Hauser et al., 2019). The result may rather reflect that households that buy green electricity are generally more aware of the environmental externalities that are associated with a high electricity consumption (such as carbon dioxide emissions), and hence are more likely to act in an energy-conserving way.

Regarding attitudes, all coefficients are statistically significantly correlated in an expected way:

- less interest in politics is associated with a lower probability of purchasing green electricity;
- having more environmental concerns and being rather worried about climate change (both measured on a simple Likert scale) also means a higher probability of paying for green electricity.

4.2. Stratification results

Given that we observe a lower probability to enroll in a green electricity tariff for individuals who claim not to be worried about climate change or the environment, it is interesting to see whether this group shows different responses concerning the supply of opt-out tariffs. In other words, we are interested in whether individuals with weak stated environmental attitudes show stronger reactions when presented with a green tariff as a default option than people who worry and care about the environment. If this was the case, we would expect the coefficient of the *default* variable to be (at least) weaker in quantitative terms (it may even become negative if the households would show a strong and adverse reaction to the default option).

In order to test this hypothesis, we run two stratified regressions of our multilevel logit model, which include only individuals showing *no worries* about the environment or climate change. Results are given in Table 4.

Compared to the full model in Column (5) of Table 3, the effect of the *default* variable is somewhat smaller for individuals who are *not worried* about climate change (Table 4, Column 1). We assume that a green default should be less effective with this group; they might regard other product characteristics than climate neutrality as more relevant and hence might be more prone to opt-out. At the same time, a green default does have a significant effect, even with that group; the effect is highly statistically significant (with a positive sign), implying that a higher share of green opt-out tariffs still leads to a higher probability of receiving green electricity, even among individuals who claim to not be worried about climate change. For individuals who are *not worried* about the environment (Table 4, Column 2), the main effect is even more substantial compared to the full model, again implying the same rationale. These results show that a higher proportion of green opt-out tariffs in a region – and hence a higher likelihood to be enrolled in such a tariff – is also effective for individuals with little worries about climate change and who hence presumably have little intrinsic interest in purchasing green electricity. If this argument holds, the default effect seems to be stronger than the (weak) motivation based on attitudes.

Table 3
Logistic regression of green energy demand on the regional share of green opt-out tariffs among German utilities without (Columns 1–4) and with (Column 5) regional effects (standard error in parenthesis).

	Logit				Multilevel logit
	(1)	(2)	(3)	(4)	(5)
	26,033	24,316	17,221	17,111	17,111
Observations					
Default	2.1433***	2.1703***	2.0067***	1.9419***	1.6593***
	(0.214)	(0.220)	(0.282)	(0.283)	(0.529)
Change	1.7053***	1.6216***	1.5758***	1.5927***	1.5843***
	(0.083)	(0.084)	(0.102)	(0.103)	(0.136)
Change × Default	−1.3131***	−1.2777***	−1.2408***	−1.2566***	−1.0207
	(0.328)	(0.336)	(0.417)	(0.419)	(0.624)
Sociodemographic					
Age		−0.0084***	0.0014	−0.0026	−0.0029
		(0.002)	(0.002)	(0.002)	(0.002)
Gender		0.0051	−0.0253	−0.0471	−0.0466*
		(0.023)	(0.029)	(0.033)	(0.028)
Marital status of individual		0.1612***	−0.1258*	−0.1026	−0.0929
		(0.059)	(0.073)	(0.074)	(0.089)
Number of persons in household		−0.1613***	−0.0362	−0.0463	−0.0586
		(0.044)	(0.056)	(0.055)	(0.060)
Number of children in household		0.2150***	0.1344**	0.1472**	0.1637**
		(0.050)	(0.060)	(0.060)	(0.065)
German		0.7416***	0.5119***	0.4779***	0.5579***
		(0.091)	(0.096)	(0.097)	(0.097)
(Socio)economic					
Years of education			0.1647***	0.1441***	0.1391***
			(0.010)	(0.010)	(0.011)
Employment status			0.0743	0.1034	0.1207*
			(0.064)	(0.065)	(0.063)
Natural logarithm of (household) income			0.0951***	0.0884***	0.0775***
			(0.021)	(0.021)	(0.024)
Health status			0.0104	−0.0027	0.0150
			(0.042)	(0.042)	(0.046)
Life satisfaction			0.0540***	0.0544***	0.0601***
			(0.019)	(0.020)	(0.017)
Health satisfaction			0.0142	0.0125	0.0153
			(0.019)	(0.019)	(0.019)
Population density			0.0001**	0.0001*	0.0001
			(0.000)	(0.000)	(0.000)
Natural logarithm of electricity costs			−0.2273***	−0.2120***	−0.1862**
			(0.071)	(0.071)	(0.082)
Attitudes					
Interest in politics				−0.2237***	−0.2235***
				(0.034)	(0.039)
Environmental concerns				−0.3032***	−0.3216***
				(0.061)	(0.061)
Worried about climate change				−0.1379**	−0.1330**
				(0.057)	(0.054)
Constant	−2.7355***	−2.7603***	−5.7583***	−3.8141***	−3.9280***
	(0.058)	(0.166)	(0.435)	(0.462)	(0.418)
var(_cons[ror96])					
Constant					0.1827***
					(0.041)

