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UNIVERSITY OF BIRMINGHAM

Title: Power plants and Life-Satisfaction: What is the Impact?
Germany, 2011-2016

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Abstract

The present dissertation aims to capture the impact of the ongoing German energy policy on reported overall life satisfaction. Specifically, it aims to capture the impact of the expansion of renewable power plants in favour of decarbonisation and denuclearisation during the period of 2011-2016. Nation-wide representative data on life-satisfaction and socioeconomic variables from the German Socioeconomic Panel Study and energy data from the German Federal Network Agency are used to estimate the relationship. Multiple fixed effects are incorporated into the panel regression. Main results show parametric instability between former East and West regions for energy generation preference. In particular, biomass energy generation poses significant negative impacts on life satisfaction for individuals living in the former East while significant positive impacts for the former West region. Additionally, hydropower pumped storage power plants exhibit highly significant positive impacts on life satisfaction, but for the West region only.

Introduction

“Not what we have, but what we enjoy, constitutes our abundance”

– Jean Antoine Petit-Senn

The success or failure of the German energy transition can be measured in diverse ways: efficiency, innovation, environmental quality and sustainability, etc. The present dissertation focuses on its impact on life satisfaction for the period of 2011-2016. Do individuals identify themselves as ‘happier’ in a period of fast integration of renewable energy sources and shutdown of conventional and nuclear energy sources? The answer depends on a variety of factors, ranging from behavioural, social and individual aspects, to location of households, aesthetics considerations and health impacts.

Fixed effects are used to capture individual traits that could explain an individual's behaviour in reporting life satisfaction. Regional and time fixed effects are also employed to seize geographical and temporal factors that are inherent to a particular region at a point in time (this is an attempt for the energy estimated coefficients to capture impacts on life satisfaction arising only from changes in mega-watts of installed capacity within the region). Given that the German energy reform has occupied an extensive period of time, the present dissertation cannot answer for its impact on life satisfaction as a whole, but it can only relate to measures taken during the years 2011-2016.

The hypothesis examined is that energy sources experiencing significant changes in mega-watts of installed capacity during the years 2011-2016 will explain significant changes in reported overall life satisfaction if and only if individuals are not neutral about them. In particular, when power plants exhibit net local negative externalities, life satisfaction improvements can be expected if significant decommission has taken place (with significant lower mega-watts of installed capacity as consequence). By reflective symmetry, high installation rates – or increased capacity - would lower life satisfaction. This would be evidenced by negative² and significant coefficients on mega-watts of installed capacity for a particular energy source, where life satisfaction is the dependent variable. On the other hand, when power plants exhibit net local positive externalities³, life satisfaction deterioration can be expected if significant decommission took place. Again, by reflective symmetry, high installation rates –or increased capacity- would improve life satisfaction where power plants generate net

² i.e. negative because life satisfaction would be expected to be higher in the years where lower mega-watts of installed capacity are present, and viceversa.

³ Although energy facilities' externalities are mainly negative (Welsch, 2016, according to the literature, it is possible for the case of renewable energies public net benefits. Moreover, all energy sources display benefits of electricity generation.

local positive externalities. The alternative hypothesis is therefore that individuals are overall neutral about local externalities of particular power plants - even where decommission/installation rates are high. Literature on energy externalities exhibits uncertainty about the impacts of renewable, conventional and nuclear energy on life satisfaction. However, solar, wind and natural gas are likely candidates for explaining changes in reported overall life satisfaction - if and only if individuals are not neutral about them - given their high degree of variation in mega-watts of installed capacity (see maps in Appendix B). The intuition is supported by installation/expansion rates: almost 35% and 77% of the power plants have been installed or expanded during the period of 2011-2016 for wind-onshore and solar energy respectively, with zero decommission rates for both (Bundesnetzagentur, 2018).

The present dissertation differentiates from previous studies mainly on its comprehensibility, i.e. the examination of all energy sources present in Germany (rather than a group of them only) and the consideration of capacity installed (instead of production only). This is relevant for a complete analysis of the German energy reform during the period in question. Results suggest the hypothesis examined does not hold true. Biomass and hydropower pumped storage mega-watts' of installed capacity hold significant impacts on life satisfaction, in spite of a coefficient of variation of less than 20% during the period analysed (Bundesnetzagentur, 2018) - see maps in Appendix B. Therefore, factors different to mega-watts of installed capacity variation within regions must explain the results (some further hypothesis are examined in the 'Discussion' section).

From this point forward a review of previous studies on local environmental externalities, life satisfaction and the German energy policy is undertaken. Later on,

the estimation methodology and the data used for estimation are presented. Results for the estimation methodology are then presented and discussed, for later conclusion.

Background and Literature Review

A foundational concept in environmental economics is the one of a preference function for environmental goods and all other goods and services (Welsch, 2002⁴). This concept applies to various environmental goods, from air quality to landscape amenities. Here, Germany is taken as a case study for identifying individuals' preference for power generation, arising from variation in time and space of power plants' local externalities of diverse nature. The following paragraphs describe the changes in energy supply brought about by the German energy reform and the externalities that can be expected from the presence and – in some cases only – operation of fossil-fuelled, nuclear, waste and renewable power plants.

Amid increasing environmental pollution, global warming, fear of natural resource depletion⁵ and provoked by political tensions such as the 1973 oil crisis and the Chernobyl nuclear accident, Germany has worked steadily towards sustainable development in alliance with an energy transition policy during the last quarter of a century. For this reason, the German energy reform has become a global reference. The main criteria dominating the reform were global warming and security of energy supply. Phasing out coal and nuclear power has been a main target for reducing greenhouse gas (GHG) emissions and improving energy efficiency⁶. At the same time,

⁴ Welsch, H. (2002) uses cross-section data for 54 countries during the period of early and mid-1990s. With the use of reported life satisfaction, he finds individuals care about prosperity and environmental quality. Moreover, he estimates a marginal rate of substitution between income and nitrogen dioxide pollution of 70 USD per kiloton of NO₂ per year. Similarly, a German citizen would require a compensation greater than 1900 USD to accept the urban air pollution experienced by Japan.

⁵ And the uncertainty of conventional sources of energy supply underlying it.

⁶ It must be noted, however, that global warming does not necessarily have a negative impact on life-satisfaction. A desirable climate is one where mean monthly temperatures float around 18.3 degrees Celsius. Moreover, Germany is not negatively affected by climate change in a direct manner. Rather,

Germany has faced the political challenge of integrating renewable energy (RE) sources in the electricity mix while meeting efficiency, security of supply and EU-compatibility objectives. The climate-neutral and non-depleting property of RE gave political support to its expansion in the late 90's. However, low investments and growth evidenced their unprofitability (Fischer, W. et al., 2015).

No surprise then, that in the year 2000 - amid the European Union's 'Campaign for a Breakthrough of Renewable Energy Sources'⁷ - Germany enacted the 'Renewable Energy Sources Act'⁸, which granted priority to RE sources on the total energy consumption mix. Specifically, the Act aimed at doubling the share of renewable energy sources within German territory by 2010. For such purpose, grid operators became obliged to purchase and pay compensation to power plant installations which supply electricity from wind, solar radiation and geothermal energy; hydrodynamic power; landfill gas, sewage treatment and biomass plants, as well as from mines (Solar Energy, 2001). Political convulsion emerged due to resistance towards the de-nuclearization policy. Nevertheless, during the coalition agreement of 2005-2009, the target for RE sources became more ambitious: their minimum share in the electricity mix was set to increase to 12.5% and 20% by 2010 and 2020 respectively. Later on, the German Integrated Energy and Climate Program renewed the compromise for RE expansion: their minimum share was now set to increase to 30% by 2020 for CO₂ emissions to reduce by 40%. Today, Germany is set to increase the minimum share

Northern Europe experiences modest gains from global warming (Maddison et al, 2011). This results suggest that efforts to reduce GHG emissions might translate into lost gains on life-satisfaction, i.e. by the experience of lower temperatures than those predicted by the climate change phenomena without Germany's energy policy reform.

⁷ For which Germany committed to reduce greenhouse gas and carbon dioxide 1990 emission levels by 21 % by 2010, and by 25% by 2005, respectively.

⁸ The 'Renewable Energy Act' followed the 'Electricity Feed Act' (1991) which did not allow for a large-scale development of renewable energy different from hydroelectric power plants, whose potential was already largely drained. Solar radiation energy and biomass plants being the most jeopardized (Solar Energy, 2001).

of renewables in the electricity mix to 80% by 2050 (Fischer, W. et al., 2015). Figure A1 (see Appendix A) shows the variation in the electricity mix between the years 2000 and 2015. The denuclearization and decarbonisation is evident: by 2015, conventional and nuclear energy sources represented altogether around 73% of their original share in the year 2000.

The ambitious goals faced by Germany invites a thoughtful analysis of energy externalities. These are unintended consequences on households' utility functions, for which there is no compensation or for which the household has no decision power. Externalities are therefore a source of market failure in need of government correction. However, as imperfect information can always be present⁹, government's role in providing accurate information and correcting market failure is, at best, limited. In some cases, public choice of instruments for correcting market failure may even increase inefficiency (Perman et al., 2011, p.121-132). Welsch, H. (2016) calls attention on the recent reconsideration of energy policies around the world and of the lack of knowledge surrounding the subject of energy externalities and the appropriate methodologies to measure them. Market failure combined with increased inefficiency brought about by public policies is therefore a possibility for the German case and for the imitating governments around the world.

The present dissertation examines externalities caused by energy facilities caused by the German energy reform on life satisfaction¹⁰. The policy enacted is one of

⁹ Perfect information is unlikely at any point in time. As Nietzsche's 'eternal return' theory might predict, we cannot be sure of our choices, because choices in one lifetime are not comparable across time. We would need various parallel lives to compare choices. This might also explain the failure of the 'completeness' axiom for rational choice in microeconomic theory. Moreover, imperfect information suggests externalities can coexist with us or can be present in the future, and we may be aware of them in different degrees or not at all.

¹⁰ There is evidence on the pervasive impact of environmental externalities on individuals' subjective well-being. Maddison, D. et al (2008) execute a hedonic analysis to better understand the demand for environmental quality and find local air and noise pollution in residential areas embody a significant

command-and-control, as it imposes a standard behaviour on grid operators towards renewable energies. Therefore, individuals do not choose their source of electricity. Moreover, individuals are assumed to face the private benefits of electricity, which are both rival and excludable¹¹. At the same time, they face local negative externalities which behave as public bad (non-rival and non-excludable) within a certain spatial range. Imperfect information is faced by both, the German government and individuals. Energy externalities can stem from the choice of electricity mix or from the sitting and decommission of power plants¹² (Welsch, 2016). The latter refers to local or regional externalities and is the focus of this dissertation. Moreover, they can be of environmental, health or amenity nature. The following paragraphs will describe the evidence found in the literature for externalities present in fossil fuels, waste, nuclear and renewable energy sources. Later on, other variables important for explaining life satisfaction and different to energy externalities are reviewed.

Fossil fuel power plants such as oil, gas and coal facilities contribute to local air pollution¹³, which is both of environmental and health importance. The emission of SO₂ and NO_x from fossil fuel electricity generation can adversely impact households living hundreds of kilometres away from the power plant location, through the process of acid rain and low-level ozone. However, emission of particulate matter (PM) from fossil fuel electricity generation becomes of decreasing importance with distance. Households nearby are therefore more likely to suffer from respiratory-related medical

impact on subjective well-being in Germany. Their study makes use of the German socioeconomic panel, which is the same dataset used here (see Data section).

¹¹ It must be noted that the focus here is on mega-watts of installed capacity and not production. Some power plants in the analysis are not in operation. Households could be living near a non-operational power plant and at the same time enjoy the benefits of electricity while suffering the local externalities arising from the presence of the energy facility.

¹² Which, in turn, originate changes in mega-watts of installed capacity and number of power plants

¹³ They also contribute to climate change by the emission of GHG, but as climate change is a global public bad, it is not sensitive to take GHG into account in this dissertation.

conditions (Welsch, H., 2016). Noise and vibration also relate to the operation of fossil fuel power plants due to the use of big engines, air intake systems and cooling fans. Fuel delivery systems can be friendly for some energy sources; such as natural gas being delivered by pipelines. However, fossil fuels are generally delivered by trucks and generate traffic congestion. Fuel delivery systems may also be of importance; whilst natural gas is delivered by pipelines, coal is delivered by trucks -which generates traffic in the area. For the case of power plants with large installed capacity (i.e. large buildings), visual disamenities can also be present (Davis L., 2011).

The use of waste for energy production holds similar externalities to those of fossil fuels, but on a larger scale in terms of pollution (Welsch, H., 2016). Heavy metals, dioxins and leachate present in waste incineration pose a disadvantage when comparing with fossil fuels. All of them have pervasive effects on health and on the ecosystem. Moreover, noise, odour and visual pollution (from the smokestack) are some of the disamenities related to incinerators (European Commission, 2000). Such disamenities are also present in landfill sites, which can reduce house prices within certain radius of distance (i.e. a reduction of house prices by 2.6% within a 3km radius for the city of Birmingham in United Kingdom – Elliot, Ham and Maddison (2013)). This reveals households' preference for housing far from landfill sites and suggests negative impacts on subjective well-being for households living near these sites. There is no reason to suppose the same does not apply to waste incinerators.

Nuclear power plant externalities also refer to environmental and health problems, but most of the time the impact is one of perception, rather than of actual damage. As risk is subject to perception, behavioural aspects can be of importance when considering the negative externalities of nuclear power plants. Uncertainty, dread, catastrophic potential, controllability, equity and risk to future generations are some of the

explanatory factors of perceived risk. However, nuclear power plants hold the advantage of being climate-neutral. For this reason, individuals who express a positive willingness to pay (WTP) for increased alternatives to nuclear power also express a lower WTP when its CO₂ free property is stated on the survey (Annuka et al, 2017). This implies individuals might experience moral benefits for nuclear power generation in their region, which in turn could impact on life satisfaction. Nonetheless, rejection for sitting and maintenance of nuclear power plants is likely because individuals associate a negative feeling to it and overestimate the risk (i.e. nuclear power is subject to 'affect heuristic'). On the other hand, individuals underestimate the risks of climate change because it is presented in statistical manner (i.e. climate change is subject to 'psychic numbing') - Slovic, (2016). This is likely to apply to Germany, as it is not a country hardly-beaten by climate change. Moreover, Kristiansen et al (2016) stress the importance of media and communications coverage and reception for an increased perceived risk of nuclear accidents. Despite this, Berger, E. (2010) concludes German overall life-satisfaction to experience no significant change after the Chernobyl accident. The literature on nuclear energy suggests mere risk perception does not impact life-satisfaction. Rather, it seems to have an impact on energy supply choice only. In case of experienced risk, however, local externalities account to higher risk of cancer and other damaging impacts on human, fauna and flora. Impacts are subject to distance decay (Welsch, 2016).

Renewable energy externalities are, on the other hand, mostly related to efficiency and equity considerations. Low energy density faced by RE threatens efficiency because they occupy larger areas of land to produce the same amount of mega-watts as conventional power plants (Welsch, 2016). On the other hand, despite the general

support for RE, NIMBYism¹⁴ behaviour evidences the threat they pose on equity. Individuals are in favour of RE as long as the siting of power plants are far from their location (Wüstenhagen et al., 2007). Due to low energy density, negative impacts¹⁵ on landscape aesthetics, biodiversity, wildlife and cultural heritage can be expected. However, impacts can also arise due to the mere presence of the power plant, such as visual shadowing (solar and wind power plants), glare risks (solar power plants), noise nuisance (wind and biomass¹⁶ power plants) and odour nuisance (biomass plants). The following paragraphs describe the findings on renewable energy externalities found in the empirical literature, starting with biomass and moving on wind and solar energy.

With respect to biomass, Möllendorff, C; Welsch, Heinz (2017) researched the link between life-satisfaction and power plant installations using the German Socio-economic panel for the years 1994-2012 with individual and region¹⁷-year fixed effects¹⁸. They encounter negative externalities on individuals living in postcode districts with biomass power plants and in adjacent districts as well. On the other hand, Venghaus and Hoffman (2016) study life-satisfaction impacts of biomass for Brandenburg, Germany and find no significant impact of this energy source. The lack of significant correlation between biomass energy production and life-satisfaction may be due to only a minority of the population to hold stronger environmental

¹⁴ Not in my back-yard behaviour

¹⁵ Positive impacts are unlikely to occur, according to the literature undergone by Welsch (2016). They may be present where some type of aesthetical crop field is grown for biomass plants.

¹⁶ Specifically, those of biogas where fuel needs to be delivered.

¹⁷ Region at the level of federal state

¹⁸ The present dissertation has the added value of using administrative districts of Germany on the fixed effects specification. Moreover, it does not focus on renewable energies only, but on all energy sources. This is important because the energy reform brings about changes in installed capacity for conventional energy sources as well.

consciousness or to the partly indirect nature of biomass externalities, as hypothesized by the authors.

Similarly, Bigelow, P. et al (2016) study on wind turbines and their impact on life-satisfaction and mental health for Ontario, Canada find personal traits to play an important role for reporting on mental health and life satisfaction¹⁹. They find individuals with neutral or positive attitude towards wind turbines experienced no significant impact on the variables analysed with the introduction of wind turbines in their neighbourhood. Individuals with negative attitude experienced lower life satisfaction and mental health. Krekel, C. et al (2016) do find, however, significant negative impacts of the presence of wind turbines on life satisfaction in Germany. Using a difference-in-difference approach and the German Socio-economic panel study for the period 2000-2012, they observe lower life-satisfaction reported after the introduction of wind turbines. The authors find a decay effect in time and space: impact becomes insignificant after five years at latest²⁰ and at a distance greater than 4 kilometers. However, they point out that the decay effect could evidence – with low likelihood, though - that the construction process of wind turbines is more significant for life-satisfaction than the presence or operation. Möllendorff, C; Welsch, Heinz (2017) detect negative externalities for individuals living on the same postcode district as that of wind power installations. On the contrary, Welsch and Biermann (2014) found a positive association between larger shares of wind and solar power on the electricity mix and subjective wellbeing for European citizens. However, von Möllendorff, C; Welsch, Heinz (2017) determine no significant effect on life-satisfaction

¹⁹ The present dissertation will capture –at least partly - these individual differences with the use of fixed effects, as described on the Methodology section.

²⁰ The authors hypothesize this could be due to households adapting to wind turbines by planting trees and building fences.

due to the presence of solar power in individuals' postcode district, but significant negative effects on adjacent districts.

Mixed results in the literature review of renewable energy externalities may be partly explained by the dynamics of ownership structures. The latter provides financial and warm-glow benefits that trade-off against the negative externalities previously described (Welsch, H., 2016). Given that renewable energies provide net benefits which are non-rival and non-excludable (i.e. public), green-power marketing can also play a moral role when they achieve a sense of community on the customer (Wiser, R., 1998). For the latter, moral benefits would need to be great enough to surpass the NIBYism phenomenon.

The remaining of this section reviews other variables important for explaining life satisfaction. These variables are closely related to the individual's behaviour with society and the categories they belong to. Dolan et al (2007) find health, employment, partnership status and social interaction to play a major role in the 'happiness' empirical literature. With respect to health, good health predicts higher subjective wellbeing. However, when self-reported, the empirical literature suggests fixed effects must be used to control for personality traits that might influence the reported value. Moreover, unemployment is a good predictor of low subjective well-being²¹. Again, fixed effects are used in the empirical literature to produce robust estimates. Dolan et al (2007) also encounter social interaction and having a stable partner to have a positive impact on subjective well-being. Other factors such as age, gender, number of children and income are also studied in the 'happiness' empirical literature. Deaton

²¹ Chadi, A. (2010) explores 'happiness' relationship with voluntary and involuntary unemployment using the German Socio-economic panel study for the years 1994-2007. He finds involuntary unemployment to be a minority case. Hence, most unemployed are actively searching for work and experience much greater suffering than those voluntarily unemployed. Therefore, the overall relationship between unemployment and low subjective wellbeing is strong.

et al (2014) find a U-shape relationship between age and subjective well-being for high income countries and Küchenhoff et al (2013) add a third stage on the age - 'happiness' relationship, where life-satisfaction experiences a declining path after the late 60s. With respect to gender, it is not as important as other control variables for explaining happiness. On the other hand, the presence of children is likely to be positive and significant for reported life-satisfaction estimates, in particular when household size has been adjusted (Dolan et al, 2008). With respect to income, Clark et al (2008) examine the relationship between 'happiness' and real income over time and conclude that positive but decreasing returns explain a constant average 'happiness' over time, despite the increasing trend experienced by real income.

After reviewing local energy externalities and other factors important for explaining life satisfaction, it is necessary to appropriately shape the relationship between life satisfaction and these variables. The following section will explain the methodology used for the empirical implementation, considering data constraints.

Methodology

The present dissertation employs the experienced preference method for estimating the effects of local environmental externalities on life satisfaction. This is a method independent of 'life-specific domains', i.e. individuals are not asked on how satisfied they feel with a particular aspect of their lives, but rather on how satisfied are they with their lives on overall terms at the present moment²² (Welsch and Ferreira, 2014). Kahneman et al (1997) call attention on the ignorance of 'experienced utility' in modern economics, in preference for 'decision utility'. The first refers to 'pleasure and pain'

²² In my opinion, this would be however difficult to assess, as my perception on my overall satisfaction with life may be biased towards past or expected future events. Perhaps individual fixed effects can capture this bias.

and is the key concept behind the implementation of the experienced preference method, while the latter is revealed by individual choices²³. Experienced utility is ignored on the basis that choices already provide all information on utility outcomes. However, the authors find individuals do behave in such a way that their experienced and decision utility differ, i.e. individuals are not experienced utility maximizers. Hence, the analysis presented here is free from the consumer rationality assumption. Moreover, Welsch and Ferreira (2014) point out the experienced preference method is not based on hypothetical changes nor is it subject to context and framing effects²⁴. Similarly, it does not require the respondent to assign monetary values on the externalities perceived. On the contrary, it is able to capture the impact of perceived and unperceived conditions that apply to the respondent. Hence, it allows for non-market valuation of a particular good by constructing a statistical relation between the good in question and reported overall life satisfaction. Valuation of local environmental externalities can benefit from this approach due to the inability to ascertain the value of environmental goods from direct observation, as with public.

Nonetheless, the experienced preference method is not exempt of threats. Reported overall life satisfaction is of ordinal nature. However current ordered regression models, such as the 'Ferrer-i-Carbonell and Frijters', 'Minimum Distance', 'Generalized Methods of Moments', 'Empirical likelihood' and the 'Blow-up and cluster' estimators suffer from lack of consistency (Baestschmann et al, 2015). Therefore, assuming life satisfaction to be of cardinal nature is important for applying a least-squares estimation. For the reported life satisfaction to be treated as a cardinal variable instead

²³ The authors quote an example suggested to them by Paul Romer: an amnesiac patient with 2 toasters. One that electrifies the patient when removing the toast and one that does not. Because the patient is amnesiac, he will be indifferent between both. However, his decision utility will differ from his experienced one.

²⁴ As opposed to the contingent valuation technique, for example.

of ordinal, it must be assumed that differences in reported scores across respondents correspond to differences in indirect utility in a proportional manner (Welsch and Ferreira, 2014). This is in theory hard to assume due to the presence of measurement error in reported life satisfaction. However, there is no expected bias on coefficients as there is no reason to assume a correlation between mega-watts installed capacity of the different energy sources and the measurement error (von Möllendorff and Welsch, 2017). Furthermore, Ferrer-i-Carbonell and Frijters (2004) compare their fixed effects ordered model with a fixed effect ordinary least-square estimation for life satisfaction and conclude that ordinality and cardinality are unimportant, but the presence of fixed effects is not. These methodological issues are all considered by von Möllendorff and Welsch (2017) and are taken as reference for the present dissertation. In addition, the inability of current software to process some of the current ordered logit models with the introduction of multiple fixed effects counts as an additional limitation²⁵.

Empirical implementation

To undertake the experienced preference method, reported overall life satisfaction is taken as dependent variable on the regression analysis (described below). The variable reports the answers on a scale of 0 to 10, of 16 year-old or older individuals when asked about their present life satisfaction, all things considered. On the other hand, the explanatory variables that aim to capture the impact of local externalities arising from power plants are the mega-watts of installed capacity present in each administrative district for each energy source (i.e. each energy source is an

²⁵ At present, SOEPremote would require a larger memory set for STATA to process a fixed-effects ordered logit 'blow-up and cluster' regression with individual, region and year fixed effects, for example. Similarly, it is computationally expensive, requiring the creation of a program to run the regression due to the inexistence of a direct command. An attempt to do this can be found on the do-files attached on Appendix D.

explanatory variable). For the model to fit the underlying process of life satisfaction, control variables widely supported by the literature review are included as explanatories. These are age, number of children in household, health status, employment status and household income after taxes. Given that age behaves as a cubic function for subjective wellbeing (e.g. Küchenhoff et al, 2013), terms for age to the power of 1, 2 and 3 are all included. Moreover, household income was adjusted by inflation using the reported CPI. For income to portray availability to spend or save, it was adjusted by household size following to the OECD modified scale (OECD, 2018). The logarithm of income adjusted by inflation and household size is taken to capture decreasing marginal utility (as suggested by the literature, e.g. Clark et al, 2008). One limitation is the self-reported nature of health status in the SOEP dataset, which may cause endogeneity (Ferrer-i-Carbonell and Frijters, 2004). Similarly, a variable for social interaction is not available to use without a great loss on observations²⁶, and is therefore not included.

Additional controls included in the analysis are fixed effects for multiple dimensions: individual (i.e. person), regional (i.e. administrative district) and time (i.e. year). Individual fixed effects capture time-invariant unobserved personality traits that can influence reported life-satisfaction. Similarly, time fixed effects control for unobserved factors that are specific to a particular time. The data on SOEP is largely sensitive to both (Ferrer-i-Carbonell and Frijters, 2004). On the other hand, regional fixed effects are included to account for the possibility of individuals moving across administrative districts. This dissertation differs from von Möllendorff and Welsch (2017)'s study by

²⁶ A proxy variable, i.e. 'relationship with friends', is present on the 'Original Individual Data' SOEP database. However, the number of responses is very low (<https://data.soep.de/soep-long/data/pl/pld0049>)

including regional fixed effects at the administrative district level, instead of at the federal state level. However, it prevents the use of region-year fixed effects due to the large number of dummies that would be needed to generate and the software limitations. The inclusion of fixed-effects is not solely based on Ferrer-i-Carbonell and Frijters (2004), but also on the results of the Hausman test in its regular and robust form (see 'TABLE C1' on the appendix, where the null hypothesis is rejected).

Because the purpose of this dissertation is to examine the spatial and temporal relationship between reported life satisfaction and mega-watts' installed capacity of different energy sources, the panel dataset is three-dimensional. The panel identification variable is set for the unique person identifier, while the panel time variable is set for the region-year²⁷ at the moment of survey. Moreover, considering the methodological issues stated above, the equation to estimate by Ordinary Least-Squares is the following:

$$Model (1): LS_{ikt} = \alpha + \sum_{j=1}^{15} \beta_j energy_{jkt} + \theta controls_{ikt} + id_i + region_k + year_t + \varepsilon_{ikt}$$

Where i refers to the unique person identifier, k to the region and t to the year of survey. LS_{ikt} is therefore the reported life satisfaction for individual i living in region k and surveyed at year t . On the other hand, $energy_{jkt}$ refers to the mega-watts of installed capacity for energy source j present in region k at time t . The coefficient on this variable, β_j , would give the average impact of an additional unit of mega-watt installed capacity of energy source j on reported life satisfaction. As for $controls_{ikt}$, these are related to individual factors discussed previously and θ accounts for the average impact of an additional unit on reported life satisfaction for non-categorical variables, such as age or income. For categorical variables, dummies are included for

²⁷ i.e. the concatenation of the administrative district and the year of survey

θ to express the impact of an individual belonging to a particular category on reported life satisfaction, as opposed to belonging to a different category (the omitted one). Furthermore, id_i , $region_k$ and $year_t$ refer to individual, region and year fixed effects respectively; while ε_{ikt} accounts for the error term and α for the constant term. Finally, robust standard errors adjusted for individual clusters are estimated.

