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Seductive subsidies? An analysis of second-degree moral hazard in the context of solar systems

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Introduction

Motivation i

- Tens of billions spent for subsidies for energy-transforming technologies (International Energy Agency, 2016)
- **Credence component** (Giraudet et al., 2018; Giraudet, 2020; Lanz and Reins, 2021)
  - **Asymmetric information**
  - Limited **Verifiability** or **Liability**
- Inefficiencies: **inflated costs, bad workmanship (shirking)** (Dulleck and Kerschbamer, 2006; Emons, 1997; Dulleck et al., 2011)
- Documented in the context of solar systems (Podolefsky, 2013; Trabish, 2013)

Motivation ii

- **Second-degree moral hazard:** impulse of supply-side to increase prices and/or reduce labor input when consumers receive third-party reimbursements (Kerschbamer et al., 2016; Huck et al., 2016; Balafoutas et al., 2017; Christensen et al., 2020)
- **This paper:** quantifies the impact of subsidy levels on total costs and electricity output of solar systems in California
- Instrumental variable strategy to address potential concerns about the endogeneity of actually implemented subsidy levels

Outlook results

- Larger subsidy levels are associated with a cost increase when customers receive unconditional upfront subsidies as compared to output-based subsidies
- Stricter verification rules reduce costs
- Particularly pronounced when third-parties own the solar system and thus receive the subsidy
- Costs are larger for government customers and lower for non-profit customers

CSI program description

Program description

- Rolled out in 2007, $2.167 million to install 1940 mW within 10 years in three IOUs
- Subsidy level determined by cumulative capacity in IOU
- Upfront (residential systems <30kW) and output-based subsidies (commercial systems >30kW)
- Output-based more robust?
  - Dispersed and discounted payments
  - Direct incentives and larger verifiability of electricity output - spillovers