Note: Robust standard errors are in parentheses.
* $p < 0.1$
** $p < 0.05$.
*** $p < 0.01$.

4.3. Predicted probabilities

Fig. 3 shows the predicted probabilities as means for the primary multilevel model, as well as for the stratified models. While the y-axis depicts the probability of receiving a green electricity tariff, the x-axis shows the share of green opt-out tariffs (*default*) within a ROR level. Although the confidence intervals are getting rather large with increasing values for *default* (point estimates should, therefore, be treated with caution for large values), the positive relationship between both variables seems to be quite evident, particularly for lower shares. For instance, the probability of purchasing green electricity increases by 6% points (~0.9 to ~0.15) if the share of green opt-out tariffs among German utilities within a ROR level increases by 40% points (Fig. 3, Panel a). The effect is still evident albeit somewhat lower (5% points by a 40% point increase) for individuals who do not worry about climate change (Fig. 3, Panel b) or the environment (Fig. 3, Panel c).

5. Discussion

In a nutshell, our main research question can be answered as

Table 4
Multilevel logistic regression with random effects for individuals with no worries about climate change (Column 1) or the environment (Column 2).

Observations	Climate	Environment
	(1)	(2)
	3340	2678
Default	1.5246**	1.9766***
	(0.639)	(0.709)
Change	1.4859***	1.4527***
	(0.243)	(0.264)
Change × Default	−0.9541	−0.6102
	(0.994)	(1.165)
Sociodemographics	✓	✓
(Socio)economic	✓	✓
Attributes	✓	✓

Notes: Robust standard errors are in parentheses.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

follows: Our data show that, as hypothesized, the supply of a green basic tariff as a pre-set choice is significantly and strongly positively associated with higher demand for green energy tariffs. In our study, a green default led – ceteris paribus – to an increase of almost 20% percentage points in green electricity consumption. We see this as strong evidence for an effective policy of employing green defaults in electricity supply. Private households might be effectively nudged into renewable energy forms and hence reduce their climate impact over the longer run.

While the green default effect is not surprising and fully in line with prior research sketched in this paper (Section 2), the present study adds to the literature in two ways: First, it is one of the first empirical studies to show the default effect with macro-level data, which adds methodological diversity to a research field that is largely based on smaller-scale experimental designs. Our study could be considered as a natural experiment in which behaviour is studied in a natural setting and is hence more likely to reflect real life, thereby increasing ecological validity (Dunning, 2007). Moreover, our approach specifically allows to identify, to account for, and control for structural, regional, and individual differences, a fact which is not necessarily given in a small scale set up. Second, our results suggest that the green default effect is strong enough to overrule preexisting environmental attitudes.

