

# Intergenerational preferences for renewable energy subsidies

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# Motivation

- Carbon pricing is often considered most efficient.
- However, renewable energy subsidies are widely adopted in many countries.
- Distributional impact is as important as efficiency (or economy-wide impact).
  - Policy acceptance is probably determined by individual welfare impact rather than economy wide impact.
  - Compensation or transfer among households can be limited.
  - Different income groups (High-income vs. low-income) and different generations (current old, current young, and future generations)

# Research question

- What are the distributional impact (intra- and inter-generational incidence) of renewable energy subsidies?
  - Why are the welfare impact different among different households?
  - Heterogeneity in income source share and spending share among income groups and age.
  - Economic impact is different over time.
- How are they different from carbon pricing policies that achieve same level of emissions reduction as renewable energy subsidies?
- Which policy would be chosen if we conduct majority voting today?

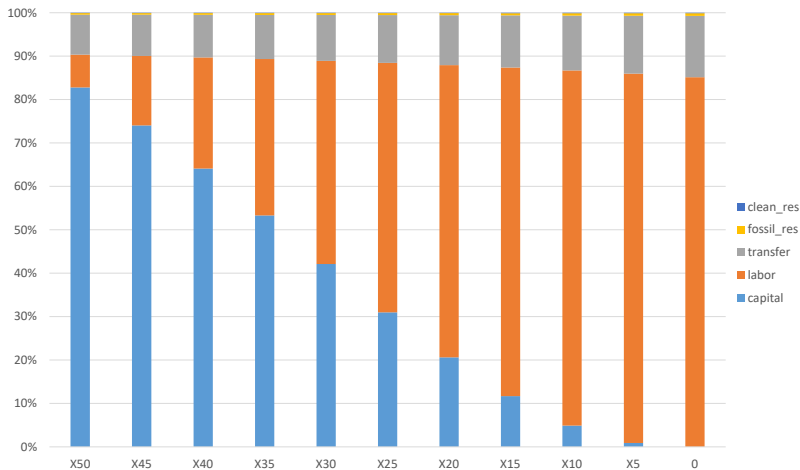
# Literature review

- Renewable energy subsidies are examined, but distributional impact is not explored.
  - Goulder, Hafstead and Williams (2016) and Rezai and van der Ploeg (2017)
- Distributional impact of renewable energy subsidies in Germany is examined in a static framework.
  - Böhringer, Landis and Reaños (2017)
- Intergenerational impact of carbon pricing policies is assessed.
  - Rausch (2013), Williams et al. (2015), Fried, Novan and Peterman (2017), and Rausch and Yonezawa (2018)
- Political economy perspective is considered in environmental policies.
  - Cremer, De Donder and Gahvari (2004), Aidt (2010), Hablar and Roeder (2013), and Hablar and Roeder (2017)

# Simulation model with overlapping generations

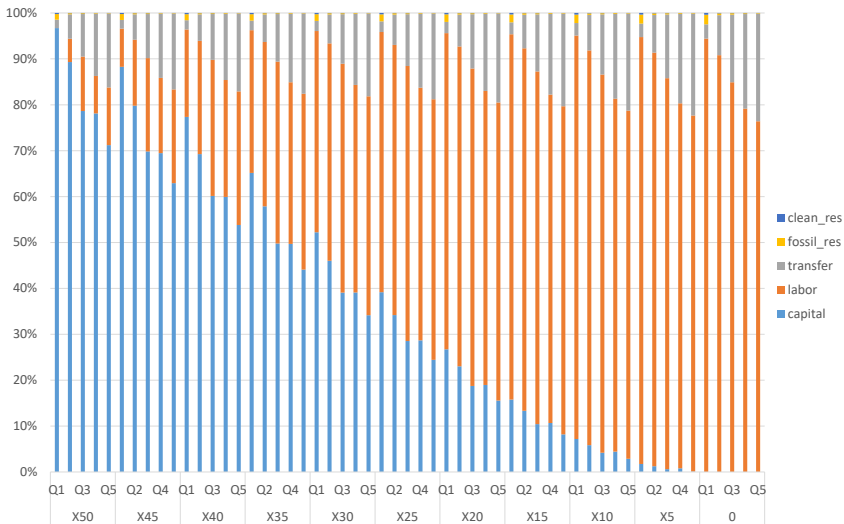
- Dynamic general-equilibrium overlapping generations (OLG) model for the US economy
  - Each generation has 55 years of economic life (age 21 through age 75).
  - In each time period (5 years), one new generation is “born” and one oldest generation dies.
    - In time 0 (2015), 11 generations (X50, X45,..., X5, 0) exist.
    - In time 5 (2020), X50 pass away, and 05 is born.
  - We split each generation into 5 different income groups: Q1(rich)-Q5(poor)
    - Labor productivity (Altig et al., 2001 AER)
    - Transfer income share (CBO 2013)
    - Resource income share (CBO 2013)
    - Intertemporal elasticity of substitution