Similarly, as local externalities may be subject to distance decay and energy density considerations (Welsch, 2016), an analysis of mega-watts per square kilometre is also carried out:

$$Model(2): LS_{ikt} = \alpha + \sum_{j=1}^{15} \beta_j energy_km2_{jkt} + \theta controls_{ikt} + id_i + region_k + year_t + \varepsilon_{ikt}$$

Where $energy_km2_{jkt}$ refers to the mega-watts of installed capacity for energy source j present in region k at time t per km^2 .

A second approach is to use the number of power plants present in an administrative district for a given year. This gives rise to 'Model (3)' and 'Model (4)':

$$Model(3): LS_{ikt} = \alpha + \sum_{j=1}^{15} \beta_j number_{jkt} + \theta controls_{ikt} + id_i + region_k + year_t + \varepsilon_{ikt}$$

$$Model(4): LS_{ikt} = \alpha + \sum_{j=1}^{15} \beta_j number_km2_{jkt} + \theta controls_{ikt} + id_i + region_k + year_t + \varepsilon_{ikt}$$

Where $number_{jkt}$ refers to the number of power plants for energy source j present in region k at time t . Similarly, $number_km2_{jkt}$ refers to the number of power plants for energy source j present in region k at time t per km^2 . This approach could be better for capturing the impact of local externalities that arise from the mere presence of facilities, such as visual impairments. If individuals are not neutral to visual impairments, then it could be that the presence of many power plants lowers with low

mega-watts installed capacity instead of just one with large capacity, would lower their life-satisfaction (although there must be a correlation between the size of the facility and the mega-watts installed).

Additionally, according to Easterlin and Plagnol (2008), life satisfaction in East and West Germany reacts differently to changes in economic variables after reunification. For this reason, a disaggregated analysis on former East and West Germany is carried out. Due to low number of observations for regions in former East, the comparison is carried out for 'Model (1)' only. Introducing energy density considerations and number of power plants does not allow for enough variation to estimate the model²⁸. The former East and West analysis gives birth to 'Model (5)' and 'Model (6)', respectively.

At last, a regression analysis for renewable and non-renewable energy sources is undertaken as an attempt to capture the impact of a transition towards renewables as a whole. 'Model (7)' outlines the algebraical expression for this estimation:

$$Model(7): LS_{ikt} = \alpha + \beta_1 renewables_{kt} + \beta_2 nonrenewables_{kt} + \theta controls_{ikt} + id_i + region_k + year_t + \varepsilon_{ikt}$$

where $renewables_{kt}$ refers to the mega-watts of installed capacity for all renewable sources (i.e. all hydroelectric, biomass, solar and wind energy) present in region k at time t . On the other hand, $nonrenewables_{kt}$ refers to the mega-watts of installed capacity for all non-renewable energy sources (oil, coal, gas, nuclear, waste, multiple and other non RE) present in region k at time t . Replicating this analysis for former East and West Germany gives 'Model (8)' and 'Model (9)' respectively

²⁸ Estimations of Models 2,3 and 4 were attempted, but coefficients could not be estimated when regressing against mega-watts and number of power plants per km². Similarly, p-values of 1.00 for regressing against number of power plants evidenced lack of variation. While the sample contains 34,758 German individuals, it only contains 8,432 individuals for East Germany.

A next step is the estimation of the average marginal willingness to pay (MWTP) for an additional mega-watt of installed capacity. The MWTP is expressed as follows (based on von Möllendorff and Welsch (2017)):

$$\text{Equation (1): } MWTP = \left[\hat{\beta}_j / \hat{\theta}income_{ikt} \right] * (\overline{income}_{ikt})$$

where $\hat{\beta}_j$ is the estimated coefficient on the energy variable(s) (i.e. $energy_{jkt}$ for 'Model (1)'). $\hat{\theta}income_{ikt}$ refers to the estimated coefficient on the logarithm of real income adjusted by household size. Moreover, \overline{income}_{ikt} is the mean real equivalent household income of all individuals surveyed during the period of analysis. The corresponding values for $\hat{\beta}_j$ and $\hat{\theta}income_{ikt}$ can be found later on the 'Results' section. Similarly, the value for \overline{income}_{ikt} can be found on 'TABLE 5'. Note that a negative MWTP would be read as average marginal willingness to accept (MWTA).

Alternative econometric estimations were also undertaken. These include cross-sectional linear and ordered logit regressions, as well as random-effects panel data. The difference in results revealed methodological sensitivity for the estimation of reported life satisfaction (see 'TABLE C5' on Appendix C).

Data

The present dissertation uses energy, demographic, socioeconomic and life-satisfaction data from Germany. A first step was the construction of a dataset that results from merging the energy and demographic databases using STATA, data analysis and statistical software. Merging provides a new dataset with the mega-watts installed capacity and number of power plants of each type of energy source and for each of the 401 German administrative districts, and for each year of the period 2011-2017. The following paragraphs describe the 'energy' and 'demographic' databases,

as well as the process undergone for their cleaning. Moreover, the last paragraph presents information on the way the final dataset was obtained. STATA do-files are attached on Appendix D for a detailed revision of the process described.

The energy data is publicly provided - in German language - by the German Federal Network Agency (*Bundesnetzagentur*²⁹) on an Excel workbook, last updated on February 2018. Such data contains a list of all power plants that provide energy services in Germany, accounting to 2,052 observations. These power plants are located in Germany, Luxembourg, Switzerland and Austria³⁰ and are described with respect to their postcode district location³¹, energy source, operation status³², capacity installed in mega-watts, year of installation, etc. One limitation of this database is the absence of location for power plants with less than 10 mega-watts of installed capacity. For this reason, such power plants, which account to 142 observations, are excluded from the analysis. Offshore wind power plants are also excluded from the analysis, as they do not belong to any administrative district. In addition, linear growth on mega-watts of installed capacity is assumed³³ for 16 power plant observations which experienced an expansion³⁴ from the year 2011 onwards but for which the database fails to provide the precise growth path. The average year of installation for the energy

²⁹ Bundesnetzagentur (2018) – direct download:

https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Unternehmen_Institutionen/Versorgungssicherheit/Erzeugungskapazitaeten/Kraftwerksliste/Kraftwerksliste_2018_2.xlsx?sessionId=D139189FB4E0AB798DAFBADF7005D751?__blob=publicationFile&v=3

³⁰ Only German locations are considered in the analysis. Observations for other countries are dropped

³¹ German postcode districts ('postleitzahl' in German language) are hierarchically below administrative districts ('kreise' in German language), i.e. an administrative district is composed of several postcode districts.

³² The variable includes the year of decommission where relevant.

³³ The annual growth in mega-watts is assumed to be the result of dividing capacity reported over the number of years between the year of installation and the year of expansion. The capacity reported is taken from the year of expansion and forward. However, for the years previous to the expansion, capacity installed for year 'T' is taken as the capacity installed of year 'T+1' minus the annual growth.

³⁴ This was evidenced by the presence of multiple years on the variable indicating the year of installation.

source is inputted for 2 power plants with no information for the year of installation or with inconsistent values. The variable for year of installation was modified to take its first value when multiple years were shown (see footnote 34) and the variable for mega-watts of installed capacity was modified according to the linear growth assumption when needed. On the other hand, no change in mega-watts of installed capacity is assumed for power plants under temporary closure, or under any other process different to final decommission³⁵. This allows to capture externalities that arise not only from energy production, but from the presence of installed power plants as well.

Also publicly available is the demographic database provided on an Excel workbook by the German Federal Office of Statistics (*DESTATIS*³⁶) and published on May 2018 -in German language as well. The data reported refers to coordinates, urbanization degree and population variables for 11,042 German municipalities with their respective postcodes. Moreover, the data is presented hierarchically, showing clearly the community, administrative district and federal state to which each listed municipality belongs to. Most importantly, the hierarchical presentation allows matching the postcodes presented on this demographic database with the ones on the 'energy' database previously described. However, 315 power plant observations on the 'energy' database were located on postcode districts unrecognized by the

³⁵ Power plants on the energy database can be operational, temporarily closed or on a special case regime (i.e. they operate on restricted mode or are found under repair). They can also be on stand-by for back-up purposes (expected to be finally decommissioned by the October 2020); this is the case of many brown coal power plants in an effort to reduce carbon-intensive energy sources. Moreover, they can be under network reserve. This is the case for many fossil-fuelled power plants in the south of Germany, which play the role of stabilizing the transmission network of wind energy flowing from north to south. Finally, they can also be under the status of final decommission (Bundesnetzagentur, 2018).

³⁶ DESTATIS (2018) – direct download:

<https://www.destatis.de/DE/ZahlenFakten/LaenderRegionen/Regionales/Gemeindeverzeichnis/Administrativ/Archiv/GVAuszugQ/AuszugGV2QAktuell.html>

demographic database, due to their presence on non-residential areas. This posed an inconvenience, given the need to merge the 'energy' with the 'demographic' database at the level of administrative districts. Nonetheless, it was possible to identify the administrative district of 266 power plant observations according to the location name³⁷. However, for the other 49 observations, the use of Google Maps, Wikipedia, and alternative websites³⁸ provided with the name of the administrative district that holds the power plants in question. The database resulting from merging the 'energy' and 'demographic' database is the 'energy 01' database. For merging, a district identification code had to be created from the 'demographic' database. This was done by concatenating the first three regional keys (i.e. federal state, region and district codes). The resulting district identification code was correspondently attached to each hierarchically lower location within the district (i.e. communities and municipalities). Then, matching at the level of postcode district between the 'energy' and 'demographic' database provided with the district identification code for power plants in the 'energy' database, except for the 315 observations with unrecognized postcode districts, for which the matching process is described above. Afterwards, all 2,052 power plant observations were replicated for the years of analysis (i.e. 2,052 observations per year, 2011-2017). This process was done in Microsoft Excel and VBA programming. Later on, STATA was used for collapsing the 'demographic' database at the level of administrative district only. A next step was merging this collapsed 'demographic' database with the database containing the 2,052 power plant observations yearly-replicated (i.e. 'expanded energy' database). When merged, it

³⁷ After matching for location name, a second verification was made: At least the first 3 digits of the postcode district must coincide. Otherwise, alternative sources of information were used.

³⁸ i.e. <http://www.plz-suche.org/de/plz>, <https://www.suche-postleitzahl.org>, <https://www.proplanta.de>, https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Unternehmen_Institutionen/NetzentwicklungUndSmartGrid/Gas/NEP_2014/Szenariorahmen_2014/NEP_GAS_2014_Gaskraftwerksliste.xls?__blob=publicationFile&v=2

became necessary to drop all observations with less than 10 mega-watts of installed capacity, as they do not provide information on the location of the power plant and hence are useless for identifying the level of exposure of local externalities that arise from power plants experienced by individuals near them. Similarly, to capture the mega-watts of installed capacity relevant for the period of analysis only, the year of decommission variable had to be created. This information was contained in the variable for power plant status in a textual format. Hence, there was a need to create a variable for the year of decommission, which would take the corresponding year in numeric format when relevant and a missing value when not. After the modifications and new variables created, it was possible to modify the variable for mega-watts of installed capacity according to the year of installation, year of analysis, and year of decommission - if any. If a power plant started operating after 2011, mega-watts of installed capacity for years of analysis prior to the year of initiation are taken as zero. Moreover, a power plant decommissioned during the period of analysis exhibits zero mega-watts on the year of analysis that coincides with its year of decommission and onwards. Similarly, if a power plant is decommissioned prior to the period of analysis, it is not considered at all. Sorting the database by administrative district, year of analysis and energy source for summing up the mega-watts of installed capacity of power plants gave rise to a variable that captures installed capacity of each energy source per administrative district and year of analysis. Furthermore, the collapsed 'demographic' database was then expanded by a factor of 140 (20 energy sources for each of the 7 years). This expanded 'demographic' database was then merged with the 'merged energy' database containing the mega-watts of installed capacity and number of power plants per administrative district, year and energy source. The

resulting database is one of 56,140 observations (20 energy sources³⁹ for the 7 years for the 401 administrative districts). This is the 'energy 02' database.

The variable for number of power plants was created at a much later stage, and hence followed a different process. First, the 'expanded energy' database previously created and described above was imported to STATA. The number of power plants for each type of energy source present in an administrative district in a given year is also calculated by taking into account the year of decommission and year of installation. First a dummy variable 'n' is created: it takes the value of 0 for the observations corresponding to the year of decommission – if any - and onwards. It also takes the value of 0 for the observations corresponding to years previous to the year of installation. Otherwise, 'n' takes the value of 1. Then, the database is sorted by administrative district, year and energy source in order to create the variable 'number', which is the sum of 'n' for each energy source present in an administrative district in a given year (i.e. the number of power plants). A variable for number of power plants specific to each energy source is created⁴⁰. Collapsing the database by administrative district, year and energy source provides with a database containing the number of power plants present in each administrative district in a given year, for each energy source (i.e. 'energy 03' database).

As the present dissertation wishes to capture the impact of changing geographical patterns in energy power plants on subjective wellbeing, socioeconomic and life-satisfaction data is required. Hence, the 'energy 02' database was merged with data

³⁹ Although there were originally 20 energy sources, for 4 of them there were no power plants that produced mega-watts for the years of analysis. Moreover, wind off-shore is deleted of the analysis because it does not correspond to any administrative district. The remaining 15 energy sources can be found on 'TABLE 2'

⁴⁰ i.e. by making this variable specific to energy source 'e' equal to the variable 'number' only for observations corresponding to the energy source 'e'. Otherwise, it takes a missing value. The missing value is then replaced as zero.

provided by Socioeconomic Panel Study (SOEP) of the German Institute for Economic Research (*DIW*)⁴¹ for the years 2011-2016⁴². The SOEP Long study database was used for the attainment of a panel data of individual analysis; for each German individual surveyed, the household they belong to, their reported life-satisfaction and their information on income, gender, health, marital status, employment, consumer price index (CPI) and other control variables were obtained. However, the information regarding the location of the households, i.e. the administrative district and federal state they live on⁴³ (and their corresponding area in km²), belong to a dataset of the SOEP Core study and was available in long format. The merging process involved therefore the following steps. First, the ‘energy 02’ database was reshaped as to contain 20 energy variables, with their corresponding mega-watts of installed capacity for each administrative district and year. The 5 energy sources that are irrelevant, as described on footnote 39 are dropped and the year 2017 is dropped. The resulting database is one of 2,406 observations (401 administrative districts per year, each with a mega-watt installed capacity for each energy variable), i.e. ‘reshaped energy 02’ database. This database was then merged with the ‘energy 03’ database containing the number of power plants, resulting in the ‘final energy’ database. Then merged again with the database that contained information on the administrative district

⁴¹ SOEP is a longitudinal study that aims to facilitate analysis of welfare-enhancing policies. For this purpose, it provides information of individuals across a range of time. A total of 15,000 households and 30,000 persons participate in the SOEP study, approximately. The variables presented at the individual level of analysis (i.e. person) take self-reported values, both for sociodemographic and economic characteristics as for well-being and life-perception related variables. This data is not publicly available, as it contains sensitive information of German households. For the same reason, the access to the database was remote, i.e. using the SOEP remote system (Goebel, J. et al, 2018).

⁴² Unfortunately, to the date, SOEP is updated until the year 2016 only. Hence, the information on 2017 for the ‘final energy’ database was disregarded

⁴³ One apparent limitation of the SOEP database is the restricted access to an individual’s postcode location. This would in theory provide with the possibility of a more accurate analysis of the externalities, given the importance of the individuals’ distance to the power plants in question. However, of the 28,000 postcode locations, only 2802 refer to geographical areas, whilst the rest correspond to specific buildings, such as post-boxes and commercial units (personal note provided by Dr. Heinz Welsch).

location of households⁴⁴ ('SOEP kreise' database from now on, where only the survey years 2011-2016 were kept). As SOEP does not allow to merge any external dataset with its own, the use of the 'input' command was crucial. Hence, the 'SOEP kreise' database was collapsed by administrative district and year of survey to input the energy variables and their observation values from the 'final energy' database. Second, this new 'SOEP kreise' database with added value on mega-watts of installed capacity and number of power plants, could now be merged with the SOEP Long study database on life-satisfaction and other control variables. Finally, observations with no information or measurement errors are dropped for each of the variables in the analysis. This reduces the number of observations from 268,093 to 160,220. The sample contains 42,956 unique individuals - some of them being surveyed more than once during the period analysed while others attrite. 'TABLE 1' below shows almost 70% of individuals surveyed attrite at some point in time. Hence, the final database is an unbalanced panel. It grants information on living location⁴⁵, reported life-satisfaction, income, age, number of children, gender, health and marital status, employment and exposure to mega-watts of installed capacity and number of power plants for all energy sources present and reported in the German energy sector for each individual surveyed during the years 2011-2016.

Summary statistics for the dependent and explanatory variables are presented in 'TABLE 2' up to 'TABLE 5' below (other statistics can also be found on Appendix C). Moreover, Appendix B contains maps displaying the degree of variation in mega-watts

⁴⁴ The 'SOEP kreise' database contained 402 administrative districts, instead of 401. It was identified that the town Osterode am Harz (which used to be administrative district 03156) is now part of Gottingen (administrative district 03152). Observations for town Osterode am Harz were correspondingly recoded.

⁴⁵ i.e. administrative district and federal state

of installed capacity experienced by each administrative district for each energy source. The process for mapping can be found on Appendix D.

TABLE 1 : Panel attrition

copies	number of observations	surplus	number of individuals surveyed	Percentage of individuals surveyed	Percentage of individuals surveyed (cummulative)
1	9244	0	9244	21.5	21.5
2	10594	5297	5297	12.3	33.9
3	13614	9076	4538	10.6	44.4
4	22216	16662	5554	12.9	57.3
5	26930	21544	5386	12.5	69.9
6	77622	64685	12937	30.1	100.0
TOTAL	160220	117264	42956	100	100

Source: own elaboration, Data: Bundesnetzagentur (2018) and SOEPv33 (https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html)

**TABLE 2 : Summary statistics of energy sources, 2011-2016
(Mega-watts of installed capacity)**

Energy variable	Mean	St.Dev	Min	Max	Obs	Total presence in administrative districts*
waste	5.44	16.66	0	228.3	160,220	57
biomass	2.45	10.05	0	138.9	160,220	49
solar	3.72	18.17	0	224.3	160,220	57
wind	28.70	85.31	0	1445.6	160,220	158
hydropower (running water)	4.81	23.91	0	263.7	160,220	43
hydropower (storage, pumped)	19.32	136.70	0	1740.0	160,220	17
hydropower (storage, not pumped)	0.62	7.43	0	124.0	160,220	4
nuclear energy	27.29	202.80	0	2572.0	160,220	8
natural gas	55.78	272.90	0	5159.5	160,220	129
marsh gas	0.11	2.02	0	42.0	160,220	2
brown coal	63.06	424.12	0	4773.0	160,220	21
hard coal	59.19	273.72	0	4082.0	160,220	49

oil	7.40	44.52	0	772.0	160,220	32
multiple (non RE)	0.28	5.45	0	120.0	160,220	2
other (non RE)	4.41	62.00	0	1352.0	160,220	18
renewables	59.62	196.52	0	2937.4	160,220	226
non renewables	222.91	750.86	0	10885.8	160,220	189

* i.e. total number of districts that have experienced the presence of the energy source during the period 2011-2016

Source: own elaboration, Data: Bundesnetzagentur (2018)

TABLE 3 : Summary statistics of energy sources, 2011-2016
(Mega-watts of installed capacity per km²)

Energy variable	Mean	St.Dev	Min	Max	Obs	Total presence in administrative districts*
waste/km ²	0.016	0.136	0	2.828	160,220	57
biomass/km ²	0.012	0.154	0	3.891	160,220	49
solar/km ²	0.014	0.138	0	2.192	160,220	57
wind/km ²	0.114	0.864	0	17.913	160,220	158
hydropower (running water)/km ²	0.013	0.088	0	3.768	160,220	43
hydropower (storage, pumped)/km ²	0.047	0.647	0	14.067	160,220	17
hydropower (storage, not pumped)/km ²	0.001	0.011	0	0.193	160,220	4
nuclear energy/km ²	0.056	0.775	0	16.555	160,220	8
natural gas/km ²	0.234	2.877	0	63.934	160,220	129
marsh gas/km ²	0.000	0.002	0	0.052	160,220	2
brown coal/km ²	0.256	3.660	0	87.036	160,220	21
hard coal/km ²	0.233	2.145	0	41.939	160,220	49
oil/km ²	0.029	0.329	0	6.565	160,220	32
multiple (non RE)/km ²	0.003	0.067	0	1.487	160,220	2
other (non RE) /km ²	0.008	0.093	0	1.768	160,220	18
renewables/km ²	0.200	1.660	0	36.340	160,220	226

non renewables/km ²	0.840	6.920	0	134.890	160,220	189
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* i.e. total number of districts that have experienced the presence of the energy source during the period 2011-2016

Source: own elaboration, Data: Bundesnetzagentur (2018) and SOEPv33 (https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html)

TABLE 4: Presence of energy sources in administrative districts^a

Energy variable	2011	2012	2013	2014	2015	2016	Max ^b	Total ^c 2011- 2016
waste	55	54	55	56	56	56	56	57
biomass	49	49	49	48	48	49	49	49
solar	36	56	56	55	56	57	57	57
wind	117	120	124	141	154	158	158	158
hydropower (running water)	42	43	43	43	43	43	43	43
hydropower (storage, pumped)	17	17	17	17	17	17	17	17
hydropower (storage, not pumped)	4	4	4	4	4	4	4	4
nuclear energy	8	8	8	8	7	7	8	8
natural gas	123	120	121	123	122	125	125	129
marsh gas	2	2	2	2	2	2	2	2
brown coal	21	20	19	19	19	19	21	21
hard coal	48	47	47	47	47	47	48	49
oil	32	32	32	31	31	31	32	32
multiple (non RE)	2	2	2	2	2	2	2	2
other (non RE)	14	14	14	15	15	17	17	18
renewables	192	197	200	213	223	226	226	226
non renewables	186	185	183	185	182	183	186	189

a) The total number of administrative districts where the energy source is present

b) The maximum number of administrative districts where the energy source has been present per year

c) The total number of administrative districts where the energy source has been present during the whole period 2011-2016. As new districts incorporate the energy source, this can differ from the yearly maximum
Source: own elaboration, Data: Bundesnetzagentur (2018)

TABLE 5 : Summary statistics of dependent and control variables, 2011-2016

Variable	Description	Mean	St.Dev	Min	Max	
<i>overall life satisfaction</i>	11 point scale variable, self-reported (dependent variable) 0 = 'completely dissatisfied' 10 = 'completely satisfied'	7.28	1.73	0	10	
<i>age</i>	age of respondent	47.89	17.24	16	105	
<i>Income</i>	Previous year household income after tax, adjusted by inflation and household size (EUR)	East	16838.24	9982.48	1.88	213866.40
		West	20406.84	16465.56	0.94	983142.70
		Germany	19653.52	15396.07	0.94	983142.70
<i>Number of children</i>	Number of children in household	0.82	1.14	0.00	11	
<i>health status</i>	5 point scale variable, self-reported 1 = 'very good' 5 = 'very bad'	2.60	0.97	1	5	
<i>very good</i>	dummy variable 1= 'very good', 0 = 'otherwise'	0.11	0.31	0	1	
<i>good</i>	dummy variable 1= 'good', 0 = 'otherwise'	0.40	0.49	0	1	
<i>satisfactory</i>	dummy variable 1= 'satisfactory', 0 = 'otherwise'	0.32	0.47	0	1	
<i>bad</i>	dummy variable 1= 'bad', 0 = 'otherwise'	0.14	0.35	0	1	
<i>very bad</i>	dummy variable 1= 'very bad', 0 = 'otherwise'	0.04	0.19	0	1	
<i>marital status</i>	categorical variable for marital status, with 5 categories, ranging from married to separated	1.71	1.07	1	5	
<i>married</i>	dummy variable 1= 'married', 0 = 'otherwise'	0.59	0.49	0	1	
<i>single</i>	dummy variable 1= 'single', 0 = 'otherwise'	0.24	0.43	0	1	
<i>widowed</i>	dummy variable 1= 'widowed', 0 = 'otherwise'	0.05	0.23	0	1	

<i>divorced</i>	dummy variable 1= 'divorced', 0 = 'otherwise'	0.09	0.29	0	1
<i>separated</i>	dummy variable 1= 'separated', 0 = 'otherwise'	0.02	0.15	0	1
<i>employment status</i>	dummy variable 1= 'employed', 0 = 'unemployed'	0.61	0.49	0	1

Source: own elaboration, Data: SOEPv33
(https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html)

Results

‘TABLE 6’ – below presents the estimates coefficients for the variables included in ‘Model (1)’ and ‘Model (2)’, as well as their standard errors and significance level. ‘Model (1)’ predicts higher life satisfaction for individuals living in locations where biomass, oil and multiple (non RE) power plants are present, but lower life satisfaction for individuals living in locations where hydroelectric plants with pumped storage are present. When introducing energy density considerations - i.e. regressing on megawatts of installed capacity per km² – oil becomes the only significant energy source and its significance increases from the 10% level to the 5%. Control variables behave as predicted by the literature and are all significant⁴⁶. With respect to the overall significance of the models, both hold overall significance at 1% level, considering all regressors. However, the energy variables altogether do not significantly explain life satisfaction changes for both models. The R² within is fairly similar between both models, but slightly higher for ‘Model (1)’.

⁴⁶ Control variables behave as the literature review predicts and are all significant. Age follows a U-shape pattern, meaning that German individuals report lower life satisfaction as they grow older, but with diminishing returns. Income is positive and significant, with results very similar to Ferrer-i-Carbonell and Frijters (2004). An increase of household income by 1% yields, on average, an increase of approximately 0.00114 units in reported life satisfaction. Moreover, health largely explains reported life-satisfaction, with better health predicting better reported life satisfaction. Similarly, having children, being married and employed predict higher life satisfaction.

Another result to note is the large size of some energy related coefficients and their standard errors in 'Model (2)'. This could indicate high multicollinearity between the energy variables. Hence, the variance-inflated factor (VIF) is calculated for 'Model (1)' and 'Model (2)', in order to detect multicollinearity and compare. Following the rule of thumb for a VIF higher than 10 indicating multicollinearity between regressors, 'TABLE 8' discards the possibility.