In the absence of qualitative data, we can only speculate on the basis of the default effect. Since we measured electricity costs by including the amount of money spent on electricity per month, and since we controlled for household income, we can rule out economic reasons – at least to some extent – being decisive for the stickiness of the green default. This is a key finding suggesting that other factors are more important than energy prices – something that conventional economic wisdom would not predict. As outlined above, behavioural economics explains the effectiveness of defaults with several psychological drivers: inertia, implied expert endorsement, ease (vs. effort), endowment, social and personal norms (and psychological and social costs attached to breaking those), as well as cognitive biases such as status quo bias (e.g., Jachimowicz et al., 2019).

In the present case, inertia and endorsement seem to be likely channels. As reported above, 69% of German households have never switched their basic provider (Bundesnetzagentur (Federal Network Agency), 2019), which reflects either a high degree of inertia or a substantial amount of trust. In practice, these providers are often municipal or public utilities and are known in the population for their financial support of the local infrastructure. Moreover, ease and effort avoidance could also be a probable driver: In the representative survey cited above, a quarter answered that they found it "too complicated" to switch providers. Utility contracts tend to be complex, and utilities are a rarely bought low-experience, low-salience product that typically does not spark huge consumer interest. This might help explain why even those individuals who claim not to worry about the environment or climate change tend to accept the green default and do not opt-out.

Next, endowment seems to be at work, i.e., the extent to which households believe that the default option reflects the status quo. The higher the perceived endowment with the default option, the more likely people are to stick due to loss aversion (Kahneman and Tversky, 1979). This might be particularly relevant when people move to new cities and are forced to make important one-off choices that will affect their daily life for a long time. We cannot see in our data whether this applies. Finally, since utility contracts are a largely invisible service, there is hardly a case for social norms as drivers.

Personal norms, however, and potential feelings of guilt and shame in the case of non-adherence to personal values of environmentally friendly choices might be at work – but we can only speculate here. In a recent experimental study, general environmental attitudes (assessed by the New Ecological Paradigm scale, Dunlap et al., 2000) did not predict choices while holding specific attitudes towards renewable energy, and holding them more strongly did lead to a higher propensity to choose the green electricity provider (Vetter and Kutzner, 2016). In a recent meta-analysis of default studies, Jachimowicz et al. (2019) find that defaults in pro-environmental domains (such as green energy defaults) tend to be less effective than those in consumer domains. In our view, this finding should be taken with many grains of salt; it might well be an artifact of the particular areas in which green defaults have been studied, and not tell us anything about green defaults in general. Nonetheless, Jachimowicz et al. (2019) reasonably speculate that firstly, the intensity, and secondly, the distribution of people's underlying preferences and attitudes in a population play important roles in how effective defaults are. In short: When one cares less about a choice, a default may be more persuasive in swaying the decision. Likewise, the

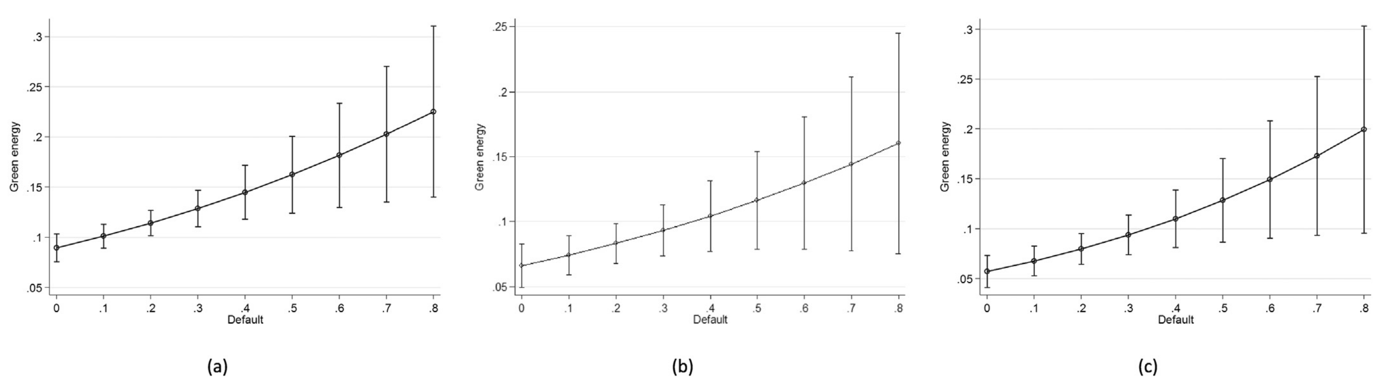

Fig. 3. Predicted probabilities for (vertical lines indicate the 95% CIs): (a) full model, (b) model for individuals stating that they are not worried about climate change, (c) model for individuals reporting that they do not worry about the environment.

