

Market Stability Reserves, Price Controls, and Other Options to Stabilize EU-ETS Prices

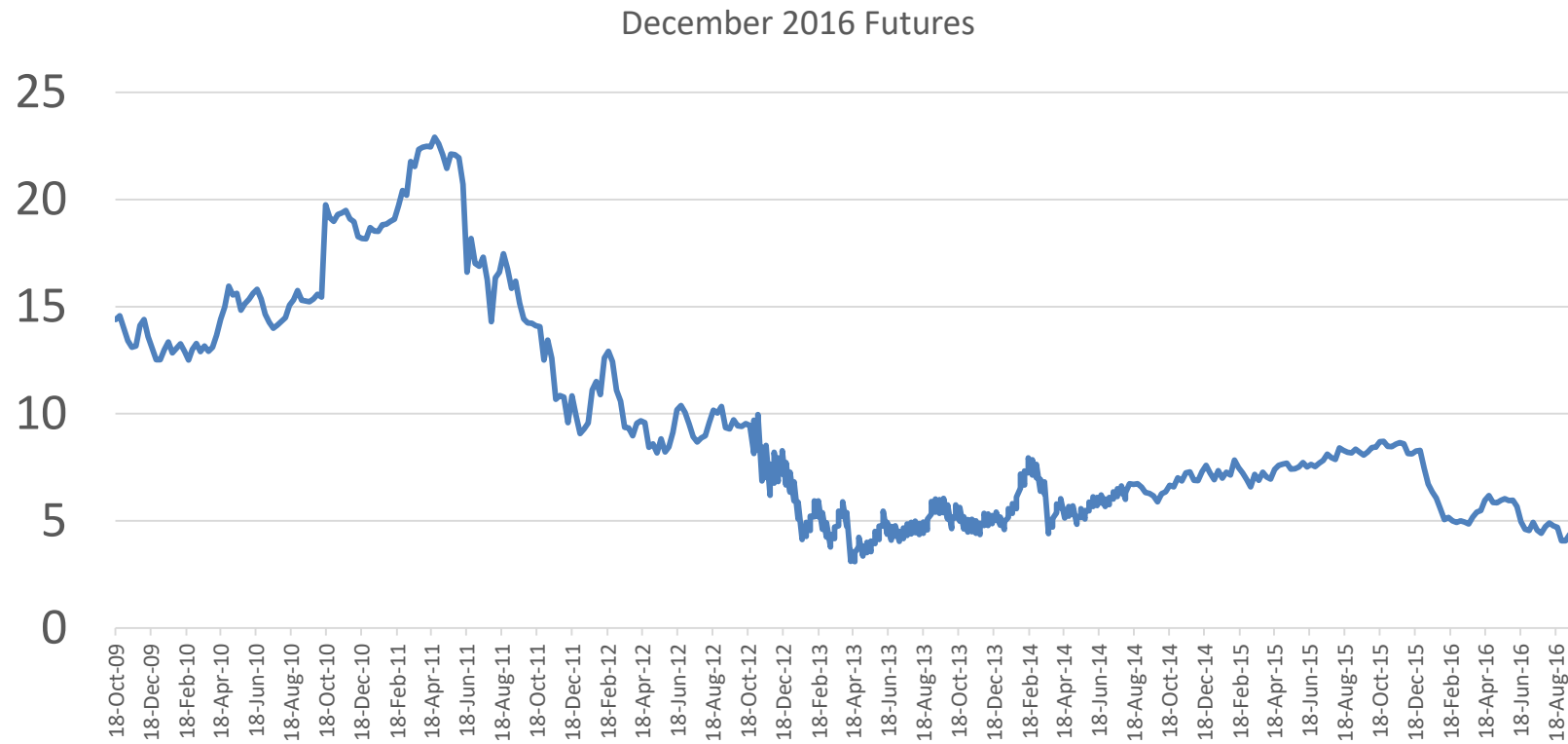
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EU-ETS Credit Prices



