

# Residential solar uptake in the Asia-Oceania region – what roles do wealth, building form & property ownership play?

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# Today's presentation

- ▶ Importance of rooftop solar in energy markets and policy more generally
- ▶ Overview of drivers of solar uptake
- ▶ Overview recent trends in rooftop solar uptake globally and Asia-Oceania region.
- ▶ Does wealth drive solar uptake? (case study: Australia)
  - ▶ Examine solar uptake by wealth decile, building form and ownership
  - ▶ What factors show the greatest association to solar uptake?
  - ▶ What role does multicollinearity play?
  - ▶ Can econometric modelling shed more light on drivers of solar uptake?
- ▶ Policy implications
- ▶ Broader policy lessons for energy economists, regulators and policy makers in our region

# The important of rooftop solar uptake analysis

- ▶ Rooftop solar is very relevant in the current energy policy debate
- ▶ Rooftop solar & batteries
  - ▶ FTM vs BTM; Drivers of uptake; Policy design
- ▶ Technological developments and innovation
  - ▶ Electric vehicles, Virtual Power Plants, Neighborhood batteries
- ▶ Climate change and move to net zero emissions target
- ▶ Impact on, and displacement of, traditional generation
  - ▶ Network cost recovery, FITs, Solar tax, Demand management – Price incentives? Technology? Consumer inertia?, Self consumption, Grid congestion
- ▶ Energy access and energy financial stress
  - ▶ Is energy “free for those who can afford it, and very expensive for those who cant”?



# Drivers of residential solar uptake

- ▶ Several explanations have been put forward by energy economists, regulators and policy makers on the drivers of solar uptake in their region.
- ▶ On the basis of the explanations, policies are designed to help overcome barriers to solar uptake.
- ▶ Solar & wealth - the most common explanation is that solar uptake is primarily driven by the households' income and wealth (rooftop solar PV being disproportionately installed by more wealthy households)
  - ▶ Policies provide financial incentives to reduce capital costs.
  - ▶ Policies are often asset/income based and only apply to home owners

# Drivers of residential solar uptake

Other plausible explanations include:

## ▶ Barriers for renters

- ▶ Transaction costs (rented properties can require special arrangements to allocate solar production on a shared roof to them; subsidies only available to home owners);
- ▶ Property form (rented properties are typically higher density and so less roof space in relation to floor space);
- ▶ Property rights (solar installation requires landlord approval and system ownership may be assigned to the landlord).

# Drivers of residential solar uptake

- ▶ Split incentives (Dodd & Nelson, 2022; Wood et al., 2012; Zander, 2020)
  - ▶ Unlike home owners, renters face uncertainty in their ability to recover system costs (renters can not easily relocate with the solar system and there are challenges in splitting costs and benefits with the landlord)
  - ▶ On the other hand, landlords have a low incentive to bear system costs when the financial benefits accrue to renters in the form of lower electricity bills (rental increases to recover system costs may not be feasible in a housing market characterized by affordability stress)

# Implication of solar uptake being driven by wealth

- ▶ Inequity: More wealthy households have access to free solar energy, receive payments for excess energy generated and fed back into the grid, and hence incur lower electricity bills.
- ▶ Widens the gap: If solar is mostly taken up by the wealthy, this could exacerbate energy financial stress and increase inequality.
- ▶ As rooftop solar uptake grows, the inequities between rich and poor will be exacerbated if wealth truly drives solar uptake.

# Implication of solar uptake being driven by wealth

- ▶ Financial (income/asset based) incentives to help ensure wealth/income is not a barrier to solar uptake
  - ▶ Grants, rebates, tax incentives and loan programmes.
  - ▶ Japan: Itabashi offers grants covering up to 5% of the initial cost of installing solar thermal systems.
- ▶ Commonly asset/income based.
  - ▶ Australia: solar rebates are means tested (income based).



