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Welfare Consequences of Government Budget Closure Assumptions Under New Environmental Policies

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Outline

- Motivation/Research Question
- Strategy
- Methods
- Results
  - Non-Debt
  - Debt
- Conclusion

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Motivation

- Computable General Equilibrium (CGE) models are commonly used tools for assessing the economy-wide impacts of energy and environmental policy and are used for regulatory analysis at EPA

- CGE models endogenize government revenue and government spending through prices and tax revenues.
  - The optimization problem behind government spending is usually not well represented in CGE models. Typically held to fixed proportions to benchmark data.
  - Most common assumption in the CGE literature is that total government consumption is held constant.
  - Any induced changes to government revenues must be recycled. Examples: lump sum payments, through existing tax system, etc.

- Holding the government budget fixed allows the CGE model to calculate welfare impacts inclusive of economy-wide changes to the tax base.
  - Government can't just print/burn money to accommodate changes to tax revenues.

- **This talk:** *how this is done can matter, especially now.*

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Motivation/Research Question

- Government budget closure assumptions may be more or less important for different types of environmental policies.
  - Carbon taxes and permit markets create a source of funding
  - Performance standards have implicit neutral funding assumptions
  - Subsidies require funding
  - Interactions with existing fiscal system
    - revenue recycling, tax burden shifting, tax interaction effects
  - Direct and indirect budgetary effects
  - Deficit/surplus, debt, and timing of budgetary balance

- Research question:
  - What are the welfare and distributional consequences of different government budget closure and financing assumptions in energy-environment CGE models?

Strategy - Overview

We employ a scenario matrix consisting of 3 dimensions, summarized below:

1. CGE model template
   - Static
   - Recursive (myopic)
   - Ramsey (intertemporal)
2. Policy Instrument Class
   - Carbon pricing
   - Subsidy-based (Clean Electricity Subsidy)
   - Regulation (We use a clean energy standard as a proxy for regulation)
3. Closure Rule (Budget Balancing Instrument)
   - Government Spending
   - Transfer payments to households
   - Taxes
   - Deficit
   - **Debt**

***** For each model template we simulate different closure rules for each policy instrument class *****

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Policy Instruments

Policy Instrument	Coverage	Description
CAP	Electricity	Emissions cap set to produce a pre-specified revenue target. The revenue from the CAP creates a budget surplus balanced with a closure rule.
CES	Electricity	Clean energy standard set to produce a pre-specified revenue target. The CES implicitly balances direct revenues/costs via a net-subsidy to clean and net-tax on dirty but produces an indirect effect on the budget which is balanced with a closure rule.
CLSUB	Electricity	Ad-valorem clean subsidy set to produce a pre-specified raw $ target value. The subsidy-induced budgetary shortfall is balanced by a closure rule.

All policies target a direct raw ($) policy value/revenue/cost

*** 50 Billion USD starting in 2017 that grows with economy each year**

- Carbon Pricing Instrument (**CAP**)
  - Electricity sector emissions cap (CAP) set to produce a pre-specified revenue target
  - The revenue from the CAP creates a budget surplus balanced with a closure rule

- Regulation Instrument (**CES**)
  - Electricity sector clean energy standard (CES) set to produce a pre-specified revenue target
  - The CES implicitly balances direct revenues/costs via a net-subsidy to clean and net-tax on dirty but produces an indirect effect on the budget which is balanced with a closure rule

- Subsidy-based instrument (**CLSUB**)
  - Ad-valorem output subsidy to clean electricity (CLSUB) set to produce a pre-specified direct raw $ value
  - The subsidy-induced budgetary shortfall is balanced by a closure rule

Budget Closure Rules

The budgetary effects of these policies can be broken into two components:

- **Direct Balancing:** The revenue/cost impact directly associated with the policy --- the raw $ policy target in our case.
- **Indirect Balancing:** The indirect effect of the policy on the government budget after taking the direct policy value into account – any additional balancing required to maintain budget neutrality.