more distributed and diverse preferences within a population are, the less a default might stick. It is safe to assume that in the German study population, most people care deeply about their environmental attitudes (intensity) and that the majority of Germans score high on pro-environmental attitudes in general and the support of renewable energies in specific (distribution). To this extent, it should not be terribly surprising to find that green defaults are "sticky." Note, however, that even in our sample, green defaults tend to be sticky among people who are not much concerned about climate change.

Regarding moderating variables, we find positive correlations between most of the measured sociodemographic variables and a higher demand for green electricity: People with German nationality, a higher level of education as well as a higher household income, a job, feelings of higher life satisfaction and interest in politics are especially likely to stick with green electricity defaults. This is not surprising and reflects what is known about environmentally conscious consumer behaviour in general. A recent representative survey of German households (UBA, 2019, p. 271) revealed unsurprisingly that formal educational level is the most important factor for the demand of green electricity.

So far, the results of our study suggest that green defaults "work," at least in this specific setting, and are hence a potentially helpful demand-side behaviourally informed energy policy instrument. The heated debate on the ethics and acceptability of regulatory nudges as policy tools in Germany (Purnhagen and Reisch, 2016) makes it particularly important closely to follow the rules of "good governance of nudging" (Sunstein et al., 2018; Sunstein and Reisch, 2019), which include full transparency and public deliberation in the implementation of defaults or other nudges. In practice, transparency and public deliberation can take many forms (see e.g., John, 2018). The minimal requirement of transparency is that nothing is covert or hidden. Consumers should be given clarity about the nature of the default rule and about the option to opt out. (We recognize that in cases involving significant externalities, constrained opt-out or mandates might turn out to be justified.) In the case of providers defaults, public deliberation might involve a process of public comment, certainly if public officials are promoting or requiring such defaults. One could also imagine a town-hall meeting on behalf of the provider, maybe in cooperation with the major or the city council, but also all kind of digital forms of customer fora where green defaults are discussed and eventually picked up by the media.

According to some people, defaults can raise special concerns from an ethical point of view, at least if people are not made aware of them (e.g., Smith et al., 2013). Some analysts even claim that defaults work best "in the dark" (Bovens, 2008), that "the default pull" happens outside the decision maker's awareness, and that many people do not even notice the presence of defaults (Dhingra et al., 2012). However, there is little evidence for the claim that defaults work best "in the dark," and considerable evidence to the contrary. In a large randomized control trial in Germany testing green energy contract defaults, the effects of green defaults seemed "not driven by unawareness" (Ebeling and Lotz, 2015, p. 868). Rather, in an awareness test, about 85% of subjects in an opt-out treatment were able to recall their choice correctly, which indicates that these choices had been made consciously (ibid., p. 870).

There is recent empirical evidence that disclosing to the nudgees how defaults work can even enhance their effectiveness (Paunov et al., 2019). Whatever will be the case, an important safeguard to address ethical concerns is (again) full transparency, i.e., telling people about the default as well as about its purpose. Good governance of nudging also includes a careful analysis of costs and benefits and an effort to ensure the use of cost-effective tools (Sunstein, 2018). Knowledge on how to estimate what works (better) is increasing. For instance, some have suggested a "theory of optimal green defaults" (Meran and Schwarze, 2015); others have showcased how cost-effectiveness of different policy instruments can be measured and compared (Bernatzi et al., 2017).

