Chasing the Sun

The Political Economy of Solar Industry Development

Ishana Ratan

Pre-Doctoral Fellow, Global China Initiative, Boston University,
PhD Candidate, Political Science, University of California, Berkeley

October 31, 2024

Colombia began with a bright solar future.

The Colombian Government approved 90 projects for more than 6 GW so that they can compete in the renewable energy auction

Figure 1. Energia Estrategica (August 2019)

But foreign firms are abandoning the market.

EDF Renewables Abandons Solar Energy Project in Colombia Following Regulatory Complications

Figure 2. Colombia Finance (October 2023)

THE FAILURE OF FDI?

FDI scales up and slows. Domestic firms invest slowly but steadily.

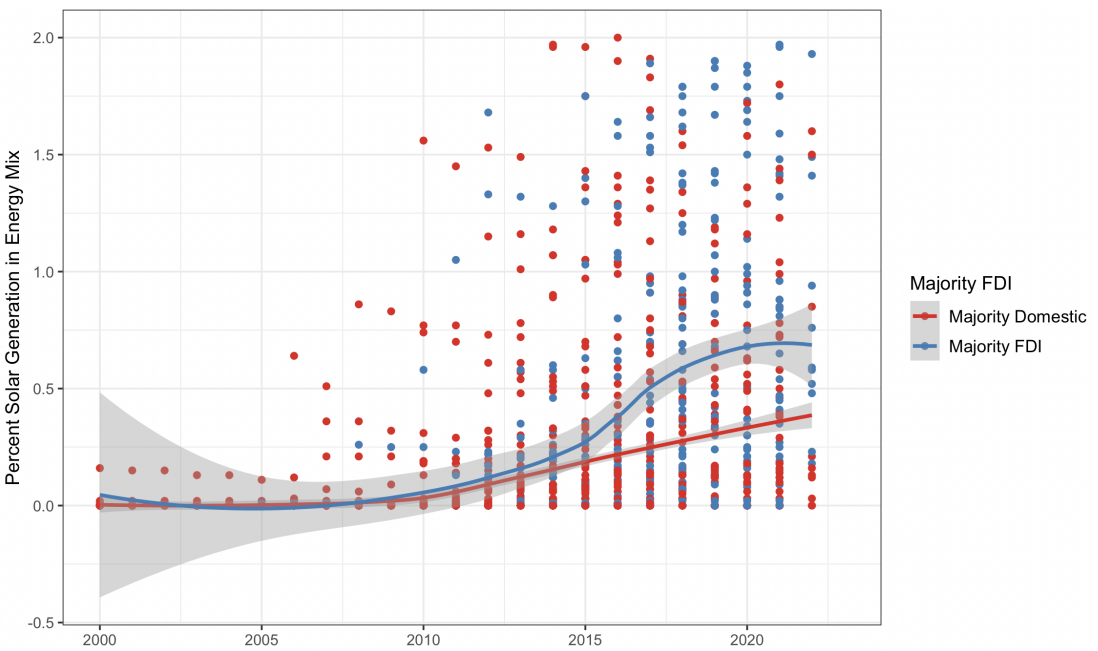


Figure 5. Solar generation in majority foreign (blue) vs. majority domestic (red) countries.

What explains variation in the rate of solar investment in the Global South?

Outline

Policy stability attracts foreign direct investment (Vernon 1971; Schneider and Frey 1985; Henisz 2000; Jensen 2012)

- However, renewable energy *requires regulatory reform* even after investments are made
- Yet there are technical and political obstacles to reform (Stokes 2020; Meckling and Trachtman 2021)

Figure 6. Utility Dive (2024)

Pro-renewables political coalitions are necessary to lobby for regulatory reform (Meckling et al. 2015; Trachtman 2021)

- The government relies on renewable energy firms for private information about policy implementation (Austen-Smith & Wright 1992)

Political economy scholarship foregrounds the influence of large, often foreign, firms over regulatory reform

- Large, foreign firms exert the most influence over regulatory standards across trade and investment (Kim 2017; Osgood 2017; Lee 2024)

- But renewable energy is decentralized (Naoi 2009) across many agencies; size can't compensate for local experience

COLOMBIA'S COFFEE SECTOR

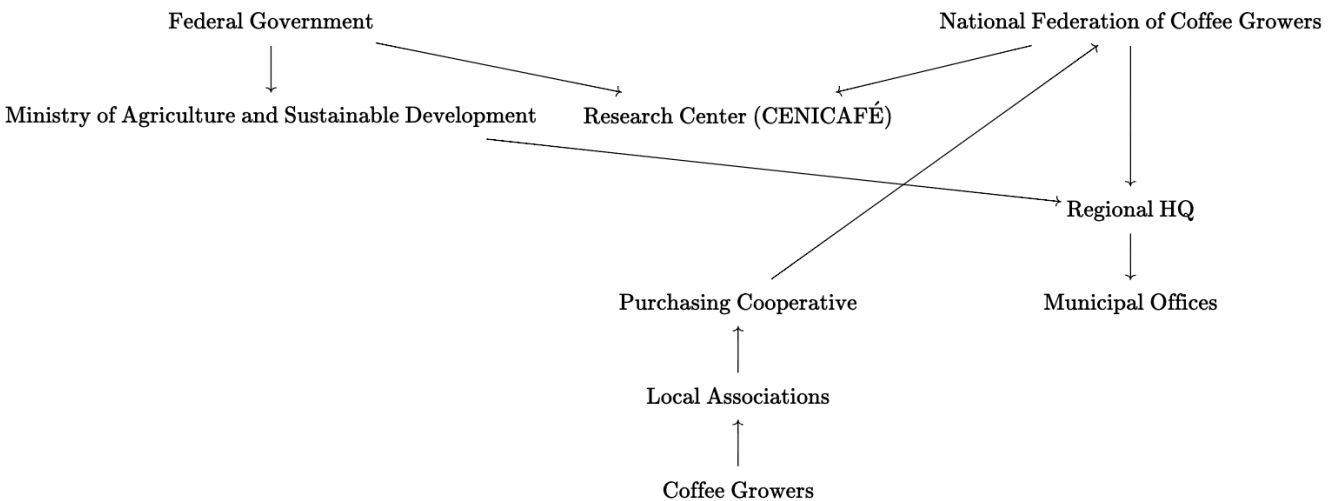


Figure 8. Adapted from Eise et. al (2021)

COLOMBIA'S RENEWABLE ENERGY SECTOR

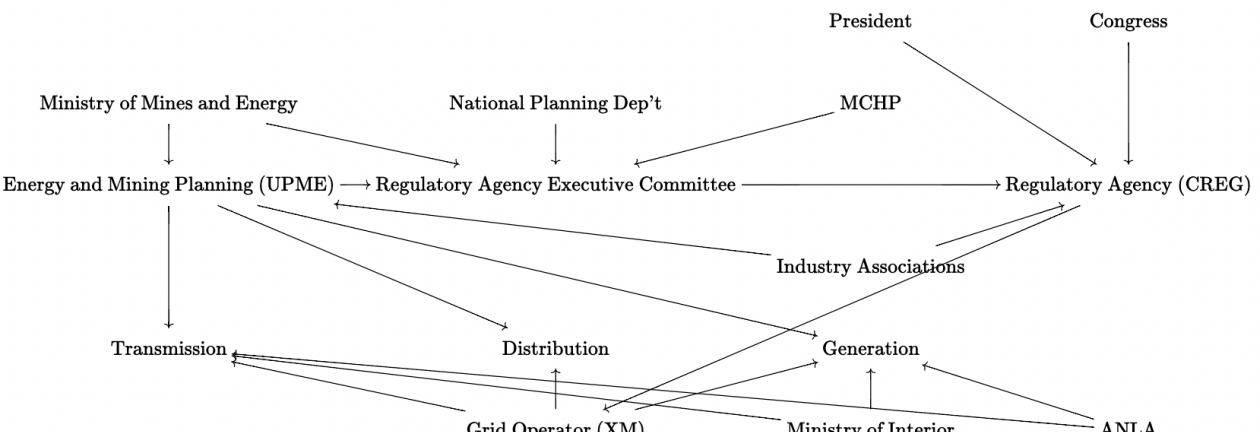


Figure 9. Adapted from Technical Assistance Report-Reforming Energy Pricing (IMF 2019)