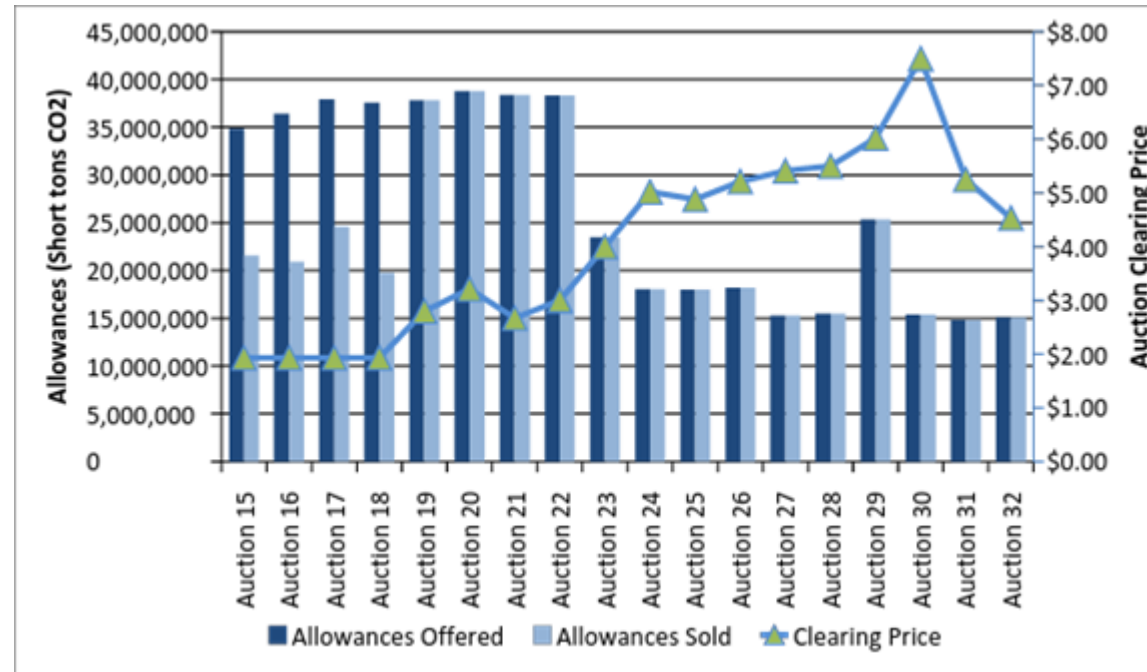
- EUA Prices have been volatile, and now settled around 5€/tCO2 range

EU-ETS Credit Prices

- “EU ETS has suffered from a large amount of excess emissions allowances largely caused by weak emission reduction targets and the inflow of carbon offsets. This has resulted in a carbon price that is too low to promote low-carbon solutions” Carbon Market Watch, July 2014
- “...at around €7 a tonne, carbon prices are far too low to influence industry behaviour and drive significant emissions cuts.” The Gaurdian, February 2015.
- “...companies receive or buy permits to emit a ton of CO₂, with the goal of prompting them to steeply reduce emissions. But, wildly gyrating prices undercut that rationale.” Politico, Jan. 2016.