To simplify the scenario matrix, in the CAP and CLSUB cases, we assume that direct and indirect balancing are covered by the same closure balancing variables.

In the CES case, only the indirect portion is covered by the closure balancing variable.

We use revenue neutrality constraints to enforce this budgetary balance:

- A balancing variable/instrument is adjusted to maintain a fixed level of government commodity demand.

Closure Rule	Balancing Variable	Description of closure assumption
BAU	Irrelevant	Business as usual - closure is irrelevant due to benchmark calibration
JPOW	Deficit/surplus	Deficit/surplus balances the budget with no intention to repay or distribute to households
KTAX	Capital income tax rate	Increase/decrease in capital income tax rate to balance budget
LTAX	Labor income tax rate	Increase/decrease in labor income tax rate to balance budget
LSITAX	Lump-sum tax/transfer	Lump-sum tax/transfer to households proportional to household income share of total income balances budget
LSPTAX	Lump-sum tax/transfer	Lump-sum tax/transfer in equal payments to each household - population-based - to balance budget

* We also model a debt closure discussed later

Key Takeaways

The overall welfare effects are negative, except for the CLSUB cases where policy costs are unaccounted for (JPOW).

Given identical direct raw $ policy targets, the CAP achieves the most emissions reductions, the CES the next most, followed by the CLSUB cases.

Little change in emissions reductions across closure assumption and model template.

It is difficult to perform a welfare comparison across these policy types since the target is a direct raw $ target and not emissions/damages --- a potential explanation for the difference in magnitudes is the narrowness/broadness of the cost-side of the policy.

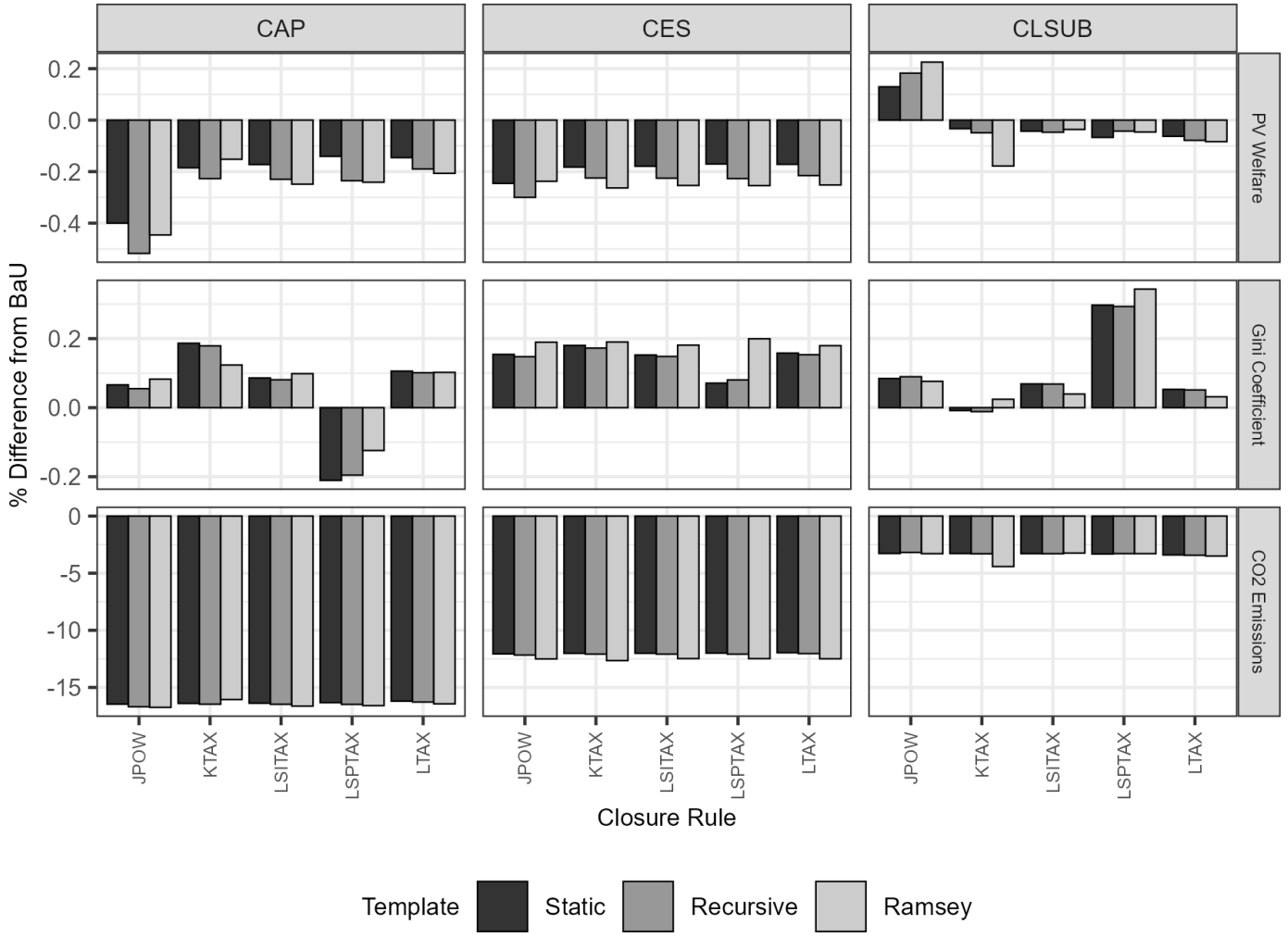
The Gini coefficient is relatively stable across Static and Recursive templates, but tends to deviate in the Ramsey case

