A Bright Future for Real Estate Investors? Solar Panels and Investors in Single Family Homes

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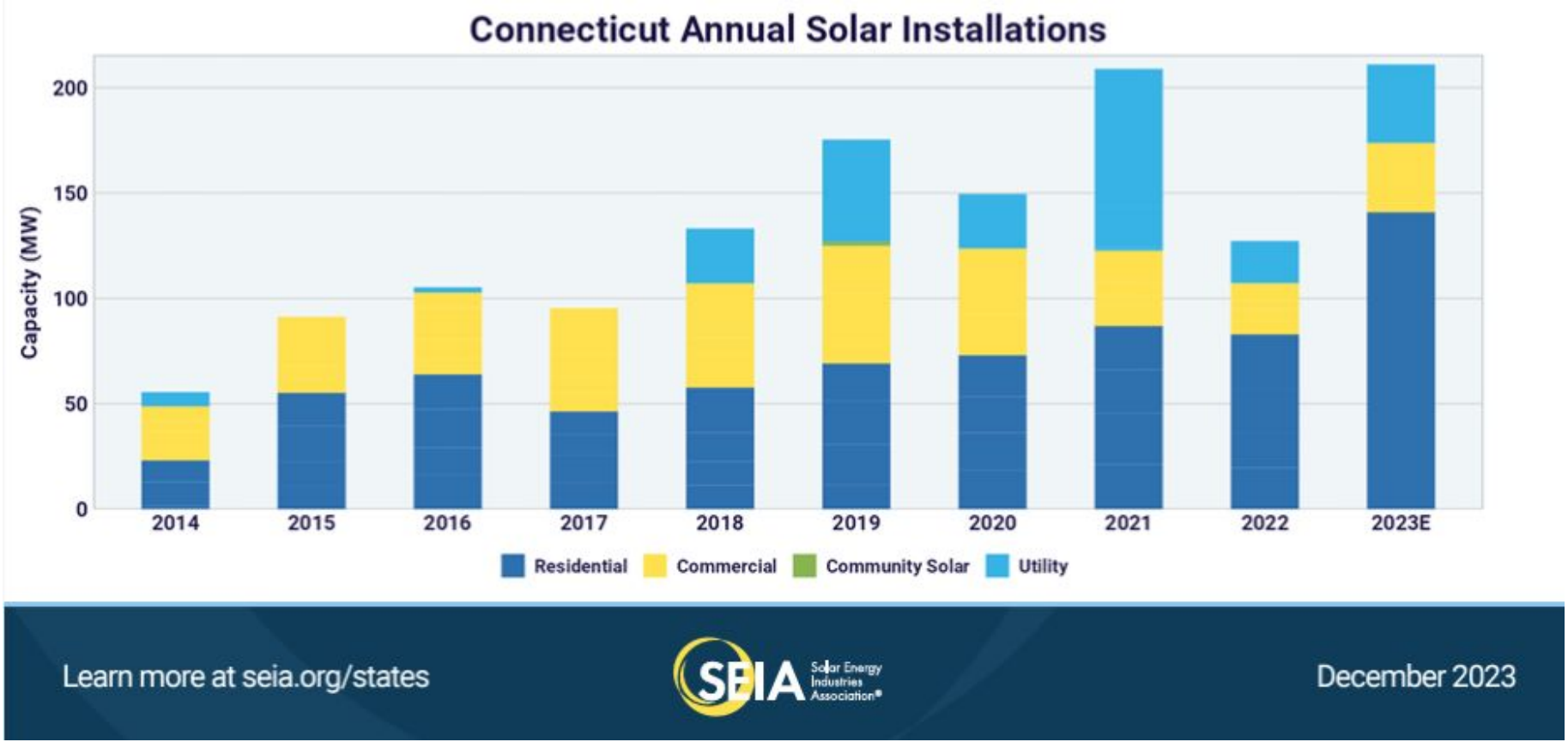

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Investor Interest in Single-Family Homes

- Single family home transitions involving U.S. investors have risen by over 50% since 2014
  - In 2021, transactions involving investor buyers and/or sellers comprised 24% of all transactions, compared to the prior decade's 14% (Henderson, 2022)
  - Investors differ in tastes and bargaining ability (Cohen and Harding, 2021)
- Differences in investor valuation of solar installations
  - Energy savings for renters
  - Green investing and advocacy
  - Signal for other home improvements