# Overview of rooftop solar uptake

- ▶ Globally, small-scale (residential) solar account for 12% of net solar PV capacity: IEA, 2020
- ▶ Solar isn't just for wealthy countries: in developing and emerging economies, distributed renewable energy provides electricity access to growing shares of the population:
  - ▶ 2019 ~ 420 million people had gained access to basic residential electricity services: IEA, 2020

# Overview of rooftop solar uptake in Asia-Oceania region

From 2018-19, the IEA (2020) data show growth in small-scale solar installation uptake is generally increasing across the Asia-Oceania region:

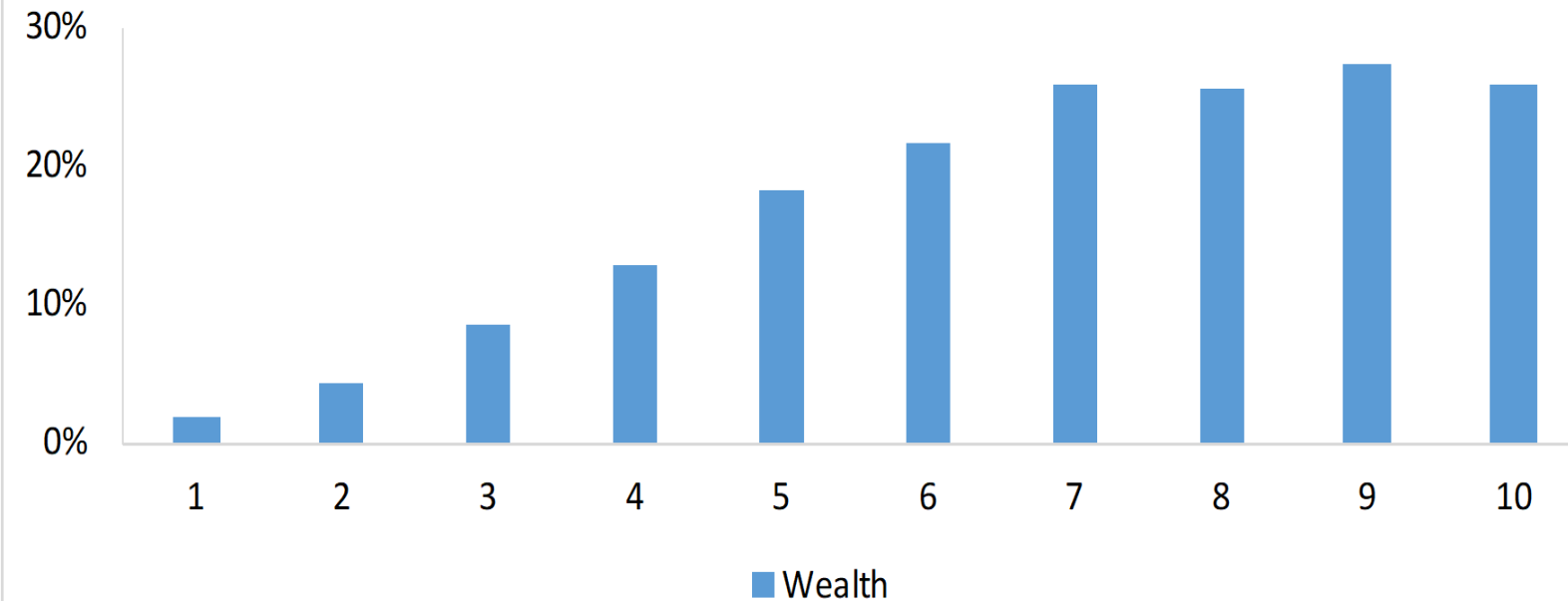
- ▶ China: increased 74%
- ▶ Australia: increased 35%
- ▶ Vietnam: surge in solar installations over several years (prior to FIT expiration)
- ▶ Japan: market contracted for fourth consecutive year (FIT scheme has ended)
- ▶ India: installations declined for the first time in 5 years (market mostly consists of commercial/industrial, comparatively few households able to afford the upfront costs)