The Ramsey model welfare deviates from the other models most in the KTAX cases – capital taxes are known to be the most distortionary.

In the Ramsey case for the CAP, capital tax recycling is preferred to labor tax recycling whereas the Recursive model shows the opposite. This is consistent with the literature; capital supply is more elastic in the Ramsey model than the Recursive model which makes it more distortionary.

**** Welfare effects do not consider benefits (avoided damages) from emissions reductions***

**** Equivalent Variation (EV) is the amount households would be willing to pay to avoid the policy being implemented***



Key Takeaways

The lowest income groups are subject to large relative swings in EV.

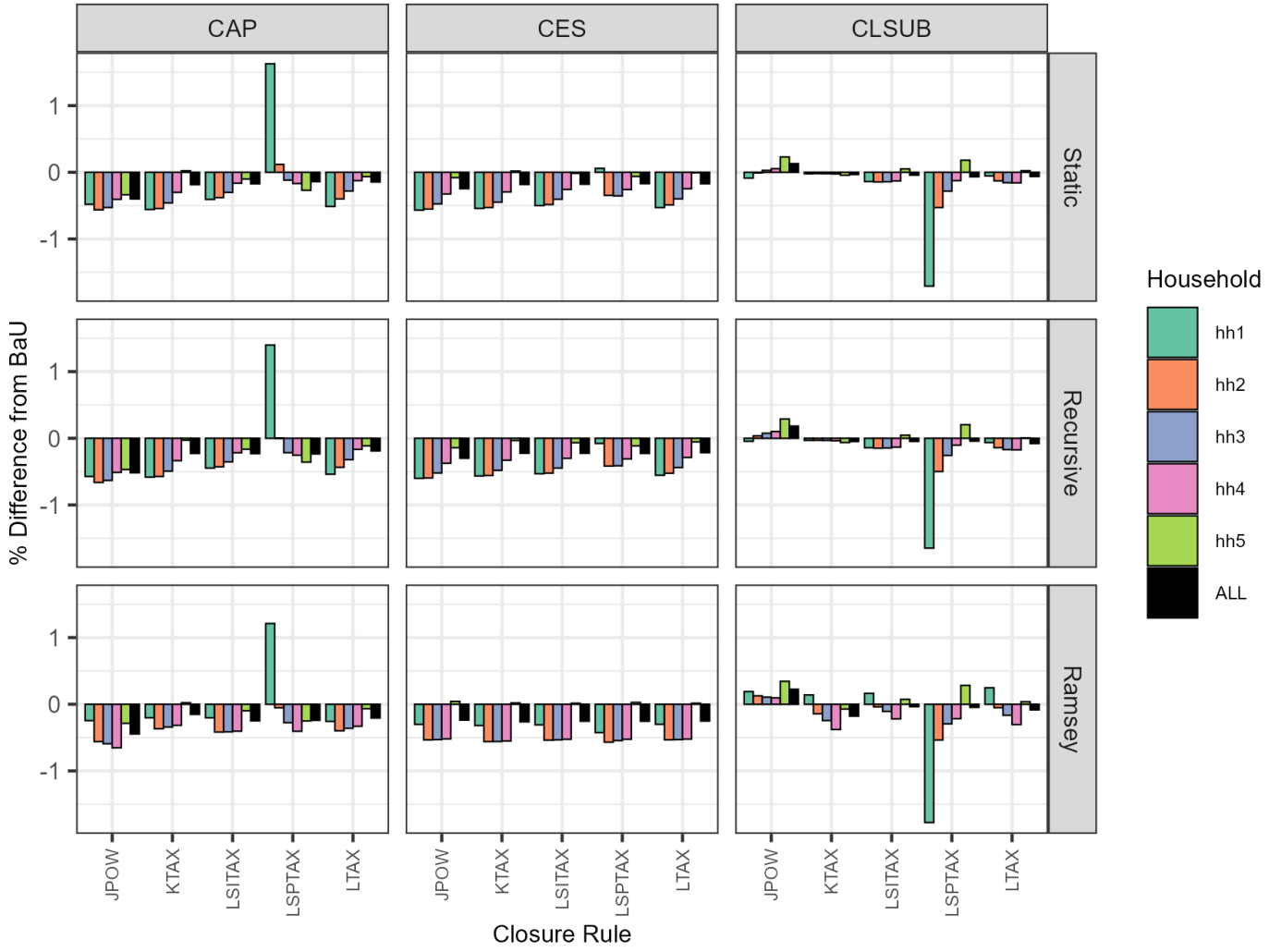
The cap and clean subsidy cases tend to show inverted/mirrored distributional patterns relative to one another.

The direct policy balancing does seem to meaningfully affect the Gini coefficient and depends on how progressive/regressive the balancing variable is.

Based on the CES results, the indirect policy balancing seems to have only small effects across closures. These can be meaningful effects in extreme cases where the lowest income groups bear the burden/benefit of the tax/transfer.

The clean subsidies are still regressive under the JPOW closure, which isn't necessarily expected. While the subsidies lower the cost of electricity to consumers, they also cause a large positive shock to the economy and induce a shift towards capital intensive technologies.

Of the closures modeled, the CAP_LSPTAX case is the most progressive --- though in theory, progressive lump-sum taxes could be levied in the CLSUB cases to force the same progressive outcomes.



Debt Closure

Clean subsidy (CLSUB) case only

Debt is amortized over a 10 year lifetime

Debt covers direct policy balancing

Indirect balancing covered by LSITAX closure

There are two main variants:

1) Debt_No_Savings – No Net Savings Accounting

2) Debt_Savings – Net Savings Accounting
   - PFX – Net savings effect price (FX price/numeraire)
   - PK – Net savings effect price (Capital Stock Price*)

The GOVT distributes the clean subsidy ($50 bln/yr starting in 2017).

