



Using a Carbon Tax to Meet U.S. International Climate Pledges

Introduction and Motivation

U.S. pledge in the Paris agreement

- Reduce greenhouse gas emissions by 26-28 percent, relative to 2005, by 2025

Current emission reduction projections

- Business-as-usual (BAU): -9.4%
- BAU + Clean Power Plan (CPP): -13.6%
- BAU + CPP + Proposed non-CO₂ regulations: -18.8%

Motivation

- Combustion of fossil fuels contribute to 94% of CO₂ emissions
- CO₂ contributes to 81% of greenhouse gas emissions

An economy-wide carbon tax on combustion fossil fuels

- Objective:
 - BAU + Carbon tax + Proposed Non-CO₂ regulations: -28%
 - Target 25.8% of CO₂ reduction relative to 2005
- Reference Case: BAU + Proposed Non-CO₂ regulations
- Tax at midstream – industry purchases primary fossil fuels (domestic and foreign)
- Revenue neutral

Overview

Model Description

Investigation Matrix of Policy Designs

		Tax Growth Rate		
		0%	3%	6%
Revenue Recycling	Lump-sum Rebate		– Price Path?	
	Payroll Tax Cut		– Emission Path?	
	Personal Income Tax Cut		– Economic Impact?	
	Corporate Income Tax Cut		– Welfare Cost?	

Delaying Policy Implementation

Sensitivity Analysis

Conclusion

- Modest cost: gross welfare loss of \$34/ton; Annual GDP loss: <0.6%
- Revenue recycling to cut existing distortionary tax reduces cost
- Delaying policy implementation is costly

Model Description

Goulder-Hafstead Energy-Environment-Economy (E3) computable general equilibrium model

Basic Components

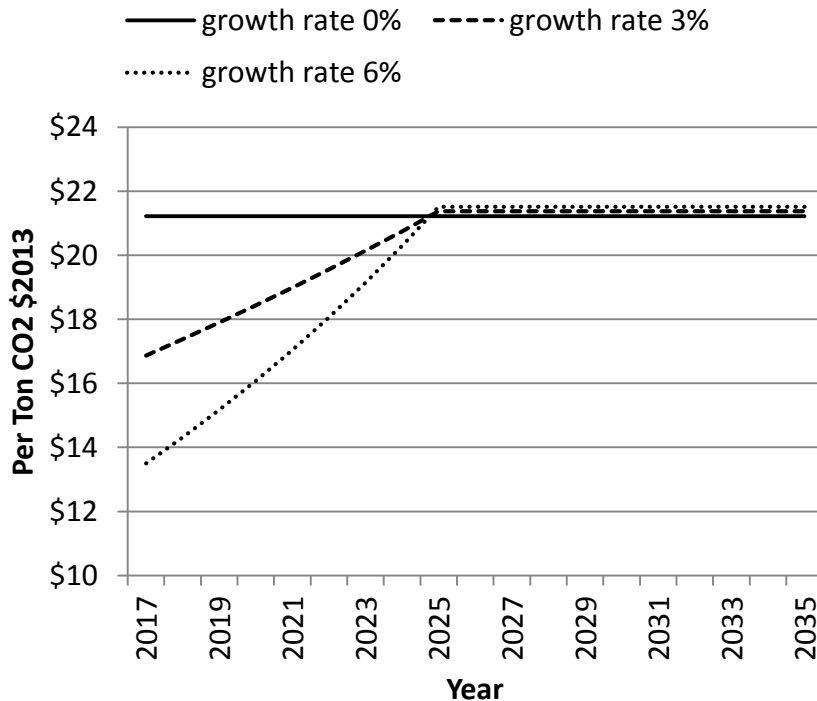
- U.S. economy with international trade
- 35 sectors with detailed representation of domestic energy supply and demand
- Annual market clearance
- Perfect foresight

Special features

- Detailed modeling of U.S. tax system
- Capital adjustment costs
- Unanticipated policy implementation