# Case study:

## Small-scale (residential) solar uptake in Australia

# Does wealth drive solar uptake?

Solar homes, as % of all homes, by wealth decile



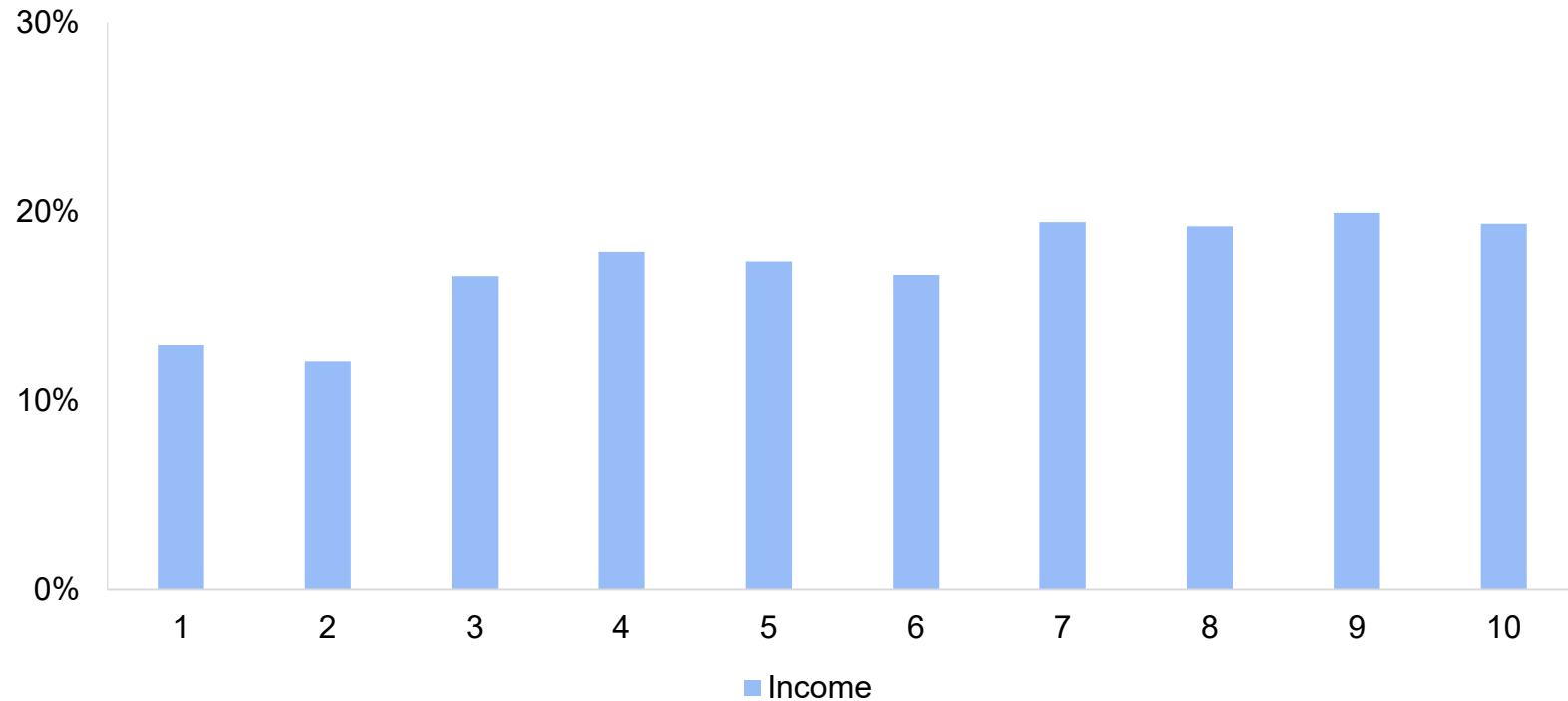
ABS SIH survey 2017-18

- Australian Bureau of Statistics survey data (N = 14,060)
- Prima facie, wealth affects rooftop solar uptake.
- On this basis, most conclude there is a solar wealth effect Australia: Best, Chareunsky, & Li (2021), Best, Burke, & Nishitateno (2019)