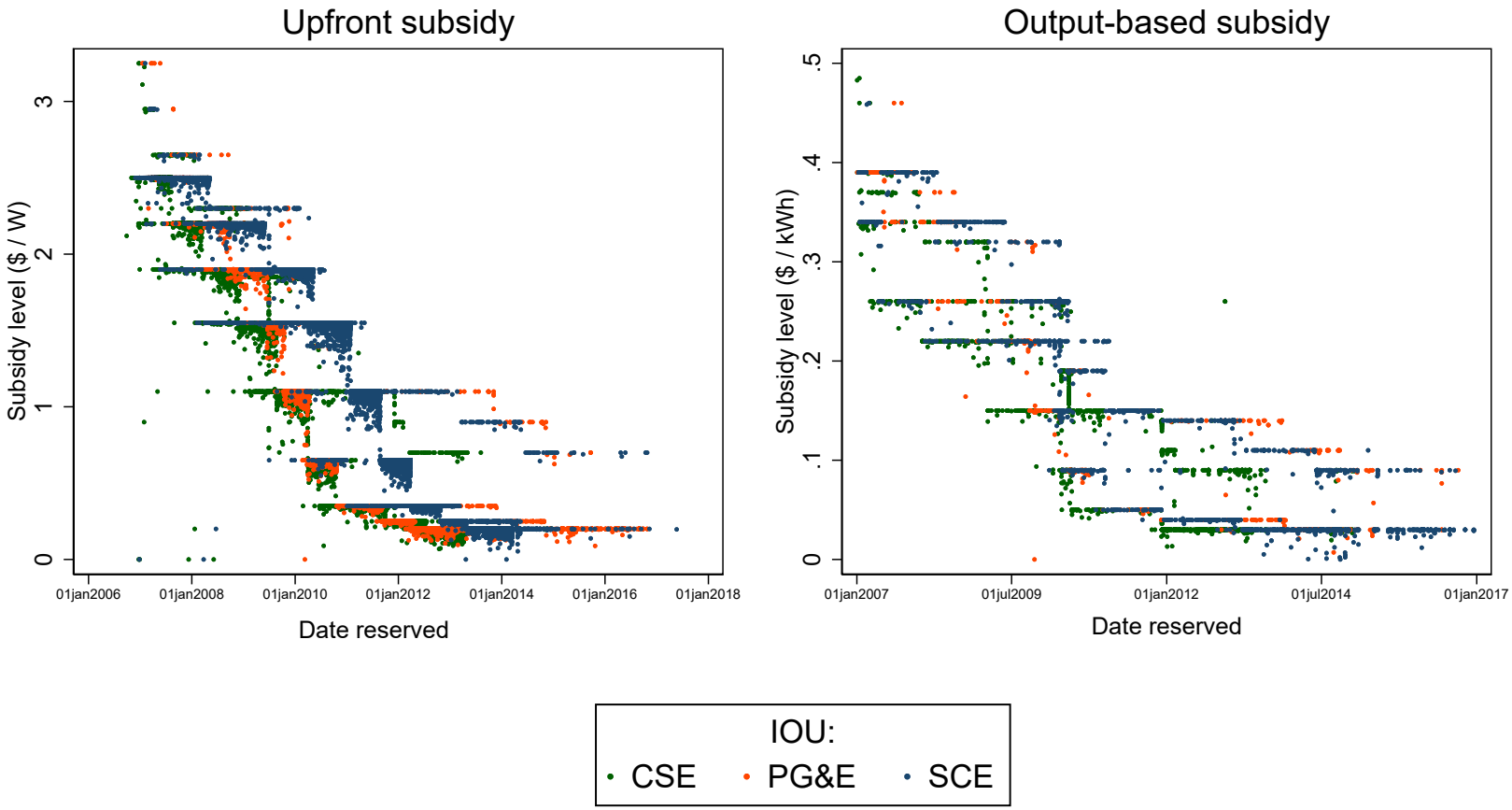
Table 1: CSI subsidy levels

		Upfront ($ per Watt)		Output-based ($ per kWh)	
mW Step	**MW in step**	**Residential/ Commercial**	**Gov't/ Nonprofit**	**Residential/ Commercial**	**Gov't/ Nonprofit**
1	50	n/a	n/a	n/a	n/a
2	70	2.5	3.25	0.39	0.5
3	100	2.2	2.95	0.34	0.46
4	130	1.9	2.65	0.26	0.37
5	160	1.55	2.3	0.22	0.32
6	190	1.1	1.85	0.15	0.26
7	215	0.65	1.4	0.09	0.19
8	250	0.35	1.1	0.05	0.15
9	285	0.25	0.9	0.03	0.12
10	350	0.2	0.7	0.025	0.088

Notes: Table 4 of California Public Utilities Commision (2017)

Program description ii - Development of subsidy levels

Figure 1: Evolution of subsidy levels



Notes: Upfront and output-based subsidy levels over time and IOU's.

Program description iii - Summary statistics

Table 2: Summary statistics

Panel A:					**Upfront subsidy**					
Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mean subsidy level ($/W)	2.40	2.02	1.58	1.03	0.60	0.30	0.21	0.20	0.21	0.22
Min subsidy level ($/W)	0.90	0.20	0.65	0.89	0.20	0.07	0.07	0.05	0.08	0.15
Max subsidy level ($/W)	3.25	2.65	2.30	2.30	1.55	1.10	1.10	0.90	0.70	0.70
Mean cost per Watt ($/W)	8.2	8.3	7.8	7.1	6.6	5.4	4.9	4.5	4.4	4.3
Mean total cost in 1000 $	51.5	46.6	44.2	39.0	35.1	32.2	31.0	29.9	32.7	33.3
Mean size in kW	6.4	5.7	6.1	5.8	5.6	6.1	6.5	6.8	7.8	8.1
Mean number of modules	34	30	30	27	25	24	25	25	28	29
Mean number of inverters	1	1	2	4	5	6	8	8	11	9
Mean previous systems	122	462	608	995	1557	3010	4722	5331	3540	5417
First two=1	9.0	4.4	5.4	3.6	1.9	1.0	1.1	0.9	1.8	1.6
Mean designfactor	0.95	0.94	0.94	0.94	0.95	0.94	0.94	0.95	0.95	0.96
TPO=1	7.1	14.4	14.4	30.9	53.1	71.9	66.7	57.6	40.4	35.6
Commercial	2.8	2.8	1.2	1.8	1.0	0.9	0.8	2.2	4.4	10.6
Government	0.6	0.6	1.1	0.4	0.8	0.6	0.1	0.1	0.0	0.7
Non-profit	1.1	0.7	0.5	0.5	0.3	0.2	0.2	0.9	3.2	2.5
Residential	95.5	96.0	96.6	97.3	98.6	98.9	98.9	96.8	92.4	86.3
Observations (141,792)	6,477	9,701	13,334	18,994	21,692	31,691	30,416	5,677	498	160
Panel B:					**Output-based subsidy**					
Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mean subsidy level ($/kWh)	0.35	0.28	0.24	0.15	0.09	0.06	0.06	0.05	0.05	0.04
Min subsidy level ($/kWh)	0.23	0.16	0.09	0.04	0.02	0.01	0.01	0.00	0.02	0.01
Max subsidy level ($/kWh)	0.49	0.39	0.34	0.32	0.26	0.26	0.14	0.11	0.11	0.09
Mean cost per Watt ($/W)	7.8	7.6	6.8	5.5	5.0	4.4	3.9	3.4	3.2	2.9
Mean total cost in 1000 $	2107.3	1523.4	1433.1	1556.6	1196.9	1013.7	813.8	1220.5	1215.0	1055.4
Mean electricity output (mWh)	39.2	28.3	32.5	40.7	36.1	33.1	30.2	48.3	59.6	47.6
Mean conversion efficiency (kWh/W)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.12	0.12
Mean size in kW	295.2	213.6	245.6	302.3	265.7	253.0	235.0	379.0	478.2	403.0
Mean number of modules	1471	1046	1195	1258	1046	919	819	1260	1978	1257
Mean number of inverters	2	3	3	18	5	14	34	39	17	26
Mean previous systems	34	150	229	640	1758	1624	2166	3036	763	4473
First two=1	10.4	6.4	7.3	7.4	4.6	3.9	3.9	4.3	5.0	3.5
Mean designfactor	1.03	1.02	1.00	0.98	0.97	0.95	0.96	0.99	0.99	0.98
TPO=1	51.4	33.1	21.0	37.6	28.2	31.5	39.7	36.2	15.1	30.6
Commercial	55.6	37.7	33.0	30.9	39.1	41.0	39.5	53.1	63.9	64.7
Government	15.3	21.5	23.4	54.4	44.3	47.8	44.0	34.9	21.9	24.7
Non-profit	2.9	6.1	4.9	6.4	8.5	7.9	14.2	10.6	14.3	10.6
Residential	26.9	34.7	38.7	8.3	8.1	3.3	2.3	1.5	0.00	0.00
Observations (4,474)	385	324	385	1,017	503	546	570	538	119	85