When faced with regulatory challenges, firms can exercise **voice** or **exit** a market

- *Outside options* determine the cost of exit (Hirschmann 1970)
- *Embeddedness* determines the cost of voice (Granovetter 1985)

Outside options reduce the cost of exit (Hirschman 1970; Dowding and John 2008)

- Foreign firms can invest abroad in future periods
- Options 'atrophy the development of the art of voice' (Hirschman, 1970, p. 43)

Firms' "attempts at purposive action are instead embedded in concrete, ongoing systems of social relations." (Granovetter 1985)

- Cultural and structural embeddedness reduce the cost of voice (Granovetter 1985; Zukin and DiMaggio 1990).
- Foreign firms are less embedded in domestic networks of policy-making compared to domestic firms (Zaheer 1995; Schneider 2010)

	High Cost of Voice	**Low Cost of Voice**
Low Exit Costs	**Typical case:** Most foreign firms	Large domestic firms (uncommon)
High Exit Costs	NA	**Typical case:** Most domestic firms

Hypothesis 1: *Countries with a higher share of domestic investment adopt more renewable energy policies.*

Hypothesis 2: *In the face of regulatory challenges, domestic firms are more likely to lobby for regulatory reform.*

Empirical Approach: Mixed methods analysis

- **Quantitative:** Large-N analysis using original firm-level solar investment data
- **Qualitative:** 100 + interviews in Colombia, Panama, and Malaysia

Hypothesis 1: *Countries with a higher share of domestic investment adopt more renewable energy policies.*

Regression Analysis: Ownership and policy adoption in low-and-middle income countries (2000-2023)

- **Independent Variable:** Percentage of solar MW from domestic firms (Original data)
- **Dependent variable:** Number of renewable energy policies adopted (t+1) (Climate Policy Database; Int'l Energy Agency; Climate Laws of the World)
  - Controls: GDP, FDI, ODA, Fossil Fuel Consumption, Democracy, Trade, Population, Land
  - Specification: OLS with country and year fixed effects, SE clustered at country level

Regression Model: OLS with country and year fixed effects, SE clustered by country (2000-2023)

	Dependent variable:		
	CPD	CLW	IEA
	(1)	(2)	(3)
Percent Domestic Solar Investment	0.095***	0.117**	0.095**
	(0.030)	(0.045)	(0.045)
N	2334	2473	2187
Year FE?	Yes	Yes	Yes
Controls?	Yes	Yes	Yes
R^2	0.291	0.192	0.264
Note:	*p<0.1; **p<0.05; ***p<0.01		

Note: The DV is the number of renewable energy policies. I control for energy imports, democracy, aid, fossil fuel generation, FDI, GDP, population, and land area.

Qualitative evidence: 69 firms, 24 gov't officials, 11 non-state actors

- Cases vary by foreign investment amount (Seawright 2008)

Hypothesis 2: *In the face of regulatory challenges, domestic firms are more likely to lobby for regulatory reform.*

Domestic firms drive regulatory reform.

> *"Solar does have a limit of 30% of maximum demand, and projects in the pipeline could potentially exceed the limit.* ***But there's so much pressure from the solar industry that they have to open up the grid.****" — Bureaucrat, Ministry of Energy and Water*

Malaysia adopted iterative policies and scaled up steadily.

Mechanism	Year Started	Lead Organization	Program Specification	Key Insights
Feed-in Tariff (FiT) - Solar	2011	seda	• MYR 0.50 - 1.77/kWh • 4 kW - 30 MW • 21 years	• Discontinued in 2017 and replaced by both LSS, SELCO and NEM • Only P. Malaysia and Sabah
Large-scale Solar (LSS)	2016	Suruhanjaya Tenaga Energy Commission	• MYR 0.17 - 0.45/kWh • 1 - 100 MW • 21 years	• 3 auctions completed • 4th LSS released in 2020 with system size capped at 50 MW • Only P. Malaysia and Sabah
Solar Net Energy Metering (NEM)	2016	seda Suruhanjaya Tenaga Energy Commission	• Based on consumers retail tariff • Up to 5 MW per applicant subjected to respective sectors • 10 years (one to one offset)	• Cumulative of 1 GW capacity to promote rooftop solar market • Revision of compensation rate to 'one-on-one offset' for 10 years in 2020 to induce uptake • Implementation of VNM allowing excess energy to be exported to designated premises under wholly owned subsidiary company • Only P. Malaysia
Solar Self-consumption (SELCO)	2017	Suruhanjaya Tenaga Energy Commission	• Tariff not applicable for SELCO • 75% of max demand / 60% of fuse rating • No tenure period	• Regulation began in 2017 but activity started before 2017 • SELCO replaced NEM in Sabah starting 2019

Figure 11. Energy Commission (2023)

Foreign firms abandon contracts and exit the market.

> *"Trina Solar decided to sign a long-term contract...when [the market conditions changed],* ***they told the government that they couldn't fulfill the contract anymore.*** *This is ripping off the market." — Former Energy Commission Director*

Colombia now faces great uncertainty over renewables.

Renewables take hit as Colombia's power project pipeline shrinks

Bnamericas
Published: Tuesday, July 16, 2024

Mini Hydro | Geothermal | Natural Gas G... | Photovoltaic | Combined cycle | Show 7 more

Colombia's power generation project portfolio has shrunk by almost 9,000MW this year, amid a sharp decline in proposed renewable energy capacity.

Energy ministry planning unit UPME has 270 active projects in its registry with combined capacity of 13,826MW, down from 321 and 22,750MW on January 1, according to BNamericas research.

Figure 126. Portafolio (Bnamericas 2024)

Key finding: Domestic firms lobby for renewable energy regulatory reform, while foreign firms exit the market

"The growth rate [of renewables] shows signs of slowing...as grid bottlenecks start to take hold in some markets." — Bloomberg New Energy Finance (2024)

Broader contributions:

- In sectors with decentralized governance, domestic firms may have “outsized” influence over regulation
- Faced with regulatory challenges, domestic firms lobby for reforms that sustain competition

Green industrial policy, environmental justice, energy crisis

- *Ishana Ratan. Does Manufacturing Matter? Foreign investment and Local Linkages in the Malaysian Solar Industry. Presented at MPSA 2023; APSA 2023 (Submitted).*
- *Ishana Ratan. What Money Can't Buy: Company Experience and Local Resistance to Large Scale Renewable Energy. Presented at APSA 2024.*
- *Anthony Calacino, Jonathan Guy, Aaditee Kudrimoti, Ishana Ratan . When the River Runs Dry: The Political Economy of Hydropower Retrenchment. Presented at APSA 2023 and APSA 2024.*

Thank you!