Investor Valuation and the Demand and Bargaining Effects

- Our approach is based on the the bargaining power model of Harding, Rosenthal, and Sirmans (2003)
  - The bargaining effect β_2: investors buy for less and sell for more
  - The demand effect β_3: valuation differences between investors and non-investors
  - Buyers and sellers are assumed equal in tastes and bargaining ability
  - How do solar installations affect transaction prices with and without investors?
- $log(price)_i = \alpha + \beta_1 Solar_i + \beta_2 (InvestorSeller_i - InvestorBuyer_i) + \beta_3 (InvestorSeller_i + InvestorBuyer_i) + \beta_4 Solar \times (InvestorSeller_i - InvestorBuyer_i) + \beta_5 Solar \times (InvestorSeller_i + InvestorBuyer_i) + \gamma X_i + TractFE + QuarterFE$

Key Findings

- A significant negative “demand effect”: investors tend to buy properties with below-average unobserved quality.
  - This effect is mitigated for properties with solar by a factor of approximately 25%
- A significant positive “bargaining effect”: investors buy for less and sell for more than non-investors do.
  - The presence of solar installations does not significantly impact the bargaining effect
- The effect of solar on the demand effect is attenuated by accounting for the presence of a new roof
  - Solar panels could signal that a property is of higher quality

Related Literature

- The HRS bargaining model, from Harding, Rosenthal, and Sirmans (2003):
  - Ihlanfeldt and Mayock (2012)
  - Ling, Naranjo, and Petrova (2018)
  - Cohen and Harding (2021)
- Solar premiums in property pricing
  - Dastrup et al. (2012)
  - Hoen et al. (2012, 2013)
  - Hoen et al. (2017)
  - Begley and Hoen (2021)
  - Gillingham and Bollinger (2021)

Data Details

- Connecticut real estate transaction data from the Warren Group (2006 to 2021)
  - Around 540,000 identified sales of single family homes in CT
  - 5,471 had solar installations prior to the day of sale
  - 862 sales with solar installations had an investor buyer and/or seller
- Proprietary data on solar installations from the Connecticut Green Bank
- Days on market data from Multiple Listing Services (MLS) by CoreLogic (2006 to 2019)
  - The MLS-Warren merged dataset contains approximately 300,000 observations, of which 1,110 had solar at sale

Methodology Details

- Investor buyers/sellers identified by buyer/seller fields (for professional investors) or when the same individual is present for 3 or more sales (individual investors)
- Computation of the demand and bargaining effects:
  - The demand effect: sum of investor-seller and investor-buyer indicators
  - The bargaining effect: difference between investor-seller and investor-buyer indicators
- Fixed effects for quarter and census tract
- Drop observations with a sale price of less than $10,000
- Exclude properties with less than 10 bedrooms, less than 30 total rooms, built after 1500, and with an interior square footage of greater than 500

Theory Behind the Bargaining and Demand Effects

- A price P can be determined by how well the buyer/seller bargains and how they value characteristics (HRS 2003):
  - $P = (d^{seller} D^{seller} + d^{buyer} D^{buyer}) + (b^{seller} D^{seller} + b^{buyer} D^{buyer}) + \gamma X + e$
  - D is an indicator for the differential characteristic; in our case, whether the individual is an investor
  - The coefficients d and b represent, respectively, the characteristics not accounted for in X and bargaining ability
- Imposing the restrictions that buyers and sellers of the same type have the same preferences for untabulated characteristics and bargaining ability ($d^{seller} = d^{buyer}$, $b^{seller} = -b^{buyer}$):
  - $P = d (D^{seller} + D^{buyer}) + b (D^{seller} - D^{buyer}) + \gamma X + e$
  - Thus, d is the demand effect coefficient and b is the bargaining effect coefficient

Specification Details

$$log(price)_i = \alpha + \beta_1 Solar_i + \beta_2 (InvestorSeller_i - InvestorBuyer_i) + \beta_3 (InvestorSeller_i + InvestorBuyer_i) + \beta_4 Solar \times (InvestorSeller_i - InvestorBuyer_i) + \beta_5 Solar \times (InvestorSeller_i + InvestorBuyer_i) + \gamma X_i + TractFE + QuarterFE$$

- Primary response variable: log transaction price
- Primary explanatory variables: bargaining effect (*InvestorSeller - InvestorBuyer*), demand effect (*InvestorSeller + InvestorBuyer*), and their interactions with the *Solar* variable, an indicator for whether solar installations were present at time of sale
- Control variables: number of bedrooms, bathrooms, total rooms, lot size, interior, property age, whether the property is part of a Solarize CT initiative, and whether the solar is leased
- Includes quarter fixed effects and census tract fixed effects

Solar Properties with Investor Buyers/Sellers

	Non-Investor Seller	Investor Seller	Total
Non-Investor Buyer	4,609	541	5,150
Investor Buyer	249	72	321
Total	4,858	613	5,471