## Lifetime income source share for current generations (X50-0)



- The older, the higher capital income share is.
- The younger, the higher labor income share is.

## Lifetime income source share across income groups (Q1-Q5)



- The richer (poorer), the higher capital (transfer) income share is.
- Resource (for clean energy and fossil fuels) is mostly owned by rich households.

## Simulation model: Other characteristics

- 10 sectors: 5 energy (Crude oil, Coal, Natural gas, Refined oil, and Electricity) and 5 non-energy sectors (Agriculture, Manufacturing, Services, Energy intensive sectors, and Transport)
- Base year data for 2011 is forward-calibrated to 2015 and steady state path is established from 2015:
  - Social accounting matrix from Global Trade Analysis Project version 9 (GTAP 9)
  - Projection of GDP, energy demand and carbon emissions from International Energy Outlook
- Electricity generation: Coal, Natural gas, Refined oil, Nuclear, Hydro and Wind



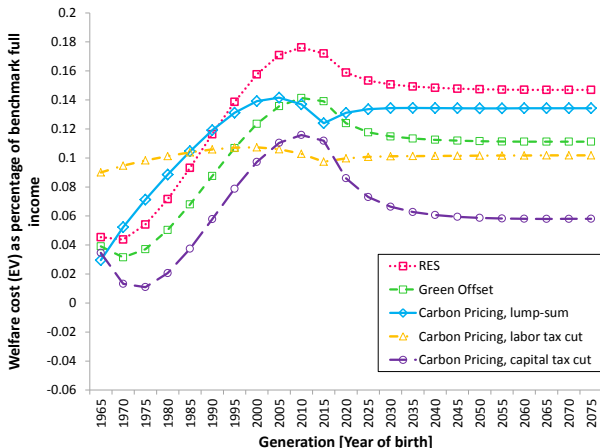
# Scenarios

- Renewable energy subsidies: How to finance subsidies
  - RES: Tax on whole electricity demand
  - Green Offset: Tax proportional to carbon intensity of electricity generation
- Carbon pricing: How to recycle revenue
  - Carbon Pricing, lump-sum: Uniform per-capita rebates
  - Carbon Pricing, labor tax cut
  - Carbon Pricing, capital tax cut

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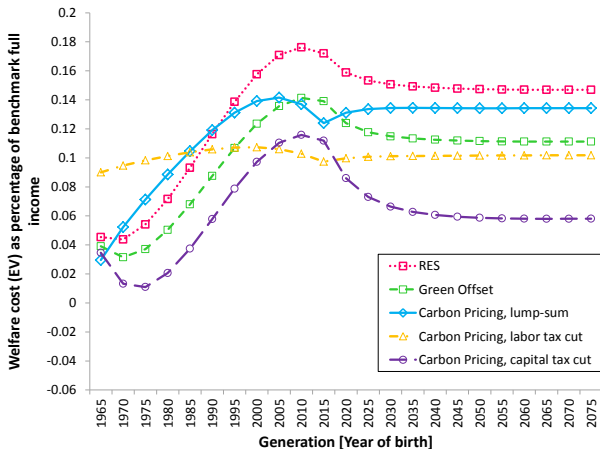
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  - Carbon Pricing, capital tax cut
- Stringency of emissions reduction: All five scenarios achieves same annual reduction for each stringency case
  - Low: US\$25 of carbon pricing
  - Medium: US\$50 of carbon pricing
  - High: US\$75 of carbon pricing