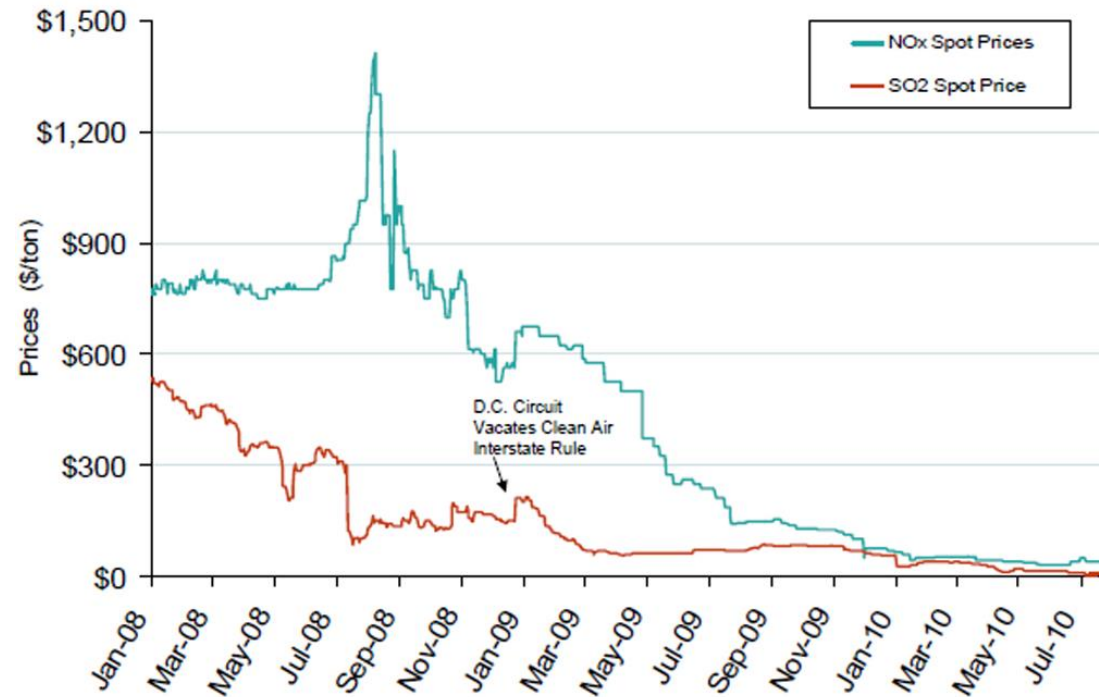
Price Volatility in Other Markets

- The EU-ETS is not alone in its price volatility and/or generally low prices
- The Regional Greenhouse Gas Initiative (RGGI) in the U.S. has hovered near its price floor since beginning in 2009



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- The SO₂ and NO_x trading programs in U.S. have seen both massive price spikes and price crashes



Policy Response

- Policy makers have considered and implemented many different policies to deal with permit over-allocation and price volatility more generally
 - Permit Price Collars (RGGI, CA's cap-and-trade, proposed U.S. federal climate policies)
 - Adjusting the value of banked permits (RGGI, US SO₂ trading program)
 - Adjusting caps in later years (RGGI, discussed for EU-ETS)
 - Market Stability Reserves (discussed for EU-ETS)
- I develop a dynamic-stochastic model, parameterized to the EU-ETS, to analyze the relative efficiencies of each of these policies

Model – Individual Firm's Problem

- Define abatement, $a_{it} = \bar{q}_{it} + \theta_t - q_{it}$
 - $\bar{q}_{it} \rightarrow$ business-as-usual (BAU) emissions
 - $\theta_t \rightarrow$ shock to BAU emissions with $\theta_t = \rho\theta_{t-1} + \epsilon_t$
 - $q_{it} \rightarrow$ chosen emissions level in period t
- $C(a_{it})$ is cost of abatement with $\frac{\partial C}{\partial a_{it}} = -\frac{\partial C}{\partial q_{it}} =: -C_{it}^q > 0$
- Firm buys x_{it} permits in auction at price p_t
- Firm can “overcomply” by banking permits: $B_{it+1} = B_{i,t} + x_{it} - q_{it}$
- Firm chooses emissions to:

$$\min_{q_{it}, x_{it}} \sum_{t=0}^T \beta^t E_t [C_{it}(\bar{q}_{it} + \theta_t - q_{it}) + p_t x_{it}]$$

$$s.t. B_{it+1} = B_{it} + x_{it} - q_{it} \text{ and } B_{it} \geq B_{min} \forall t$$

Model – Individual Firm's Problem

- Minimization leads to:
 1. $-C_{it}^q = \beta E_t[-C_{it+1}^q + \lambda_{it}] \rightarrow$ firm equates expected discounted marg. abatement cost across time periods (corrected for min bank constraint)
 2. $\frac{E_t[p_{t+1}] - p_t}{p_t} = r - \frac{\lambda_{it}}{p_t} \rightarrow$ permit prices rise at discount rate in expectation, unless min bank constraint binding.
- These conditions are used in the numeric simulations to derive equilibrium emissions paths