# Does income drive solar uptake?

Solar homes, as % of all homes, by income decile



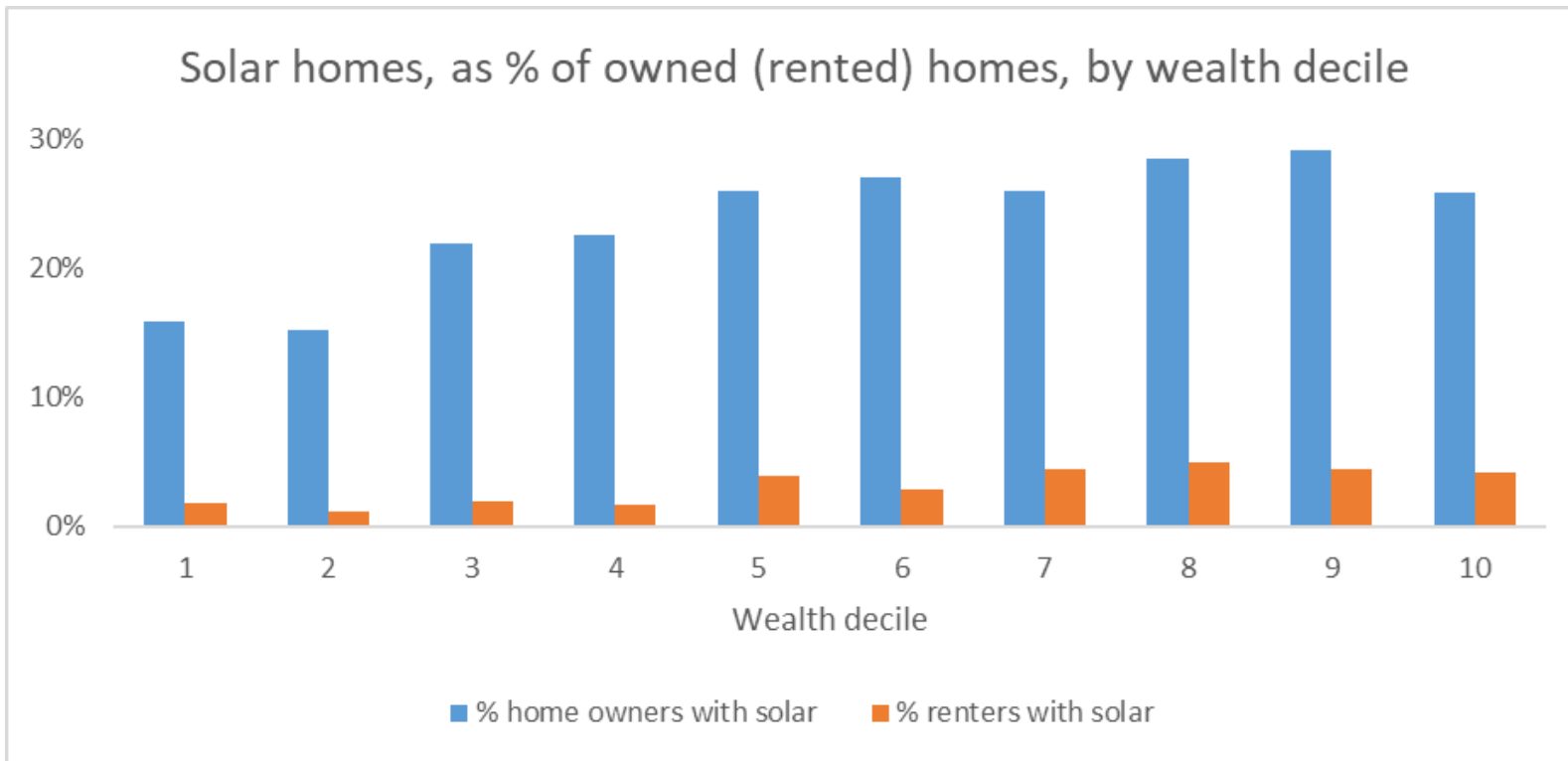
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- Australian Bureau of Statistics survey data (N = 14,060)
- Prima facie, income is not associated with solar uptake.
- On this basis, most conclude there is a wealth but no income effect driving solar uptake in Australia.

# Does ownership drive solar uptake?

- ▶ Australian Bureau of Statistics survey data reports home ownership is associated with solar uptake:
  - ▶ Overall, 3% of renters have solar and 24% of home owners have solar.
  - ▶ Home owners are almost 8 times more likely to have solar than renters.
  
- ▶ How are wealth, home ownership and solar uptake associated?