Contact: ishanaratan@berkeley.edu

Appendix Content

Data Description

- Summary Statistics
- Snapshot of Original Dataset
- Domestic vs. Foreign Solar Investment
- Policy Database Examples
- Interview Descriptives

Background: FDI and Solar Scale-Up

- Main Result
- Regression Table (Over 2)
- Regression Table (Over 1)
- Regression Table (Over 3)

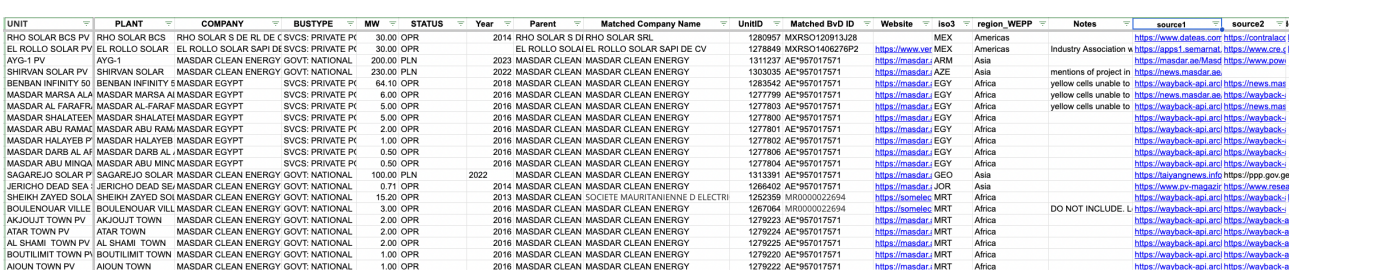
Analysis: Domestic Firms and Policy Adoption

- Policy Database Comparison
- Regression Table (Domestic Investment, CLW)
- Regression Table (Domestic Investment, CPD)
- Regression Table (Domestic Investment, IEA)
- Regression Table (Embedded Investment)
- Regression Table (Reverse Causality)

Table. Summary Statistics

Variable	Length	Mean	Min	Max
Solar Energy Share (% Generation) (Ember Climate)	2699	0.56	0	26
Count Renewable Energy Policies (CPD)	2928	0.11	0	6
Democracy (VDEM)	2673	0.44	0.067	0.92
Count Renewable Energy Policies (CLW)	2928	0.24	0	5
Energy Imports (Ember Climate)	2707	-0.027	-48	43
Percentage Foreign Investment	2928	0.2	0	1
Domestic Energy Competition (WEPP)	2720	0.4	0.00000076	1
Domestic Core Competency (OEC)	1909	-0.44	-2.8	1.4
Property Rights (VDEM)	2673	0.67	0.006	0.95
Foreign Direct Investment (net, log) (WDI)	2573	20	10	25
Trade (net) (WDI)	2563	76	2.2	348
Corruption (WDI)	2674	-0.63	-1.9	1.6
GDP per capita (log) (WDI)	2869	7.6	4.7	9.9
Count Renewable Energy Policies (IEA)	2928	0.21	0	8
Population (WDI)	2928	16	12	19
Land Area (sq. km) (WDI)	2660	12	5.7	17
Overseas Development Assistance (WDI)	2684	3.6	-2.5	6.6
Political Constraints (PolCon)	2351	0.2	0	0.72