TABLE 6: Model (1) and Model (2) estimation results

<i>dependent variable:</i> overall life satisfaction	estimate (standard error)	
<i>independent variables:</i>		
<i>energy sources</i>	Model (1)	Model (2)
waste	0.0053219 (0.0062652)	2.005572 (2.227125)
biomass	0.0564234** 0.0233779	8.90451 (5.682746)
solar	0.0006198 (0.0006229)	1.644675 (1.230647)
wind	-0.0000107 (0.0001331)	-0.0259242 (0.2376542)
hydropower (running water)	0.002629 (0.0103538)	0.2301322 (3.636717)
hydropower (storage, pumped)	-0.0517608** (0.0206479)	-13.28932 (9.294492)
hydropower (storage, not pumped)	-0.0038006 (0.0149865)	-3.444584 (18.86345)
nuclear energy	-0.0001048 (0.0001296)	-0.087955 (0.1090652)
natural gas	0.0000604 (0.0000831)	0.0335617 (0.0245297)
marsh gas	0.0043262 (0.0139956)	1.93118 (5.724522)
brown coal	0.0000155 (0.000055)	0.0086274 (0.0332223)
hard coal	0.00000779 (0.0000243)	-0.0074178 (0.0101628)
oil	0.0099577* (0.0051191)	13.16111** (5.869036)
multiple (non RE)	0.3749736** (0.1748882)	49.16671 (84.40578)
other (non RE)	0.0000974 (0.0008721)	0.0698424 (0.286891)

controls

age	-0.1195707*** (0.206984)	-0.1198505*** (0.207073)
age ²	0.0025012*** (0.0004155)	0.0025063*** (0.0004156)
age ³	-0.0000148*** (0.00000262)	-0.0000148*** (0.00000263)
log(adjusted income)	0.1134846*** (0.0159992)	0.1135191*** (0.0160085)
number of children in household	0.0899088*** (0.0130564)	0.0900881*** (0.0130534)

health status ('very bad' omitted)

very good	1.972063*** (0.041612)	1.972053*** (0.0416192)
good	1.721611*** (0.0391394)	1.721428*** (0.0391436)
satisfactory	1.392323*** (0.0383841)	1.392111*** (0.0383873)
bad	0.9076199*** (0.0370068)	0.9075013*** (0.0370106)

marital status ('married' omitted)

single	-0.1484541*** (0.0360089)	-0.1494973*** (0.036119)
widowed	-0.42015*** (0.0802105)	-0.4201425*** (0.0803465)
divorced	-0.0893758* (0.0478416)	-0.0897449* (0.0478677)
separated	-0.3354216*** (0.0542452)	-0.3352841*** (0.054251)
<i>employed (1=employed, 0=unemployed)</i>	0.0388886*** (0.0145792)	0.0386562*** (0.0145827)

equation characteristics

Individual fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Region fixed-effects	Yes	Yes
Number of individuals	42,956	42,956
Number of observations	160,220	160,220
R ² within	0.0617	0.0616
between	0.0784	0.0785
overall	0.0730	0.0732

Overall significance (F-test)

For all variables included	Yes ***	Yes ***
For the 15 energy sources only	No	No

*** significant at 1% level, ** significant at 5% level, * significant at 10% level

Source: own elaboration, Data: SOEPv33
 (https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html) and
 Bundesnetzagentur(2018)

Regressing against number of power plants instead of mega-watts of installed capacity gives similar results ('TABLE 7'). Biomass and oil energy sources continue to predict higher life satisfaction while pumped storage hydroelectric power plants also continue to predict lower life satisfaction. Power plants generating electricity from multiple non RE sources become insignificant, however. As with the mega-watts' approach, oil becomes the only significant energy source when considering the number of power plants per km². For both 'Model (3)' and 'Model (4)', energy sources continue to be altogether insignificant for explaining changes in life satisfaction. It is also important to note that estimated coefficients and standard errors are higher when considering the number of power plants instead of mega-watts of installed capacity. This is true with and without energy density considerations. A VIF analysis is undertaken for 'Model (3)' and 'Model (4)'. Results on 'TABLE 8' below continue to reject the presence of multicollinearity. However, Choi (2011) warns high coefficient estimates with moderate t-values accompanied by a small R² are enough to mistrust regression outputs of being spurious.

TABLE 7: Model (3) and Model (4) estimation results

<i>dependent variable:</i> overall life satisfaction	estimate (standard error)	
	Model (3)	Model (4)
<i>independent variables:</i>		

energy sources

waste	0.0188391 (0.0548344)	24.33535 (18.30269)
biomass	0.4349202** (0.1890475)	22.43033 (23.50759)
solar	0.0133714 (0.0109112)	26.2567 (20.73478)
wind	-0.0000628 (0.0033128)	-0.4444297 (5.251993)
hydropower (running water)	-0.0048405 (0.1003951)	-3.071897 (32.27341)
hydropower (storage, pumped)	-0.61404* (0.3363382)	-420.2631 (361.1982)
hydropower (storage, not pumped)	-0.2630292 (0.6627821)	-689.3051 (952.307)
nuclear energy	-0.1331881 (0.1652384)	-112.5459 (139.273)
natural gas	0.0037079 (0.0134409)	1.304849 (3.548626)
marsh gas	0.2269407 (0.5828611)	-24.64961 (260.6402)
brown coal	-0.0087024 (0.0247545)	0.9612813 (21.45316)
hard coal	0.0065874 (0.011068)	-3.437993 (3.457133)
oil	0.3223534* (0.1665312)	308.9287** (144.2312)
multiple (non RE)	-0.6715952 (2.104362)	-191.6627 (2035.701)
other (non RE)	0.0322176 (0.0391932)	6.131734 (8.351294)

controls

age	-0.1197463*** (0.0207021)	-0.1199724*** (0.0207134)
age ²	0.0025062*** (0.0004154)	0.0025106*** (0.0004156)
age ³	-0.0000148*** (0.00000262)	-0.0000148*** (0.00000262)
log(adjusted income)	0.1134072*** (0.0159902)	0.1136629*** (0.0160073)
number of children in household	0.0897483*** (0.0130561)	0.0900555*** (0.0130539)
<i>health status ('very bad' omitted)</i>		
very good	1.971893*** (0.0416092)	1.972124*** (0.0416194)

good	1.72129*** (0.0391333)	1.721445*** (0.0391421)
satisfactory	1.392091*** (0.0383785)	1.392158*** (0.0383862)
bad	0.9073662*** (0.0370032)	0.9075434*** (0.0370093)
<i>marital status ('married' omitted)</i>		
single	-0.1487685*** (0.0360299)	-0.1501357*** (0.0361479)
widowed	-0.4200115*** (0.08258)	-0.4201932*** (0.0803457)
divorced	-0.089924* (0.0478265)	-0.0896787* (0.0478664)
separated	-0.3359469*** (0.0542087)	-0.3351194*** (0.0542209)
<i>employed (1=employed, 0=unemployed)</i>	-0.0389876*** (0.0145825)	0.0387353*** (0.0145852)
<i>equation characteristics</i>		
Individual fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Region fixed-effects	Yes	Yes
Number of individuals	42,956	42,956
Number of observations	160,220	160,220
R ² within	0.0617	0.0616
between	0.0783	0.0781
overall	0.0731	0.0729
Overall significance (F-test)		
For all variables included	Yes ***	Yes ***
For the 15 energy sources only	No	No

*** significant at 1% level, ** significant at 5% level, * significant at 10% level

Source: own elaboration, Data: SOEPv33 (https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html) and Bundesnetzagentur(2018)

TABLE 8: Variance Inflated Factor

energy source variable	Model (1)	Model (2)	Model (3)	Model (4)
waste	2.2	1.28	3.77	1.44
biomass	1.65	1.15	2.12	1.08
solar	1.43	1.11	1.39	1.1
wind	2.06	1.19	2.96	1.82
hydropower (running water)	1.18	1.01	1.21	1.02
hydropower (storage, pumped)	1.79	1.03	1.53	1.07
hydropower (storage, not pumped)	1.01	1.00	1.02	1.00
nuclear	1.18	1.01	1.19	1.04
natural gas	4.55	1.52	5.42	1.68
marsh gas	1.07	1.02	1.04	1.01
brown coal	1.13	1.04	1.08	1.04
hard coal	1.56	1.22	1.95	1.11
oil	1.9	1.33	1.74	1.22
multiple (non RE)	4.36	1.11	7.10	2.04
other (non RE)	1.06	1.12	1.17	1.09
mean VIF	1.87	1.14	2.31	1.25

Source: own elaboration, Data: SOEPv33 (https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html) and Bundesnetzagentur (2018)

The former West versus former East Germany analysis shows opposite preferences for biomass power plants (‘TABLE 9). In former East Germany, 1 mega-watt increase in biomass installed capacity lowers life satisfaction by almost 0.09, on average. On the other hand, individuals located in former West experience on average an almost 0.06 increase in life satisfaction when biomass installed capacity increases by 1 mega-watt. Both results are significant at the 5% level. Moreover, individuals located in former West hold a highly significant preference for hydroelectric pumped storage power plants. A 1-mega-watt increase in hydroelectric pumped storage power plants’ installed capacity increases, on average, life satisfaction in the former West region by almost 0.02. The latter result is significant at the 1% level. Oil-fuelled power plants’ estimated coefficients are weakly significant for explaining life satisfaction, with a positive and smaller impact. However, the 95% confidence interval for the coefficient on oil (not reported in tables) has a negative lower bound of -0.0008866 and a positive

upper bound of 0.0192273. Hence, with 95% confidence, there is no certainty about the sign of the coefficient⁴⁷. Most importantly, results for former East and West Germany hold overall significance for the energy variables, as opposed to previous models presented. Please note energy sources were grouped for the East analysis in order to avoid omitted variables due to collinearity, probably due to lower observations available⁴⁸.

TABLE 9: Model (5) and Model (6) estimation results
(former West vs former East Germany)

<i>dependent variable:</i> overall life satisfaction	estimate (standard error)	
<i>independent variables:</i> <i>energy sources</i>	Model (5)^a	Model (6)^b
waste	0.0038012 (0.0110738)	0.0031308 (0.0075916)
biomass	0.0586933** (0.0233078)	-0.0884592** (0.0441045)
solar	0.0009923 (0.0036414)	-0.0002187 (0.0006979)
wind	-0.0001013 (0.0001504)	-0.0001746 (0.0003739)
hydropower (grouped)	n.a	-0.0008497 (0.000879)
hydropower (running water)	0.0027398 (0.0105449)	n.a
hydropower (storage, pumped)	0.0171666*** (0.0034874)	n.a
hydropower (storage, not pumped)	-0.0029879 (0.0155685)	n.a
nuclear energy	-0.0001226 (0.0001299)	0.0059055 (0.0043255)
gas (grouped)	n.a	0.0003136 (0.0004468)

⁴⁷ This is also true for 'Model (1)' and 'Model (3)'.

⁴⁸ When the former East analysis was carried out without grouping energy sources, results were the same as presented here, but with omitted variables. Overall significance for the energy variables hold as well, at the 1% significance level. However, if the same grouping was applied to the West analysis, the model loses significance for the energy variables. For this reason, the West analysis was maintained in its original form.

natural gas	0.0000664 (0.0000849)	n.a
marsh gas	0.0062858 (0.0150804)	n.a
coal (grouped)	n.a	0.000131 (0.0001171)
brown coal	0.00000736 (0.0000571)	n.a
hard coal	0.00000245 (0.000025)	n.a
oil	0.0091703* (0.005131)	0.0024596 (0.0018061)
multiple (non RE)	-0.0265737 (0.0297627)	omitted
other (non RE)	-0.0001714 (0.000926)	-0.0004635 (0.0025894)
<i>controls</i>		
age	-0.1105693*** (0.0230566)	-0.1365171*** (0.0484519)
age ²	0.0021492*** (0.0004658)	0.0035675*** (0.0009738)
age ³	-0.0000124*** (0.00000296)	-0.0000226*** (0.00000586)
log(adjusted income)	0.1114939*** (0.171514)	0.1229412*** (0.0429709)
number of children in household	0.093194*** (0.0141354)	0.0676379*** (0.0338479)
<i>health status ('very bad' omitted)</i>		
very good	1.93627*** (0.0482308)	2.073574*** (0.0836034)
good	1.68928*** (0.0456414)	1.806419*** (0.0764944)
satisfactory	1.366673*** (0.0448361)	1.458646*** (0.0746152)
bad	0.875533*** (0.0433347)	0.9965917*** (0.0710989)
<i>marital status ('married' omitted)</i>		
single	-0.1668711*** (0.0419625)	-0.0473826*** (0.0701023)
widowed	-0.3343654*** (0.0970976)	-0.6591572*** (0.1388112)
divorced	-0.0760954 (0.0540454)	-0.1218096 (0.104794)
separated	-0.3266898*** (0.0602413)	-0.3855917*** (0.1293705)

<i>employed</i> (1= <i>employed</i> , 0= <i>unemployed</i>)	0.0481299*** (0.0160972)	0.0150309 (0.0346293)
<i>equation characteristics</i>		
Individual fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Region fixed-effects	Yes	Yes
Number of individuals	34,758	8,432
Number of observations	126,398	33,822
R ² within	0.0602	0.0676
between	0.0899	0.0160
overall	0.0809	0.0229
Overall significance (F-test)		
For all variables included	Yes***	Yes***
For the 15 energy sources only	Yes***	Yes***

*** significant at 1% level, ** significant at 5% level, * significant at 10% level

a) Model (1) replicated for former West Germany

b) Model (1) replicated for former East Germany and adapted to grouped variables to avoid omitted variables due to multicollinearity

Source: own elaboration, Data: SOEPv33 (https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html) and Bundesnetzagentur (2018)

Control variables maintain the expected signs in the West-East analysis. Income, however, holds a higher coefficient for East Germany. This goes in line with Frijters et al (2004)'s finding on the large attribution of real income for changes in life satisfaction for East Germany after reunification⁴⁹.

'TABLE 10' below displays results for the grouped regression against renewable and non-renewable energy sources. When grouped into these categories, the energy variables are insignificant for explaining changes in reported overall life satisfaction. Moreover, the overall significance for the energy variables is absent, even when disaggregating by West ('Model (8)') and East Germany ('Model (9)'). A further

⁴⁹ Between 35-40% of the increase in life-satisfaction is attributable to the increase in real income, examining the periods of 1990-2001 and using the German SOEP data.

analysis was undertaken with mega-watts of installed capacity per km², number of power plants, and number of power plants per km² but the model continued to hold low explanatory power, so it is not worth presenting the tables here (regressions can be found on do-files of Appendix D).

TABLE 10: Model (7), Model (8), Model (9)
(renewable vs non-renewable energy)

<i>dependent variable:</i> overall life satisfaction	estimate (standard error)		
	Model (7)^a	Model (8)^b	Model (9)^c
<i>independent variables:</i>			
<i>energy sources</i>			
renewables	0.0000239 (0.0001278)	-0.0001182 (0.0001513)	-0.0001846 (0.0003265)
non-renewables	0.0000165 (0.0000209)	0.00000804 (0.0000215)	0.0001481 (0.0001076)
<i>controls</i>			
age	-0.1200398*** (0.0206945)	- 0.1109977*** (0.0230511)	-0.1370296*** (0.0484097)
age ²	0.0025154*** (0.0004157)	0.0021621*** (0.000466)	0.0035716*** (0.0009482)
age ³	-0.0000148*** (0.00000263)	- 0.0000124*** (0.00000296)	-0.0000227*** (0.00000586)
log(adjusted income)	0.1134945*** (0.0160189)	0.1114752*** (0.0171444)	0.1228854*** (0.0430442)
number of children in household	0.0896817*** (0.0130561)	0.0929035*** (0.014133)	0.0677258** (0.0338066)
<i>health status ('very bad' omitted)</i>			
very good	1.972311*** (0.0416118)	1.936876*** (0.0482312)	2.073769*** (0.0835645)
good	1.721779*** (0.0391381)	1.689801*** (0.0456412)	1.806144*** (0.0764768)
satisfactory	1.392173*** (0.0383826)	1.366867*** (0.0448368)	1.458433*** (0.0746013)
bad	0.9076704*** (0.0370032)	0.8759575*** (0.0433356)	0.9963249*** (0.0710616)

marital status ('married' omitted)

single	-0.1508715*** (0.0361703)	-	0.1698889*** (0.0422125)	-0.0476205 (0.0700328)
widowed	-0.4199144*** (0.080345)	-0.333608*** (0.0973401)	-	-0.65955448*** (0.1387689)
divorced	-0.0910476* (0.0479351)	-0.0775416* (0.054201)	-	-0.1232108 (0.1046305)
separated	-0.3365688*** (0.0542592)	0.3280004*** (0.060262)	-	-0.3856303*** (0.1293462)
<i>employed (1=employed, 0=unemployed)</i>	0.0392071*** (0.014581)	0.0482557*** (0.0160997)	-	0.0153618 (0.0345982)

equation characteristics

Individual fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Region fixed-effects	Yes	Yes	Yes
Number of individuals	42,956	34,758	8,432
Number of observations	160,220	126,398	33,822
R ² within	0.0615	0.0599	0.0676
between	0.0778	0.0901	0.0194
overall	0.0727	0.0813	0.0287
Overall significance (F-test)			
For all variables included	Yes***	Yes***	Yes***
For the 2 energy variables only	No	No	No

*** significant at 1% level, ** significant at 5% level, * significant at 10% level

a) Germany, b) former West Germany, c) former East Germany

Source: own elaboration, Data: SOEPv33 (https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html) and Bundesnetzagentur (2018)

MWTP estimations are taken for 'Model (5)' and 'Model (6)' only, since these are the only models with overall significance for the energy variables. Estimates show – with 95% confidence - an average German located in the former West is WTP at least 12% of its annual real income for an additional unit of mega-watt installed capacity on biomass power plants, equivalent to 2,381 euros. On the contrary, an average German

located in the former East is willing to accept (WTA) at least 2% of its annual income, equivalent to 274 euros. Additionally, in the former West region, individuals are WTP 9% of their real income or more, equivalent to 1820 euros for one additional mega-watt installed capacity of hydropower pumped storage (see 'TABLE 11' below). Summary statistics and description for income variable are found on the 'Data' section. Estimated coefficients can be found on 'TABLE 9' of this section.

TABLE 11: Marginal Willingness to Pay estimation

<i>Estimation Model</i>			Model (5)		Model (6)
<i>energy variable (mega-watts of installed capacity)</i>			biomass	hydropower (storage, pumped)	biomass
<i>estimated coefficient on energy variable</i>	95% <i>CI</i>	$\hat{\beta}_j$	0.059	0.017	-0.088
		<i>lower bound</i>	0.013	0.010	-0.175
		<i>upper bound</i>	0.104	0.024	-0.002
<i>estimated coefficient on log(adjusted real income)</i>			0.111	0.111	0.123
<i>mean income (euros)</i>			20406.8	19645.2	16838.2
<i>Marginal Rate of Substitution (MRS)</i>	95% <i>CI</i>	$\hat{\beta}_j$	0.53	0.15	-0.72
		<i>lower bound</i>	0.12	0.09	-1.42
		<i>upper bound</i>	0.94	0.22	-0.02
<i>MWTP (euros)</i>	95% <i>CI</i>	$\hat{\beta}_j$	10743	3025	-12116
		<i>lower bound</i>	2381	1820	-23957
		<i>upper bound</i>	19104	4229	-274

Source: own elaboration, Data: SOEPv33 (https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html) and Bundesnetzagentur (2018)

Discussion

Results confirm parametric instability between former regions of East and West Germany. Not only are estimated coefficients different in size and sign for both regions, but the model gains overall significance for the energy variables when the two regions are analysed separately. Hence, individuals located in the former East and West regions hold different preferences for energy supply, and in particular, for the siting of power plants.

Main results show biomass as a point of conflict between regions in the Germany energy transition towards renewables. While individuals located in the former West experience a higher life satisfaction with more mega-watts of biomass installed capacity, individuals in the former East experience a lower life satisfaction. On the other hand, hydroelectric power generated by pumped storage facilities are positively correlated with life satisfaction in the former West Germany.

Results are difficult to rationalize given the low decommission and installation rates for biomass and hydroelectric (pumped storage) power plants during the period of 2011-2016. Biomass power plants suffered a decommission rate and installation rate of 0% and 3.2% respectively. Similarly, hydroelectric pumped storage power plants exhibit 0% decommission and installation rate during the period in question (Bundesnetzagentur, 2018). Maps in Appendix B also show a low coefficient of variation in mega-watts of installed capacity within regions for both type of energy sources, discarding the possibility of expansion in mega-watts for power plants already installed explaining the result. Moreover, the administrative districts where biomass power plants were installed during the period of 2011-2016 were not new to the energy source. The hypothesis examined can therefore be rejected, i.e. for the period examined, the presented dissertation does not found evidence of changes in mega-

watts of installed capacity for a particular energy source explaining changes in life satisfaction.

Alternative explanations include the possibility of a dependent relationship within energy sources (i.e. biomass and hydropower pumped storage power plants could impact life satisfaction through their changing relationship with other energy sources). It would therefore be necessary to know which other energy sources interact with biomass power plants within administrative districts. Moreover, a dynamic relationship between life satisfaction and power plants is also possible. von Möllendorff and Welsch (2017) examine this alternative and find highly significant lag coefficients, meaning that odour nuisance adaptation is weak. Taking these two possibilities into account, 'TABLE 12' below shows the administrative districts where biomass power plants have been installed since 2005 and the region they belong to. One thing to notice is the interaction of biomass power plants within administrative districts occurs often. In the former West, this interaction seems to predominate with natural gas and coal power plants, while in the former East the most common interaction is with wind energy turbines. Geeta et al (2016) show higher normalized annual output of kilowatts per m² in areas with high velocity wind. This could suggest wind speed is greater in the East region, implying odour from biomass would dissipate more quickly. However, many factors can influence odour nuisance. Piringner et al (2016) point out the 'German Odour Regulation' is looser than the Austrian, meaning that separation distances from annoying odour sites are likely lower in Germany. Moreover, they point out separation distances depend on meteorological conditions, such as wind speed and direction, as well as other factors such as the presence of mixed commercial and residential areas or residential and commercial areas being located in valleys where the flow of wind is channelled and stable. Since the former East Germany cities have experienced

shrinking and population migration towards the urban fringe (Bontje, 2004), it could be that commercial and residential buildings to be located near power plant sites. If residential and commercial areas in East Germany are located in such a way that odour protection from biomass power plants is low, then the result is compatible with von Möllendorff and Welsch (2017) 's finding on weak hedonic adaptation for biomass (as wind conditions are uncontrollable for households) and their finding for both own and adjacent postcode districts holding significant negative impacts from biomass power plants.

On the other hand, former West Germany is heavier in conventional fossil-fuelled power plants. One explanation for individual's preference for biomass in this region could be a combination of lower wind speed (hence, hedonic adaptation in this region could be stronger) and increasing environmental conscience. This hypothesis would not be compatible with Venghaus and Hoffman (2016)'s finding on individuals being neutral towards biomass power plants. However, their study is in Brandenburg, belonging to the East region. When looking at WTP for environmental protection, Urfei and Witzke (2001) find West Germany to have much higher WTP than East, although this is largely explained by income differences. Additionally, according to the literature review undergone by Welsch (2016), some biomass inputs, such as canola instead of maize, may produce higher visual pleasure than others. Hence, a stronger environmental willingness, difference in crop inputs, and/or lower odour nuisance in West could explain preference for biomass power plants in this region.

TABLE 12: Biomass power plants regional presence and introduction since 2005
(MW: mega-watts)

Administrative districts where present since 2005:	Region	Biomass power plants	Other power plants
01062	WEST	1 power plant installed in 2005 (20 MW)	1 natural gas plant installed in 2009 (127 MW)

03256	WEST	1 power plant installed in 2005 (22 MW)	2 natural gas plants installed in 1973 (481 MW total)
03402	WEST	1 power plant of 22 MW installed in 2005	2 natural gas plants installed in 1973 (485 MW total) 5 wind energy plants installed from 1994 onwards (99.4 MW total)
03455	WEST	1 power plant installed in 2006 (1.9 MW)	2 natural gas plants installed from 1968 onwards (58.6 MW total) 4 wind energy plants installed from 1996 onwards (61.5 MW total)
03456	WEST	1 power plant installed in 2006 (20 MW) 1 power plant installed in 2014 (10.6 MW)	3 wind energy plants installed since 2002, 53 MW in total 1 solar plant installed in 2011, 24.7 MW
05162	WEST	1 power plant installed in 2008 (12.1 MW)	3 brown-coal power plants decommissioned in 2011 (383 MW total) 9 brown-coal power plants present since 1966 (4773 MW total) 2 Natural gas power plants from 1992 onwards (603.9 MW total)
05554	WEST	1 power plant installed in 2006 (11.4 MW)	5 wind energy plants installed from 2002 onwards (73.1 MW total)
05978	WEST	2 power plant installed in 2005 & 2006 (37.7 MW)	2 hard-coal power plant since 1981 (1331 MW total) 8 natural gas power plants since 1973 (1397 MW total)
07143	WEST	1 power plant installed in 2006 (14 MW)	4 wind energy power plants installed from 2004 onwards (172 MW total)
08212	WEST	1 power plant installed in 2010 (78 MW)	2 natural gas power plants since 194 (390 MW total) 2 oil power plants since 1995 (70 MW total) 1 hard-coal power plants since 1985 (517 MW) 1 hard-coal power plant since 2014 (834 MW)
08421	WEST	1 power plant 8.7 MW installed in 2003 (8.7 MW) 1 power plant of 4.5 MW installed in 2012 (4.5 MW)	1 hard-coal power plant since 1978 (20.7 MW)
09661	WEST	2 power plants installed in years 2005,2010 (1.9 MW total)	1 natural gas power plant since 2013 (47 MW) 1 natural gas power plant decommissioned in 2012 (27 MW) 1 oil power plant since 1991 (0.5 MW)

09176	WEST	1 power plant installed in 2007 (15.1 MW)	1 wind energy power plant installed in 2015 (21.5 MW) 2 oil power plants since 1973, now in network reserve (772 MW total)
09771	WEST	1 power plant installed in 2007 (9.6 MW)	1 hydropower (running water) power plant since 1983 (12.4 MW)
11000	BOTH	1 power plant installed in 2005 (16.5 MW)	1 waste power plant since 1998 (36 MW) 1 natural gas power plant decommissioned in 2016 (144 MW) 5 natural gas power plants since 1972 (1040 MW total) 2 oil power plants since 1971 (327 MW total) 4 hard-coal power plants since 1969 (777 MW total)
12060	EAST	1 power plant installed in 2006 (20 MW)	4 natural gas power plants since 1990 (150 MW total) 2 solar energy power plants since 2010 (35.1 MW total) 1 wind energy power plant since 2004 (22.5 MW)
13075	EAST	1 power plant installed in 2006 (17.8 MW)	2 natural gas power plants (29.8 MW total) 3 solar energy power plants installed since 2009 (51.6 MW total) 8 wind energy power plants installed since 1999 (2 installed in 2014 & 2015) (216.9 MW total)
15091	EAST	1 power plant installed in 2009 (18.1 MW)	5 wind energy power plants (64 MW total) (from 2005 onwards)
16061	EAST	1 power plant installed in 2006 (18.1 MW)	none
16075	EAST	1 power plant installed in 1999 (53.5 MW) 1 power plant installed in 2008 (12.9 MW)	1 hydropower (pumped storage) since 1932 (79.8 MW) 1 solar energy power plant installed in 2012 (11.1 MW) 2 wind energy power plants since 2002 (12.8 MW total)

Source: own elaboration, Data: Bundesnetzagentur (2018)

On the other hand, administrative districts in the former West region where hydropower pumped storage (HPS) power plants are present rarely interact with other energy sources (and when they do, it usually is with other hydropower sources such

as running water). Moreover, no installation of HPS power plants have occurred since 1989, with the exception of 1 power plant in 2007 (Bundesnetzagentur, 2018). For this reason, it is not worth presenting the table here. Nonetheless, the highly significant results for HPS in West Germany could be explained by an increase in proposed projects of HPS power plants not yet installed. According to Steffen (2012), 12 PHS projects with clearly defined locations and with commenced spatial planification procedures by 2012 were present in Germany. Most of this PHS projects are of 200 mega-watts of installed capacity or more. Most importantly, PHS ongoing projects are mainly located near existing PHS plants or in adjacent locations and in West Germany⁵⁰ (i.e. PHS projects cluster around existing locations). Moreover, most ongoing PHS projects are expected to be completed from 2018 onwards. Therefore, significant and positive results for PHS plants on overall life satisfaction presented here may be capturing positive wellbeing impacts from anticipation. Some of the anticipated wellbeing impacts might be the expectation of reactivation of the regional economy and moral gains from the integration of renewable energy, as well as expected financial gains from future savings on expensive power purchases during peak hours (Steffen, 2012).

Furthermore, results presented here suggest the renewable energy transition holds no significant impact as a whole for the period of 2011-2016. Rather, its impact should be examined by type of fuel. Opposite to previous studies, such as Krekel et al (2016) and von Möllendorff and Welsch (2017), no significant impact of wind energy onshore power plants on life satisfaction is found. For the case of von Möllendorff and Welsch (2017)'s study - which followed a similar methodology as the one presented here - the impact on wind energy was negative but weakly significant for mega-watts of installed

⁵⁰ This can be appreciated in Figure 2 of Steffen (2012)

capacity. Hence, given the limited time period analysed here, it is sensitive not to find significant negative impacts. On the opposite spectrum, results here suggest health impacts and traffic congestion from fossil-fuelled power plants do not significantly explain changes in life satisfaction, as one would expect by the literature review.