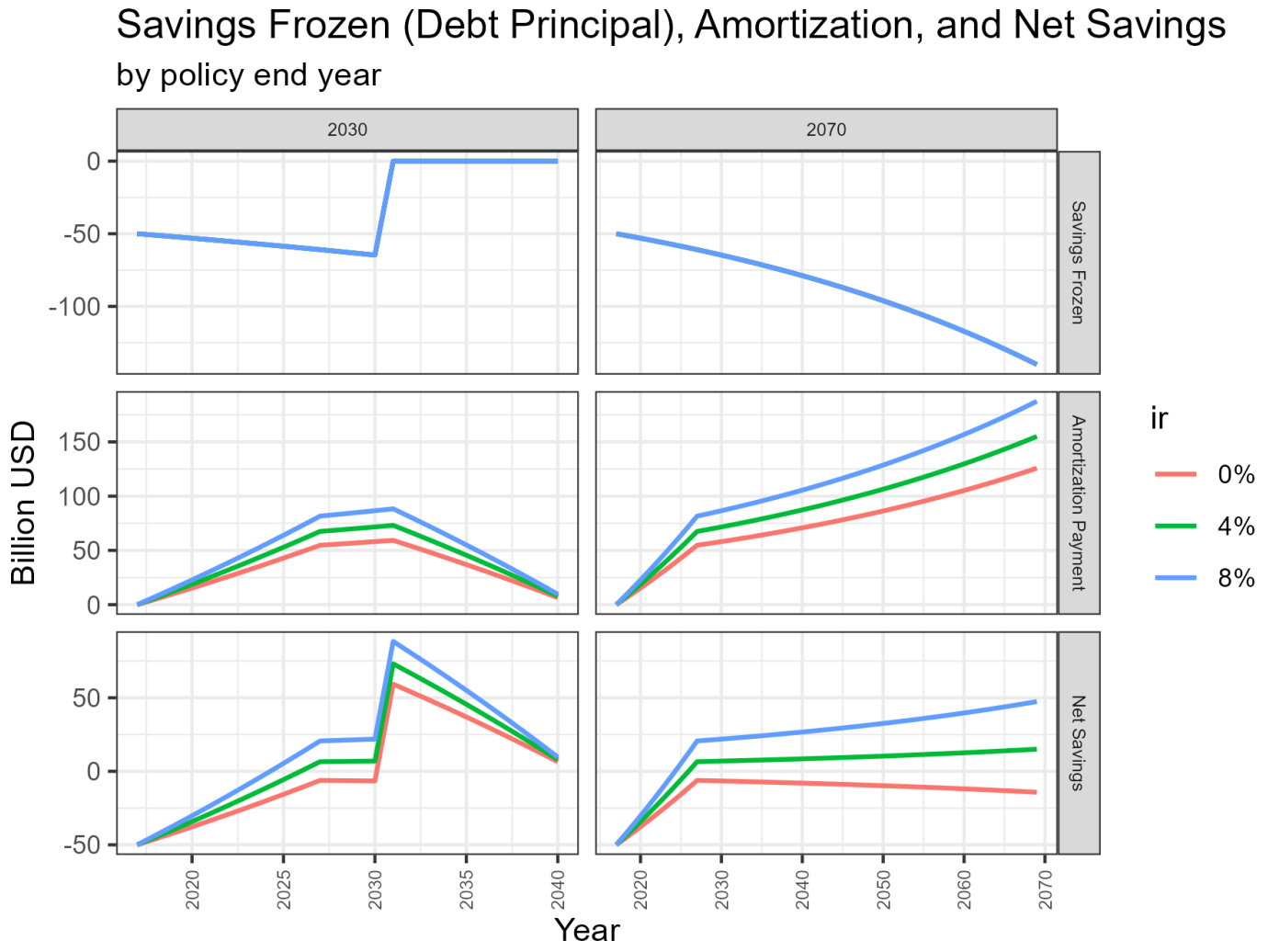
To access those funds today GOVT must issue debt and then repay it over time (Amortization Payment).

The debt principal either comes from abroad (No_Savings) or from U.S. households (Savings).

If U.S. households purchase the debt, the principal is no longer available for investment elsewhere in the economy (Savings Frozen), until it is repaid with interest (Amortization Payment).

This creates a net effect on household savings/investment (Net Savings) and ultimately the capital stock.

