



# Capping Carbon: A Survey of Carbon Pricing Mechanisms and their Efficacy

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# Motivation

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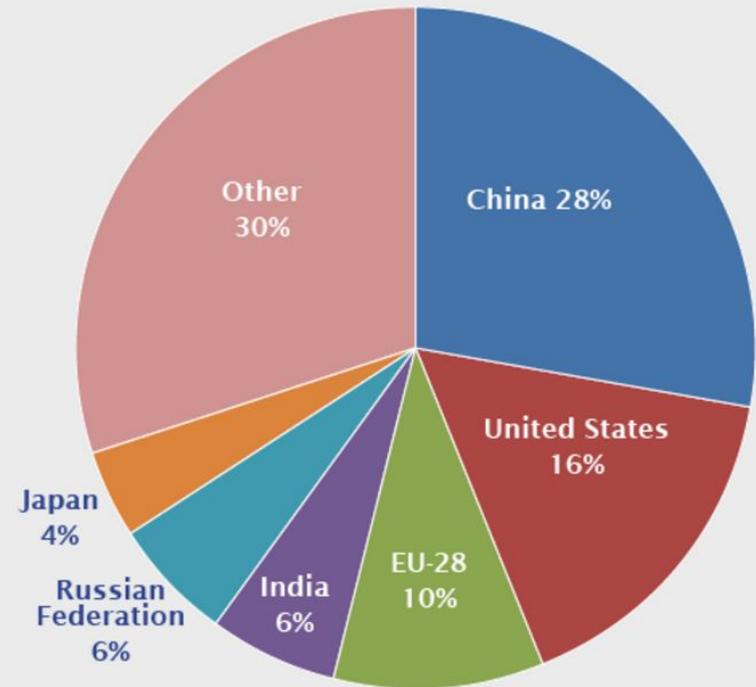
- Became interested in the economics of climate change last year
- Climate change is a real problem with real consequences
- Goal of thesis: tie in the theoretical with the actual (big picture)



# The Carbon Problem

- Anthropogenic climate warming
  - Greenhouse Gases (GHGs)
  - Carbon dioxide
- Disproportionate emissions
- Disproportionate effects
- Uncertainty
- Carbon Dioxide is a negative externality

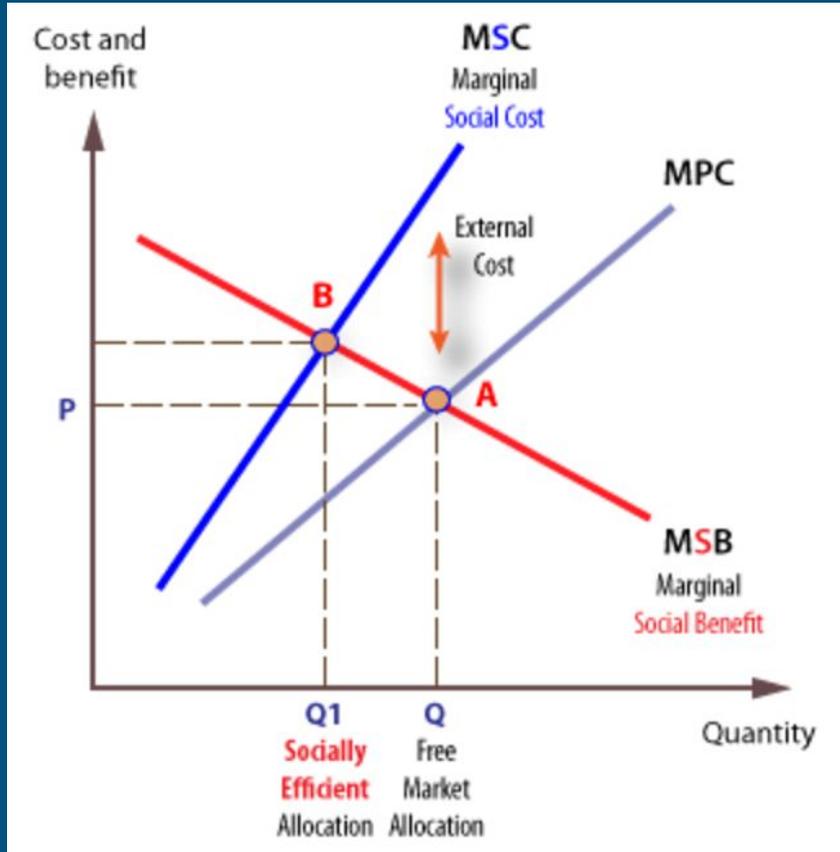
2011 Global CO<sub>2</sub> Emissions from Fossil Fuel Combustion and Some Industrial Processes



“If global warming is the mother of all public goods, it may also be the father of decision making under uncertainty.”

