Nicaragua's Climate Mitigation Policy: Sectoral and Inter-Household Effects

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Today's presentation

- Motivation
- Research question
- MANAGE model
- Results
- Next Steps

Motivation

- Nicaragua is a late signatory to the Paris Agreement, believing that the agreement did not have stringent enough commitments by developed countries
  - Nicaragua's unconditional target: 60% or more of electricity generation coming from renewables by 2030
  - Emissions are just over 15 MtCO2eq (2 tCO2eq per capita or 0.01% of the global GHG emissions)
- Low emitter but will be greatly affected by the extreme weather
  - "World's fourth-most affected by extreme weather (2017 Germanwatch Climate Risk Index)

Nicaragua's Climate Change Vulnerability

- 41% of Nicaraguans live in the rural areas and a substantial share of their income comes from rain-fed agriculture
  - Less than 2% of household use irrigation
  - 25% of farming households experience chronic or temporary food security (FAO, 2020)
- Nicaragua's mean annual temperature has increased (expected to increase by 3.5 ˚C by 2100) and the precipitation will decrease by 36.6% with respect to 1960's.

Research Question

- Assess the economy wide and distributional impacts of Nicaragua's NDC.
  - Gini Coefficient of 0.48
  - Richest quintile accumulates 45.4% of total expenditutre
  - Poorest quintile accounts for 6.8%

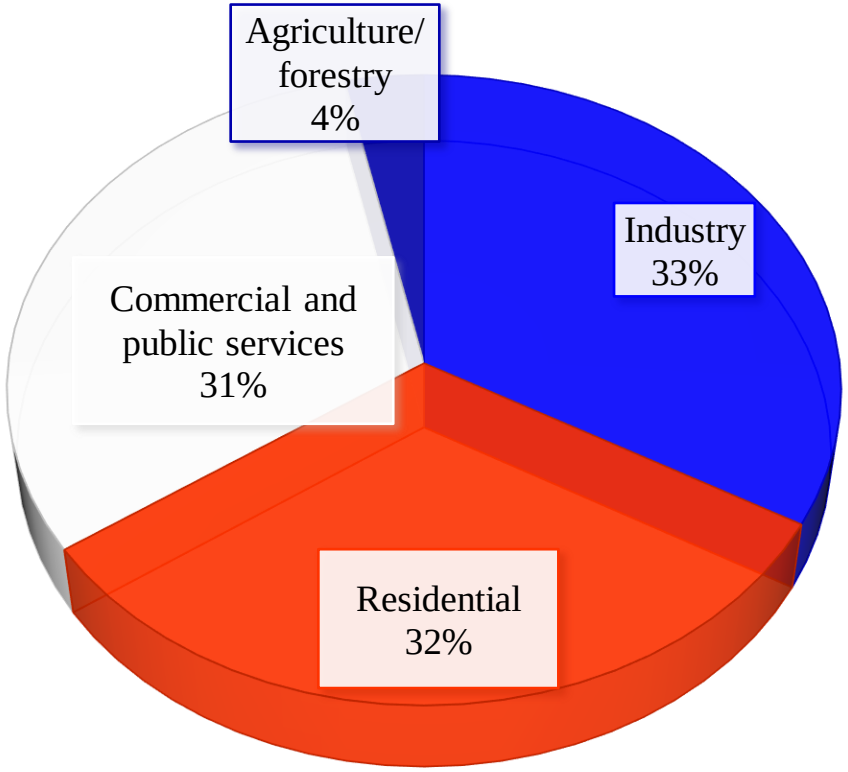
Scenarios

- A business-as-usual (BaU) scenario where the country maintains its 50 percent share of renewables
- Nicaragua meets its unconditional target of 60 percent of electricity generation coming from renewable sources by 2030
- Includes additional reduction in emissions consistent with keeping global warming below 2°C
- Increase in the share of renewables by 85 percent by 2030 (in line with the original commitment from Nicaragua)

Energy Indicators

Electricity GWh	
Total production	4579
Imports	34
Exports	-22
Domestic supply	4591
Statistical differences	6
Transformation	0
Energy industry own use	364
Losses	837
Final consumption	3396

