

# Assignment 3

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## 1 Outline

*Please prepare 400-500 words on your research topic, the relevant academic literatures and a first attempt of formulating a research question.*

The United Kingdom housing energy fact file, produced for the Department for Energy and Climate Change, shows energy used by households to be the single largest source of energy use in the UK (Palmer and Cooper 2013, 5). Household energy usage accounts for 29% of energy use and CO<sub>2</sub> emissions in the UK, and as such represents a major source of potential reductions in greenhouse gas emissions (Palmer and Cooper 2013, 5). Moreover, household emissions have been identified as “low hanging fruit” due to the “potential to achieve large reductions” through actions that “require limited up-front government expenditures, generate net savings for the individual, and do not confront other barriers.” (Vandenbergh, Barkenbus, and Gilligan 2008).

This paper seeks to analyse neighbourhood household emissions data in England and Wales across time and geography in order to identify drivers of emissions and emissions trends. Differences in local environmental regulation and regulatory powers will be operationalised to analyse their effect on emissions. In addition, the effect of socioeconomic and environmental attributes of neighbourhoods will be measured. The paper will build on research which has developed a “nested typology of human settlements” to understand the “interdependence between attributes [and] their place specific contexts” (Baiocchi et al. 2015).

Based on recently available data from the last census (2011), the paper will extend Baiocchi et al’s analysis to build a fixed-effects model that should give a more detailed picture of how regulatory, socioeconomic and environmental attributes of different communities affect changes in emissions over time. Emissions data is available at the middle layer super output area (MSOA) level. These 7201 geographical units are bounded to contain between 2,000 and 6,000 households, and allow us to control for unobserved time-constant

heterogeneity by observing the effect of changes in our independent variables on our dependent variable in while holding unobserved differences geographical units constant.

If possible, the analysis in the paper could be extended by building a more detailed picture of emissions from a smart meter dataset that is also available at the MSOA level, but shows emissions per hour, rather than per year. Building on emerging energy use segmentation methodologies (Kwac, Flora, and Rajagopal 2014), policy-relevant usage patterns could be developed, and the effects of regulatory, socioeconomic and environmental attributes on shaping such patterns.

## 1.1 Research Question

How do local regulatory, socioeconomic and environmental attributes of neighbourhoods affect household emissions in different area types in England and Wales.

## 2 Literature and Theory

*Please prepare 250-400 words on the theoretical framework of your dissertation: address the theories your Master thesis will engage with and mention why these theories can help you answering your specific research question. When specifying your theoretical framework, please note which concepts are of central importance and critically reflect those.*

Household GHG emissions caused by energy use can be thought of as a function of how much energy households consume (how warm they heat the house in winter etc.), how much households employ energy-saving behaviours, and how much households employ energy-saving technologies (energy-efficient appliances, insulation for homes etc.). Each of these three drivers can be affected by further, measureable, attributes of households.

This paper categorises these attributes into three categories: regulatory, socioeconomic and environmental attributes. It aims to explore the explanatory power of these attributes on household emissions, and to generate cross-sectional models in two points in time as well as a fixed effects model to analyse changes in emission over time. Further, given that these attributes may have different effects on the different behavioural drivers, and hence the effect may be dependent on degree and on local community types, this paper seeks to use a tree regression model (Breiman et al. 1983) to assess drivers in different community types. The approach draws on *A Spacial Typology of Human Settlements and their CO<sub>2</sub> Emissions in England* (Baiochi et al. 2015), but uses new data to extend the analysis to incorporate changes in emissions over time.

### 2.1 Regulatory Attributes

More research needs to be done about what kind of data can be collected on the regulatory environment in local areas. However, a preliminary hypothesis is that where local authorities enact legislation to promote environmental sustainability, household energy emissions will be lower.

### 2.2 Socioeconomic Attributes

As both the consumption of more or less electricity and the employment of energy-saving technologies are consumption decisions, income will be a key variable in driving energy use. Preliminary analysis on the effect of income on energy consumption suggests a positive relationship, which may be due to a greater capacity to expend income on energy. However, when the dataset is broken down into local authorities, there is variation in the direction of the effect of income on energy consumption.

While a positive relationship suggests greater capacity to spend income on energy, negative effects suggest that with greater income comes a greater capacity to employ energy-saving technologies such as household