Notes: Averages over year by subsidy type. I do not report summary statistics for 2006 and 2017 because there were only a few applications in these years.

Identification strategy

Identification strategy i - OLS

$$Y_i = \alpha + \beta_i s_i + \varphi_u + \delta_k + \omega_c + \varsigma_f + X_i\phi + \mu_t + \epsilon_i \quad (1)$$

- Y_i cost or electricity output per Watt (design factor) for system i (Pless and van Benthem, 2019)
- s_i subsidy level for system i
- φ_u IOU FE, δ_k county FE (Gillingham et al., 2016)
- ω_c installer FE
- ς_f technology FE (make and model of modules and inverters) (Pless and van Benthem, 2019)
- X_i vector of control variables: number of modules and inverters, indicator of j_{th} system by installer (Bollinger and Gillingham, 2014), age of system i
- μ_t monthly FE
- ϵ_i is a random error term
- Standard errors clustered at zip code level (Pless and van Benthem, 2019)

Identification strategy ii - IV

- Potential issue: difference in predetermined and actual subsidy levels could indicate installers are able to influence subsidy-levels and self-select into specific subsidy level
- Exploit plausibly exogenous variation of the predetermined subsidy level as part of an IV
- Instrument:

$$Z_i = \textit{predetermined } s_i \tag{2}$$

- First stage:

$$s_i = \eta + \theta Z_i + \vartheta_u + \iota_k + \kappa_t + \xi_c + \varrho_f + X_i\tau + \nu_i. \tag{3}$$

Identification strategy iii - Robustness

- Drop applications in +- week vicinity os subsidy level drop date (Hughes and Podolefsky, 2015; Pless and van Benthem, 2019)
- Additionality: Cost per Watt with nameplate, control for designfactor
- Self-installed systems
- Propensity score matching
  - Exact matching on technology and quarter installed
  - Systems receiving a subsidy levels larger above the median as treated (i.e. $D_i = 1$)
  - ATT: $\Delta^{TT} = E[Y_{it}(1) - Y_{it}(0) \mid D_i = 1]$, where $Y_{it}(1)$
- Linear, quadratic and cubic time trends instead of employing monthly fixed effects

Results

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Cost - Upfront subsidy

Table 3: Cost per Watt of upfront systems

	All obs. included		Drop obs. +- 2 weeks	
	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)
Subsidy level	0.231***	0.247***	0.261***	0.250***
	(0.033)	(0.038)	(0.034)	(0.039)
N	136,876	136,876	125,038	125,038
1st-stage partial F-stat.	-	52717.1	-	50239.1

Notes: The outcome variable is cost per Watt of upfront systems. All specifications include fixed effects for the IOU, county, month, installer as well as for make and models of modules and inverters. Further, all specifications include controls for the amount of modules and inverters as well as an indicator for the number of systems a installer has installed before system i. The 1st stage partial F-statistics for the instrumental variables are derived from first- stage regression results reported in Appendix 7, Table B1. Robust standard errors clustered at the zip code level are reported in parentheses. *, ** and *** denote statistical significance at 5%, 1% and 0.1% respectively.

