How to get photovoltaics on the roofs?

Empirical evidence on the public support for a residential solar mandate in Germany

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Background and Motivation

- Globally, the expansion of solar photovoltaic (PV) has mainly been driven by economic incentives such as feed-in-tariffs, -premiums or subsidies (e.g., Best et al., 2019; Jacksohn et al., 2019).
- Germany has set the goal to install 22 GW of PV annually to reach an installed capacity of 215 GW by 2030.
- Recently, solar mandates are being discussed and implemented, e.g., in Italy, California (USA), and Tokyo (Japan).
- Some German federal states are introducing solar mandates for non-residential buildings such as parking lots or office buildings, but no nationwide mandate exists.

This paper

Tries to answer the following questions:

- What explains homeowners' past and future decisions (not) to invest in solar PV?
- What explains homeowner's support (or opposition) of a solar mandate for residential buildings?
- Are homeowners that already own a solar PV system more likely to support a solar mandate?

Literature

We build on the findings of three recent overview studies on the determinants of public support for climate policy: Drews and van den Berg (2015), Bumann (2021), and Bergquist et al. (2022). They find that...

- ... the perception of **policy design elements** such as perceived fairness and effectiveness are among the most important determinants of public support.
- ... other factors such as **climate change perceptions and social norms** also influence public support.
- ... **socio-demographic factors** do not influence support as much.

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Dependent variables

In our study, we use the following dependent variables:

- Ownership of a solar PV system [yes/no]
- Intention to install a solar PV system [yes/no]
- Support of solar mandate [yes/no]
- Perceiving solar mandate as ecologically effective [yes/no]

Solar mandate: Homeowners are obliged to install a solar PV system on their rooftop in the case of a roof renovation.

Sample: ∼1,300 German homeowners that are (co-)decision-makers in their households.

Explanatory variables

Concept	Variable
Technology-specific beliefs & attitudes (Solar PV)	Perceived return advantage Perceived cost hedging Perceived environmental benefit Perceived autarky effect Trust in PV installer Aesthetic perception
Social norms	Perceived social desirability PV in neighbourhood
Economic preferences	Risk preferences Patience ...
Respondent characteristics	Age Gender ...
Financial factors	Household Income Sufficient available funds

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Solar mandate support & perceived effectiveness

- A solar mandate for residential buildings is a rather unpopular measure among homeowners.
- The support for a solar mandate seems to be tied to perceived environmental effectiveness.

		Support for solar mandate	
		Yes	No
Perceived effectiveness	High	35.0%	22.3%
	Low	2.5%	40.1%
	Total	37.5%	62.5%

Table 1: Distribution of support and perceived effectiveness

AMEs from binary probit models [1]

	Model 3: Support for solar mandate	Model 4: Perceived effectiveness of solar mandate
Perceived effectiveness of solar mandate	**0.445*** **	
	(0.024)	
PV ownership	**0.071*** **	-0.023
	(0.024)	(0.029)
Perceived return advantage	0.032	0.035
	(0.026)	(0.033)
Perceived cost hedging	0.011	**0.125*** **
	(0.032)	**(0.036)**
Perceived environmental benefit	-0.016	**0.197*** **
	(0.044)	**(0.044)**
Perceived autarky effect	-0.028	-0.013
	(0.028)	(0.031)
Trust in PV installers	**0.071*** **	**0.116*** **
	(0.024)	**(0.028)**
Aesthetic perception	**0.054** **	-0.009
	(0.023)	(0.026)

AMEs from binary probit models [2]

	Model 3: Support for solar mandate	Model 4: Perceived effectiveness of solar mandate
Perceived social desirability of PV expansion	**0.068*** **	0.031
	(0.022)	(0.026)
PV in neighborhood	-0.007	0.024
	(0.027)	(0.029)
EUR 30,000 available without credit	0.012	0.023
	(0.023)	(0.027)
Economic preferences	Yes	Yes
Political identification	Yes	Yes
Respondent characteristics	Yes	Yes
N	1334	1334

Notes: Average marginal effects from binary probit models.
Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 2: Regression results on support and perceived effectiveness of a solar mandate

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Discussion

- We find that a solar mandate is a rather unpopular policy measure among German homeowners.
- Perceived environmental effectiveness of a solar mandate is strongly correlated with its acceptance (potential bidirectional link).
- While support is not explained by technology-specific beliefs, the perceived effectiveness is strongly correlated with beliefs about cost-hedging abilities and environmental benefits of residential PV systems.
- In line with the literature, we find that socio-demographic factors do no play a large role in the perception of a solar mandate.

Limitations and future research

- Even though our sample consists of those affected by the policy, it is not representative for the German population.
- Future research could include questions regarding knowledge about existing subsidies (Palm and Lantz, 2020).

Comments and Questions (Thank you!)

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Robustness checks and Extensions

- Different econometric approaches
  - Ordered probit models
    - 3-point dependent variables
    - 5-point dependent variables
- Different model specifications
  - Omitting perceived effectiveness from support model (potential bidirectional link between support and perceived effectiveness)
  - Stepwise regressions

Survey and Sample

- The survey as well as some relevant survey items were jointly developed with three German utilities and conducted in summer of 2023.
- A pilot study with ∼500 participants was conducted in the end of 2022.
- The sample consists of ∼1,300 German homeowners that are (co-)decision-makers in their households investment decisions.

Literature

Determinants of solar PV adoption

Literature on homeowners' investment behavior in solar PV has identified several factors determining the likelihood of investing in solar PV:

- The main driver for solar PV adoption is often found to be an economic incentive (e.g., Best et al., 2019; Jacksohn et al., 2019)
- In comparison, the role of environmental concerns is not as clear (e.g., Ruokamo et al., 2023; Schelly and Letzelter, 2020).
- Other factors such as social norms (e.g., Petrovich et al., 2019), trust in solar PV companies (e.g., Schelly and Letzelter, 2020), and aesthetics (Corbett et al., 2022) have also been found to affect investment decisions.
- Finally, available financial resources have been emphasized as a relevant factor because of the large amount of money required to invest in solar PV (Best et al., 2019; Petrovich et al., 2019).

Results: PV ownership and intention to install

Regarding the determinants of PV ownership, we mostly confirm previous findings:

- PV ownership is determined by economic factors such as a belief in a good return rate.
- Building characteristics such as a south-facing roof and ownership of related technologies (heat pump, electric vehicle) are positively correlated with PV ownership.
- Aesthetic perceptions, trust in relevant actors, and social norms are correlated with PV ownership.
- Lastly, we find that technology-specific beliefs about autarky, cost hedging capabilities and environmental benefits do not explain past PV adoption.

Quote etc.

"Write your Quote here."

Example

(1) Don't agree at all – (5) Agree completely; [Don't know]

Additional; don't use often

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