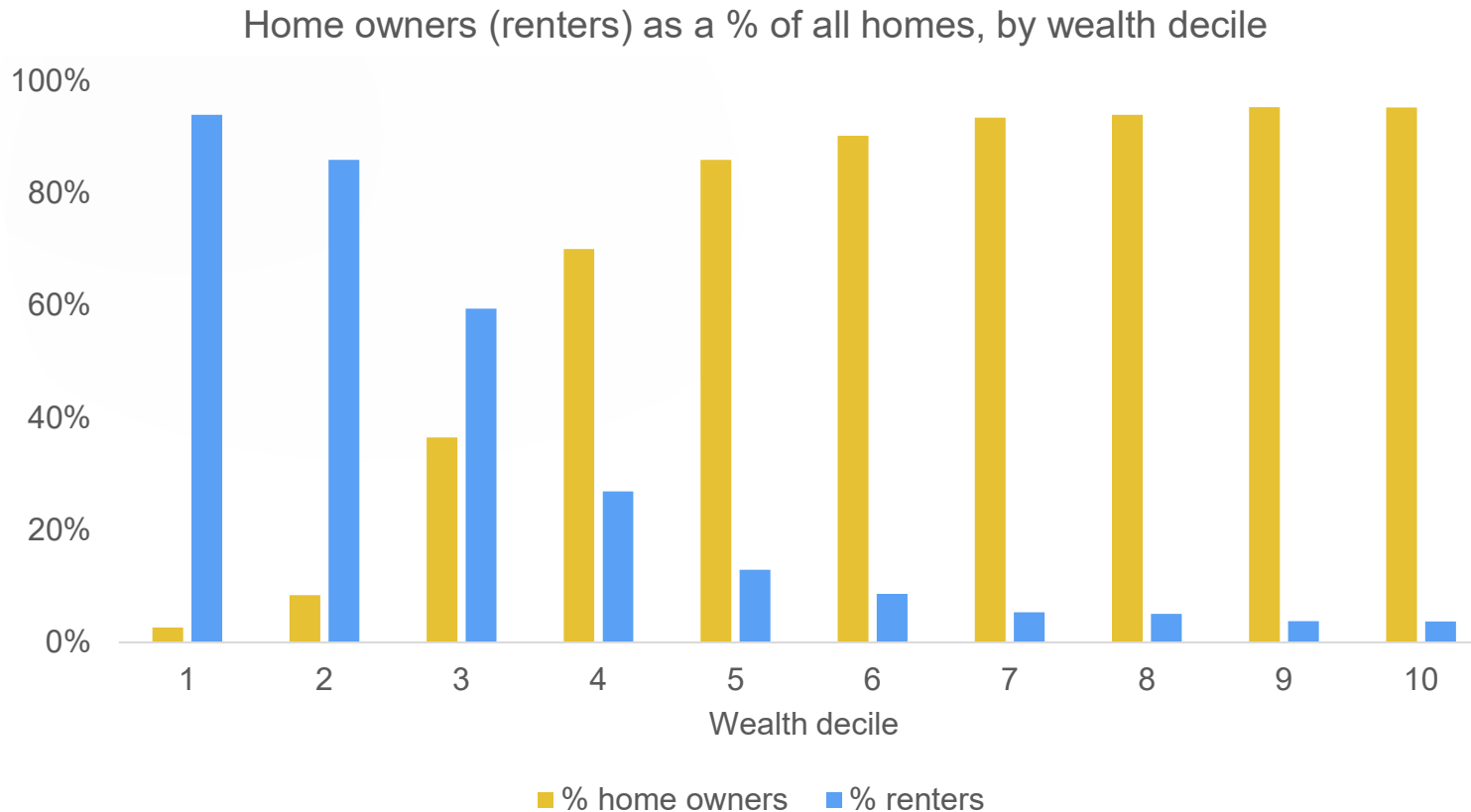
# Does ownership drive solar uptake?



- Australian Bureau of Statistics survey data (Owners = 9,444, Renters = 4,297)
- When solar uptake for home owners and renters is analysed, the **wealth effect largely evaporates.**
- Solar uptake amongst renters is inconsequential.