Summary Statistics

	Properties With Solar			Properties Without Solar		
Variable	**Obs**	**Mean**	**SD**	**Obs**	**Mean**	**SD**
Log Price	5,471	12.6540	0.5600	535,964	12.5207	0.7856
Bedrooms	5,471	3.3045	0.7827	535,964	3.3051	0.9303
Bathrooms	5,471	2.2036	0.9224	535,964	2.1049	0.9985
Total Rooms	5,471	6.9505	1.7327	535,964	7.0096	2.0106
Lot Size (tsf)	5,471	44.6987	93.2468	535,964	43.0791	133.3028
Interior (tsf)	5,471	1.9085	0.9034	535,964	1.9219	1.2721
Investor Buyer	5,471	0.0587	0.2350	535,964	0.1179	0.3225
Investor Seller	5,471	0.1120	0.3155	535,964	0.2468	0.4312
Bargaining Effect (IS - IB)	5,471	0.0534	0.3763	535,964	0.1289	0.5023
Demand Effect (IS + IB)	5,471	0.1707	0.4098	535,964	0.3647	0.5723
Solar Lease	5,471	0.7724	0.4193			
Solarize CT	5,471	0.0451	0.2076			

Quarter and Census Tract FE, Robust SE

Log Price	Coefficient	SE
Bargaining Effect	0.0520***	0.0015
Solar	0.0449***	0.0126
BE x Solar	-0.0054	0.0167
Demand Effect	-0.1864***	0.0014
DE x Solar	0.0433**	0.0178

Alternative Specifications and Robustness

- Including solar installer fixed effects
- Using logged lot size, interior, and age
- Alternative standard errors and clustering
- Including an indicator for whether the installations was a part of the Solarize CT incentive, a cost reduction and tax incentive program
- Excluding use codes designated for condominiums

Days on Market

- By merging in data for days on market from MLS, we construct the theta measure, which measures whether the market favors buyers or sellers: a high theta indicates market favors buyers, and a low one indicates favoring sellers (Carrillo, 2013)
  - This measure helps account for local real estate market conditions at a given time
- The MLS dataset also includes information regarding additions to the property, such as new roofing

Accounting for Market Conditions with Theta

Log Price	Coefficient	SE
Theta	-0.0844*	0.0500
Bargaining Effect	0.0347***	0.0018
Solar	0.0458***	0.0091
BE x Solar	-0.0462*	0.0284
Demand Effect	-0.2034***	0.0017
DE x Solar	0.1552***	0.0245

Accounting for New Roof and Other Property Additions

Log Price	Coefficient	SE
Bargaining Effect	0.0271***	0.0019
Solar	0.0763***	0.0197
BE x Solar	-0.0472*	0.0284
Demand Effect	-0.2098***	0.0019
DE x Solar	0.1552***	.0242
New Roof	-0.0138***	0.0034
BE x New Roof	0.0636***	0.0059
DE x New Roof	0.1055***	0.0059

Competitiveness and Listing Density

- One method for controlling for the simultaneous determination of days on market and selling price is to use two instrumental variables: competitiveness and listing density
  - Competitiveness (an instrument for days on market) accounts for the number of competing properties
  - Listing density (an instrument for transaction prices) accounts for the window of opportunity for potential buyers to purchase either the subject property or competing properties

Determining Days on Market

Log Days on Market	Coefficient	SE
Log Price	0.138	0.367
Competitiveness	0.372*	0.183
Solar	0.114	6.91
Bargaining Effect	-0.0407	0.522
BE x Solar	0.0656	12.00
Demand Effect	-0.0659	0.472
DE x Solar	0.0539	10.60
New Roof	-0.0217	0.856
BE x New Roof	-0.0506	1.818
DE x New Roof	0.0682	1.709

Determining Transaction Price

Log Price	Coefficient	SE
Log Days on Market	-0.0121***	0.000784
Listing Density	-0.0202***	0.000884
Solar	0.079***	0.02
Leased x Solar	-0.0495*	0.0235
Bargaining Effect	0.0273***	0.00151
BE x Solar	-0.0473	0.0348
Demand Effect	-0.253***	0.00135
DE x Solar	0.170***	0.0308
New Roof	-0.0155***	0.00249
BE x New Roof	0.0615***	0.00528
DE x New Roof	0.108***	0.00496

Conclusion

- We examine the effect that the installation of solar panels have on investors' willingness to pay and its potential as a signal for unobserved quality
- While investors value unobserved qualities less than non-investors, solar panels can bridge this valuation gap
- The presence of a new roof attenuates this mitigation, evidence that solar panels can act as a signal of quality to investors