(Nordhaus, 2008)

# Carbon Dioxide is a Negative Externality



## Externality Solutions:

1. Command and control (quantity)
2. Pigouvian Tax (price)
3. Coasian trading (property rights)

# Social Cost of Carbon (SCC) Estimates

Table 2: A Survey of Notable Social Cost of Carbon Estimates

Model	Study	SCC (t/CO <sub>2</sub> )	SCC (t/C)	Discount Rate	Regional Assessment	Assessment of Uncertainty
DICE	Nordhaus (2008)	\$7.40	\$27.16	5.5%	No	Moderate (Premium added to impact of climate change)
RICE	Nordhaus (2011)	\$11.31	\$41.51	5.5%	Yes	Moderate (Premium added to impact of climate change)
FUND	Tol (2011)	\$7.17	\$22.68	5%	Yes	Low (Adaptation parameters)
PAGE	Stern (2006)	\$96.40	\$353.79	1.4%	Yes	High (Adjusted discount rate and premium added to impact of climate change)
DSICE	Cai et al. (2015)	\$34.06	\$125.00	5%	No	High (Represented by a stochastic variable)

# SCC Estimates - The Discount Rate

**Table 1: Distribution of Social Cost of Carbon Estimates for Different Discount Rates**

	<b>Discount Rate</b>		
	<b>0%</b>	<b>1%</b>	<b>3%</b>
<b>Mean</b>	\$40	\$33	\$14
<b>Median</b>	\$32	\$25	\$10
<b>95<sup>th</sup> Percentile</b>	\$133	\$112	\$56

*\*Values are in 1995 dollars per ton of carbon dioxide*

Sources: Tol (2009), Van den Bergh and Botzen (2015)

# Carbon Taxes

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## How a carbon tax works:

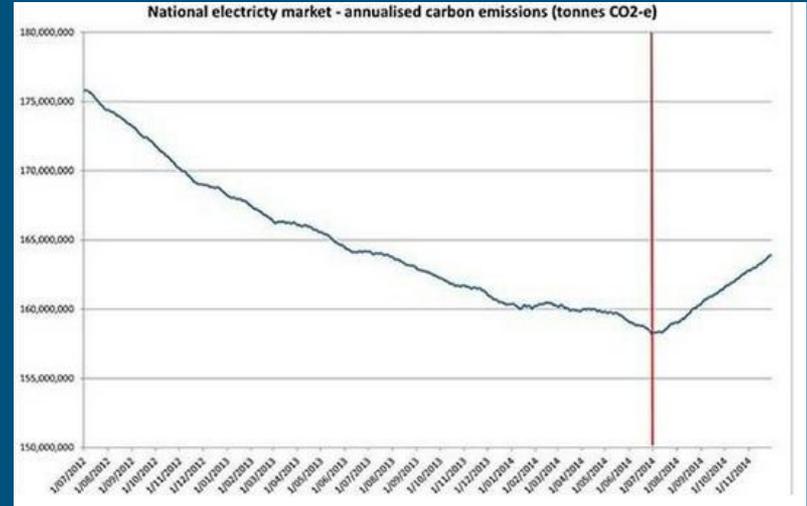
- Direct Pricing
- Advantages
- Disadvantages

## Case Studies:

- Sweden (1991)
- British Columbia (2008)
- Ireland (2010)
- Australia (2012)
- US
  - Boulder, CO (2006)
  - Montgomery County, MD (2010)