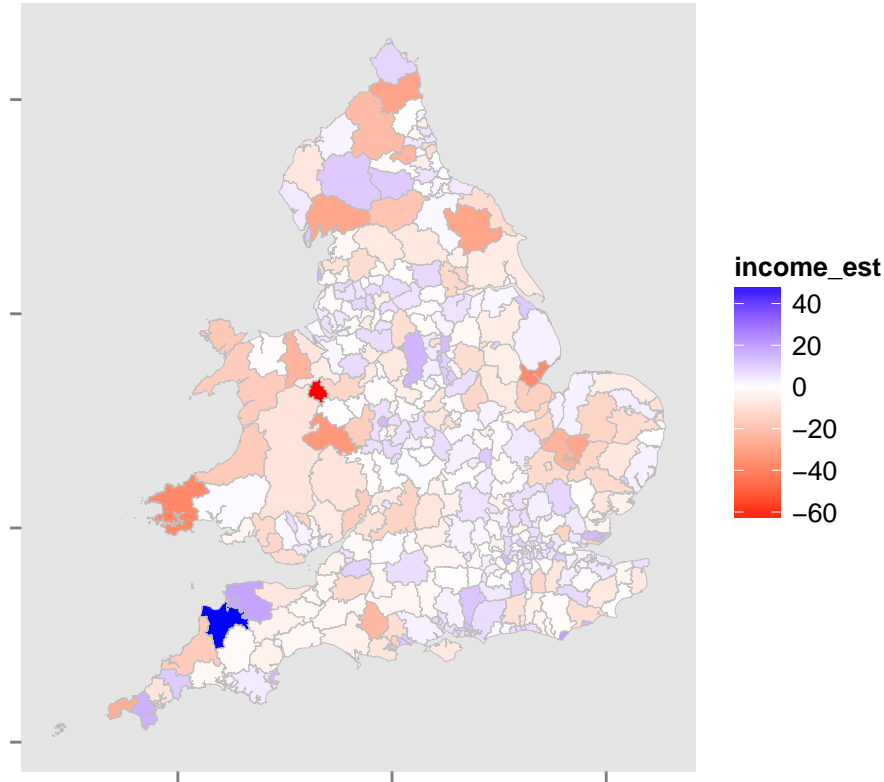


Figure 1: Income coefficient regarding energy use within each local authority

insulation. There is prima facie evidence of geographical variation on effect direction, supporting the theory that socioeconomic attributes' effects on energy emissions varies between different community types.

## 2.3 Environmental attributes

Colder regions require more energy-intensive heating, but may also incentivise the installation of more efficient housing insulation. Likewise, areas of greater housing density require less energy-intensive heating, but may disincentivise expenditure on insulation.

## 3 Concept

*Discuss the conceptualization of your main concepts. Express the concept in different words and come up with a minimal and a maximal definition of the concepts in question (Reflect on whether they are necessary and argue why they are (or why not)).*

*Describe how you will operationalization your concepts (i.e. variables)*

- *If you rely on existing data, reflect on whether the data actually matches your concept.*
- *If you will rely on new data (quantitative or qualitative) reflect which data could measure your concept*

### 3.1 Household Emissions of Greenhouse Gases

This paper looks into *household emissions of greenhouse gases*. This refers to the amount of gases that contribute to climate change that are emitted as a result of the activity of households. Though GHG emissions attributable to households may also be caused by other types of consumption, this paper takes a specific, clearly defined and more easily measurable subset of total household emissions of GHGs: those caused by the consumption of electricity and gas. Despite being a subset of total household emissions, household energy use's size is non-trivial, estimated by the government to account for 29% of CO<sub>2</sub> emissions in the UK.

Energy use by households is a concept that is directly measurable: households use a certain number of kilowatt hours of electricity and cubic meters of gas each year. This quantity is recorded on meters. Good data therefore exists to measure the concept. The paper uses data from the Office for National Statistics which reports total and average energy usage at the MSOA level.

## Literature

- Baiocchi, Giovanni, Felix Creutzig, Jan Minx, and Peter-Paul Pichler. 2015. "A Spatial Typology of Human Settlements and Their {CO<sub>2</sub>} Emissions in England." *Global Environmental Change* 34: 13–21. doi:<http://dx.doi.org/10.1016/j.gloenvcha.2015.06.001>.
- Breiman, Leo, Jerome Friedman, Richard Olshen, Charles Stone, D Steinberg, and P Colla. 1983. "CART: Classification and Regression Trees." *Wadsworth: Belmont, CA* 156.
- Hojjati, Behjat, and Steven H. Wade. 2012. "U.S. Household Energy Consumption and Intensity Trends: A Decomposition Approach." *Energy Policy* 48: 304–14. doi:<http://dx.doi.org/10.1016/j.enpol.2012.05.024>.
- Kwac, Jungsuk, J. Flora, and R. Rajagopal. 2014. "Household Energy Consumption Segmentation Using Hourly Data." *Smart Grid, IEEE Transactions on* 5 (1): 420–30. doi:[10.1109/TSG.2013.2278477](http://dx.doi.org/10.1109/TSG.2013.2278477).
- Maraseni, Tek Narayan, Jiansheng Qu, and Jingjing Zeng. 2015. "A Comparison of Trends and Magnitudes of Household Carbon Emissions Between China, Canada and {UK}." *Environmental Development* 15: 103–19. doi:<http://dx.doi.org/10.1016/j.envdev.2015.04.001>.
- Palmer, Jason, and Ian Cooper. 2013. *United Kingdom Housing Energy Fact File 2013*. Department of Energy & Climate Change.
- Vandenbergh, Michael P, Jack Barkenbus, and Jonathan M Gilligan. 2008. "Individual Carbon Emissions: The Low-Hanging Fruit." *UCLA Law Review* 55: 08–36.