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Project goals

Subsidising renewables may create a virtuous circle of adoption through the mechanisms of social contagion, which makes adoption more likely where neighbours have chosen to install a given renewable energy technology. This project aims at assessing causally the magnitude and dynamics of these peer effects in the adoption of solar energy by households and firms in Switzerland. We exploit the unique context of Switzerland, and in particular the presence of sharp language barriers and subnational variation in subsidies, to examine the role and divers of social contagion in the adoption of renewable energy.

Summary

The transition towards a greener economy requires countries to switch from fossil to renewable sources of energy. This transition has proven to be difficult due to lock-in effects. Policymakers in most developed countries are trying to foster the adoption of renewable energies and, given the important resistance to the adoption of first-best instruments such as carbon taxes (cf. Thalmann 2004; Saelen and Kallbekken 2011; Baranzini & Carattini 2014; Carattini et al. 2016; Baranzini & Carattini 2017), some European countries, including Switzerland, heavily subsidize the adoption of renewable energy. This type of policy comes with important costs, which can represent hundreds of euros per ton of CO_2 abated (cf. Marcantonini & Ellerman 2014; Marcantonini & Valero 2015; Crago & Chernyakhovskiy 2017). Over the long run, however, such subsidies may create a virtuous circle of adoption through the mechanisms of social contagion, which makes adoption more likely where the installed base is larger. The international literature shows indeed that thanks to social contagion, the likelihood of adoption of solar PV is higher in neighbourhoods where the installed PV base is larger (cf. Bollinger and Gillingham 2012; Graziano and Gillingham 2015). In principle, temporary subsidies in a given region may thus lead to a higher pace of adoption even when the financial incentive is discontinued.

This project focuses on the adoption of solar photovoltaic (PV) panels by households and firms in Switzerland. It uses spatial econometrics techniques to identify the magnitude and drivers of peer effects in the adoption of solar PV and to assess how such effects may vary in presence of policy interventions. In a second stage, we analyse how people would respond to policy measures and other types of interventions, by relying on survey data and choice-experiment techniques. More precisely, we aim at:

1. Assessing the strength and drivers of peer effects in the adoption of solar PV in Switzerland.
2. Leveraging the exogenous presence of cultural borders in Switzerland and the countrywide implementation of a feed-in tariff to measure the effect of social spillovers (or lack thereof).
3. Exploiting the subnational variation in financial supporting schemes to evaluate their effect on PV adoption.
4. Applying choice experiment techniques to identify the preferred attributes potentially leading to adoption of solar PV, including the role of policy measures and other interventions.

Work undertaken and findings obtained

Assessing peer effects in the adoption of solar PV in Switzerland

In 2016, we built on the literature review and the rich dataset that we developed in the first part of the project to assess the magnitude and drivers of peer effects in the adoption of solar panels. We published our results in July 2017 in a working paper titled “What drives social contagion in the adoption of solar photovoltaic technology?” (Grantham Research Institute on Climate Change and the Environment Working Paper 270, see Annex). The paper has been submitted for publication in an international peer-reviewed Journal and is currently in the “Revise and resubmit” status. It was presented at 6 international conferences between 2017 and early 2018: Swiss Society of Economics and Statistics; European Society of Ecological Economics; European Association of Environmental and Resource Economics; Association of Environmental and Resource Economics; European Economic Association, American Economic Association. It has also been presented in seminar series at the universities of Stirling, United Kingdom, and Verona, Italy.

In our paper, we address the following main questions: How do peer effects work in practice? Do they apply in the same way to all types of solar panels? Do they emerge only for residential adopters, does contagion also work for firms, and between households and firms? While the literature has so far focused on residential solar PV adoption only, we also examine the behaviour of firms and farms. In addition, we investigate in detail the impact of PV characteristics, such as size and type, on the magnitude of social spillovers. Our approach works as follows. We model the number of new PV adoptions in a municipality during a quarter as a function of the average installed PV systems around them, using different radii to take into account the effect of distance. For each geocoded PV installation in the database, we count the number of pre-existing installations, at the time of the decision to adopt. By exploiting the lag between the time of the decision to adopt and the time of installation, we apply the identification strategy of Bollinger and Gillingham (2012), crucial to address the issue of reflection (Manski, 1993). We address the issues of homophily, and confounding from correlated unobservables, by enriching the model with municipality-specific and quarter-specific fixed effects, as well as interaction dummies between cantons, the administrative units composing the Swiss federal state, and quarters. In addition, we incorporate time-varying socio-economic controls and detailed location characteristics to account for spatial and temporal heterogeneity.