Cost - Upfront subsidy - Robustness checks

Table 4: Robustness checks for the cost per Watt of upfront systems

	Designfactor	Self-installed	NN matching	Linear	Quadratic	Cubic
	(1)	(2)	(3)	(4)	(5)	(6)
Subsidy level	0.270***	0.239	0.147***	0.333***	0.347***	0.366***
	(0.036)	(0.349)	(0.017)	(0.030)	(0.030)	(0.029)
N	136,877	1,266	26,412	136,877	136,877	136,877
1st-stage partial F-stat.	52800.1	1411.9		50687.4	51985.8	53594.4

Notes: The outcome variable is cost per Watt of upfront systems. All specifications include fixed effects for the IOU, county, month, installer as well as for make and models of modules and inverters. In columns 4 to 6, I drop monthly fixed effects and add a variable indicating the month (either linear, quadratic or cubic) of reservation since the start of the CSI program. Further, all specifications include controls for the amount of modules and inverters as well as an indicator for the number of systems a installer has installed before system i. The 1st stage partial F-statistic for the instrumental variable is derived from first-stage regression results reported in Appendix 7, Table B2. Robust standard errors clustered at the zip code level are reported in parentheses. *, ** and *** denote statistical significance at 5%, 1% and 0.1% respectively.

Cost - Output-based subsidy

Table 5: Cost per Watt of output-based systems

	All obs. included		Drop obs. +- 2 weeks	
	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)
Subsidy level	1.499	3.955	0.898	3.934
	(1.860)	(4.156)	(2.023)	(4.555)
N	3,711	3,711	3,426	3,426
1st- stage partial F-stat.	-	288.5	-	240.6

Notes: The outcome variable is cost per Watt of output- based systems. All specifications include fixed effects for the IOU, county, month, installer as well as for make and models of modules and inverters. Further, all specifications include controls for the amount of modules and inverters as well as an indicator for the number of systems a installer has installed before system i. The 1st stage partial F-statistic for the instrumental variable is derived from first-stage regression results reported in Appendix 7, Table B1. Robust standard errors clustered at the zip code level are reported in parentheses. *, ** and *** denote statistical significance at 5%, 1% and 0.1% respectively.

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Electricity output - Output-based subsidy

Table 6: Electricity output per Watt of output-based systems

	All obs. included		Drop obs. +- 2 weeks	
	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)
Subsidy level	−0.004	−0.016	−0.006	−0.031
	(0.010)	(0.024)	(0.011)	(0.028)
N	206,517	206,517	189,912	189,912
1st- stage partial F-stat.	-	285.8	-	215.3

Notes: The outcome variable is electricity output per Watt of output-based systems. All specifications include fixed effects for the IOU, county, month, installer as well as for make and models of modules and inverters. Further, all specifications include controls for the amount of modules and inverters as well as the age in years of the system. The 1st stage partial F-statistic for the instrumental variable is derived from first-stage regression results reported in in Appendix 7, Table B1. Robust standard errors clustered at the installer level are reported in parentheses. *, ** and *** denote statistical significance at 5%, 1% and 0.1% respectively.

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First two installations

Table 7: Mandatory field inspections

	Cost upfront		Cost output-based		Electricity output output-based	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)
Subsidy level	0.228***	0.245***	1.481	3.895	−0.004	−0.016
	(0.033)	(0.038)	(1.865)	(4.169)	(0.010)	(0.024)
First two = 1	−0.106*	−0.107*	−0.268	−0.285	−0.001	−0.000
	(0.043)	(0.044)	(0.197)	(0.201)	(0.002)	(0.002)
First two = 1 x Subsidy level	0.121	0.122	1.552	2.041	0.008	0.002
	(0.062)	(0.063)	(1.873)	(2.280)	(0.018)	(0.020)
N	136,876	136,876	3,711	3,711	206,517	206,517
1st- stage partial F-stat.	-	26697.7; 49463.8	-	144.7; 171.29	-	149.4; 572.0

Notes: The outcome variable is cost per Watt of upfront systems (columns 1 and 2), cost per Watt of output-based systems (columns 3 and 4) and electricity output per Watt of output-based systems (columns 5 and 6). All specifications include fixed effects for the IOU, county, month, installer as well as for make and models of modules and inverters. Further, all specifications include controls for the amount of modules and inverters as well as an indicator for the number of systems a installer has installed before system *i* and the age in years of the system in columns 5 and 6. The 1st stage partial F-statistics for both instrumental variables is derived from first- stage regression results, where the second F-statistic is derived from the first-stage of the interacted variable. First-stage results are reported in Appendix 7, Table B3. Robust standard errors clustered at the zip code level are reported in parentheses. *, ** and *** denote statistical significance at 5%, 1% and 0.1% respectively.