Policy Scenarios

- All policies to stabilize permit prices can be thought of as altering the allocation of permits in each period
 - Note also $\sum_i x_{it} = y_t$, where y_t is t^{th} period allocation
- 1. Market Stability Reserve: $y_{t+1} = y_{t+1}^s - D_t^U \gamma B_t + D_t^L y^L$
 - y_{t+1}^s - stated allocation of permits in period $t + 1$
 - D_t^U - indicator variable equal to 1 if aggregate bank $B_t \geq B^U$ and $\gamma > 0$
 - D_t^L - indicator variable equal to 1 if $B_t \leq B^L$ and y^L is pre-determined addition to $t + 1$ allocation if $D^L = 1$

Policy Scenarios

2. Permit Price Collar: $y_t = y_t^s + D_t^C y_t^C - D_t^F y_t^F$
- D_t^C - indicator variable equal to one if p_t would be above p_t^C in absence of the collar and y_t^C is permits added to maintain the price ceiling
 - Note y_t^C may not be big enough to keep $p_t = p_t^C$
 - D_t^F - indicator variable equal to one if p_t would drop below p_t^F in absence of permit reductions and y_t^F is number of permits removed from allocation to keep prices at p_t^F
3. Permit Reduction Policies: $y_t = s_t y_t^s$
- $0 \leq s_t \leq 1$
 - s_t modeled such that it either reduces stated allocation by constant amount each period or it vacates final few period's allocations

Numeric Simulation

- Use a representative firm numeric simulation to examine each policy scenario
- Model uses individual firm cost minimization results to determine emissions each period (i.e. firms emit to equalize discounted expected MAC's across period)
- Model is parameterized to EU-ETS
 - Use EU-ETS stated allocation from 2014-2050 including “backloading” plan
 - BAU emissions and MAC's come from a CGE model
 - MSR policy designed to meet proposal of EC ($B^U = 0.833, \gamma = 0.12, B^L = 0.4, y_t^L = 0.1y_t^S$)
 - Remaining policies designed to give same *expected emissions* as MSR

Scenario Comparisons

Scenario comparison.

Policy	Emissions	NPV Costs
Basic	58.89 [58.95, 58.95]	478.38 [79.51, 1387.55]
Reduction – Const.	44.22 [44.22, 44.22]	1096.06 [296.97, 2566.18]
Reduction – End	44.22 [44.22, 44.22]	1084.90 [292.31, 2667.35]

Notes: Emissions are in billions of mtCO₂ and NPV Costs are in billions of €.

- Price collars result in lower expected NPV of costs than MSR
- Permit reduction policies are more costly in expectation, but give guaranteed emissions reductions