Price Path

Carbon tax paths, Lump-sum Rebates, by Growth Rate



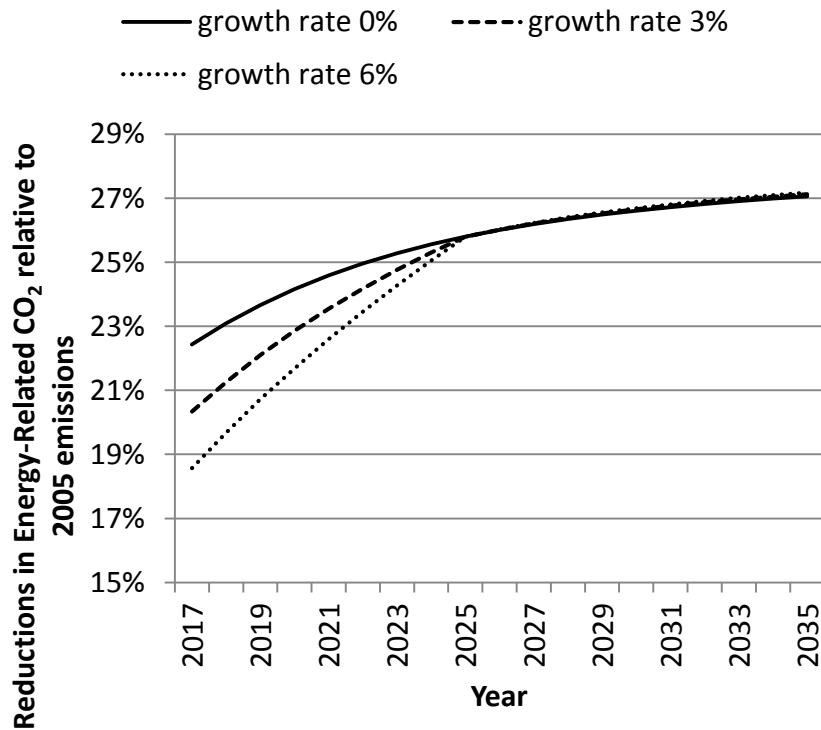
Initial Carbon Tax by Growth Rate and Revenue Recycling Method

	Initial Carbon Price in 2017 (2013\$/ton)		
	Gr 0%	Gr 3%	Gr 6%
Lump-sum Rebate	\$21.22	\$16.87	\$13.50
Payroll Tax Cut	\$21.28	\$16.92	\$13.53
Personal Income Tax Cut	\$21.32	\$16.95	\$13.56
Corporate Income Tax Cut	\$21.95	\$17.43	\$13.94

- Similar tax rate in 2025 and beyond among different growth rates
- Similar price paths among different revenue recycling designs
- For all designs, 2025 tax level: \$21-22

Emission Path

CO₂ emission reduction paths, Lump-sum Rebates, by Growth Rate



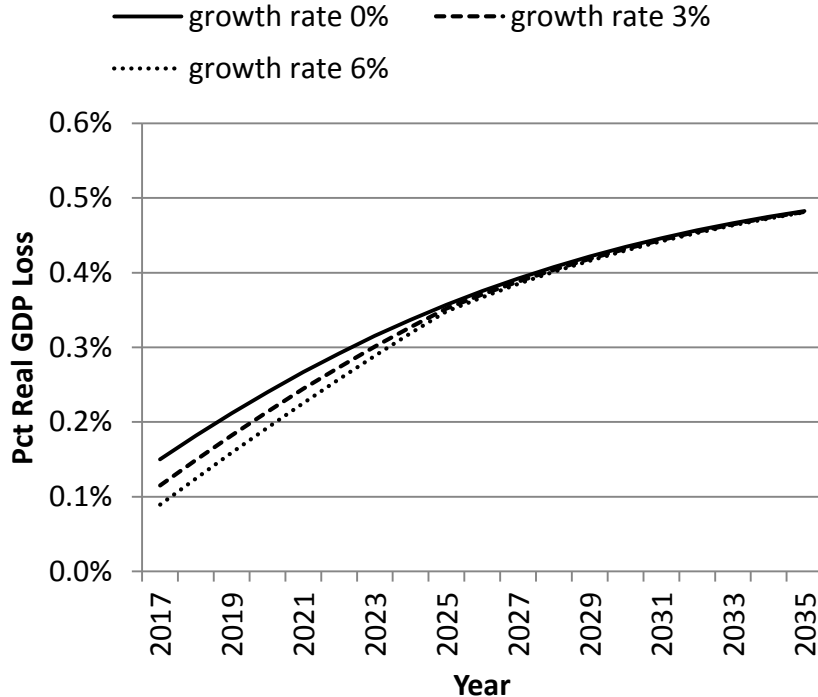
Cumulative emission reduction by Growth Rate and Revenue Recycling Method