Additionally, the use of region fixed effects in the estimation would in theory, capture the impact of living in a region with a particular characteristic that may be omitted in the analysis. A closer look at administrative district dummies omitted in the regression due to collinearity could reveal opportunities for methodological improvements.

'TABLE 13' below show the administrative district dummies omitted due to collinearity:

TABLE 13: Administrative district dummies omitted in Model (1)

03255
04012
07231
07232
07233
07317
07334
08225
09777
09275
09276
09279
09377
09474
09478
09565
09575
09675
09762
09778
10041
12072
16062
16065
16068

Source: own elaboration, Data: SOEPv33
(https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html)
and Bundesnetzagentur (2018)

One additional consideration for interpretation of results is the reduction in variation in the data analysed due to the use of fixed effects. Mummolo and Peterson (2017) point out that, even though fixed effects are used to avoid selection bias arising from omitted variables⁵¹, they also greatly reduce explanatory power. Considering the present analysis, we are comparing life-satisfaction outcomes for individuals with certain characteristics. Therefore, we are evaluating if German individuals who experience higher than average mega-watts of installed capacity for a particular energy source present in their region - given their health and marital status, age, number of children in the household, income and employment status – report higher overall life-satisfaction than the average individual of the same characteristics during the period 2011-2016. Since the data is large in sample and nationwide representative, this might not be a relevant criticism for the analysis presented here. Nevertheless, further studies can compare results with and without multiple fixed effects.

Conclusions

The present dissertation has studied the impact of power plants on overall life-satisfaction in Germany. This was done by using the German SOEP longitudinal study for the years 2011-2016 and energy data from the German Federal Network Agency. Moreover, it is the variation in mega-watts of installed capacity across time and

⁵¹ For the present analysis, this would be, for example, making sure that the estimated coefficient on an energy variable is not biased due to omitted factors that may also explain changes in life satisfaction, such as health and income.

regions, along with control variables and fixed effects, that allows the models to explain variations in reported overall life-satisfaction. The main finding from this approach is parametric instability between former West and East regions in Germany for mega-watts of installed capacity explaining variations in life-satisfaction. In particular, biomass power plants' mega-watts of installed capacity exhibit significant positive impacts on life-satisfaction for the former West region, while exhibiting significant negative impacts for the former East. Hydroelectric power from pumped storage power plants' mega-watts of installed capacity are found to be highly significant and positive for the individuals living in the former West Germany region.

These results are found in spite of the low variation in mega-watts of installed capacity within administrative districts. Hypothesis on geological conditions surrounding biomass power plants and environmental consciousness, as well as lead (anticipation) impacts for hydropower pumped storage power plants⁵² are raised on the previous section but could be examined more carefully by future studies. Moreover, a more extensive period of analysis could help to better capture the impact of the decarbonisation (i.e. coal in particular) and denuclearization energy reform on life-satisfaction – if any – from the decommission of coal and nuclear power plants. Similarly, a more specific geographical system could help detecting the distance of each household from the power plant location, making the analysis more precise. Looking carefully at administrative district dummies omitted due to collinearity in the panel regression could also help for a further interpretation of results.

⁵² A dynamic relationship can be estimated for hydropower pumped storage power plants.

References

- Annuikka, V. et al (2017) Weighing the Risks of Nuclear Energy and Climate Change: Trust in Different Information Sources, Perceived Risks, and Willingness to Pay for Alternatives to Nuclear Power. *Risk Analysis: An International Journal*, Vol.37 (3), p.557-570
- Baetschmann, G., Staub, K. E. and Winkelmann, R. (2015) Consistent estimation of the fixed effects ordered logit model. *J. R. Stat. Soc. A*, 178: 685-703. doi:10.1111/rssa.12090
- Berger, E. (2010) The Chernobyl Disaster, Concern about the Environment, and Life Satisfaction. German Institute for Economic Research (DIW Berlin).
- Bigelow, P. et al (2016) Changes in quality of life and perceptions of general health before and after operation of wind turbines. *Environmental Pollution* 216 (2016) 608-615.
- Bontje, M. (2004) Facing the challenge of shrinking cities in East Germany: The case of Leipzig. *GeoJournal*, Vol. 61, No. 1 (2004), pp. 13-21
- Bundesnetzagentur (2018) Power plant list (https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Versorgungssicherheit/Erzeugungskapazitaeten/Kraftwerksliste/kraftwerksliste.html) Last visited the 04th of September 2018
- Chadi, A. (2010) How to Distinguish Voluntary from Involuntary Unemployment: On the Relationship between the Willingness to Work and Unemployment-Induced Unhappiness. *KYKLOS*, Vol. 63 – August 2010 – No. 3, 317–329
- Choi, I. (2011) Spurious Fixed Effects Regression*. *Oxford Bulletin of Economics and Statistics*, April 2013, Vol.75(2), pp.297-306 (doi: 10.1111/j.1468-0084.2011.00688.x)
- lark, A., Frijters, P., and Shields, M. (2008) Relative Income, Happiness, and Utility: An Explanation for the Easterlin Paradox and Other Puzzles. *Journal of Economic Literature*, 46(1), 95-144. Retrieved from <http://www.jstor.org/stable/27646948>
- Davis, L. (2011) The Effect of Power plants on Local Housing Values and Rents. *Review of Economics and Statistics*, Vol.93(4), pp.1391-1402
- Deaton, A. et al (2014) Subjective wellbeing, health, and ageing. *Lancet* 2015; 385: 640–48. Published Online November 6, 2014. [http://dx.doi.org/10.1016/S0140-6736\(13\)61489-0](http://dx.doi.org/10.1016/S0140-6736(13)61489-0).
- DESTATIS (2018) Community Directory Information System (<https://www.destatis.de/DE/ZahlenFakten/LaenderRegionen/Regionales/Gemeindeverzeichnis/Gemeindeverzeichnis.html>) Last visited the 03rd of July 2018
- Dolan, P. et al (2008) Do we really know what makes us happy? A review of the economic literature on the factors associated with subjective well-being. *Journal of Economic Psychology* 29 (2008) 94–122

Easterlin, R. and Plagnol, A. (2008) Life satisfaction and economic conditions in East and West Germany pre- and post-unification. *Journal of Economic Behavior & Organization*. Volume 68, Issues 3–4, December 2008, P. 433-444 (<https://doi.org/10.1016/j.jebo.2008.06.009>)

ESRI (2017) Deutschland, Open Data shapefiles (<https://opendata-esri-de.opendata.arcgis.com/datasets/esri-de-content::vergewaltigung-und-sexuelle-n%C3%B6tigung-kreise-2017/data>) Last visited 23/09/2010

European Commission (2000) A Study on the Economic Valuation of Environmental Externalities from Landfill Disposal and Incineration of Waste. DG Environment. Final Main Report

Ferrer-i-Carbonell A. and Frijters, P. (2004) How Important Is Methodology for the Estimates of the Determinants of Happiness? *The Economic Journal*, 114(497), 641-659. Retrieved from <http://www.jstor.org/stable/3590299>

Frijters, P. et al (2004) "Money Does Matter! Evidence from Increasing Real Income and Life Satisfaction in East Germany Following Reunification". *American Economic Review*, 94 (3): p. 730-740.

Fischer, W. et al. (2015) The German Energiewende - History and status quo. Institute of Energy and Climate Research, Department of Systems Analysis and Technology Evaluation (IEK-STE), Jülich Research Centre, Jülich, Germany

Geeta, S. et al (2016) Matching the Characteristics of Low Wind Speed Turbines with Candidate Wind Regimes. *Energy Procedia*, September 2016, Vol.95, pp.286-293

Goebel, J., et al (2018) The German Socio-Economic Panel Study (SOEP) *Journal of Economics and Statistics*

Huhtala, A., Remes, P. (2017) Quantifying the social costs of nuclear energy: Perceived risk of accident at nuclear power plants. *Energy Policy*, Volume 105, June 2017, Pages 320-331

Kahneman, D. et al (1997) Back to Bentham? Explorations of Experienced Utility, *The Quarterly Journal of Economics*, Volume 112, Issue 2, 1 May 1997, p. 375–406, <https://doi.org/10.1162/003355397555235>

Krekel, C.; Zerrahn, A. (2016) Does the presence of wind turbines have negative externalities for people in their surroundings? Evidence from well-being data. *Journal of Environmental Economics and Management* 82 (2017) p. 221–238

Kristiansen, S. et al (2018) Risk Perception of Nuclear Energy After Fukushima: Stability and Change in Public Opinion in Switzerland. *International Journal of Public Opinion Research*, 2018, Vol.30 (1), p.24-51

Küchenhoff, H. et al (2013) Well-being over the life span: semiparametric evidence from British and German longitudinal data. *The Review of Economics and Statistics*, March 2013, 95(1): 154–167

- Maddison, D & Rehdanz, K 2008, 'Local Environmental Quality and Life Satisfaction in Germany' *Ecological Economics*, vol. 64, no. 4, pp. 787-797. DOI: 10.1016/j.ecolecon.2007.04.016
- Maddison, D & Rehdanz, K 2011, 'The impact of climate on life satisfaction' *Ecological Economics*, vol. 70, no. 12, pp. 2437-2445. DOI: 10.1016/j.ecolecon.2011.07.027
- Elliott, R, Ham, Y & Maddison, D, (2013) 'The valuation of landfill disamenities in Birmingham' *Ecological Economics*, vol. 85, pp. 116-129. DOI: 10.1016/j.ecolecon.2012.09.006
- Mummolo, J. and Peterson, E. (2017) Improving the Interpretation of Fixed Effects Regression Results. *Political Science Research and Methods*, 2018, pp.1-7
- OECD (2018) Note on equivalence scales (www.oecd.org/els/soc/OECD-Note-EquivalenceScales.pdf) Visited the 24th of August 2018
- Perman, R. et al. (2011) *Natural Resource and Environmental Economics*. 4th edition. Pearson Education Limited.
- Piringer, M. et al (2016) Factors influencing separation distances against odour annoyance calculated by Gaussian and Lagrangian dispersion models. *Atmospheric Environment*, Volume 140, September 2016, Pages 69-83
- Slovic, P. (2016) Understanding Perceived Risk: 1978–2015, *Environment: Science and Policy for Sustainable Development*, 58:1, 25-29
- Steffen, B. (2012) Prospects for pumped-hydro storage in Germany. *Energy Policy*, Jun 2012, Vol.45, p.420
- Solar Energy (2001) Act on granting priority to renewable energy sources (Renewable Energy Sources Act, Germany, 2000). Vol.70(6), pp.489-504
- Urfei, G. and Witzke, H. (2001) Willingness to Pay for Environmental Protection in Germany: Coping with the Regional Dimension. *Regional Studies*, Vol. 35.3, pages 207-214
- Venghaus, S; Hoffmann, J. (2016) The impacts of energy from biomass on the perceived quality of life of the rural population in Brandenburg, Germany. *Innovation: The European Journal of Social Science Research*, 29:3, 337-372, DOI: 10.1080/13511610.2016.1192991
- von Möllendorff, C; Welsch, Heinz (2017) Measuring Renewable Energy Externalities: Evidence from Subjective Well-being Data. *Land Economics*, 2017, Vol.93 (1), p.109-127
- Welsch, H. (2016) Electricity Externalities, Sitting and the Energy Mix: A Survey. *International Review of Environmental and Resource Economics*.
- Welsch, H. and Ferreira, S. (2014) Environment, Well-Being, and Experienced Preference. Department of Economics, University of Oldenburg.

Welsch, H.; Biermann, P. (2014) Electricity Supply Preferences in Europe: Evidence from Subjective Well-being Data. *Resource and Energy Economics* 38, p.38-60

Welsch, H. (2002) Preferences over Prosperity and Pollution: Environmental Valuation based on Happiness Surveys. Department of Economics, University of Oldenburg. *KYKLOS*, Vol. 55, 2002, Fasc. 4, p. 473–494

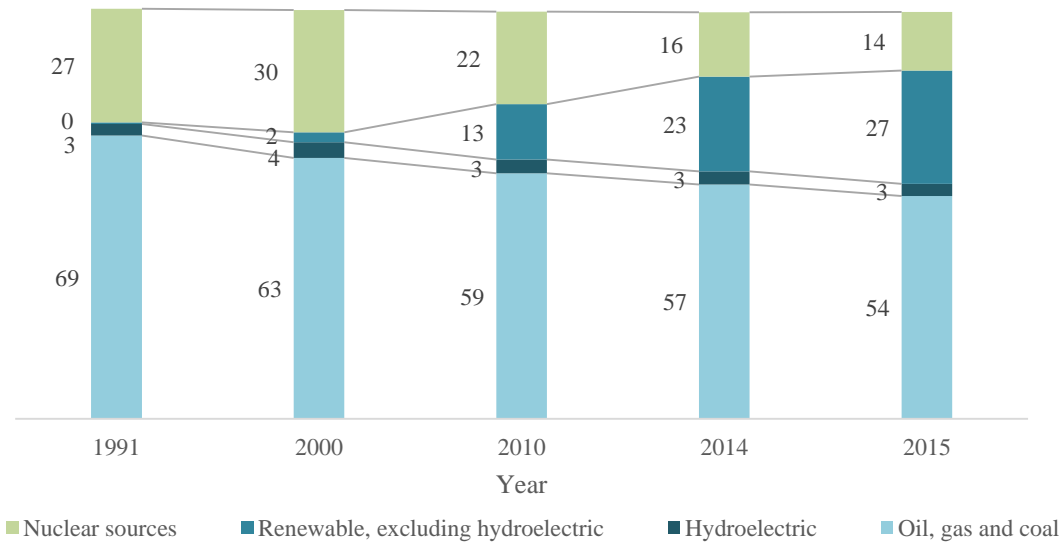
Wiser, R. (1998) Green power marketing: increasing customer demand for renewable energy. *Utilities Policy*, volume 7, issue 2, June, p. 107-119

Wüstenhagen et al (2007) Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policy*, Vol.35 (5), p.2683-2692

World Bank (2018) Open Data <https://data.worldbank.org/>. Last visited the 13th of August 2018.

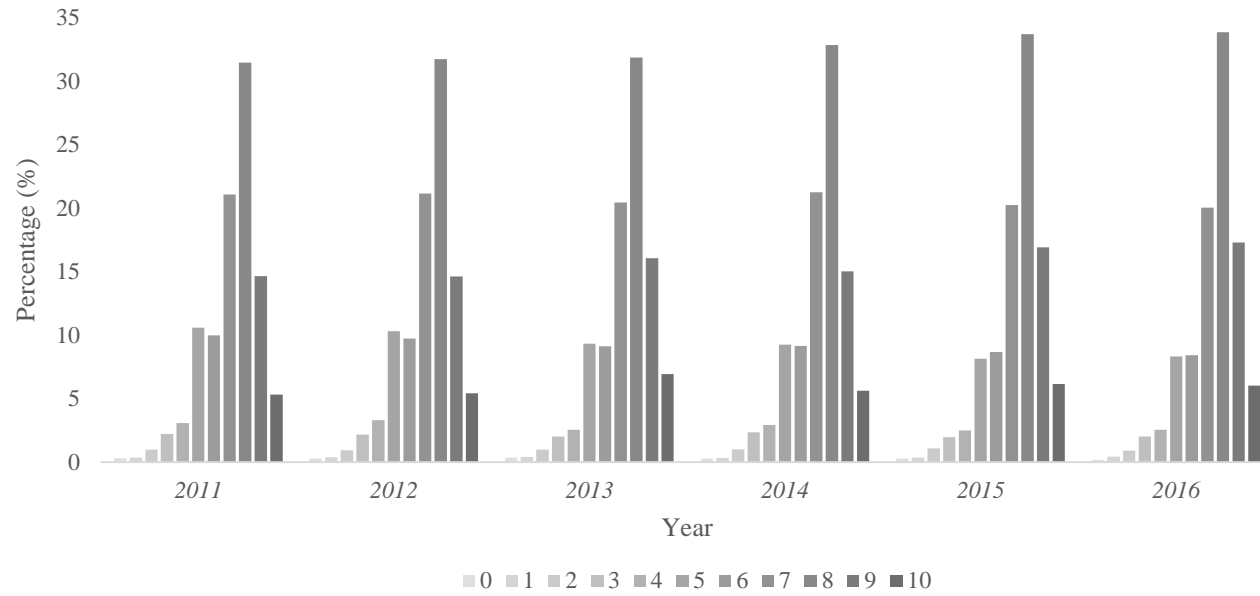
Appendix A

Figure A1: Electricity production sources
(% of total)
Germany



Source: World Bank (2018)

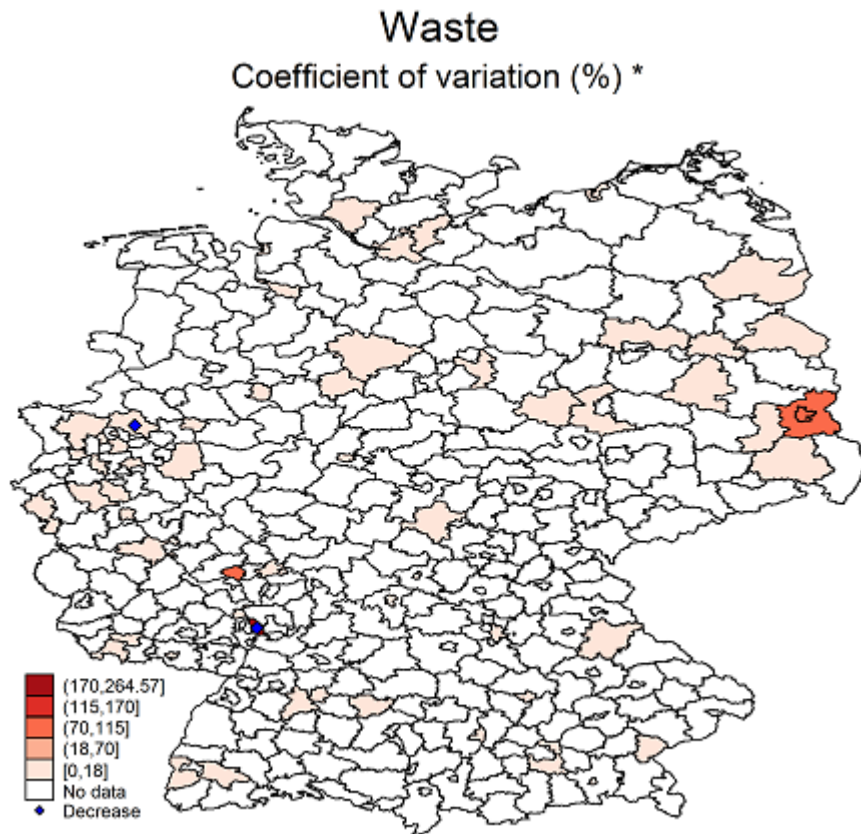
Figure A2: Overall life satisfaction over time



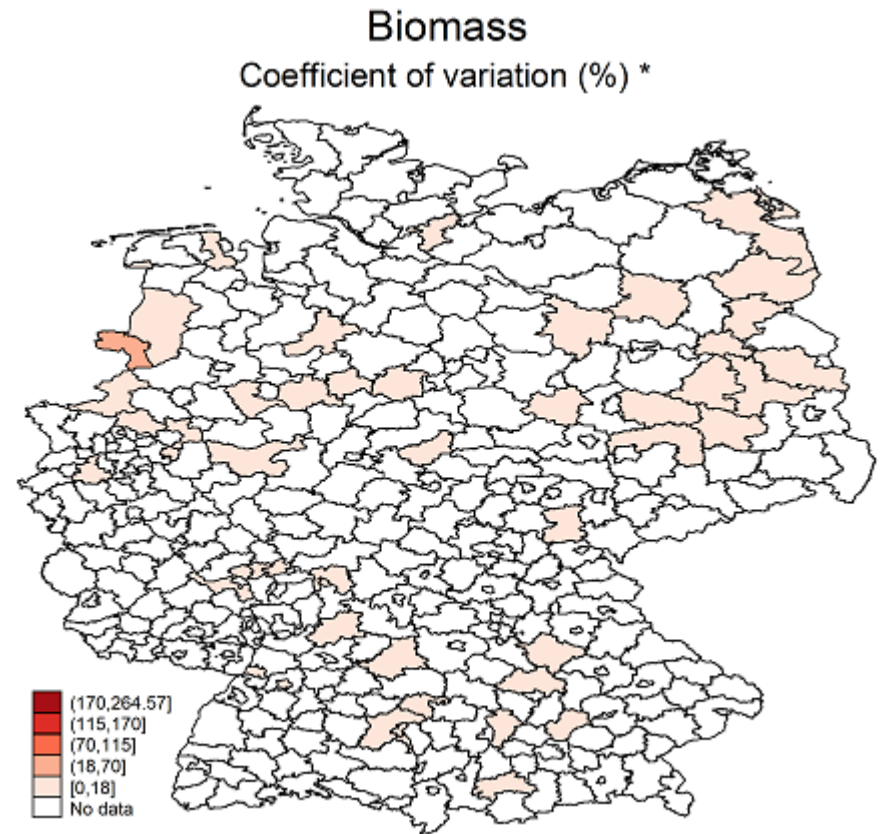
Source: own elaboration, Data: SOEPv33 (https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html)

Appendix B

Source: own elaboration, Data: Bundesnetzagentur (2018) and ESRI (2017)

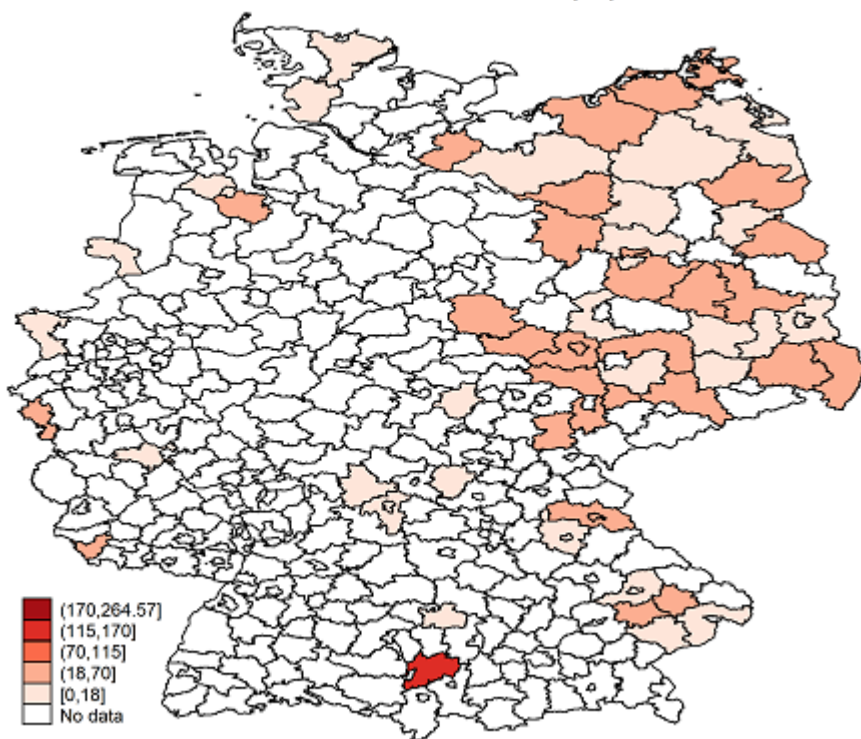


*installed capacity (mega-watts), 2011-2016



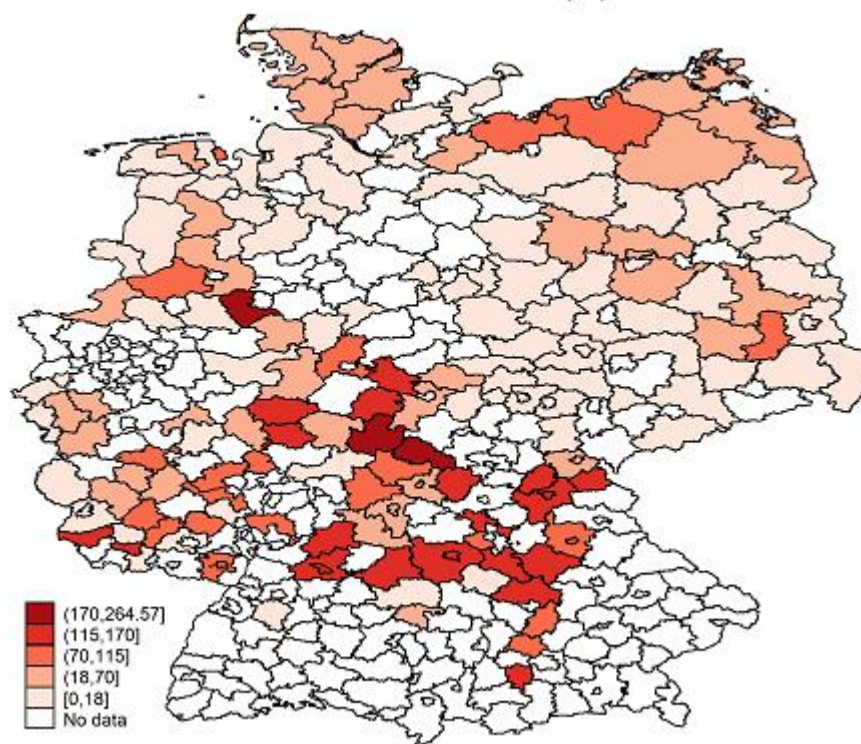
*installed capacity (mega-watts), 2011-2016

Solar
Coefficient of variation (%) *



*installed capacity (mega-watts), 2011-2016

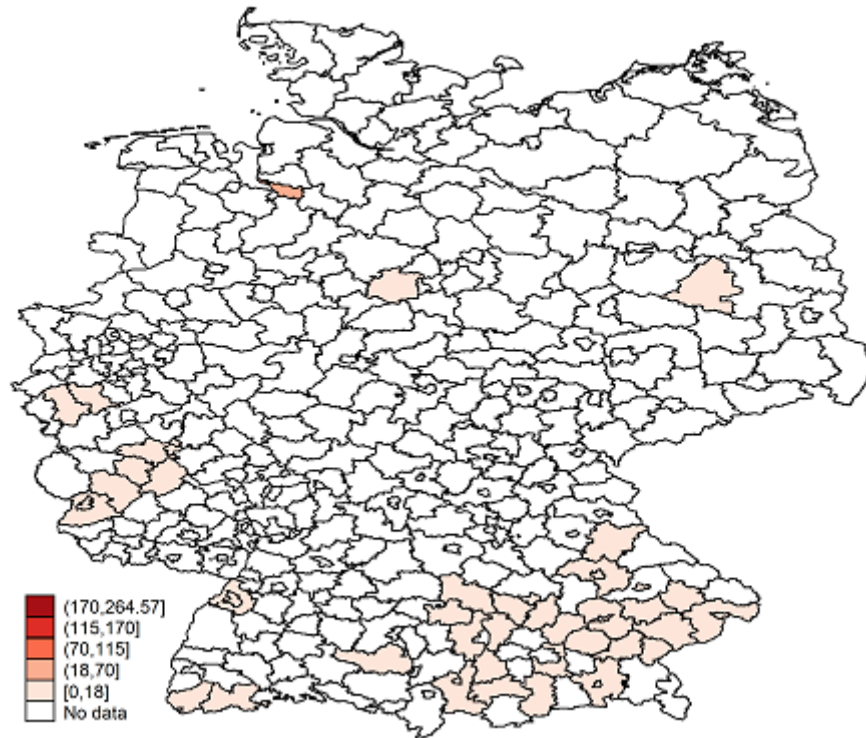
Wind energy on-shore
Coefficient of variation (%) *



*installed capacity (mega-watts), 2011-2016

Hydropower (running water)