ABS SIH survey 2017-18

# Does ownership drive solar uptake?



ABS SIH survey 2017-18

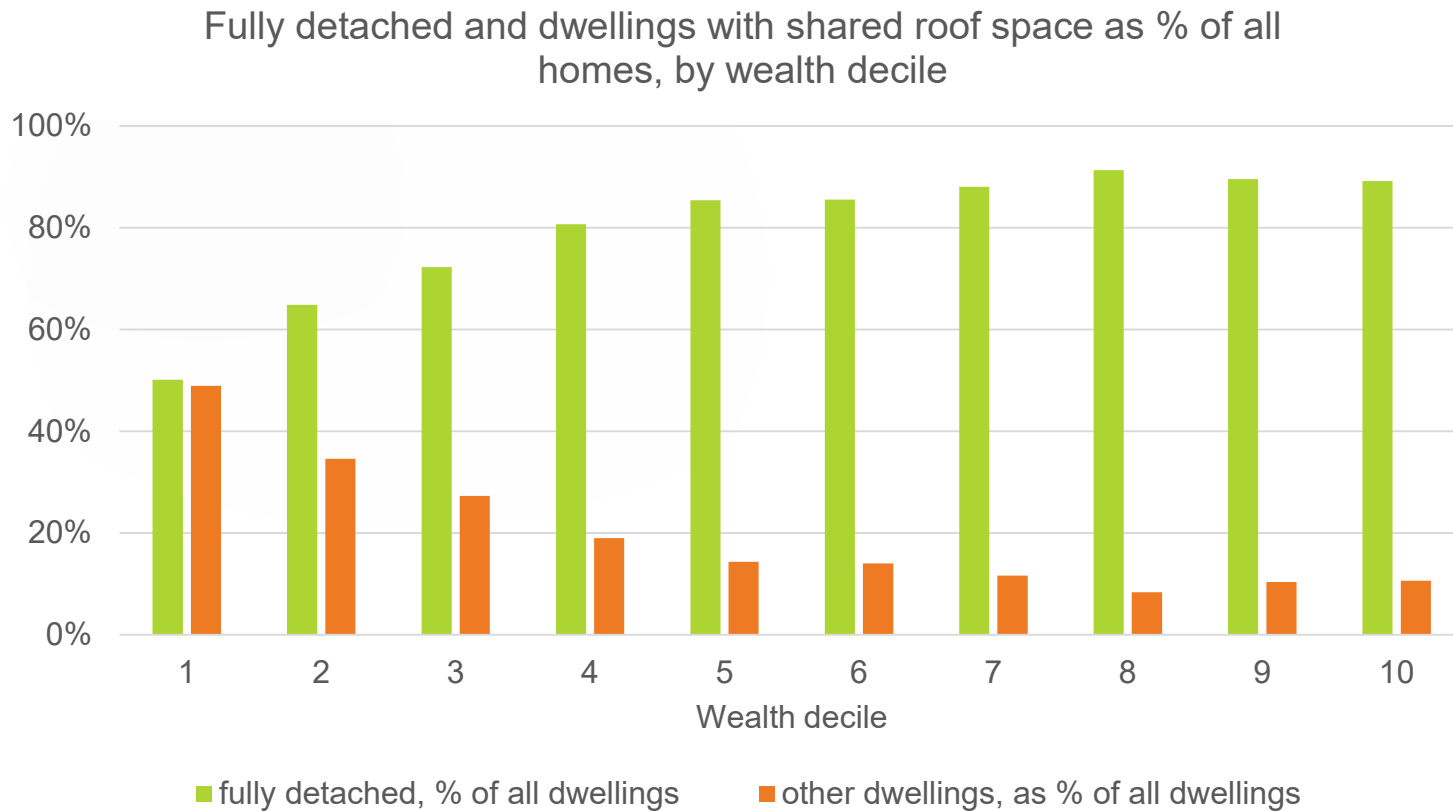
- Ownership is one reason why wealth appears to drive solar uptake:
  - Least wealthy are more likely to be renters.
  - Most wealthy likely to be home owners.
- Interrelationship:
  - Wealth & ownership.
  - Ownership & solar uptake.



# Does building form drive solar uptake?

- ▶ Having established the interrelationship between solar uptake and ownership and wealth, we now consider how building form is related to solar uptake:
  - ▶ 21% of fully detached homes have solar,
  - ▶ 3% of other dwellings (shared roof space) have solar.
- ▶ Ownership is also related to building form:
  - ▶ Most houses are owner occupied (75%),
  - ▶ Most dwellings with shared roof space are rented (62%)
- ▶ How is wealth related to building form and solar uptake?