Subsidy recipients

Table 8: Third- party owned systems

	Cost upfront		Cost output-based		electricity output output-based	
	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)	OLS (5)	2SLS (6)
Subsidy level	0.136***	0.150***	−0.035	3.473	−0.008	−0.027
	(0.034)	(0.040)	(3.581)	(4.415)	(0.011)	(0.019)
TPO = 1	0.161***	0.160***	−0.336	−0.092	−0.000	−0.001
	(0.020)	(0.020)	(0.469)	(0.432)	(0.001)	(0.002)
TPO = 1 x Subsidy level	0.315***	0.307***	1.252	3.804	−0.009	−0.009
	(0.027)	(0.029)	(2.539)	(4.175)	(0.010)	(0.014)
N	136,876	136,876	3,711	3,711	206,517	206,517
1st-stage partial F-stat.	-	26345.8; 1.7e+5	-	240.2; 410.9	-	207.1; 549.4

Notes: The outcome variable is cost per Watt of upfront systems (columns 1 and 2), cost per Watt of output-based systems (columns 3 and 4) and electricity output per Watt of output-based systems (columns 5 and 6). All specifications include fixed effects for the IOU, county, month, installer as well as for make and models of modules and inverters. Further, all specifications include controls for the amount of modules and inverters as well as an indicator for the number of systems a installer has installed before system i and the age in years of the system in columns 5 and 6. The 1st stage partial F-statistics for both instrumental variables is derived from first- stage regression results, where the second F-statistic is derived from the first-stage of the interacted variable. First-stage results are reported in Appendix 7, Table B4. Robust standard errors clustered at the zip code level are reported in parentheses. *, ** and *** denote statistical significance at 5%, 1% and 0.1% respectively.

Ownership

Table 9: Customer sector

	Cost upfront		Cost output-based		Electricity output output-based	
	OLS (1)	2SLS (2)	OLS (3)	2SLS (4)	OLS (5)	2SLS (6)
Subsidy level	0.276**	0.184	2.309	−10.577	−0.003	−0.069
	(0.095)	(0.102)	(2.192)	(16.817)	(0.014)	(0.039)
Sector						
Government	0.845*	1.039**	0.359	1.047	0.001	0.004
	(0.329)	(0.402)	(0.220)	(0.942)	(0.001)	(0.002)
Non-Profit	−0.459***	−0.474***	0.270	0.760	0.002	0.005*
	(0.120)	(0.131)	(0.418)	(0.953)	(0.002)	(0.002)
Residential	0.052	0.042	0.019	0.264	−0.005	−0.004
	(0.058)	(0.056)	(0.499)	(0.678)	(0.003)	(0.003)
Sector x Subsidy level						
Government x Subsidy level	0.144	0.039	−0.160	−1.558	0.005	−0.012
	(0.263)	(0.323)	(1.887)	(2.940)	(0.013)	(0.016)
Non-profit x Subsidy level	0.312*	0.410**	−4.370	−6.884	−0.011	−0.002
	(0.122)	(0.132)	(2.762)	(4.040)	(0.020)	(0.023)
Residential x Subsidy level	−0.065	0.029	−8.115***	−3.698	−0.011	0.019
	(0.083)	(0.086)	(2.258)	(5.780)	(0.017)	(0.024)
N	136,876	136,876	3,711	3,711	206,517	206,517
1st-stage partial F-stat.	-	31145.7; 271.5; 435.5; 1.5e+05	-	62.3; 183.2; 100.3; 2056.5	-	157.6; 171.0; 139.0; 1516.1

Notes: The outcome variable is cost per Watt of upfront systems (columns 1 and 2), cost per Watt of output-based systems (columns 3 and 4) and electricity output per Watt of output-based systems (columns 5 and 6). All specifications include fixed effects for the IOU, county, month, installer as well as for make and models of modules and inverters. Further, all specifications include controls for the amount of modules and inverters as well as an indicator for the number of systems a installer has installed before system i and the age in years of the system in columns 5 and 6. The 1st stage partial F-statistics for the four instrumental variables is derived from first-stage regression results, where the second F-statistic is derived from the first-stage of the interacted variable for government customers, the third F-statistic is derived from the first-stage of the interacted variable for non-profit customers and the fourth F-statistic is derived from the first-stage of the interacted variable for residential customers. First-stage results are reported in Appendix 7, Table B5. Robust standard errors clustered at the zip code level are reported in parentheses. *, ** and *** denote statistical significance at 5%, 1% and 0.1% respectively.

Conclusion

- Employing an IV (potential self-selection) and further controlling for a wide range of potential confounding factors
  - Significant association of larger upfront subsidy levels and increased costs
- Programs need to be robust towards moral hazard induced by subsidies
- Verification of work whenever possible
  - Align incentives by performance contracting

Thank you!