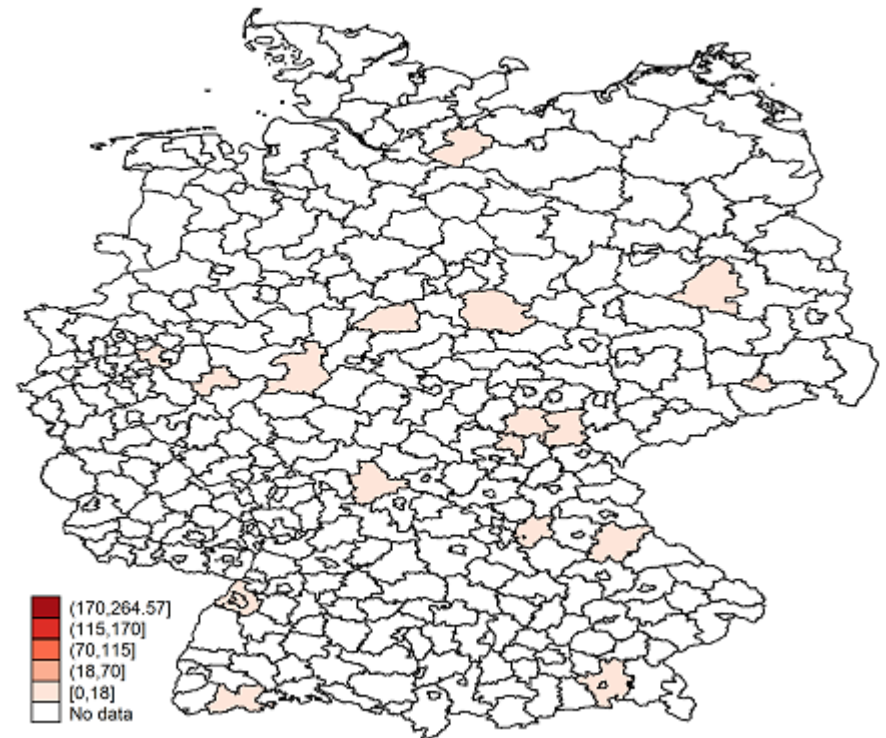
Coefficient of variation (%) *



*installed capacity (mega-watts), 2011-2016

Hydropower (pumped storage)

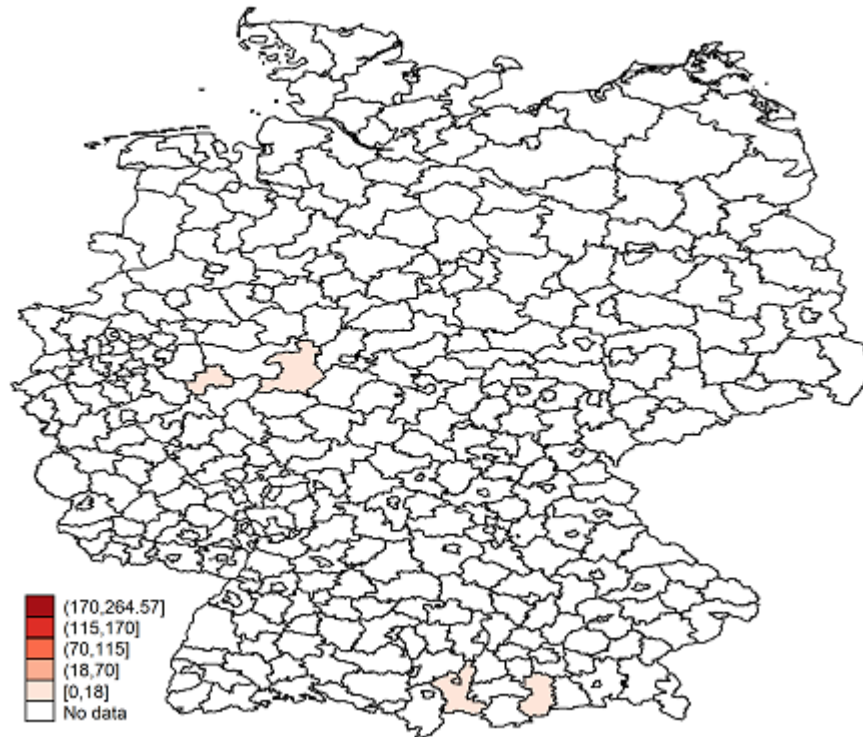
Coefficient of variation (%) *



*installed capacity (mega-watts), 2011-2016

Hydropower (storage, not pumped)

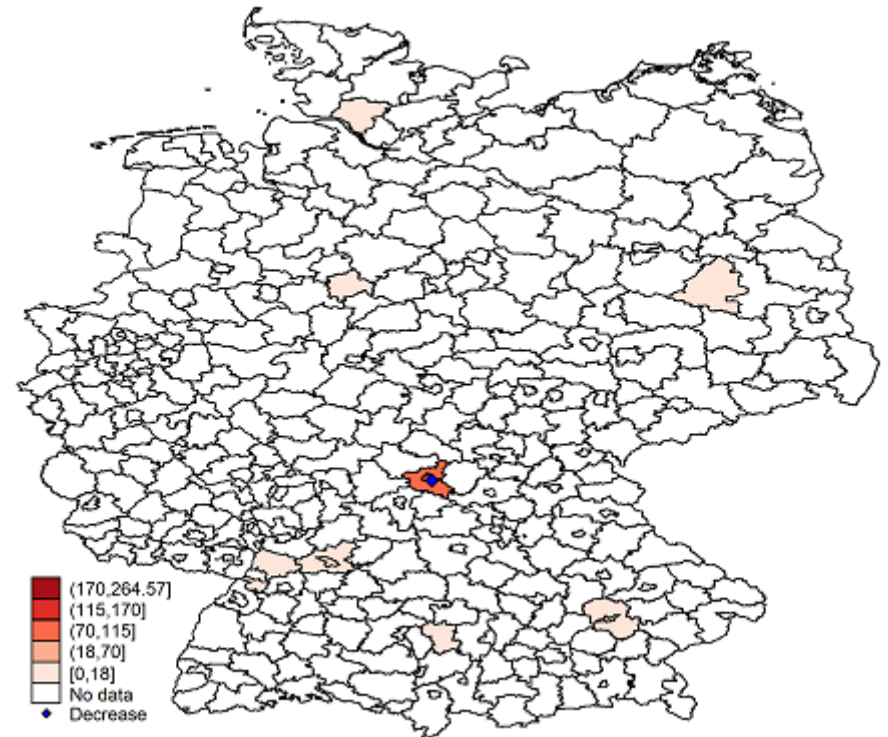
Coefficient of variation (%) *



*installed capacity (mega-watts), 2011-2016

Nuclear

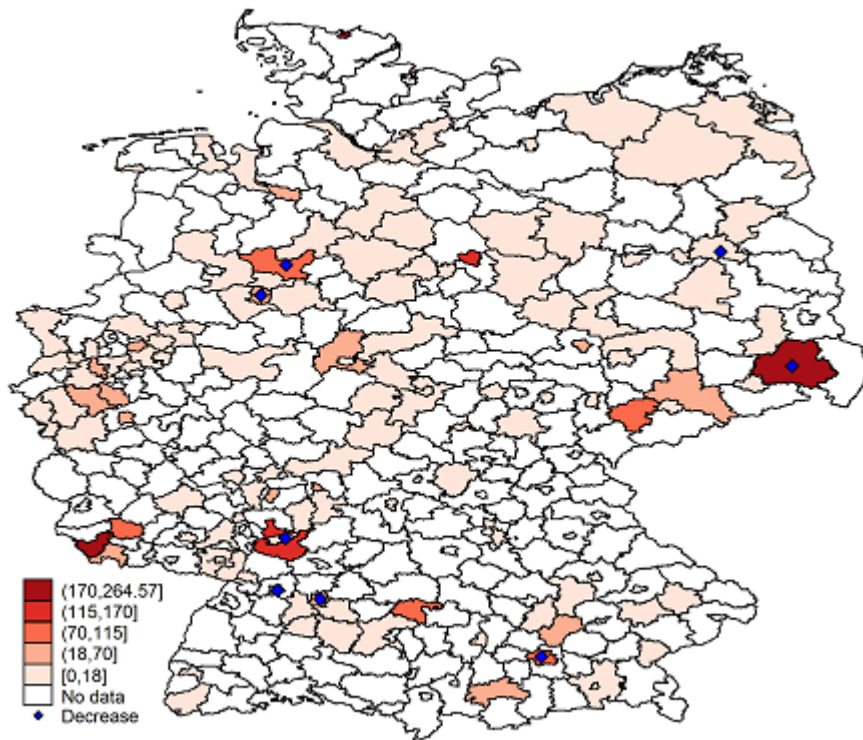
Coefficient of variation (%) *



*installed capacity (mega-watts), 2011-2016

Natural gas

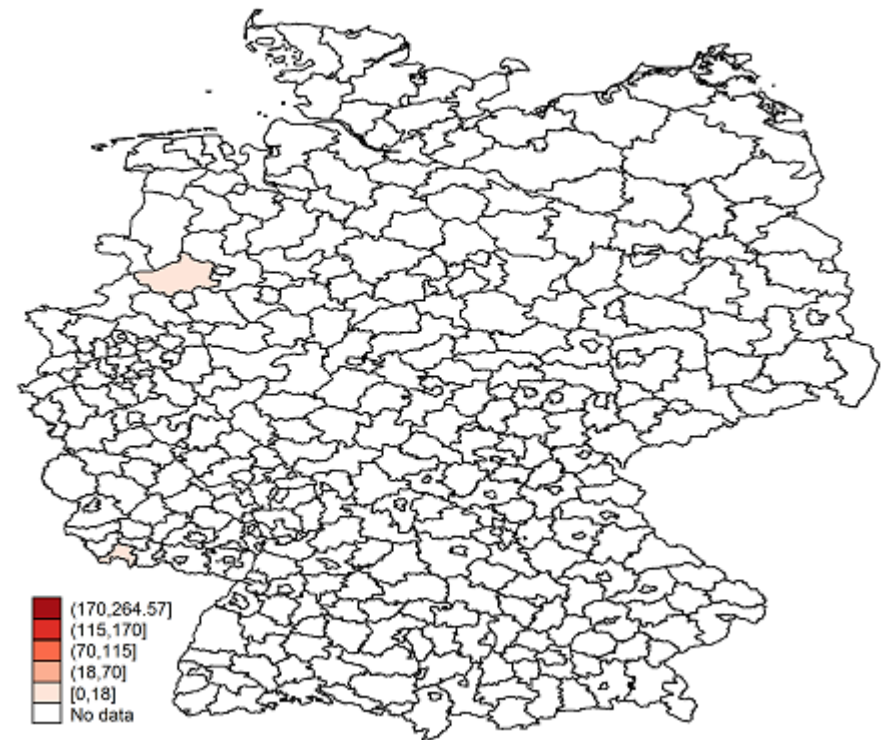
Coefficient of variation (%) *



*installed capacity (mega-watts), 2011-2016

Marsh gas

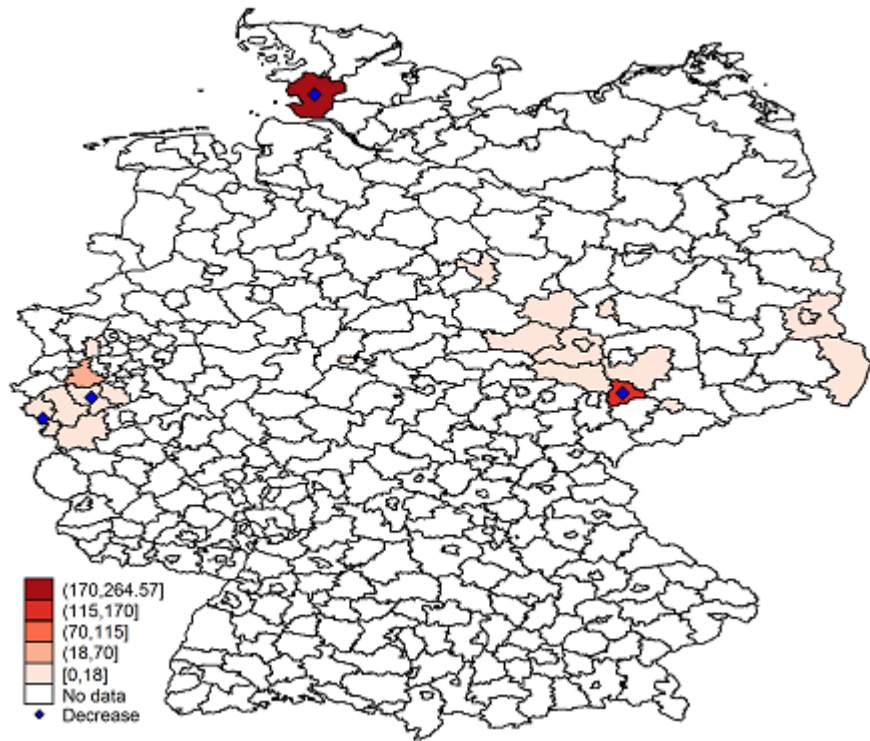
Coefficient of variation (%) *



*installed capacity (mega-watts), 2011-2016

Brown coal

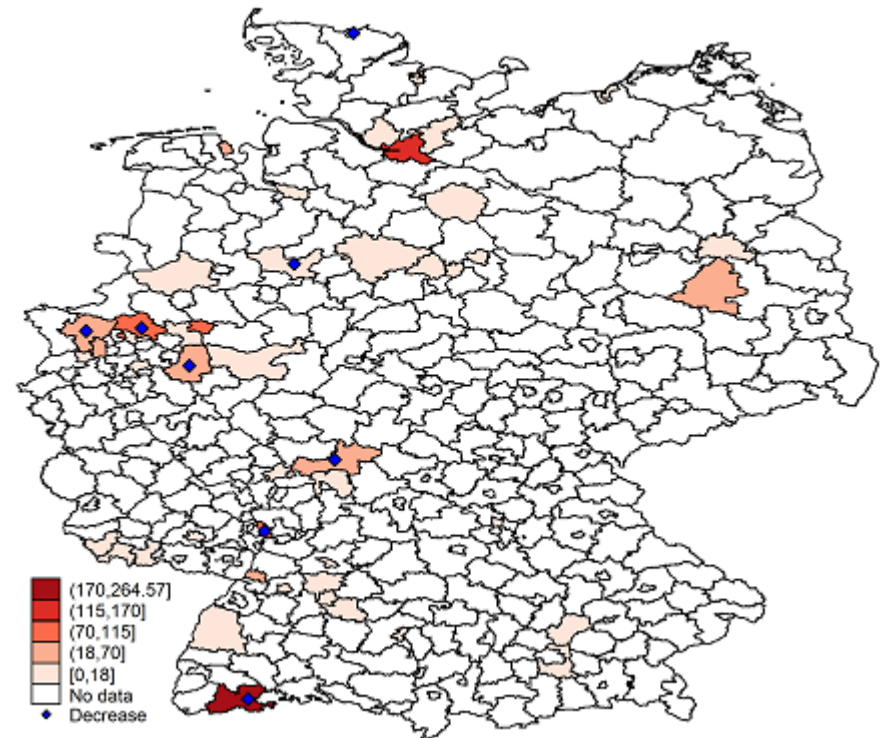
Coefficient of variation (%) *



*installed capacity (mega-watts), 2011-2016

Hard coal

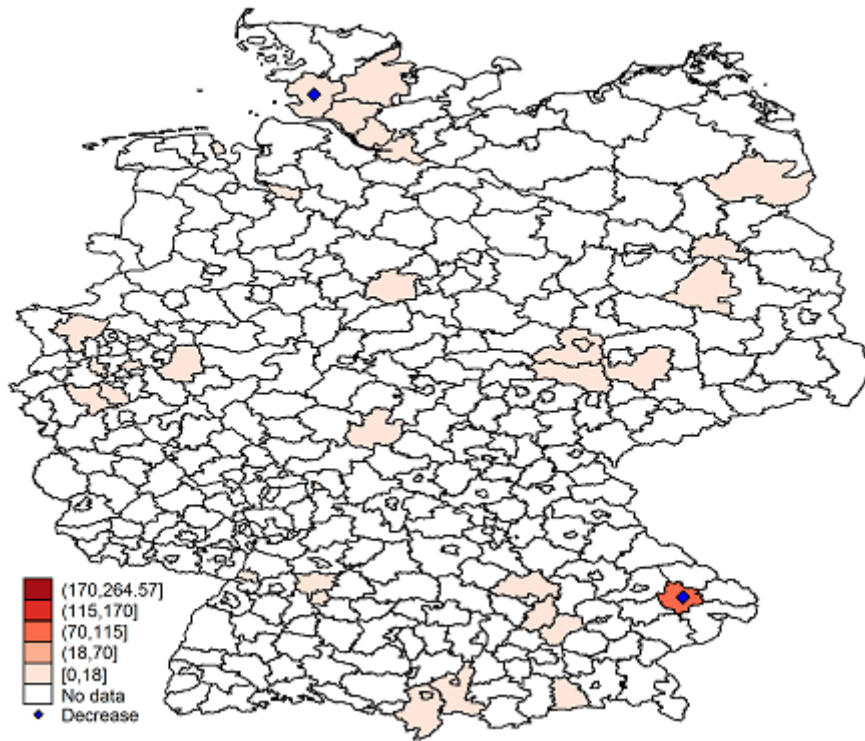
Coefficient of variation (%) *



*installed capacity (mega-watts), 2011-2016

Oil

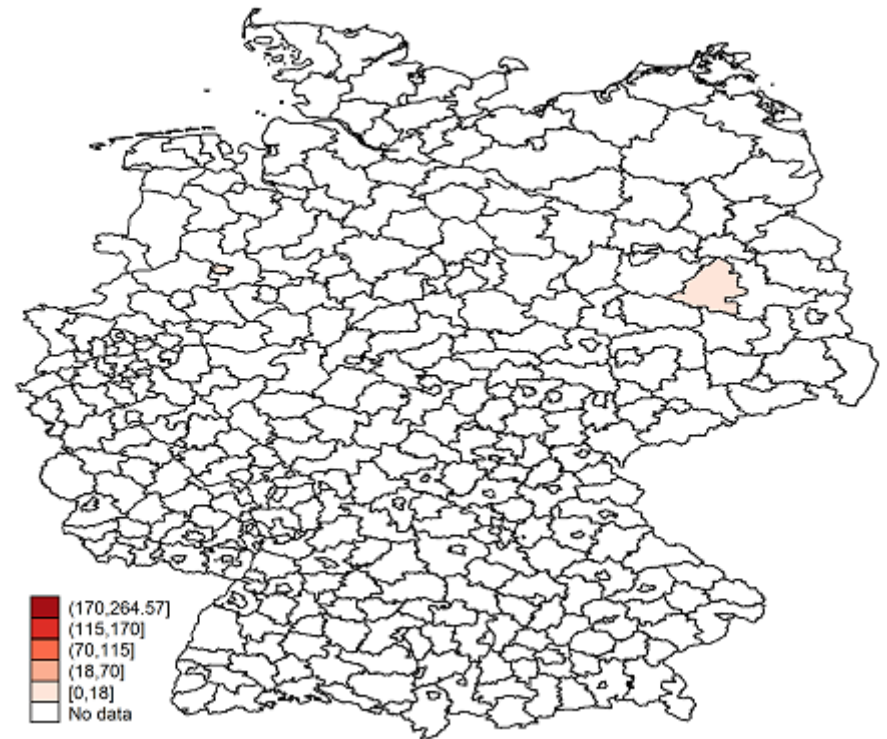
Coefficient of variation (%) *



*installed capacity (mega-watts), 2011-2016

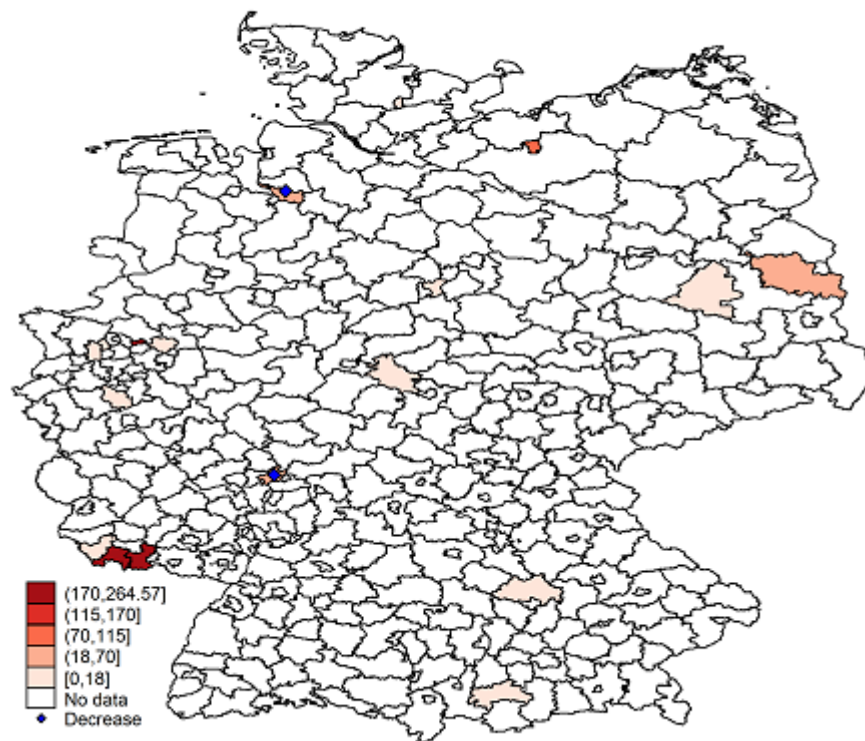
Multiple (non RE)

Coefficient of variation (%) *



*installed capacity (mega-watts), 2011-2016

Other (non RE) Coefficient of variation (%) *



*installed capacity (mega-watts), 2011-2016

Appendix C

TABLE C1: Hausman test on Model (1)		
Ho: Difference in coefficients is not systematic		
Regular Hausman Test (command 'hausman')		
including region and year dummies	Chi ² (376) = 623.79	Prob > Chi ² = 0.0000
not including region and year dummies	Chi ² (27) = 4082.65	Prob > Chi ² = 0.0000
Robust Hausman Test (command 'xtoverid')		
including region and year dummies	Sargan-Hansen statistic Chi ² (407) = 4634.442	Prob > Chi ² = 0.0000
including year dummies	Sargan-Hansen statistic Chi ² (33) = 4203.297	Prob > Chi ² = 0.0000
not including region and year dummies	Sargan-Hansen statistic Chi ² (29) = 3977.187	Prob > Chi ² = 0.0000

Source: own elaboration, Data: SOEPv33 (https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html) and Bundesnetzagentur (2018)

TABLE C2 : Tabulation of control categorical variables, 2011-2016

Variable	Description	Frequency	Percentage (%)	Cumulative Percentage (%)
<i>health status</i>				
very good	dummy variable 1= 'very good', 0 = 'otherwise'	16854	10.51	10.51
good	dummy variable 1= 'good', 0 = 'otherwise'	64737	40.39	50.90
satisfactory	dummy variable 1= 'satisfactory', 0 = 'otherwise'	50831	31.71	82.62
bad	dummy variable 1= 'bad', 0 = 'otherwise'	22201	13.85	96.47
very bad	dummy variable 1= 'very bad', 0 = 'otherwise'	5665	3.53	100.00
<i>marital status</i>				
married	dummy variable 1= 'married', 0 = 'otherwise'	95266	59.43	59.43
single	dummy variable 1= 'single', 0 = 'otherwise'	37982	23.70	83.13
widowed	dummy variable 1= 'widowed', 0 = 'otherwise'	8650	5.40	88.53
divorced	dummy variable 1= 'divorced', 0 = 'otherwise'	14760	9.21	97.74
separated	dummy variable 1= 'separated', 0 = 'otherwise'	3630	2.26	100.00
<i>employment status</i>				
	0 = 'unemployed'	62534	39.01	39.01
	1= 'employed'	97754	60.99	100.00

Source: own elaboration, Data: SOEPv33 (https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html)

TABLE C3 : Percentiles and skewness statistics, 2011-2016

Variable	skewness	p10	p25	median	p75	p90	p95	p99
<i>dependent variable</i>								
overall life satisfaction	-1.03	5	6	8	8	9	10	10
<i>non-categorical controls</i>								
real income adjusted for household size	13.40	8406	11533	16374	23664	33699	42225	66800
age	0.27	25	35	46	60	73	78	86
number of children in household	1.42	0	0	0	2	2	3	4

Source: own elaboration, Data: SOEPv33 (https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html)

TABLE C4 : Percentiles for energy data, 2011-2016

Variable	p10	p25	median	p75	p90	p95	p99
<i>Fuel</i>							
waste	0.0	0.0	0.0	0.0	19.5	37.5	72.5
biomass	0.0	0.0	0.0	0.0	12.1	16.8	30.6
solar	0.0	0.0	0.0	0.0	0.0	18.8	93.8
wind	0.0	0.0	0.0	28.0	73.1	126.0	386.2
hydropower (running water)	0.0	0.0	0.0	0.0	0.0	25.0	132.2
hydropower (storage, pumped)	0.0	0.0	0.0	0.0	0.0	43.0	625.0
hydropower (storage, not pumped)	0.0	0.0	0.0	0.0	0.0	0.0	15.0
nuclear energy	0.0	0.0	0.0	0.0	0.0	0.0	1360.0
natural gas	0.0	0.0	0.0	11.6	104.6	322.3	854.9
marsh gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0
brown coal	0.0	0.0	0.0	0.0	0.0	352.0	2219.0

hard coal	0.0	0.0	0.0	0.0	26.9	400.0	1190.0
oil	0.0	0.0	0.0	0.0	0.0	38.0	235.0
multiple (non RE)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
other (non RE)	0.0	0.0	0.0	0.0	0.0	0.0	85.0

Source: own elaboration, Data: Bundesnetzagentur (2018)

