

China's Solar Energy Foreign Aid to Pakistan: Trade-Offs Between Industrial Development and Local Market Dynamics

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Introduction

Research Question:

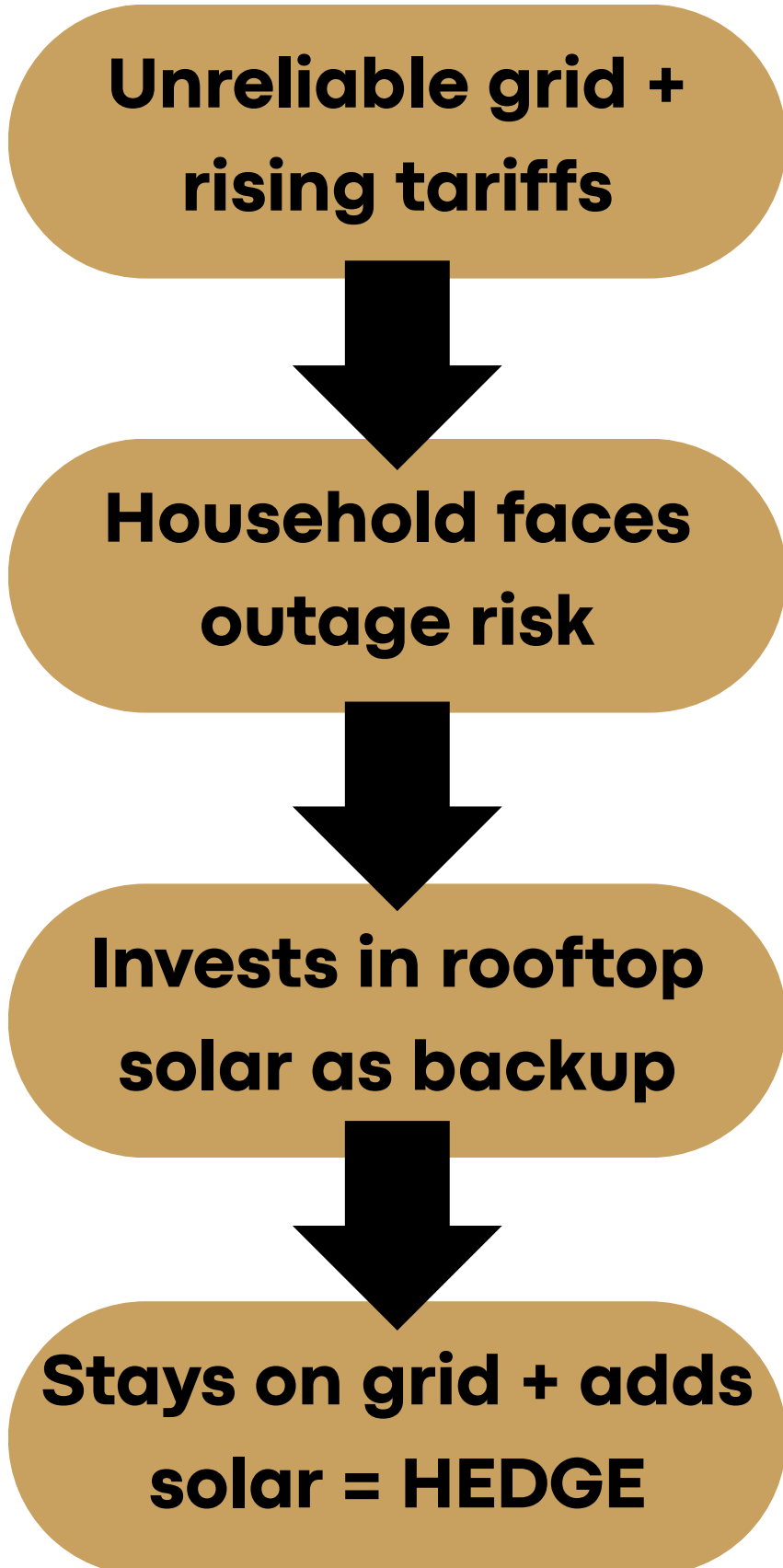
Does foreign aid for solar energy promote or crowd out household solar adoption in Pakistan?