- Questions or suggestions?
- Contact: evert.reins@unine.ch

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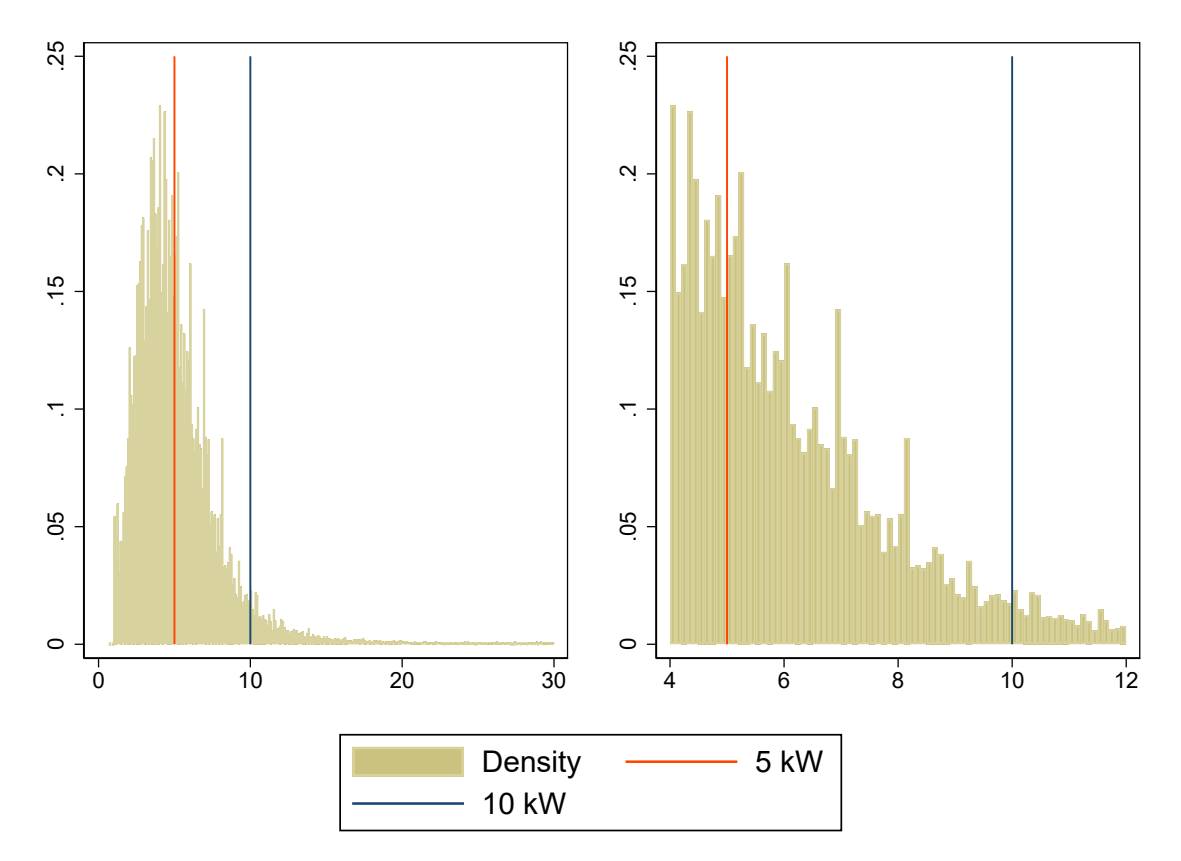
Within analysis of subsidy types