TABLE C5: Alternative Estimations results

<i>dependent variable:</i> overall life satisfaction	estimate (standard error)							
	Model A1^a	Model A2^b	Model A4^c					
			2011	2012	2013	2014	2015	2016
<i>independent variables:</i> energy sources								
waste	0.0055328 (0.0059601)	0.0018339 (0.0007096)	0.0017632* (0.0010386)	0.0005328 (0.0010193)	0.0005384 (0.0006965)	0.0013203 (0.0010742)	0.0007315 (0.0011828)	0.001049 (0.0012459)
biomass	0.0466426** (0.0203565)	-0.0007916 (0.0010275)	0.0005097 (0.0015051)	-0.0010109 (0.0017436)	-0.0005575 (0.0012748)	-0.0009737 (0.0016715)	-0.0009449 (0.002)	-0.000565 (0.0017693)
solar	0.0004078 (0.0006007)	-0.0029291 (0.0004825)	-0.0020695** (0.0009332)	-0.0023921** (0.0010234)	- 0.0027032** * (0.0008666)	- 0.0039997** * (0.0010494)	- 0.0036597** * (0.0008859)	- 0.0033893** * (0.0009505)
wind	0.0000223 (0.0001273)	0.0000904 (0.0001211)	-0.0006615** (0.00027)	-0.000463 (0.0003097)	0.0002251 (0.0003081)	0.0003079 (0.0003862)	0.0001534 (0.000184)	0.0003198 (0.0001979)
hydropower (running water)	-0.0022587 (0.0097423)	0.0014709 (0.0005828)	0.0013757* (0.0007088)	-0.0000987 (0.0007716)	0.0005472 (0.000685)	0.0004234 (0.0007547)	0.001079 (0.0009556)	0.0005707 (0.001144)

hydropower (storage, pumped)	-0.0475011*** (0.017057)	0.0000798 (0.0001441)	-0.0001565 (0.0001529)	0.0002184 (0.000142)	-0.0000444 (0.0000722)	0.0000594 (0.0002483)	0.0003014 (0.0003751)	0.0003647 (0.0003996)
hydropower (storage, not pumped)	-0.0013337 (0.0073705)	0.0000185 (0.0021581)	0.0004538 (0.0031848)	0.0004219 (0.002478)	0.0011122 (0.0013221)	-0.0003143 (0.0022661)	-0.0011264 (0.000897)	- 0.0037756** * (0.0008186)
nuclear energy	-0.0001061 (0.0001233)	0.0000142 (0.0000517)	0.000023 (0.0000914)	0.0000302 (0.0000748)	2.26e-06 (0.0000653)	0.0000279 (0.0001086)	-0.0000474 (0.000128)	-0.0000395 (0.0000805)
natural gas	0.000034 (0.0000791)	-0.000091 (0.000049)	-0.0000012 (0.0000737)	0.0000544 (0.0000569)	-0.0000672 (0.0000643)	- 0.0002489** * (0.0000772)	-0.0001252* (0.0000697)	-0.000074 (0.0000653)
marsh gas	-0.0115236*** (0.0042979)	0.001497 (0.0030451)	0.0051095** (0.0023104)	0.0007094 (0.0019686)	0.0009166 (0.0091632)	-0.0002208 (0.0026207)	-0.0028913 (0.0035119)	-0.0034302 (0.0039948)
brown coal	5.40e-06 (0.0000522)	-0.0000231 (0.00002)	-0.000038 (0.0000243)	-0.00259e-05 (0.0000139)	-0.0000296* (0.0000161)	0.0000319 (0.0000209)	0.0000204 (0.0000174)	-0.0000227 (0.0000193)
hard coal	5.59e-06 (0.0000231)	0.0000925 (0.0000254)	-0.0000312 (0.0000281)	0.0000681** * (0.0000244)	0.0000465** * (0.0000166)	0.0001178** (0.0000477)	0.0001113** * (0.0000349)	0.0001578** * (0.0000346)
oil	0.0100673** (0.004931)	-0.0003928 (0.0001613)	-0.0002008 (0.0002532)	-0.0002312 (0.0001748)	-0.0005091** (0.0002372)	0.0000479 (0.0002729)	0.0000213 (0.0002423)	-0.0002657 (0.0002271)
multiple (non RE)	0.3458667** (0.1437381)	0.0013483 (0.0029058)	0.0033121 (0.0034247)	-0.0030863 (0.0035916)	0.0061204* (0.0031647)	0.008107* (0.0046496)	0.0018655 (0.0048141)	-0.0019266 (0.005192)
other (non RE)	0.0005478 (0.0008242)	-0.0000268 (0.0000995)	0.0003481*** (0.0000887)	0.0002206** * (0.0000506)	-0.0000381 (0.0000284)	0.0001011** (0.0000469)	-0.0000117 (0.0000447)	0.0000178 (0.000037)
controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*equation
characteristic
s*

Individual effects	random-effects	random-effects	No	No	No	No	No	No
Year effects	random-effects	No	No	No	No	No	No	No
Region effects	random-effects	No	No	No	No	No	No	No
Number of individuals	42,956	42,956	n.a	26683	30813	27310	25287	24335
Number of observations	160,220	160,220	25792	26683	30813	27310	25287	24335
R ² within	0.0559							
between	0.3311	n.a	Pseudo R ² = 0.0805	Pseudo R ² = 0.0774	Pseudo R ² = 0.0688	Pseudo R ² = 0.0699	Pseudo R ² = 0.0781	Pseudo R ² = 0.0778
overall	0.2607							

*** significant at 1% level, ** significant at 5% level, * significant at 10% level

a) Model (1) adapted to random effects (multiple) - XTREG

b) Model (1) as logistic regression and adapted to random effects (individual only) -XTOLOGIT

c) cross-sectional ordered logit regression with standard errors clustered at the administrative district level - OLOGIT

Source: own elaboration, Data: SOEPv33 (https://www.diw.de/de/diw_01.c.571790.de/soep_v33.html) and Bundesnetzagentur (2018)

Appendix D

Do-file 01: Generating the variable that captures the net nominal power per kreis, per year and per energy source

```
clear
```

```
cd "U:\dissertation" //location of the excel file
```

```
*log using dis1
```

```
import excel "U:\dissertation\_Kraftwerkliste_2018_eng.xlsx", sheet("mfS3b") cellrange(A1:AL14365) firstrow //powerplant excel, contains all powerplant observations for years 2011-2017
```

```
browse if energy_main==" //we can see that the variable energy_source indicates that these observations are of multiple energy sources
```

```
encode energy_main, gen(energy_main2) //making energy_main numerical with labels
```

```
replace energy_main2 = 11 if energy_main==" // for those cases of energy_main=="
```

```
destring year_start, replace force
```

```
bysort energy_main: egen m = mean(year_start)
```

```
format m %12.0f
```

```
replace year_start= round(m) if year_start==. | year_start==0.982133741705
```

```
browse m energy_main year_start // year_start has been replaced with the mean values of their energy source, for those observations with no year_start, with a decimal or with "(Year)" as value
```

```
drop if missing(power_plant_id) //(994 observations deleted)
```

```
drop if missing(kreis_id) //(203 observations deleted)
```

```
drop if kreis_id== "." //(196 observations deleted)
```

```
save mfs3, replace //12,971 obs left (all of these should find a kreis match. Otherwise, something would be wrong)
```

```
clear
```

```
cd "U:\dissertation" //location of the excel file
```

```
import excel "U:\dissertation\_PLZ, Kreis, breitengrad, langengrad.xlsm", sheet("mfS1") cellrange(A1:y16108) firstrow //demographic database
```

```
*destring plz, force replace //(5065 missing values generated)
```

```
*drop if missing(area) //(4,982 observations deleted)
```

```
drop if plz=="" //(5,065 observations deleted)
```

```
save mfs1, replace
```

```
set more off
```

```
*problem: area, latitude and longitude are reported for the lowest regional level, i.e for each municipality
```

```
*solution? Maybe generate a weighted average per kreis, as follows:
```

```
bysort kreis_id2: egen kreis_area= sum(area) // the sum of area in all municipalities of a Kreis is the Kreis's total area
```

```
replace kreis_area=round(kreis_area,0.01) //for 2 decimal places
```

```
generate coord_weight = area/kreis_area //this weight will be used when collapsing the panel data later on
```

```
//i.e. the proportion of area of each municipality with respect to the kreis total area is the weight assigned to each municipality's latitude and longitude when estimating the kreis's latitude and longitude
```

```
//latitude and longitude should be numerical variables
```

```
destring latitude, force replace // if we keep these variables for kreis latitude and longitude, it will still be precise, because they refer to a community within a kreis
```

```
destring longitude, force replace
```

```
gen latcord= latitude*coord_weight
```

```
bysort kreis_id2: egen kreis_latitude= sum(latcord)
```

```
gen loncord=longitude*coord_weight
```

```
bysort kreis_id2: egen kreis_longitude= sum(loncord)
```

```
*problem: population variables are reported for the lowest regional level, i.e for each municipality
```

```
*solution? Sum as follows:
```

```
destring pop_total , replace force
```

```
destring pop_male , replace force
```

```
destring pop_female , replace force
```

```
destring pop_km2 , replace force
```

```
bysort kreis_id2: egen kreis_pop_total= sum(pop_total) // the sum of population in all municipalities of a Kreis is the Kreis's total population
```

```
bysort kreis_id2: egen kreis_pop_male= sum(pop_male) // the sum of male population in all municipalities of a Kreis is the Kreis's total male population
```

```
bysort kreis_id2: egen kreis_pop_female= sum(pop_female) // the sum of female population in all municipalities of a Kreis is the Kreis's total female population
```

```
bysort kreis_id2: egen kreis_pop_km2= sum(pop_km2) // the sum of population in km2 in all municipalities of a Kreis is the Kreis's total population in km2
```

```
//these kreis population variables will be used when collapsing the panel data later on
```

```
*drop if missing(kreis_id2) // (5,065 observations deleted)
```

```
duplicates drop kreis_id2, force //(10,641 observations deleted) when dropping duplicates of kreis_id, leaving the mfs1 database with only 401 obs, 1 observation per kreis)
```

```
drop kreis_id
```

```
rename kreis_id2 kreis_id // we have the same variable 'kreis_id' on both databases that will be merged
```

```
//redefining urb_degree as a numerical value with labels
```

```
tab urb_degree
```

```
tab urb_degree_desc
```

```
destring urb_degree, replace
```

```
label define urbanization 1 "dicht besiedelt" 2 "mittlere Besiedlungsdichte" 3 "gering besiedelt"
```

```
label values urb_degree urbanization
```

```
drop urb_degree_desc
```

```
drop kreis_id3 area pop_total pop_male pop_female pop_km2 plz
```

```
save mfs1a, replace
```

```
//export excel using "U:\dissertation\KREIS database.xlsx", sheet("mfs1a") sheetmodify firstrow(variables)
```

```
//mfs3a is data set that contains power plants data
```



```
//merge 1:m is used because mfs1 contains - after dropping duplicate observations - only 401 observations (1 observation per kreis) and mfs3a contains many observations per kreis
```

```
merge 1:m kreis_id using mfs3 //
```

```
keep if _merge==3 // 12971 observations of power plants for years 2011-2017 (as expected >>> means all relevant powerplants found a match)
```

```
drop company power_plant_location power_plant_name bundesland blockname compensatory heat_extraction designation network powergrid_name
```

```
//We can see, for example, that for kreis 01001, we have 6 power plants, each has an observation for the years 2011-2017. This gives 42 observations for kreis 01001
```

```
browse power_plant_id energy_main kreis_id kreis_area energy_nnp year_start Year if kreis_id == "01001"
```

```
generate year_off = 2011 if power_plant_status2== "Endgültig Stillgelegt 2011"
```

```
replace year_off = 2012 if power_plant_status2== "Endgültig Stillgelegt 2012"
```

```
replace year_off = 2013 if power_plant_status2== "Endgültig Stillgelegt 2013"
```

```
replace year_off = 2014 if power_plant_status2== "Endgültig Stillgelegt 2014"
```

```
replace year_off = 2015 if power_plant_status2== "Endgültig Stillgelegt 2015"
```

```
replace year_off = 2016 if power_plant_status2== "Endgültig Stillgelegt 2016"
```

```
replace year_off = 2017 if power_plant_status2== "Endgültig Stillgelegt 2017"
```

```
*all other powerplant status are treated as in operation, with '.' (missing) as observation in variable year_off
```

```
***/// REMEMBER year_start HAS ANORMALITIES /// ***
```

```
generate years_op= year_off - year_start + 1 if year_off!=. //total number of years in operation
```

```
replace years_op = 2017 - year_start + 1 if year_off ==.
```

```
generate years_op2 = years_op //years of operation since 2011, our analysis baseline year
```

```
replace years_op2 = 7 if year_start < 2011 & year_off ==. //powerplants that started before 2011 and are still in operation
```

```
replace years_op2= year_off - 2011 if year_off!=. & year_start < 2011 //powerplants that started before 2011 and are no longer in operation
```

```
generate mega = years_op2*energy_nnp // sum of total net capacity of each power plant
```

```
bySORT kreis_id energy_main: egen mega1 = sum(mega) // sum of total net capacity per kreis, for each energy source. This can tell us the energy-intensity of a kreis, as a stock rather than as a flow
```

```
sort kreis_id Year year_start
```

```
browse power_plant_id energy_main2 kreis_id kreis_area energy_nnp year_start year_off years_op years_op2 Year mega mega1 if kreis_id == "01001"
```

```
***Generating a variable that captures the net nominal power of each power plant per year 2011,2012,....,2017***
```

```
//assumption: there is no net capacity active in the year of decommission
```

```
browse if energy_nnp==. // (175 observations with no information on net nominal power) //i.e. 12796 obs do have
```

```
tab power_plant_id if energy_nnp==. // 25 powerplants do not have information on net nominal power for the 7 years of analysis (which makes 25*7=175 obs in total)
```

```

generate energy_nnp2=.

replace energy_nnp2=0 if year_off <= 2011 //if the power plant was decommissioned in 2011 or earlier, there is no relevant net nominal power for that power plant

browse power_plant_id energy_main2 kreis_id kreis_area energy_nnp energy_nnp2 year_start year_off Year years_op years_op2 if energy_nnp2==0 //REVISAR years_op2

replace energy_nnp2= energy_nnp if year_off==. & year_start <=2011 // if the powerplant started in 2011 or before, then - given that our observations correspond to 2011/2017 - place the net nominal power in each observation

*browse power_plant_id energy_main2 kreis_id kreis_area energy_nnp energy_nnp2 year_start year_off Year years_op years_op2 if energy_nnp2==energy_nnp

replace energy_nnp2= energy_nnp if year_off!=. & year_off > 2011 & inrange(Year,year_start,year_off-1) // powerplants that are no longer in operation, but were in operation somewhere between 2011-2017

//for the latter, it is again assumed that at the year of decommission there is no capacity in MW (net nominal power)

*browse power_plant_id energy_main2 kreis_id kreis_area energy_nnp energy_nnp2 year_start year_off Year years_op years_op2 if year_off!=. & year_off > 2011 & inrange(Year,year_start,year_off-1)

*browse power_plant_id energy_main2 kreis_id kreis_area energy_nnp energy_nnp2 year_start year_off Year years_op years_op2 if year_off==. & year_start >2011 //this powerplant's energy_nnp2 need to be modified:

replace energy_nnp2= energy_nnp if year_off==. & year_start>2011 & Year >= year_start //power plants that are still in operation but started later than 2011

replace energy_nnp2= 0 if energy_nnp2 ==. // observations of powerplants in Years where there was no net capacity installed

//Now that I have the net nominal power generated by each powerplant in each year of analysis 2011-2017, I can get the total capacity per kreis in 2011, 2012,...,2017 per energy source

bysort kreis_id Year energy_main2: egen mega2 = sum(energy_nnp2) // sum of total net capacity per kreis, per year, for each energy source

*browse if kreis_id == "01001" & energy_main2 == 14

generate kreis_id2 = kreis_id

destring kreis_id2, replace force

```

```
egen kreis_mix = concat(kreis_id2 energy_main2 Year), punct(_) //variable that is a unique ID for kreis, energy source and year
duplicates drop kreis_mix, force
```

```
//dropping every variable that is not relevant for a kreis level analysis
```

```
drop power_plant_id year_start year_off years_op years_op2 power_plant_status power_plant_status2 energy_source energy_spec1 energy_spec2 energy_main
MWsum_status MWsum_main_status plzdigits _merge energy_nnp
```

```
sort kreis_id energy_main2 Year
```

```
browse kreis_id location_name travel_area_id travel_area_desc urb_degree kreis_area kreis_latitude kreis_longitude kreis_pop_total kreis_pop_male kreis_pop_female
kreis_pop_km2 energy_main2 mega mega1 mega2 kreis_mix
```

```
destring location_id1, replace force
```

```
label define location_id1 10 "Land" 20 "Regierungsbezirk" 30 "Region (nur in Baden-Württemberg)" 40 "Kreis" 50 "Gemeindeverband" 60 "Gemeinde"
```

```
label values location_id1 location_id1
```

```
label variable location_id1 "type of location, i.e. state,region,district,municipality,community"
```

```
destring location_id2, replace force
```

```
label define location_id2 60 "Markt" 61 "Kreisfreie Stadt" 62 "Stadtkreis (nur in Baden-Württemberg)" 63 "Stadt" 64 "Kreisangehörige Gemeinde" 67 "Große Kreisstadt"
```

```
label values location_id2 location_id2
```

```
label variable location_id2 "type of kreis, municipality or community"
```

destring rs1, replace force

label define rs1 01 "Schleswig-Holstein" 02 "Hamburg" 03 "Niedersachsen" 04 "Bremen" 05 "Nordrhein-Westfalen" 06 "Hessen" 07 "Rheinland-Pfalz" 08 "Baden-Württemberg" 09 "Bayern" 10 "Saarland" 11 "Berlin" 12 "Brandenburg" 13 "Mecklenburg-Vorpommern" 14 "Sachsen" 15 "Sachsen-Anhalt" 16 "Thüringen"

label values rs1 rs1

label variable rs1 "Regionalschlüssel (RS) bundesland/ state identifier"

destring rs2 rs3 rs4 rs5, replace force

label variable rs2 "Regionalschlüssel (RS), RB:Regierungsbezirk / Region identifier"

label variable rs3 "Regionalschlüssel (RS), Kreis/ district identifier"

label variable rs4 "Regionalschlüssel (RS), VB:Gemeindeverband/community identifier"

label variable rs5 "Regionalschlüssel (RS), Gem:Gemeind/ municipality identifier"

egen place = concat(rs1 rs2 rs3 rs4 rs5)

label variable place "location complete identifier"

label variable location_name "Gemeindename/ name of place"

label variable kreis_id "kreis identifier: concatenation of rs1, rs2, rs3"

label variable kreis_name "name of the kreis, as indicated on the demographic excel file"

label variable longitude "coordinates of some location within the kreis"

label variable longitude "coordinates of some location within the kreis"

label variable travel_area_id "travel area identifier"
label variable travel_area_desc "travel area description"
label variable urb_degree "dicht besiedelt: very populated , gering besiedelt: sparsely populated, mittlere Besiedlungsdichte: average population density"
label variable kreis_area "kreis area in km2"
label variable kreis_pop_total "kreis total population"
label variable kreis_pop_male "kreis male population"
label variable kreis_pop_female "kreis female population"
label variable kreis_pop_km2 "kreis total population in km2"

label variable energy_main2 "main energy source/fuel"
label variable energy_main_eng "main energy source/fuel, english"
label variable mega "kreis net nominal power in MW, for the observation's energy source"
label variable mega2 "kreis net nominal power in MW, for the observation's energy source and year"

label variable Year "Year of the observation"
label variable kreis_mix "unique ID for kreis, energy source and year"

label variable MWsum_regional "Total net electrical capacity in MW of the observation's state/bundesland"
label variable MWsum_main_regional "Total net electrical capacity in MW of the observtion's state/bundesland and main energy source"
label variable MWsum_renewable "Total net electrical capacity of renewable energy sources. Not specific to the observation"
label variable MWsum_nonrenewable "Total net electrical capacity of non-renewable energy sources. Not specific to the observation"
label variable MWsum_main_renewable "Total net electrical capacity in MW of renewable energy generated by the observation's main energy source"

```
label variable MWsum_main_nonrenewable "Total net electrical capacity in MW of non-renewable energy generated by the observation's main energy source"
```

```
label variable MWsum_renewableHistory "Total net electrical capacity in MW of renewable energy, as of: 31.12.Year of the observation"
```

```
label variable MWsum_nonrenewableHistory "Total net electrical capacity in MW of non-renewable energy, as of: 31.12.Year of the observation"
```

```
label variable MWsum_main_renewableYear "Total net electrical capacity in MW of renewable energy of main energy source of the observation, as of:31.12.Year of the observation"
```

```
label variable MWsum_main_nonrenewableYear "Total net electrical capacity in MW of nonrenewable energy of main energy source of the observation, as of:31.12.Year of the observation"
```

```
save mfs1c, replace
```

```
*****
```

```
*xtset kreis_id2 Year
```

```
*save panelpp, replace
```

```
*log close
```

Do-file 02: Expanding the database for 20 energy sources, 7 years and 401 kreis.

```
clear
```

```
set more off
```

```
*cd "U:\dissertation" //location of the excel file
```

```
*import excel "U:\dissertation\KREIS database.xlsx", sheet("mfs1a") firstrow
```

```
*expand 20 //there are 20 energy sources >> we want to have 20 observations per kreis
```

```

*expand 7 // there are 7 years (2011-2017) >> we want to have 20 observations per kreis per year

*sort kreis_id

*export excel using "U:\dissertation\KREIS database.xlsx", sheet("mfS1b2") sheetmodify firstrow(variables)

//AFTER MODIFYING WITH VBA:

clear

set more off

cd "U:\dissertation" //location of the excel file

import excel "U:\dissertation\KREIS database.xlsx", sheet("mfS1b2") firstrow //56140 obs (401*7*20)

label define esource 1 "Abfall" 2 "Biomasse" 3 "Braunkohle" 4 "Deponiegas" 5 "Erdgas" 6 "Geothermie" 7 "Grubengas" 8 "Kernenergie" 9 "Klär gas" 10 "Laufwasser" 11
"Mehrere Energieträger (nicht erneuerbar)" 12 "Mineralölprodukte" 13 "Pumpspeicher" 14 "Solare Strahlungsenergie" 15 "Sonstige Energieträger (nicht erneuerbar)" 16
"Speicherwasser (ohne Pumpspeicher)" 17 "Steinkohle" 18 "Unbekannter Energieträger (nicht erneuerbar)" 19 "Windenergie (Offshore-Anlage)" 20 "Windenergie (Onshore-
Anlage)"

//label define esource 1 "Abfall" 2 "Biomasse" 3 "Braunkohle" 4 "Erdgas" 5 "Grubengas" 6 "Kernenergie" 7 "Laufwasser" 8 "Mehrere Energieträger (nicht erneuerbar)" 9
"Mineralölprodukte" 10 "Pumpspeicher" 11 "Solare Strahlungsenergie" 12 "Sonstige Energieträger (nicht erneuerbar)" 13 "Speicherwasser (ohne Pumpspeicher)" 14
"Steinkohle" 15 "Windenergie (Offshore-Anlage)" 16 "Windenergie (Onshore-Anlage)"

label values energy_source esource

destring location_id1, replace force

label define location_id1 10 "Land" 20 "Regierungsbezirk" 30 "Region (nur in Baden-Württemberg)" 40 "Kreis" 50 "Gemeindeverband" 60 "Gemeinde"

label values location_id1 location_id1

label variable location_id1 "type of location, i.e. state,region,district,municipality,community"

```


destring location_id2, replace force

label define location_id2 60 "Markt" 61 "Kreisfreie Stadt" 62 "Stadtkreis (nur in Baden-Württemberg)" 63 "Stadt" 64 "Kreisangehörige Gemeinde" 67 "Große Kreisstadt"

label values location_id2 location_id2

label variable location_id2 "type of kreis, municipality or community"

destring rs1, replace force

label define rs1 01 "Schleswig-Holstein" 02 "Hamburg" 03 "Niedersachsen" 04 "Bremen" 05 "Nordrhein-Westfalen" 06 "Hessen" 07 "Rheinland-Pfalz" 08 "Baden-Württemberg" 09 "Bayern" 10 "Saarland" 11 "Berlin" 12 "Brandenburg" 13 "Mecklenburg-Vorpommern" 14 "Sachsen" 15 "Sachsen-Anhalt" 16 "Thüringen"

label values rs1 rs1

label variable rs1 "Regionalschlüssel (RS) bundesland/ state identifier"

destring rs2 rs3 rs4 rs5, replace force

label variable rs2 "Regionalschlüssel (RS), RB:Regierungsbezirk / Region identifier"

label variable rs3 "Regionalschlüssel (RS), Kreis/ district identifier"

label variable rs4 "Regionalschlüssel (RS), VB:Gemeindeverband/community identifier"

label variable rs5 "Regionalschlüssel (RS), Gem:Gemeind/ municipality identifier"

egen place = concat(rs1 rs2 rs3 rs4 rs5)

label variable place "location complete identifier"

label variable location_name "Gemeindename/ name of place"

label variable kreis_id "kreis identifier: concatenation of rs1, rs2, rs3"

label variable kreis_name "name of the kreis, as indicated on the demographic excel file"

label variable longitude "coordinates of some location within the kreis"

label variable longitude "coordinates of some location within the kreis"

label variable travel_area_id "travel area identifier"

label variable travel_area_desc "travel area description"

label variable urb_degree "dicht besiedelt: very populated , gering besiedelt: sparsely populated, mittlere Besiedlungsdichte: average population density"

label variable kreis_area "kreis area in km2"

label variable kreis_pop_total "kreis total population"

label variable kreis_pop_male "kreis male population"

label variable kreis_pop_female "kreis female population"

label variable kreis_pop_km2 "kreis total population in km2"

encode urb_degree, gen(urb_degree2)

drop urb_degree

rename urb_degree2 urb_degree

label variable Year "Year of the observation"

```
rename energy_source energy_main2
```

```
drop area area_date
```

```
*log using dis2
```

```
merge m:m kreis_id Year energy_main2 using mfs1c // 56140 obs in total (confirms everything is ok)
```

```
label variable energy_main2 "main energy source/fuel"
```

```
label variable energy_main_eng "main energy source/fuel, english"
```

```
label variable mega "kreis net nominal power in MW, for the observation's energy source"
```

```
label variable mega2 "kreis net nominal power in MW, for the observation's energy source and year"
```

```
label variable kreis_mix "unique ID for kreis, energy source and year"
```

```
egen kreis_mix2 = concat(kreis_id energy_main2 Year), punct(_)
```

```
drop kreis_mix
```

```
rename kreis_mix2 kreis_mix
```

```
browse kreis_id kreis_area Year energy_main2 mega1 mega2 kreis_mix _merge
```

//IMPORTANT: We want to keep matched and unmatched observations. This is because an unmatched observation only indicates that "mfs1c.dta" did not contain an observation of a particular energy source of a particular kreis.

```
replace mega2=0 if mega2==.
```

```
replace mega1=0 if mega1==.
```

```
drop mega1 energy_nnp2 kreis_id2 //not relevant anymore
```

```
drop location_id1 location_id2 rs1 rs2 rs3 rs4 rs5 location_name place area_date coord_weight latcord loncord plz energy_main_eng MWsum* m mega
```

```
label variable kreis_mix "kreis_energysource_Year"
```

```
save mfs1d ,replace
```

```
decode energy_main2, generate(fuel)
```

```
replace fuel = "Mehrere Energieträger" if fuel=="Mehrere Energieträger (nicht erneuerbar)"
```

```
replace fuel = "Sonstige Energieträger" if fuel=="Sonstige Energieträger (nicht erneuerbar)"
```

```
replace fuel = "Speicherwasser" if fuel=="Speicherwasser (ohne Pumpspeicher)"
```

```
replace fuel = "Unbekannter Energieträger" if fuel=="Unbekannter Energieträger (nicht erneuerbar)"
```

```
replace fuel = "Windenergie (Offshore)" if fuel == "Windenergie (Offshore-Anlage)"
```

```
replace fuel = "Windenergie (Onshore)" if fuel == "Windenergie (Onshore-Anlage)"
```

```
*log close
```

Do-file 03: Generating a matrix of 401*20 that allows to visualize the mega-watts of installed capacity over time, per kreis and energy source.
Trying graphs

```
clear
set more off
cd "U:\dissertation" // the location should be modified accordingly

use mfs1d //dta file that contains the capacity installed (mega2) of each type of powerplant (energy_main2) in each kreis (kreis_id) per year (Year)
sort kreis_id energy_main2 Year //we want the observations to be in this order for visualizing purposes
browse //to look at the data base

//PROGRAMMING THE MATRIXES CREATION
gen n = _n // this variable 'n' keeps the original order of the observation (which will change after sorting)
sort Year kreis_id energy_main2 //sorting

forvalues year = 2011/2017 { //7 matrixes created, 1 per year

set matsize 800
matrix mat`year' = J(401,20,.) //401 kreis and 20 energy sources //creation of matrixes per year
```

```
levelsof kreis_id, local(mtg) // macro 'mtg' contains unique values of kreis_id
```

```
matrix rownames mat`year' = `mtg'
```

```
levelsof energy_main2, local(mtg2)
```

```
matrix colnames mat`year' = `mtg2'
```

```
mat list mat`year'
```

```
local row = 1 + 8020*(`year'-2011)
```

```
forvalues fila = 1/401 { // rows of mat`year'
```

```
forvalues columna = 1/20 { // columns of mat1
```

```
local valor = mega2[`row'] // keeps each value of variable "mega2"
```

```
matrix mat`year'[`fila',`columna'] = `valor' // and placed in mat1
```

```
local row = `row' + 1 // for the next value of variable "mega"
```

```
}
```

```
}
```

```
mat list mat`year', format(%12.2f) //for 2 decimal places
```

```
}
```

```
display `row' //helps to confirm that it stops and do nothing at row 56141 of the dta file
```

```
//SHOWING THE MATRIXES CREATED
```

```
mat list mat2011, format(%12.2f)
```

```
browse kreis_id energy_main2 mega2 Year if Year==2011
```

```
mat list mat2012, format(%12.2f)
```

```
browse kreis_id energy_main2 mega2 Year if Year==2012
```

```
mat list mat2013, format(%12.2f)
```

```
browse kreis_id energy_main2 mega2 Year if Year==2013
```

```
mat list mat2014, format(%12.2f)
```

```
browse kreis_id energy_main2 mega2 Year if Year==2014
```

```
mat list mat2015, format(%12.2f)
```

```
browse kreis_id energy_main2 mega2 Year if Year==2015
```

```
mat list mat2016, format(%12.2f)
```

```
browse kreis_id energy_main2 mega2 Year if Year==2016
```

```
mat list mat2017, format(%12.2f)
```

```
browse kreis_id energy_main2 mega2 Year if Year==2017
```

```
*matrix mat1 = mat2012-mat2011
```

```
*mat list mat1 //shows the matrix with the changes in capacity between 2011 and 2012
```

```
summarize //to check irregularities: I can't find any no more
```

```
bysort energy_main2: summarize mega2 // we can see that there is no Windenergie (Offshore-Anlage) capacity installed in any kreis (which is what is expected)
```

```
//the same applies to:
```

```
*Deponiegas, reason: all deponiegas observations on the powerplant database are less than 10MW of capacity and have no location identifier
```

```
*Geothermie, reason: all deponiegas observations on the powerplant database are less than 10MW of capacity and have no location identifier
```

```
*Klärgas, reason: all deponiegas observations on the powerplant database are less than 10MW of capacity and have no location identifier
```