	Cumulative Emissions Reduction 2017-2025 (mmt)		
	Gr 0%	Gr 3%	Gr 6%
Lump-sum Rebate	8173	7610	7111
Payroll Tax Cut	8176	7611	7112
Personal Income Tax Cut	8181	7616	7116
Corporate Income Tax Cut	8255	7678	7169

- Increasing emission reduction overtime reflecting capital adjustment
- Similar emission reduction paths across different revenue recycling designs
- Tax rate starting low: less cumulative emission reductions

Economic Impact (GDP)

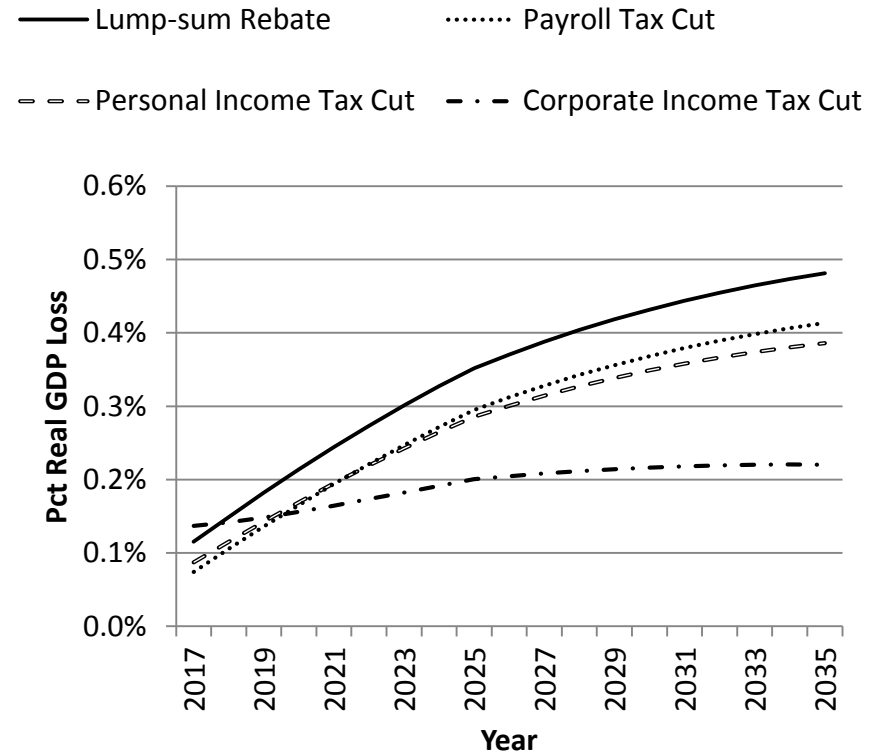
Percentage of real GDP loss (as a percent of reference case GDP), Lump-sum Rebates, by Growth Rate



- GDP loss: <0.4% in 2025; <0.6% annual
- Higher tax rate, higher GDP loss
- Losses continue to grow after 2025 due to impacts from reduced investment in the earlier periods



Percentage of real GDP loss (as a percent of reference case GDP), 3% Tax Growth rate, by Revenue Recycling Method.



- Revenue recycling to cut distortionary taxes reduces GDP losses

Welfare Cost

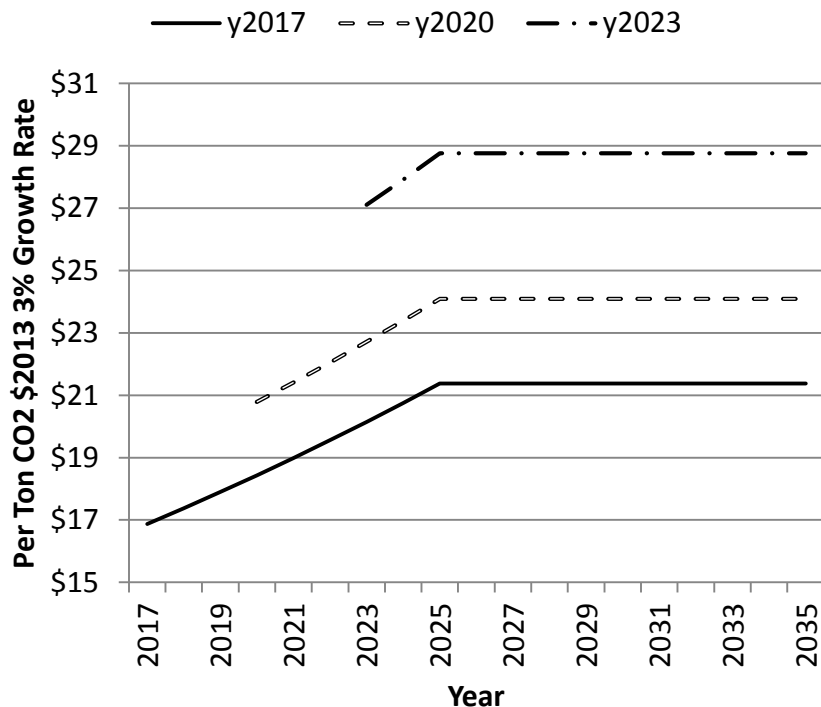
Gross welfare Costs by Growth Rate and Revenue Recycling Method