We find that distance is an important determinant of social contagion: PV systems installed further away show persistently lower impact on the adoption of new PV systems than the nearest ones. In line with Graziano and Gillingham (2015), we find that the oldest nearby installations have a lower impact in the adoption choice than the most recently built PV systems. Besides providing new evidence about the influence of spatially close, pre-existing PV systems on the adoption decisions of residential owners, our analysis reveals that firms and farms also react to neighbouring PV panels, although in a lesser extent than households do. On average, an extra PV installation within 1 km increases the number of residential adoptions in the municipality by 0.11 installations per quarter, and by 0.09 for commercial adoptions. Addressing our main research questions, we investigate the variation of social spillovers across ownership, size and type of the solar panels. Our results show that, everything else equal, social contagion is primarily due to similar ownership, i.e. firms (farms) are mainly influenced by the nearby firm-owned (farm-owned) installations. Furthermore, we observe that large PV systems impact adoptions more heavily than smaller ones. In addition, we find that adoptions are more heavily stimulated by the most visible PV systems. By combining the analysis of ownership, size and type, our study contributes to the understanding of the drivers of social contagion. Our results shed new light on the specific mechanisms behind social contagion in adoption of solar panels. Our evidence complements that of Narayanan and Nair (2013) on hybrid cars, who find with data for California that peer effects work only for Toyota Priuses, and not for the other hybrid model in their data, the Honda Civic Hybrid, suggesting an important role for visibility effects (see also Sexton and Sexton 2014).

The impact of cultural borders in the diffusion of solar PV

The literature shows that social spillovers are an important driver of technology adoption in general (e.g. Arndt, 1967; Bass, 1969), and of solar PV in particular (e.g. Graziano and Gillingham, 2015; Rode and Weber, 2016). Previous studies have also highlighted the localized nature of social spillovers. However, social spillovers may be hampered by the presence of cultural barriers. That is, residents of municipalities adjacent to a language border may benefit less from social interactions with PV owners located on the other side, which may reduce the exchange of information on the technology. In presence of a cultural barrier, the pool of individuals from which to learn, at a given distance, may be smaller, limiting the power of social spillovers to address information asymmetry and reduce uncertainty on investments in solar energy.

Switzerland offers the ideal framework to analyse the effect of cultural borders on the adoption of solar PV. Language groups live in geographically distinct regions separated by sharp language borders that are exogenous to the implementation of federal policies promoting the adoption of solar PV. In 2008, Switzerland introduced a countrywide feed-in tariff for the electricity generated from solar PV systems. By strongly modifying the profitability of PV installations, the new support scheme created a major shock to the solar PV market. We exploit the combination of these two factors to identify the role of cultural borders in affecting social spillovers and the adoption of a clean technology.

We base our analysis on the dataset provided by SFOE, which we completed with socio-economic characteristics related to the adoption of solar installations, such as age, income, level of unemployment, and green preferences, and a second set of variables measuring contextual factors that may be linked to the feasibility and profitability of PV installations, such as the type of building and solar radiation. We identify the boundary between French- and German-speaking parts as the most suitable for our research question, because it crosses Switzerland from North to South for about 270 km along regions with a large variability of population density and topography. Natural barriers are also absent from most of the boundary. Importantly, about half the length of the French-German border is located within bilingual cantons (Fribourg, Bern and Valais), which allows us to focus on the language border while keeping institutional features constant.

To perform our analysis of impact of the border on PV adoption, we first need to precisely identify the location of the language border. Then, we compute the distances of each PV installation to the border. To define the language border, we thus combine two datasets. The first dataset, provided by the Swiss federal statistical office, contains data on the most widely used national language at home by permanent residents. We use municipal data for 2016, municipalities representing the finest level at which this information is available. The second dataset is produced by the Swiss office of topography (swisstopo), and includes georeferenced data of municipalities boundaries. Based on these data, we identify municipalities as either French- or German-speaking. After having identified all pairs of contiguous municipalities whose main language is different from each other (one French- and one German-speaking), we obtain the language border as the line generated by the shared borders of these municipalities. For more precision, we increase the resolution of Swisstopo's spatial data to have at least one geographical point every 50 meters along the language border. Having established the spatial separation between the two linguistic regions, we can compute the distances between the location of each PV installation and the closest border point. We aggregate these measures at the municipality level to obtain the mean Euclidean distance to the border for all PV installations located within a municipality. Starting from 2,289 municipalities, we select 733 municipalities whose PV installations are located on average less than 25 km away from the language border. This leaves us with 18,960 PV installations.

Preliminary results show that the language border hampers the diffusion of solar PV. All else being equal, we observe a positive correlation between the number of adoptions in a municipality and the mean distance of these installations from the border. That is, compared to regions further away from the border, we find a relative depression in the uptake of solar PV in proximity to the border. We further investigate the causal origin of this spatial pattern. In the spirit of difference-in-differences with heterogeneous effects, we explore the effect of the language border on the adoption of solar PV after the implementation of a feed-in tariff that in 2008 strongly modified the financial profitability of PV. We confirm that the language border does cause a divergence in uptake. Municipalities located in the proximity of the border experience a lower rate of adoption than others located further away. A placebo test confirms that this pattern emerges with the implementation of the feed-in tariff. This effect is, however, moderated by the language skills of a municipality's population. The effect of proximity to the border is much stronger for municipalities whose population is in large part not familiar with the language of the other side. The effects that we measure are persistent over time, and consistent with the role of localized social spillovers in the adoption of clean technologies.