# Intergenerational incidence (Income groups are aggregated)



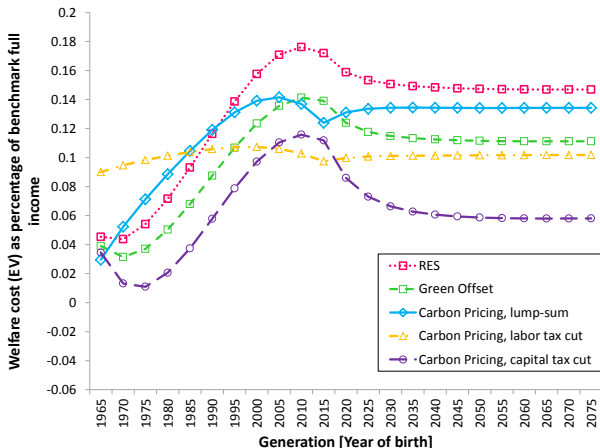
- Carbon Pricing, lump-sum: Smaller loss for current-old and -middle generations.
- Because of high capital intensity of renewable energy, negative impact on capital return is smaller than that on wage.
- For current generations, the younger they are, the higher their labor income share is.

# Intergenerational incidence (Income groups are aggregated)



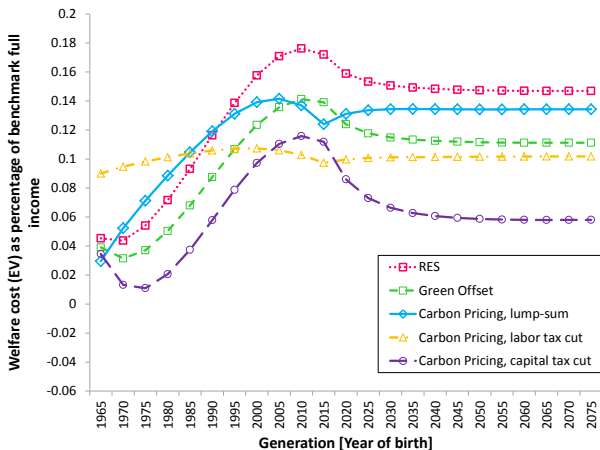
- Carbon Pricing, labor tax cut: Similar welfare loss among generations.
- Labor tax cut is good for current young and future generations because of their high share of labor income.

# Intergenerational incidence (Income groups are aggregated)



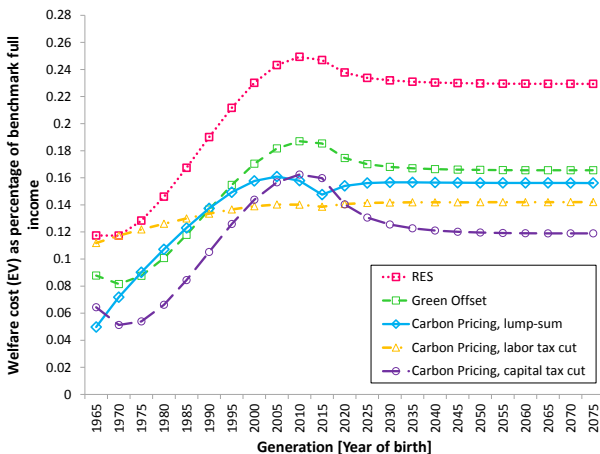
- RES, Green Offset, and Carbon Pricing with capital tax cut : Good for current-old and -middle generations and future generations.
- Current-old and -middle generations enjoy appreciation of existing capital asset.
- Increased economic growth (with some time lags) is enjoyed by future generations.