# Does building form drive solar uptake?



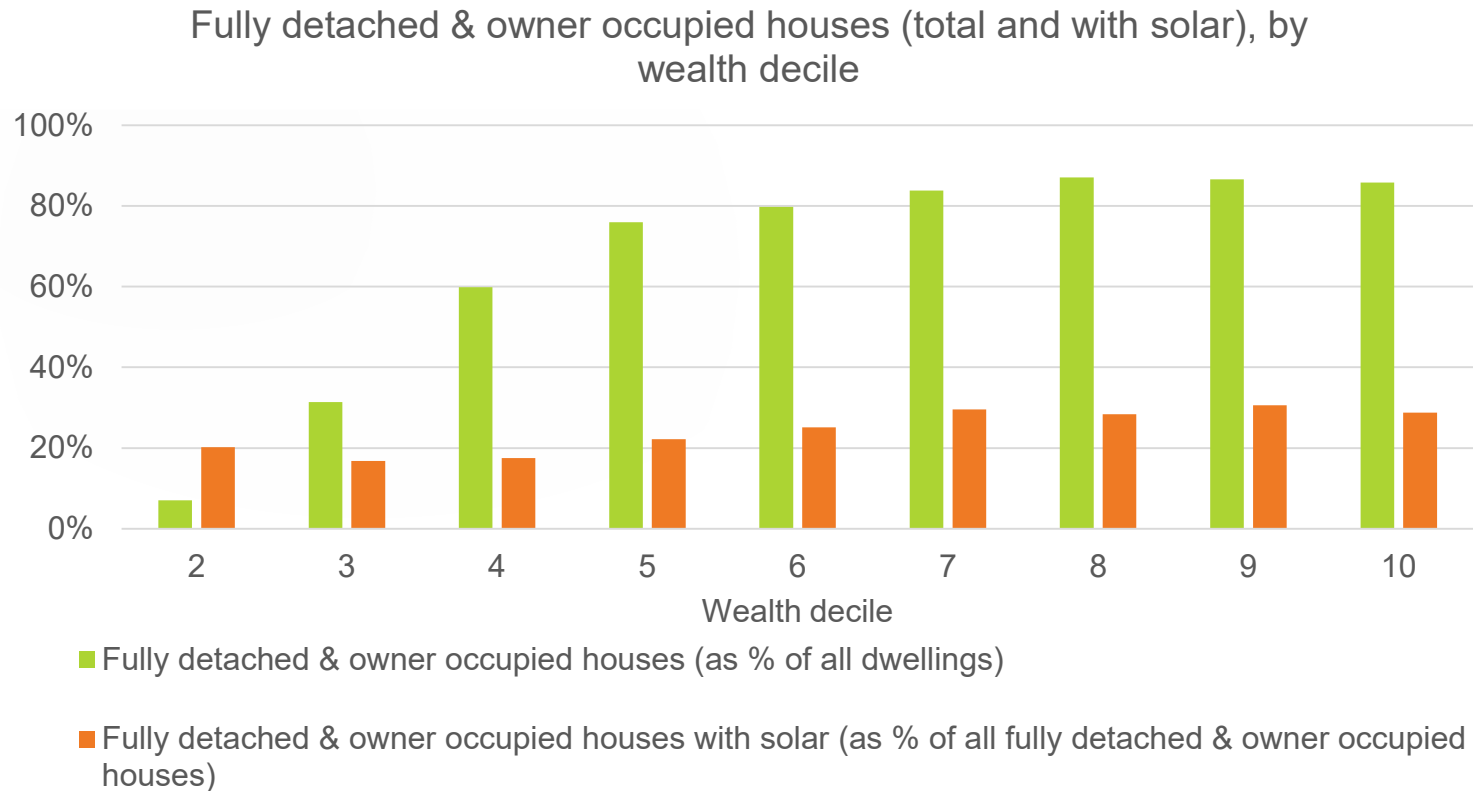
ABS SIH survey 2017-18

▶ Building form is one reason why wealth appears to drive solar uptake:

- ▶ Less wealthy are more likely to have shared roof space.
- ▶ Most wealthy are more likely to live in fully detached house.

▶ Insufficient sample to enable full analysis of building form, ownership, wealth decile and solar uptake.

# Does building form and ownership drive solar uptake?



ABS SIH survey 2017-18

Note: 1<sup>st</sup> decile is excluded as low number of observations render the result unreliable.