U.S. households are financing the subsidies.



* The Recursive model uses the rental rate on capital instead of the capital stock price

Key Takeaways

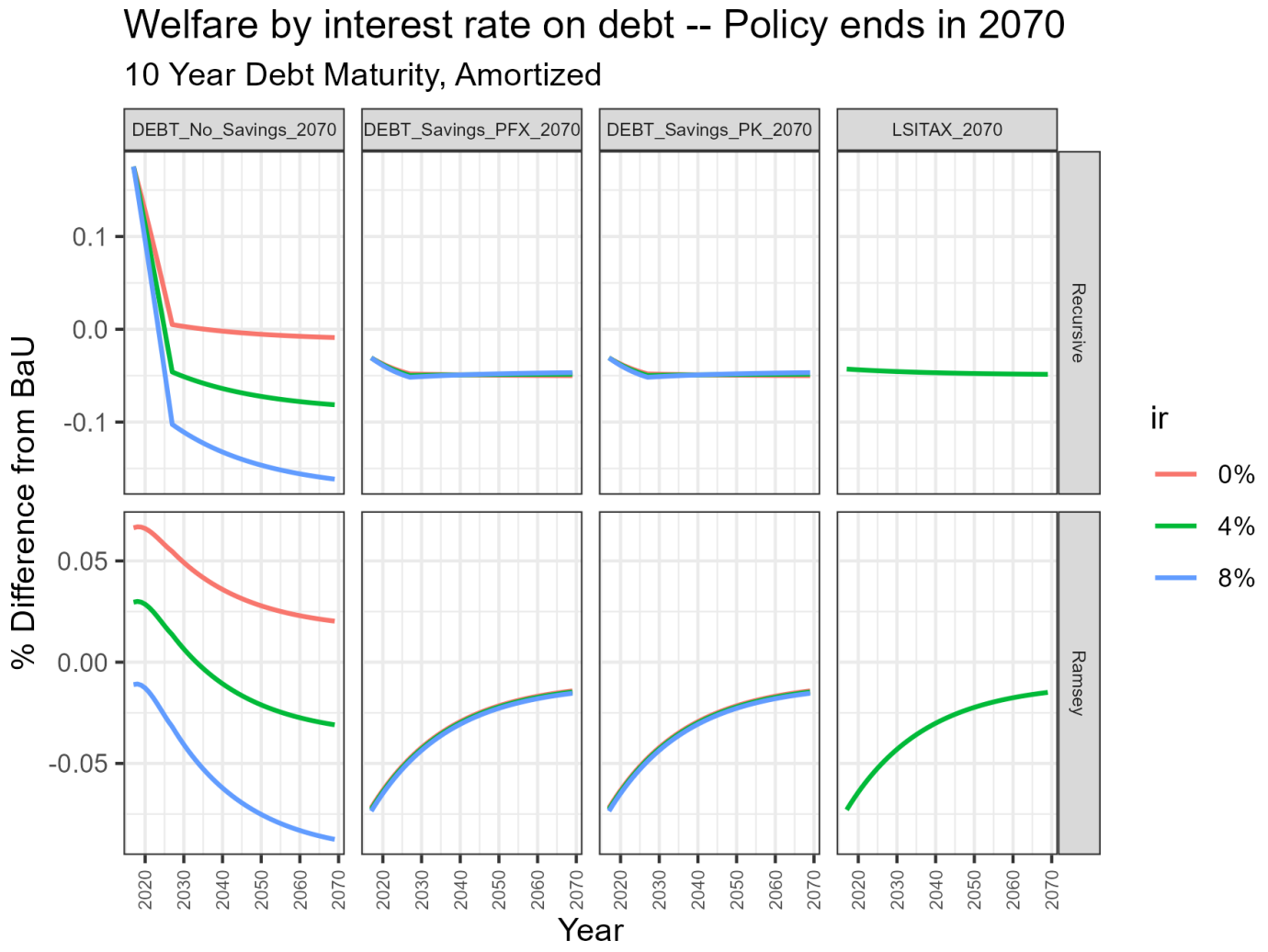
These cases carry a remaining balance into the end of the time horizon -- the debt is not fully repaid by 2070.