The role of local subsidies and other supporting schemes

In this part of the project, we aim at evaluating the effect of subnational subsidies and other supporting schemes on the adoption of solar PV. During 2016 and 2017, we performed an extensive research on the existing data provided by private companies, Swissolar, Energiefranken (Faktor Verlag AG) and Subventionsbatiment (Docu Media Suisse Sarl). We came to the conclusion that these sources are not exhaustive. Moreover, historical data are not readily available. Hence, we decided to build a dataset ourselves – as part of the contribution of this project. We thus contacted the 26 Cantonal Energy Offices using a web-based survey to facilitate data collection. We collected data on fiscal deductions, cantonal subsidies and municipal subsidies.

Preferences for solar PV

We designed a discrete choice experiment (DCE) to identify the preferred attributes potentially leading to the adoption of solar PV by firms. The survey was tested on about 100 Geneva-based firms. The final survey was developed in collaboration with SATISCAN Sàrl, a Geneva-based marketing firm. The survey is currently underway and we expect to receive the data by March 2018.

In the DCE part of the survey, firms are asked 12 times to choose among 3 option: two alternative PV installations or no (new) PV (status quo). PV installations differ from one another by their technical and financial characteristics. We interviewed several PV installers and experts to determine the relevant attributes and levels. We selected the following four attributes: the type of mounting system; the existence of a digital display screen; the annual cash flow; and the net price.

The inclusion of attributes such as the type of mounting system and digital display screens are consistent with our interest in aesthetics and reputational effects. The levels of the attributes "cash flow" and "net price" are set to replicate the financial effects of leasing, capital subsidies, and feed-in-tariff. Besides the analysis of which attributes are the most relevant for firms, the survey also includes questions aimed at confirming the influence of peers (other spatially close firms, direct competitors, etc.) in the adoption choices.

National cooperation

Point 3 of our project requires data about subnational subsidies for solar PV. These subsidies are provided at different administrative levels, i.e. at the municipal, cantonal, and, of course, federal level. Given this important heterogeneity, we contacted several companies to obtain information on solar subsidies, i.e. Swissolar, Energiefranken (Faktor Verlag AG), and Subventionsbatiment (Docu Media Suisse Sarl). We completed existing information by contacting all the 26 Swiss Cantonal Energy Offices to answer our web-based survey on cantonal and municipal solar PV subsidies programmes.

At our request, we also obtained specific databases from the Swiss federal statistical office (FSO), from the Federal office for meteorology and climatology (MeteoSwiss), and from www.toitsolaire.ch, a joint project between MeteoSwiss, the Swiss federal office of topography (swisstopo) and the Swiss federal office of energy (SFOE).

From an academic perspective, we note that Martin Péclat is now enrolled in the PhD programme in Economics of the University of Neuchâtel. His PhD Thesis on solar PV adoption in Switzerland is supervised by prof. Milad Zarin Nejadan, University of Neuchâtel, and prof. Andrea Baranzini, HEG Geneva.

International cooperation

Stefano Carattini is currently Postdoctoral Fellow at Yale University and part of the research group of Professor Kenneth Gillingham. Kenneth Gillingham wrote some of the seminal papers on peer effects in the adoption of solar PV in the USA and developed the methodology that we use in our project.

Outlook for 2018

The very rich database that we created allows us to perform points 1, 2 and 3 of the project. Our results show that there are peer effects in the adoption of solar PV in Switzerland and that cultural borders hampers the extent of social spillovers. Those results represent the pillars of our project, on which we build for the continuation of our research programme. The outlook for 2018 is the following:

1. Submit the revised version of the paper "What drives social contagion in the adoption of solar photovoltaic technology?" (planned for Spring 2018).
2. Leveraging the presence of cultural borders within Switzerland to assess their implications on social spillovers. Preliminary version of the paper completed in early 2018 and submitted to the main conferences in the field for the summer conference season. Working paper version available planned for summer 2018.

3. Completing the empirical analyses taking advantage from the particular context of Switzerland, in particular exploiting the subnational variation in subsidies to evaluate the effect of temporary and continued subsidies. Preliminary version of the paper beginning 2019 (expected).
4. Analyse data from the DCE survey on firms to identify the preferred attributes potentially leading to the adoption of solar PV in the private sector. Preliminary version of the paper in Fall 2018 (expected).
5. Design the DCE survey on households to identify the preferred attributes potentially leading to the adoption of solar PV by residential customers. Administration of the survey expected for Fall 2018.

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