Size distribution

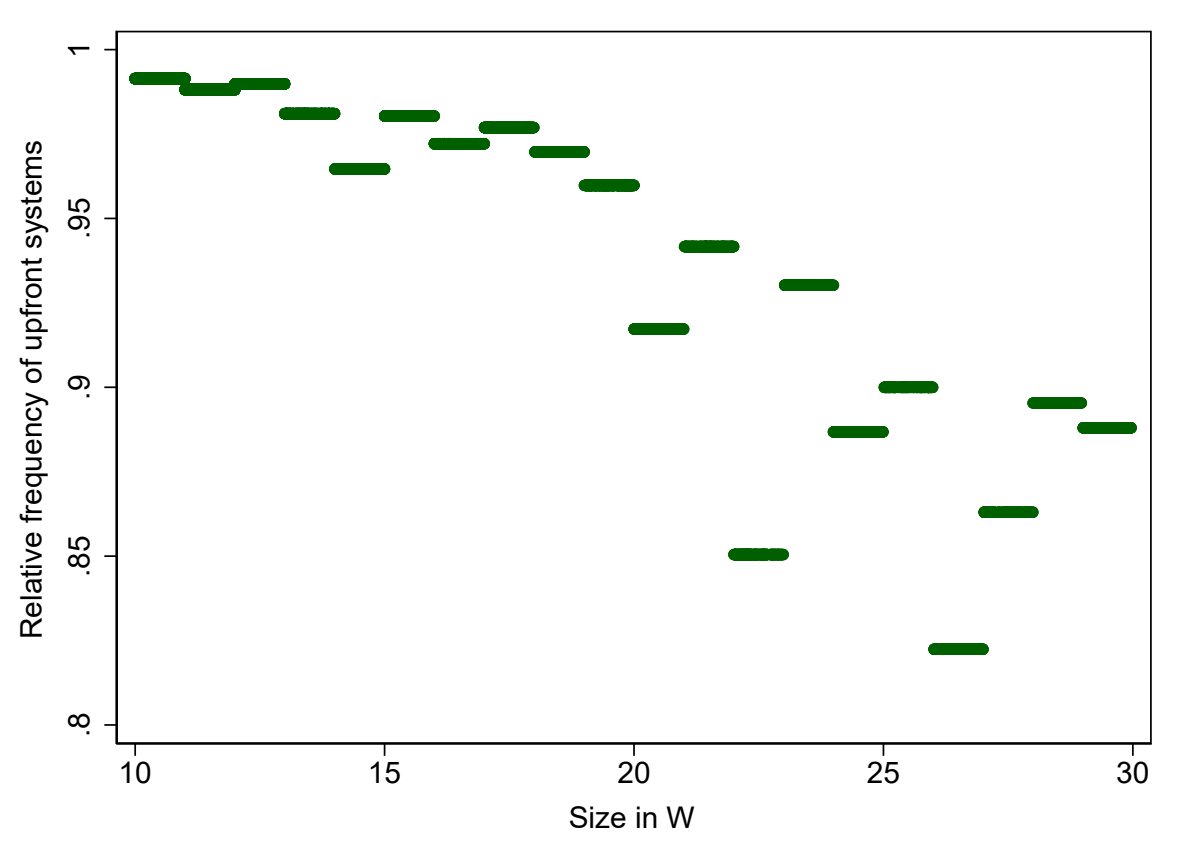
Figure A1: Size distribution of upfront systems



Notes: Distribution of system size of upfront systems. The left panel shows all upfront systems up to 30 kW. The right panel shows the distribution of the subset of system sized four to twelve kW.

Ratio of upfront and output-based systems

Figure A2: Ratio of upfront and output-based systems



Notes: Ratio of upfront to output-based systems by size if system size is between 10 and 30 kW. The bin size is 1 W, so for example the first band represents the ratio conditional on systems being sized from 10 to 11W.

Within regressions

Table A1: Within regressions

	10 to 30 kW		20 to 30 kW		25 to 30 kW	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)
Subsidy level	−1.541	123.483	2.835	35.096	2.104	90.267
	(2.077)	(190.272)	(3.801)	(214.332)	(11.553)	(108.852)
Upfront	0.024	5.391	0.568	0.298	0.207	−0.437
	(0.233)	(8.549)	(0.304)	(1.960)	(2.205)	(5.691)
Upfront x Subsidy level	1.760	−119.385	−2.869	−33.517	−2.420	−85.865
	(2.034)	(184.370)	(3.618)	(203.194)	(10.855)	(103.582)
# Observations	4,999	4,999	586	586	161	161
1st-stage partial F-stat.	-	1487.9; 1455.3	-	359.7; 348.2	-	142.9; 98.3

Notes: The outcome variable is cost per Watt. I pool upfront and output-based systems. All specifications include fixed effects for the IOU, county, month and installers. Note that columns 3 to 6 do not include fixed effects for make and model of modules and inverters because the number of clusters is otherwise insufficient to calculate a robust covariance matrix. Further, I only include installers who install both upfront and output-based systems. I explicitly control for the size of the system. The 1st stage partial F-statistics for both instrumental variables is derived from first-stage regression results, where the second F-statistic is derived from the first-stage of the interacted variable. Robust standard errors clustered at the zip code level are reported in parentheses. *, ** and *** denote statistical significance at 5%, 1% and 0.1% respectively.

First stage-regression results

Table B1: First stage results for Tables 3, 5 and 6

	Table 3		Table 5		Table 6	
	All obs. (1)	Dropped obs. (2)	All obs. (3)	Dropped obs. (4)	All obs. (5)	Dropped obs. (6)
Predetermined s_i	0.855^{***}	0.886^{***}	0.415^{***}	0.396^{***}	0.413^{***}	0.393^{***}
	(0.004)	(0.004)	(0.024)	(0.026)	(0.024)	(0.027)
# Observations	136,876	125,038	3,711	3,426	206,517	189,912

Notes: The outcome variable is the subsidy level of upfront systems in columns (1) and (2) and the subsidy level of output-based systems in columns (3) to (6). All specifications include fixed effects for the IOU, county, month of installation, installers as well as make and model of modules and inverters. Robust standard errors clustered at the zip code level are reported in parentheses. *, ** and *** denote statistical significance at 5%, 1% and 0.1% respectively.