DATA SNAPSHOT



UNIT	PLANT	COMPANY	BUSTYPE	MW	STATUS	Year	Parent	Matched Company Name	UnitID	Matched BvD ID	Website	iso3	region_WEPP	Notes	source1	source2
RHO SOLAR BCS PV	RHO SOLAR BCS	RHO SOLAR S DE RL DE C	SVCS: PRIVATE P(	30.00	OPR	2014	RHO SOLAR S DI	RHO SOLAR SRL	1280957	MXRSO120913J28		MEX	Americas		https://www.dateas.com	https://contralacc
EL ROLLO SOLAR PV	EL ROLLO SOLAR	EL ROLLO SOLAR SAPI DE	SVCS: PRIVATE P(	30.00	OPR		EL ROLLO SOLAI	EL ROLLO SOLAR SAPI DE CV	1278849	MXRSO1406276P2	https://www.ver	MEX	Americas	Industry Association w	https://apps1.semarnat.	https://www.cre.g
AYG-1 PV	AYG-1	MASDAR CLEAN ENERGY	GOVT: NATIONAL	200.00	PLN	2023	MASDAR CLEAN	MASDAR CLEAN ENERGY	1311237	AE*957017571	https://masdar.a	ARM	Asia		https://masdar.ae/Masd	https://www.pow
SHIRVAN SOLAR PV	SHIRVAN SOLAR	MASDAR CLEAN ENERGY	GOVT: NATIONAL	230.00	PLN	2022	MASDAR CLEAN	MASDAR CLEAN ENERGY	1303035	AE*957017571	https://masdar.a	AZE	Asia	mentions of project in	https://news.masdar.ae	
BENBAN INFINITY 50	BENBAN INFINITY 5	MASDAR EGYPT	SVCS: PRIVATE P(	64.10	OPR	2018	MASDAR CLEAN	MASDAR CLEAN ENERGY	1283542	AE*957017571	https://masdar.a	EGY	Africa	yellow cells unable to	https://wayback-api.arc	https://news.mas
MASDAR MARSA ALA	MASDAR MARSA AI	MASDAR EGYPT	SVCS: PRIVATE P(	6.00	OPR	2016	MASDAR CLEAN	MASDAR CLEAN ENERGY	1277799	AE*957017571	https://masdar.a	EGY	Africa	yellow cells unable to	https://news.masdar.ae	https://wayback-
MASDAR AL FARAFR	MASDAR AL-FARAF	MASDAR EGYPT	SVCS: PRIVATE P(	5.00	OPR	2016	MASDAR CLEAN	MASDAR CLEAN ENERGY	1277803	AE*957017571	https://masdar.a	EGY	Africa	yellow cells unable to	https://wayback-api.arc	https://news.mas
MASDAR SHALATEEN	MASDAR SHALATEI	MASDAR EGYPT	SVCS: PRIVATE P(	5.00	OPR	2016	MASDAR CLEAN	MASDAR CLEAN ENERGY	1277800	AE*957017571	https://masdar.a	EGY	Africa		https://wayback-api.arc	https://wayback-
MASDAR ABU RAMAD	MASDAR ABU RAM	MASDAR EGYPT	SVCS: PRIVATE P(	2.00	OPR	2016	MASDAR CLEAN	MASDAR CLEAN ENERGY	1277801	AE*957017571	https://masdar.a	EGY	Africa		https://wayback-api.arc	https://wayback-
MASDAR HALAYEB P	MASDAR HALAYEB	MASDAR EGYPT	SVCS: PRIVATE P(	1.00	OPR	2016	MASDAR CLEAN	MASDAR CLEAN ENERGY	1277802	AE*957017571	https://masdar.a	EGY	Africa		https://wayback-api.arc	https://wayback-
MASDAR DARB AL AI	MASDAR DARB AL	MASDAR EGYPT	SVCS: PRIVATE P(	0.50	OPR	2016	MASDAR CLEAN	MASDAR CLEAN ENERGY	1277806	AE*957017571	https://masdar.a	EGY	Africa		https://wayback-api.arc	https://wayback-
MASDAR ABU MINQA	MASDAR ABU MINC	MASDAR EGYPT	SVCS: PRIVATE P(	0.50	OPR	2016	MASDAR CLEAN	MASDAR CLEAN ENERGY	1277804	AE*957017571	https://masdar.a	EGY	Africa		https://wayback-api.arc	https://wayback-
SAGAREJO SOLAR P	SAGAREJO SOLAR	MASDAR CLEAN ENERGY	GOVT: NATIONAL	100.00	PLN	2022	MASDAR CLEAN	MASDAR CLEAN ENERGY	1313391	AE*957017571	https://masdar.a	GEO	Asia		https://taiyangnews.info	https://ppp.gov.ge
JERICHO DEAD SEA	JERICHO DEAD SE/	MASDAR CLEAN ENERGY	GOVT: NATIONAL	0.71	OPR	2014	MASDAR CLEAN	MASDAR CLEAN ENERGY	1266402	AE*957017571	https://masdar.a	JOR	Asia		https://www.pv-magazin	https://www.resea
SHEIKH ZAYED SOLA	SHEIKH ZAYED SOL	MASDAR CLEAN ENERGY	GOVT: NATIONAL	15.20	OPR	2013	MASDAR CLEAN	SOCIETE MAURITANIENNE D ELECTRI	1252359	MR0000022694	https://somelec	MRT	Africa		https://wayback-api.arc	https://wayback-
BOULENOUAR VILLE	BOULENOUAR VILL	MASDAR CLEAN ENERGY	GOVT: NATIONAL	3.00	OPR	2016	MASDAR CLEAN	MASDAR CLEAN ENERGY	1267064	MR0000022694	https://somelec	MRT	Africa	DO NOT INCLUDE. L	https://wayback-api.arc	https://wayback-
AKJOUJT TOWN PV	AKJOUJT TOWN	MASDAR CLEAN ENERGY	GOVT: NATIONAL	2.00	OPR	2016	MASDAR CLEAN	MASDAR CLEAN ENERGY	1279223	AE*957017571	https://masdar.a	MRT	Africa		https://wayback-api.arc	https://wayback-a
ATAR TOWN PV	ATAR TOWN	MASDAR CLEAN ENERGY	GOVT: NATIONAL	2.00	OPR	2016	MASDAR CLEAN	MASDAR CLEAN ENERGY	1279224	AE*957017571	https://masdar.a	MRT	Africa		https://wayback-api.arc	https://wayback-a
AL SHAMI TOWN PV	AL SHAMI TOWN	MASDAR CLEAN ENERGY	GOVT: NATIONAL	2.00	OPR	2016	MASDAR CLEAN	MASDAR CLEAN ENERGY	1279225	AE*957017571	https://masdar.a	MRT	Africa		https://wayback-api.arc	https://wayback-a
BOUTILIMIT TOWN P	BOUTILIMIT TOWN	MASDAR CLEAN ENERGY	GOVT: NATIONAL	1.00	OPR	2016	MASDAR CLEAN	MASDAR CLEAN ENERGY	1279220	AE*957017571	https://masdar.a	MRT	Africa		https://wayback-api.arc	https://wayback-a
AIOUN TOWN PV	AIOUN TOWN	MASDAR CLEAN ENERGY	GOVT: NATIONAL	1.00	OPR	2016	MASDAR CLEAN	MASDAR CLEAN ENERGY	1279222	AE*957017571	https://masdar.a	MRT	Africa		https://wayback-api.arc	https://wayback-a
SHERABAD SOLAR P	SHERABAD SOLAR	MASDAR CLEAN ENERGY	GOVT: NATIONAL	457.00	CON	2022	MASDAR CLEAN	MASDAR CLEAN ENERGY	1310666	AE*957017571	https://masdar.a	UZB	Asia	global ultimate owner	https://masdar.ae/Masd	https://www.powe
SAMARKAND SOLAR	SAMARKAND SOLA	MASDAR CLEAN ENERGY	GOVT: NATIONAL	200.00	PLN		MASDAR CLEAN	MASDAR CLEAN ENERGY	1310538	AE*957017571	https://masdar.a	UZB	Asia		https://masdar.ae/Masd	https://www.ebrd.
JIZZAX SOLAR PV	JIZZAX SOLAR	MASDAR CLEAN ENERGY	GOVT: NATIONAL	200.00	PLN		MASDAR CLEAN	MASDAR CLEAN ENERGY	1310537	AE*957017571	https://masdar.a	UZB	Asia		https://masdar.ae/Masd	https://www.adb.c
NUR NAVOI SOLAR P	NUR NAVOI SOLAR	MASDAR CLEAN ENERGY	GOVT: NATIONAL	100.00	OPR	2021	MASDAR CLEAN	MASDAR CLEAN ENERGY	1250872	AE*957017571	https://masdar.a	UZB	Asia		https://web.archive.org/	https://www.ebrd
FRESH FRUITS SOLA	FRESH FRUITS SOI	FRESH FRUITS CO	COMM: RETAIL	2.01	OPR	2017	FRESH FRUITS C	FRESH FRUITS COMPANY GENERAI	1258998	AE0000388996	https://freshfruit	JOR	Asia		http://www.control-solar	https://www.enfso
BENBAN ACCESS/ER	BENBAN ACCESS/E	ACCESS POWER MEA	SVCS: PRIVATE P(	50.00	OPR	2019	ACCESS POWER	ACCESS POWER MEA	1268474	AE0048410638	https://access-s	EGY	Africa		https://wayback-api.arc	https://wayback-
BENBAN ACCESS/ER	BENBAN ACCESS/E	ACCESS POWER MEA	SVCS: PRIVATE P(	50.00	OPR	2019	ACCESS POWER	ACCESS POWER MEA	1292757	AE0048410638	https://access-s	EGY	Africa		https://wayback-api.arc	https://wayback-
SOROTI1 SOLAR PV	SOROTI SOLAR	ACCESS POWER MEA	SVCS: PRIVATE P(	10.00	OPR	2016	ACCESS POWER	ACCESS POWER MEA	1266087	AE0048410638	https://access-s	UGA	Africa	Dual ownership	https://wayback-api.arc	
PIND DADAN-2 PV	PIND DADAN-2	TECHACCESS	SVCS: PRIVATE P(	11.50	PLN	2016	TECHACCESS	TECH ACCESS ASIA FZ-LLC	1267074	AE0087809705	https://techacce	PAK	Asia	Changed "Matched Cc	https://www.enfsolar.co	https://www.prnev
PIND DADAN-1 PV	PIND DADAN-1	TECHACCESS	SVCS: PRIVATE P(	11.50	PLN	2016	TECHACCESS	TECH ACCESS ASIA FZ-LLC	1267073	AE0087809705	https://techacce	PAK	Asia	Changed "Matched Cc	https://www.enfsolar.co	https://www.prnev
CHERIKOV SOLAR PV	CHERIKOV SOLAR	SOLAR LAND LLC	SVCS: PRIVATE P(	109.00	OPR	2019	UNITED GREEN	UNITED GREEN FZE	1275273	AE0119921429	https://unitedgn	BLR	Europe	London Based Compe	https://www.pv-magazir	https://sngsolar.c
KANDAHAR SOLAR P	KANDAHAR SOLAR	SOLARISTAN	SVCS: PRIVATE P(	30.00	PLN	2019	SOLARISTAN	ZULARISTAN	1290572	AF000064012AFG	https://www.zul	AFG	Asia		https://www.pv-tech.org	https://www.powe
UKKO SOLAR PV	UKKO SOLAR	UJESJELLES KANALIZIME	UTIL: WATER WAS	1.00	OPR	2015	UJESJELLES KA	UJESJELLES KANALIZIME KORCE S	1292403	ALJ64103141O	https://www.shi	ALB	Europe	Hard to find sources. I	http://www.akbn.gov.al/wp-content/upload	
SEMAN SUNPOWER I	SEMAN SUNPOWEI	SEMAN SUNPOWER SHPK	SVCS: PRIVATE P(	1.90	OPR	2019	SEMAN SUNPOW	SEMAN SUNPOWER	1290602	ALK81722018P	https://opencori	ALB	Europe	Company does not ha	https://www.pv-magazir	https://www.ocnr
TAVUSH SOLAR PV	TAVUSH SOLAR	SOLARON	SVCS: PRIVATE P(	0.15	OPR	2017	SOLARON	PROFPANEL SPY	1290567	AM038.110.58885	https://www.sol	ARM	Asia	Profpanel is the paren	https://www.solaron.am/en/projects/Comm	
PS PASIP PV	PS PASIP	LA COOP EMPRESA ELEC	UTIL: GOVT OWNE	1.89	OPR	2019	LA COOP EMPRE	LA COOP EMPRESA ELECTRICA DE	1282252	AR30-54571754-5	https://www.cec	ARG	Americas	JV with Emesa	https://web.archive.org/	https://www.losan
EL BORBOLLON VER	EL BORBOLLON VE	UNIVERSIDAD NACIONAL	UTIL: GOVT OWNE	0.01	OPR	2020	UNIVERSIDAD N	UNIVERSIDAD NACIONAL DE CUYO	1313619	AR30-54666946-3	https://www.uni	ARG	Americas	JV with EMPRESA MI	https://web.archive.org/	https://wayback-a
YPF PS ZONDA-III PV	YPF PS ZONDA-I	YPF ENERGIA ELEC SA (Y	SVCS: PRIVATE P(	100.00	PLN		YPF SA	YPF SOCIEDAD ANONIMA	1313937	AR30-54668997-9	https://www.ypf	ARG	Americas		https://web.archive.org/	https://wayback-
YPF PS ZONDA-II PV	YPF PS ZONDA-I	YPF ENERGIA ELEC SA (Y	SVCS: PRIVATE P(	100.00	PLN		YPF SA	YPF SOCIEDAD ANONIMA	1313936	AR30-54668997-9	https://www.ypf	ARG	Americas		https://web.archive.org/	https://wayback-
YPF PS ZONDA-I PV	YPF PS ZONDA-I	YPF ENERGIA ELEC SA (Y	SVCS: PRIVATE P(	100.00	CON	2023	YPF SA	YPF SOCIEDAD ANONIMA	1313607	AR30-54668997-9	https://www.ypf	ARG	Americas		https://web.archive.org/	https://wayback-
EL BORBOLLON VER	EL BORBOLLON VE	MUNICIPALIDAD DE GENE	UTIL: GOVT OWNE	0.01	OPR	2020	MUNICIPALIDAD	MUNICIPALIDAD DE GENERAL LAS I	1313619	AR30-66454342-3		ARG	Americas	JV with EMPRESA MI	https://web.archive.org/	https://wayback-a
PS SIERRAS DE ULL	PS SIERRAS DE UL	GENNEIA SA	SVCS: PRIVATE P(	80.00	CON	2022	GENNEIA SA	GENNEIA S.A.	1313745	AR30-66523411-4	https://www.ger	ARG	Americas	This and the other 3 pla	https://www.power-tech	https://es.us.finar
PS SIERRAS DE ULL	PS SIERRAS DE UL	GENNEIA SA	SVCS: PRIVATE P(	32.00	OPR	2018	GENNEIA SA	GENNEIA S.A.	1313744	AR30-66523411-4	https://www.ger	ARG	Americas		https://www.power-tech	https://renewables
PS SIERRAS DE ULL	PS SIERRAS DE UL	GENNEIA SA	SVCS: PRIVATE P(	25.00	OPR	2018	GENNEIA SA	GENNEIA S.A.	1239691	AR30-66523411-4	https://www.ger	ARG	Americas		https://www.globaldata.c	https://renewable
PS SIERRAS DE ULL	PS SIERRAS DE UL	GENNEIA SA	SVCS: PRIVATE P(	25.00	OPR	2018	GENNEIA SA	GENNEIA S.A.	1313743	AR30-66523411-4	https://www.ger	ARG	Americas	Additional source has a	https://www.power-tech	https://renewables
CHIMBERA SOLAR-II	CHIMBERA SOLAR	GENNEIA SA	SVCS: PRIVATE P(	8.00	PLN		GENNEIA SA	GENNEIA S.A.	1227486	AR30-66523411-4	https://www.ger	ARG	Americas	Wrong matched compar	https://cdm.unfccc.int/Us	https://web.archiv
CHIMBERA SOLAR-I F	CHIMBERA SOLAR	GENNEIA SA	SVCS: PRIVATE P(	2.00	OPR	2013	GENNEIA SA	GENNEIA S.A.	1227485	AR30-66523411-4	https://www.ger	ARG	Americas	MV ramped up to 7 MV	https://web.archive.org/	https://www.pv-m