In the "*Savings*" cases, there is little difference from the No Debt case (LSITAX).

The "*No Savings*" case shows wide deviation

These scenarios bound the reality of U.S. government debt financing due to a global banking system.

Increasing interest rates on the debt decrease welfare in the "No Savings" case.



Key Takeaways

These cases end the policy in 2030, leaving time for the policy to be fully repaid and the model to reconverge to a steady-state.

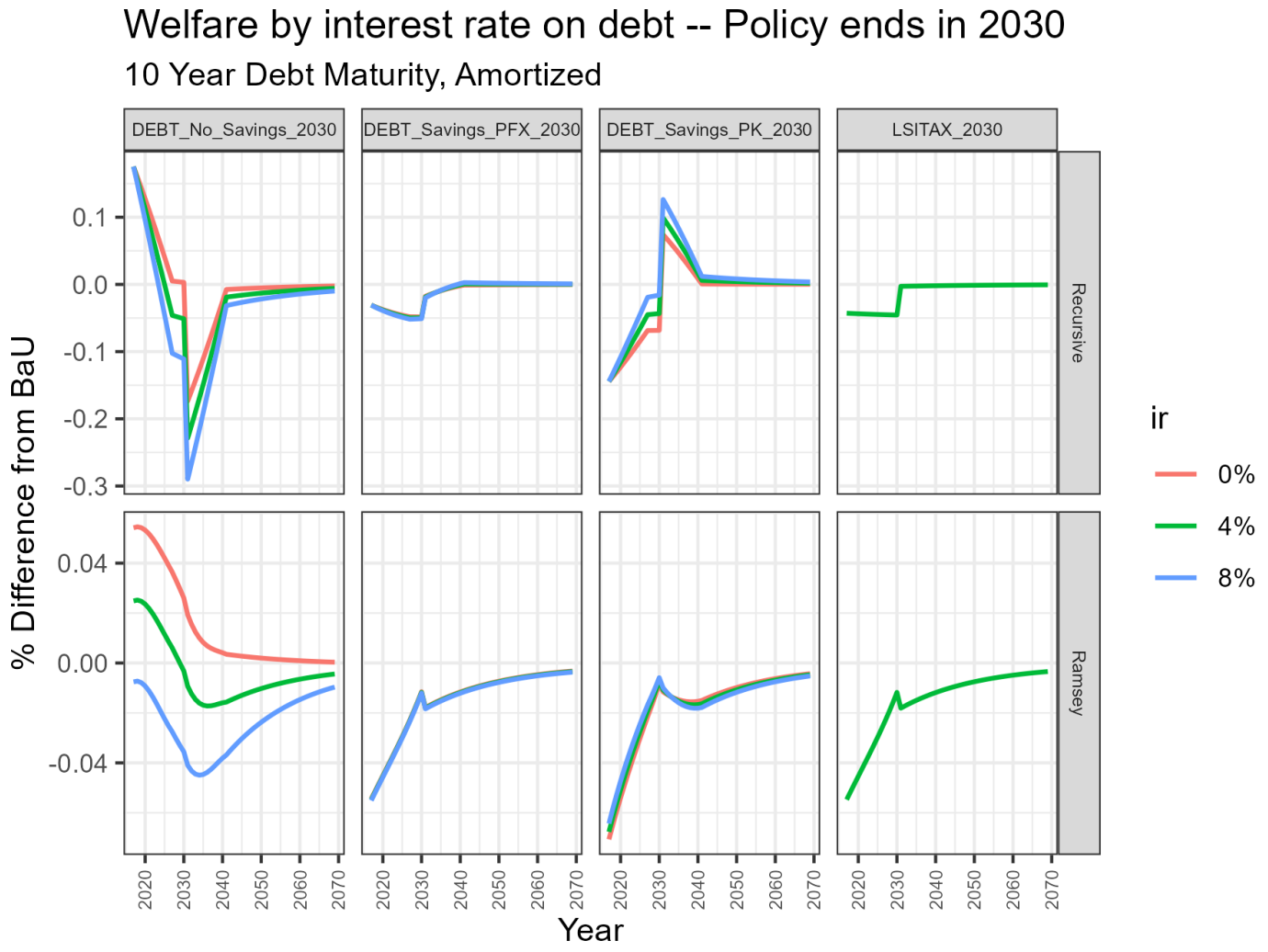
The extent to which domestic savings are impacted seems to be the most important assumption w.r.t. welfare effects for Debt closures in the Ramsey Model.