*Unbekannter Energieträger (nicht erneuerbar), reason: the only 1 unbekannter (unknown energy source) on the powerplant database is less than 10MW of capacity and has no location identifier

```
set matsize 800
```

```
matrix matriz = J(401,20,..)
```

```
sort kreis_id energy_main2 Year
```

```
egen media = mean(mega2) in 1/7
```

```
egen desv = sd(mega2) in 1/7
```

```
levelsof kreis_id, local(mtg) // macro 'mtg' contains unique values of kreis_id
```

```
matrix rownames matriz = `mtg'
```

```
levelsof energy_main2, local(mtg2)
```

```
matrix colnames matriz = `mtg2'
```

```
forvalues k = 0/400 {
```

```
forvalues a = 0/19 {
```

```
local i = 1 + 7*`a' + 140*(`k')
```

```
local fin= 7*(^a+ 1) + 140*(^k')
```

```
egen media_`a'= mean(mega2) in `i'/^fin'
```

```
replace media= media_`a' in `i'/^fin'
```

```
drop media_`a'
```

```
egen desv_`a'= sd(mega2) in `i'/^fin'
```

```
replace desv= desv_`a' in `i'/^fin'
```

```
drop desv_`a'
```

```
}
```

```
}
```

```
gen coefvar = (desv/media)*100 // 4522 values non-missing
```

```
save mfs1e, replace
```

```
clear
```

```
set more off
```

```
use mfs1e
```

```
forvalues kreis = 0/400 {
```

```

forvalues energy = 0/19 {

local fila= `kreis' + 1
local columna= `energy' + 1

local i= 1 + 7*`energy' + 140*(`kreis')

local valor1 = media[`i']
local cv = coefvar[`i']

matrix matriz[`fila',`columna'] = `cv'

}

}

matlist matriz, format(%12.2f)

*putexcel set "coeficiente_variacion_matrix", modify
*putexcel A1 =matrix(matriz)

ssc inst tabplot
sort kreis_id energy_main2 Year

```

```
*tabplot energy_main2 kreis_id if Year==2011 in 1/280, percent(kreis_id) horizontal
```

```
label define english 1 "Waste" 2 "Biomass" 3 "Brown coal" 4 "Landfill gas" 5 "Natural gas" 6 "Geothermal" 7 "Marsh gas" 8 "Nuclear energy" 9 "Sewage gas" 10  
"Hydropower (running water)" 11 "Multiple (non RE)" 12 "Petroleum" 13 "Hydropower (pumped storage water)" 14 "Solar" 15 "Other (non RE)" 16 "Hydropower (storage  
water, not pumped)" 17 "Hard coal" 18 "Unknown (non RE)" 19 "Wind (offshore)" 20 "Wind (onshore)"
```

```
label values energy_main2 english
```

```
graph dot energy_main2 if Year==2011, over(energy_main2 kreis_id) ///
```

```
*https://statadaily.com/2010/09/15/stacked-bar/
```

```
drop if coefvar < 10
```

```
graph bar (sum) mega2 if Year==2011 in 1/1400, over(energy_main2, axis(off)) over(kreis_name, label(angle(90) labsize(1))) asyvars stack legend(cols(10) size(1.3) colfirst  
symxsize(1) rowgap(0.2) bm(tiny) region(c(none))) //xsize(20.000) ysize (10.000) //ytitle("installed capacity (MW)", size(1.5) height(10)) ylabel(0(1000)2000,angle(0)  
format(%12.0gc) labsize(2)) ysize(10.000) title("installed capacity (MW)") //saving(graph1_2011)
```

```
clear
```

```
set more off
```

```
cd "U:\dissertation"
```

```
use mfs1e
```

```
encode kreis_id, generate(idkreis)
```

```

drop if energy_main2==4
drop if energy_main2==6
drop if energy_main2==9
drop if energy_main2==18
drop if energy_main2==19

```

```

recode energy_main2 (5=4) (7=5) (8=6) (10=7) (11=8) (12=9) (13=10) (14=11) (15=12) (16=13) (17=14) (20=15), gen(energy_main3)

```

```

***-----ALL REGIONS-----***

```

```

scatter energy_main3 idkreis [w=mega2]if Year==2011, msymbol(circle_hollow) ylabel(1(1)15) xlabel(1(1)401) xtitle("administrative district") xlabel(,labsize(1))ylabel(1
"Waste" 2 "Biomass" 3 "Brown coal" 4 "Natural gas" 5 "Marsh gas" 6 "Nuclear energy" 7 "Hydropower (running water)" 8 "Multiple (non RE)" 9 "Petroleum" 10
"Hydropower (pumped storage water)" 11 "Solar" 12 "Other (non RE)" 13 "Hydropower (storage water, not pumped)" 14 "Hard coal" 15 "Wind (onshore)", angle(360)
labsize(2)) ytitle(" " size(0.2)) xsize(20.000)

```

```

scatter energy_main3 idkreis [w=mega2]if Year==2014, msymbol(circle_hollow) ylabel(1(1)15) xlabel(1(1)401) xtitle("administrative district") xlabel(,labsize(1))ylabel(1
"Waste" 2 "Biomass" 3 "Brown coal" 4 "Natural gas" 5 "Marsh gas" 6 "Nuclear energy" 7 "Hydropower (running water)" 8 "Multiple (non RE)" 9 "Petroleum" 10
"Hydropower (pumped storage water)" 11 "Solar" 12 "Other (non RE)" 13 "Hydropower (storage water, not pumped)" 14 "Hard coal" 15 "Wind (onshore)", angle(360)
labsize(2)) ytitle(" " size(0.2)) xsize(20.000)

```

```

scatter energy_main3 idkreis [w=mega2]if Year==2017, msymbol(circle_hollow) ylabel(1(1)15) xlabel(1(1)401) xtitle("administrative district") xlabel(,labsize(1))ylabel(1
"Waste" 2 "Biomass" 3 "Brown coal" 4 "Natural gas" 5 "Marsh gas" 6 "Nuclear energy" 7 "Hydropower (running water)" 8 "Multiple (non RE)" 9 "Petroleum" 10
"Hydropower (pumped storage water)" 11 "Solar" 12 "Other (non RE)" 13 "Hydropower (storage water, not pumped)" 14 "Hard coal" 15 "Wind (onshore)", angle(360)
labsize(2)) ytitle(" " size(0.2)) xsize(20.000)

```

```

*keep if Year == 2011| Year==2014| Year==2017

```

```

*scatter energy_main3 idkreis [w=mega2], msymbol(circle_hollow) ylabel(1(1)15) xlabel(1(1)401) xtitle("administrative district") xlabel(,labsize(1))ylabel(1 "Waste" 2
"Biomass" 3 "Brown coal" 4 "Natural gas" 5 "Marsh gas" 6 "Nuclear energy" 7 "Hydropower (running water)" 8 "Multiple (non RE)" 9 "Petroleum" 10 "Hydropower

```

```
(pumped storage water)" 11 "Solar" 12 "Other (non RE)" 13 "Hydropower (storage water, not pumped)" 14 "Hard coal" 15 "Wind (onshore)", angle(360) labsize(2)) ytitle("size(0.2)) xsize(20.000)
```

```
***-----BUNDESLAND 01-----***
```

```
*Schleswig-Holstein
```

```
scatter energy_main3 idkreis [w=mega2]if Year==2011 in 1/1575, msymbol(circle_hollow) ylabel(1(1)15) xlabel(1(1)15) xtitle("administrative district") xlabel(1 "Flensburg, Stadt" 2 "Kiel, Landeshauptstadt" 3 "Lübeck, Hansestadt" 4 "Neumünster, Stadt" 5 "Dithmarschen" 6 "Herzogtum Lauenburg" 7 "Nordfriesland" 8 "Ostholstein" 9 "Pinneberg" 10 "Plön" 11 "Rendsburg-Eckernförde" 12 "Schleswig-Flensburg" 13 "Segeberg" 14 "Steinburg" 15 "Stormarn",labsize(3) angle(45))ylabel(1 "Waste" 2 "Biomass" 3 "Brown coal" 4 "Natural gas" 5 "Marsh gas" 6 "Nuclear energy" 7 "Hydropower (running water)" 8 "Multiple (non RE)" 9 "Petroleum" 10 "Hydropower (pumped storage water)" 11 "Solar" 12 "Other (non RE)" 13 "Hydropower (storage water, not pumped)" 14 "Hard coal" 15 "Wind (onshore)", angle(360) labsize(2)) ytitle("size(0.2)) xsize(10.000)
```

```
scatter energy_main3 idkreis [w=mega2]if Year==2014 in 1/1575, msymbol(circle_hollow) ylabel(1(1)15) xlabel(1(1)15) xtitle("administrative district") xlabel(1 "Flensburg, Stadt" 2 "Kiel, Landeshauptstadt" 3 "Lübeck, Hansestadt" 4 "Neumünster, Stadt" 5 "Dithmarschen" 6 "Herzogtum Lauenburg" 7 "Nordfriesland" 8 "Ostholstein" 9 "Pinneberg" 10 "Plön" 11 "Rendsburg-Eckernförde" 12 "Schleswig-Flensburg" 13 "Segeberg" 14 "Steinburg" 15 "Stormarn",labsize(3) angle(45))ylabel(1 "Waste" 2 "Biomass" 3 "Brown coal" 4 "Natural gas" 5 "Marsh gas" 6 "Nuclear energy" 7 "Hydropower (running water)" 8 "Multiple (non RE)" 9 "Petroleum" 10 "Hydropower (pumped storage water)" 11 "Solar" 12 "Other (non RE)" 13 "Hydropower (storage water, not pumped)" 14 "Hard coal" 15 "Wind (onshore)", angle(360) labsize(2)) ytitle("size(0.2)) xsize(10.000)
```

```
scatter energy_main3 idkreis [w=mega2]if Year==2017 in 1/1575, msymbol(circle_hollow) ylabel(1(1)15) xlabel(1(1)15) xtitle("administrative district") xlabel(1 "Flensburg, Stadt" 2 "Kiel, Landeshauptstadt" 3 "Lübeck, Hansestadt" 4 "Neumünster, Stadt" 5 "Dithmarschen" 6 "Herzogtum Lauenburg" 7 "Nordfriesland" 8 "Ostholstein" 9 "Pinneberg" 10 "Plön" 11 "Rendsburg-Eckernförde" 12 "Schleswig-Flensburg" 13 "Segeberg" 14 "Steinburg" 15 "Stormarn",labsize(3) angle(45))ylabel(1 "Waste" 2 "Biomass" 3 "Brown coal" 4 "Natural gas" 5 "Marsh gas" 6 "Nuclear energy" 7 "Hydropower (running water)" 8 "Multiple (non RE)" 9 "Petroleum" 10 "Hydropower (pumped storage water)" 11 "Solar" 12 "Other (non RE)" 13 "Hydropower (storage water, not pumped)" 14 "Hard coal" 15 "Wind (onshore)", angle(360) labsize(2)) ytitle("size(0.2)) xsize(10.000)
```

Do-file 04: Reshaping the database for merging with SOEP data and estimation

```
clear
```

```
set more off
```

```

cd "\\adf\storage\M\G\MTG724\dissertation"
use mfs1e

sort kreis_id Year energy_main2

forvalues s = 1/20 {
generate energy`s' = .
}

forvalues veces = 1/2807 { // 56140/20=2807
forvalues s = 1/20 {
local obs = 20*(`veces'-1) + `s' // `s'*`veces'
local obs2= 1 +20*(`veces'-1)
replace energy`s' = mega2[`obs'] in `obs2'
}
}
browse kreis_id Year energy_main2 mega2 energy*

label variable energy1 "Abfall/Waste"
label variable energy2 "Biomasse/Biomass"
label variable energy3 "Braunkohle/Brown coal"
label variable energy4 "Deponiegas/Landfill gas"

```

```
label variable energy5 "Erdgas/Natural gas" //4
label variable energy6 "Geothermie/Geothermal"
label variable energy7 "Grubengas/Marsh gas" //5
label variable energy8 "Kernenergie/Nuclear energy" //6
label variable energy9 "Klär gas/Sewage gas"
label variable energy10 "Laufwasser/Hydropower (running water)" //7
label variable energy11 "Mehrere Energieträger (nicht erneuerbar)/Multiple (non RE)" //8
label variable energy12 "Mineralölprodukte/Petroleum" //9
label variable energy13 "Pumpspeicher/Hydropower (pumped storage water)" //10
label variable energy14 "Solare Strahlungsenergie/Solar" //11
label variable energy15 "Sonstige Energieträger (nicht erneuerbar)/Other (non RE)" //12
label variable energy16 "Speicherwasser (ohne Pumpspeicher)/Hydropower (storage water, not pumped)" //13
label variable energy17 "Steinkohle/Hard coal" //14
label variable energy18 "Unbekannter Energieträger (nicht erneuerbar)/Unknown (non RE)"
label variable energy19 "Windenergie (Offshore-Anlage)/Wind (offshore)"
label variable energy20 "Windenergie (Onshore-Anlage)/Wind (onshore)" //15

drop mega2 energy_main2 kreis_mix

drop if energy1 ==.

drop energy4 energy6 energy9 energy18 energy19 //15 energy sources left only
```



```
rename energy5 energy4  
rename energy7 energy5  
rename energy8 energy6  
rename energy10 energy7  
rename energy11 energy8  
rename energy12 energy9  
rename energy13 energy10  
rename energy14 energy11  
rename energy15 energy12  
rename energy16 energy13  
rename energy17 energy14  
rename energy20 energy15
```

```
destring kreis_id, generate(kreis)
```

```
egen kreis_year =concat(kreis Year), punct(-)
```

```
browse kreis_id Year kreis_year energy*
```

```
sort kreis_id Year
```

```
drop if Year==2017
```

```
save mfSOEP, replace
```

```
//export excel using "mfSOEP2", firstrow(variables) replace
```

Do-file 05: Merging the ‘final energy’ database with ‘SOEP kreise’ database and running the estimations

```
// PART 1
```

```
use $soep33/kreise_1 //469,289 observations
```

```
replace kkz_rek = 3152 if kkz_rek == 3156 //The town Osterode am Harz (used to be kreis 03156) is now part of Gottingen(kreis 03152)
```

```
soepdrop if kkz_rek < 0 //14,863 observations deleted
```

```
//sort hhnr hhnrakt syear
```

```
soepkeep if syear >=2011 & syear<=2016 //278,713 observations deleted
```

```
egen kreis_year = concat(kkz_rek syear), punct(-)
```

```
sort kkz_rek syear
```

```
save $mydata//klong , replace
```

```
// PART 2
```

```
///INPUTING MY DATA
```

```
use $mydata/klong , clear
```

```
collapse (first) foreigner bula kreis_year, by (kkz_rek syear)
```

```
tab syear
```

```
describe, short // 2,406 obs (perfect, 6 observations - 1 per year- for each kreis)
```

```
tab kkz_rek
```

```
sort kkz_rek syear
```

```
quietly: input energy1  energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10  energy11  energy12  energy13  
energy14  energy15  n_years_1  n_years_2  n_years_3  n_years_4  n_years_5  n_years_6  n_years_7  
n_years_8  n_years_9  n_years_10  n_years_11  n_years_12  n_years_13  n_years_14  n_years_15  number_1  
number_2  number_3  number_4  number_5  number_6  number_7  number_8  number_9  number_10  
number_11  number_12  number_13  number_14  number_15  kreis_pop_total  kreis_pop_km2
```

```
0      0      0      0      0      0      0      0      0      0      0      0      0      147      0      0      0      0      1      0
      0      0      0      0      0      0      0      0      0      32      0      0      0      0      0      0      0      0      0      0
      0      0      0      0      5      0      87432  1541
```

```
//GOES ON....
```

```
end
```

```
soepkeep kkz_rek syear bula kreis_year energy* n_years_* number_* kreis_pop_total kreis_pop_km2
```

```
save $mydata//klonginput_x , replace
```

```
//PART 3
```

```
*opening data that contains the energy MW installed & number of powerplants for each kreis, which is at the kreis level:
```

```
use $mydata//klonginput_x , clear
```

```
sort kkz_rek syear
```

```
describe, short
```

```
save $mydata//klonginput_x , replace
```

```
use $mydata//klong , clear
```

```
sort kkz_rek syear
```

```
save $mydata//klong , replace
```

```
use $mydata//klonginput_x , clear
```

```
sort kkz_rek syear
```

```
*merging with the SOEPcore kreise dataset which contains the household and person identifiers
```

```
merge 1:m kkz_rek syear using $mydata//klong
```

```
*175,713 obs merged, all observations were matched
```

```
*this merged dataset is now at the level of persons and contains the kreise and energy variables
```

```
soepdrop _merge
```

```
sort hhnr hhnrakt syear
```

```
save $mydata//klongmerged_x , replace
```

```
//PART 4
```

```
use $mydata//klongmerged_x , replace
```

```
sort hhnr hhnrakt syear
```

```
save $mydata//klongmerged_x , replace
```

```
use $soep331/pequiv ,clear //SOEPlong dataset with life satisfaction variable
```

```
rename cid hhnr
```

```
rename hid hhnrakt
```

```
rename pid persnr
```

```
soepkeep if syear >=2011 & syear<=2016 // (595,016 observations deleted)
```

```
sort hhnr hhnrakt syear
```

```
save $mydata//pequivsort //, replace
```

```
use $mydata//pequivsort , clear
```

```
*merging with the dataset that contains the kreis identifiers and MW installed of each type of energy:
```

```
merge m:1 hhnr hhnrakt syear using $mydata//klongmerged_x //using is at the hh level, while master is at the person level
```

```
soepkeep if _merge==3 //(268,093 obs out of 342227 kept) //74,111 observations not matched from using and 23 from master
```

```
//the 74,111 not matched 'using' obs are reasonable, as they would have been 131,630 if 'using' was $soep33/kreise_1
```

```
soepdrop _merge
```

```
//tab kreis_year
```

```
//tab kkz_rek
```

```
label variable energy1 "Abfall/Waste"
```

```
label variable energy2 "Biomasse/Biomass"
```

```
label variable energy3 "Braunkohle/Brown coal"
```

label variable energy4 "Erdgas/Natural gas" //4

label variable energy5 "Grubengas/Marsh gas" //5

label variable energy6 "Kernenergie/Nuclear energy" //6

label variable energy7 "Laufwasser/Hydropower (running water)" //7

label variable energy8 "Mehrere Energieträger (nicht erneuerbar)/Multiple (non RE)" //8

label variable energy9 "Mineralölprodukte/Petroleum" //9

label variable energy10 "Pumpspeicher/Hydropower (pumped storage water)" //10

label variable energy11 "Solare Strahlungsenergie/Solar" //11

label variable energy12 "Sonstige Energieträger (nicht erneuerbar)/Other (non RE)" //12

label variable energy13 "Speicherwasser (ohne Pumpspeicher)/Hydropower (storage water, not pumped)" //13

label variable energy14 "Steinkohle/Hard coal" //14

label variable energy15 "Windenergie (Onshore-Anlage)/Wind (onshore)" //15

gen renewables1= energy2 + energy11 + energy15

label variable renewables "biomass,solar,wind, excludes hydroelectric"

gen hydroelectric = energy7 + energy10 + energy13

label variable hydroelectric "running water, pumped storage, storage not pumped"

gen renewables2= renewables1 + hydroelectric

label variable renewables2 "includes hydroelectric"

gen conventional = energy3 + energy4 + energy5 + energy9 + energy14

label variable conventional "oil, coal, gas"

gen nuclear = energy6

label variable nuclear "nuclear energy"

gen waste = energy1

label variable waste "waste"

gen coal = energy3 + energy14

label variable coal "coal"

gen conventional2= energy9 + energy4 + energy5

label variable conventional2 "conventional- coal"

gen nonrenewables = energy1 + energy3 + energy4 + energy5 + energy6 + energy8 + energy9 + energy12 + energy14

label variable nonrenewables "all - renewables2"

gen nonrenewables2 = nonrenewables - nuclear - coal

label variable nonrenewables2 "nonrenewables- nuclear - coal"

gen oil = energy9


```
gen gas = energy4 + energy5
gen hydroelectric2 = energy7 + energy13 //excludes hydropower (storage, PUMPED)

rename p11101 lifes //https://data.soep.de/soep-long/data/pequiv/p11101
rename d11101 age //https://data.soep.de/soep-long/data/pequiv/d11101
generate age2 = age^2
rename d11102ll gender //https://data.soep.de/soep-long/data/pequiv/d11102ll
rename i11102 income //HH post-govt income https://data.soep.de/soep-long/data/pequiv/i11102
rename d11106 hh_members // Number of persons in HH https://data.soep.de/soep-long/data/pequiv/d11106

rename y11101 cpi //consumer price index
generate income_adj=income/(cpi/100)

rename d11107 hh_children

generate hh_adults = hh_members - hh_children

//adjusting income for household size (OECD modified scale)

generate add_adults = 0
replace add_adults = (hh_adults - 1) if hh_adults > 1 //number of additional adults
```

```
generate hh_scale_adults = hh_adults //there could be a household with no adults ...(?)
replace hh_scale_adults = 1 + add_adults*0.5 if hh_adults > 1 //each additional addult is accountedd as 0.5 more

generate add_children = 0
replace add_children = (hh_children - 1) if hh_children > 1 //number of additional children

generate hh_scale_children = hh_children //there could be a household with no children ...
replace hh_scale_children = 1 + add_children*0.3 if hh_children > 1 //each additional children is accountedd as 0.3 more

generate hh_scale_members = hh_scale_adults + hh_scale_children

generate income_adj2 = income_adj/hh_scale_members
generate income_adj3 = log(income_adj2)

rename m11126 health // https://data.soep.de/soep-long/data/pequiv/m11126
rename d11104 marital //https://data.soep.de/soep-long/data/pequiv/d11104
rename e11102 employment //https://data.soep.de/soep-long/data/pequiv/e11102
rename m11120 health2 //codebook shows no one took this test
```

```
sort hhnr hhnrakt persnr syear
```

```
egen id = group(hhnr hhnrakt persnr)
```

```
duplicates report id syear // 0 duplicates
```

```
//duplicates report hhnr hhnrakt persnr syear // 0 duplicates
```

```
//confirms there should not be a duplicates error when setting data as panel
```

```
save $mydata//klongmerged2_x , replace
```

```
//creating the panel time variable
```

```
sort kkz_rek syear
```

```
egen region_Year = group(kkz_rek syear) //panel time variable created
```

```
duplicates report id region_Year //no duplicates
```

```
duplicates tag id region_Year, gen(isdup)
```

```
soepdrop if isdup >0 //no drops
```

```
soepdrop isdup
```

```
save $mydata//klongmerged3_x , replace
```

```
codebook id //7862 3unique values
```

```
codebook region_Year //no missing values
```

```
codebook lifes age age2 gender income hh_members hh_adults hh_scale_members hh_children income_adj income_adj2 income_adj3 health health2 marital employment  
energy* //no missing values
```

```
describe
```

```
describe, short
```

```
rename kkz_rek kreis_id
```

```
rename syear Year
```

```
//declaring data as panel:
```

```
xtset id region_Year //unbalanced panel, time variable (1 to 2406) with gaps (delta of 1 unit)
```

```
*should I use the tsvfill command?
```

```
soepdrop if lifes < 0 //https://data.soep.de/soep-long/data/pequiv/p11101
```

```
soepdrop if age < 0 //on the codebook, there appears to be values of -1
```

```
soepdrop if gender < 1 /// 1 is male, 2 female
```

soepdrop if income < 0 //(4,482 observations deleted)

soepdrop if income_adj3 == . //(74 observations deleted)

soepdrop if health < 1 //on the codebook, there appears to be negative values which correspond to mistakes or no answers

soepdrop if marital < 1 //on the codebook, there appears to be negative values which correspond to mistakes or no answers

*health status: <https://data.soep.de/soep-long/data/pequiv/m11126>

generate health_d1 = health ==1 // for value of 1 (very good)

generate health_d2 = health ==2 // for value of 2 (good)

generate health_d3 = health ==3 //for value of 3 (satisfactory)

generate health_d4 = health == 4 // for value of 4 (poor)

generate health_d5 = health == 5 // for value of 5 (bad)

*marital status: <https://data.soep.de/soep-long/data/pequiv/d11104>

generate marital_d1 = marital==1 //for married

generate marital_d2 = marital==2 //for single

generate marital_d3 = marital==3 //for widowed

generate marital_d4 = marital==4 //for divorced

generate marital_d5 = marital==5 //for separated

generate age3= age ^ 3 //cubic age

```
//year dummies (for when i.Year is not allowed)
```

```
gen y2011 = Year==2011
```

```
gen y2012 = Year==2012
```

```
gen y2013 = Year==2013
```

```
gen y2014 = Year==2014
```

```
gen y2015 = Year==2015
```

```
gen y2016 = Year==2016
```

```
//kreis dummies (for when i.kreis_id is not allowed)
```

```
levelsof kreis_id, local(kreis)
```

```
foreach k of local kreis {
```

```
gen kreis_`k' = `k'
```

```
gen kdummy_`k' = 0
```

```
}
```

```
foreach k of local kreis {
```

```
replace kdummy_`k' = 1 if kreis_`k' == kreis_id
```

```
}
```

```
codebook employment
```

```
tab employment
```

```
soepdrop if employment < 0
```

```
gen region = 111102 //https://data.soep.de/soep-long/data/pequiv/111102
```

```
soepdrop if region != 1 & region != 2 // 1: west , 2: east
```

```
forvalues e=1/15 {
```

```
gen ekm2_`e' = energy`e'/area //generating variable of MW per km2
```

```
gen numberkm2_`e' = number_`e'/area //generating variable of number of power plants per km2
```

```
gen numberpop_`e' = number_`e'/kreis_pop_total
```

```
}
```

```
gen nonrenewables_km2= nonrenewables/area
```

```
gen renewables2_km2= renewables2/area
```

```
gen oil_km2 = energy9_km2
```

```
gen gas_km2= energy4_km2 + energy5_km2
```

```
gen coal_km2= energy3_km2 + energy14_km2
```

```
gen hydro_km2 = energy7_km2 + energy10_km2 + energy13_km2
```

```
gen numberkm2_ren = numberkm2_2 + numberkm2_7 + numberkm2_10 + numberkm2_13 + numberkm2_11 + numberkm2_15
```

```
gen numberkm2_non = numberkm2_1 + numberkm2_3 + numberkm2_4 + numberkm2_5 + numberkm2_6 + numberkm2_8 + numberkm2_9 + numberkm2_12 +  
numberkm2_14
```

```
gen number_ren = number_2 + number_7 + number_10 + number_13 + number_11 + number_15
```

```
gen number_non = number_1 + number_3 + number_4 + number_5 + number_6 + number_8 + number_9 + number_12 + number_14
```

```
missings report
```

```
bysort bula: egen oil_bula_sum = sum(energy9)
```

```
sort kreis_id Year
```

```
describe, short //160,220 obs
```

```
codebook id kreis_id Year region_Year
```

```
// 42,956 unique id, 401 unique kreis, 6 unique years, 2404 unique region_Year
```



```
save $mydata//klongmerged_final_x , replace
```

```
///PART 5
```

```
***** SIMPLE REGRESS *****
```

```
use $mydata//klongmerged_final_x, clear
```

```
xtset , clear
```

```
quietly: regresslifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15
```

```
estat vif
```

```
estat vce , corr
```

```
quietly: regress lifes ekm2_*
```

```
estat vif
```

```
estat vce , corr
```

```
////////////////////////////////////
```

```
quietly: regress lifes numberkm2_* age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4
employment
```

```
estat vif
```

```
estat vce , corr
```

```
quietly: regress lifes numberkm2_1 numberkm2_2 numberkm2_3 numberkm2_4 numberkm2_5 numberkm2_6 numberkm2_7 numberkm2_8 numberkm2_9 numberkm2_10
numberkm2_11 numberkm2_12 numberkm2_13 numberkm2_14 numberkm2_15 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4
marital_d2 marital_d3 marital_d4 marital_d5 employment
```

```
estat vif
```

```
estat vce , corr
```

```
***** HAUSMAN TEST *****
```

```
use $mydata//klongmerged_final_x , clear
```

```
//1) This did not work because of vce option present
```

```
*xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 gender
income_adj3 health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment i.kreis_id i.Year, re vce(cluster id)
```

```
*estimate store re
```

```
*xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 gender  
income_adj3 health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment i.kreis_id i.Year, fe vce(cluster id)
```

```
*estimate store fe
```

```
*hausman fe re
```