FINAL CONSUMPTION



MANAGE Model

- The Mitigation, Adaptation, and New Technologies Applied General Equilibrium (MANAGE) is a recursive dynamic single country computable general equilibrium model
  - Designed to focus on energy, emissions & climate change
  - Detailed specification for the energy sector that allows:
    - Capital/labor/energy substitution in production
    - Intra-fuel energy substitution across all demand agents
    - Multi-output and multi-production structure

MANAGE Model

- Assumptions
  - Household demand using constant-differences-in elasticity (CDE) utility function (similar to GTAP)
  - Single energy bundle
    - Disaggregated by energy type
  - Import demand follows Armington
  - Allows for export demand and import supply functions: defaults to small country assumption
  - Different closures available

Data

- MANAGE was tailored to reflect the Nicaraguan economy using the Nicaraguan social accounting matrix (SAM)
  - Nicaragua's 2010 SAM was update to 2014 by using information from Central Bank and Ministry of Finance
  - Cross entropy was used to match the information of different macro targets
  - Different elasticities of substitution, income and price were tested.

BAU Scenario: Electricity Generation in Nicaragua by Source

	2014	2024	2034
Thermal	48.1%	48.5%	48.0%
Hydro	9.4%	9.6%	9.8%
Geothermal	14.3%	14.5%	14.8%
Biomass	6.4%	6.3%	6.3%
Wind	21.8%	21.2%	21.1%
	100.0%	100.0%	100.0%

BAU Scenario: Sectorial Evolution of Nicaragua

	2014	**2024**	**2034**
Agriculture	14.9%	13.5%	12.1%
Mining	1.9%	1.6%	1.3%
Electricity	3.2%	2.7%	2.5%
Food	15.7%	13.5%	11.5%
Wearing apparel	4.7%	9.1%	12.3%
Manufacturing	4.3%	3.9%	3.5%
Refined oil	3.1%	3.6%	3.9%
Construction	7.1%	7.0%	7.2%
Private services	34.0%	33.8%	34.1%
Public services	11.2%	11.4%	11.6%
	100.0%	100.0%	100.0%

BAU Scenario: Greenhouse Emissions

	Level
2014	7143.631083
2015	8123.550186
2016	8292.416811
2017	8490.650162
2018	8703.282146
2019	8936.675593
2020	9196.145071
2021	9486.164615
2022	9806.617084
2023	10156.21457
2024	10533.50126
2025	10936.87174
2026	11364.87467
2027	11817.19603
2028	12293.6985
2029	12794.24781
2030	13318.7135
2031	13867.09117
2032	14439.96455
2033	15038.09105
2034	15662.26587
2035	16313.3327
Total	246715.1962

Scenario 2: 60% of electricity coming from renewable sources (via emissions tax)

Changes in EV between Scenario 2 and BAU

	2024	2034
Soc	20.4%	20.5%
R_hh1	-2.6%	-1.1%
R_hh2	-2.7%	-1.0%
R_hh3	-2.8%	-1.1%
R_hh4	-3.0%	-1.1%
R_hh5	-2.9%	-1.0%
R_hh6	-3.0%	-1.1%
R_hh7	-3.1%	-1.1%
R_hh8	-3.1%	-1.1%
R_hh9	-3.1%	-1.1%
R_hh10	-3.2%	-1.1%
U_hh1	-2.6%	-1.1%
U_hh2	-2.7%	-1.0%
U_hh3	-2.8%	-1.1%
U_hh4	-3.0%	-1.1%
U_hh5	-2.9%	-1.0%
U_hh6	-3.0%	-1.1%
U_hh7	-3.1%	-1.1%
U_hh8	-3.1%	-1.1%
U_hh9	-3.1%	-1.1%
U_hh10	-3.2%	-1.1%

Scenario 2: 60% of electricity coming from renewable sources (via emissions tax)