Hypothesis:

- H1: Facilitation—Aid ↑ adoption
H2: Displacement—Aid ↓ adoption
H3: Heterogeneity—Displacement is stronger where infrastructure is better

Background Context:

- Grid electricity
- Rooftop solar
- Solar + Grid (hybrid use)



Method

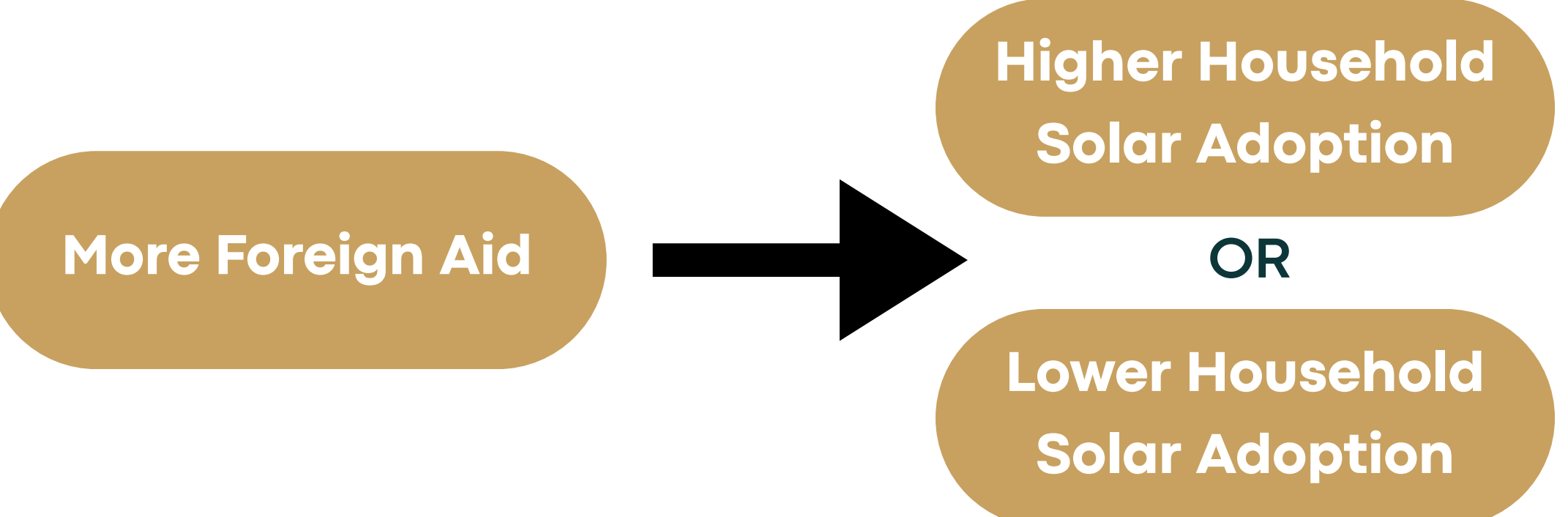
Outcome Design: Three Categories

Separating household strategies avoids mixing fundamentally different behaviors into one "solar" variable.

Grid Only	Solar + Grid	Solar Only
Public supply only	Grid-connected + solar backup	Fully off-grid
Placebo outcome	Core outcome: the hedging behavior	Off-grid exit

OLS Possibility:

OLS: The most direct approach: Ordinary Least Squares (OLS) regression — simply check whether districts receiving more solar aid have higher or lower household solar adoption rates.



Specific confounder:

- Energy poverty: Districts with worse electricity access attract more aid.
- Institutional capacity: Districts where projects are easier to implement attract donors.
- Baseline solar adoption: Districts with mature solar environments may attract more aid.
- Political targeting: Aid flows to politically connected districts (leader birth regions, co-ethnic areas).