There are some limitations to our study: While we cannot identify a causal relationship in our cross-sectional setting, we think that the rich set of covariates, as well as the inclusion of regional variation in our logistic regression, help to absorb most possible confounding factors. However, as noted above, we cannot entirely rule out the possibility that we do not measure (real) supply-side-driven effects but rather (or partly) a demand-side-driven effect. Energy providers might, for example, based on their market research and algorithms, offer green tariffs as default assuming a strong demand ("pull") for green energy in some regions. We try to capture this problem by controlling for regional variation using a random-effects model, allowing for different intercepts. Another limitation relates to our data: While our micro data are from 2015, our macro data are from 2016. Hence, the 2016 data serve only as a proxy for the regional variation, which we would observe if we used data from 2015. According to the German Energy Industry Act (EnWG §36 Abs. 1), the respective basic provider is the one with the most clients in the region, and its role is fixed for a three-year period (here: 2013–2015; 2016–2018). While basic providers were reassigned in 2016, the energy market did not change dramatically; hence, one can assume that the basic providers stayed largely the same.

6. Conclusion

Can choice-preserving strategies contribute to reductions in greenhouse gas emissions? Our principal finding here is that they can. We show that in Germany, green defaults, automatically enrolling customers in cleaner energy sources, tend to stick, especially but not only among those who are concerned about the problem of climate change. This finding, based on real-world rather than experimental evidence, attests to the power of automatic enrollment in addressing environmental problems, including climate change, and also adds to the growing literature on the potentially substantial effects of shifting from opt-in to opt-out strategies.

The present study suggests that green electricity defaults constitute a promising approach for climate change mitigation (and other environmental values, such as reduction of air pollution in the ambient air) and potentially a supplement or substitute for the use of subsidies or hard regulation. To be sure, effectiveness and acceptability will depend on the contextual, market, and policy conditions of the respective national setting and one should be cautious to generalize. Future research should hence expand the national scope of the present paper and conduct similar studies in other countries with other conditions and historically determined pathways. This is all the more relevant against the backdrop of the new European Green Deal (European Commission, 2019), that aims for a European wide energy transition towards renewable energies. Moreover, there is a general lack of interculturally comparative research investigating the effectiveness and robustness of behavioural policies such as defaults across countries and cultures, as well as across fields of application. Our goal here has been empirical, rather than normative, but our central findings have evident relevance to policymakers. Many economists believe that the best response to greenhouse emissions is a carbon tax (Nordhaus, 2013), and an optimal carbon tax should, by definition, produce the optimal emissions level. If so, there should be no need for other instruments. In many nations, however, a carbon tax is not feasible, and even when it is feasible, political or other constraints might ensure that it is set at a suboptimal level. If this is so, or if the existing mix of regulatory and other instruments does not produce adequate emissions reductions, green defaults are worth serious consideration. They might turn out to be supplementary to more aggressive approaches, and potentially they could be substitutes.

If this is so, green defaults might come from private institutions, public officials, or some combination. Energy providers might voluntarily conclude, for economic or other reasons, that green defaults are appropriate. Perhaps most consumers would approve of that conclusion. Perhaps such providers would enjoy a reputational benefit. If providers voluntarily provide green defaults, there would seem to be little reason for objection, given the findings here. Alternatively, public officials might mandate green defaults, as through legislation or regulation that explicitly directs providers to adopt them through a kind of national command-and-control. As suggested, a decision to that effect should be adopted only after a careful assessment of its welfare effects, with careful attention to costs and benefits. We could easily imagine other approaches from public officials. For example, they might grant subsidies to energy providers that choose to offer green defaults, or impose taxes on energy providers that decline to do so. In principle, the size of the subsidy or the tax should track the social cost of carbon. Of course, the choice among approaches might be affected not only by costs and benefits, but by an understanding of distributional effects and by the nature of the relevant energy markets. In markets with just one provider, or two or three, it would be relatively simple to adopt a mandate, and a significant subsidy or tax might move the entire market abruptly, potentially for the better.

Backed by the empirical evidence presented in this study, we conclude echoing a recent overview of demand-side climate mitigation energy policies (Mundaca et al., 2019, p. 10): "Emerging evidence suggests that policies are likely to be more (cost-) effective when they systematically take behavioural factors into account. (…) We need to seize this opportunity to complement or improve the existing policy mixes."

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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