	Welfare Cost (-EV) Per Ton Reduced (Policy Lifetime)		
	Gr 0%	Gr 3%	Gr 6%
Lump-sum Rebate	\$34.16	\$34.24	\$34.35
Payroll Tax Cut	\$27.51	\$27.67	\$27.85
Personal Income Tax Cut	\$23.65	\$23.85	\$24.07
Corporate Income Tax Cut	\$8.61	\$8.99	\$9.38

- Corporate income tax cut is the most cost-efficient
- Tax growth rate between 2017-2025 has minimum impact on policy lifetime cost
- Gross welfare costs less than benefits or co-benefits of carbon emission reductions

Delaying Policy Implementation

Carbon Tax Paths, Lump-sum Rebates, 3% growth rate, by Implementation Year



Cumulative Emissions Reductions (mmt Energy-Related CO2), and Welfare Cost, Lump-Sum Rebates, by Implementation Year and Growth Rate

	Cumulative Emissions Reduction 2017-2025 (mmt)			Welfare Cost (-EV) Per Ton Reduced (Policy Lifetime)		
	Gr 0%	Gr 3%	Gr 6%	Gr 0%	Gr 3%	Gr 6%
y2017	8173	7610	7111	\$34.16	\$34.24	\$34.35
y2020	5586	5325	5087	\$38.24	\$38.26	\$38.30
y2023	2930	2869	2812	\$43.91	\$43.90	\$43.89

- Higher tax rate
- Higher welfare cost (more stringent policy)
- Less cumulative emission reduction between 2017-2025
- Rather starting cheap than starting late

Sensitivity Analysis

		Initial Carbon Price in 2017 (2013\$/ton)	Cumulative Emission Reduction 2017-2025 (mmt)	EV/Ton over the Policy Life-time
Base Case: Lump-sum Rebate, Constant tax (0% growth rate)		\$21.22	8173	\$34.16
Generator Elasticity	-1	+14%	+7%	+14%
(Base Case = 3)	+1	-9%	-5%	-8%
Elasticity of Labor Supply	-0.2	+0.03%	-0.14%	-21%
(Base Case = 0.3)	+0.2	-0.02%	+0.11%	+19%
Adjustment Cost	-5	-20%	-5%	-10%
(Base Case = 7)	+7	+15%	+5%	+8%

- Generator elasticity: how flexible the power sector is in providing electricity from coal-fired, other fossil and nonfossil generators
- Elasticity of labor supply: how much household changes its labor supply in response to change in real wage
- Adjustment cost: associated with the installation or removal of physical capital

Conclusions

Using a carbon tax policy to meet 2025 Paris Agreement...

Economic costs are modest

- A constant, revenue neutral, economy-wide carbon tax with lump-sum rebate
 - Tax rate: \$21 (in 2013 dollars)
 - Policy lifetime gross welfare cost: \$34/ton (less than benefit or co-benefit of carbon emission reductions)
 - Annual GDP loss: <0.6%

Revenue recycling significantly impacts the cost

- Policy lifetime welfare cost:
 - -19% under payroll tax cut
 - -31% under personal income tax cut
 - -75% under corporate income tax cut
- Similar price and emission paths across different revenue recycling designs

Delaying implementation is costly

- Each year of delay between 2017-2025:
 - +4~5% policy lifetime welfare cost
 - +1000 mmt cumulative CO₂ emission

Thank you!