Table B2: First stage results for Table 4

	(1)	(2)	(4)	(5)	(6)
Predetermined s_i	0.855***	0.877***	0.869***	0.872***	0.876***
	(0.004)	(0.023)	(0.004)	(0.004)	(0.004)
# Observations	136,876	136,876	136,876	136,876	136,876

Notes: The outcome variable is the subsidy level of upfront systems in columns (1) and (2) and the subsidy level of output-based systems in columns (3) to (5). All specifications include fixed effects for the IOU, county, month of installation, installers as well as make and model of modules and inverters. Robust standard errors clustered at the zip code level are reported in parentheses. *, ** and *** denote statistical significance at 5%, 1% and 0.1% respectively.

Table B3: First stage results for Table 7

	Cost upfront		Cost output-based		Electricity output output-based	
	s_i	First Two x s_i	s_i	First Two x s_i	s_i	First Two x s_i
	(1)	(2)	(3)	(4)	(5)	(6)
Predetermined s_i	0.854^{***}	-0.007^{***}	0.415^{***}	-0.008^{***}	0.413^{***}	-0.001^{***}
	(0.004)	(0.001)	(0.024)	(0.004)	(0.024)	$(0.5e{-}4)$
# Observations	136,876	136,876	3,711	3,711	206,517	206,517

Notes: The outcome variable is the subsidy level of upfront systems in columns (1) and the subsidy level of output-based systems in columns (3) and (5). In columns (2), (4) and (6) the outcome variable is the respective subsidy level interacted with a variable indicating whether the system is among the first two installed by an installer. All specifications include fixed effects for the IOU, county, month of installation, installers as well as make and model of modules and inverters. Robust standard errors clustered at the zip code level are reported in parentheses. *, ** and *** denote statistical significance at 5%, 1% and 0.1% respectively.

Table B4: First stage results for Table 8

	Cost upfront		Cost output-based		Electricity output output-based	
	s_i	TPO x s_i	s_i	TPO x s_i	s_i	TPO x s_i
	(1)	(2)	(3)	(4)	(5)	(6)
Predetermined s_i	0.854^{***}	-0.034^{***}	0.473^{***}	-0.208^{***}	0.452^{***}	-0.201^{***}
	(0.004)	(0.002)	(0.022)	(0.021)	(0.022)	(0.019)
# Observations	136,876	136,876	3,711	3,711	206,517	206,517

Notes: The outcome variable is the subsidy level of upfront systems in columns (1) and the subsidy level of output-based systems in columns (3) and (5). In columns (2), (4) and (6) the outcome variable is the respective subsidy level interacted with a variable indicating whether the system owned by a third-party. All specifications include fixed effects for the IOU, county, month of installation, installers as well as make and model of modules and inverters. Robust standard errors clustered at the zip code level are reported in parentheses. *, ** and *** denote statistical significance at 5%, 1% and 0.1% respectively.

Table B5: First stage results for Table 9

	Cost upfront				Cost output-based				Electricity output output-based			
	s_i	Gov x s_i	Np x s_i	Res x s_i	s_i	Gov x s_i	Np x s_i	Res x s_i	s_i	Gov x s_i	Np x s_i	Res x s_i
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Predetermined s_i	0.616***	0.699***	0.781***	0.985***	0.316***	0.611***	0.603***	0.981***	0.411***	0.603***	0.588***	0.977***
	(0.008)	(0.023)	(0.012)	(0.001)	(0.040)	(0.023)	(0.014)	(0.012)	(0.028)	(0.025)	(0.027)	(0.013)
# Observations	136,876	136,876	136,876	136,876	3,711	3,711	3,711	3,711	206,517	206,517	206,517	206,517

Notes: The outcome variable is the subsidy level of upfront systems in columns (1) and the subsidy level of output-based systems in columns (5) and (9). In columns (2), (6) and (10) the outcome variable is the respective subsidy level interacted with a variable indicating whether the customer is governmental (Gov). In columns (3), (7) and (11) the outcome variable is the respective subsidy level interacted with a variable indicating whether the customer is non-profit (Np). In columns 4, 8 and 12 the outcome variable is the respective subsidy level interacted with a variable indicating whether the customer is residential (Res). All specifications include fixed effects for the IOU, county, month of installation, installers as well as make and model of modules and inverters. Robust standard errors clustered at the zip code level are reported in parentheses. *, ** and *** denote statistical significance at 5%, 1% and 0.1% respectively.