# Carbon Tax Conclusions

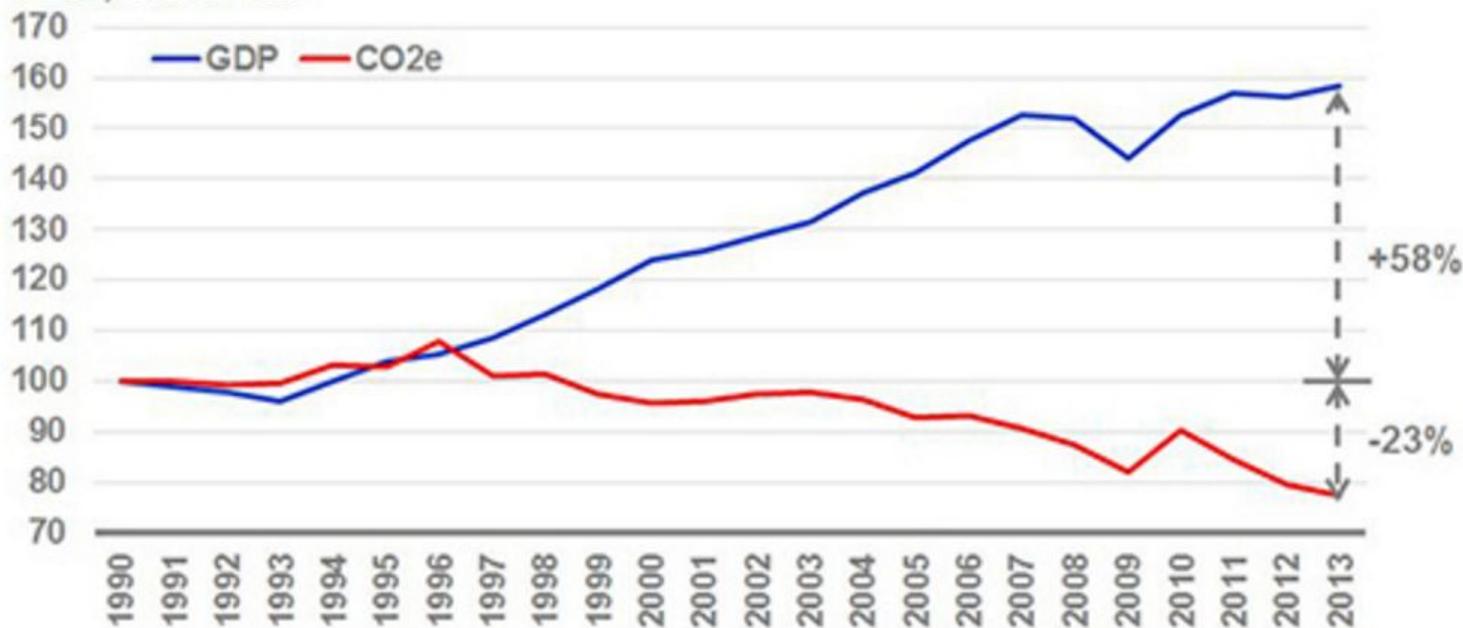
- Two paradoxes:
  - Diversified energy portfolios
  - Environmentally-conscious public
- The fine line between emissions reduction and hurting industries
- Need for constant revision and renewal
- Effects on GDP
- Importance of revenue-neutral policies
  - Ireland's deal
  - British Columbia's low income credits