//2) This did not work because of vce option present

```
*xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 gender  
income_adj3 health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment i.kreis_id i.Year, re vce(robust)
```

```
*estimate store re
```

```
*xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 gender  
income_adj3 health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment i.kreis_id i.Year, fe vce(robust)
```

```
*estimate store fe
```

```
*hausman fe re
```

//3) Works. Result: FE is more appropriate (i.e. we cannot say difference in coefficients is not systematic)

```
xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment i.kreis_id i.Year, re
```

```
estimate store re
```

```
xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment i.kreis_id i.Year, fe
```

```
estimate store fe
```

```
hausman fe re
```

```
//4) Works. Result: FE is more appropriate (i.e. we cannot say difference in coefficients is not systematic)
```

```
xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment , re
```

```
estimate store re
```

```
xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment , fe
```

```
estimate store fe
```

```
hausman fe re
```

```
///ROBUST FORM:
```

```
use $mydata//klongmerged_final_x , clear
```

```
xi: xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 hh_children employment health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 y2011 y2012 y2013 y2015, re
```

```
xtoverid
```

```
xi: xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 hh_children employment health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 , re
```

```
xtoverid
```

```
soepdrop kdummy_9177 kdummy_12051 kdummy_13076 kdummy_16075 kdummy_16077
```

```
xi: xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment y2011 y2012 y2013 y2015 kdummy_* , re
```

```
xtoverid
```

```
*** OLS REGRESSION with individual, kreis and year fe ****
```

```
use $mydata//klongmerged_final_x , clear
```

//MW

```
xtreg lifes energy* age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment  
i.kreis_id i.Year, fe vce(robust)
```

```
test energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment
```

```
test energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15
```

//MW per km2

```
xtreg lifes ekm2_* age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment  
i.kreis_id i.Year, fe vce(robust)
```

```
test ekm2_1 ekm2_2 ekm2_3 ekm2_4 ekm2_5 ekm2_6 ekm2_7 ekm2_8 ekm2_9 ekm2_10 ekm2_11 ekm2_12 ekm2_13 ekm2_14 ekm2_15 age age2 age3 gender  
income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment
```

```
test ekm2_1 ekm2_2 ekm2_3 ekm2_4 ekm2_5 ekm2_6 ekm2_7 ekm2_8 ekm2_9 ekm2_10 ekm2_11 ekm2_12 ekm2_13 ekm2_14 ekm2_15
```

//number of power plants

```
xtreg lifes number_* age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment  
i.kreis_id i.Year, fe vce(robust)
```

```
test number_1 number_2 number_3 number_4 number_5 number_6 number_7 number_8 number_9 number_10 number_11 number_12 number_13 number_14 number_15  
age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment
```

```
test number_1 number_2 number_3 number_4 number_5 number_6 number_7 number_8 number_9 number_10 number_11 number_12 number_13 number_14 number_15
```

```
//number of power plants per km2
```

```
xtreg lifes numberkm2_* age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment  
i.kreis_id i.Year, fe vce(robust)
```

```
test numberkm2_1 numberkm2_2 numberkm2_3 numberkm2_4 numberkm2_5 numberkm2_6 numberkm2_7 numberkm2_8 numberkm2_9 numberkm2_10 numberkm2_11  
numberkm2_12 numberkm2_13 numberkm2_14 numberkm2_15 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2  
marital_d3 marital_d4 marital_d5 employment
```

```
test numberkm2_1 numberkm2_2 numberkm2_3 numberkm2_4 numberkm2_5 numberkm2_6 numberkm2_7 numberkm2_8 numberkm2_9 numberkm2_10 numberkm2_11  
numberkm2_12 numberkm2_13 numberkm2_14 numberkm2_15
```

```
//for WEST and EAST Germany:
```

```
forvalues r = 1/2 {
```

```
use $mydata//klongmerged_final_x , clear
```

```
soepkeep if region == `r'
```

```
//MW
```

```
xtreg lifes energy* age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment  
i.kreis_id i.Year, fe vce(robust)
```

```
test energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment
```

```
test energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15
```

//MW per km2

```
xtreg lifes ekm2_* age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment  
i.kreis_id i.Year, fe vce(robust)
```

```
test ekm2_1 ekm2_2 ekm2_3 ekm2_4 ekm2_5 ekm2_6 ekm2_7 ekm2_8 ekm2_9 ekm2_10 ekm2_11 ekm2_12 ekm2_13 ekm2_14 ekm2_15 age age2 age3 gender  
income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment
```

```
test ekm2_1 ekm2_2 ekm2_3 ekm2_4 ekm2_5 ekm2_6 ekm2_7 ekm2_8 ekm2_9 ekm2_10 ekm2_11 ekm2_12 ekm2_13 ekm2_14 ekm2_15
```

//number of power plants

```
xtreg lifes number_* age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment  
i.kreis_id i.Year, fe vce(robust)
```

```
test number_1 number_2 number_3 number_4 number_5 number_6 number_7 number_8 number_9 number_10 number_11 number_12 number_13 number_14 number_15  
age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment
```

```
test number_1 number_2 number_3 number_4 number_5 number_6 number_7 number_8 number_9 number_10 number_11 number_12 number_13 number_14 number_15
```

//number of power plants per km2

```
xtreg lifes numberkm2_* age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment  
i.kreis_id i.Year, fe vce(robust)
```

```
test numberkm2_1 numberkm2_2 numberkm2_3 numberkm2_4 numberkm2_5 numberkm2_6 numberkm2_7 numberkm2_8 numberkm2_9 numberkm2_10 numberkm2_11  
numberkm2_12 numberkm2_13 numberkm2_14 numberkm2_15 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2  
marital_d3 marital_d4 marital_d5 employment
```

```
test numberkm2_1 numberkm2_2 numberkm2_3 numberkm2_4 numberkm2_5 numberkm2_6 numberkm2_7 numberkm2_8 numberkm2_9 numberkm2_10 numberkm2_11  
numberkm2_12 numberkm2_13 numberkm2_14 numberkm2_15
```



```
}
```

```
//FOR EAST ONLY (grouping due to multicollinearity)
```

```
use $mydata//klongmerged_final_x , clear
```

```
soepkeep if region == 2
```

```
gen number_coal = number_3 + number_14
```

```
gen number_gas = number_4 + number_5
```

```
gen number_hydro = number_7 + number_9 + number_13
```

```
gen numberkm2_coal = numberkm2_3 + numberkm2_14
```

```
gen numberkm2_gas = numberkm2_4 + numberkm2_5
```

```
gen numberkm2_hydro = numberkm2_7 + numberkm2_9 + numberkm2_13
```

```
//MW
```

```
xtreg lifes oil coal gas energy1 energy6 hydroelectric energy2 energy11 energy15 energy8 energy12 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment i.kreis_id i.Year, fe vce(robust)
```

```
test oil coal gas energy1 energy6 hydroelectric energy2 energy11 energy15 energy8 energy12
```

```
test oil coal gas energy1 energy6 hydroelectric energy2 energy11 energy15 energy8 energy12 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment
```

```
//MW per km2
```

```
xtreg oil_km2 coal_km2 gas_km2 ekm2_1 ekm2_6 hydro_km2 ekm2_2 ekm2_11 ekm2_15 ekm2_8 ekm2_12 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment i.kreis_id i.Year, fe vce(robust)
```

```
test oil_km2 coal_km2 gas_km2 ekm2_1 ekm2_6 hydro_km2 ekm2_2 ekm2_11 ekm2_15 ekm2_8 ekm2_12
```

```
test oil_km2 coal_km2 gas_km2 ekm2_1 ekm2_6 hydro_km2 ekm2_2 ekm2_11 ekm2_15 ekm2_8 ekm2_12 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment
```

```
//number
```

```
xtreg number_9 number_coal number_gas number_1 number_6 number_hydro number_2 number_11 number_8 number_12 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment i.kreis_id i.Year, fe vce(robust)
```

```
test number_9 number_coal number_gas number_1 number_6 number_hydro number_2 number_11 number_8 number_12
```

```
test number_9 number_coal number_gas number_1 number_6 number_hydro number_2 number_11 number_8 number_12 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment
```

```
//number per km2
```

```
xtreg numberkm2_9 numberkm2_coal numberkm2_gas numberkm2_1 numberkm2_6 numberkm2_hydro numberkm2_2 numberkm2_11 numberkm2_8 numberkm2_12 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment i.kreis_id i.Year, fe vce(robust)
```

```
test numberkm2_9 numberkm2_coal numberkm2_gas numberkm2_1 numberkm2_6 numberkm2_hydro numberkm2_2 numberkm2_11 numberkm2_8 numberkm2_12
```

```
test numberkm2_9 numberkm2_coal numberkm2_gas numberkm2_1 numberkm2_6 numberkm2_hydro numberkm2_2 numberkm2_11 numberkm2_8 numberkm2_12 age
age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment
```

```
forvalues r = 1/2 {
```

```
use $mydata//klongmerged_final_x , clear
```

```
soepkeep if region == `r'
```

```
xtreg lifes oil coal gas energy6 hydroelectric waste energy2 energy11 energy15 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4
marital_d2 marital_d3
```

```
xtreg lifes oil_km2 coal_km2 gas_km2 energy6_km2 hydro_km2 energy1_km2 energy2_km2 energy11_km2 energy15_km2 age age2 age3 gender income_adj3 hh_children
health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment i.kreis_id i.Year, fe vce(robust)
```

```
}
```

```
*** OLS REGRESSION with individual fe only ****
```

```
use $mydata//klongmerged_final_x , clear
```

```
xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender
income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment, fe vce(robust)
```

*** OLS REGRESSION grouped (renewable vs nonrenewable) with individual, kreis and year fe ****

```
use $mydata//klongmerged_final_x , clear
```

```
//MW of installed capacity
```

```
xtreg lifes renewables2 nonrenewables age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment i.kreis_id i.Year, fe vce(robust)
```

```
forvalues r = 1/2 {
```

```
use $mydata//klongmerged_final_x , clear
```

```
soepkeep if region == `r'
```

```
xtreg lifes renewables2 nonrenewables age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3
```

```
xtreg lifes renewables2 nonrenewables age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment i.kreis_id i.Year, fe vce(robust)
```

```
}
```

```
//MW of installed capacity per km2
```

```
xtreg lifes renewables2_km2 nonrenewables_km2 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment i.kreis_id i.Year, fe vce(robust)
```

```
test renewables2_km2 nonrenewables_km2 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment
```

```
test renewables2_km2 nonrenewables_km2
```

```
forvalues r = 1/2 {
```

```
use $mydata//klongmerged_final_x , clear
```

```
soepkeep if region == `r'
```

```
xtreg lifes renewables2_km2 nonrenewables_km2 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment i.kreis_id i.Year, fe vce(robust)
```

```
test renewables2_km2 nonrenewables_km2 age age2 age3 gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d2 marital_d3 marital_d4 marital_d5 employment
```

```
test renewables2_km2 nonrenewables_km2
```

```
}
```

```
***** SUMMARY STATISTICS *****
```

```
use $mydata//klongmerged_final_x , clear
```

summarize lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3
gender income_adj2 hh_children health health_d1 health_d2 health_d3 health_d4 health_d5 marital marital_d1 marital_d2 marital_d3 marital_d4 marital_d5 employment

tab lifes

tab health

tab marital

tab employment

bysort Year: summarize lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age
age2 age3 gender income_adj2 hh_children health health_d1 health_d2 health_d3 health_d4 health_d5 marital marital_d1 marital_d2 marital_d3 marital_d4 marital_d5
employment

summarize renewables1 renewables2 hydroelectric waste nuclear conventional conventional2 nonrenewables nonrenewables2

bysort Year: summarize renewables1 renewables2 hydroelectric waste nuclear conventional conventional2 nonrenewables nonrenewables2

tabstat lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender
income_adj2 hh_children health marital, statistics(skewness p10 p25 p50 p75 p90 p95 p99)

tabstat lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender
income_adj2 hh_children health marital, statistics(skewness p10 p25 p50 p75 p90 p95 p99) by(Year)

```
summarize nonrenewables renewables2 nonrenewables_km2 renewables2_km2 number_ren number_non numberkm2_ren numberkm2_non
```

```
summarize energy* ekm2_* number_* numberkm2_*
```

```
//to capture the number of kreis that have capacity installed of an energy source, in time
```

```
//uno
```

```
forvalues e = 1/15 {
```

```
use $mydata//klongmerged_final_x , clear
```

```
quietly: soepdrop mega`e'
```

```
quietly: collapse (sum) energy`e' ekm2_`e', by(kreis_id)
```

```
count if energy`e' != 0
```

```
count if ekm2_`e' != 0 //both are the same, as they should
```

```
}
```

```
//dos
```

```
forvalues e= 1/15 {
```

```
use $mydata//klongmerged_final_x , clear
```

```
quietly: collapse (sum) energy`e' ekm2_`e', by(kreis_id Year)
```

```
forvalues y = 2011/2016 {
```

```
count if energy`e' != 0 & Year==`y'
```

```
count if ekm2_`e' != 0 & Year==`y' //both are the same, as they should
```

```
}
```

```
}
```

```
//tres
```

```
use $mydata//klongmerged_final_x , clear
```

```
quietly: collapse (sum) renewables2 renewables2_km2 nonrenewables nonrenewables_km2, by(kreis_id)
```

```
count if renewables2 != 0
```



```
count if renewables2_km2 != 0 //both are the same, as they should
```

```
count if nonrenewables != 0
```

```
count if nonrenewables_km2 != 0 //both are the same, as they should
```

```
//cuatro
```

```
use $mydata//klongmerged_final_x , clear
```

```
quietly: collapse (sum) renewables2 renewables2_km2 nonrenewables nonrenewables_km2, by(kreis_id Year)
```

```
forvalues y = 2011/2016 {
```

```
count if renewables2 != 0 & Year==`y'
```

```
count if renewables2_km2 != 0 & Year==`y' //both are the same, as they should
```

```
count if nonrenewables != 0 & Year==`y'
```

```
count if nonrenewables_km2 != 0 & Year==`y' //both are the same, as they should
```

```
}
```

```
*-----  
-----  
*****  
*****  
*****
```

```
*****ALTERNATIVE ESTIMATIONS*****
```

```
*** XTOLOGIT (RE) ***
```

```
use $mydata//klongmerged_final_x , clear
```

```
//invidual re:
```

```
xtologit lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment, vce(cluster kreis_id)
```

```
xtologit lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment, vce(robust)
```

```
//individual & region-year re:
```

```
*xtologit lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 gender  
income_adj3 health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 kreis_id##Year
```

FEOLOGIT BUC MODEL(works:

<https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=2ahUKEwi388GZo4TdAhUkDcAKHZTeBUIQFjABegQICRAC&url=http%3A%2F%2Fftp.iza.org%2Fdp5443.pdf&usg=AOvVaw2sNmUFa4yEjX0nVuxYe021>)

```
use $mydata//klongmerged_final_x , clear
```

```
capture program drop feologit_buc
```

```
program feologit_buc, eclass
```

```
version 10
```

```
gettoken gid 0: 0
```

```
gettoken y x: 0
```

```
tempvar iid id cid gidcid dk
```

```
qui sum `y'
```

```
local lk= r(min)
```

```
local hk= r(max)
```

```
bys `gid': gen `iid'=_n
```

```
gen long `id'=`gid'*100+`iid'
```

```
expand `='hk'-`lk'
```

```
bys `id': gen `cid'=_n
```

```
qui gen long `gidcid'=`gid'*100+`cid'
```

```
qui gen `dk'=`y'>=`cid'+1
```

```
clogit `dk' `x', group(`gidcid') cluster(`gid')
```

```
end
```

```
// individual fe:
```

```
feologit_buc id lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3  
gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment
```

```
*feologit_buc id lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2  
gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment, vce(cluster kreis_id) //invalid group
```

```
*feologit_buc id lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2  
gender income_adj3 health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment, vce(robust) //too much memory
```

```
// //needs to increase memory size to 5152m bytes
```

```
//individual & year fe
```

```
feologit_buc id lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3  
gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment y2011 y2012 y2013 y2014 y2015
```

```
*feologit_buc id lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2  
gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment y2011 y2012 y2013 y2014 y2015,  
vce(cluster kreis_id) //invalid group
```

```
*feologit_buc id lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2  
gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment y2011 y2012 y2013 y2014 y2015,  
vce(robust) //too much memory
```

```
// individual and region-year fe:
```

```
feologit_buc id lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3  
gender income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment , group(region_Year) noemptycells
```

```
//needs to increase memory size to 5152m bytes
```

```
*** CROSS-SECTIONAL REGRESSIONS ***
```

```
forvalues y = 2011/2016 {
```

```
use $mydata//klongmerged_final_x , clear
```

```
xtset , clear
```

```
soepkeep if Year == `y'
```

```
ologit lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment, vce(cluster kreis_id)
```

```
ologit lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment, vce(robust)
```

```
}
```

```
*** GLS REGRESSION with individual, kreis and year re ****
```

```
use $mydata//klongmerged_final_x , clear
```

```
*xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment i.kreis_id i.Year, re
```

```
xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 hh_children health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment i.kreis_id i.Year, re vce(cluster id)
```

```
xtreg lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 health_d1 hh_children health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment i.kreis_id i.Year, re vce(robust)
```

```
//reghdfe lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment, vce(cluster id) absorb(id region_Year) keepsingletons
```

```
//reghdfe lifes energy1 energy2 energy3 energy4 energy5 energy6 energy7 energy8 energy9 energy10 energy11 energy12 energy13 energy14 energy15 age age2 age3 gender  
income_adj3 health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2 marital_d3 marital_d4 employment, vce(cluster id) absorb(id region_Year) keepsingletons
```

```
//reghdfe lifes renewables1 hydroelectric waste conventional nuclear age age2 age3 gender income_adj3 health_d1 health_d2 health_d3 health_d4 marital_d1 marital_d2  
marital_d3 marital_d4 employment, vce(robust) absorb(id region_Year) keepsingletons
```

```
//xtreg lifes energy15 age age2 age3 gender income3 health marital_d1 marital_d2 marital_d4 employment, fe
```

Do-file 06: Mapping the coefficient of variation for each energy source

```
clear
```

```
set more off
```

```
*cd "\\adf\storage\M\G\MTG724\dissertation\Data visualization\Maps"
```

```
cd "C:\Users\mtgon\OneDrive\Documents"
```

```
ssc install spmap
```

```
ssc install shp2dta
```

```
ssc install mif2dta
```

```
** SOURCE FOR SHAPEFILE: https://opendata-esri-de.opendata.arcgis.com/datasets/esri-de-content::vergewaltigung-und-sexuelle-n%C3%B6tigung-kreise-2017
```

```
*shp2dta using Vergewaltigung_und_sexuelle_Nötigung__Kreise_2017, database(usdb2) coor(distcoord2) genid(id)
```

```
*use usdb2, clear
```

```
*****  
*****
```

```
*GENERATING VARIABLE for change in capacity
```

```
use mfs1e, clear
```

```
drop if Year==2017
```

```
gen mega3 =.
```

```
sort Year kreis_id energy_main2
```

```

forvalues y = 1/6 { //years

local inicio = 1 + 8020*(`y'-1)
local fin = 8020*`y'

local beg= 40101 // 1+ (8020*5)

forvalues p = `inicio'/`fin' {

local mega2016 = mega2[`beg']
replace mega3 = `mega2016'-mega2[`p'] in `p'
local beg = `beg' + 1
}
}

label variable mega3 "change in MW installed, period 201x - 2016"
browse kreis_id Year energy_main2 mega2 mega3 kreis_mix

gen lmega3 = log(mega3)

codebook mega3 lmega3
count if mega3==0

```


save mfs1f, replace

//VERIFYING that the change goes in one direction only (either continously decreases or increases throughout the years)

clear

set more off

//cd "\\adf\storage\M\G\MTG724\dissertation\Data visualization\Maps"

cd "C:\Users\mtgon\OneDrive\Documentos"

use mfs1f, clear

gen uno=.

gen negative = .

gen positive = .

sort kreis_id energy_main2 Year

forvalues t= 1/8020 { //times

forvalues y = 1/6 { //years

local p = `y' + 6*(^t-1)

local j = mega2[`p']

local pp= `p' +1

```

local k = mega2[`pp']
*local kk= `pp' - 1
*local ele = mega2[`kk']

replace uno= 1 if `k' > `j' in `p'
replace uno= 0 if `k' == `j' in `p'
replace uno= -1 if `k' < `j' in `p'
replace uno= uno[`p'-1] in `p' if `y'==6
*replace uno= uno[`p'-1] in `p' if `y'==7

}
}

forvalues t= 1/8020 { //times

local inicio = 1 + 6*(^t-1)
local fin = 6 + 6*(^t-1)

forvalues y = 1/6 { //years

local p = `y' + 6*(^t-1)

```

```
if uno[`p`] < 0 {  
  replace negative = 1 in `inicio`/^`fin`  
}
```

```
if uno[`p`] > 0 {  
  replace positive = 2 in `inicio`/^`fin`  
}
```

```
}  
}
```

```
browse kreis_id Year energy_main2 mega2 uno positive negative mega3 kreis_mix if negative == 1 & positive == 2
```

```
save mfs1f ,replace
```

```
//8 kreis do experience non uni-directional shifts in MW capacity installed, particularly in the erdgas(natural gas) and steinkohle (hard coal) industries
```

```
*****
```

```
use mfs1f, clear
```

```
set more off
```

```
drop media desv
```

```
egen media = mean(mega2) in 1/6
```

```
egen desv = sd(mega2) in 1/6
```

```
forvalues k = 0/400 {
```

```
forvalues a = 0/19 {
```

```
local i= 1 + 6*`a' + 120*(`k')
```

```
local fin= 6*(`a'+ 1) + 120*(`k')
```

```
egen media_`a'= mean(mega2) in `i'^fin'
```

```
replace media= media_`a' in `i'^fin'
```

```
drop media_`a'
```

```
egen desv_`a'= sd(mega2) in `i'^fin'
```

```
replace desv= desv_`a' in `i'^fin'
```

```
drop desv_`a'
```

```
}
```

```
}
```

```
drop coefvar
```

```
gen coefvar = (desv/media)*100 // 17934 values non-missing
```

```
tabstat coefvar, statistics( iqr p90 p95 p99 max)
```

```
// coefvar | 18.54634 77.45966 121.3975 244.949 244.949
```

```
histogram coefvar
```

```
keep if Year==2011
```

```
drop Year
```

```
label define english 1 "Waste" 2 "Biomass" 3 "Brown coal" 4 "Landfill gas" 5 "Natural gas" 6 "Geothermal" 7 "Marsh gas" 8 "Nuclear energy" 9 "Sewage gas" 10  
"Hydropower (running water)" 11 "Multiple (non RE)" 12 "Petroleum" 13 "Hydropower (pumped storage water)" 14 "Solar" 15 "Other (non RE)" 16 "Hydropower (storage  
water, not pumped)" 17 "Hard coal" 18 "Unknown (non RE)" 19 "Wind (offshore)" 20 "Wind (onshore)"
```

```
label values energy_main2 english
```

```
gen punto=.
```

```
gen punto2=.
```

```
replace punto=1 if negative==1 & positive==. //negative values
```

```
replace punto2=1 if positive==1 & negative==. //positive values
```

```
//replace punto=0 if punto == .
```

```
//replace punto2=0 if punto == .
```

```
save mfsmap, replace
```

```
***merging distcoord with puntos ***
```

```
forvalues e = 1/20 {
```

```
use distcoord2, clear
```

```
collapse (mean) _X _Y , by(_ID)
```

```
save puntos`e',replace
```

```
use mfsmap, clear
```

```
sort kreis_id
```

```
keep if energy_main2 == `e'
```

```
collapse (mean) punto punto2, by(kreis_id)
```

```
gen _ID= _n
```

```
merge 1:1 _ID using puntos`e'
```

```
keep _ID _X _Y punto punto2
```

```
sort _ID
```

```
save puntos`e', replace
```

```
}
```

```
***** MAPPING for energy sources
```

```
**maps for energy_main2==4,6,9,18,19 will be excluded in the analysis because they have no installed capacity
```

```
*for energy sources that show a decrease in MW installed throughout the years 2011-2016:
```

```
forvalues e = 1/20 {
```

```
//1,3,5,8,12,15,17
```

```
use mfsmap, clear
```

```
sort kreis_id
```

```
keep if energy_main2 == `e'
```

```
gen id= _n
```

```
spmap coefvar using distcoord2 , id(id) clmethod(custom) clbreaks(0 18 70 115 170 264.57) fcolor(Reds) point(data(puntos`e'.dta) x(_X) y(_Y) proportional(punto) size(0.7)  
shape(diamond) fcolor(blue) ocolor(black) legenda(on) leglabel(Decrease) name(map`e') saving(map`e' , replace)
```

```
}
```

```
*for energy sources that show no continuous decrease in MW installed throughout the years 2011-2016:
```

```

forvalues e = 20/20 {
//2,7,10,11,13,14,16,20
use mfsmap, clear
sort kreis_id
keep if energy_main2 == `e'
*replace coefvar = -1 if coefvar == .
gen id= _n

spmap coefvar using distcoord2 , id(id) clmethod(custom) clbreaks(0 18 70 115 170 264.57) fcolor(Reds) legenda(on) name(map`e') saving(map`e' , replace)

}

**FOR oil only (main result)

use mfs1e, clear
sum energy_main2 if energy_main2 == 12

forvalues y = 2011/2017 {
use mfs1e, clear
sort kreis_id
keep if energy_main2 == 12
keep if Year == `y'

```



```
gen id= _n
replace mega2 = . if mega2==0
spmap mega2 using distcoord2 , id(id) clmethod(custom) clbreaks(10 100 250 500 800) fcolor(Reds) legenda(on) name(oil`y') saving(oil`y' , replace)

}
```