Scenario Comparisons

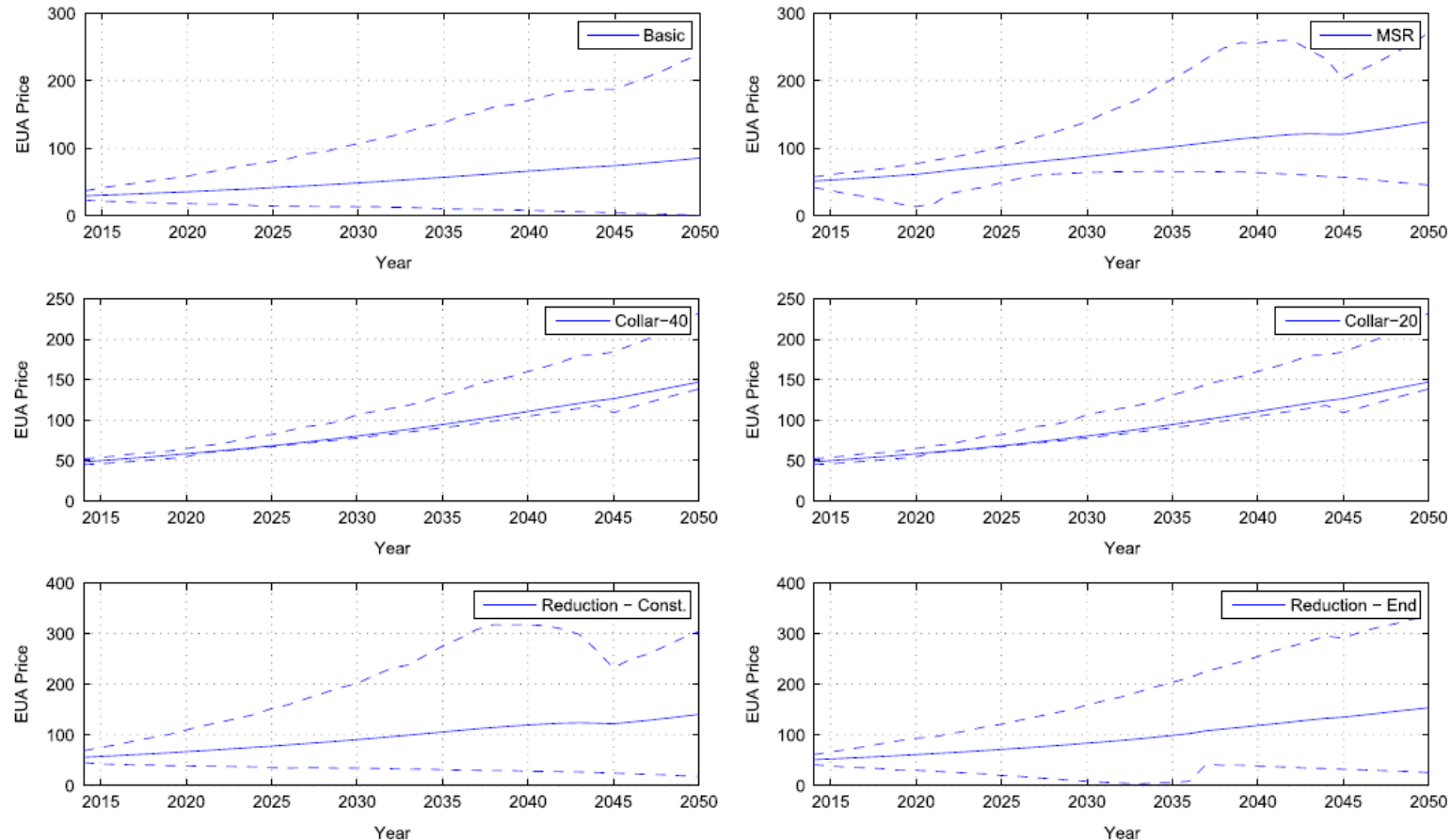
Scenario comparison.

Policy	Emissions	NPV Costs
Basic	58.89 [58.95, 58.95]	478.38 [79.51, 1387.55]
MSR	44.22 [32.44, 54.61]	998.11 [535.80, 1884.87]
Collar-40	44.22 [24.25, 58.45]	936.09 [846.99, 1402.69]
Collar-20	44.22 [24.15, 59.04]	934.83 [851.10, 1352.64]

Notes: Emissions are in billions of mtCO₂ and NPV Costs are in billions of €.