Snapshot of Solar Data Collection: This dataset includes project level details about company ownership of solar projects in low and middle income countries, and information about company website.

Histogram: Distribution of Foreign Solar Investment

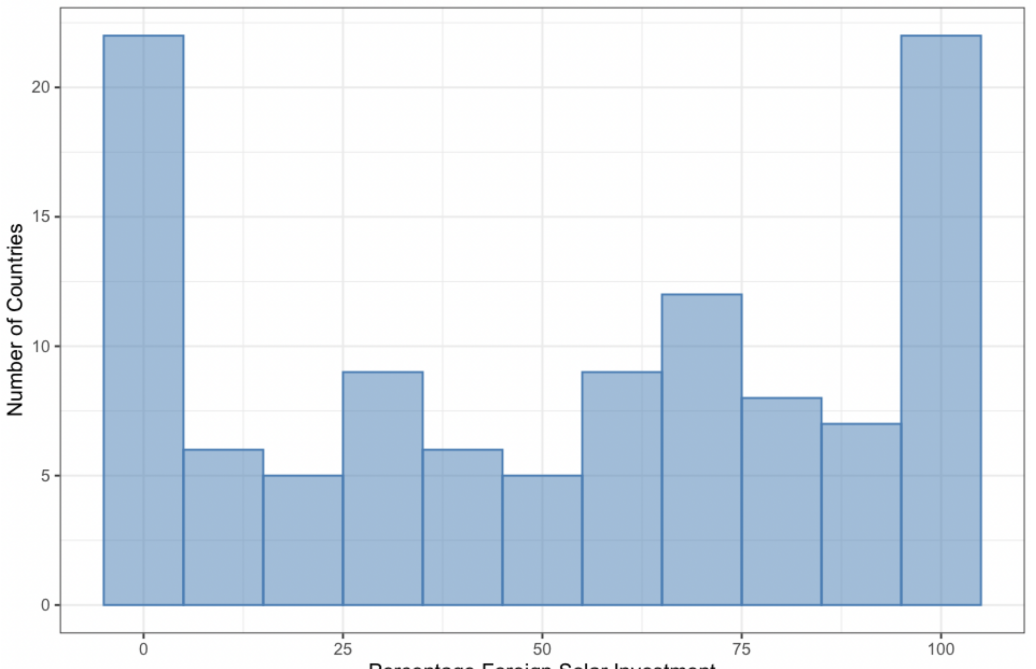


Figure 5. The x-axis shows the percent of foreign solar investment in low and middle income countries (2023).

Appendix

Analysis: Policy Adoption

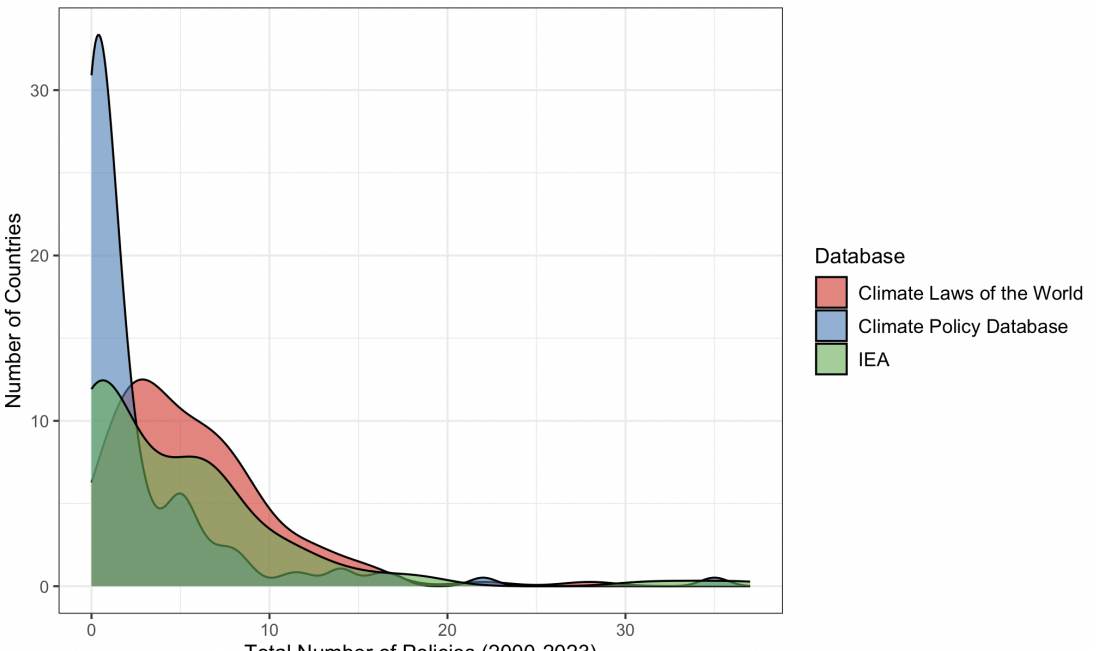


Figure 10. Number of renewable energy policies per country (2000-2023)