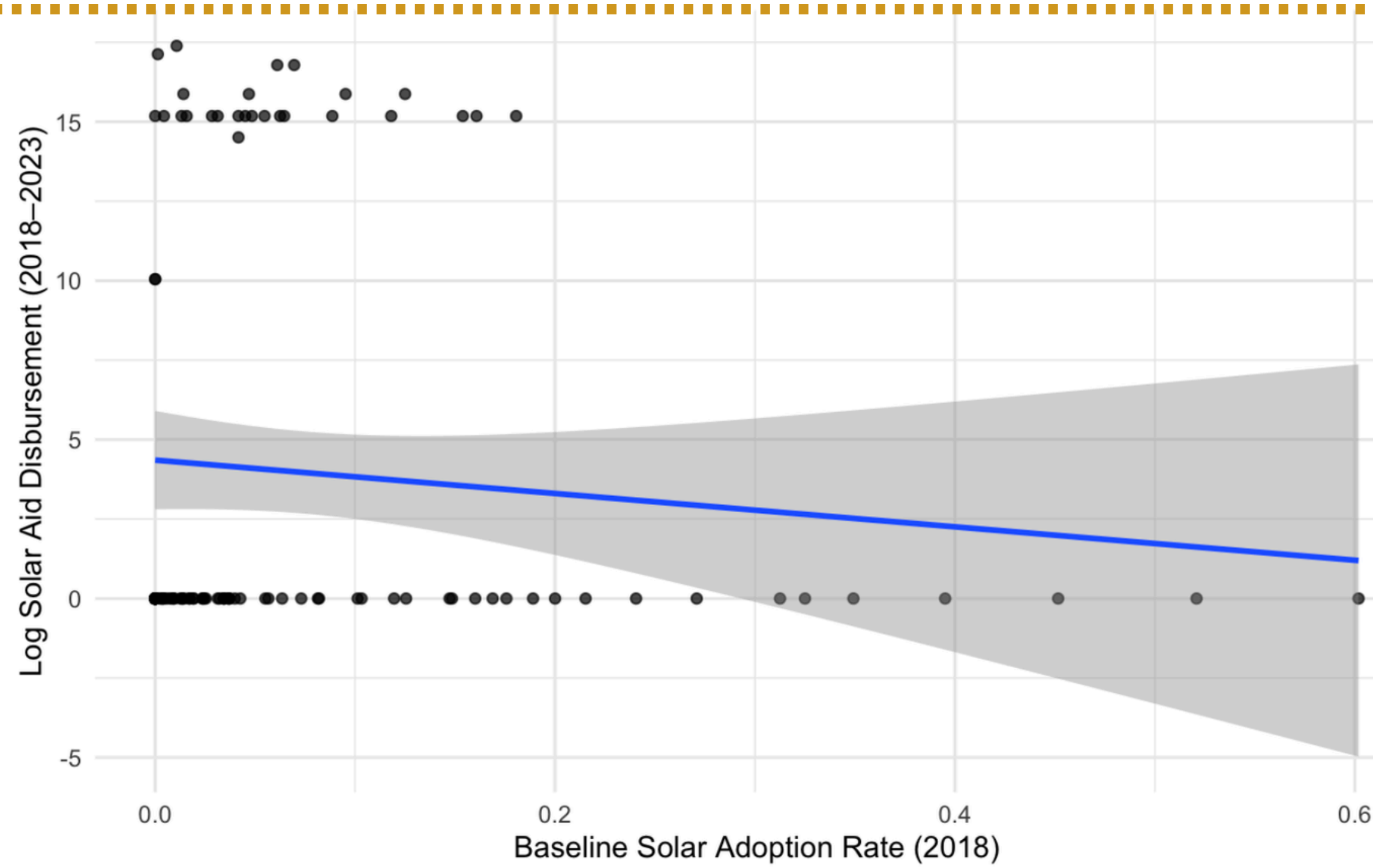