# Intergenerational incidence (Income groups are aggregated)



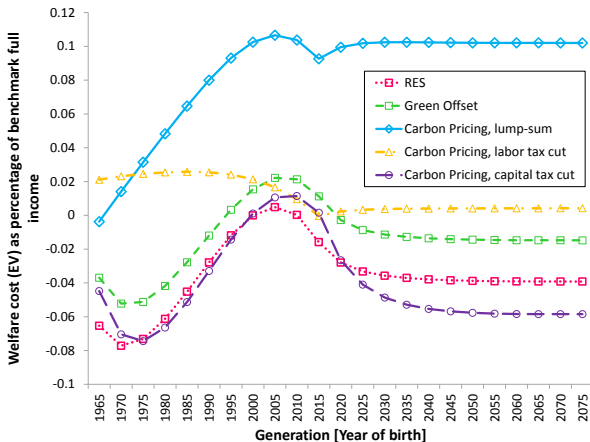
- Green Offset is better than Carbon Pricing with lump-sum and RES, but Carbon Pricing with capital tax cut is still better.

# Intragenerational incidence: Medium income quintile (Q3)



- Medium income quintile (Q3) have similar intergenerational incidence as aggregate one.
- While Carbon Pricing with lump-sum is better for lower-income households, intergenerational incidence of other scenarios are similar for Q2 - Q5.

# Intragenerational incidence: Highest income quintile (Q1)



- Carbon Pricing, lump-sum is bad for high income households.
- RES is better than Green Offset, and RES is even comparable to Carbon Pricing, capital tax cut.
- This is because resource of clean energy is mainly owned by high-income households.



## Voting results: RES vs. Carbon Pricing

- Setup: We take a vote today (2015), and only generations alive today vote based on their expected remaining lifetime welfare impact.

**Table:** Voting share supporting RES over carbon pricing with...

	Stringency		
	Low	Medium	High
Uniform per-capita lump-sum rebates	36.9	25.1	25.1
Labor tax recycling	41.6	31.5	25.1
Capital tax recycling	1.6	14.4	25.1

- When renewable energy subsidies are financed by whole electricity demand (RES), renewable energy subsidies are unlikely to win against carbon pricing.

# Voting results: Green Offset vs. Carbon Pricing

**Table:** Voting share supporting Green Offset over carbon pricing with...

	Stringency		
	Low	Medium	High
Uniform per-capita lump-sum rebates	59.0	54.0	46.3
Labor tax recycling	51.3	48.6	56.0
Capital tax recycling	0	0	8.6

- When renewable energy subsidies are financed by electricity tax based on carbon content of electricity generation (Green Offset), Green Offset could be chosen over Carbon Pricing with lump-sum or labor tax cut.
- However, if Carbon Pricing with capital tax cut is available, almost everyone prefers carbon pricing with capital tax cut.

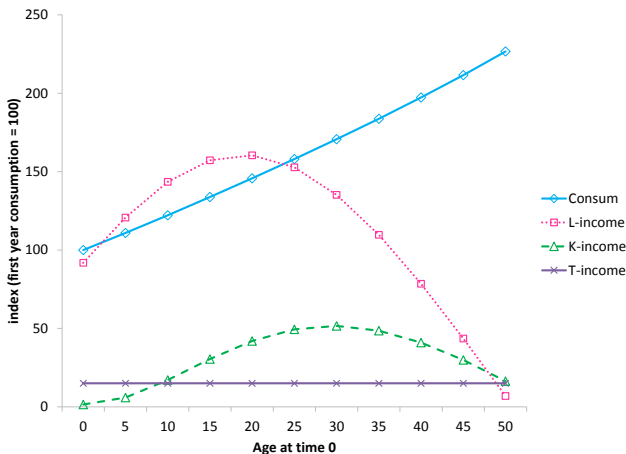
## What have we learned?

- Renewable energy subsidies are good for current-old and -middle generations and future generations.
- Current-old and -middle generations enjoy appreciation of existing capital asset, whereas future generations enjoy economic growth.
- High income households prefer RES than Green Offset since resource of clean energy is mainly owned by them.
- When renewable energy subsidies are financed by tax on whole electricity demand (RES), carbon pricing is likely to be chosen.
- When renewable energy subsidies are financed by tax based on carbon content of electricity generation (Green Offset), Green Offset could be chosen over carbon pricing with lump-sum or labor tax cut.
- If carbon pricing with capital tax cut is available, carbon pricing with capital tax will be chosen.

# Thank you!

- Questions?

# Income and consumption profile for each age



- Labor income increases first and then decreases.
- Capital asset is accumulated first and then used later.

# Utilitarian social welfare results

