Social Effects in the Diffusion of Solar Photovoltaic Technology in the UK

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Source: SolarGIS © 2014 GeoModel Solar


Source: Richter, 2013

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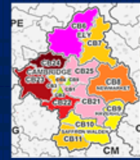


Source: Royal Mail, Richter, 2013

Motivation:

Solar Energy & the Economy:

- Solar PV is vital for a decentralized energy system as part of a low-carbon economy
- Self-generation turns consumers into "pro-sumers"
  - incentive structures change
  - new ownership & business models emerge
- Feed-In-Tariffs (FITs) are proven instrument to promote solar PV
  - threefold financial benefits for adopters
  - re-distributional impacts: from non-adopters to adopters "Reverse Robin Hood tax" if adopters mainly high income


Source: Richter, 2014

Solar Energy & the Society:

- Non-financial factors matter for adoption, too:
  - non-financial barriers such as warranty issues
  - non-financial drivers like social effects via word-of-mouth & observational learning
- Observational learning in solar PV adoption:
  - solar PV panels are visible for passers-by
  - this reduces uncertainty surrounding the technology
  - observational learning can lead to spatial adoption clusters
- Exploiting channels such as social effects could push adoption
  - especially among more risk-averse groups of the population

If social effects in adoption exist, targeted interventions could exploit them to promote diffusion & possibly mitigate re-distributional impacts of FITs.

Econometric Model:

- Measure of appetite for solar PV panels: adoption rate $y_{zt} = \frac{Y_{zt}}{n_{zt}}$
  - Y_{zt}: number of *new* installations in neighbourhood *z* in month *t*
  - n_{zt}: number of owner-occupied households in *z* in *t*
- Measure of social effects: installed base in neighbourhood $b_{zt} = \sum_{\tau=1}^{t} Y_{z\tau}$
  - b_{zt-3}: cumulative number of solar PV installations in *z* by the end of *t*

Main equation:

$$y_{zt} = \alpha_t + \beta \cdot b_{zt-3} + \underbrace{\alpha_{zq} + \epsilon_{zt}}_{u_{ztq}}$$

- 3 types of unobservables to focus on the effect of interest β: α_t, α_{zq}, ϵ_{zt}
- α_{zq}: why time-*varying* fixed effects and why fixed on neighbourhood-*quarter*?
  - control for neighbourhood specific characteristics that vary over time
  - address endogeneity (e.g. due to self-selection & OVB)
  - avoid perfect collinearity with lagged installed base b_{zt-3}

Third lag of installed base captures technology-specific time lag between the *decision* to adopt and the *completion* of the solar PV installation.

Identification & Estimation:

- To fully eliminate the neighbourhood-quarter effects α_{zq} drop first month of each quarter and run POLS on the first differenced equation:

$$\Delta y_{zt} = \Delta\alpha_t + \beta\Delta b_{zt-3} + \Delta\epsilon_{zt}$$

Feed-in-Tariffs (FITs) surely do...

...but what else feeds the British appetite for solar PV panels?

The neighbours' fittings?

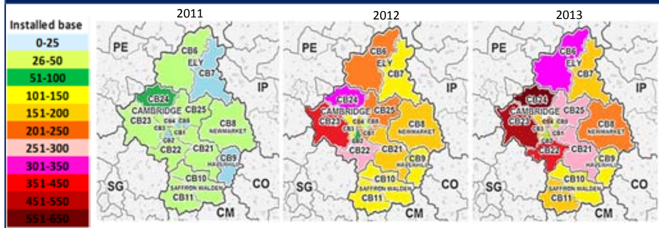
Yes.

And community projects could fuel the scale!

Data:

- Central FIT Register, April 2010 - March 2013 (DECC, 2013):
  - registers all micro-generation installations in the UK since the introduction of the FIT
  - provides individual identifier, location (postcode district), capacity & completion date
- Neighbourhood Statistics, Census March 2011 (ONS, 2013):
  - neighbourhood characteristics for 2,269 postcode districts in England & Wales
  - e.g. number of owner-occupied households, social class, tenure, deprivation level, education…
- Analysis: only postcode districts with at least 1 domestic solar PV system considered (2,239 districts)
  - a postcode district consists of on average 6,629 owner-occupied households
  - the average installed base in March 2010 & 2013 was 3 & 148 panels per postcode district, respectively

Cleaned data set: 332,216 domestic solar PV installations in 2,239 postcode districts.



Installed base in the CB postcode area (illustrative example) in March 2011, 2012, 2013.
Source: Ordnance Survey & Royal Mail, own calculations.

The maps show clustering of solar PV installations within postcode districts, using Cambridge as an example.

The clusters could be due to contextual factors or social effects. While the former do not induce social multipliers, the latter do.

The analysis finds that social effects drive diffusion.

Main Results:

1) 1 new PV panel in a neighbourhood increases the adoption rate 3 months later by 7.48 x 10^{-6}

The adoption rate of solar PV technology *is* affected by social effects as measured by the installed base in the neighbourhood.

- at the average adoption rate of 0.0007 installations per owner-occupied households per month this implies a 1% increase of the adoption rate
- at the average installed base & average installation rate, the installed base elasticity is 0.71: a 1% increase of the installed base increases the adoption rate by 0.71%
- at the average number of 6,629 owner-occupied households, 20 new panels in a neighbourhood-month cause 1 new adoption 3 months later via social effects alone

2) Less affluent neighbourhoods show stronger social effects
  - for risk-averse late adopters observational learning is more important (Rogers, 1962)

The neighbours' solar PV fittings have a positive (& significant) impact on the adoption rate. Highly visible community solar panel installations could promote adoption.

Robustness:

Heterogeneous Social Effects:

- Social effects are decreasing with the size of the installed base & over time
- Social effects are stronger during months of announcements of FIT cuts

Testing Different Lags:

- Social effects are effective in a narrow time window (2 to 3 months)

Redefining Neighbourhoods to 347 Local Authorities:

- Social effects are less pronounced on a more localized level

Limitations & Further Research:

- Social effects are assumed to spread within defined neighbourhoods only
  → spatial econometric methods could allow for more diverse spillovers, e.g. across borders
- Findings are consistent with social effects and observational learning
  → but household level data could improve analysis
- If inertia in decision process leads to partial adjustment, results could be confounded
- What is the impact of solar PV technology on electricity demand load curves?

Social effects are heterogeneous & particularly strong for "classic late-adopters" (Rogers, 1962).

Conclusion:

- ✓ First econometric analysis of diffusion of solar PV technology in the UK
- ✓ Empirical evidence for social effects in the adoption of solar PV technology
- ✓ Results are consistent with significant positive social effects
- ✓ Social effects vary over time & are stronger on a more localized level
- ✓ Less affluent neighbourhoods show stronger social effects

The adoption rate of solar PV technology *is* affected by social effects.
These effects are particularly relevant in deprived neighbourhoods.
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Targeted interventions such as community projects could promote diffusion & mitigate re-distributional effects of FITs!

Thank you.

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