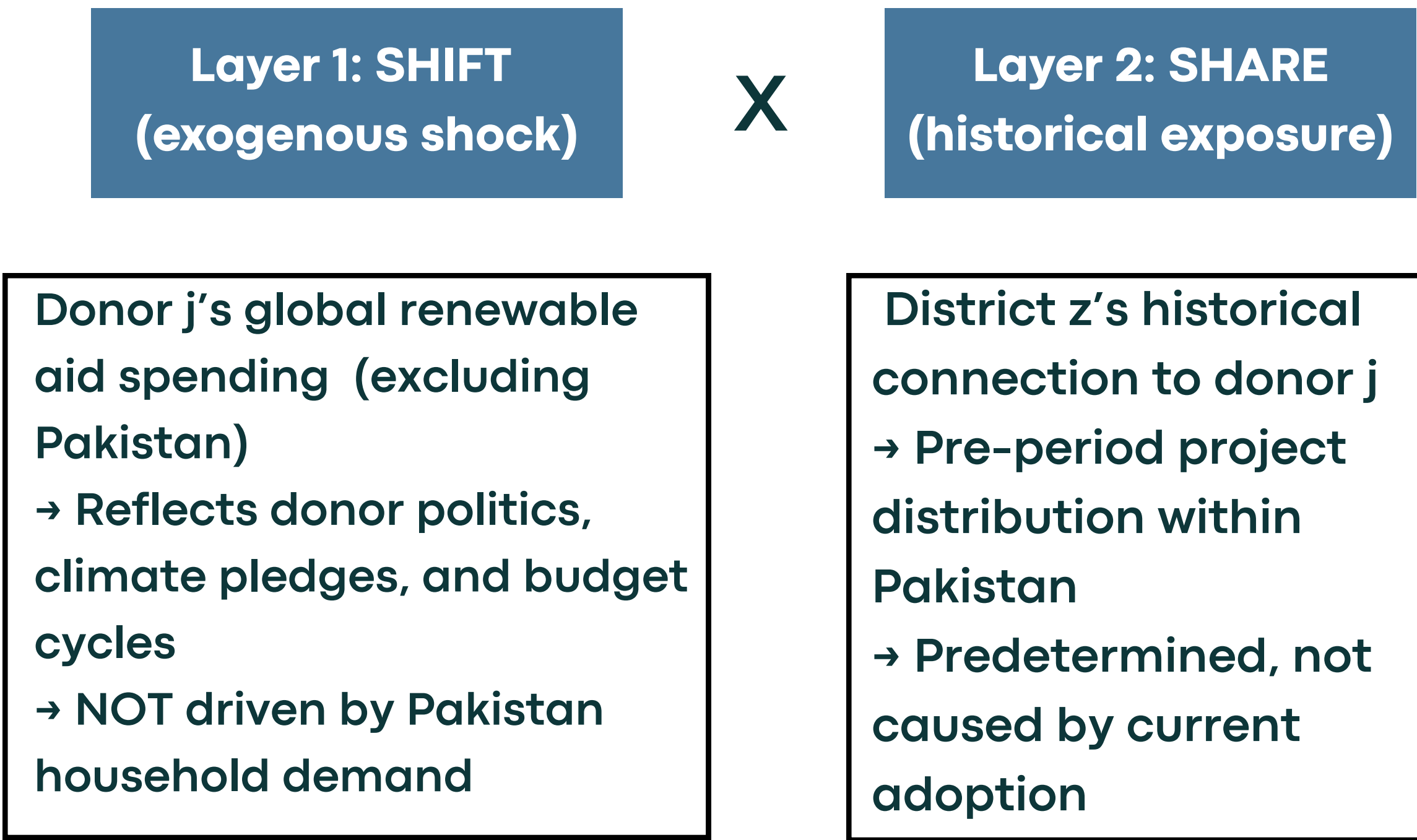