Examples of renewable energy policies:

- "New auction of renewable energy towards the energy transition" (IEA)
- "Decree 829 - Tax incentives for non-conventional renewable energy" (CLW)
- "Law 1715, regulating the integration and promotion of non-conventional renewable energy in the national energy system" (CPD)
- "Generation and Transmission Expansion Plan 2016-2030" (IEA)

Policy Database Example (Climate Policy Database)

country_iso	decision_date	policy_name
COL	2002	Law 788/2002, establishing the Tax Reform Colombia (2002)
COL	2003	Rural Electrification Fund Colombia (2003)
COL	2014	Law 1715, regulating the integration and promotion of non-conventional renewable energy to the national energy system Colombia (2014)
COL	2014	Implementation of Mechanisms of Electricity Demand Response (Decree 2492/2014) Colombia (2014)
COL	2017	Generation and Transmission Expansion Plan 2016-2030 Colombia (2017)
COL	2017	Electric Coverage Expansion Plan 2016-2020 (PIEC) Colombia (2017)
COL	2019	Non-conventional renewable energy auction Colombia (2019)
COL	2019	Renewable energy target Colombia (2019)
COL	2020	Decree 829 - Tax incentives for non-conventional renewable energies - streamlined procedure Colombia (2020)
COL	2020	New mechanism to provide energy service to more Colombian homes Colombia (2020)
COL	2021	Ten milestones for the mining and energy sector Colombia (2021)
COL	2021	Rules of the 2021 Renewable Energy Auction Colombia (2021)
COL	2021	Reactivation, Recovery and Sustainable & Inclusive Growth "Compromiso por el futuro de Colombia" Colombia (2021)
COL	2021	Renewable energy Auction Colombia (2021)
COL	2021	First audtion of Energy Storage System with Batteries Colombia (2021)
COL	2021	Energy Transition Roadmap Colombia (2021)
COL	2022	Resolution 40715/2019: Wholesale Energy Market with RES Colombia (2022)

Climate Policy Database Policy List. The figure shows the list of Climate Policy Database policies in Colombia that count towards my measure of renewable energy policy adoption.

Interviews by country and interviewee type.

Table. Agency Type by Country and Actor Characteristics

Country	Association	Government	Industry	Total
Panama	2	2	16	20
Malaysia	1	10	17	28
Colombia	4	11	30	45
Other	1	1	6	8

Analysis 1: Ownership and the pace of solar deployment

- **Independent Variable:** Percentage of solar capacity from foreign firms (Original data)
- **Dependent variable:** Time until solar reaches two percent of the energy mix (kwH) (Ember Climate)
  - Controls: Corruption, Fossil Fuel Consumption, Energy Imports, GDP, FDI, Democracy, Trade, Population, Land Area (WDI)
  - Specification: Survival analysis with year fixed effects, SE clustered at country level

APPENDIX

BACKGROUND: FDI SCALES SOLAR

Table. FDI and Solar Scale Up

	Dependent variable:	
	Time to X Percent	
	Two Percent	Three Percent
	(1)	(2)
Percent Foreign Solar Investment	1.255**	1.189*
	(0.457)	(0.481)
Controls?	Y	Y
Observations	2,143	2,186
Akaike Inf. Crit.	321.414	304.973
Note:	*p<0.05; **p<0.01; ***p<0.001	

Regression Table: Solar Scale Up (Over 2)

	Model 1 (VDem)	Model 2 (VDem)	Model 3 (PolCon)	Model 4 (PolCon)
(Intercept)	−22.227	−22.406	−19.724	−22.019
	(2992.272)	(2809.002)	(3064.651)	(2817.998)
Percent Foreign Solar	1.005*	1.255**	1.234*	1.415**
	(0.474)	(0.457)	(0.536)	(0.534)
Energy Imports	0.017	0.016	0.015	0.016
	(0.037)	(0.038)	(0.042)	(0.044)
Democracy	0.972	0.024		
	(1.104)	(1.069)		
Fossil Fuel Gen.	0.002	0.003	0.002	0.004
	(0.003)	(0.003)	(0.003)	(0.003)
Trade	0.005	0.004	0.004	0.006
	(0.005)	(0.005)	(0.006)	(0.006)
GDP (per capita)	−0.225	−0.297	−0.224	−0.480+
	(0.301)	(0.231)	(0.325)	(0.261)
FDI	0.063		−0.005	
	(0.195)		(0.207)	
Total_policies	0.019		0.058	
	(0.049)		(0.051)	
Land Area	−0.267	−0.225	−0.171	−0.155
	(0.173)	(0.172)	(0.197)	(0.200)
Population	0.199	0.334	0.079	0.329
	(0.287)	(0.207)	(0.320)	(0.236)
Corruption		0.952*		1.371**
		(0.401)		(0.431)
Political Constraints			0.040	0.087
			(0.972)	(0.964)
Num.Obs.	2093	2143	1914	1946
AIC	319.1	321.4	269.7	260.0
BIC	499.8	491.5	447.5	427.2
Log.Lik.	−127.573	−130.707	−102.847	−99.979

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression Table: Solar Scale Up (Over 1)

	Model 1 (VDem)	Model 2 (VDem)	Model 3 (PolCon)	Model 4 (PolCon)
(Intercept)	−21.321	−21.244	−18.589	−20.416
	(2989.437)	(2800.826)	(3063.749)	(2853.523)
Percent Foreign Solar	0.822*	1.141**	1.043*	1.246**
	(0.382)	(0.366)	(0.411)	(0.399)
Energy Imports	0.024	0.025	0.029	0.027
	(0.027)	(0.028)	(0.028)	(0.029)
Democracy	1.107	−0.154		
	(0.874)	(0.839)		
Fossil Fuel Gen.	−0.001	0.001	−0.002	0.000
	(0.002)	(0.002)	(0.003)	(0.003)
Trade	0.003	0.002	0.002	0.002
	(0.004)	(0.004)	(0.005)	(0.004)
GDP (per capita)	−0.198	−0.212	−0.182	−0.244
	(0.245)	(0.189)	(0.263)	(0.203)
FDI	0.132		0.102	
	(0.161)		(0.167)	
Total policies	0.008		0.040	
	(0.042)		(0.045)	
Land Area	−0.219	−0.141	−0.196	−0.137
	(0.144)	(0.142)	(0.159)	(0.156)
Population	0.036	0.193	−0.080	0.151
	(0.234)	(0.165)	(0.258)	(0.181)
Corruption		1.100***		1.037***
		(0.302)		(0.310)
Political Constraints			0.023	−0.233
			(0.763)	(0.747)
Num.Obs.	2023	2070	1859	1889
AIC	423.2	429.3	370.9	370.3
BIC	602.8	598.4	547.8	536.7
Log.Lik.	−179.618	−184.655	−153.468	−155.169