- ▶ However, we can examine solar uptake across wealth decile for owners of fully detached houses (n=8,429).
- ▶ Ownership and building form drive solar uptake:
  - ▶ More wealthy houses are more likely to own a fully detached house.
- ▶ **Solar uptake by owners in fully detached houses is not associated with wealth.**

# Explaining the association between solar & wealth

- ▶ **Property ownership, wealth and solar uptake:**
  - ▶ Least wealthy are renters / Most wealthy are home owners
  - ▶ Renters face barriers and split incentives
- ▶ **Building form, wealth and solar uptake:**
  - ▶ Least wealthy occupy apartments / Most wealthy occupy detached houses
  - ▶ Shared roof space is a major barrier to solar uptake
- ▶ **Dwelling type, property ownership, wealth and solar uptake:**
  - ▶ Least wealthy occupy rented apartments / Most wealth occupy owned houses
  - ▶ Apartments are largely unsuitable for solar due to shared roof space.



# Explaining the association between solar & wealth

- ▶ Wealth, per se, is not the primary driver of solar uptake.
- ▶ Home ownership and dwelling structure are major drivers of solar uptake.
- ▶ ....but wealth is a driver of home ownership and building form.
- ▶ Once we account for home owners vs renters, and building form, we find no evidence of a wealth effect.

# Can econometrics assist?

- ▶ So far we have demonstrated:
  - ▶ Interrelationship between wealth, building form and ownership, and
  - ▶ Strong association solar uptake and building form/ownership.
- ▶ Econometric studies to estimate the likelihood of solar uptake by Australian households overall as a function of wealth, income, building form and ownership:
  - ▶ Best et al. (2019) use a logit model to estimate solar uptake across a large sample (~17,000) of residential dwellings and conclude wealth is positively associated with solar uptake.
  - ▶ Best et al. (2021) use a similar but more parsimonious model that includes solar subsidies to undertake a similar analysis on a large sample of residential dwellings and similarly conclude wealth is positively associated with solar uptake.

# Can econometrics assist?

However, these models:

- ▶ Suffer from multicollinearity because of the association between wealth, building form and ownership (as demonstrated here), and
- ▶ Do not perform well when the data is appropriately segmented into owners and renters (to overcome the multicollinearity) (Mountain et al., 2021), and
- ▶ Suffer from omitted variable bias as they do not accurately capture prices, grid consumption or solar self consumption and export (where relevant).

# Can econometrics assist?

- ▶ Despite more recent attempts to analyse the relationship between solar uptake in fully detached houses (which are predominantly owner-occupied) and wealth, data limitations mean we are unable to confidentially isolate the impact of wealth on solar uptake holding ownership and building form constant: Mountain et al., 2021.
- ▶ Thus, while we can be confident in the interrelationship between solar uptake and building form and ownership, the relationship between solar uptake and wealth (holding other factors constant, namely building form and ownership) is not well understood.



# Broader policy lessons

- ▶ What lessons can the Asia-Oceania region learn from the Australian findings on solar, wealth, building form and ownership?
- ▶ Claims of a solar wealth nexus may be based on precursory understanding of the drivers and barriers to rooftop solar uptake, and an insufficient interrogation of the available data.
- ▶ Building form and ownership (which are strongly related to wealth) play an important role in determining whether a household will install solar – differences in *all* of these factors should be better taken into account when designing policies to encourage solar uptake.
- ▶ Financial incentives do not take into account the barriers presented by split incentives and building form.

# Broader policy lessons

- ▶ Not saying wealth isn't important....
- ▶ Although wealth may not be directly associated with solar uptake – building form and ownership are - and these are strongly related to wealth.
- ▶ Solely focusing on financial incentives to reduce capital costs may exacerbate socio-economic inequities among households, particularly as solar uptake grows.

# Broader policy lessons

- ▶ Policy makers must consider building form and ownership:
  - ▶ Overcoming barriers presented by renter barriers and split incentives (e.g. define property rights and cost recovery principles, incentives targeted to landlords)
  - ▶ How to better enable those with shared roof space to maximize any capacity for rooftop solar energy (e.g. technological innovation. communal installation), and to better access the benefits of solar energy (e.g. batteries)
  - ▶ Data collection – only with accurate data on solar uptake, ownership, building form, wealth and income, consumption and prices can evidence based policy making be undertaken.

Thank you

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# Questions & Discussion

# References

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