The Ramsey model:

- *PFX case perfectly replicates the LSITAX case* – indicating that the conventional modeling approaches closely approximate the DEBT case across the entire time horizon.
- Small differences emerge when paired with the price on the capital stock PK, and interest rate sensitivities matter more.

The Recursive model:

- Closely mimics but does not perfectly match the LSITAX case
- In the PFX case, smoothing occurs once the policy ends and the payment stream tails off
- The PK case is actually levied on the rental rate not the capital stock price



Key Takeaways

PV welfare and Gini coefficient differences are relatively stable across the savings and LSITAX cases for Ramsey and all cases for Recursive.

The Recursive vs. Ramsey welfare result in the top two rows of the leftmost column indicates the intertemporal model is reallocating consumption and investment decisions to mitigate policy costs relative to the recursive case.

Concluding Remarks / Summary

Emissions are not very sensitive to the closure choice

Indirect policy balancing does not lead to large welfare differences in most cases, but can have non-trivial distributional consequences in extreme cases

Lump-sum instruments can be used to create distributionally equivalent policy across cap and clean subsidy cases at a small welfare cost

Non-lump-sum instruments that are distortionary such as capital and labor taxes can lead to significant welfare differences

Our results suggest the long run welfare consequences of modeling the complicated budget balance can be well approximated using conventional techniques within the period that costs occur in *intertemporal models* --- so long as it is assumed that debt is procured from domestic household savings.

While the time path of welfare costs may deviate widely in *recursive models*, the total PV welfare differences across all debt assumptions are relatively small in recursive models.

It is important to consider how the debt is being procured and how the financial system can spread the savings impact across agents (e.g., domestic vs. foreign savings impacts).

Timing of payback (maturity length) and interest rate on the debt can matter differently depending on which market clearance condition is affected by household debt procurement – more work is needed to explore these effects.

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Thank You!

Questions

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Appendix

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Full Set of Revenue Neutrality Assumptions

Closure Rule	Balancing Variable	Description of closure assumption
BAU	Irrelevant	Business as usual - closure is irrelevant due to benchmark calibration
JPOW	Deficit/surplus	Deficit/surplus balances the budget with no intention to repay or distribute to households
TRNFX	Govt Spending	Govt spending balances the budget but does not affect household utility
KTAX	Capital income tax rate	Increase/decrease in capital income tax rate to balance budget
LTAX	Labor income tax rate	Increase/decrease in labor income tax rate to balance budget
LSGINI	Lump-sum tax/transfer	Lump-sum tax/transfer to households maintains a target Gini coefficient and government budget balance
LSITAX	Lump-sum tax/transfer	Lump-sum tax/transfer to households proportional to household income share of total income balances budget
LSPTAX	Lump-sum tax/transfer	Lump-sum tax/transfer in equal payments to each household - population-based - to balance budget
TRAN	Transfer payments	Proportional adjustment to benchmark transfer payments maintains budget balance

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Alternative Explanation for Debt Closure

1) Government borrows the full policy cost from households
2) Households buy the debt using their savings
3) Government returns the full policy cost to households over time by raising taxes on households
4) Government returns the interest to households over time by raising taxes on households