Figure 2.1: Baseline District Solar Adoption and Subsequent Solar Aid Allocation.

Why OLS fails:

- Donors do not allocate by need.
- Aid allocation is a political process, not a price signal.
- Aid is not randomly assigned across districts.
- OLS conflates cause and selection.

Two layers isolate the clean portion of aid variation



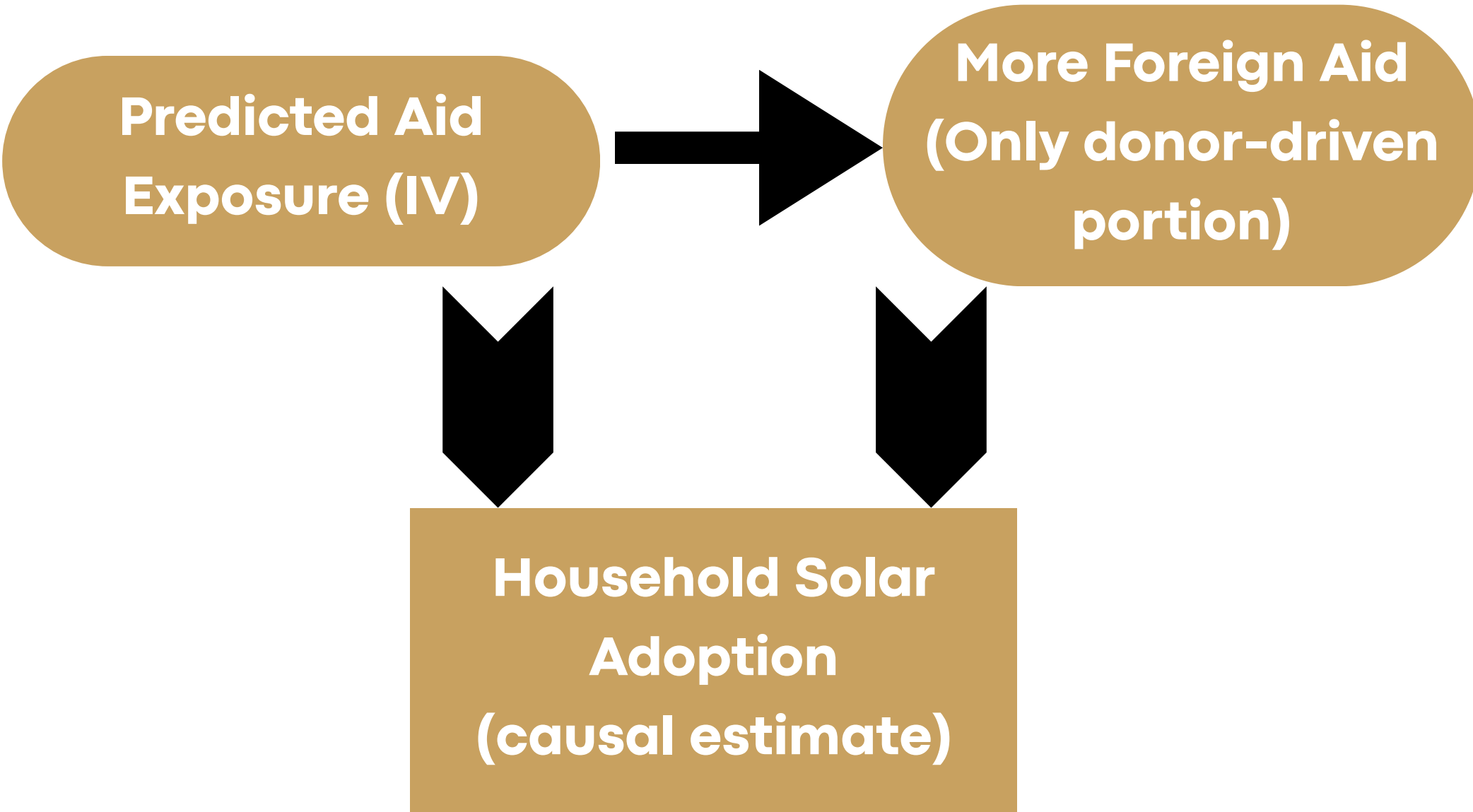
Result

Table 6.1: 2SLS Estimates of the Effect of Solar Aid on Household Solar Adoption

Panel A: First-Stage			
Solar Aid Disbursement (in log)			
Donor Renewable Aid Supply (in log)	(1)		
	-7.934*		
	(3.423)		
First-stage R ²	0.747		
Kleibergen-Paap Wald rk F-statistic	5.37		
Solar Aid Disbursement (in log)			
	Solar + Grid (1)	Solar Only (2)	Grid Only (3)
Solar Aid Disbursement (in log)	-0.048*	0.004	0.042
	(0.021)	(0.010)	(0.026)
HH Income (in log)	0.005***	-0.000	-0.004**
	(0.001)	(0.001)	(0.001)
Baseline solar adoption	✓	✓	✓
Region FE	✓	✓	✓
Province FE	✓	✓	✓
Observations	23,572	23,572	23,572

Note: *p < 0.1; **p < 0.05; ***p < 0.01; ****p < 0.001. An observation is a household. Standard errors are clustered at district level.

Stage 1: Instrument Variable



Stage 2: Aid Effect on Household Behavior?

Grid Only	Solar + Grid	Solar Only
+0.042	-4.8	+0.004

Aim

Economic Question?

- Is solar aid a complement or substitute for household solar? (as two commodities)
- Will it crowd out private adoption?

What's truly discovering? Actual aim of this study?

MECHANISM LEVEL —(POLITICAL SCIENCE)

A macro policy intervention (aid, top-down, decided by donors)

Enter

A micro behavioral pattern (household self-insurance)

Conclusion

Before:

- Households face unreliable grid
- Protect against outages and tariff volatility
- They install rooftop solar at their own expense
- This is self-insurance / hedging

After:

- Donor-funded public solar projects arrive
- Local electricity environment improves
- Households perceive lower risk
- No longer need private rooftop solar

Top-Down Macro Policy

Intervention

Bottom-Up Personal Decision

Foreign Aid On Solar Energy

Decrease in Solar + Grid

Interpret in the Context of Pakistan