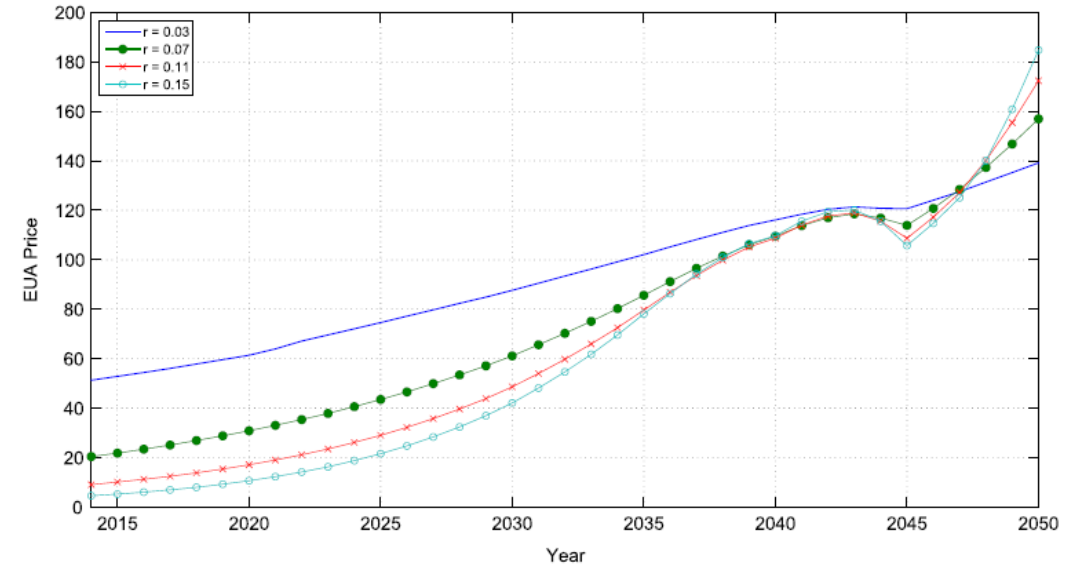
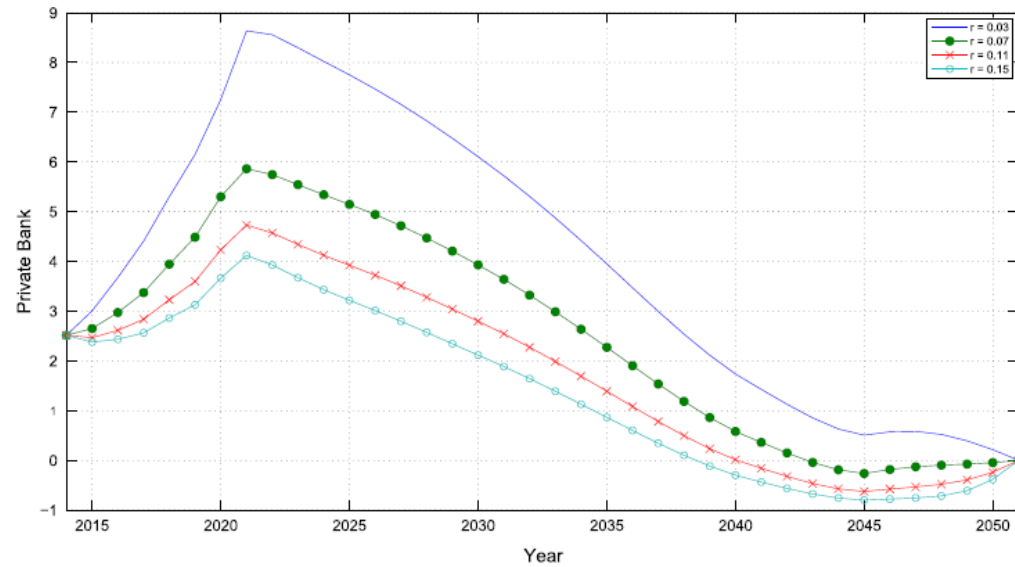
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Scenario Comparisons