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression Table: Solar Scale Up (Over 3)

	Model 1 (VDem)	Model 2 (VDem)	Model 3 (PolCon)	Model 4 (PolCon)
(Intercept)	−26.919	−24.802	−27.925	−24.230
	(2954.177)	(2815.562)	(4983.799)	(4679.705)
Percent Foreign Solar	0.995*	1.189*	1.251*	1.360*
	(0.502)	(0.481)	(0.583)	(0.572)
Energy Imports	−0.027	−0.035	−0.028	−0.050
	(0.033)	(0.033)	(0.034)	(0.035)
Democracy	1.908	1.021		
	(1.202)	(1.180)		
Fossil Fuel Gen.	−0.001	−0.001	−0.001	−0.001
	(0.003)	(0.003)	(0.004)	(0.004)
Trade	0.013*	0.010*	0.009	0.007
	(0.005)	(0.005)	(0.007)	(0.007)
GDP (per capita)	0.013	−0.138	0.296	−0.150
	(0.319)	(0.232)	(0.376)	(0.269)
FDI	−0.104		−0.169	
	(0.196)		(0.207)	
Total_policies	−0.030		−0.112	
	(0.062)		(0.108)	
Land Area	−0.186	−0.167	−0.149	−0.167
	(0.186)	(0.183)	(0.224)	(0.229)
Population	0.477	0.323	0.468	0.283
	(0.314)	(0.218)	(0.377)	(0.279)
Corruption		0.439		0.980*
		(0.404)		(0.426)
Political Constraints			1.200	1.148
			(1.052)	(1.060)
Num.Obs.	2133	2186	1944	1978
AIC	294.5	305.0	238.0	236.7
BIC	475.8	475.7	416.3	404.4
Log.Lik.	−115.234	−122.487	−86.999	−88.344

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Policy Database Comparison

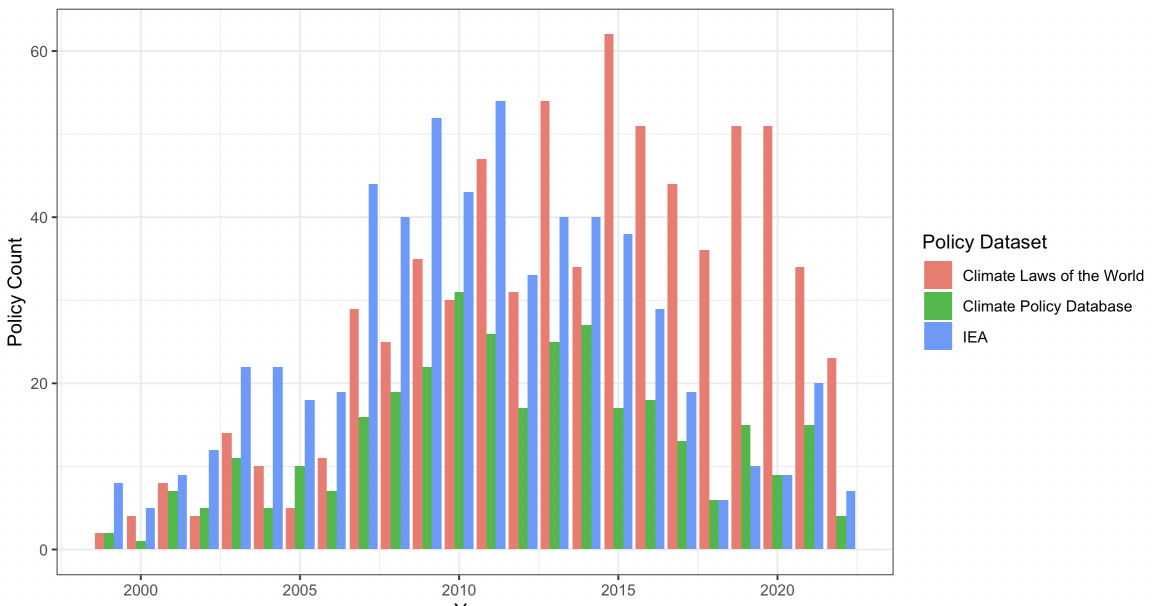


Figure A.3: Policy Adoption Measurement Discrepancies. The x-axis shows year of policy adoption. The y-axis shows the total annual count of policies as recorded by the Climate Policies Database, Climate Laws of the World, and International Energy Agency Policy Database.

REGRESSION TABLE: POLICY ADOPTION, CLW

Table A.3.2: Domestic Firms and Policy Adoption, Climate Laws of the World

	Model 1 (Domestic Share)	Model 2 (Count of Firms)	Model 3 (Count of Projects)
Percent Domestic Solar	0.100*		
	(0.046)		
Count Domestic Firms (log)		0.167***	
		(0.033)	
Count Domestic Projects (log)			0.151***
			(0.028)
Energy Imports	0.000	−0.001	−0.002
	(0.007)	(0.007)	(0.007)
Democracy	−0.219	−0.155	−0.138
	(0.152)	(0.152)	(0.152)
Development Aid	−0.004	−0.006	−0.007
	(0.024)	(0.024)	(0.024)
Fossil Fuel Gen.	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)
FDI	0.003	0.002	0.003
	(0.014)	(0.013)	(0.013)
GDP (per capita)	−0.017	−0.005	−0.006
	(0.052)	(0.052)	(0.052)
Population	−0.461**	−0.404*	−0.398*
	(0.166)	(0.166)	(0.166)
Land Area	0.750	0.393	0.396
	(0.809)	(0.801)	(0.800)
(Intercept)	−2.024	1.776	1.636
	(11.112)	(11.007)	(10.999)
Num.Obs.	2334	2334	2334
R2	0.192	0.199	0.200
R2 Adj.	0.138	0.146	0.147
Log.Lik.	−1786.967	−1776.037	−1774.568
F	3.555	3.730	3.753
RMSE	0.52	0.52	0.52

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

REGRESSION TABLE: POLICY ADOPTION, CPD

Table A.3.3: Domestic Firms and Policy Adoption, Climate Policy Database

	Model 1 (Domestic Share)	Model 2 (Count of Firms)	Model 3 (Count of Projects)
Percent Domestic Solar	0.083**		
	(0.030)		
Count Domestic Firms (log)		0.037+	
		(0.022)	
Count Domestic Projects (log)			0.036+
			(0.019)
Energy Imports	0.008+	0.008+	0.008+
	(0.004)	(0.004)	(0.004)
Democracy	0.015	0.019	0.024
	(0.101)	(0.101)	(0.101)
Development Aid	0.001	−0.001	−0.001
	(0.016)	(0.016)	(0.016)
Fossil Fuel Gen.	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
FDI	0.000	−0.002	−0.002
	(0.009)	(0.009)	(0.009)
GDP (per capita)	0.005	0.011	0.011
	(0.034)	(0.034)	(0.034)
Population	−0.139	−0.120	−0.118
	(0.110)	(0.110)	(0.110)
Land Area	0.438	0.243	0.241
	(0.536)	(0.534)	(0.533)
(Intercept)	−3.638	−1.314	−1.324
	(7.362)	(7.335)	(7.333)
Num.Obs.	2334	2334	2334
R2	0.290	0.289	0.289
R2 Adj.	0.243	0.241	0.242
Log.Lik.	−826.214	−828.713	−828.280
F	6.129	6.084	6.091
RMSE	0.34	0.35	0.35

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression Table: Policy Adoption, IEA