Greenhouse emission reduction in scenario 2

	BAU	Emissions tax	Reduction in emissions
2014	7143.63	7143.63	0.00
2015	8123.55	8111.72	11.83
2016	8292.42	7516.54	775.88
2017	8490.65	7654.40	836.25
2018	8703.28	7892.07	811.21
2019	8936.68	8136.75	799.92
2020	9196.15	8413.08	783.07
2021	9486.16	8713.59	772.57
2022	9806.62	9045.17	761.44
2023	10156.21	9402.94	753.28
2024	10533.50	9787.57	745.93
2025	10936.87	10196.70	740.17
2026	11364.87	10629.43	735.45
2027	11817.20	11085.31	731.88
2028	12293.70	11564.34	729.36
2029	12794.25	12066.39	727.86
2030	13318.71	12591.36	727.36
2031	13867.09	13139.25	727.84
2032	14439.96	13710.64	729.32
2033	15038.09	14306.25	731.84
2034	15662.27	14926.83	735.43
2035	16313.33	15573.18	740.16
Total	246715.20	231607.13	15108.06

Scenario 3: Scenario consistent with keeping global warming below 2°C

Changes in EV between Scenario 2 and BAU

	2024	2034
soc	30.2%	31.1%
R_hh1	-6.1%	-4.0%
R_hh2	-6.4%	-4.0%
R_hh3	-6.6%	-4.1%
R_hh4	-7.0%	-4.3%
R_hh5	-6.9%	-4.2%
R_hh6	-7.0%	-4.2%
R_hh7	-7.2%	-4.3%
R_hh8	-7.3%	-4.4%
R_hh9	-7.3%	-4.3%
R_hh10	-7.5%	-4.3%
U_hh1	-6.2%	-4.0%
U_hh2	-6.5%	-4.0%
U_hh3	-6.6%	-4.1%
U_hh4	-7.0%	-4.3%
U_hh5	-7.0%	-4.2%
U_hh6	-7.0%	-4.2%
U_hh7	-7.2%	-4.3%
U_hh8	-7.3%	-4.4%
U_hh9	-7.3%	-4.3%
U_hh10	-7.5%	-4.3%

Scenario 3: Scenario consistent with keeping global warming below 2°C

Greenhouse emission reduction in scenario 2

	2024	**2034**
soc	30.2%	31.1%
R_hh1	-6.1%	-4.0%
R_hh2	-6.4%	-4.0%
R_hh3	-6.6%	-4.1%
R_hh4	-7.0%	-4.3%
R_hh5	-6.9%	-4.2%
R_hh6	-7.0%	-4.2%
R_hh7	-7.2%	-4.3%
R_hh8	-7.3%	-4.4%
R_hh9	-7.3%	-4.3%
R_hh10	-7.5%	-4.3%
U_hh1	-6.2%	-4.0%
U_hh2	-6.5%	-4.0%
U_hh3	-6.6%	-4.1%
U_hh4	-7.0%	-4.3%
U_hh5	-7.0%	-4.2%
U_hh6	-7.0%	-4.2%
U_hh7	-7.2%	-4.3%
U_hh8	-7.3%	-4.4%
U_hh9	-7.3%	-4.3%
U_hh10	-7.5%	-4.3%

Scenario 4: 85% of electricity coming from renewable sources (via emissions tax)

Changes in EV between Scenario 2 and BAU

	2024	2034
soc	-76.1%	-77.6%
R_hh1	-13.5%	-21.3%
R_hh2	-14.6%	-22.9%
R_hh3	-14.6%	-22.9%
R_hh4	-15.6%	-24.2%
R_hh5	-15.8%	-24.5%
R_hh6	-15.9%	-24.5%
R_hh7	-16.2%	-24.8%
R_hh8	-16.1%	-24.8%
R_hh9	-16.6%	-25.4%
R_hh10	-16.6%	-25.4%
U_hh1	-13.6%	-21.4%
U_hh2	-14.7%	-23.0%
U_hh3	-14.6%	-23.0%
U_hh4	-15.6%	-24.2%
U_hh5	-15.9%	-24.5%
U_hh6	-15.9%	-24.5%
U_hh7	-16.2%	-24.8%
U_hh8	-16.2%	-24.9%
U_hh9	-16.7%	-25.4%
U_hh10	-16.6%	-25.4%

- **THANK YOU!**