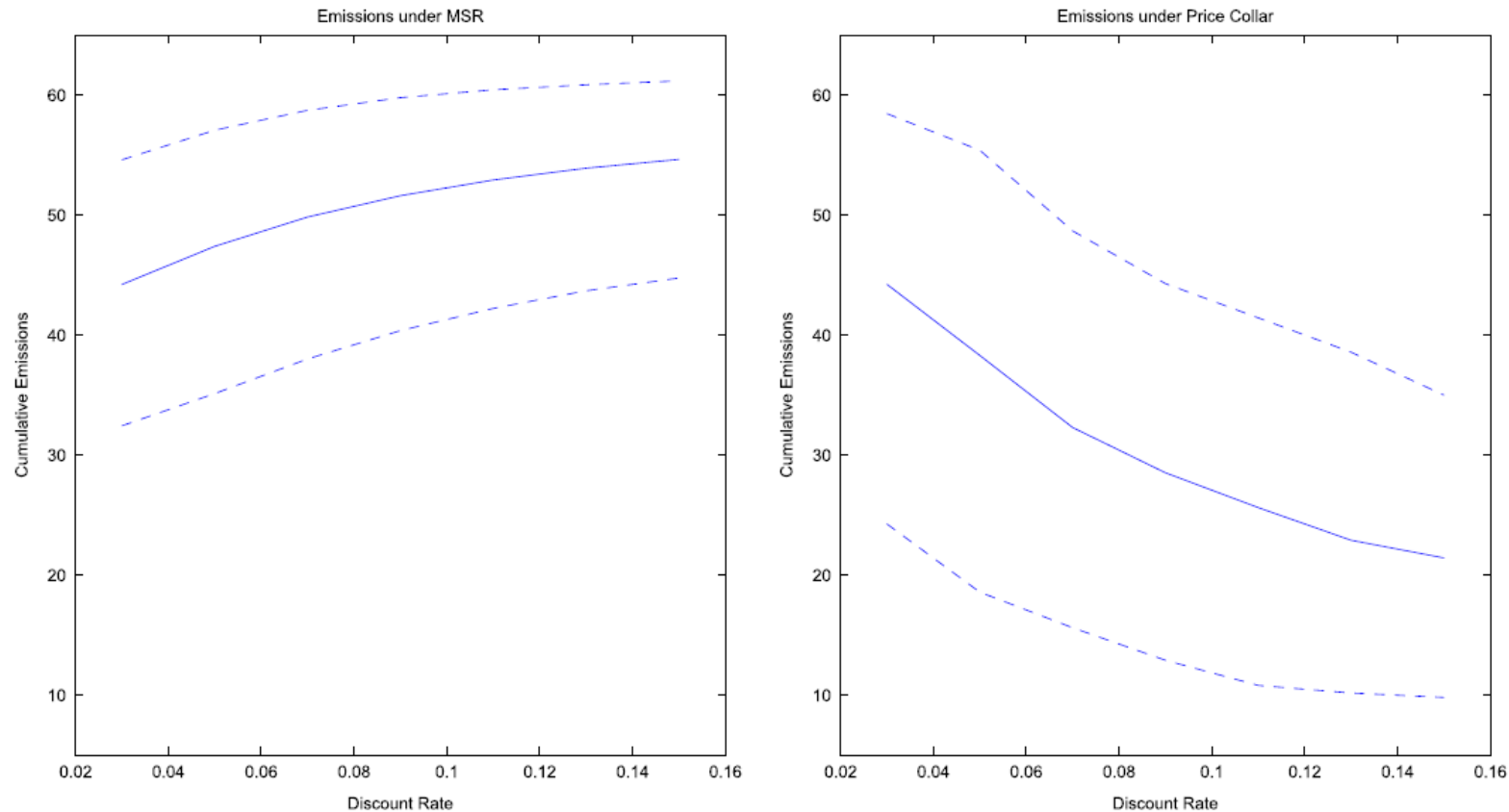
- MSR does better at protecting against low price outcomes than permit reduction policies, but price collar reduces price variance even more

Scenario Comparison



- Because the MSR adjust allocations based on the cumulative bank level, it is very sensitive to discount rates applied

Scenario Comparison



- As the discount rate applied increases, the MSR becomes less effective in terms of removing permits
- Opposite true for a given price collar

Conclusion

- Stability in cap-and-trade systems has been and continues to be an area of concern for policy makers
 - In particular, the perceived problem of over-allocation has appeared to be more problematic for existing cap-and-trade programs than extreme high-cost outcomes.
- I analyze several policies (MSR, Price Collars, Direct Permit Reduction) aimed at stabilizing prices and/or avoiding permit over-allocation
- Simulation results indicate:
 1. Collar can be designed to achieve same expected emission reductions at lower expected cost and price variance than other policies considered
 2. MSR policy is sensitive to discount rate applied
 3. Design elements of MSR can also greatly impact its ability to stabilize prices and protect against “over-allocation”.