Australia's Emissions from Power Generation Before and After the Carbon Tax

# Real GDP and CO<sub>2</sub>e Emissions in Sweden, 1990-2013

Real GDP and CO<sub>2</sub>e emissions  
Index, 1990=100



CO<sub>2</sub> = approximately 80%  
of CO<sub>2</sub>e emissions

Sources: Swedish Environmental Protection Agency, Statistics Sweden

# Trading Schemes

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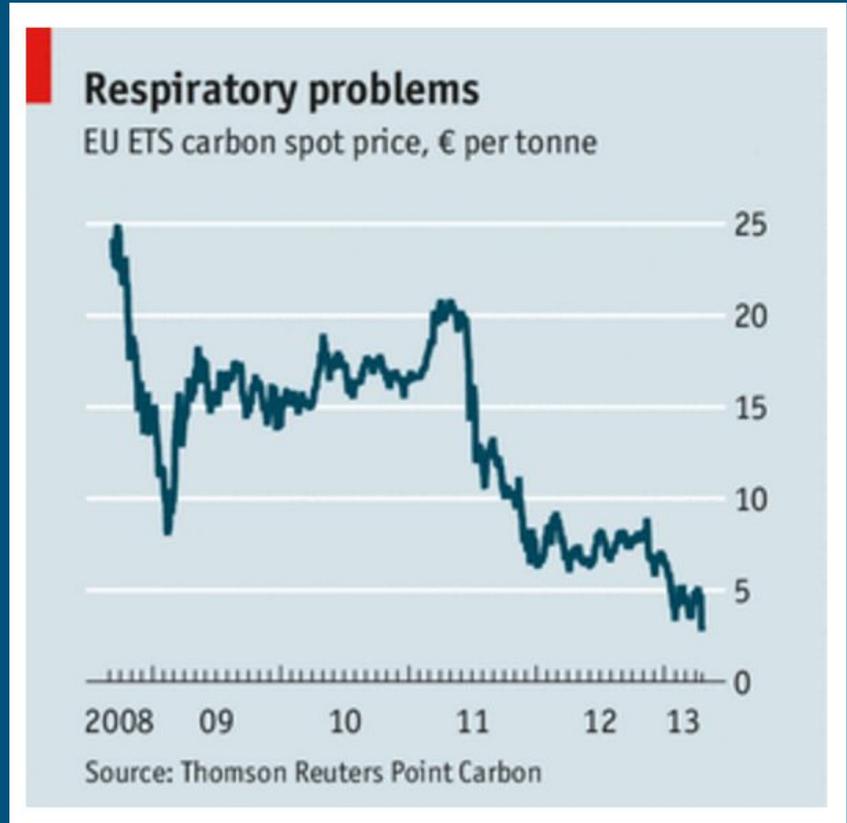
- Cap and trade
- Advantages
  - Carbon market establishes price
  - Emissions cap
  - Can develop into trans-national policy
- Disadvantages
  - Allocate or auction allowances (tradeoff)
  - Offset credits can undermine price
  - Still requires legislative intervention

## Case Studies

- Clean Air Act (1990)
- European Union Emissions Trading Scheme (EU ETS) (2003)
- Regional Greenhouse Gas Initiative (RGGI) (2009)
- Western Climate Initiative (WCI)
- California Trading Scheme (2012)

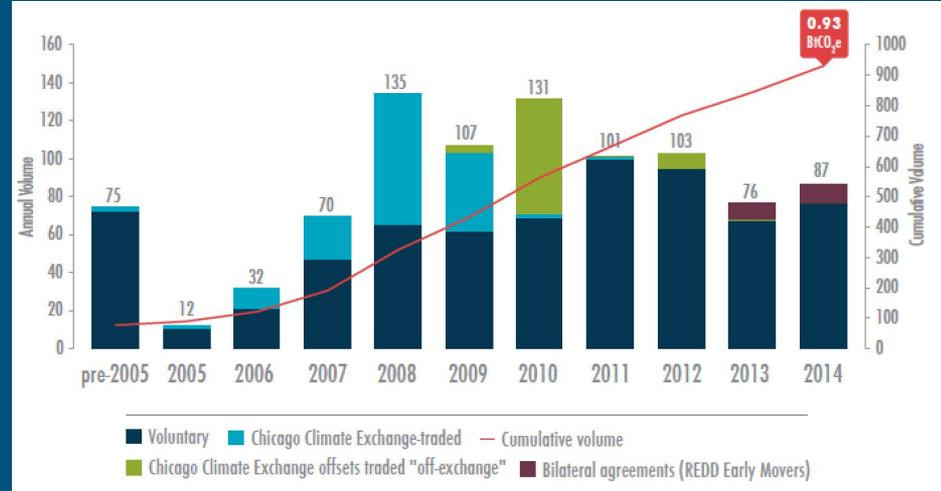
# Trading Scheme Conclusions

- Carbon markets need price stability
- Legislative flexibility
  - Cap adjustment
  - Removing allowances from market
- Limits on carbon offset credits
- Use of price floors
- Is cap-and-trade dead in the US?



# Voluntary Markets

- Carbon offsetting
- Defining the Voluntary Market
  - Buyers
  - Sellers
- Offset Prices
  - Cost of projects, not SCC
  - More resistant to economic shocks
  - Dependent on policy development
- Market trends
- Environmental Impact



# Analysis and Conclusions

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- Carbon pricing is “learning by doing”
- Mandate Markets vs. Voluntary Markets
  - Efficiency
  - Environmental impact
- Tax or Trade
- Carbon Pricing in the United States
- An International Solution
  - Implementation issues
  - Enforcement
- Areas for Further Research