Table. Table A.3.4: Domestic Firms and Renewable Energy Policy Adoption

	Model 1 (Domestic Share)	Model 2 (Count of Firms)	Model 3 (Count of Projects)
Percent Domestic Solar	0.094*		
	(0.045)		
Count Domestic Firms (log)		0.088**	
		(0.033)	
Count Domestic Projects (log)			0.071*
			(0.028)
Energy Imports	0.000	0.000	0.000
	(0.007)	(0.007)	(0.007)
Democracy	0.111	0.138	0.141
	(0.151)	(0.152)	(0.152)
Development Aid	0.006	0.004	0.003
	(0.024)	(0.024)	(0.024)
Fossil Fuel Gen.	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)
FDI	−0.009	−0.010	−0.010
	(0.013)	(0.013)	(0.013)
GDP (per capita)	0.017	0.026	0.025
	(0.052)	(0.052)	(0.052)
Population	−0.251	−0.217	−0.217
	(0.165)	(0.165)	(0.165)
Land Area	0.103	−0.165	−0.154
	(0.803)	(0.798)	(0.798)
(Intercept)	2.715	5.739	5.595
	(11.034)	(10.974)	(10.975)
Num.Obs.	2334	2334	2334
R2	0.263	0.264	0.264
R2 Adj.	0.214	0.215	0.215
Log.Lik.	−1770.618	−1769.111	−1769.579
F	5.359	5.385	5.377
RMSE	0.52	0.52	0.52

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression Table: Embedded Investment

Table A.3.5: Embedded Investment and Policy Adoption

	Model 1 (CPD)	Model 2 (CPD)	Model 3 (CLW)	Model 4 (CLW)	Model 5 (IEA)	Model 6 (IEA)
(Intercept)	−2.917	−3.427	−0.655	−0.821	3.832	3.855
	(7.351)	(7.810)	(11.094)	(11.803)	(11.017)	(11.720)
Percent Embedded Solar	0.056*	0.054+	0.057	0.053	0.049	0.046
	(0.028)	(0.029)	(0.042)	(0.044)	(0.042)	(0.044)
Energy Imports	0.008+	0.008+	0.000	0.000	0.001	0.000
	(0.004)	(0.005)	(0.007)	(0.007)	(0.007)	(0.007)
Democracy	0.011		−0.227		0.105	
	(0.101)		(0.152)		(0.151)	
Development Aid	0.001	−0.002	−0.005	−0.013	0.004	0.004
	(0.016)	(0.017)	(0.024)	(0.025)	(0.024)	(0.025)
Fossil Fuel Gen.	0.000	0.000	−0.001	−0.001	0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
FDI	−0.001	0.000	0.004	0.004	−0.009	−0.009
	(0.009)	(0.010)	(0.014)	(0.014)	(0.013)	(0.014)
GDP (per capita)	0.008	−0.001	−0.014	−0.044	0.019	0.017
	(0.034)	(0.037)	(0.052)	(0.056)	(0.052)	(0.056)
Population	−0.127	−0.065	−0.458**	−0.476**	−0.239	−0.161
	(0.110)	(0.118)	(0.165)	(0.178)	(0.164)	(0.177)
Land Area	0.370	0.343	0.643	0.702	0.005	−0.081
	(0.535)	(0.567)	(0.807)	(0.857)	(0.801)	(0.851)
Corruption		0.094*		0.119+		0.103
		(0.042)		(0.063)		(0.063)
Num.Obs.	2336	2237	2336	2237	2336	2237
R2	0.289	0.296	0.191	0.192	0.262	0.265
F	6.103	6.063	3.534	3.429	5.336	5.204

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression Table: Reverse Causality

Table A.3.6: Reverse Causality Test (IEA)

	Model 1 (Percent Domestic)	Model 2 (No. Domestic Firms)	Model 3 (No. Domestic Projects)
(Intercept)	29.174***	−10.563	−11.536
	(5.131)	(6.822)	(8.044)
IEA Policy	0.009	−0.041**	−0.044**
	(0.010)	(0.013)	(0.015)
Energy Imports	0.003	0.004	0.009+
	(0.003)	(0.004)	(0.005)
Democracy	−0.204**		
	(0.070)		
FDI	−0.020**	−0.008	−0.010
	(0.006)	(0.008)	(0.010)
Fossil Fuel Gen.	0.000	−0.001+	−0.001+
	(0.000)	(0.000)	(0.000)
Development Aid	−0.047***	−0.024+	−0.030+
	(0.011)	(0.014)	(0.017)
GDP (per capita)	0.034	−0.073*	−0.080*
	(0.024)	(0.031)	(0.037)
Population	−0.017	−0.246*	−0.304**
	(0.077)	(0.098)	(0.116)
Land Area	−2.105***	1.147*	1.297*
	(0.373)	(0.497)	(0.586)
Num.Obs.	2334	2473	2473
R2	0.532	0.384	0.382
R2 Adj.	0.500	0.344	0.342
AIC	286.2		
BIC	1138.0		
Log.Lik.	4.889	−710.762	−1118.350
F	17.009	9.511	9.440
RMSE	0.24	0.32	0.38

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression Table: Reverse Causality

Table A.3.6: Reverse Causality Test (CPD)

	Model 1 (Percent Domestic)	Model 2 (No. Domestic Firms)	Model 3 (No. Domestic Projects)
Climate Policy Database	0.0245+	0.0138	0.0125
	(0.0143)	(0.019)	(0.023)
Energy Imports	0.003	0.005	0.009+
	(0.003)	(0.004)	(0.005)
Democracy	−0.203**		
	(0.070)		
FDI	−0.019**	−0.009	−0.010
	(0.006)	(0.008)	(0.010)
Fossil Fuel Gen.	0.000	−0.001+	−0.001+
	(0.000)	(0.000)	(0.000)
Development Aid	−0.046***	−0.025+	−0.031+
	(0.011)	(0.014)	(0.017)
GDP (per capita)	0.033	−0.074*	−0.081*
	(0.024)	(0.031)	(0.037)
Population	−0.017	−0.242*	−0.299*
	(0.077)	(0.099)	(0.116)
Land Area	−2.108***	1.164*	1.315*
	(0.373)	(0.498)	(0.587)
(Intercept)	29.191***	−10.846	−11.842
	(5.128)	(6.836)	(8.058)
Num.Obs.	2334	2473	2473
R2	0.532	0.381	0.380
R2 Adj.	0.501	0.341	0.339
AIC	284.1		
BIC	1135.9		
Log.Lik.	5.959	−715.983	−1122.706
F	17.038	9.406	9.353
RMSE	0.24	0.32	0.38

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regression Table: Reverse Causality

Table A.3.6: Reverse Causality Test (CLW)

	Model 1 (Percent Domestic)	Model 2 (No. Domestic Firms)	Model 3 (No. Domestic Projects)
(Intercept)	28.933***	−11.435+	−12.511
	(5.118)	(6.794)	(8.011)
CLW Policy	0.034***	0.069***	0.079***
	(0.010)	(0.013)	(0.015)
Energy Imports	0.004	0.005	0.009+
	(0.003)	(0.004)	(0.005)
Democracy	−0.199**		
	(0.070)		
FDI	−0.019**	−0.008	−0.009
	(0.006)	(0.008)	(0.010)
Fossil Fuel Gen.	0.000	−0.001+	−0.001+
	(0.000)	(0.000)	(0.000)
Development Aid	−0.047***	−0.025+	−0.030+
	(0.011)	(0.014)	(0.017)
GDP (per capita)	0.033	−0.075*	−0.083*
	(0.024)	(0.031)	(0.037)
Population	−0.004	−0.218*	−0.271*
	(0.077)	(0.098)	(0.116)
Land Area	−2.105***	1.176*	1.328*
	(0.372)	(0.495)	(0.583)
Num.Obs.	2334	2473	2473
R2	0.534	0.389	0.387
R2 Adj.	0.503	0.349	0.347
AIC	274.0		
BIC	1125.8		
Log.Lik.	11.001	−700.802	−1108.219
F	17.177	9.711	9.643
RMSE	0.24	0.32	0.38

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

REFERENCES I

TO BE ADDED